THE SOUL OF ALL SCENERY

A History of the Sky in Art

STANLEY DAVID GEDZELMAN

For centuries, painters recognized that the sky is, as Thomas Cole once wrote, '*The Soul of All Scenery*', and have painted it accordingly. *The Soul of All Scenery* is a cultural and natural history of artistic discovery of the atmosphere's many faces - its colors, optical phenomena, clouds, signs of changing weather, and marks of climate. It intertwines the art and the science of the beauty of nature as revealed in and glorified by the sky.

Stanley David Gedzelman served as a widely published Professor of Atmospheric Science at the City College of New York (CCNY) for 42 years prior to retirement in 2012. His research specialties include atmospheric optics, clouds, and the aesthetic links between art and science.

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A History of the Sky in Art

Stanley David Gedzelman

Professor Emeritus of Atmospheric Sciences
City College of New York

To my wife, Bernice

Loving companion of so many years.

and

To my son, Evan and daughter, Elise

Joys of my life

May their children surpass them as they have surpassed me.

Stanley David Gedzelman Books

5585 Munsel Lane, Apt 204
Boynton Beach, FL 33437
and
55 West 5th Avenue, Apt 15D
San Mateo, CA 94402

Email: stanleydavidgedzelman@gmail.com

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Table of Contents

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Preface

For centuries, painters have recognized that the sky is, as Thomas Cole once wrote, `the soul of all scenery', and have painted it accordingly. Go to the art museums and observe carefully how much space and effort the great artists have devoted to the sky. Worlds you may never have noticed will open up before your eyes. Behind the Mona Lisa's elusive smile is a misty canopy of air that Leonardo painted deliberately after years of observation and research to magnify the distant mountains and impart an aura of grandeur and mystery.

Aside from the attentions of the great artists and a scattering of naturalists, the atmosphere has been one of humankind's most persistent collective blind spots. As a result, pitifully little has been written on all the artists' aerial triumphs. One remarkable exception was John Ruskin's pioneering study, Modern Painters, which first appeared in 1843 and included large sections devoted to meteorological aspects of art. A century of almost absolute silence followed, during which the subject was buried under a vast wasteland of vacuous adjectives containing little more substance than a few conventionally obligatory references to the phenomenon Leonardo named aerial perspective.

The study of the sky in art also remained moribund for reasons that stem from the century-old forced separation of art and science into two cultures. Our blind acceptance of the cult that artistic creativity exists in a vacuum of emotive genius has brought us to the point that when we see clouds in paintings we refuse to believe that the artist may have intended simply to paint clouds. Art historians retreat to the shade of clouds' symbolic meanings and iconographic content, all the time remaining ignorant of the nature of clouds and simultaneously demeaning naturalistic interpretations as pedestrian at best. Meteorologists pass by the painted clouds involuntarily, never daring to risk exposure as uncultured boors by applying their expertise to what they have been warned may be no more than irrelevant phantasms.

Over the past half-century a few nonconforming meteorologists and art historians have begun to redraw attention to the meteorological content of art. I conceived and wrote *The Soul of all Scenery* in the environment of growing knowledge and acceptance provided by their studies. They helped me see paintings with the dual view of the meteorologist's focus on natural source material and the art historian's emphasis on cultural sources, and thereby expose the enduring tryst of science and art.

The Soul of All Scenery is a cultural and natural history of artistic discovery of the atmosphere's many faces - its colors, optical phenomena, clouds, signs of changing weather, and marks of climate. Painted and real skies are compared and analyzed with a scientific perspective that has, in many cases, become available only during the past century. Thus, for example, I demonstrate that the seventeenth century Dutch painters disclosed piece by piece a picture of the clouds and weather around winter storms, a picture not synthesized until the decades following World War I!

I also show how artists have treated the atmosphere as the soul of their scenery. The ever changing, cloud laced skies of Holland gave her sky painters more than adequate cause to pursue the fleeting rays of light on their mostly shaded land and seek the essence of motion and change. In China, a land where haze, mist or dust often bleach the sky to near white and blur all distant landscape features, centuries of painters left the sky blank and stressed the atmosphere's obscuring powers. Italy's far more limpid air helped nurture the high atmospheric visibility of her Renaissance paintings.

The prevailing climate is only one determining factor in the artists' choice of atmospheric setting. In every age, painters have, perhaps unwittingly, also used the sky as a mirror to our souls and a signpost of the times. The high visibility and small, well-chiseled clouds of the early Renaissance, an expansive age of discovery, gave way without any commensurate climate change to darkened and obscured stormy skies with wondrous optical phenomena in the more turbulent and pessimistic sixteenth century.

Because the sky is a reflection of the souls and times of the artists, it poses a severe litmus test for would-be imposters. In 1848, a group of British painters formed the Pre-Raphaelite Brotherhood. Their avowed intent was to restore to art the clarity of vision and presumed idealism of the fifteenth century, but their clouds and occasional rainbows betrayed non-Renaissance origins.

I began work on The Soul of All Scenery in the spring of 1978 while writing an introductory textbook in meteorology called The Science and Wonders of the Atmosphere. To research its brief section on meteorology in art and learn how the great artists painted the sky, I visited the Metropolitan Museum of Art. That day I found a new love. At first I judged my love harshly with the parochial eye of a textbook meteorologist, looking for distinct, classical cloud forms. Gradually, it dawned on me that the artists, with their heightened visual sensitivities, sometimes had a deep feeling for aerial viewpoints I was unaware of. Patiently, they taught me to be a better observer of the sky and of beauty in general.

I have derived immense pleasure from researching and writing *The Soul of All Scenery*. It has given me an opportunity to meet and learn from some of the most remarkable human beings that ever lived. I am both humbled and exalted by my encounter with genius and profound accomplishment.

22 January 1993

CHAPTER 1
BEFORE THE SKY: THE EPIC VACUUM

Art, like the Earth, was born without an atmosphere. Five billion years ago, the Solar System did not exist. Nearby space contained only a giant, slowly rotating nebula composed of dust and gases, remnants of an ancient supernova. There were no planets and there was no Sun. Then, about 4.6 billion years ago something disturbed the equilibrium of this nebula and it began to contract. The Sun grew as a ball in the center but a small amount of excess matter revolved too rapidly to be drawn inward and flattened into a swirling disk where the planets eventually coalesced.

The Earth formed airless within this disk by the silent collisions and aggregation of rocks and dust that circled the infant Sun. The larger the Earth grew, the more strongly its gravitational field attracted nearby meteors and, in geologic terms (100 million years), nearby space was soon swept clean. The continuous bombardment had heated the Earth so intensely that it melted the scarred surface.

Heat generated in the young Earth helped create the atmosphere and oceans. A noxious mixture of gases imported by meteors, asteroids, and comets that included water vapor but not oxygen were released on impact or expelled from the depths of the Earth, as they are from volcanic eruptions today. The present atmosphere, which consists almost entirely of free oxygen and nitrogen and a small, variable amount of water vapor, took eons to evolve.

As Earth cooled, the vapor condensed to form a canopy of great clouds, and rained down upon the bare ground. Salts in the rocks dissolved in this water as it cascaded downhill to form the oceans. By 4 billion years ago the Earth had an appreciable atmosphere and ocean. Life began somewhere in the seas over 3.5 billion years ago. Still, it would take more than another 3 billion years for photosynthesis to produce enough oxygen to support its artists.

Animals first emerged from the sea and crawled on the land about 530 million years. Humans have walked the face of the Earth less than 1% of that time. And it is only about 40,000 years ago - the last 1% of the human episode - that we began to deliberately create works of art. Then, a little more than 2000 years ago, sky painting was added as a belated afterthought to the artists' repertoire.

Not surprisingly, the earliest painted skies were blue. Prior to that we must infer the appearance of the sky and the workings of the atmosphere from occasional writings or more indirect evidence.

There is good reason to believe that by the time life appeared on Earth, the sky had already turned blue and the clouds looked like the ones we see today. The early continents, propelled by the slowly churning molten interior of the Earth, drifted across the globe as they still do, albeit somewhat faster, and experienced similar excursions of climate.

Only silent witnesses testify to these past events. But the climate, the weather, and even the clouds have left their signature upon the Earth and in our souls. Where an early glacier surged and then wasted, a large rubble heap of rocks and soil called a moraine was left behind to mark its terminus. Where raindrops impacted on the surface to leave little craters or pits in the sand that later hardened into rock, we see the fossilized footprints of ancient cloudbursts. And even in our early art, where the sky was almost always summarily excluded, there is a record of the atmospheric environment our ancestors experienced.

1.1 Prehistoric Art: Up from the Ice Age

Art is a child of the climate. It was born during the winter of the last Ice Age and blossomed as the world began to thaw. We, Homo sapiens, are its other parent, for many earlier Ice Ages had come and gone in the past million years without leaving any such legacy. Our 'modern' ancestors followed the abundant game to the brink of the ice. The severity of the climate may have prodded their increased capacity for ingenuity. But art, no matter what its function or purpose, is a luxury, so it was the occasional respites from the normally harsh climate that afforded sufficient leisure and surplus to create masterpieces.

The earliest known remains of art are found in caves from Spain to Austria.[1] Some of the finger scratch marks in the clay and painted handprints date back to about 40,000 BP (years Before Present). The oldest known animal paintings, found in the Chauvet Cave in the Ardeche Valley of Southeast France date back 31,000 years. Carved 'Venuses' (usually faceless) and a few etchings of animals (the Lion-Man) are as much as 40,000 years old. The oldest known convincing human portrait, found at Dolni Vestonice, just east of Vienna, was carved from ivory 30,000 years old. Realism in sculptures may have been achieved earlier than in paintings because paintings require the additional intellectual hurdle of transforming three dimensions into two.

Technology also played its role in locating and preserving the paintings. The deep interiors of the caves, where most of the murals are found, were neither visited nor painted until adequate lighting was provided by torches or the more reliable, spoon-shaped lamps invented at least 25,000 BP.

The great cave murals were executed from the peak of the last Ice Age through the period when the ice sheets were most rapidly melting about 10,000 BP. After that, the proper environment for the creation or preservation of such exquisite works apparently no longer existed. The caves were abandoned and their entrances were sealed by landslides, deposits or roof collapses, or, as in the case of the Cosquer Cave near Marseilles, by rising sea level. The memory of cave painting was obliterated for some 10,000 years but the murals were simultaneously protected from vandalism and atmospheric corrosion.

The secrets of these caves were first revealed in the 19th century. In 1863, a French paleontologist came upon a reindeer figurine in a cave in the Dordogne region of southwestern France. The next year he found an engraving of a mammoth in another nearby cave. At first, he and others discounted the possibility the works were ancient, but the discovery of hundreds of prehistoric artifacts convinced people of our long heritage. Many of these artifacts were displayed at the Paris Exposition of 1878.

Marcelino de Sautuolo was one of the tourists at the Paris Exposition. The next year he began to open a recently discovered cave on his property at Altamira in northern Spain. His five-year old daughter playing within the cave spotted painted bison on the low ceiling and excitedly cried out "Papa, look at the painted bulls!". De Sautuolo was certain the works were genuine pieces of an ancient art because they resembled some of the carvings he had seen at the Paris Exposition, and because he knew that Altamira had not been previously explored.

De Sautuolo's claim was greeted with a sense of incredulity that quickly escalated to public ridicule. Professional archaeologists at the 1880 Congress of Anthropology and Prehistoric Archaeology held in Lisbon summarily dismissed the paintings as forgeries. However, many more caves were reopened over the next few decades, so that the case for the prehistoric origin of much cave art became indisputable. Our ancestors had to be accorded new respect.

The vast preponderance of prehistoric art

[1] Monumental discoveries about our ancestors will continue unabated. Hand stencils dating to 52,000 BP and a painting of a bantang bull dated to 40,000 BP were found in Lubang Jeriji Saléh cave of Borneo. An even older painted panel of animals and theriantropes (hybrid animal-humans) coated by limestone dated to 43,900 BP was discovered in the Leang Bulu’ Sipong Cave on Sulawesi, Indonesia 2017 and dated in 2019.

dwells on animals. The animals were often portrayed in etching, painting, or sculpture with a remarkable fidelity to nature. At the climax of this art, shading was used and the rock surface for a painting might be chosen so that its relief would add to the illusion of depth. The artists strove to depict the animals as realistically as possible and used all the means at their disposal to achieve this end.

All other aspects of the cave murals are primitive by comparison. With few exceptions, including the ivory carving at Dolni Vestonice and some etched portraits at La Marche, the human figure remained undeveloped, anonymous and even faceless, acquiring individuality only when disguised with an animal mask. If narrative was present in the paintings, it was simple and generally confined to some interaction between hunter and hunted. Typically this was indicated by an injured or dismembered animal or human.

The landscape and weather were also neglected in Ice Age art. The few examples of painted objects from the landscape were rudimentary at best, and arranged haphazardly. Ice Age people were deeply concerned about their surroundings and about the weather but it apparently never occurred to them to express that concern overtly in art. There is not a single painting in which the sky appears.

Despite these thematic limitations, the cave murals have always been seen as climatological documents. The animals - mammoths and wooly rhinoceroses, among others - were recognized as Ice Age creatures adapted to enduring severe winter conditions.

However, there is a work that does contain another sign of the climate conditions of the waning Ice Age. This is the so-called *Swimming Stags* (Fig. 1-1), a mural in the cave of Lascaux..

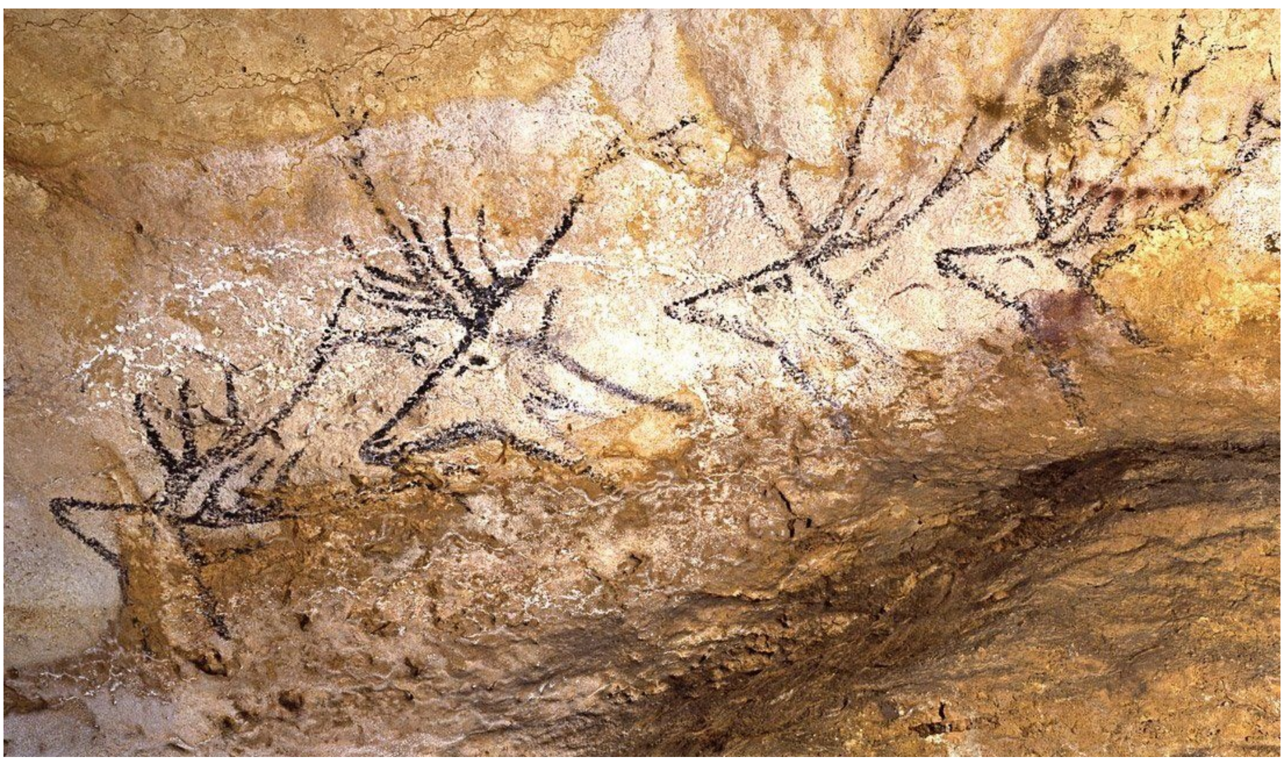


Fig. 1-1 *The Swimming Stags* c. 17,500 BP. Cave of Lascaux.

Lascaux is situated in southwestern France, about 85 miles east of Bordeaux along the slopes of the valley of the Vezere River. The present climate around Lascaux is temperate. In most years, summers are pleasant while winters are cloudy but mild. Snow is unusual near sea level. But at the depth of the Ice Age, some 26,000 to 20,000 BP, the climate was bitter. The Gulf Stream was shunted far south of its present track across the Atlantic and left the Bay of Biscay frigid. Temperatures averaged almost 10ºC below present values, so that southwestern France had a climate like Lapland has today.

The harsh climate restricted forest to fragmented stands of cold-resistant trees such as birch and spruce. The region was then at the northern fringe of the boreal forest and bordered on the tundra where large herds of grazing animals could be supported. It was this abundant food supply that kept people from visiting sunnier climes. Ironically, once the post Ice Age warming had progressed sufficiently, closed forest reclaimed the land. The large herds then emigrated and the hunters, in pursuit, abandoned the caves.

For millennia a layer of soil sealed the entrance to Lascaux. Then, late in the 19th century disease destroyed a vineyard located right over the cave. A pine forest quickly reclaimed the land. A small opening to the cave was exposed around 1920 when a large tree was uprooted and ripped off the soil layer covering the entrance. Still, another 20 years passed before anyone ventured into the opening. On 8 September 1940, a group of four teenage boys followed their dog into the cave. They discovered the paintings almost immediately and, within a few days, penetrated to Lascaux's deepest recesses. The boys realized the significance of their find and brought their teacher, who helped spread the news.

Lascaux proved to be a miraculous find. The recesses of the cave were occupied for less than 500 years, around 17,500 BP. The short occupancy minimized the amount of overpainting and resulted in a high degree of stylistic uniformity. Curiously, a census of the painted animals reveals no mammoths in Lascaux, which suggests that the cave was occupied during a period of warmer conditions than prevailed for most of the Ice Age. Traces of pollen brought into the cave by the artists confirm this picture, showing that trees characteristic of warmer conditions had taken root nearby. It appears that at the time the paintings were executed, Lascaux was basking in interstadial conditions. Winter may still have been cold but the summers then were almost as warm as at present. The respite lasted roughly 500 years, after which frigid conditions (and mammoths) returned, and the cave was abandoned.

The climatic warming not only brought painters into the depths of Lascaux, it provided a theme for the *Swimming Stags*. This frieze consists of a procession of five stags apparently crossing a river. All are portrayed from the neck up, emerging from what looks like a water line but is really nothing more than a fortuitous line of color change in the rock that the artist used to advantage to create a feeling of an environment.

The description of the scene offered by Mario Ruspoli, in *The Cave of Lascaux: The Final Photographs*, is compelling. The first stag has head tilted up but neck tilted back as if climbing out of the water at river's edge. The second stag, whose head is level, appears to be walking in the shallow, near-shore water. The last three stags, shown with necks stretched forward and upward, are apparently still swimming in deeper, mid-stream waters. The narrative and presence of an element of landscape makes the *Swimming Stags* unique in prehistoric cave art. No sign of the sky is present, but the abrupt color discontinuity at the supposed water surface is as close an approach to atmosphere as exists in all of prehistoric art.

The *Swimming Stags* celebrated and perhaps was intended to invoke the vulnerability of the swift and powerful red deer when water briefly deprived them of their great speed. Today caribou reenact the same pageant during their annual migration across northern Canada and Alaska. Pressed by the inflexible timetable of the seasons, the caribou risk both drowning in raging streams or rivers and eager predators hiding on the far banks rather than waiting a few weeks for the season to advance and the flood waters to subside.

This flood contains the key to the *Swimming Stags* meteorological message. The time is spring during the warm interregnum in the wake of the Great Ice Age. The stags were crossing one of the streams or rivers in the vicinity of Lascaux swollen by melting snow and glacial ice from the nearby highlands (see Fig. 9-60).

At the height of the last Great Ice Age not all the rivers ran into the sea, for many were frozen. A great volume of water that evaporated from the sea fell as snow upon the land and accumulated into continent-size ice caps. The world is no stranger to such ice caps. Today they cover some 6 million square miles of land in Antarctica and Greenland to an average depth of over a mile. But 20,000 BP ice caps buried an additional 8 million square miles to a similar depth (Fig. 1-2). The largest covered Canada and the northern United States, halting midway through what is now New York City. Another covered northern Europe, kindly stopping just north of London. Further south, extensive glaciers spread out from the Alps and Pyrenees onto the surrounding plains. Even some of the modest highlands near Lascaux, such as the Auvergne and Cevennes Mountains of southern France, experienced glaciation.

The world's coastlines were also altered. So much of the ocean's water remained in escrow upon the land that sea level was roughly 400 feet lower than today and much land now submerged was then high and dry. If people migrated from Asia to North America at that time they would never have suspected they were entering a new continent, for Alaska and Siberia were not separated by water. England and France were also physically united, for there was no English Channel.

Fig. 1-2. Extent of ice caps and exposed land 21,000 years ago (top) and now (bottom). Imbrie, J. and K. P. Imbrie, *Ice Ages: Solving the Mystery*. Enslow, 1979.

During the Ice Age there were also places where the watery domain expanded. Many lakes were much larger than they are today, for one influence of the cold is to reduce water loss by evaporation. The Caspian Sea was 100 feet higher than it is now and, at 300,000 square miles, was about twice as large. The expansive Lake Bonneville, now shrunken to a remnant called the Great Salt Lake, then overflowed its banks, spilled into the sea, and was fresh.

The landscape was also carpeted differently. The refrigerating influence of the ice caps was felt hundreds of miles away. Frigid, dense air cascaded down the edges of the ice caps, blasting the surrounding plains with brutal regularity. The colder Atlantic Ocean chilled Europe further. The zones of vegetation appeared in more or less the same order as today but were displaced southward. Thus, the ice caps were surrounded by a belt of tundra that almost reached Lascaux and Altamira.

Twenty one thousand years ago the ice finally began to melt faster than it could accumulate. One of the primary driving forces for the major climate changes over at least the past 2,000,000 years has been Earth’s changing orbit. The gravitational pull of the Moon, Sun, and planets disturbs the Earth's orbit, changing it slightly each year. Slowly, the eccentricity and the obliquity of the orbit change, while the equinoxes precess.

The climate-related changes of Earth's orbit are almost periodic. The eccentricity varies with cycles of approximately 400,000 and 100,000 years. Right now the orbit is nearly circular and the distance from the Sun varies by 3 million miles about its average of 93 million miles. Around 50,000 years from now the orbit will be more elliptical and the distance from Earth to Sun will vary by almost 8 million miles. The obliquity, or tilt of Earth's axis, which is now 23.5º and decreasing, varies between 21.75º and 24.25º with a period of about 40,000 years. The equinoxes advance or precess with a complex period of approximately 22,000 years. Right now we are closest to the Sun around January 3, the heart of winter in the North Hemisphere. Perihelion advances about 1 day every 60 years. Around 11,000 years from now we will be closest to the Sun on July 3.

The orbital changes scarcely affect the total sunlight striking Earth each year, but alter the climate by increasing the sunlight at some seasons and latitudes, and reducing it at others. The ice caps of the North Hemisphere seem to grow best when less sunlight strikes the high latitudes during summers and more during winters. This reduces summer melting and actually increases winter snowfall.

Three of the orbital cycles match documented cycles in the climate. For the past 700,000 years the 100,000-year cycle has dominated, with major Ice Ages repeating every 100,000 years. The disproportionate impact of the 100,000-year cycle on climate is not yet well understood, but may be a consequence of the long time it takes for the great volume of ice to melt and the Earth's surface to rebound. Whatever the reason, about 21,000 BP the Sun finally began to heat the Earth more effectively and the ice caps began to melt.

The melting started slowly but accelerated to a fever pitch. In its most rapid phase from about 14,500 to 7500 BP, the ice caps melted so quickly that sea level rose an average of 4 feet a century, with bursts (as from about 14300 to 14000 BP) exceeding 15 feet per century. The sea finally approached its present level about 5000 BP.

The torrents of melt water carved out huge river valleys down whose mostly empty beds today's meandering rivers trickle. Epic floods were much more common than now. Occasionally, ice dams temporarily blocked the flow of water but would eventually burst, and produce monumental floods downstream. Around 7500 BP the rising Mediterranean may have burst through the Bosphorus, flooding the Black Sea, which had previously been fresh, and possibly giving rise to the flooding myths of Gilgamesh and Noah. In all the regions bordering the icecaps, the glacial runoff, seasonal or episodic in nature, inundated the lowlands. The *Swimming Stags* therefore stands as a document symbolic of flooding on a grand scale - a surge of release that led us from the depths of the Ice Age to civilization.

Nine thousand years ago, the great Scandinavian Ice Sheet was gone and Europe was warmer than today. The epoch of general warming had been eventful, for it was marked by periods in which the retreating ice halted or even readvanced. By 12,900 BP almost half of Scandinavia had emerged from the ice. Then the ice advanced once again to reclaim southern Sweden and Finland for some 1300 years. This temporary climatic reversal in Europe, called the Younger Dryas, ironically coincided with the splitting and increased melting of the North American Ice Sheet and outpouring of melt water down the McKenzie River. The lighter fresh water covered the sea surface and spread from the Arctic to the North Atlantic Ocean, refreezing in the winters, deflecting the Gulf Stream southward and cooling Europe. But eventually the ice and tundra retreated northward, the flood subsided, and Europe warmed. This drew the artists out of the caves, scattered them ever further about the face of the Earth, and forced them to ply their trade on other convenient surfaces.

Nine thousand years ago the thriving town of Jericho was already ancient. By then, agriculture, animal husbandry, and the manufacture of pottery were time-honored although not universally known practices. Jericho had been founded at least 1000 years earlier at a fresh water spring in the Jordan River Valley. It is now about seven miles from the Dead Sea but the ancient Sea's salty shoreline was closer to the city than it is today. Jericho owes its antiquity, its successes and its misfortunes to its location at a strategic crossroad in the Near East. It was both an oasis and a trading post. It had access to two of the Ancient world's vital natural resources - salt and bitumen.

Jericho's wealth allowed her to purchase luxuries such as obsidian, which was widely used in the ancient world to make knives, arrowheads and even mirrors. But there is no natural source of this dark and very hard, volcanic glass anywhere near Jericho, so it had to be imported. Analysis of the exact mineral content has enabled us to pinpoint the source of Jericho's obsidian as the Anatolian Plateau of Turkey, about 500 miles to the north.

For many years, nothing was known of the early peoples of the Anatolian Plateau. Then, in 1952, James Mellaart spotted the mound of Çatal Hüyük in the distance and vowed to return. Excavations began late in 1961. Over the next three years Mellaart's research team unearthed about 3% of what may have been the largest, most populous, and most artistic city in the world 9000 BP.

Çatal Hüyük is located on the Konya Plain, about 35 miles west of the hilly region where obsidian is found. Although precipitation is only about 10 inches a year, several rivers flowing out of the nearby highlands watered the area. Thus it teemed with wildlife and wild grains and so was ideally suited for hunting and agriculture. Çatal Hüyük first became a major city about 9400 BP and was occupied for about 1200 years. Around 8200 BP it was abandoned without any signs of violence, most likely as the result of an abrupt climatic shift to cooler and drier conditions.

Almost from the moment excavations began, it became apparent that Çatal Hüyük had been a major art center. James Mellaart noted that, "The people of Çatal Hüyük painted what they could and when they could." Carvings of women, bull's heads and a variety of animals jutted from the walls of the shrines and houses, and bucrania (altars with bull's horns) were built into platforms on the floors. Unlike the art of Lascaux, in Çatal Hüyük the human being was often portrayed with as much care as the animals. This rise in self-appraisal is quite understandable; the citizens of Çatal Hüyük exercised far more control over the environment than did their ancestors in Lascaux.

The mud-brick houses of Çatal Hüyük had

their entrances in the roofs, possibly for security. The walls were protected from moisture, even as they are today, with a fresh coat of plaster applied each summer, after the brief rainy season around May. The plastered walls were then decorated with paintings, mostly of animals and hunting scenes. The painters' palettes had virtually no restrictions, for the available pigments included red, blue, green, yellow, brown, white and black! The artists also seem to have been quite confident and experienced; they painted directly on the walls without even tracing preliminary outlines.

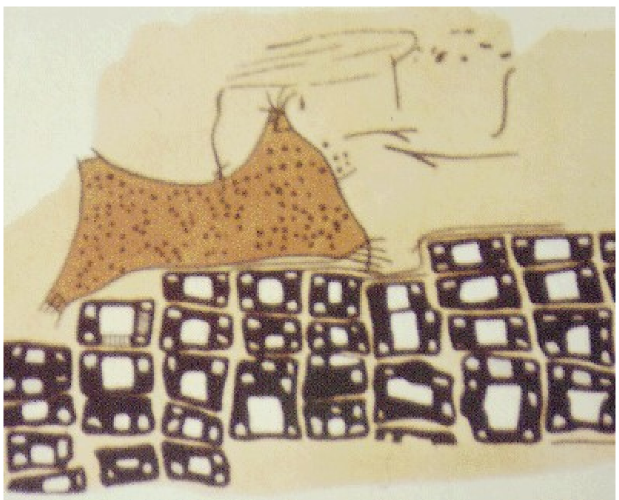


Fig. 1-3. *Eruption Above Çatal Hüyük*. (c. 7100 BCE.) *Çatal Hüyük: A Neolithic Town in Anatolia*. James Mellaart. Mc.Graw Hill, 1967.

In the midst of this city of religious shrines, one anomalous painting captured a volcanic eruption that took place shortly after 9100 BP, and is the earliest known example of a landscape (Fig. 1-3). Perhaps it required an earthshaking event to rouse the artist from the entrenched complacency of the accepted repertoire and look aside for a new source of inspiration.

A profile of a twin-peaked volcano rises beyond the houses of the city or of a town at the base of the volcano. This is Hasan Dağı (Fig. 1-4), located 80 miles east of Çatal Hüyük and one of the chief sources of the city's obsidian and wealth. Hasan Dağı is now extinct, its last eruption ending more than 3000 years ago, but it was active when the city thrived. The houses of Çatal Hüyük are shown in plan view as in a map, packed closely together with their entrances in the roofs. The erupting volcano is miniaturized because of its great distance from the city, but is seen in great detail. Lava streams flow from several vents at the base while incandescent tephra bombs are shot from the cone and dot the slopes they have fallen on.

Fig. 1-4. Twin peaks of Hasan Dağı.

Fig. 1-5. Eruption cloud of Chaiten, in Chile with lightning 06 May 2008.

A great, amorphous cloud created by the eruption towers over the peak and has already broadened considerably. Two lines extend downward from this cloud, one striking the mountain, while two other forked horizontal lines appear to the right of the peak. These lines are almost certainly lightning bolts, which are so often produced in and around volcanic clouds (Fig. 1-5). The painting thus contains the earliest known representation of both clouds and lightning in art. Lightning bolts would not appear again until the Sumerians represented them almost 4000 years later. The next known painted or carved cloud arose even later.

Fig. 1-6. Apollo 17 photograph of the Earth centered over Africa, 08 Dec 1972

Few early artists had access to such finely plastered walls. For most, bare rock surfaces sufficed. Rock etchings and paintings are found around the world from easily accessible locations to some of the most hostile and remote settings. In 1850, Heinrich Barth, a German explorer and artist in his own right, saw rock paintings at the Springs of Isolane and near Tel Issaghan in the middle of the Sahara desert. Barth reasoned that the climate must have been wetter when the paintings were executed because the animals depicted in them could not possibly have survived the forbidding desert conditions he was experiencing. Barth's conclusion of a once wetter Sahara is now universally accepted.

Today the Sahara is a true desert. It lies in a band between 20º and 30º North Latitude that stretches the width of Africa (Fig. 1-6). The mean annual rainfall in this broad zone is less than 4 inches everywhere but in the few isolated highlands. The core regions of the desert receive less than 1 inch per year and several years may elapse between successive rainfalls. The landscape is of course mostly bare but seldom sterile; life has learned to wait in suspended animation for the rain.

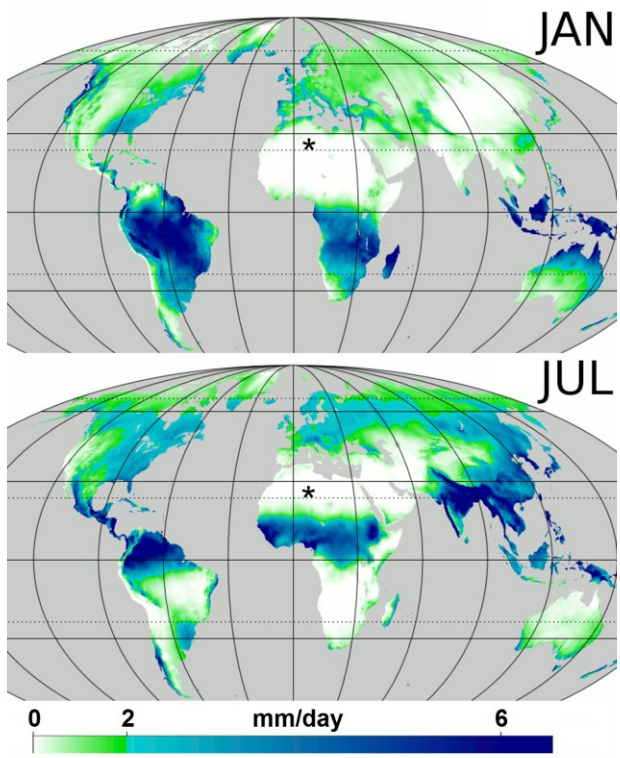


Fig. 1-7. JAN and JUL rainfall (mm/day) Asterisk indicates position of the Tassili n'Ajjer

The Sahara now has been abandoned by all but the wildest excursions of the storm belts that water the lands both to its north and south (Fig. 1-7). North of the Sahara lies the mid-latitude storm belt with its extratropical cyclones (winter storms or lows - see §7.2). This storm belt is located at the boundary of polar and tropical air masses because extratropical cyclones are powered by horizontal temperature differences. In the months around January, the domain of polar air surges southward in pursuit of the retreating Sun. Winter storms cross the Mediterranean frequently, watering the northern fringe of Africa from Morocco to Tunisia. Mediterranean Africa was the granary of Rome and still could be fertile with proper management. But winter storms seldom track south of the Atlas Mountains, so there the Sahara begins.

It was not always so. At the height of the Ice Age the domain of polar air was much larger. Some of the winter storms tracked further southward, crossing the northern Sahara from west to east. The northern Sahara was wetter then and certainly cooler. But gradually the cold and storms retreated northward with the shrinking ice caps and abandoned the Sahara.

South of the Sahara lies another rain belt. This is the tropical rain belt and it approaches the Sahara in its season. The tropical rain belt is fueled directly by the heat of the Sun and so follows the Sun in its annual migration about the equator. In the months around July, when the Sun lies overhead north of the equator, the tropical rains approach the Sahara but only reach the Sahel. In some years, as between 1968 and 1974 and again between 1980 and 1984, the rain belt does not move as far north as normal. Then parts of the Sahel fail to get their rains and killing drought is inevitably the result. As people die the Sahara relentlessly expands southward.

But should the tropical rain belt break loose from its present bounds and wander further north around July it would turn the Sahara into a grassland or savannah. This was the case in much of the Sahara between about 14,000 and 5,000 BP. Lake Chad was then over 100,000 square miles - 20 times larger than it is today. Many other lakes, long since reduced to dry beds, dotted the southern Sahara. The Niger and Senegal Rivers had discharges far greater than at present and active rivers or streams filled the now empty and often dune-covered channels that cross the desert. Water loving animals such as hippopotamuses and crocodiles made wetter parts of the Sahara their home. Humans traversed the Sahara or settled there freely, hunted the abundant game and immortalized them on the rocks. Then, beginning about 5,500 years ago, the Sahara fell victim to a progressive desiccation that has continued up to the present.

The Sahara has grown dry with good reason. Because of the precession of the equinoxes, 11,000 years ago we were closest to the Sun around July 1, now we are furthest. The difference is a mere 3 million miles but it has reduced the direct intensity of the July Sun by 7% and cooled the North Hemisphere summer. At first it might seem that a more intense summer Sun is the last thing anyone in the Sahara would want. But a more intense summer Sun is precisely what brought the rains to the Sahara for it forced the tropical rain belt of July further north and made it more vigorous than today. For the same reason Arabia and the Punjab of India, today mostly desert, were then much wetter and served as temporary seats to some of the earliest civilizations.

Eventually the slow, inexorable advance of perihelion, the date the Earth is closest to the Sun, exacted its toll. Around 5,500 BP perihelion did not come until October and the summer rains began to fail. Years of drought and famine became more common. By the time of Christ, perihelion had advanced to early December, far too late to arouse summer rains. From the Atlas Mountains of Morocco to the Indus River of India the desert had conquered.

The history of Saharan rock etching and painting mirrors the climate changes. One of the great outdoor art museums is found in the Tassili n'Ajjer in the central Sahara. At higher elevations the Tassili gets a few showers late in summer and perhaps a winter storm but for the most part it is a desiccated and almost uninhabited sandstone plateau marked by immense cliffs and spires. But rain helped carve the Tassili. As it ran off the plateau it ate into the soft sandstone, creating a network of deep gullies and pinnacles much as in Bryce Canyon. In a humid climate, sandstone pinnacles would become waterlogged near their bases and soon collapse. But even in the wettest of times the Sahara was not a humid region and the occasional rains cut deeply into the dry rock fabric. Sandblasting by wind and water seepage then slowly undermined these cliffs and spires, leaving hollows and overhangs at the bases. And it was in these protected hollows that the people of the Tassili lived and painted.

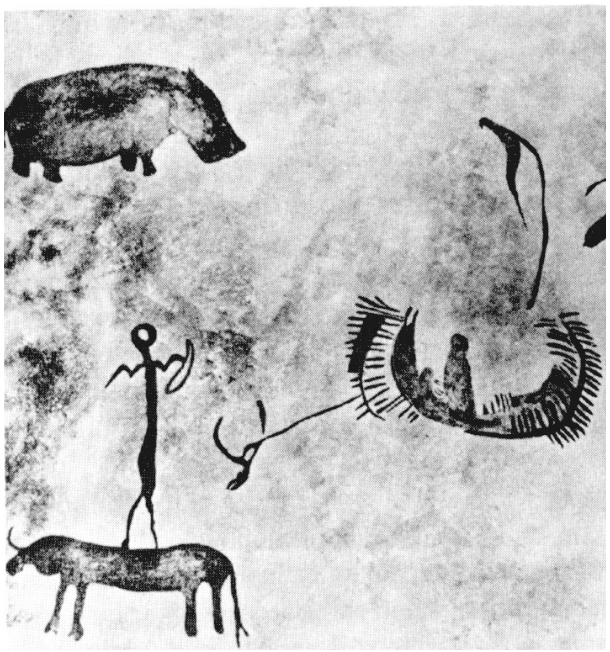


Fig. 1-8. *Hippopotamus Hunt*. C. 5500 BP. Aounrhet, Sahara. H. Lhote, *The Search for the Tassili Frescoes: the Story of the Pre-historic rock painting of the Sahara*. Hutchinson 1959

The earliest Saharan artists were hunters. In at least one work (Fig. 1-8), about 5500 BP, they depicted a hippopotamus hunt conducted from canoes. Independent archaeological evidence corroborates that it described a local event in a watery environment. How inviting a place the Sahara must then have been. But some time after this pictograph all the hippos, crocodiles and boats disappeared from Saharan art. Cattle were depicted with increasing frequency, sometimes in large herds, showing that herdsmen had replaced the hunters and that the artists had some notion of perspective.

Agriculture also came to the Tassili, and with it a greater concern about the weather and the human figure. At Aounrhet is a famous fresco known as the *White Lady* or *Horned Goddess* (Fig. 1-9). A shower of grain from a row of wheat falls on the Goddess. Could this be a rainstorm? The Goddess and twenty other small figures (which may have been painted earlier) are running toward the right. Some are leaning, as if caught by a sudden summer shower. Hiroshige would later delight in capturing such moments (see Fig. 9-55).

Fig. 1-9. *The Horned Goddess*. C. 5500 BP Aounrhet, Sahara. H. Lhote, *The Search for the Tassili Frescoes: the Story of the Pre-historic rock painting of the Sahara.* Hutchinson 1959

A single figure in the *Horned Goddess*

stands apart from the crowd. A small, stately goddess between the legs of the Horned Goddess stands erect and faces the left. The rain does not bother this small goddess and never will, for a protective covering arches above her head - an unmistakable striped rainbow. Here is the earliest known indisputable example of a painted rainbow!

If the *Horned Goddess* with its rainbow represented a promise of adequate rain, that promise was not fulfilled much longer. The drying Sahara began evicting her tenants. Many went to Egypt, long famous as a refuge from famine. After about 3200 BP, horses with chariots replaced the Sahara's painted herds. Some of these are shown in the "flying gallop" pose common in (but not original to) Minoan and Mycenaean art, in which all four legs of the running animals are stretched outward as far as possible. This cultural link to the Mediterranean suggests that the Saharan highways were still active. But the Sahara's progressive desiccation was irreversible. By 300 CE, camels had replaced the horses on the highways and walls of the Tassili. The camels were painted poorly, for none fared well in the unforgiving Sahara.

1.2 Ancient Art: Weather in a Vacuum

As the Sahara dried up, thirsty peoples converged on Egypt and squeezed into the narrow Nile River Valley. Egypt is as rainless as the rest of the Sahara but the Nile provides a thin strip of its land with a water supply as dependable as the precipitation of a humid climate. By the time of the First Dynasty the Egyptians rarely saw rain and had little reason to suspect that all rivers ultimately derive from precipitation. Instead, the Egyptians accorded rain secondary status, referring to it as the Nile of the sky.

Every year the Nile begins to rise about the time of the summer solstice and, before being dammed, continued doing so until the land was flooded and fertilized some hundred days later. The insular Egyptians had absolutely no idea this was due to the northward excursion of the tropical rain belt, for in historical times it never reached Egypt, but they grew to depend on its rhythm.

Thus the Nile was a good parent, providing water, fertile soil and, because of a prevailing wind from the north, round-trip transportation so that civilization took root there naturally. Egypt was for the most part a land of plenty; we know from the biblical stories how it fed outsiders. But on each side the desert was ever threatening and the Egyptians remained pressed in this loving but shockingly narrow ribbon of land.

These basic environmental features impressed themselves deeply in the Egyptian soul and marked the character of Egyptian art. The *Hunt Among the Papyrus* (Fig. 1-10) is set in the shallow water of a papyrus marsh, perhaps in the Nile Delta. Flying birds and lotus blossoms are seen near the top of the papyrus reeds that tower over two hunters. The men stand in step on a boat. Each is about to spear a submerged hippopotamus that has already been tethered, while a crocodile also crouches below the water line to avoid detection.

The style of dress shows, to no one's surprise, that Egypt's climate has long been warm. Here is a land of plenty with the controlled, confident sport and rhythm of civilization. Art and humankind had come a long way since Lascaux, Çatal Hüyük and the Tassili.

But Egyptian art has its severe limitations. To begin with, the scene lacks dimension. All the participants have been pressed onto a narrow ledge from which they may not stray. The papyrus reeds form a high wall at which the universe terminates. The picture ends at the top of the papyrus for, as is characteristic of works lacking apparent depth, there is no sky. Water appears but it is rendered only in cross section.

The zigzag lines painted on an unruffled water surface imply a strangely disjoint mode of thought that appears to have been prevalent in ancient Egypt. It is similar to the rigidly obeyed Egyptian convention of painting human bodies frontally and faces in profile. Once a style became accepted and established, Egyptians allowed little or no room for innovation.

Fig. 1-10. *The Hunt Among the Papyrus*. C. 2250 BCE. Egyptian Museum, Berlin.

Landscape art was one of the first victims in the triumph of convention and symbolism over observation and innovation in Egyptian art. This has been the case ever since the dawn of painting - landscape art has been offered as a sacrificial lamb wherever convention and symbolism have reigned.

In the *Hunt Among the Papyrus* there was no need to paint the sky because the reeds block out all hints of a background. But through all their wall scenes the Egyptians never painted the sky or its clouds, even when nothing obstructed the view. In place of the atmosphere was always empty space. When the sun god, Aten, sent his rays to shine upon the Pharaoh, Akhenaten (see Fig. 1-16) they passed through the void. When birds were shown flying they flew through a vacuum. Often, birds were crowded together like Egyptians in the Nile Valley and would not have had room to flap their wings.

Despite the complete absence of sky from all Egyptian scenes the Egyptians did find a way to paint the sky! Where do these artistic Egyptian skies appear? The answer struck me by complete surprise when I finally visited the temples of Egypt yet it is eminently logical - the Egyptians represented their skies not on the temple walls but on their ceilings. These ceiling skies remained true to the disjoint Egyptian mode of thought, for in this manner they have been separated from the landscapes on the walls. Thus earth and sky have been forever distinguished. All the Egyptian skies are nocturnal deep blue and crowded with ranked troops of five pointed stars, as if in an astronomical Nile Valley. Sometimes these skies appear propped up by the long, thin Goddess Nut, whose golden body was lined with stars and other heavenly bodies.

Although the Egyptians chose not to reveal any evidence of the atmosphere and its clouds in their art, some meteorological information does appear almost surreptitiously in their hieroglyphics. Fig. 1-11 shows several of the symbols used to represent storms and clouds. In these symbols it is easy to recognize both whirlwinds (spirals) and flat-based clouds (semicircles) from which showers (diagonal lines) or water (zig-zag lines) are falling.

Fig. 1-11. Storm hieroglyphics. http://hieroglyphs.net

Egypt may have had its occasional storms but there the sun god, Amun-Ra, reigned supreme. But even though the floodplain of Mesopotamia is almost as rainless and sunbaked as Egypt, swirling storms and intense showers occur far more often in the mountains just to the north. Thus the Mesopotamians knew that it was their winter rains that swelled their rivers. For this reason the sun god, Shamash had to share power with Enlil, god of air and Earth. For this reason also, Mesopotamian art has a bit more meteorological content than Egyptian art.

Agriculture is often assumed to have originated in and around the highlands that abut Mesopotamia. The move to the almost rainless floodplains of the Tigris and Euphrates Rivers was accelerated once techniques of irrigation were mastered. There, empires arose even earlier than in Egypt but the course of Mesopotamian civilization, like their weather, was never as regular or predictable as in Egypt. The rich, flat, open land of the floodplains provided an impetus to continual armed conflict. Not only did the Mesopotamians fight ceaselessly among themselves, they were regularly at war with the mountain peoples. Fragile works of art in ancient Mesopotamia were not likely to be preserved.

Fortunately for us, Mesopotamian artists in the mineral-poor floodplains frequently worked in stone and clay. Perhaps the most common form of their art is the seal, an engraved stone tablet or cylinder, which left a raised impression when stamped or rolled on a clay surface. In many of these seals the pitiless Sun, surrounded by rays like the petals of a flower, blazes above a scene with animals, people or gods. The crescent Moon accompanies the Sun in some of these scenes, which first appeared in Sumerian art about 6000 BP and continued to do so for several millennia. Lightning bolts also made their Sumerian debut in Akkadian times (c. 2300 BCE). In Fig. 1-12, a cast from a cylinder seal shows the lightning goddess, Zarpenik riding on a winged griffin with a bunch of thunderbolts in each hand. Thunder, created by the whip of the weather god, duly follows in her wake.

Fig. 1-12. Cylinder seal of lightning and thunder. A. Parrot, *Sumer* 1960, p. 189.

The Akkadian, Sargon established the first great Mesopotamian empire around 2300 BCE. At his death, Sargon's subjects rebelled and his third son, Naram-Sin spent much of his reign reconsolidating and then expanding the empire. One of Naram-Sin's successful campaigns was probably conducted to confiscate mineral wealth from the Lullubu, a people of the nearby Zagros Mountains. The *Victory Stele of Naram-Sin* (Fig. 1-13) commemorates this achievement. But Naram-Sin's victories did not long endure. Insidious drought vanquished his empire about 2200 BCE and imposed 300 years of silence on the land. A millennium after Naram-Sin, an Elamite art devotee (conqueror) raised the stele from the dust and imported it to his mountain kingdom for his collection, no doubt at bargain rates. Finally, in 1897 the stele was dug out of the ground at Susa in the Zagros and transferred, once again at bargain rates, to Paris.

The *Victory St*ele shows the monarch as a towering figure, glorified like a god and standing atop a wavy foothill in front of a conical peak. The landscape features represent the Zagros Mountains and the trees in the foothills suggest the battle took place in or at the edge of a forest. Two auspicious stars shine overhead but, as with Egyptian works, only an ominous void can be found between heavens and Earth. Yet even though drought's handwriting was on the wall, what monarch would allow carved clouds to overshadow a triumph? From that point, nature in the art of the Ancient Middle East was rarely treated as more than a mere handmaiden to the exploits of kings and gods.

Fig. 1-13. ***Victory Stele of Naram-Sin*****. C. 2250 BCE. Louvre, Paris.**

After the drought, other Empires arose only to fall again. Shortly before the palace at Mari was destroyed in 1760 BCE, a wall painting commemorated the Investiture of its king, Zimri-Lim. The painting shows a bird flying between palm trees and has a mottled blue and tan background. This painting almost revealed a cherished secret - the sky - and does betray a sincere, developed appreciation for nature.

The elements of a scenic sense in this painting at Mari call to mind the contemporaneous art of the Minoans. Other evidence at Mari shows the city was a thriving commercial center that maintained economic ties with Crete.

Around 2000 BCE, a great civilization arose on Crete and the nearby islands. The Minoans established an impressive commercial fleet and capitalized on the strategic location of their island. They apparently remained immune from invasion for centuries and peaceably acquired immense wealth. The Minoans knew that the sky could enrage the sea and make it swallow their ships but most of the time the sky was clear, the wind predictable and the sea not as tempestuous as the North Atlantic.

So we must thank the sea and sky for their art but it was the Earth that preserved it for us. Crete, like Çatal Hüyük lies directly above the boundary of the colliding African and Eurasian continental plates. Frequent earthquakes and, in places, volcanic eruptions mark this geologically active region. About 1700 BCE a catastrophic earthquake leveled the palaces on Crete but they were rebuilt on an even grander scale only to suffer destruction once again.

The archaeologist, Spyridon Marinatos, hypothesized that the second destruction of the palace at Knossos, and even the collapse of Minoan civilization was due to the eruption of Santorini. Seventy five miles north of Crete stand the crescent-shaped islands of Thera and Therasia. These form a fragmented ring eight miles in diameter around a bay in which there are two volcanic islets known as the Kameni or Burnt Ones. They are all that remains of the island of Kalliste and of Santorini, which erupted and then collapsed into the sea in a summer possibly between 1628 and 1626 BCE.

Santorini was one of the largest eruptions in the last 10,000 years. About 14 cubic miles of volcanic ash were blown into the sky, four times more than at Krakatoa in 1883. The ash was carried in a spreading plume to the southeast by the northwest winds that prevail during summer in the eastern Mediterranean. Deposits of this ash on the sea floor indicate that it lightly coated the eastern half of Crete but buried nearby Rhodes with from 6 inches to a foot. If the eruption occurred before the harvest, widespread famine on Crete could have resulted.

An even more devastating blow, however, may have come from the sea. When the hollowed volcano finally collapsed it produced a series of tsunamis or tidal waves that radiated outward and took aim for the north shore of Crete. In deep water such waves are innocuous and are rarely more than a foot high. But as they enter shallow water they slow down and pile up into walls of water that can tower over 100 feet. Such waves would have utterly destroyed all coastal structures and led to enormous loss of life.

Fig. 1-14. ***The Flotilla Frieze*****. C. 1630 BCE Akrotiri.**

No known writings record the eruption of Santorini, although it may have been the source of the legend of Atlantis. Even so, the eruption was recorded and preserved in places far removed from the eastern Mediterranean. Sulfurous gases and dust particles shot into the stratosphere by the volcano were then carried around the world by the winds. Some were deposited as an acidic veneer on the ice of Greenland and buried by the inevitable snowstorms. Icecaps, like trees, are marked by annual rings. In the center of Greenland an almost uninterrupted sequence of ice rings led to an estimated date of 1645 BCE for a huge eruption although the chemistry of the volcanic dust is not a match to Santorini. This date was then refined to 1628-1626 BCE by the stunted growth of Irish oaks and frost damage to Bristlecone Pines in the American Southwest.

In 1967, after years of searching, Marinatos uncovered the town of Akrotiri on the island of Thera, buried like Pompeii under a thick layer of pumice and ash. Whatever was the fate of the Minoans on Crete, Akrotiri was certainly a victim of the eruption. The excavation exposed a number of buildings that had been partially destroyed and then crudely repaired. In the weeks or months before the final blast, damage to structures indicates the town was rocked by earthquakes - typical precursors of major eruptions. The volcanic activity seems to have begun gradually but convincingly. Only one body and few valuables have been found in the excavations. Apparently the people took Santorini's warnings to heart and had ample time to evacuate with most of their possessions.

Since the treasured murals were stuck to the walls they were left behind for us. One of these is the so-called *Flotilla Frieze* (Fig. 1-14). This work documents the voyage of a fleet between two port cities. It shows the sea with harbors, the cities at each end of the voyage, and the surrounding hills.The mural shows complete human dominance everywhere but in the hills at the top left, where a lion is chasing some deer. Above the lion, the deer and the trees is a small space reserved for the sky. Strangely, the sky is a neutral tan rather than blue, while the sea and even some of the land do appear blue. The Minoans were getting ready to paint the sky. They stood on the brink of the modern world some 3650 years ago.

The artist attempted with some success to develop a sense of perspective. The *Flotilla Frieze* is a legitimate landscape, perhaps the first in the history of the human race and represents an astonishing advance over all known earlier paintings.

The *Flotilla Frieze* is a unique remnant in Minoan art but it was not an accident. A bronze dagger dug up from a tomb at Mycenae shows engraved lions running beneath some stylized cumulus clouds. The dagger dates to approximately 1550 BCE. A gold cup recovered from another Mycenaean tholos (round) tomb at Vaphio in Laconia shows a scene of a bull being captured (Fig. 1-15) Two trees grace the background while either foliage or garlanded clouds hang from the top. The cup is dated to 1500 BCE and although nothing like it has been found on Crete it is done in the style of the Minoan artists.

Fig. 1-15. *Gold Cup II*. c. 1500 BCE. National Museum, Athens.

After the demise of Minoan civilization, art declined throughout Greece and Crete. Its unique scenic art and even its memory were buried like Atlantis. When interest in scenic art was revived in Greece over 1000 years later, the art of Egypt and the Near East served as its source.

The Sun figured greatly in Egyptian art, especially when Akhenaten elevated the sun god, Aten to short-lived sole possession of divinity. In numerous works, crepuscular rays beam from the Sun disk down through cloudless skies to bless Akhenaten and his family (Fig. 1-16). Crepuscular rays (see §6.2 and §9.1) were finally wrested from supernatural settings by clouds in late 15th century art, for they are the product of the contrast between sunlight and shade.

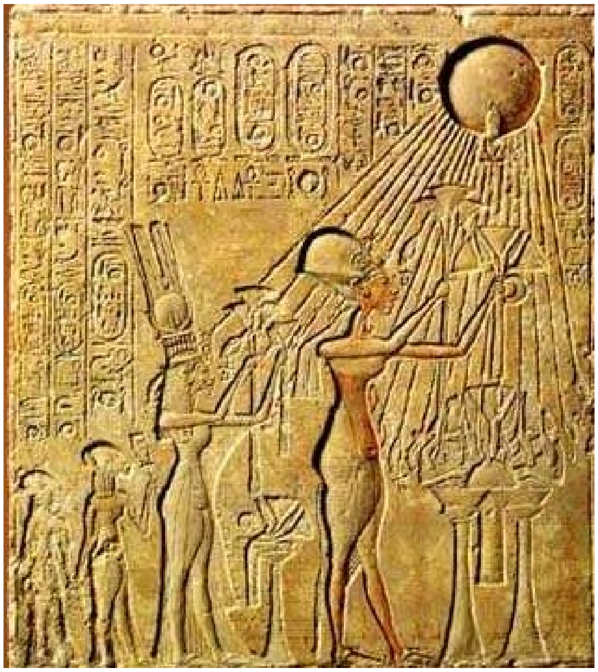


Fig. 1-16. ***Aten Illuminating Akhenaten and his Family*** **c. 1340 BCE. Amarna.**

Fig. 1-17. ***Ashur in the Aura*****. c. 850 BCE.**

By the 9th century BCE, the Assyrians had proudly elevated their chief god, Ashur from his humble status as the god of agriculture to the sunlike war god. In *Ashur in the Aura* (Fig. 1-17) a winged and bearded prototype of Zeus is encased in a flaming halo or nimbus. What a grand lineage would descend from this image!

1.3 Appraisal of Prehistoric and Ancient Sky Painting

For 30,000 years, painters viewed the world before their eyes but made virtually no attempt to portray the sky realistically. Prehistoric and ancient art is characterized by a world view fixated on animals or people and their actions. In order to gain admission to the world of early art, elements from the vegetable and mineral kingdoms had first to pass in shrunken form through a fine sieve. Meteorological elements were screened by an even harsher censor. But to portray a scene with a proper sense of perspective or show a graded pale blue, cloud-filled sky was summarily forbidden.

The way a people depict the sky in their art amounts to a cultural autobiography. The evolution of sky painting thus parallels not only the evolution of all art but of the human adventure as well. We must, of course be careful about drawing conclusions about the limitations of early sky art on the basis of the grossly incomplete and probably biased artistic remains we possess. Funerary art, religious in outlook and therefore thematically limited, was buried purposely and hence was far more likely to be preserved than any secular art with its more worldly focus. Whenever art has been found on the walls of dwellings, as at Çatal Hüyük, Mari, or Akrotiri, a more worldly focus emerges and our ideas and knowledge concerning the ancients have been revolutionized. Much of this secular art probably still remains to be discovered; for example, only 3% of Çatal Hüyük has been excavated. But even when these provisos are taken into account, the absence of sky in what early art we have points to something significantly different about the way our ancestors viewed the universe.

Several properties of the atmosphere made it particularly difficult for early peoples to comprehend and represent. First, most meteorological phenomena are highly transitory. Clouds are ever changing, rainbows last but a few minutes, and the life of a lightning bolt is so brief that we know it mainly by the fuzzy afterimage it burns into the retina. The sky could not be tamed to pose for artists before the invention of the camera.

The elusive air takes on the character of an invisible and intangible abstraction rather than a concrete object. Water, with its waves and vortices, was depicted long before the sky, for water can be seen and felt. Even Aristotle in the *Meteorologica* (Book II, Ch. 4) insisted there was a difference between air and wind – “Yet it is absurd to suppose that the air which surrounds us becomes wind simply by being in motion.”

The atmosphere also seems to be remote. For this reason it is consigned to act as a medium rather than an object. In art, the sky serves primarily to provide the setting. In this sense it plays the same role as linear perspective in landscape, which may be why sky painting and linear perspective both appeared and developed almost simultaneously. To a surprising degree and in more than a metaphoric sense, the presence of landscape in a people's art shows they have attained a sense of perspective concerning the world and people around them while the appearance of sky demonstrates an appreciation of the "atmosphere" of their surroundings.

Early peoples viewed the world and framed their art largely in epic terms as a series of acts performed with no reliance on the environment by various heroic or superhuman figures. Even if the ancients made astute observations about the state of the sky and could anticipate some changes in the weather by watching the wind or clouds, they still regarded these happenings as actions of the Gods. In epic (or religious) literature, meteorological description was used only as a means to heighten the dramatic impact of or testify to some heroic action. Homer, for instance, knew that a northwest wind was a drying wind but he stressed the role of personal actions rather than nature in allowing the funeral pyre of Patroclus to burn.

> There was some delay with the body of Patroclus also; the pyre refused to kindle. But a remedy suggested itself to the swift Achilles. Standing clear of the pyre, he prayed and offered splendid offerings to the two winds, Boreas of the north and Zephyr of the Western Gale....
>
> The two winds rose uproariously, driving the clouds before them.... When they came to the deep soiled land of Troy, they fell upon the funeral pyre and the fire blazed up with a terrific roar.

Homer, *The Iliad*.

In most early art meteorological description would have been impossible, for any accurate rendition of the natural setting would automatically destroy its anthropocentric foundation. Thus, when the world of nature was depicted it could only consist of disjoint, subservient elements taken out of context. Zeus could hurl his thunderbolts but to put him on a cloud in the sky would have made him look small and would have been tantamount to botching the story. The sky and the landscape could be tolerated only on very restrictive terms.

There are enough elements of sky art to outline its early evolution through 30,000 years. Prehistoric cave art, the product of a hunting society, dealt almost exclusively with animals and their interactions with people. References to the climatic conditions that nurtured and preserved this art are certainly present but were always inadvertent.

Meteorological objects appeared in art with the development of agriculture, animal husbandry, and other trades and industries, for people then assumed greater control over their environment and became increasingly aware of their dependence on it. The sky itself could not yet appear in their art but important discrete aerial objects made their debut. It is always easier to represent a few apparently solid objects than to show the medium that relates one thing to another. Thus, the shock of a volcanic eruption aroused an early artist in Çatal Hüyük to paint its volcanic cloud and lightning bolts while the joy of a life-sustaining rain shower in the drying Sahara inspired one of its artists to paint a rainbow.

Art of the early civilizations was more complex. Increased mastery over the environment was coupled with a new form of dominion - control of one's fellow humans. Definite ideas about scenery developed, but still the sky was omitted or at best removed to ceilings even when space on the murals was reserved for it. In this art the absence of sky suddenly becomes both conspicuous and disturbing. Whereas prehistoric artists did not seem to even think about painting the sky, painters of the early civilizations appear to have refused. The apparently deliberate, routine removal of sky where it surely belongs bespeaks a loss of innocence bordering on belligerence. It furthermore marks the imposition of ideology, propaganda and censorship, the sophisticated substitutes for taboo. Civilization brought with it great powers for humanity but its cost in terms of lost innocence was high.

Minoan artists broke these shackles and seemed about to paint the sky. The *Flotilla Frieze* represents a profound advance in scenic conception. Yet that concept was as fragile as Minoan civilization itself. A volcanic eruption, a loss of markets or an invasion was enough to bring about its demise and no one afterward carried the scenic banner. When Minoan civilization collapsed, its scenic sense disappeared with it. Minoan influence did indeed spread far, as the 'flying gallop' pose of Saharan chariot scenes indicates, but people selectively adapt from others only what they are ready for. The world was not yet ready for the sky.

What unique features enabled the Minoans to arrive at their new scenic conception? More fundamentally, what are the preconditions that must be satisfied before sky painting can begin? People tend to depict in their art only what they feel some control over. The feeling of control takes two forms - either the ability to manipulate the environment or the feeling that its workings are comprehensible. The natural setting and the sky with its unpredictable weather long remained far beyond human control and comprehension. No wonder they were so long left out of the picture. In a certain sense our ancestors simply could not see the air or acknowledge its existence.

The air was not revealed to us until science and technology extended our knowledge and sense of power over the elements. Prior to that, all atmospheric phenomena had to be brought down to size. This was accomplished by one of two universally adopted techniques - either miniaturizing concrete objects such as lightning, or transmuting the phenomena into tangible symbols via the epic view. Thus, the Egyptians sometimes represented the air and sky in personified manner by showing Shu, the god of air holding up the star-studded figure of the sky goddess, Nut arched over a scene, while the various civilizations of the Near East employed a panoply of weather related gods to act out their meteorological dramas. But the direction of symbolic representation was never reversed; for example, early peoples may possibly have used the hair of the wooly mammoth to symbolize rain, but rain was never used in early art to symbolize mammoths.

A feeling of control over the elements comes only when a naturalistic outlook replaces the epic view of the universe. Events can then be depersonalized and treated as manifestations of general laws. The consciously inventive faculty can then be developed to manipulate the environment. Here the leading role of natural philosophers or scientists, inventors, and businessmen is fundamental to the development of landscape art.

Consider the Minoans. They conquered the sea and established a commercial network that brought them great wealth. Successful businessmen built the villas in Akrotiri. The fate of landscape art has always hinged on the support and mundane tastes of such pragmatic patrons. Practical considerations always underlie the conduct of business. Minoan businessmen provided a home for the murderer, Daedalus because he was a sculptor, architect and inventor par excellence, thereby allowing scientific and naturalistic attitudes to flourish.

Success in commerce and industry also spurs landscape art indirectly by leading to urbanization. The countryside comes to represent a refuge from the hectic pace and crowded conditions of city life. The more cosmopolitan and commercial a society, the more it is apt to portray and romanticize the natural setting in all the arts. Landscape painting is also a child of the city.

A strong dose of idealism is essential for the creation of sky art, but unbridled idealism is not. Whenever exclusive control of sky art has passed into the hands of an established church or state or the intelligentsia it has been redirected to serve other gods than nature, and it has withered. Whenever theologians and bureaucrats have been left to their own devices, they soon transform sky art into an uninspired but palatable chant of stylized, ideological assertions. The intelligentsia revel in esoteric and often abstract formulations of self-created worlds, and vainly delight in purging memory of the simple, natural roots of their creations. Oddly, it is the businessmen, often unfairly stereotyped as the incarnation of everything culturally philistine, who have always proven faithful allies of aerial art by keeping its worldly focus intact. And the ancient world was slowly growing more businesslike.

CHAPTER 2
THE SKY APPEARS

Business was proceeding as usual on the morning of 24 August 79 CE when Mt. Vesuvius erupted explosively, sending a tremendous cloud into the clear summer sky. Years later, Pliny the Younger recalled that scene.

> A cloud was ascending, the form of which ...[resembled] a pine tree, for it shot up to a great height in the form of a very tall trunk which spread itself out at the top into a sort of branches.

This is an accurate description of the classic pino cloud produced by large eruptions or explosions (Fig. 1-5). Pliny also observed that lightning flashed from the cloud and that

> It appeared sometimes bright and sometimes dark and spotted according as it was more or less impregnated with earth and cinders.

For two days the nearby towns of Pompeii, Herculaneum and Stabiae were continuously bombarded with stones and ash from this impregnated cloud, while choking gases filled the air. At the height of the eruption, a glowing cloud of gas and incandescent dust hurtled down the mountain, instantly asphyxiating all who had remained behind.

Summer is the dry season in southern Italy but the volcanic cloud also produced heavy rain. This rain saturated the unconsolidated ash deposits, creating mudslides that overwhelmed the towns. By the time the volcano settled back to sleep and the skies cleared on the third day, everything but a few of Pompeii's rooftops had been buried. Within a few decades even these traces were obliterated.

Some of Pompeii's survivors returned shortly afterwards and tried to recover unclaimed valuables, but as with Santorini some 1700 years earlier, a great treasure of art was left on the walls. The towns were soon forgotten and left undisturbed until the 18th century. Much of what we know of Roman painting comes from these three towns - over 3000 murals have been uncovered.

One hundred and thirty miles to the northwest, in Rome, life was barely affected by the tragedy around Vesuvius. Rome itself has never been touched by a volcanic eruption, but humbler catastrophes buried a few of its palaces, estates or villas while leaving some murals intact. A few of these paintings predate the eruption of Vesuvius by at least a century.

Roman murals include examples of almost every form of art - still-life scenes, genre scenes, portraits, architectural vistas, pornography, and landscapes with sky. The murals were executed using techniques that were apparently well established. From the point of view of naturalism, later Roman works seldom approached and never surpassed the quality of these early masterpieces. Shading gave a feeling of solidity while recession into distance was handled quite effectively although with some inconsistencies because the concept of linear perspective had not been enunciated formally. Thus we have caught an art form midstream, at the height of its development. It is often assumed that these Roman murals are based on Hellenistic originals, none of which has survived.

Roman murals are thus the earliest known paintings in which the sky appears in all its glory. Although Roman artists did not create any painted clouds that can match Pliny's vivid written description, they knew that the sky is a milky blue that is whiter near the horizon than at the zenith. They also knew that distant features of the landscape become indistinct and assume a gray or blue tinge. Thus they were the first to represent the phenomenon of aerial perspective. And even when landscape was not the theme, Roman artists effectively utilized such aerial effects of shading, blurring, and color gradation for purely dramatic purposes.

2.1 Sky Color and Aerial Perspective

Why is the sky blue?

This remained an unanswered question to the Ancient Greeks and Romans. The Ancients also probably had no idea why the sky whitens toward the horizon or why it turns red at sunrise or sunset. They may not have realized that light from the intervening atmosphere makes distant dark features of the landscape appear blue. The astute Roman artists simply recorded their observations of sky color and aerial perspective. Explanations would come much later.

All atmospheric optical phenomena - sky color, rainbows, mirages, etc. - are produced when the path of light is disturbed or obstructed. If visible sunlight passed through the atmosphere without being disturbed the sky would be as black as it is on the Moon and the stars would be visible during the day.

Many atmospheric optical phenomena are also beautifully colored even though they derive their light from the Sun, which is almost white. White light, as Isaac Newton first demonstrated, is actually a composite of all the colors of the spectrum - violet, blue, green, yellow, orange, and red. The various colored atmospheric optical phenomena are produced by processes that separate the different colors of the spectrum.

In 1802, Thomas Young demonstrated that each color of the spectrum corresponds to a different wavelength. The colors of the spectrum are arranged in order of increasing wavelength from violet (0.4 micrometers) to blue, green, yellow, orange and red (0.7 micrometers). Sorting colors amounts to sorting wavelengths.

In 1871, Lord Rayleigh (John Strutt) answered the age-old question of why the sky is blue. Skylight is sunlight that has struck air molecules or dust particles (aerosol particles) in the atmosphere and been scattered in all directions. Rayleigh showed that particles that are tiny compared to the wavelength of light, such as air molecules, scatter light with low efficiency but great selectivity, scattering short visible light waves (violet and blue) much more efficiently than the longer orange and red waves, just as your body easily reflects the tiny ripples that strike it in the bathtub while ocean waves pass around you undisturbed on their way to shore. This preferential scattering of short waves by tiny particles is called Rayleigh scattering in honor of its discoverer. Tiny particles also scatter light more or less equally in all directions (though somewhat less light is scattered by 90°, where it is polarized).

Scattering of light by particles of all sizes was derived mathematically by Ludvig Lorenz in 1890 and independently by Gustav Mie in 1908. Lorenz-Mie theory shows that larger particles scatter light with much greater efficiency, but deflect most of the light by small angles. Furthermore, particles that are much larger than the wavelength scatter all colors of light with comparable efficiency. Figure 2-1 indicates the impact of particle size on scattering.

If air molecules scatter the shortest waves most efficiently, why isn't the sky ever violet? Air molecules scatter significant amounts of blue and green light and progressively smaller amounts of yellow, orange and even red light. The weighted average of this mixture of scattered light is blue.

The sky is less blue when the air is polluted and humid. Most aerosol particles are comparable in size to the wavelength of light. Indeed, the largest aerosol particles, as well as cloud droplets and ice crystals scatter all colors of light with comparable efficiency. (That is why nearby clouds tend to assume the color of the light that strikes them.) When relative humidity increases above about 70%, salt particles in the air deliquesce or get wet and swell, so that they scatter more light less selectively, and by smaller angles. Therefore, the more polluted the air and the higher the humidity the more bleached or whitened the sky appears, especially in the part of the sky near the Sun.

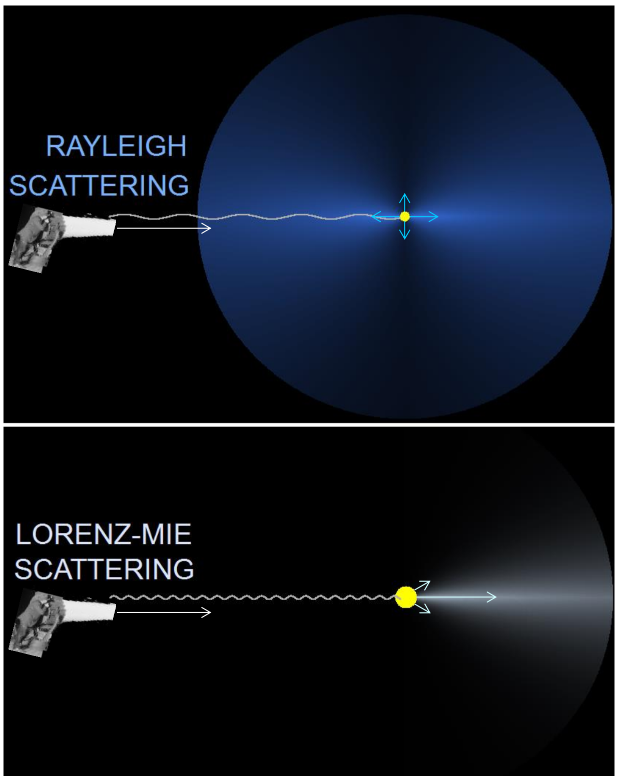


Fig. 2-1. Comparison of Rayleigh and Lorenz-Mie Scattering. Small particles scatter mostly blue light almost equally in all directions. Large particles scatter all colors equally but mostly by small angles.

Large quantities of aerosol particles with diameters between 1 and 2 micrometers produce unusual color effects in the sky. Major forest fires or large volcanic eruptions change sky color by filling the stratosphere with tremendous concentrations of aerosol particles in this size range. Such particles behave in an anomalous way, actually scattering red light more efficiently than blue! During the day, these particles have a pronounced but typically rather bland effect. Countering the normal Rayleigh scattering, they whiten the sky within about 45º of the Sun. But at twilight, when the lower atmosphere lies in the shadow of night, the particle-laden stratosphere is still bathed in sunlight. Then, scattering by aerosol particles dominates, and the sky turns a spectacular, deep blood red to a great height (Fig. 2-2 top). This preferential scattering of long waves by micrometer size particles can also turn the Moon or Sun blue!

Fig. 2-2. (Top) Post Pinatubo red predawn twilight sky over New York City in October 1991. (Bottom) Typical graded blue sky over the Blue Ridge Mountains in Virginia. Distant landscape features are tinged blue by intervening skylight.

Spectacular twilight colors last only several months after huge volcanic eruptions. Slowly, the micrometer size particles fall out of the stratosphere, and are then rapidly washed to the ground by rain or snow. Smaller sulfate particles, also produced by the eruptions, can continue to whiten the sky and cool the Earth's climate for several years, but are too small to produce the red twilights. Eventually even the smaller particles settle out of the stratosphere, and sky color returns to normal.

Even under clean air conditions, sky color is not uniform, but gradually whitens toward the horizon (Fig. 2-2 bottom). The color gradient is largest near the horizon and imperceptible near the zenith. Around sunrise and sunset, the sky can take on the entire range of color from blue above to deep red at the horizon, and the gradation is often so dramatic, even without the aid of volcanic dust, that everyone is familiar with the colors of twilight.

Why is the horizon sky so bleached or reddened? While a modest amount of Rayleigh scattering makes the sky blue, too much can turn it white or even red! Thus, Rayleigh scattering, like the Lord, both giveth and taketh. Any beam of light passing through the atmosphere is attenuated by scattering. Since the short waves are scattered more easily, they are rapidly deflected from the beam, while the less easily scattered long waves tend to remain in the beam and penetrate the atmosphere. Thus, any beam of light is reddened in its passage through the atmosphere. The greater the thickness of atmosphere a light must penetrate, the redder it gets.

This process turns the Sun red as it approaches the horizon. The atmosphere is a thin veneer above the Earth's surface. The lower the Sun in the sky the longer its path through the atmosphere and the more the sunlight is depleted by scattering. When the Sun is overhead, a pure, dry atmosphere scatters about 4% of the red light and 30% of the violet light in the sunbeam. Thus, 70% of the violet light still penetrates this thin veneer and the sunlight at sea level is only slightly yellow. But when the Sun is at the horizon its path through the atmosphere is so oblique that it must penetrate about 40 times as much air to reach the ground (Fig. 2-3). By the time a sunbeam reaches the ground, 80% of its red light and 99.9999% of its violet light have been scattered in pure air. Thus, the Sun turns red because virtually all the blue and violet light have been removed from the direct sunbeam.

The horizon sky is bleached or reddened for the same reason. At twilight the observer stands shrouded in darkness and only the distant sky beyond the horizon is bathed in sunlight. The directly illuminated part of the atmosphere then scatters a small amount of sunlight toward the observer's eyes. At its source, this scattered sunlight or skylight is predominantly violet and blue, but it must pass through so much air before it reaches the twilight observer that a second scattering removes virtually all the blue and violet. What finally does reach the observer is a small fraction of the yellow, orange and red light, but virtually no violet or blue light. Thus, even distant skylight appears red!

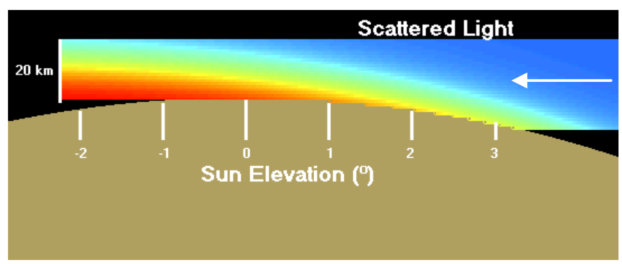


Fig. 2-3. Progressive reddening of scattered sunlight as it passes through the atmosphere near twilight.

During the middle of the day the red light from the distant horizon mixes with the predominantly blue scattered light from the nearby atmosphere. The net result is a bleached or whitened horizon sky.

The horizon will turn orange or red at noon if the nearby sky is shaded. This happens during a total solar eclipse or when a dark cloud comes overhead. The dull orange horizon is correctly interpreted as an ominous sign, for the dark cloud is often the leading edge of a thunderstorm. But the color results from the selective depletion of a light beam by scattering due to air molecules and aerosol particles, and is incidental to the weather's impending violence.

Rayleigh scattering is responsible for the phenomenon of aerial perspective for it imparts a blue tinge to the distant, dark features of the landscape (Fig. 2-2). Several mountain ranges including the Blue Ridge Mountains of Virginia and North Carolina, and the Blue Mountains of Jamaica and Australia have been named for their apparent color. But the blue color is as elusive as the water beneath Tantalus, for as you approach the mountains, it gradually merges into the color of the underlying vegetation or rocks. The blue ridge is always the next ridge.

Distant landscape features turn blue so long as they are darker than the sky. The little light that reaches your eyes from distant dark objects is overwhelmed and tinged by blue scattered light of the intervening atmosphere. Interestingly, the most distant mountain ridges turn almost white because the horizon sky is itself considerably whitened by distant scattered light. The scattering of light from the object and its replacement by sky light also blurs distant objects.

Aerial perspective, the progressive coloration and blurring of objects with distance provides us with a qualitative scale to judge the distance and size of landscape features. The manifestations of aerial perspective have long been part of the stock-in-trade of virtually all landscape painters. For over a millennium, Chinese artists have focused on the various effects of aerial perspective, while Leonardo da Vinci, who first explained the phenomenon, was preoccupied with finding the ways to best capitalize on its dramatic value.

Even today's cartoonists execute their scenes with blue skies above that grade to white horizons and distant blue hills. But it was in Roman art that a knowledge of aerial perspective first appears.

2.2 Roman and Hellenistic Painting

Several of the earliest and best examples of Roman sky painting come from the series of murals known as the *Odyssey Landscapes*. These were found in a Roman house that was uncovered during excavations on the Esquiline Hill in 1848. *The Laistrygonians Hurling Rocks at the Fleet of Odysseus* (Fig. 2-4) might serve as a primer in sky painting. The ships are anchored in a natural harbor that is almost enclosed by precipitous cliffs. The view looks out from a brown and golden promontory towards the distant silvery gray cliff. The sky is cloudless and blue but whitens appreciably in the gap between the distant cliffs just above the surface of the open sea (although it is possibly an indistinct, distant hilly shore).

The *Odyssey Landscapes* exhibit a level of technical facility and confidence that suggests landscape art was already part of a well-established tradition. This conclusion is reinforced by the emphasis on shading and aerial effects. In the early development of an art form, the outlines of objects are stressed. Only much later is attention shifted to the more subtle differences in shading that characterize the airiness of the *Odyssey Landscapes*.

The Romans sometimes exaggerated aerial effects. In their architectural vistas, buildings only a short distance from the immediate foreground were painted as indistinctly as if they had been seen through a thick mist. In some works, buildings literally emerged from the blue without any solid earth to anchor their foundations. On occasion, the mood was further enhanced by eliminating any trace of the horizon line. The net effect was to create the impression of a 'floating' world. Roman patrons apparently found the floating world effects quite pleasing, for they were repeated often enough. This seemingly innocent practice does not accord well with the normally limpid air of Italy. It suggests a people bent on a life of ease, luxury, and perhaps even decadence.

Fig. 2-4. *The Laistrygonians Hurling Rocks at the Fleet of Odysseus.* C. 50-25 BCE. Vatican Museum.

Fig. 2-5. *A Villa Beside the Sea*. C. 70. Stabia. Museum of Fine Arts, Boston.

The *Villa Beside the Sea* from Stabia (Fig. 2-5) shows some of these aerial properties although it retains a distinct horizon line. The scene contains two villas, one in the foreground and another no more than 200 meters behind it. As in the *Odyssey Landscapes*, the villa in the foreground is distinct and has gold and brown highlights while the more distant villa is pale gray and indistinct. To complete the mood, there is only the barest hint of solid ground - an indistinct hill; only villas, water, sky and trees stand out.

If atmospheric visibility in *A Villa Beside the Sea* were as poor as is suggested by the faded appearance of the more distant villa, then the horizon line could not be seen. Nevertheless, the sky is shown quite distinctly and even has a lighter, orange band near the horizon. The horizontally banded sky would later become a mark of Early Christian and Carolingian art; thus it probably continued to appear with some frequency in Roman art. The discrete banding is an unfortunate sign, for it indicates that the artists had identified a shortcut and no longer needed to refer directly to nature when painting the sky. Observations made directly from nature carry their own value and are not easily conventionalized or trivialized. Technical shortcuts, on the other hand, indicate the artist has been severed from the initial source of inspiration. Ultimately, technical shortcuts can become ends in themselves. Whenever they do, they show the feeling for nature has grown stale.

The Romans used grossly exaggerated atmospheric effects for dramatic purposes to highlight the principal characters or actions. Figures in the foreground would be painted distinctly with bold colors so as to stand out from blurred and gray figures just a few feet back. An example of this technique appears in the *Zeus in the Clouds* from Herculaneum (Fig. 2-6). Here, even the wingtips of Eros are made to fade in the distance.

Fig. 2-6. *Zeus in the Clouds*. C. 70. Herculaneum.

Zeus in the Clouds is one of the earliest true landscape paintings that contains clouds, a rainbow and a thunderbolt. The bow consists of several opaque colored stripes which give it a distinctly unpleasant effect. Real rainbows exhibit a sharp but continuous color gradation that the artist should have noticed considering his sensitivity to the effects of aerial perspective. Much of the almost ethereal beauty of rainbows derives from their shimmering translucence, yet artists have almost invariably insisted on painting them as if they were arched leaden cloaks that clog the sky. The thunderbolt was merely intended as a spear, like so many earlier painted or engraved thunderbolts. Clouds, however are a much rarer breed in Ancient Art. The clouds Zeus rests on are very poorly preserved but do appear to be the puffy tops of cumulus.

Fig. 2-7. *Sacrifice of Iphigen*ia. C. 70. Pompeii.

Clouds appear in the *Sacrifice of Iphigenia* (Fig. 2-7) from Pompeii (purportedly a copy of a 4th century BCE painting by Timanthes), but this has been extensively repainted and so, may have been altered. The clouds in this mural lack distinct outlines. They are essentially amorphous mists that serve to hide Artemis and one of her nymphs until they emerge to rescue Iphigenia. The background of the mural resembles a stage backdrop more closely than a landscape; it exhibits a continuous gradation from deep blue above to a pale earth tone below without giving the slightest hint of a horizon line. Seldom in the history of art has the distinction between earth and air been denied with such effectiveness and indifference.

The appearance of clouds is exceptional in Roman art, for the Roman artist preferred to keep the sky clear. There is some meteorological basis to such a choice. The skies of Italy and Greece do tend to be relatively cloud free during the summer. Zeus, of course, is the cloud gatherer so it is natural to find him surrounded by clouds and Artemis herself was no mere earthbound mortal. But if the *Sacrifice* and some later Carolingian illuminated manuscripts are representative, most of the few clouds that do appear in Roman art were treated as formless mists with deemphasized outlines.

The absence of distinct cloud forms from Roman landscape paintings constitutes another sign of a mature art form. No one begins life by focusing attention on the nuances of the things in nature. How then did the mature art form of sky painting begin? The scenes take their story lines from Greek mythology and hint at a Greek origin. Certainly the Greeks seem to have established the fundamental frame of mind needed for sky painting. They traveled widely and founded trading posts all around the Mediterranean. In these cities Philosophy was born with Science grafted to her side, Mathematics was advanced and the foundations of Drama were lain. Then came the Persian Wars. The improbable Greek victory imparted a spirit of ebullience, which was transferred to all their subsequent endeavors. All the possibilities of life seemed limitless. Landscape art could only be born of an outward looking people.

Plato, in the *Critias*, wrote that artists were "reproducing the earth, mountains, rivers, forests, sky and all that encompasses them." Greek pottery of Plato's time reveals no such vistas. A few details from the world of nature such as trees were included in rather piecemeal fashion but there were no landscapes and certainly no sky. But after about 450 BCE, they do reveal recognition of and perhaps the first serious attempts to deal with the problems of perspective.

Landscape is more conveniently displayed on walls or panels than on pots. Background scenery was required for the Greek plays and this may have provided the direct impetus and proper stage for the birth of landscape art. About 440 BCE, atmospheric effects of shade and light were apparently recognized and described in a treatise by Agatharchus, an artist employed by Sophocles and Aeschylus to paint scenery for their plays. A few years later Appolodorus was nicknamed shadow painter for his mastery of these effects. Apparently most of these works still focused on the human figure and did not stress landscape but it is easy to imagine that the props for Aristophanes' play, *The Clouds* might have shown some sky.

Some classical Greeks seem to have disdained the artistic innovations of their contemporaries. Solon thought of theatrical art as a deception, and Plato's objections to the lure and trickery of the arts are well known. These criticisms suggest to me that the Classical Greeks made tentative advances in representing the landscape, but did not fully develop landscape art. Realistic and convincing landscape art may well be spurned and disparaged but in general it is far too matter of fact to elicit such virulent opprobrium. Of course, our ancestors have surprised us more than once.

In 1968 a rare find, a Greek mural, was discovered in a tomb in Paestum, one of the Greek outposts in Italy. This mural, which dates to about 400 BCE shows a diver in mid-air plunging toward the water. The water is painted and the scene is framed by a few trees, but the space for the sky was left neutral.

A decade later, in 1978, an even more significant find was announced. At Vergina in Macedon a tomb dating to the time of Alexander the Great was uncovered. A mural on the outer wall shows a hunting scene. The mural has been credited to either Nicomachus or his son Aristides, who flourished around 325 BCE. The latest the scene could have been executed was shortly before 270 BCE, when the Royal tombs were buried to protect them from being plundered by the Gauls. In the scene, humans, animals and trees are all crowded as if on a narrow stage and the sky is still left neutral, but behind this stage loom mountains that have been turned purple by the distance. An atmospheric effect had finally been acknowledged. Sky painting could not be delayed much longer.

Landscape and sky art were probably developed in the Hellenistic or Roman worlds during the century or two after Alexander the Great. Throughout this most interesting time a great transformation in the human soul was taking place around the Mediterranean. The world was becoming increasingly cosmopolitan. War, commerce and trade brought diverse peoples, goods and ideas in close contact. Science, which had been invented some time before, was now being distinguished from philosophy and finding a new ally in technology. And when people rested from their labors they sought respite in less crowded, idyllic surroundings. This tendency is reflected in their art.

One of the prevalent attitudes that permitted the birth of landscape art is exemplified by a statement reportedly made by Archimedes - "Give me a place to stand and I will move the Earth." Fundamental advances in astronomy and mechanics had been made around the Mediterranean and especially in Alexandria and Syracuse. Archimedes' claim typifies the almost revolutionary sense of confidence and feeling of power that came with the adoption of the scientific attitude about the world of nature. For the first time the universe seemed basically rational and capable of subjugation. Humans envisioned themselves the ultimate masters of their own fate. It is the anticipation of power rather than its possession that breeds optimism.

Just as Archimedes' life symbolized a new outlook that permitted the development of sky painting, so too the events surrounding his death were of pivotal importance in art history. For years Rome had coveted the wealth of Syracuse but had been content to use the Sicilian city as a buffer against Carthage. Syracuse was at that time the most glorious of the many outpost city states which the Greeks had established in Italy and the western Mediterranean several centuries earlier. In 212 BCE the expanding Roman Republic finally overran Syracuse despite Archimedes' war machines.

The Roman general, Marcellus had given specific orders to his army that Archimedes be spared. Most of us know the story of how a young soldier came upon the old man drawing geometrical figures in the sand and slew him when he insisted on a little more time to complete a proof. After the victory, Marcellus commanded his troops to strip Syracuse of her works of art and haul them back to Rome. This was an order his soldiers followed scrupulously.

The confiscation of an enemy's art represented a radical departure from accepted Roman practice. Rome had previously taken gold, silver and slaves back from her victories, but had always spurned the art of her foes, long considering it a mark of degeneracy. Marcellus was one of a breed of Roman generals who deeply admired Hellenistic culture and his decision, according to Livy, marked "the beginning of [Roman] admiration for Greek works of art." For the next two hundred years most Roman victories in the Hellenized part of the world were marked by the wholesale confiscation of Greek statuary and panel paintings. Wealth flowed into Rome on an unprecedented scale and quickly transformed her. Long before the pillage finally tapered off, Rome, the connoisseur, was actively importing and commissioning the art she had so belatedly but rapidly fallen in love with.

The concentration of wealth and the growth of slavery from all these wars caused a mass migration of the disenfranchised to the larger cities. As the poor poured into Rome the wealthy fled to country estates. A love of the countryside and a feeling for nature that had never existed before developed among the Romans and reached an intensity that would not be encountered again until the end of the 18th century. Historians constantly remind us of Petrarch's celebrated climb of Mt. Ventoux (near Avignon in Southern France) in 1336, but 1200 years earlier in 125, the Roman emperor, Hadrian climbed the more difficult Mt. Aetna in Sicily at age 50. He did so with far less literary fanfare, simply to witness the majesty of the sunrise. This is the spirit that had the Romans cover their walls with landscape fantasies.

Greek and Roman art were basically secular even if mythological themes were constantly repeated. So far as we know, religion did not contribute directly to the birth of sky painting. In fact, the retreat of religion's sphere of influence over human affairs - its need to "render therefore unto Caesar the things which are Caesar's" helped render the ground fertile for the birth of sky painting. Religions around the world had for centuries gradually been yielding ground to science on matters concerning natural phenomena and refocusing their messages on moral and ethical solutions to the world's problems. Christ's response to the Sadducees and Pharisees when they asked him to convince them by performing a miracle highlights this transformation of religious emphasis.

> The Pharisees also with the Sadducees came, and tempting desired him that he would show them a sign from heaven.
>
> 2. He answered and said unto them, When it is evening, ye say, It will be fair weather: for the sky is red.
>
> 3. And in the morning, It will be foul weather to-day: for the sky is red and lowering. Oh ye hypocrites, ye can discern the face of the sky; but can ye not discern the signs of the times?
>
> 4. A wicked and adulterous generation seeketh after a sign;
>
> *King James Bible*. *The Gospels According to St. Matthew*. Chapter 16.

This quotation suggests that a considerable repository of meteorological knowledge was taken for granted in the ancient world. More fundamentally, it demonstrates that even Christ treated religious and naturalistic matters on separate planes. For the first time in history the sky had become part of the human domain and could be painted as it really appeared. A window had been created that gave us access to the heavens. Thereafter, although it might at times be painted over, it could never again be sealed.

CHAPTER 3
THE ETERNAL SKY: THE MEANING BEYOND

For 500 years Roman artists maintained a fixed gaze through their open window to the sky. Astonishingly, there are almost no signs of innovation in Roman sky painting after the time of Pompeii. The theme of aerial perspective was repeated almost ad nauseam while other features of the sky such as clouds and optical phenomena were virtually ignored. Yet even as Rome lay dying, she managed to bequeath a viable tradition of sky painting to the Early Christians and Byzantines.

Rome's beneficiaries took a brilliant but all too brief glance at the heavens and produced a few mosaics that stand as landmark works in the history of sky art. To them we owe the glory of the sunset and the resurrection of clouds in art. But once in power, it no longer served their interests to examine the sky. They then barred all further access to the heavens with a curtain of gold, and sky painting throughout Europe slept for almost a thousand years.

3.1 Early Christian Art and the Byzantine Demise

The beginning of Rome's long decline might symbolically be traced to a seemingly minor incident that occurred early in the reign of Vespasian. Vespasian reached Rome in October 70, resolved to restore order and discipline to a Roman government that had languished under Caligula, Nero and several dissolute successors. He embarked on a vigorous construction program that included the Colosseum. Suetonius relates that an inventor approached the emperor with plans for a hoisting machine that would greatly reduce the need for manpower but was rebuffed with the reply, "I must feed my poor." Vespasian feared the machine would exacerbate unemployment in a society already overrun by idlers and slaves. Labor saving devices such as the water wheel were not wanted and consequently were neglected until there was a significant decline in both the general population and the number of slaves late in the 4th century. But a society that does not use its inventors will eventually lose its inventors.

Writing about 70, Pliny the Elder addressed this troubling issue. He noted that his fellow citizens were driven solely by short-sighted commercialism and wrote further,

> no addition whatever is being made to knowledge by means of original research and in fact even the discoveries of our predecessors are not being thoroughly studied.

Pliny, it should be noted, was a man of his times, for in his encyclopedic writings he indiscriminately lumped scientific findings together with the grossest superstitions.

Pliny's characterization of Roman society as totally unoriginal, uninventive and shortsighted was unduly harsh but must have contained a core of truth. Perhaps a more profound aspect of Roman society was its surprisingly desultory and haphazard attitude toward innovation. The concept of progress was undeveloped and little value was attached to research. Romans did appear to be directed almost entirely by immediate results. Specific innovations were not adopted unless they produced an immediate improvement (which is rare for new inventions). Promising general techniques were disregarded. And, if new devices or techniques produced only a minor improvement, the old methods were seldom abandoned but were maintained side by side with the new. In an environment with such a casual and perhaps even cavalier attitude toward experiment, civilization will eventually decline and innovations in sky painting will also cease.

The indifference with which Romans greeted new and more accurate observations can be seen in Roman sky and landscape art. Uniformly blue skies appeared side by side with color graded skies, as if old falsehoods were as good as new truths.

The unbroken series of carved scenes that spiral up Trajan's Column, dedicated in 113 (Fig. 3-1), betrays the same curious ambivalent Roman attitude toward innovation. Recession into distance is handled reasonably well in some of the scenes but in others the depth seems severely limited and characters are packed together in a manner that would come to characterize Medieval art. Little, if any, room is left for the sky in these scenes. Roman sculptors apparently saw no compelling reason to incorporate the aerial discoveries of their fellow painters.

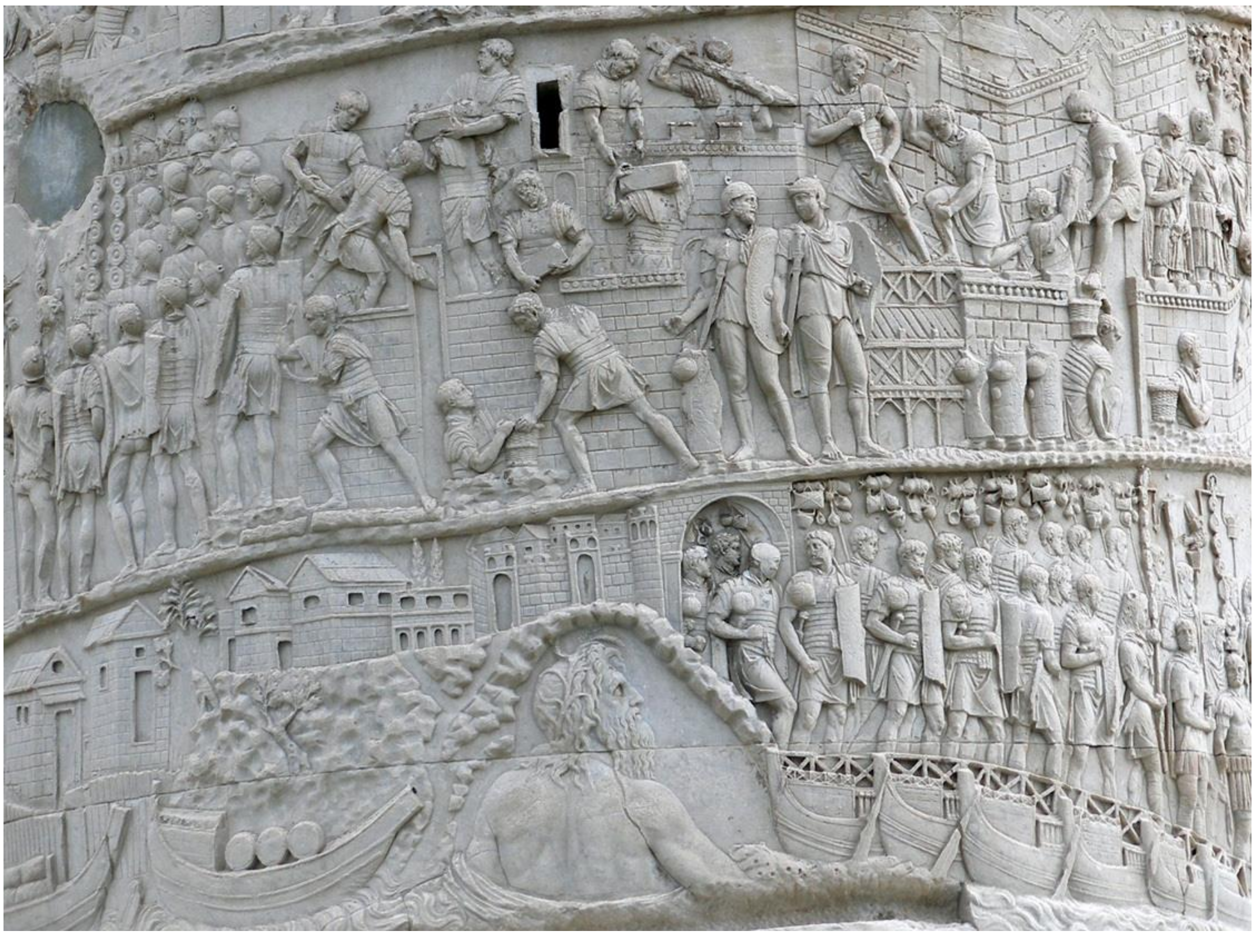


Fig. 3-1. Scene from Trajan's Column. 113. British Museum, London.

For almost 50 years after Trajan's death, Rome enjoyed peace and prosperity. But early in the reign of Marcus Aurelius revolts broke out in Britain and Germany, and Parthia declared war. Roman armies squashed the uprisings but brought plague back from the East as the price of victory. The pestilence spread through the Empire, decimating the population and reducing the normal conduct of business to chaos. Sensing Roman weakness, rebellions against Rome erupted everywhere. For the remainder of Aurelius's tenure in office, the stoic and peace loving philosopher felt compelled to remain almost constantly on the battlefield.

The high mortality rate caused by the pestilence and the seemingly interminable military difficulties of these years did much to sap Roman confidence. Pessimism and a feeling of helplessness infiltrated all levels of society, leaving their mark in Roman art and philosophy. The long inviolable classical rules of proportion and organic form were relaxed. In art, relative size was once again employed to denote the social or spiritual importance of a figure, as it had in much Egyptian art.

Fig. 3-2. *Marcus Aurelius's Column. The Miracle of the Rain*. c. 190

This technique was employed in one of the scenes from *Marcus Aurelius's Column, the Miracle of the Rain* (Fig. 3-2). The scene recounts how a meteorological event altered the outcome of an important military encounter between the Romans and one of the Germanic Tribes. Roman forces were suffering extreme thirst from a drought while the enemy maintained control of the water supply in the river valley. When death from thirst seemed certain, a flash flood saved the Roman forces and simultaneously drowned many of the unfortunate enemy in the flooded river valley.

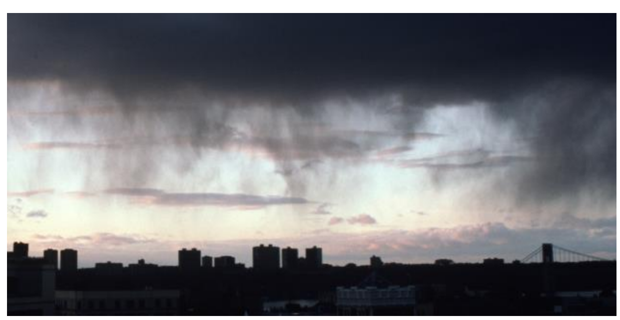


Fig. 3-3. Rain fall streaks over Fort Lee, New Jersey.

The rain in the *Miracle* falls profusely below the outstretched arms of a giant winged figure. The enemy is swept beneath the swirling flood waters while the conquering Romans are about to trample on them.

Rain fall streaks are best seen by contrast against clear, dry air below cloud base. They are dark if shaded (Fig. 3-3) and bright if sunlit, which is most likely when the Sun is low in the sky (so it can pass below cloud base) and behind the observer.

This scene marks the reappearance of the supernatural and the beginning of the slow but inexorable degeneration of naturalism in Roman art. Apparently, during Aurelius' regime, the Romans began to rely increasingly on miraculous and supernatural solutions for their problems. The old world order was impotent to combat plague and could no longer provide an adequate sense of security against human foes. Rome was still able to win her battles but the effort was exhausting. Each victory seemed merely to reveal yet another hungry and eager enemy massing on the frontiers.

Artists at this time also began to place more emphasis upon emotional suffering. The Greeks and Romans had never flinched at showing physical pain in their art but had long been reluctant to represent spiritual agony. From the time of Aurelius's Column, spiritual troubles were depicted with increasing frequency. At first the new expressiveness was largely restricted to conquered barbarians but by 230, some 50 years later, even Roman citizens and Emperors were shown in this way. Spiritual unhappiness had become a widely recognized and publicly acceptable Roman emotion.

The emotional vulnerability provided the opportunity for religion and philosophy to inject once again into the public forum their essentially irrational and mysterious prescriptions for the nature of the universe. A host of new cults and doctrines filled the marketplace and competed for control of people's minds and souls. Slowly, Christianity emerged victorious. Constantine's conversion in 323 may have been little more than a tacit acknowledgment that Christianity had already become a major political force in the Empire. Thereafter Christianity quickly replaced paganism as the principal religion and began to build great churches. These had to be filled with appropriate works of art.

The Good Shepherd mosaic (Fig. 3-4) reflects the changes that had come over the Empire and its art. *The Good Shepherd* represents a radical departure from most earlier Roman art. It has a soothing quality. The setting is pastoral and the shepherd is comforting and protecting his placid flock. The sheep are healthy, the land is green and fertile, and no storm clouds or wild beasts threaten.

Fig. 3-4. *The Good Shepherd*. c. 450. Mausoleum of Galla Placidia, Ravenna. Note waves at bottom!

The brightness and clarity of *The Good Shepherd* mosaic are among its most striking and new features. The prevalent Roman haze has finally been washed away, as by a heavy rainstorm, and even the most distant parts of the landscape (which admittedly do not seem very far away) can be seen distinctly. The youthful and confident religion was announcing to the world the clarity and purity of a new creed. It had nothing to hide. Its shepherd was providing paternal comfort and divine guidance. He was cleansing his flock's soul of spiritual suffering. All was candor, joy and love.

The shepherd, of course is Christ, while the sheep represent the greatly increased Christian flock. Christ's head is surrounded by a gold nimbus or halo and his staff is a gold crucifix, each to imply divinity.

But Christ's love and protection came with a high price tag. The good Christian was required to focus attention on otherworldly concerns. This is why the scene is placed on an elevated mesa, and set off from the wavy world below by a precipice of unknown height. The landscape is also severely flattened to affirm that corporality as indicated by physical depth, the seat of all evil, is to be despised.

The sky of *The Good Shepherd* remained blue despite the mosaic's new message, for the Early Christian Church enlisted classical values and images as allies in its accession to worldly power. The sky consists of two bright blue stripes, with the lighter stripe near the horizon and the darker one above. The Romans had frequently used this simple convention to represent the graduated sky (recall Fig. 2-5), and apparently never lost sight of its physical significance.

The Early Christians adopted the convention of sky banding and, for a brief time, also used it with some discrimination. In *The Good Shepherd*, the boundary between the bands is not horizontal as it should be. Ultimately the banding would be stripped of its connection with the world of nature so that by the time of Carolingian art it had acquired its own meaning. The Early Christians inherited Roman culture and benefitted from it even as they set about dismantling its exposed and rotting foundations. This is one of the ironies of history. The Early Christians disparaged and ultimately helped destroy the Classical heritage that had been placed at their fingertips while many of their descendents would yearn for the Roman past - its order, magnificence and sophistication - but had fallen so far they could not even begin to comprehend it.

For some years after *The Good Shepherd*, the Early Christians and Byzantines continued to find inspiration in the sky. To them, as to St. John the Divine, the sky was important as a source of Revelation and a symbol of heaven. Even the clouds merited attention for it was written that Christ had disappeared into a cloud and prophesied he would once again appear in clouds - "Behold, he cometh with clouds; and every eye shall see him."

Fig. 3-5. *Christ Appearing in the Clouds*. C. 530. Church of St. Cosmas and St. Damian, Rome.

And so, in the Church of St. Cosmas and St. Damian in Rome, we find the magnificent mosaic of the apse, *Christ Appearing in the Clouds* (Fig. 3-5). This was executed about 530 and was accompanied by the inscription,

> This hall of God shines in its adornment with enamels, a hall where the precious light of faith gleams even more brightly. To the people a sure hope of salvation comes from the martyrs who heal their ills, and the temple before named as

> sacred has increased in honour. Felix has made to the Lord this offering, worthy of the Lord's servant, that he may be granted life in the airy vault of heaven.
>
> quoted in *The Mosaics of Rome*. p 94. Walter Oakeshott

The mosaic is, indeed, a monument of religious splendor. Its brilliant and sparkling colors display the mosaic technique to maximum advantage. A deep blue sky occupies a large percentage of the mosaic, for Christ has appeared in the clouds to announce the Last Judgment. It is the sky of twilight, perhaps the final twilight on Earth. No wonder its blue is so deep and its clouds, which support Jesus, are streaked with such bright red.

This cloud-filled, twilight sky contrasts sharply with all known remains of earlier Roman art. The colors of Roman murals tend to be far more subdued than in this mosaic. This is due in part to the fact that mosaic colors retain their extraordinary brilliance while paints invariably fade or darken as they age. But earlier Roman mosaics never employed such spectacular colors and many were done in black and white. Bedazzling the spectator was one of the deliberate aims of the Early Christian Church.

The mere presence of clouds was also intended to strike Romans, who had generally preferred a clear sky with at most a few formless mists of clouds lacking substance. The attention that the Early Christian artists lavished upon clouds represents their singular contribution to sky painting. For the first time, substantial clouds were accorded their rightful place in the sky. Clouds helped buoy Europeans through the Dark Ages and finally liberated them in the 15th century. Never again would they entirely disappear from European art.

By the end of the 4th century, clouds were regularly appearing in Early Christian art. The first clouds tended to resemble tubes or loaves of bread, and can be variously identified as cumulus or their flattened and sometimes banded relatives, stratocumulus and altocumulus (see §5.2). The clouds of the *Christ Appearing in the Clouds*, for example, are most likely flattened, banded stratocumulus or altocumulus often seen at twilight.

Gradually, these smooth and pliable clouds froze into flattened triangles with horizontal bottoms and scalloped tops. In this odd and highly stylized form they were almost universally adopted by Byzantine artists and clung to life until the Renaissance. It is possible that these triangular clouds proved so enduring because they suggested the Trinity to the medieval mind. Yet as odd and stylized as such clouds may seem, their shape was ultimately derived from observation. They resemble either small cumulus or altocumulus castellanus, which characteristically do have flat bottoms and gently corrugated tops. They are also Mediterranean clouds, for summer skies around the Mediterranean are dry skies that stunt cloud growth.

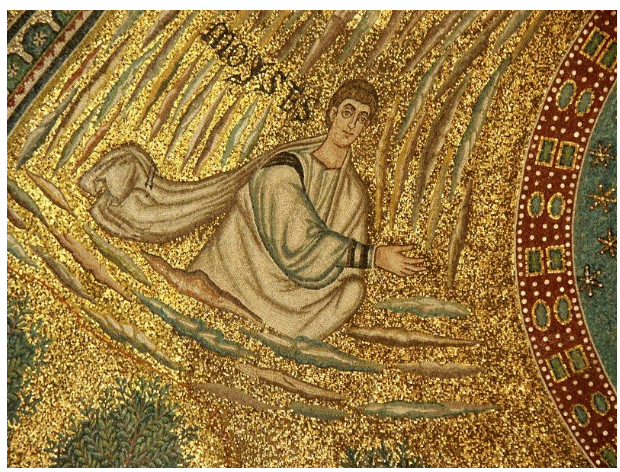


Fig. 3-6. *Apse of Sant' Apollinare*, Detail. C. 550. Classe, Ravenna.

Then the atmosphere disappeared. The mosaic from the apse of Sant' Apollinare in Classe, Ravenna (Fig. 3-6) was completed only a few years after the *Christ Appearing in the Clouds* yet its form is ossified. Here the viewer is besieged by legions of stylized triangular clouds with flat bases and scalloped tops, some rotated by 90º. The cloud legions appear in a sky that has become largely golden. The Church of this work is a confident, controlling power. It no longer has need of tolerance or innovation. As Eric Hoffer noted in *The True Believer*, "The conservatism of a religion – its orthodoxy - is the inert coagulum of a once highly reactive sap." The blue sky and clouds represented Christianity's highly reactive sap - the gold, its inert coagulum.

The gold sky served many purposes in medieval art and managed to outlive the Middle Ages. The gold imparted an aura of majesty to all works. It helped the figures stand out distinctly from the background. But its primary role was to remove the background. Gold skies simply obliterated any earthly reference point, dissociating the scene from the material realms of time and space and relocating it in the spiritual domain of the eternal and holy. And this, according to the Church fathers, symbolized ultimate reality. Heaven had blocked out the sky.

Sant' Apollinare represents the swan song of the Western Empire. Increasingly from the time of Constantine, men of talent had been drawn into the service of the Church, forgoing government careers, and hastening the civil decline. The stern Roman code of discipline had long since been drowned in a fragrant bath of luxury. Even the climate may have played a crucial role in Rome's downfall. Barbarians, probably forced from their central Asian grazing lands by an extended drought after about 300, migrated westward and repeatedly stormed an inward looking and fearful civilization.

In 541, when Sant' Apollinare was under construction, plague broke out in Egypt. It rapidly spread across Europe and then eastward into Asia. Repeated outbreaks over the next 25 years along with the ensuing civic breakdown may have reduced the population by as much as 50% and wreaked havoc on the economy of the Empire. Justinian's costly wars to reunite the Empire only added to the chaos. Rome symbolized this decay - its population, once a million, had fallen to 40,000. It was at this point that darkness finally descended over much of Western Europe.

Byzantium, ensconced within the safety of her walls and at the economic crossroads of Eastern Europe, managed to lead a nervously comfortable existence through the Middle Ages. The Byzantines helped to preserve and transmit the accumulated heritage of the Classical world, but their efforts were marked by such conservatism that in many fields, such as sky art, they added little to this heritage.

The conservatism of Byzantine art was no accident. Church and State dictated the themes, flavor, and even the remains we have of Byzantine art and ensured their unwavering devotion to a timeless and changeless Christian creed. An almost Egyptian immobility returned to the human scene. Artistic creativity was simply not a Byzantine issue. A decree of the Church Council of Nicaea in 787 ensured that artists were not to be regarded as individualists or creators. "It is for the painters to execute; it is for the clergy to ordain the subjects and govern the procedure." The role of religious art was defined quite narrowly in Byzantium. Its sole function was to illustrate theological truths in an orthodox manner. Just as we do not want our copiers to change the originals one iota, so too the Byzantine patrons demanded their artists to preserve the "true message" they were employed to transmit.

The Byzantine attitude toward painting fluctuated from a relatively benign inflexibility regarding innovations to a harsh and ruthless intolerance of the very existence of any painted images. Oddly enough, the Council of Nicaea had the effect of liberalizing the attitude towards art in Byzantium. The Council helped weaken the influence of the Iconoclasts who had come to power in 726. The Iconoclasts abhorred all graven images, in imitation of Islam's juggernaut, and caused a wave of destruction that eradicated almost all earlier works of art in Byzantium.

In Western Europe, no single wave of destruction matched the achievements of the Iconoclasts. Nevertheless, by the time of Charlemagne, some 200 years after Justinian, Roman heritage in Western Europe had faded to little more than a vague memory of past grandeur and glory. When Charlemagne returned from Rome in 800, he passed through Ravenna and was deeply impressed by the churches and their mosaics. He had his chapel at Aachen modeled after the Church of San Vitale at Ravenna.

Ravenna's mosaics may also have served as models for Carolingian painters, since the striped sky is one of the trademarks of Carolingian illuminations. Most of the stripes are blue but a significant fraction are pink because of the popularity of twilight scenes. The color sequence of these stripes often bears a relation to the real world but at times,

> The painters seem to have forgotten the actual significance of the convention and used it merely decoratively, as the sequence of colors has no relation to anything that exists in nature.
>
> D. Pearsall and E. Salter. *Landscapes and Seasons of the Medieval World*. p 41.

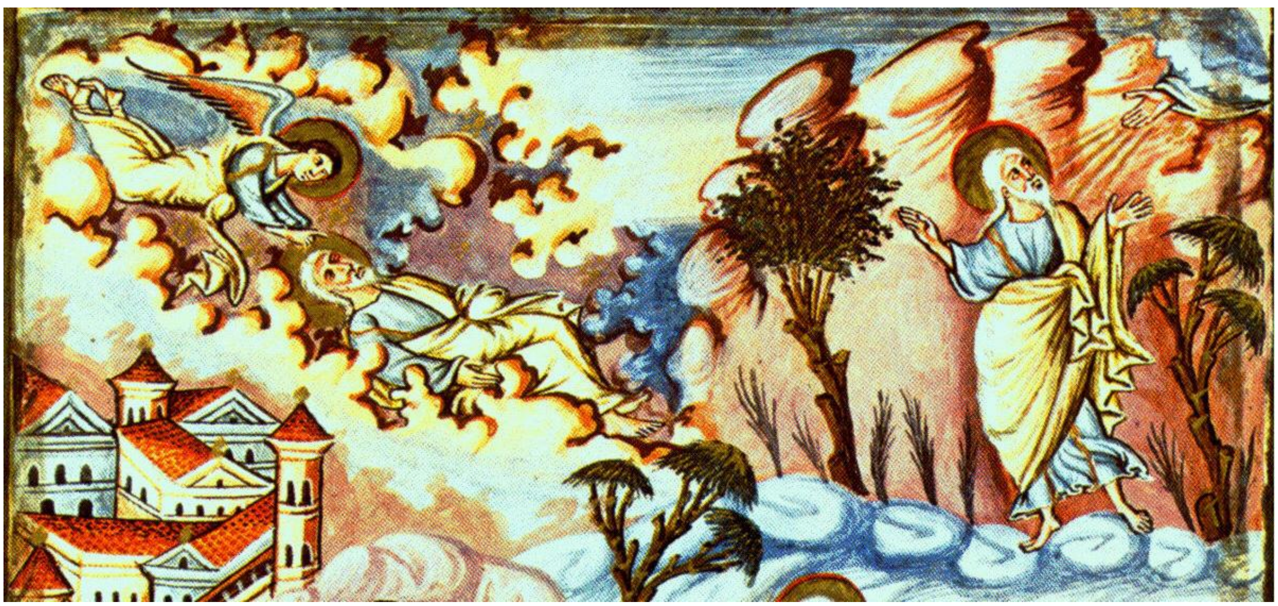


Fig. 3-7. *Bible of San Paolo fuori Le Mura*. *Frontspiece to Deuteronomy*. C. 870. Abbey of San Paolo fuori le Mura, Rome.

The *Frontspiece to Deuteronomy* from the *Bible of San Paolo fuori Le Mura* (Fig. 3-7) contains an aerial color sequence that has come unhinged from nature. In the upper left, Moses has died and is being transported across the sky to heaven by an apocryphal angel. Three colored stripes appear above the prophet's feet. From top to bottom they are light blue, almost white and dark blue. If the top two stripes corresponded to clear sky and the bottom to the ocean, as in some Carolingian manuscripts, the sequence would be natural. But here, in contradistinction to anything from the natural world, the three colors tint the clouds while the clear sky appears to grade to burgundy.

The fascinating, but stylized, clouds in the *Frontspiece to Deuteronomy* resemble the tops of burgeoning cumulus and give a distinct feeling of the eddying motion that molds them. Such a flowing representation of clouds is exceptional in European art but has long been familiar to Chinese artists. The clouds of the

Frontspiece are probably based on some Roman or Early Christian prototype, now lost. Even though the cloud protuberances are ultimately abstracted from nature, the artist tilted a few of them so that they aim diagonally downward, a possible but most unlikely orientation.

The indiscriminant jumbling of observations from nature in the *Frontspiece* reveals a basic aspect of the intellectual state of its creators. Imagination and, in its wake, symbolism had replaced substance. In a sense, the Carolingians were like children who have found an abandoned car. They played for a while with the steering wheel, perhaps hummed to imitate the engine's purr, but had little idea of an engine's significance and no concept of its design. The Carolingians were able to transmit to their descendents only the inert rusted frame of the vehicle of civilization. They knew only, like children know, that their car couldn't go but that once upon a time their forefathers, the Romans, had somehow smoothly run a vastly superior Empire. It was in this impotent state that barbarian marauders from the north and east returned again and again over the next two centuries to brutalize and ravish Western Europe. And as the Europeans huddled together, paralyzed with fear and saddled with ignorance, the forests slowly but inexorably grew over them and cast them back into darkness.

3.2 The Divine Light of Natural Halos

The halo, emblem of divine light and beacon of medieval painting, was the only reliable source of illumination for the souls that lived through the long Dark Ages. Figures 3-4, 3-5, and 3-7 give some indication of how common halos were in medieval art. During the same time period, Buddhist painters in Asia were equally enthusiastic about halos. Indeed, there is good reason to name the period from about 450 to 1000, the Age of the Halo.

Halos in art have an ancient source. In Sumeria, where the halo was recognized as a sign of impending rain, the Sun was sometimes represented as the wheel of a heavenly chariot, while the rim served as the prototype of the halo. By the 9th century BCE, the Assyrian god, Ashur was placed in the aura or halo (recall Fig. 1-17). The imagery of a heavenly chariot, taken from Babylonian sources, was absorbed into Jewish culture through the Vision of the prophet Ezekiel, which was represented in later Jewish and Christian art as a series of halos. Spiked aureoles also appeared around the head of the Persian sun god, Mithra and in that form they were appropriated by the Greek sun god, Helios. Rome, in its turn, embraced the cult of Mithra, perceiving the god as a beautiful youth with a radiant halo emanating from his head. The Roman halo formed one more channel in the braided halo river that discharged directly into the sea of Christian art.

Fig. 3-8. *Buddha With Halo and Nimbus*. Cave 249, Dunhuang, Gansu Province. C. 530.

By the time halos appeared in Christian and Buddhist art, they had mostly lost their spikes or rays. In Christian art halos, invariably encapsulating the heads of holy and divine figures, were represented as circular disks of solid gold, sometimes accompanied by thin radial rays. Buddha had a halo around his head and an oval aureole or mandorla enveloping his body. These were concentric rings of various colors, but on occasion, spiked flames still burned on the shoulders of various divine Buddhist figures, as in *Buddha With Halo and Nimbus* from Cave 249, Dunhuang (Fig. 3-8).

A number of different atmospheric optical phenomena could have inspired artists to represent halos. First is the circular aureole immediately around the Sun. This is produced by the scattering of sunlight by aerosols.

A second phenomenon is the corona, a series of colored rings of light usually a few degrees from the Sun. Coronas only appear when the sunlight is partially obstructed by certain thin, translucent clouds (see §6.2). Aureoles and coronas would more properly be represented as solid disks rather than thin rings.

Fig. 3-9. A 22° halo. It has a reddish inner fringe and outside whose brightness fades gradually.

The most likely natural source for ringed halos is the panoply of atmospheric ice crystal halos. Ice crystal halos are seldom, if ever, noticed by today's city dwellers, but they appear in the sky quite frequently. They are most common in Polar Regions during the winter where they can form right in front of your eyes, but they can be seen at any time of the year and at any place on Earth because at heights above about four miles the air is always cold enough to produce ice crystals. Halos are frequently seen in sheets of translucent ice crystal clouds called cirrostratus, as in Fig. 3-9, and serve as harbingers of approaching winter storms (see Fig. 5-10), hurricanes, and thunderstorms.

Few people recall ever having seen an ice crystal halo. This is partly because most ice crystal halos appear relatively near the Sun and are difficult to see amidst the general glare. When searching for halos in the sky it is often necessary and always wise to block the Sun from view. Even then, most halos are not bright enough to emerge clearly from the background skylight, so it is necessary to become somewhat practiced in finding them. On occasion, however, halos are so bright and exhibit such spectacular colors that they can take your breath away.

Fig. 3-10. *The Vision of the Prophet Ezekiel* c. 450. Church of Hosios David, Salonika.

Perhaps it was a spectacular halo display that inspired Ezekiel's mystical and apocalyptic Vision of a heavenly chariot. The Vision is difficult to interpret because it is couched in prophetic and miraculous terms, but it still matches many features of ice crystal halo displays. The Vision has also justifiably been compared to the Aurora Borealis, but artists from at least the 5th century, as in the mosaic, *The Vision of the Prophet Ezekiel* from the apse of the Church of Hosios David in Salonika (Fig. 3-10), have almost invariably interpreted it as a halo phenomenon. Here it is accompanied by colored crepuscular rays and an arched rainbow seat.

This work contains several departures from naturalism. Crepuscular rays (see §6.2) emanate from the Sun, but only when obstacles such as clouds or mountains cast shadows that alternate with sunlit regions. They may have color but never color bands. Rays emanating from the unobstructed Sun in clear skies are merely the physiological result of afterimages momentarily burned into the retina. Rainbows appear opposite the Sun and the outside of the primary rainbow is red.

Ezekiel noted the date and place of his Vision, but neglected to say whether it was day or night. This exile from Israel was then living in Chaldea by the river, Chebar (Khabur), between the Tigris and Euphrates Rivers, about 50 miles southeast of ancient Babylon. According to the dating system employed by the prophets, the Vision occurred during July of the year 593 BCE. If the *Vision* did in fact occur at this time of the year it would have been truly remarkable because summer is the dry season in Chaldea and the summer skies of Iraq are generally clear.

Which aspects of Ezekiel's Vision match observed features of atmospheric ice crystal halos? Ezekiel wrote of wheels like rings, and wheels within wheels, eyes, wings, and a single rigid leg. The apparition and wheels did not rotate as they moved about the sky and when the apparition was high in the sky the wings were let down. The colors were variously compared to burnished bronze, fire, electrum, amber, beryl, sapphire, and finally a rainbow.

Fig. 3-11. Halo display at Oberwiesenthal, Germany that matches many features of Ezekiel's Vision. The "foot" is seen because the view faces downslope. Claudia Hinz, photographer.

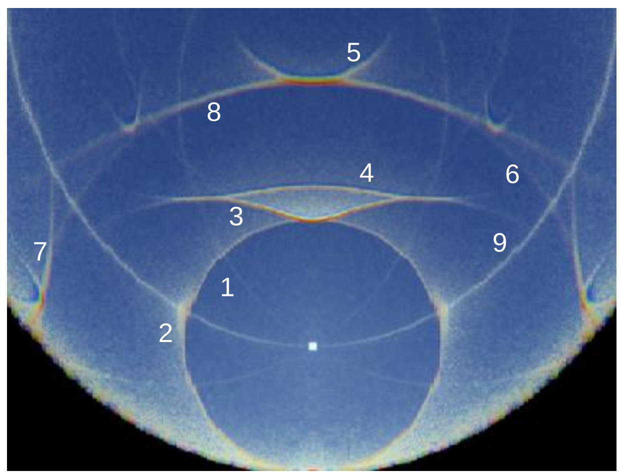


Fig. 3-12. Computer simulation of a halo display similar to Fig. 3-10. Key: 1 =22° halo, 2 = sun dog, 3 = upper tangent arc, 4 = Parry Arc, 5 = circumzenithal arc, 6 = 46° halo, 7 = infralateral arc, 8 = supralateral arc, 9 = parhelic circle. Hook-shaped arcs on arcs 7 and 8 and sun dogs appear like "eyes" in Ezekiel's Vision. The lower tangent arc or "foot" (not shown because below the horizon) forms below the base of the 22° halo. Sun pillar is missing in this simulation.

The extraordinary and spectacular but entirely natural atmospheric halo display seen looking down a ski slope at Oberwiesenthal, Germany (Fig. 3-11), and closely matched by the computer simulation (Fig. 3-12) seems to be almost an embodiment of *Ezekiel's Vision*.

Let us diagnose this panoply. Perhaps the most common halo is the 22º halo (as in Fig. 3-9), so named because it is a circular ring seen at an angle of 22º from the Sun (or Moon). This is Ezekiel's inner wheel or ring. Large segments of the 22º halo can be seen about 50 times a year in much of the middle latitudes. Just outside either side of the 22º halo and at the same level as the Sun are bright spots or "eyes", called parhelia or sun dogs because they follow the Sun in its transit across the sky. These are also common visitors in the sky.

The outer wheel is the 46º halo, which is seldom seen in its entirety. In this display, it is accompanied and largely overwhelmed by the much brighter and more colorful supralateral and infralateral arcs. Attached to these arcs are four (very rare) colorful hook-shaped arcs that might be taken for eyes.

Bright arcs that touch the tops of both halos are the "wings". The arc touching the 22º halo is the upper tangent arc while that touching the 46º halo is the circumzenithal arc. The Parry arc is the rare cap like arc (a second pair of wings?) above the 22º halo. At the bottom of the 22º halo are two arcs which are almost fused into a "leg". This is seen in Fig. 3-10 because the downslope view allows us to see below the normal horizon line, where the arc forms when the Sun is low in the sky.

Several arcs pass through the Sun and either reach or pass through the 22° halo to give it the impression of a wheel with spokes. The vertical arc is the sun pillar. The parhelic circle is the horizontal arc that runs through the Sun and is centered on the zenith. When the Sun is high in the sky the parhelic circle and the 22º halo cross like two intersecting circles.

Some of the arcs or spots such as the parhelia and the tangent arcs can be incredibly bright, while arcs associated with the 46° halo, such as the circumzenithal arc, sometimes exhibit colors with even greater purity than those of the brightest rainbow.

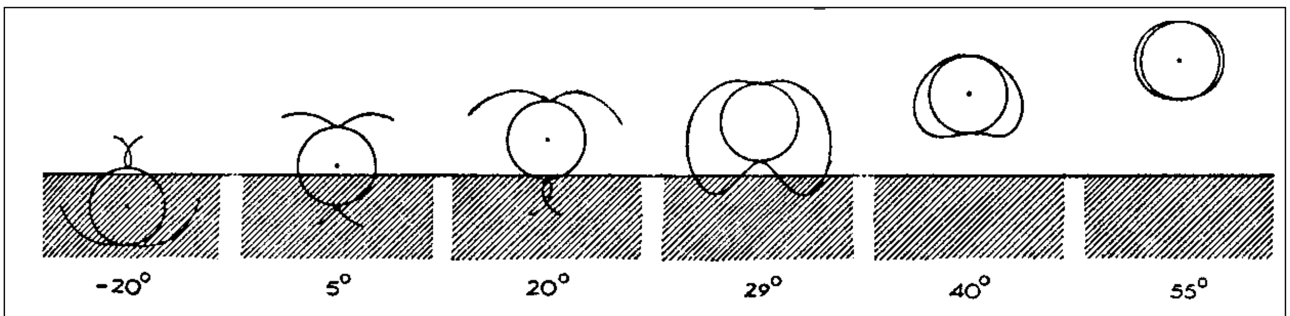


Fig. 3-13. The changing shape of the upper tangent arcs. ***Rainbows, Halos and Glories*****, Robert Greenler.**

Finally, since the parhelia or eyes remain at the sides of the halo as the Sun rises, and the parhelic circle remains horizontal and does not rotate, circular halos might give the impression of wheels that do not turn as they move. The upper tangent arcs or wings are among the halo arcs whose shape varies with the height of the Sun. The higher the Sun in the sky the less arched the tangent arcs or wings. Thus, when the apparition is high in the sky the wings seem to be let down. Once the Sun climbs higher than about 29° the wings join the leg to enfold the halo in a circumscribed halo (Fig 3-13).

Several natural questions follow from seeing an extraordinary halo display such as that of Fig. 3-11. 1: How do halos form? 2: What accounts for such incredible diversity of shapes? And, 3: Why are such displays so incredibly rare?

Atmospheric halos are produced when sunlight or moonlight penetrates clouds that consist of ice crystals. The crystals act as prisms, reflecting and/or refracting (bending) the light. Light refracts whenever it passes obliquely from one medium to another (such as from air to water or to glass), as through a prism. The prism refracts each color or light wave at a slightly different angle - red the least and violet the most. Thus, when a narrow beam of white light enters the prism a complete spectrum emerges from the other side.

Like halos, rainbows are also produced when sunlight is refracted and reflected. But whereas halos are produced by ice crystals, rainbows involve raindrops. The differences between halos and rainbows arise from the differences between the shapes of ice crystals, which are basically all hexagonal (six sided) prisms (Fig. 3-14), and raindrops, which are all nearly spherical.

Fig. 3-14. Ice crystal shapes. Ken Libbrecht.

The wondrous diversity of halo shapes results from three principal factors, 1: the precise shape of the ice crystals, 2: their orientation as they fall and, 3: the Sun's height in the sky. Most ice crystals have six rectangular sides and two hexagonal faces but this barely restricts their diversity. Ice crystals can resemble snow crystals, flat plates, long pencils or even bullets or umbrellas (Fig. 3-14). They can tumble in all directions as they fall or, like many wind-blown seeds, may fall with a preferred orientation. Finally, the Sun's height in the sky determines which faces of a crystal the sunlight strikes and which it exits from.

How do crystals get their shapes? Water molecules are shaped like tiny triangular H_2O boomerangs, with the oxygen atom at the center and the hydrogen atoms bonded on each side at an angle of 104.5°. The triangular vapor molecules lock arms as tiny hexagonal ice crystals. Almost all ice crystals are built on a hexagonal or six sided plan, but there are such incredible variations, it is no wonder no two crystals are exactly alike. First are the different growth habits. The hexagons can deposit concentrically to form plate-shaped crystals. They can deposit on top of one another as columns to resemble new wooden pencils. If we sharpened the pencil by tapering each of the six sides the pencil would resemble crystals with pyramidal endings.

These are the simple crystals. Most crystals are more complex. Many form in clusters or are partly hollow, especially when growth is rapid. Many are coated with droplets that have stuck and frozen to them and look as if they had been engulfed by parasites. Then there are the classically branched snow crystals.

Specific temperature and humidity conditions lead to the various crystal habits. Crystals can only grow when the air is slightly supersaturated with vapor for ice, in other words, when relative humidity is slightly above 100%. Branching snow crystals form when supersaturation is high (≈15%) and temperature is near -15°C. As humidity in the cloud pulses, each branch of the crystal experiences growth pulses, hence the infinite variations. When the air is only slightly supersaturated solid pencils and plates respectively above and below about -10°C grow slowly, patiently, and regularly, filling in gaps.

No sooner have the crystals formed than countless sunbeams strike them. Some of the sunbeams are reflected, as by a mirror. Fresnel's law tells what percent are reflected. The beams that are not reflected pass into the crystal and are refracted following Snell's Law. These sunbeams proceed to the back or bottom of the crystal where they can either exit it or reflect inside it. Ultimately, almost all sunbeams escape the crystal and head in a variety of directions.

Classically branched snow crystals are exceedingly beautiful, but have so many facets that sunbeams emerge from them in a host of incoherent directions - too many to produce halos (except sun pillars). The simple pencil and plate crystals offer sunbeams the fewest departure paths and thereby produce the best halos. In most ice crystal clouds only a small fraction of crystals are simple plates or pencils; that is the main reason most halos are so dull.

The halo's brightness and color purity also depend on the cloud thickness and height. To form a halo, a sunbeam can strike at most a single crystal. Any beam that strikes a second crystal will almost invariably be deflected into some incoherent direction. A good rule is when the cloud is too thick for the Sun to cast shadows it is too thick to see a halo.

The halo beam is like a spreading searchlight beam. When the cloud is high in the atmosphere the crystals producing a halo seen at the ground cover a much wider area (and hence volume) of cloud. The larger the volume, the smaller the probability that most crystals have only a few simple forms, and the smaller the chance of seeing spectacular halo displays from high clouds. But when crystals form right in front of your eyes, just above ground level in mostly clear skies, as they do in the Polar Regions or on ski slopes (where snow guns manufacture crystals), they come from such a small volume with such uniform conditions that many may be alike, so brilliant halos are far more likely.

How do the various halos form? The 22º circular halo (inner wheel) is often seen by itself. It is produced when light is refracted as it enters one of the six rectangular sides of the ice crystal and refracted again as it exits two sides away (Fig. 3-15). Light following such a path is deviated by an angle of 22º or more from its initial direction (that of a sunbeam). The halo appears at 22º because light deviated by the minimum value of 22º is produced by the greatest range of crystal orientations and is therefore the most intense and brightest.

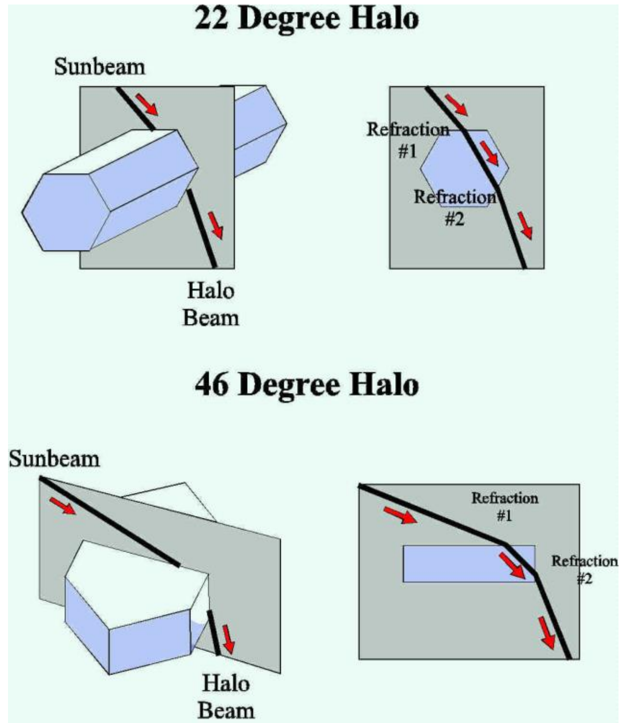


Fig. 3-15. The paths of light beams passing through ice crystals to produce the 22º and 46º halos.

To form a complete circular halo many of the ice crystals must tumble or be oriented in random fashion as they fall so that the light is equally likely to be refracted in any direction - up, down left, right, or diagonally.

The 22º halo possesses two additional pronounced features. First, the inside of the halo (the part nearest the Sun) is always reddish because red is refracted the least of all the colors of the spectrum. Second, the sky immediately inside the halo is darker than just outside because no light is refracted by a smaller angle than 22º. Thus, if divine halos maintained their link with atmospheric halos they would be red-rimmed translucent rings of light rather than solid gold disks.

The 46º halo (big wheel) results when sunlight passes through one rectangular side and one hexagonal face of a layer of randomly oriented crystals. This may sound simple, but even under optimal conditions – perfect thick solid plate crystals – there is only a small probability that light takes this path. Under these optimal conditions, the 46° halo is still less than 1/5th as bright as the 22° halo, so it is almost invariably masked by background skylight.

The various spots and arcs appear when the crystals fall with a preferred orientation. If only some of the crystals are oriented, the 22º halo will still appear but will be brighter either near the top and bottom or on the sides, where it joins some of the arcs and spots.

Oriented crystals produce the brightest halos because they concentrate the deflected sunbeams on a small part of the sky. Crystals tend to fall in an oriented manner with their longest dimensions almost horizontal. You can demonstrate this easily. Cut a piece of paper about 2" long and less than ½" wide. Hold it over your head and drop it. It will soon begin to spin with its longest axis almost horizontal. Because of that, when light strikes one side of a long pencil crystal and exits two sides away, the light will be bent either almost up or down to form the tangent arcs. The Parry arc and the hook-shaped arcs form when, in addition, one of the rectangular faces of pencil crystals is horizontal. When the light passes through one rectangular side and one hexagonal face of the horizontally falling pencils it will produce the supralateral and infralateral arcs.

Thin plate crystals fall with hexagonal faces nearly horizontal and all six sides nearly vertical. When sunbeams enter a side and exit two sides away they will be bent left or right and produce the sundogs. Light entering a vertical side and exiting through the bottom face leads to the circumhorizontal arc, which is parallel to the horizon and a little more than 46º below the Sun. Light entering the top face and exiting a vertical side produces the circumzenithal arc, which circles the zenith and appears a little more than 46º above the Sun.

Sunbeams reflected from one of the vertical sides of the plates or columns form the parhelic circle. All of the halo arcs that pass right through the Sun are formed by light that is reflected by oriented crystals.

When the crystals have a preferred orientation, the path of the refracted or reflected light is restricted and resulting halos are more intense. This is why the arcs and spots can be far brighter and more brilliantly colored than the circular halos. The sun dogs usually have the greatest intensity and may actually be mistaken for the Sun itself. On occasion the arcs can be brighter than the brightest rainbows and arcs of the 46° halo can have higher color purity. When bright halo displays arch across the sky, some of the arcs surely will appear like rainbows, perhaps as Ezekiel observed.

The elevation of the Sun is very important in determining the brightness, shape and even the possibility of the arcs or spots. The sun dogs tend to be brightest when the Sun is about 22º above the horizon. As the Sun gets higher, the sun dogs begin to fade and move out from the 22º halo because of the oblique angle at which the sunlight enters the crystals. The sun dogs disappear when the Sun climbs higher than about 61º in the sky because the sunlight can then no longer both enter a vertical side and exit two sides away.

The circumhorizontal arc, which is frequently mistaken for a rainbow, can only form when the Sun is above 58º and is potentially brightest with highest color purity when the Sun is 68º above the horizon. Its complement, the circumzenithal arc is potentially brightest with highest color purity when the Sun is about 22º above the horizon but cannot form once the Sun rises higher than 32º. This is also true of the supralateral arc.

The shape of most halo arcs depends on the Sun's height. When the Sun is near the horizon the upper tangent arc or wings are stretched high but as the Sun rises they droop, and merge with the lower tangent arc once the Sun climbs to about 29° above the horizon and finally merge with the 22º halo once the Sun climbs above about 61º above the horizon (see Fig. 3-13). Since Ezekiel reported that the wings relaxed when the Vision rose in the sky it seems that the Vision took place during the morning hours of a spring or summer day.

When crystals have pyramidal ends the circular halos they produce appear at different angles from the Sun than the 22° halo, namely 9°, 18°, and 35°, to mention three. This too could account for the wheels within wheels of Ezekiel's Vision.

With the close of the Middle Ages the halo fell from favor. During the Renaissance, it appeared much less frequently, although the solid gold disk was refined to a more delicate, translucent ring that hovered weightlessly above the heads of occasional divine and holy figures. Somehow, as the world grew secular, the halo was never divested of its religious associations and so, virtually vanished from art. Only recently have a few artists begun to notice real halos. Otherwise, the 20th century has reserved the halo for almost exclusive use in cartoons, where it either identifies poor departed souls or represents our consciences. Even in such anecdotal uses, there seems to be an unwritten conspiracy to treat the halo as the exclusive property of the world beyond, an eternal symbol of divinity - or death.

There is one notable exception in which the halo appears in all its naturalistic glory. On 21 April, 1535, from 7:00 to 9:00 AM an extraordinary halo display was observed over Stockholm and painted in the *Storkyrkan* (the Cathedral). The *Vadersolstavlan*, or weather-sun picture (Fig. 3-16) contains a topographic view of Stockholm. The halo complex appears in the sky above the city but rotated by 135°. The halos were considered nonsensical until Alf Nyberg pointed out that the artist used a fisheye view of the sky to represent them. A fisheye view is usually aimed vertically, showing the zenith near the center of the sky while the perimeter of the sky represents a circuit of the horizon.

Fig. 3-16. *Vadersolstavlan*. 1535, Storkyrkan, Stockholm, Sweden.

The Sun appears as a blazing spot in the upper right part of a sky laced with cirriform clouds. The circle running through the Sun is the parhelic circle. The two nearest spots or eyes are the sun dogs while there is a spot opposite the Sun (the anthelion) and two spots 120º from the Sun (the 120º parhelia). The small bright semicircle, concentric to the parhelic circle and facing the Sun is the circumzenithal arc. The arc that presents its convex side to the Sun is the infralateral tangent arc to the 46º halo. The circle around the Sun is probably the 22º halo but it has several problems. First, the Sun should be located at the center of the halo, and second, when the Sun is low in the sky, the sun dogs are only a short distance outside the 22º halo.

The two arcs that emanate from the sundogs are problematic. They may be a hybrid form of the upper tangent arc or Parry arc although neither touch the sundogs. These cross at an angle that places the Sun about 22º above the horizon, the height at which the sun dogs and the circumzenithal arc tend to be brightest. On 21 April at the latitude of Stockholm (59º 20') the Sun is found at this height at 7:35 AM, near the middle of the recorded observation period. The halo complex of the *Vadersolstavlan* was a remarkable recording of an extraordinary event, but was interpreted by the church rector, Olaus Petrias as a warning from God to the Swedish King. Thus, even when the observed properties of halos were carefully recorded, their primary purpose was for divination.

Half a world away and more than a century earlier, in 1425, the Emperor of China, Chu Kao-Chi, recorded a number of halo phenomena. It seems that the Emperor was preoccupied with halos and used them to foretell his fate. Unfortunately, he must have spotted the wrong arc, for within a year he was ousted from power, and China quietly passed on to other hands.

CHAPTER 4
THE EBB AND FLOW OF NATURE'S WIND: ASIAN SKY PAINTING

China had an ancient civilization a thousand years before Rome was founded as a rude farmers' hamlet. When Rome rose from its humble origins to rule the Mediterranean, China was still a great nation. When Rome finally succumbed to pressures from the sparse plains of Asia and internal dissolution, China had already long since cast aside her problems and returned to greatness.

Chinese landscape art began to soar just as Europe blocked its skies with a gold curtain. Nevertheless, the birth and early development of sky painting in China remains as obscure as the beginning of sky painting in Europe. In both civilizations, ancient literature describes the accomplishments of landscape artists whose works have been long lost or destroyed. But contemporary written descriptions can only testify to an increased concern about representing nature. If, for example, Giotto's work were judged solely by the assessment of his contemporaries, he would be acknowledged as a master of realism, while if we relied on John Ruskin's 19th century testimony, we would compare Giotto's technical abilities to those of a stammering infant.

The sky first appeared in Chinese art centuries after it had in European paintings, and after Rome and China had developed strong economic ties. The art found all along the Silk Road, the caravan routes of Central Asia, suggests that prior to 600 CE, artistic ideas moved predominantly eastward and that sky painting did not blossom in China until she had learned the Hellenistic technique of shading to provide the illusion of depth. It is difficult to tell if the Chinese discovered sky painting independently or if they first learned of it from Europe.

No matter what their initial inspiration, Chinese artists developed landscape and sky painting anew and with a different emphasis than in the West. Chinese sky paintings are basically philosophical poems of the atmosphere. They are distillations of an ancient philosophy of the meaning of nature and man's place in it, and of climate conditions very different from those in Europe. A thousand years ago, Chinese painters saw things in the sky that most Western painters are just beginning to learn through time lapse videos. For centuries while the West slept, patient and sensitive Chinese eyes traced the flow of air and plumbed the depths of aerial effects without these aides.

Then in the 13th and 14th centuries, China repaid any possible earlier debt to the West. Mongol conquests linked China with Persia and indirectly with Europe. Chinese experts in every field were transferred all over Asia and brought their culture wherever they went. Suddenly, in the first half of the 14th century artists in Persia were painting the sky gloriously, using Chinese techniques that were modified to suit the drier Persian atmosphere. Not long afterward, stray glimpses of sky began appearing with increasing frequency in European art. Contacts with Persia may have hastened the European Renaissance in sky painting.

4.1 The Birth of Chinese Sky Painting

Landscape was a late addition to the Chinese scene even though its roots can be traced back to quite ancient times. By 2255 BCE, hieroglyphic motifs for mountains and trees were said to be among the 12 insignia of the legendary Emperor Shun. Other primitive precursors of landscape art such as abstracted forms for forests and streams as well as the whirling 'cloud forms' appear on the ritual bronzes (Fig. 4-1) of the Shang Dynasty (1766 to 1122 BCE).

The Chinese cloud forms exemplify an ancient and seemingly universal human fascination with whirls and spirals. Vortices have appeared repeatedly in the art of widely separated societies. Not all were based on observations of fluid motions. Some were inspired by the spiral or curled patterns of seashells, ram's horns, leaves, or coiled animal movements. More often than not, the spirals or scrolls were abstracted and divorced from their natural roots. They were seldom incorporated into anything that vaguely resembled a scene. In art of the Shang Dynasty they might well be used to adorn the skin of elephants or the fur of tigers but they never appeared in anything vaguely resembling a scene.

Fig. 4-1. *Ceremonial vessel ho* in bronze with fluid motifs in the form of vortices and cloud scrolls. C. 1100 BCE. Freer Gallery of Art, Washington, DC.

Fig. 4-2. *The Escape of Enemies Across a River*. Wall Panel. Ashurnasirpal's Palace at Nimrud 878 BCE, British Museum. Vortices are carved as swirling flow lines in the water at far left and at right below the fortifications.

On rare occasion, spirals in ancient art were depicted in their natural setting. An Assyrian wall carving at the Palace at Nimrud celebrating the victory of Ashurnasirpal in 878 BCE shows enemy soldiers attempting to escape certain capture by swimming in the river with flotation bladders (Fig. 4-2). The rapid current is indicated by carved flow lines interlaced with eddies or whorls that were most likely seen by the artists walking along the banks of the swiftly flowing Tigris River.

In Western Art, spiral patterns degenerated into decorative dead ends such as the petrified scrolls on Ionic and Aeolian capitals of temples (Fig. 4-3). Only in China was the link between symbol and nature retained and nurtured. The whirling cloud form was associated with the writhing dragon form, which brought or withheld rain and ascended to the clouds in waterspouts and tornadoes. Both forms were considered to symbolize humid elements - the very breath and spirit of life.

Fig. 4-3. Aeolian Capital from a Green Temple.

The transformation from symbolic to scenic art began during the Han dynasty, which was established in 206 BCE and ruled China with only a single interruption for about 400 years. During those creative years paper and the first seismometer were invented, the compass was improved, and commerce helped culture thrive.

As the Chinese learned to distinguish natural phenomena from the supernatural they modified and absorbed the antique forms into a coherent picture of nature. But this took time. At first, heaven and earth were treated as separate domains. A painting from the inside of a bronze toilet box (Fig. 4-4) shows how use of the cloud form had evolved by the time of the Han dynasty. The phoenix in the center seems to fly through empty space but is surrounded by swirling lines that accentuate the turbulence of its flight. The only earthly reference points are the tear-shaped clouds that appear at the fringe of the dish. The stress markings appear to catch the cloud in motion and are, in fact, the ancient cloud forms. The work still belongs to the realms of symbolism and decoration but it constitutes an important step in the direction of naturalism.

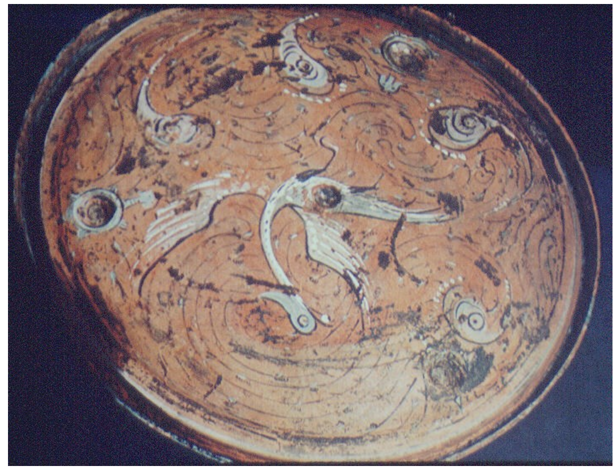


Fig. 4-4. Bronze Toilet Box with Phoenix and Clouds. Museum of Fine Arts, Boston.

Even when heaven and earth were portrayed in a single work, clouds and sky were relegated to ceilings and segregated from mountains and trees on the walls below, somewhat as in Egyptian art. In the Ceiling mural, *Ascending to Heaven* in Dingjiazha Tomb 5 in Jinquan, Gansu Province (c. 4th-5th century) various deities fly around a sky full of flowing cloud forms while trees grow atop the airless gumdrop mountains below (Fig. 4-5).

Fig. 4-5. Ceiling mural, *Ascending to Heaven* in Dingjiazha Tomb 5 in Jinquan, Gansu Province c. 4th-5th century.

The Chinese have maintained an enduring love affair with their mountains. It was recorded that one Chinese Emperor was so infatuated with mountains he had some constructed for his pleasure in the palace gardens; the pyramids of Mesopotamia, Egypt, Mexico, Peru, etc. render this story eminently believable. It also makes sense that the Chinese would attempt to paint their mountains. A mural of a mountain scene from the first century CE has been found in a recently opened tomb in Pinglu, near the San-men Gorge of the Hwang Ho River (Fig. 4-6).

Fig. 4-6. ***Landscape With Fortified Manor House*.**

Like many other peoples, the ancient Chinese wanted to provide their dead with a familiar and beloved environment. A tomb located in the hilly countryside was therefore a natural place to paint a mountain scene. Presumably the departed soul would be able to look on the wall at the manor he had once owned and gaze at the mountains beyond.

Trees grew on those painted slopes, which pile one beyond the other in a seemingly endless series. Above all the mountains there is a space for the sky, but it was left neutral, and even the bird does not venture into it. But the hills do convey a feeling of atmosphere, for their tops are painted darkly and are clearly outlined while the valleys appear washed out as if by haze or fog. Here is a primitive prototype for centuries of later Chinese sky paintings.

The painted cloud forms and early scenes bear a native stamp. But during the Han dynasty, China maintained extensive although indirect relations with the West, largely as a result of her silk and their gold. Regular trade along the length of the Silk Road between Rome and China was established before 100 BCE. Contact between Rome and China remained indirect for the most part although in 166 CE, a Roman delegation did reach China. Several relay transfers were invariably required to get the silk from its secret source to its ultimate destination.

The typical route (Fig. 4-7) was similar to the one taken much later by Marco Polo, who traversed it from west to east. The silk was carried from the heart of China toward her northwest frontiers and thence across the fringes of the Takla Makan desert north of the Himalayas. After crossing the mountain passes of the Pamir Range, it was carried westward across the plains of Persia, which was then under the control of the Parthians. From there the silk reached the eastern outposts of the Roman Empire, usually in Syria or in Armenia on the Black Sea.

The Parthians choked off the land route by levying an exorbitant (25%) tax on all goods that passed through their lands. This encouraged Roman merchants to seek a cheaper route; they soon learned from Hippalus to sail with Asia's pulsing winds of the monsoon (Fig. 4-8).

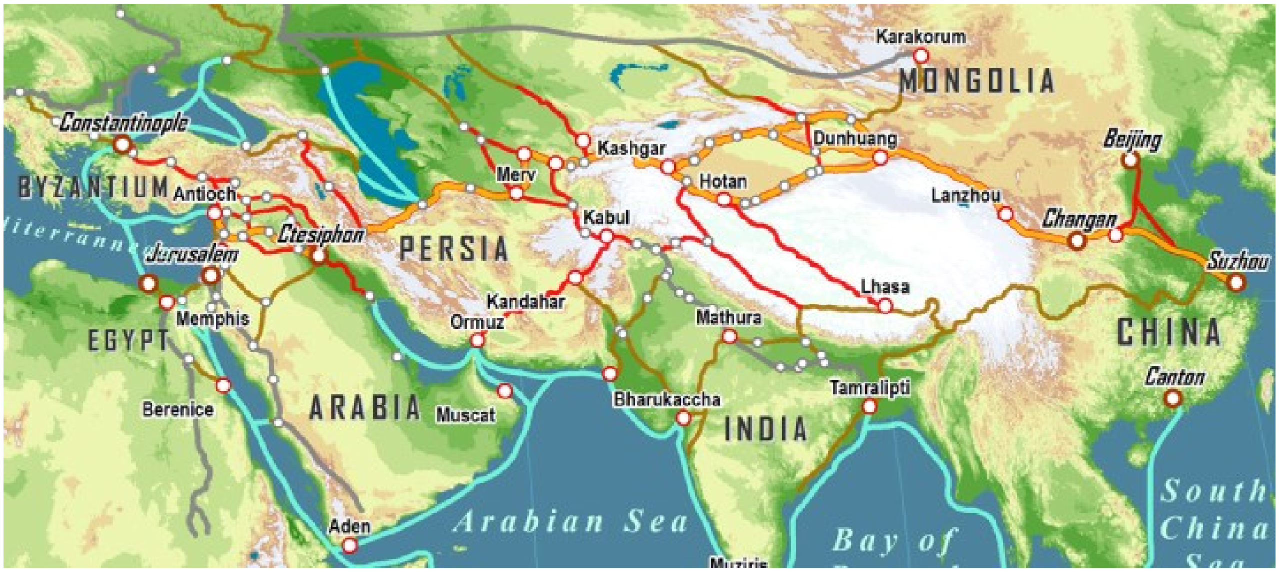


Fig. 4-7. Trade Routes of Asia.

4.2 The Youth of Chinese Sky Painting: The Monsoonal Flow of Air and Clouds

All of Asia pulses to the monsoon's annual heartbeat, which is powered by the seasonal cycle of the Sun's heating. The word, monsoon, derives from the Arabic mausim or season. During the summer months the Sun heats the Asian landmass and the heated, light air rises. Cooler winds from the surrounding oceans rush in like a giant sea breeze, bringing great quantities of moisture inland. In most of Asia summer is the rainy season.

When the Sun heads south in late summer, the Asian landmass begins to cool and the winds from the sea gradually weaken. In autumn the winds pause briefly before setting in from the opposite direction. Throughout the winter months the cold, dense air from the dry interior of continental Asia skirts the Himalayas and drains southeastward out to sea through China, much as a land breeze does along coastal regions at night. This continues until the spring when the land once again begins to heat up and the annual cycle is completed.

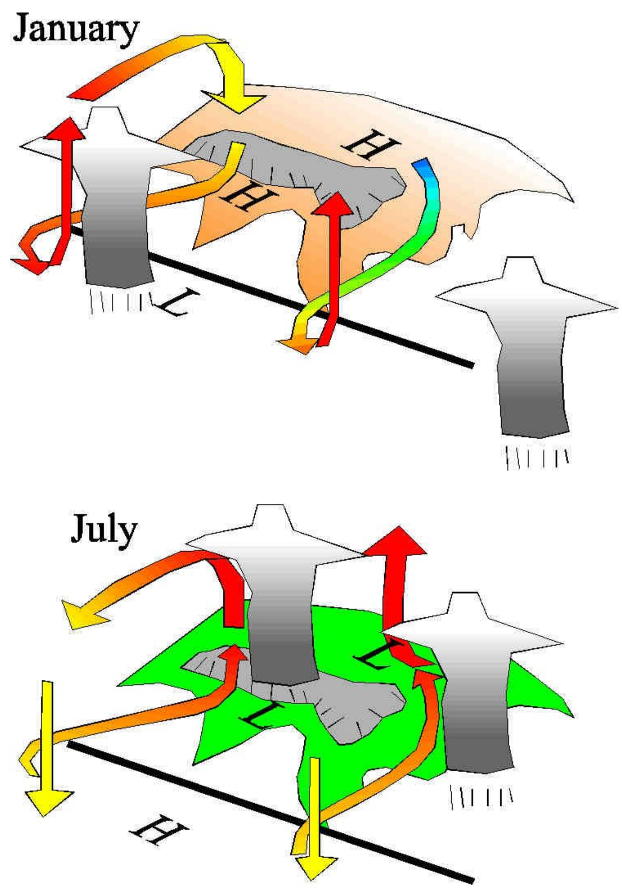


Fig. 4-8. Seasonally reversing winds and moving rain belts of the Asian Monsoon.

Around India these seasonally reversing winds are remarkably regular and reliable, even though precipitation varies widely from year to year. The summer winds over the Indian Ocean originate in the Southern Hemisphere and cross the equator in their northward journey. Once in the Northern Hemisphere, they are deflected to their right by the Earth's rotation and so, approach the Indian subcontinent from the southwest.

During the winter months the air descends the slopes of the Himalayas and pours out from India. Earth's rotation turns it to its right so that the wind blows across the north Indian Ocean from the northeast, like all good trade winds.

Hippalus, a Greek sailor shortly before the time of Christ, is credited with the discovery that these monsoon winds, long known at the shore, also extend far out to sea over the Indian Ocean. This made it possible to sail confidently for days without sight of land. No longer did sailors feel compelled to cling timidly to the southern shore of Asia. In one step, voyages were reduced from months to weeks, and profits soared. In summer, fleets set sail from Egypt via the Red Sea or from Arabia via the Persian Gulf and headed toward India under SW winds. Then, after sojourning abroad like Sindbad, the NE winter monsoon returned them safely home with their precious cargos.

From India other merchants continued on to China, skirting either side of the Himalayas. The southern route was usually by sea and had to circumvent Southeast Asia. The more common, northern route seems to have been up the Indus River valley, where the Gandharan civilization was centered, and then over the mountain passes of the Hindu Kush to join the Silk Road. In any event, it is along the Silk Road where the transmission of Roman and Hellenistic art is documented on stone! Many paintings have been preserved in the dry caves near these once flourishing trading posts.

If landscape art was inspired in India by these contacts with Rome, it has disappeared without a trace. Not one of the early Indian civilizations showed the least concern for landscape in art. The secular art of India was often frankly sexual, apparently preoccupied with the boundless fertility of that tropical land. But Gandharan India did adopt and transmit the Hellenistic techniques of shading to give figures dimensionality and the diagonal representation of buildings. These reached Miran, near the western outposts of China (about 400 miles west of Dunhuang), before the close of the 3rd century. Their entry into Chinese art seems to have been delayed by the collapse of the Han dynasty around 220 and the subsequent political chaos. In the 4th century, Miran was abandoned but other outposts soon took over, for even at the worst of times traffic continued to trickle along the Silk Road.

The period following the collapse of the Han dynasty is known as the Chinese Middle Ages. A resurgence of religious feeling accompanied the decline of political organization. Buddhism began to filter slowly into China at this time although Taoism remained the dominant religion and philosophy. Taoism contains its share of magical elements but never stressed the otherworldly to the degree that Christianity did. In fact, Taoism, which dates back to the 4th century BCE urges one to leave the hustle and bustle of society and learn to live in harmony with nature. During times of political turmoil and conflict, a retreat to the peace of the mountainous countryside held considerable allure in Chinese cultural circles.

The Chinese Middle Ages was different than Europe’s Dark Ages. Contact with the outside world temporarily diminished during the 4th century but never entirely ceased. Cultural activities, in fact, were revitalized at this time by the elimination of conservative traditions that had been maintained throughout the Han dynasty. Art in particular benefited because Han artists had been stigmatized as mere artisans. It was during the Middle Ages that Chinese painters were first hailed as poets and geniuses.

Chinese writings made it clear that a deeply rooted love of landscape had become established and that painters at this time were doing something about it. In an essay on landscape painting, Tsung Ping (375-443) wrote that after he had grown too old and feeble to climb the mountains he had scaled in his youth, he re-experienced his former travels by painting the scenes from memory on his walls and then gazing upon them. Nothing remains of his work.

Thus, it was during the Chinese Middle Ages, probably at the end of the 4th century, that landscape art began to blossom in China. Only a few later copies of the early landscape works remain. If they are faithful, they show a new concern for portraying coherent scenes rather than merely rendering individual landscape elements such as clouds, mountains, and trees.

Fig. 4-9. Gu Kaizhi. *Admonitions of the Court Instructress*. British Museum, London

A 7th (?) century copy of a scene from the *Admonitions of the Court Instructress*, (Fig. 4-9) attributed to Gu Kaizhi (c. 345 - c. 406) indicates the change. In the place of the earlier pile of mountains towers a single, deeply eroded peak. A serpentine path carved into the mountain in the form of a tree-lined ledge is rendered with a fairly strong sense of perspective. Bubbly froths of cumulus clouds rest atop and alongside the peak, showing that the artist knew that mountains often make their own clouds. Two other cumulus clouds drift across the sky on either side of the peak. Each of these is composed of the ancient cloud scrolls and supports a venerable figure encircled by a miniaturized halo studded with tiny circles that might represent sun dogs.

By the 5th century, heavy traffic had resumed on the Silk Road and Buddhism, with its traces of Hellenistic influence, began pouring into China from Gandharan India. At the beginning of the 6th century, Chang Seng-yu is credited with introducing shading to give the illusion of depth into Chinese painting. This technique, with its concern for representation of the third dimension, may have helped stimulate the development of landscape art in China. If the inspiration for landscape art came from the west, it is fitting that most of the earliest Chinese sky paintings have been found in the caves at Dunhuang, at the western gatepost of China. The caves were hollowed out of solid rock by monks from the time of the founding of the religious retreat by Lo Tsun in 366. The monks prepared and then painted the walls of their caves with a variety of works including landscape scenes. These generally reflected the dry environment of the Silk Road.

One of the early cave paintings shows a mountain range rising abruptly from a flat, rocky plain (Fig. 4-10). In the sky above the sawtooth peaks, float substantial, almost triangular and flat-based cumulus, vaguely reminiscent of the loaf-shaped clouds in early Christian paintings. In another scene from the same cave rain streaks from similar loaf-shaped clouds fall onto the mountains and ground below. The Chinese long knew that mountain peaks are often decked in clouds, but would not often let such solid looking objects in their sky.

Fig. 4-10. *Cloudscape*. 538-39. Cave 285, Dunhuang.

Sky art was also developing to the east in China at the same time. Clouds and a distant sky appear in the *Nelson Stone Sarcophagus*, probably based on a highly regarded painting. A row of small mountains near the top embedded in a series of horizontal lines creates an impression of great distance. The lines seem to represent the sea but they merge with the ancient cloud forms blowing in from the right. At the same time, the clouds seem about to collide with the nearby tree on the right. It seems a convincing sense of perspective had not yet been developed. As Max Loehr noted,

> Reality in a landscape of this stage is tied to objects. The objects alone are real. Neither space, as such, nor atmosphere exists as yet. The advance over Han designs consists in the fact that the clouds rather than birds are used to symbolize the air.
> Max Loehr, *The Great Painters of China* p. 26.

Over the next two or three centuries the rendering of perspective improved markedly. A series of poetic 'desert' landscapes at Dunhuang show this progress. In *Meditation by the Setting Sun* (Fig. 4-11), the grass-covered Earth is depicted as a light blue-green wash, while distant mountains at the horizon are tinted blue. And the red setting Sun contemplated by the monk tinges two nearby lines of stratocumulus.

By the 8th century, Chinese painters had learned to represent scenes in a convincing manner. One of the earliest Chinese sky paintings for which there are reliable copies is *The Emperor Hsuan-tsung's Journey to Ch'eng-tu* (Fig. 4-12).

Fig. 4-11. *Meditation by the Setting Sun*. Dunhuang Cave 320. 8th Century.

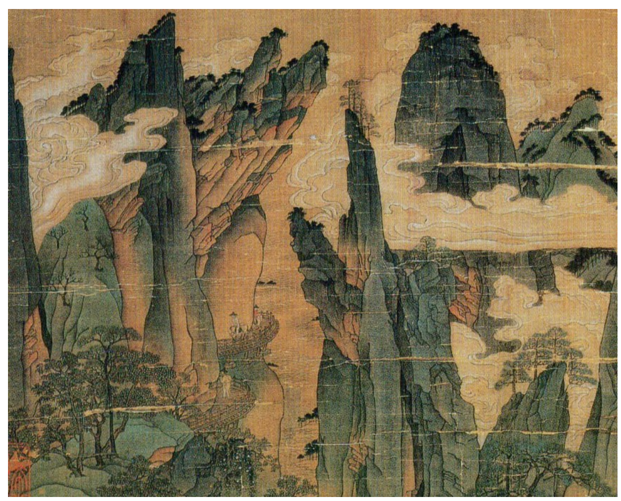


Fig. 4-12. *The Emperor Hsuan-tsung's Journey to Ch'eng-tu*. Palace Museum Collection, Taichung

In 755, the Emperor fled the capital with his favorite mistress in the wake of an armed rebellion. The original is presumed to date from some time late in the 8th century. The mountains are rendered as precipitous and sometimes unbelievably overhanging crags that bear a remarkable resemblance to the Huang Shan or Yellow Mountains of Southern Anhui.

The Chinese would remain fond of such mountain forms and would, with increasing effectiveness, continue to employ them for centuries.

The painting suggests that knowledge of aerial perspective had not yet reached China. The outlines of the most distant trees and mountains are almost as distinct as those in the immediate foreground. Colors are bright and sharp. The neutral sky has no tonal gradation and can be distinguished from the water only by the waves and by the clouds.

Clouds figure prominently in the *Journey*. They ooze their way through the mountain passes, like trails of toothpaste. Streak lines within the clouds render the air's normally invisible flow patterns tangible and enable us to see the atmosphere's secret whirling eddies and waves. These streak lines within the clouds are the ancient cloud forms.

Clouds must be perfectly positioned and sized to mark the patterns of airflow. If a cloud line is not located at an interface where waves have formed, no waves will be seen. If the clouds on the interface are too thick or if they cover the sky, the waves will be drowned in a sea of clouds. Most distinct flow patterns are also highly transitory; in just a few minutes, eddies disintegrate or waves break and the patterns dissolve into turbulence. The waves that formed on the line of cumulus in Fig. 4-13 were visible for less than two minutes before they crested, broke and dissipated into chaos.

Fig. 4-13. Breaking (Kelvin-Helmholtz) waves in a row of cumulus over NYC.

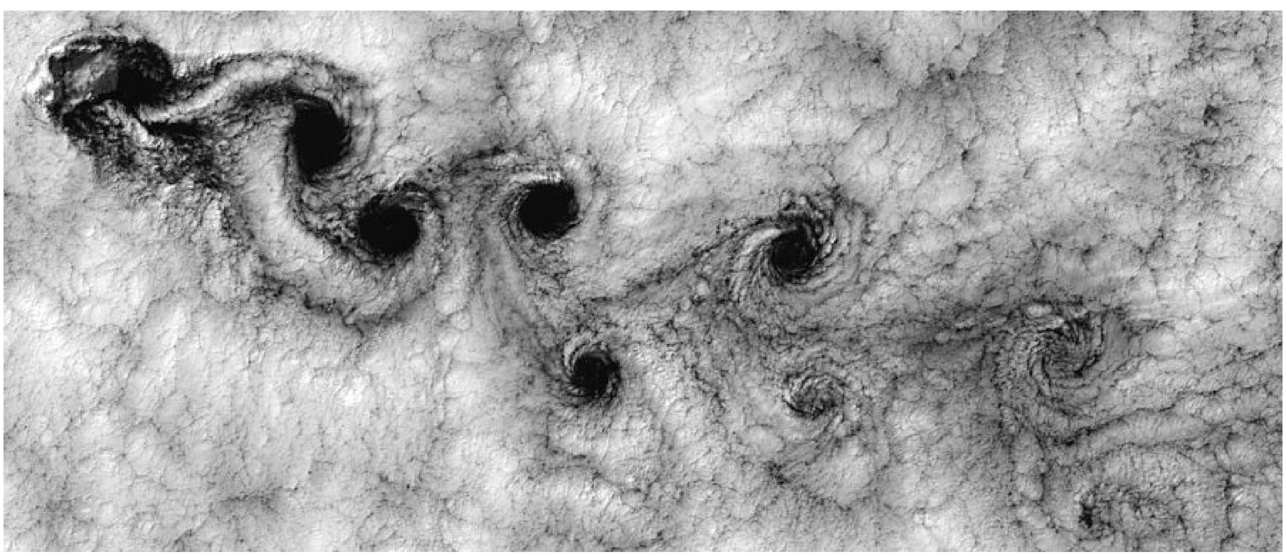


Fig. 4-14. Von Karman vortices form in the wake of Alexander Selkirk Island, 15 September 1999. Landsat, 7 WRS Path 6 Row 83, center: -33.18, -79.99.

The vortices represented by the ancient cloud forms occur in a number of distinct situations. A train of von Karman vortices forms in the wake of any obstacle in the flow, such as an island (Fig. 4-14). Such von Karman vortices are the ones depicted in the Assyrian bas reliefs and are now seen from satellite in disturbed patterns of stratocumulus clouds.

Other vortices form as breaking waves produced by strong wind shear on the interface between two stably stratified layers in the air. These Kelvin-Helmholtz waves are visible only when a thin cloud deck occupies the interface, as in Fig. 4-15.

Fig. 4-15. Breaking Kelvin-Helmholtz waves with air circling clockwise revealed by a cloud layer. Photograph provided by Margaret Lemone

Fig. 4-16 Trailing wingtip vortex pair in the wake of a plane emerging from a cloud deck. Steve Morris, photographer.

Vortex pairs form in the wake of airplane wingtips as the plane emerges from a cloud deck, as in Fig. 4-16. In this photo, air in the vortex on the right rotates counterclockwise, air in the vortex on the left circles clockwise, and air sinks in the center of the double vortex, depressing the cloud top. Similar vortex pairs form behind an oar moved through the water.

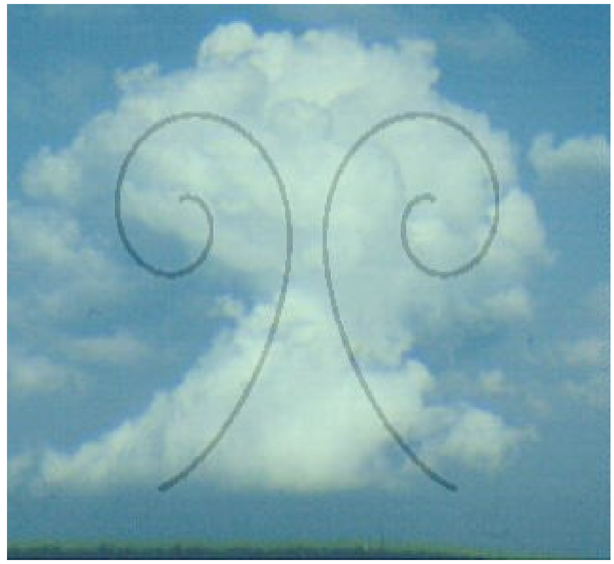


Fig. 4-17. Mushroom cumulus over Yonkers, NY.

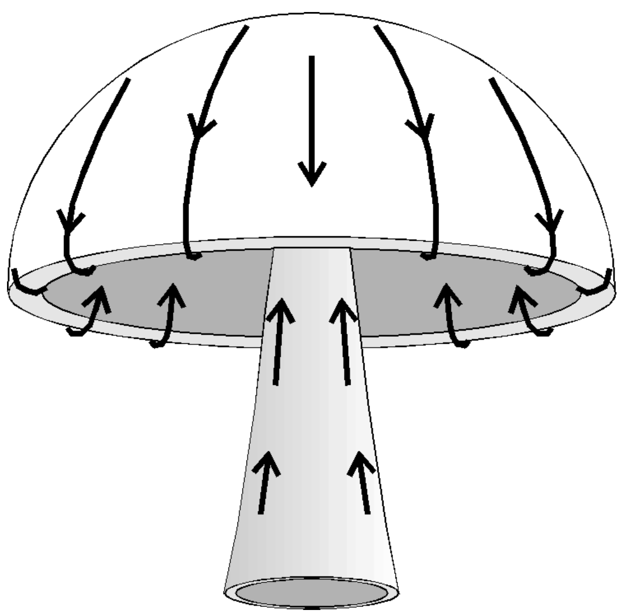


Fig. 4-18. Air motions in mushroom cumulus.

Vortex pairs also characterize the turbulent motions of rising mushroom-capped cumulus clouds (Fig. 4-17) or any explosive cloud including the pino cloud of Vesuvius. Each such cloud consists of a buoyant stem or core and a growing cap of hot, humid air (Fig. 4-18). The air in the stem of the cloud rises freely until it reaches the cap, where its upward motion is slowed by contact with the quiescent surroundings. But the air in the cap is still propelled by the rising column of hot air in the stem below and so, is forced to spread out along the top and curl down the sides. In this way the cap gradually rises and expands. Finally, after entraining some of the air from the immediate surroundings, the air flows inward along the underside of the cap and back toward the stem. This flow pattern, which is easily seen in explosions or fireballs in movies, can also be seen by patiently observing any mushroom-shaped turret of a cumulus for a minute or so, and is revealed by the strain lines in the mushroom turrets of the clouds in *The Emperor Hsuan-tsung's Journey to Ch'eng-tu*.

The Chinese penchant to view clouds as flow markers, like their tendency to stress process as a fundamental aspect of nature, may be a natural consequence of living in a land governed by the pulsing flow of the monsoon. The temperature in the traditional art centers of China drops by 45º to 60ºF from summer to winter. Winter sets in and departs with startling abruptness. The stark contrast between the hot, humid, rainy, luxuriant summer with its persistent winds from the south, and the frigid, dry, dusty, sterile winter blast from the north encourages a view that the universe consists of the pull of opposite forces (Yin and Yang).

In Western Europe the temperature difference between winter and summer is 30ºF or less. The seasonal transitions are far gentler and more gradual, and are not marked by a monsoonal wind shift. Europeans have also observed the flow in their clouds - Pliny correctly noted the evolution of the pino cloud of Vesuvius with its growing trunk (stem) and spreading branches (cap) - but, possibly lulled by more gently changing seasons and less frequent thunderstorms, have apparently not felt such observations to be compelling.

But even though the signs of airflow in real clouds are seldom so obvious, you need only watch growing cumulus carefully for several minutes (or observe their evolution using time lapse photography) as they swell into the sky to see their outlines evolve in the manner of an unfolding mushroom cap or a breaking wave - just as is indicated in *The Emperor Hsuan-tsung's Journey to Ch'eng-tu*.

The time lapse view is one of three fundamental modes of representing clouds. Clouds can also be conceived of as formless mists whose chief property is the ability to disguise or hide objects (as in the *Sacrifice of Iphigenia*, Fig. 2-7) or as solid objects with distinct outlines. Most later Chinese masters would treat clouds as formless mists and carry the execution of this conception to almost unimaginable lengths. The Early Christians, and almost all Europeans and Americans since, have viewed clouds as solid objects with distinct outlines and have stressed their basic form (see §5.2) or the play of light on them.

It was the Chinese who discovered that clouds can be viewed as tracers of the flowing winds of time. The deeper significance of the ancient Chinese cloud forms should now be clear. They are the dye markers of the flow in air, signposts of the perpetual flux in all of nature, embodiments of process, evolution, dynamism. Since the Chinese cloud forms existed from very early times, the penchant to view clouds as symbols of the flow in nature has long been part of the Chinese psyche.

What are clouds? Clouds are assemblages of tiny water droplets or ice crystals that block our vision in a region of the atmosphere. The droplets are on average so small (10 μm ≈ 0.0004" in diameter) that if strung together like beads, 30,000 of them would stretch only a foot and one billion of them weigh less than an ounce. A typical cubic foot of cloud air contains about 300,000 of these droplets. The droplets are so tiny that they are passively swept along with any gentle air currents. This makes it possible to walk through a cloud or fog without getting wet.

Clouds, like fog, are not solid objects although they may appear solid when viewed from a distance. A feather placed at the top of the densest cloud will fall through it just as it falls through clear air. Many clouds seem solid when viewed from afar because they reflect light as well as or better than most solid objects. The light entering a cloud quickly strikes droplets or crystals and is repeatedly scattered or deviated from its original course. Most of the light soon reemerges in an incoherent fashion from the same side of the cloud it entered without having penetrated so much as 100 feet.

The apparent solidity of a cloud depends critically on the size and concentration of droplets or crystals and on the clarity of the surrounding air. Chinese artists faithfully recorded the differences between the distinct outlines of flowing cumulus and the indistinct edges of valley fog. Rapidly growing clouds such as towering cumulus appear most solid because they have a high concentration of droplets right to the outer edge of their turrets that block vision. When such clouds punch up into clean, dry surroundings, the visual contrast redoubles their impression of solidity.

Evaporating or slowly forming clouds and much fog appear amorphous and indistinct because they have fewer and smaller drops at the edges and are often surrounded by humid air filled with water-engorged, light scattering aerosols, so you can see, with fading clarity, some distance into them. Ice crystal clouds and rain fall streaks also tend to appear fuzzy rather than solid because they contain fewer (though larger) particles than water droplet clouds.

The colors of clouds depend on the light that strikes them. Thick clouds in direct sunlight appear white because they reflect the sunlight, which is white. They appear golden or red at dawn and dusk because the sunlight that has reached them is itself golden or red. The bases of opaque clouds or cloud fragments shaded by a higher cloud layer appear dark gray because little light has been able to penetrate. Scattering of light by the intervening atmosphere alters the color of distant clouds, tinting them pink, orange, or yellow if sunlit and blue or purple (at twilight) if shaded.

Chinese sky painting began by viewing clouds from afar but eventually came to present the view from within. When clouds, mist and haze are viewed from afar their form is of the essence. When viewed from within they act in the opposite manner, blurring the outlines of all objects and making their basic forms seem to melt away. Most of the light coming from an object inside a cloud will strike a droplet or crystal and be diverted before reaching our eyes. Thick haze can blur objects within a few hundred yards and sometimes make it impossible to see the clouds above. In the thickest clouds or fogs, objects only a few yards away can literally vanish from sight.

It would seem that clouds should fall since they consist of liquid droplets or ice crystals, which are heavier than air. The typical cloud droplet is so small and light air resistance ensures that it settles to the ground at about 1/40 mile per hour. This lethargic settling rate is more than offset by the rising of air that produces most clouds in the first place, and even if the air is not rising, the slightest puff of wind is sufficient to keep the droplets airborne.

Only larger particles can fall from the clouds. Ice crystals are usually larger (50 - 2500 μm ≈ 0.002 - 0.1") and fall faster than cloud droplets. As a result, ice crystals often fall out of the cloud base and trail below as cirrus. In clouds thicker than about 1 km some of the falling droplets and crystals grow by coalescence or accretion when they collide. Those that grow large enough fall out as rain or snow. A typical raindrop (diameter ≈ 1 mm ≈ 0.04") is as massive as one million cloud droplets and falls about 15 mph (≈ 7 m/s).

The tiny cloud droplets can be used to trace the atmospheric flow patterns because they move passively with the wind. Naturally, it is not possible to follow the path of any given droplet; for that, a microscope would be needed. Instead, it is necessary to look for protuberances at the edges of the cloud. These localized regions of cloud droplets also move with the wind and trace its flow patterns.

The *Emperor Hsuan-tsung's Journey to Ch'eng-tu* represents a turning point in Chinese history and painting. The old, feeble emperor, preoccupied with his favorite mistress, had allowed a squabble between his generals to escalate into a full-scale rebellion. It took two years to restore the throne to its 'rightful' heir. But in suppressing the rebellion, the Chinese foolishly requested military assistance from the Hui-heh, nomads living to the northwest, who then ravaged much of the northern part of China for an additional 14 years. Millions of Chinese lost their lives and the glorious period of the T'ang dynasty came to an end.

China did not heal quickly from this wound. Somehow, the T'ang Dynasty managed to linger on for over a century despite a succession of weak Emperors. Power at court gradually slipped from the Emperors and fell into the hands of eunuchs, who raised intrigue to a high level and neglected the needs of the country. China fragmented into several essentially independent, squabbling sub-kingdoms ruled by warlords.

All these troubles helped to produce some extremely parochial attitudes toward foreigners and outside influences in general. Xenophobia was raised to such a pitch that in 836, a decree forbade Chinese to have any relations with outsiders. Shortly after that Buddhism, seen as a corrupting foreign influence (and far too rich and powerful), was suppressed. All other foreign religions were banned outright. On several occasions, as in Canton in 878, foreigners were massacred.

The political turmoil and resulting parochialism had a direct effect on fine art. The atmosphere of unlimited visibility, graced by the swirling cloud forms, continued to remain highly popular in the more decorative arts such as the landscape scenes of porcelains and carved dishes. But some time in the 9th or early 10th centuries the clouds in fine Chinese painting began to dissolve into formless mists that wound through the valleys and rose to envelop the distant peaks in an obscuring atmosphere. Mist and obscuration were the twin legacies these painters bequeathed to the masters who raised Chinese landscape and sky painting to its greatest heights during the Sung dynasty.

4.3 The Zenith of Chinese Sky Painting

In 959, a young general named Chao K'uang-yin was appointed Commander of the Imperial Army by the dying Emperor because of a signal action. Chao had been accused of extorting bribes and appropriating large chests of gold and jewels for his personal fortune after a successful military campaign. When the chests were opened, they were found to contain only books - books that the cultured general had rescued from almost certain destruction. Shortly after Chao's appointment, the old Emperor died.

On February 2, 960, while marching to suppress an uprising of the Khitans, a nomadic people from Mongolia, Chao K'uang-yin was presumably awakened by his generals in the middle of the night and proclaimed Emperor. In this way, we are told, the Sung Dynasty was born. The Khitans were soon mollified and political order was finally restored in China.

As Emperor, Chao instituted a policy whereby all government officials were appointed on the basis of intellectual abilities as determined by standard examinations. What followed was a time of unprecedented creativity and great economic expansion. New, more effective strains of rice and techniques of rice growing helped swell the population and allowed increasing urbanization. The manufacture of paper and inks was greatly improved and in 1040, movable type was invented so that the printing industry greatly expanded. Gunpowder was also invented although the Chinese failed to exploit its military potential. The first documented use of the ancient compass for navigation is credited to Sung mariners by 1117. In time, China donated these gifts to the world.

Artists prospered as well. No longer bound by the Buddhist preoccupation with human and religious themes, they began by stressing the monumentality of the natural world and the relative insignificance of Man, strangely downplaying the greatly increased scale of human inventiveness and prosperity that helped this art to flourish. In these works it is typical to find towering waterfalls cascading from immense, forested mountains. Evidence of human activity is almost always present but is generally inconspicuous and insignificant in comparison with the scale of the natural features of the landscape.

And what is it that has so greatly enhanced the feeling of epic monumentality in these works? It is the discovery and masterful treatment of aerial perspective (possibly by Li Cheng)! All features in the foreground are rendered in detail with short, sharp brushstrokes while the more distant features are treated lightly with broad, pale washes. (This is one advantage of using inks and watercolors as the Chinese have.) In most Sung landscapes there are no clouds and the sky is simply left blank. Color is deemphasized and many of the paintings are almost monochrome. Time, of course, has added to this character. Fog and mist lacking distinct outlines are quite common, especially at the base of mountains or waterfalls. We notice these mists and fogs in the paintings only when our eyes pass from mountain crest to valley. Then, we suddenly realize we are no longer seeing anything solid.

Most of these features can be seen in the masterpiece of Fan K'uan, *Travelling Among Streams and Mountains* (Fig. 4-19). Fan K'uan was something of a nonconformist. He was not a member of the Chinese Academy. Instead, he spent much time in the Ts`in-ling Mountains of Shensi near the Hwang Ho River and learned to capture their character.

Fig. 4-19. Fan K'uan. *Traveling Among Streams and Mountains*. C. 1000. Palace Museum Collection, Taichung.

In *Traveling Among Streams and Mountains*, one must search for the manor that merges into the hillside or the small mule train wending its way silently along the path at bottom right. The scene is dominated by the huge mountainous crag with its steep canyons and towering ribbon waterfall and the forested foothill in the foreground.

Fig. 4-20. Li Gongnian *Landscape*. c. 1120. Art Museum, Princeton University.

Here we are face to face with the immensity of space and time. And where is the valley floor that the waterfall empties into? We can only surmise, for it is filled with a mist or fog that adds to the sense of mystery and infinity. Fan K'uan and the other Sung landscape painters were trying to immerse themselves in the soul of nature. Fan stated this clearly.

> Those before me made it their rule never to be detached from the things. Rather than learning from other men, therefore, I should learn from the things themselves, or, better still, from their inner nature.

The early works, such as Fan K'uan's, tended to be valley views in which distant features of the landscape are blocked by an imposing nearby mountain. The furthest features of the landscape are then not very distant and so rendition of the effects of aerial perspective had to be subtle. But artists quickly scaled the heights and began to offer more panoramic vistas.

Fig. 4-21 Mountains emerging from valley fog. NCAR photograph.

The panoramic view in Li Gongnian's *Landscape* (Fig. 4-20) dramatizes the full majesty of mist in the mountains (compare Fig. 4-21). The nearby wintry trees are rendered in great detail but the mountains fade dramatically in the distance. The furthest peaks are mere silhouettes, barely able to emerge from the mists and general obscuration of the thicker atmosphere below. Eight hundred years later, Caspar David Friedrich would show Europeans the clear air above valley fog (see Fig. 9-4).

Troubles were not long in returning to China. Early in his rule, Chao K'uang-yin had secured the resignation of all his generals. Thereafter, army leaders were chosen on the basis of scholarship rather than martial ability and were frequently transferred to prevent them from establishing any undesirable allegiances. Soldiers were chosen from the poorest and most downtrodden elements of society, and their faces were branded upon enlisting! Military qualities, formerly admired by the Chinese were disparaged, while intellectual refinement became the single most highly valued personality trait. Although the armed forces continued to grow during early Sung times, these steps had the effect of unilaterally disarming China in the presence of her enemies.

Invasion from the north began in 1122 after two decades of unbridled extravagance at court provoked an internal uprising. The weakened Sung were pushed southward to the gates of Hangchow, which became their new capital. The period thereafter, until the conquest by the Mongols, has been termed the Southern Sung. It was marked by continued economic prosperity but a dreamy, introspective passivity that tended to deny the existence of earthly cares.

It is the Southern Sung painters who discovered the ultimate possibilities of mist. In many of their landscapes we see, to a degree far beyond what the Romans were ever able to attain, the visage of a 'floating' world. The mist served to reduce the solid texture of the material world and replace it with the incorporeal spirit of nature. It also helped reduce the scale, replacing the monumentality of earlier Northern Sung works with a more limited vision of a personal universe. No longer was it necessary to convey the impression of "a hundred peaks and ten thousand trees" - a single tree and lone peak would now suffice. Southern Sung landscapes are maps of the soul. They capture the fleeting impressions of a meteorological moment, at times using little more than a few broad brushstrokes. All the rest is a dream in the great Void.

Fig. 4-22. Hsia Kuei. *Boats Returning to the Mist-Shrouded Village*. c 1210. Kansas City, Nelson Gallery and Atkins Museum, Kansas City.

A beautiful example of Southern Sung obscuration is Hsia Kuei's *Boats Returning to the Mist-Shrouded Village* (Fig. 4-22). Only a few houses of a small fishing village are vaguely visible through dense patches of ground fog. Earth is so tenuous that in the lower right foreground it is not possible to tell where the water ends and the land begins. Trees, which help distinguish the sky from earth, emerge from the fog and also define the limits of visibility. This world appears to end at the further edge of the village until we notice hints of a distant, inaccessible mountain range.

What motivated the Chinese artists to select aerial perspective as a main vehicle for expressing their philosophy? The aerial effects in Chinese paintings are not mere figments of the imagination - they are adopted from the monsoonal nature of China's climate. During the winter, waves of bitterly cold, dry Siberian air surge southward, sweeping relentlessly across China. Snow often falls along the leading edge of these outbreaks and then remains on the ground as long as the arctic blast continues. Because of this, many Chinese landscape scenes depict snow-covered ground.

Winter and early spring skies in China are often cloudless, but the air is commonly laden with loess, a fine dust picked up in dust storms that form several days a month as the wind whips across the wastes of the Gobi desert. The finest dust particles remain suspended in the air for thousands of miles so that even as far south as Hong Kong, the dust bleaches sky color and visibility is reduced below ten miles 75% of the time from December to May.

As the Sun marches northward in spring, the arctic blast begins to yield to the strengthening tropical air mass. During May and June, the meteorological battlefront between tropical and polar air masses lies right over China. The result is the soaking the Mei-Yu or Plum Rains, which bring dull, dreary days. Finally, by June in the south and July in the north, the oppressively hot, humid southerly winds of summer are well established. The dust of winter is gone but is replaced by a thick layer of humid air and haze (now further thickened by pollution).

Fig. 4-23. Hong Kong on a hazy autumn day.

China's humid, hot summer air extends from the ground upward to a great height. Lush vegetation exudes its own mix of fragrant hydrocarbons that adds to the general haziness. Under such conditions the blue of the sky is almost washed out and all colors appear subdued (Fig. 4-23). The atmosphere can get so 'thick' that the Sun will turn red and disappear in a cloudless sky when it is still as much as 10º above the horizon! Even dark rain clouds become difficult to decipher. Similar skies dominate the Eastern United States during summer and early autumn. Of course, both American and especially Chinese skies are now greatly thickened by air pollution.

On hazy days it is easy to understand why the Chinese so often left the atmosphere as a neutral wash and why they dispensed with all but the most subtle hints of a horizon line. Haze and mist deemphasize solid forms and make Nature appear continuous and infinite.

Finally, in late summer and fall, when the Sun weakens but winter's northerly winds have not yet set in, fog is quite common, particularly in the valleys. The fog tends to form at night and usually burns off by afternoon, except in the deeper valleys, where it may persist for days on end.

The Chinese feeling for the monumentality of nature is intimately bound up with the obscuring properties of dust, haze, mist, and fog. About five hundred years ago, Leonardo da Vinci noted in his *Treatise on Painting* that,

> objects seen through a fog will appear larger than they are in reality because the aerial perspective does not agree with the linear

On pure, clear days outlines of even the most distant objects are sharp, so even the largest mountains seem closer and modest under the crystalline vault of heaven. On days of reduced visibility even relatively nearby objects appear blurred, and make us assume that they are further away and therefore larger. Chinese artists routinely utilized this magnifying property of obscuration. In so doing, they anticipated Leonardo's great 'discovery' by about 500 years.

4.4 Looking Backward

Even as Kua Hsi was painting his *Boats Returning to the Mist-Shrouded Village*, the Mongol hordes of Genghis Khan were beginning to pour down from the steppes of Asia. After taking Beijing in 1215, Genghis turned westward and set out to conquer the rest of the civilized world. By the time his grandson, Kublai finally obliterated the Sung Dynasty in 1279, the Mongols had linked almost all of Asia.

Painting revived quickly in the early days of the Yuan (Mongol) Dynasty but showed a new face. A generation of patriotic, but often starving painters arose who were not associated with the Academy. They designed their paintings to express disdain for the Mongols and for all spineless countrymen who besmirched their nation's honor by cooperating with the Mongols. It was, of course, wise to express this disdain subtly. The upstart painters began by spurning the accomplishments of their immediate predecessors in the Academy. In landscape they did this by clearing the air and restoring some color and substance to matter. Overnight, as if by magic, all the dreamy and poetic vistas evaporated and the distant mountains appeared in all their glory. But the new landscapes were not really new. Instead, the early Yuan painters consciously sought to recapture the lost glory of the past by imitating the approach of ancient masters.

Events over the next several centuries helped perpetuate the glorification of the past practiced by the early Yuan landscape painters. The Mongols drained the wealth and destroyed the initiative of the country, deliberately excluding the Chinese from important business and government positions, and ruthlessly suppressing their intellectuals. Irregularities of the monsoon compounded the problem. An alternating series of excessively rainy and dry years culminating in the floods of 1332 either drowned or starved millions and set loose an outbreak of bubonic plague that may have reached Europe as the Black Death sixteen years later. These natural disasters precipitated the fall of the Yuan Dynasty and served to increase China's inward and backward looking tendencies.

Early in the 15th century, great maritime expeditions of the Ming Dynasty sailed on monsoon winds across the Indian Ocean. Ironically, these only proved to be a prelude for a closed door policy. China's fleet was dismantled and her coasts fell prey to pirates. Troubles from nomads in the north led to the reconstruction of the Great Wall. China, ever suspicious of outsiders, grew positively isolationist and reactionary. A country that had for long remained at the innovative forefront of civilization folded in upon itself and allowed time and progress to flow from it and pass it by. In such an environment it is no wonder her artists consigned themselves to adulating the past and repeating the themes of their hallowed ancestors.

4.5 Recap of Chinese Sky Painting

The magic and limitations of Chinese landscapes are bound inextricably. Chinese landscapes transport us to fairy tale worlds that one gladly enters and sadly leaves. The paintings shield us from a nature "red in tooth and claw" and give us one that has been carefully sanitized for our material comfort and spiritual enjoyment. What a pleasure it is to trace a path through mountains and forest from one rural manor or small village to another. As long as we wish, we are welcome guests in these sparsely populated worlds. We are free to stop at any point in order to reflect, rest, or drink from a clear stream. Here, all urban cares have been left behind and, as the long scrolls are slowly unrolled, time goes on without end.

The charm of Chinese landscapes is so intoxicating that it takes a conscious effort to realize the artists employed a severely restricted view of reality. There are no cities to crowd the land and no substantial clouds to clutter the sky. Who would ever guess from the largely vacant landscapes that by 1120 CE, the population of Sung China reached 120 million! Perhaps we should not expect to see many urban scenes; landscape painting has always offered harried city dwellers a pastoral respite from chronic crowding. But what could be the reason for purging solid-looking clouds from the sky? The sky over even the most mist-shrouded Chinese valley exhibited far more variability than her artists ever allowed.

Only certain kinds of skies could properly limit the dosage of reality to fit the dream worlds of the Chinese fairy-tale landscapes. Haze or mist blurred the sharp distinctions and softened the harsh substance of the real world. Now, if even solid objects were dissolved, how could anyone attribute a variety of chiseled forms to the fleeting clouds? So when clouds were painted, their solid outlines had to be eliminated, either by melting them so they would flow, or reducing them to amorphous mists.

Civilizations reveal their souls in their sky paintings. Interestingly, Chinese and Roman (or Hellenistic) sky paintings were marked by similar biases and restrictions. Roman painted skies were typically bluer, but both stressed exaggerated obscuration effects and both proscribed the use of solidly chiseled clouds. Advances in sky painting came during the more vibrant periods in each of these civilizations - times of unprecedented advances in commerce and technology and times of great political ferment when new governments or dynasties were still consolidating their power. But the ascending phases of these societies were rather brief and the notion of progress never fully took root. Probably because both societies were amply populated they avoided labor-saving devices and found a way of relegating important inventions as toys. The almost unbelievable history of a clock designed to provide a Sung Emperor with astrological forecasts but maintained in the strictest secrecy from the rest of Chinese society is the paradigm of how the scope of technological and scientific developments was constricted in Rome and China.

In China, these tendencies were compounded by the fact that the artists formed a class unto themselves. They were the poets and philosophers, often in government service, and usually did not rely on commissions from worldly people. One of the great common threads running through Chinese painting was the tendency to be antimaterialistic. The practical concerns and enterprises of businessmen were scornfully disparaged. As a result, landscape art in China remained perpetually severed from the mainstream of its society. It suffered from too much idealism, too much sophistication, too much philosophy and, as time went on, too much tradition.

4.6 Sky Painting Reaches Persia

Although China's painters doomed themselves to repeating the atmospheric discoveries of their honored ancestors, information about Chinese sky painting crossed Asia and even may have sparked the awakening painters in Europe.

The Mongol conquests reopened China, bringing traffic along the Silk Road to flood stage. The Mongols favored Persian merchants so that Persian became the business language all along the route from Beijing to Tabriz. The Chinese, largely bypassed in business, were used by the Mongols for their technical expertise in a variety of fields, and sent to work on projects throughout the Middle East.

Shortly after Ghazan became ruler in Persia, he instructed his vizier, Rashid al-Din to compile and illuminate a Chronology of Ancient Nations. Around 1300, Chinese artists arrived in Tabriz to help in the task. And it is through these artists that sky painting reached Persia.

In *Muhammad Investing `Ali* (Fig. 4-24), the sky makes a grand debut in Persian art, tapering from a deep blue above to a lighter shade near the horizon. Persians occasionally experienced blinding dust and sand storms but they apparently had little use for the routine obscuration of the Chinese atmosphere in their art. Visibility is therefore unimpeded although there is little depth. Three trees frame the sky and mark the horizon line while the mostly bare ground befits the dry Persian plateau - isolated tufts of grass and flowers are spotted across the sandy surface. Where then is visible proof of the Chinese influence?

Fig. 4-24. *Muhammad Investing `Ali*. 1307. Edinburgh University Library.

The color-graded sky could have come from China, for the Chinese did occasionally represent the phenomenon as early as the 11th century. But the sky in Chinese art was usually executed in the monochrome style and left as a neutral wash. Visibility in Chinese paintings did increase during the Yuan Dynasty, but the scenes still possessed a sense of monumentality and distance that most Persian miniatures lacked. Persian settings are dry with only scrubby vegetation or prominently isolated trees. These features bespeak familiarity with the Persian environment and do not seem to suggest a strong Chinese influence.

It is the clouds that most brashly betray the Chinese origin of many Persian miniatures. The large, mushroom-shaped cumulus of *Muhammad Investing `Ali* has the unmistakable flow lines of Chinese clouds (Fig. 4-25) and is correctly oriented in an upright position.

Fig. 4-25. Cloud form from large stone carving. Ming Dynasty. Forbidden Palace, Beijing, China.

In some later Persian works the clouds and flow lines became highly stylized. Some of the whirls come from cloud turrets that are either sideways or up-side-down and descending. Since air in cumulus clouds is usually warm and buoyant this is generally not the case (except in downbursts - see §6.1). The degree of stylization suggests that later Persian artists adopted the convention as if it were a decorative feature and lacked a full appreciation of its underlying physical significance.

For several centuries flowing clouds continued to make occasional appearances in Persian art, vestiges of the fading Chinese influence. Persian artists developed their own unique worlds of charm and beauty. They made no new meteorological discoveries but remained true to their dry surroundings. Visibility was high at all times while the sky was often a clear deep blue. On occasion, the Persians even took pleasure in painting their sky golden, for they also maintained links with Europe and apparently were impressed by some of the Gothic and Byzantine paintings.

An awakening Europe was also growing more receptive to ideas from the East that accompanied the goods along the trade routes. The Persians and Arabs, living in an arid land, bore a special love for their gardens and may have imparted this love to their Medieval European brethren. It is also possible that the Persians passed along to Europe some fragment of what they had learned about the sky from China. If they did so, Persia and China can claim an essential role in sparking the European Renaissance in sky painting.

CHAPTER 5
IDEAL CLOUD FORMS IN A CRYSTALLINE SKY

In the year 1212, an adolescent shepherd named Stephen announced that Christ had appeared to him and had commanded him to lead a children's crusade to reconquer the Holy Land. Despite Royal protestations, some 20,000 children followed Stephen through France to Marseilles where the waters were supposed to divide and enable them to walk on dry land to Palestine. When the sea remained stubbornly in place, two 'generous' ship owners provided free passage for the children in seven ships. Two of the ships sank in a storm, drowning all aboard. The five remaining vessels, probably speeded by improved sails and guided by the compass, arrived safely at the ports of Tunisia and Egypt. There, their precious cargo was promptly sold into slavery.

This scandalous event exposed a medieval triumvirate busy at work. Throughout the Middle Ages, Faith, Commerce, and Technology remained uneasy but steadfast partners. People remained publicly committed to the creed that everything derived from God and should be devoted to His glorification. Nevertheless, the everyday conduct of Europeans became increasingly pragmatic so that by the time of the Fourth Crusade, commercial interests played a central role in the planning and operation of even the most sacred missions. And in all their ventures, medieval Europeans eagerly utilized whatever technical innovations and laborsaving devices they could get their hands on, showing none of the reluctance toward inventions that characterized most of Roman and Chinese history.

The partners of this triumvirate were also responsible for creating a new art form - realistic sky painting, which arose with breathtaking suddenness in the early years of the 15th century. Paintings were commissioned by a new, emerging class of worldly patrons, who helped tear down the sky-blocking golden and brocaded curtains by insisting on real scenes with unlimited visibility. The Church reluctantly helped by mandating a search for the ideal form of each of God's creations, even the various clouds. Painters, who often doubled as inventors, architects or engineers, were then called upon to examine the newly revealed sky and distil its elemental forms from the very chaos of clouds.

The early 15th century artists quickly identified most of the major cloud genera and learned how to represent them accurately. Each cloud was enlisted to serve as an ideal representative of its class. No ragged fragments were admitted into this society of perfect specimens. Each cloud was then accorded its proper place in the sky and was not allowed to block the view of another.

Aerial perspective was also rediscovered at this time, possibly because the coloration appears to be a well-defined, inherent property of distant objects. Nevertheless, unlimited atmospheric visibility was mandated, for nothing was allowed to blur a single detail of even the most distant object. Haze and storms were banished from the 15th century skies.

So, the people of the 15th century could see forever. The attention they lavished on the things about them led them to discover new worlds and gradually abandon sterile viewpoints. This was more than a Renaissance, it was an epoch of discovery and creation. However, the discrete and crystalline view of nature that emerged is a characteristic of youth. It soon must fade and give way to less optimistic and more sophisticated conceptions. But that is the story of a later time. During the 15th century a pristine sense of adventure propelled the hands of genius, and the sky with its clouds appeared in all their glory for the first time in human history.

5.1 Prelude to Rebirth: Earthly Shocks

As the year 1000 approached, people in Western Europe had good reason to believe that the time of the Last Judgment was imminent. The continent had been ravaged and depopulated by centuries of plague, political chaos, and waves of foreign marauders. Much of the land had reverted to forest, where, in the darkness, fear, illiteracy and superstition reigned supreme. But after 955, when the Magyars were stopped at the Battle of Lechfeld, Western Europe was finally left in a state of relative peace and allowed to begin her long recovery from the Dark Ages.

The European recovery was encumbered by a thorny tangle of symbolic associations that had grown over each object in nature during the Dark Ages. The outer appearance of every object was interpreted as the mere visible signpost of an underlying transcendental meaning established by God. Here, for example, is what clouds signified to Isidore, Bishop of Seville (c. 560-636).

> The clouds are to be understood as holy evangelists, who pour the rain of the divine word on those who believe. For the air itself, empty and thin, signifies the empty and wandering minds of men, and then, thickened and turned into clouds, typifies the confirmation in the Faith of minds chosen from among the empty vanity of the unfaithful. And just as rainy clouds are made from the empty air, so the holy evangelists are gathered to the Faith from the vanity of this world.
>
> Isidore of Seville. *On Clouds* from *On the Nature of Things* quoted from W. Middleton *A History of the Theories of Rain*, p. 12.

Medieval artists, invariably working in the service of the Church, were trained to represent all objects in an abstracted manner so as to divert attention from their physical nature and fix it on some 'underlying' meaning. Abbot Suger stated this unambiguously, insisting, "the purpose of art is to lead men through the visible world to the invisible certainties."

So long as the Church remained the sole patron of the arts, this mold could not be broken. Thus, whenever clouds were represented, their natural beauty was downplayed and they were recast to serve some symbolic purpose, as in the *Frontspiece to Deuteronomy* of the *Bible of San Paolo fuori Le Mura* (Fig. 3-7). Such clouds are merely curtains through which the hand of God, a device likely derived from Jewish or early Christian art (as in the synagogue at Dura-Europos, Syria, c. 250 CE), emerges to bless the event.

It took philosophers centuries to gain the courage to dismiss the hierarchy of symbolism as excess baggage. In 1324, William of Ockham popularized and extended the argument of Durand de Saint-Pourçain that symbols have no inherent relationship with objects; they are merely poetic images that exist in the mind. In his *Summary of All Logic* Ockham asserted a basic criterion to be used in any explanation. Ever since it has been called Ockham's razor.

> What can be explained on fewer principles is explained needlessly by more. Everything, however, which is explained through positing something distinct from the act of understanding can be explained without positing such a distinct thing. For to stand for something and to signify something can belong as well to the act of understanding as to this fictive entity; therefore, one ought not to posit anything else beyond the act of understanding.

William of Ockham, *Summary of All Logic*.

Ockham's razor made a virtue of simplicity and is the credo by which modern science and technology operate.

In spite of Occam's razor, people were very reluctant to part with their symbols and took a long time to do so. The medieval love of symbolizing persisted in life and art long after the Renaissance. A tendency to symbolize may be an inherent part of our thought processes and is still very much alive.

Symbolism was not entirely sterile, for it championed the notion that the universe was constructed according to a divine (and possibly mathematical) plan. The game was then to see if the objects and their various interrelations could provide the key for deciphering God's plan of the universe. By setting people on this trail of discovery, the forces of symbolism inadvertently hastened their own demise! Eventually, the practical benefits of investigations of the natural world were seen to outweigh the theological implications, and the symbolic associations began to fade into the background and wither away.

Begrudgingly then at first, investigation of the natural world was granted official sanction on the following basis - since all things are created by God they partake in divinity and therefore merit man's attention. The rapid transformation of art began about 1400 when the scales finally tipped in favor of the new concern with the world of nature.

However, neither philosophy nor religion initiated the new appreciation of nature. While philosophers and theologians fretted over precise interpretations of the legions of symbolic associations, mostly illiterate but practical men had set about the job of restoring Europe and were inventing useful toys that helped transform our concept of the universe and its workings. By no coincidence, the first truly realistic sky paintings appeared within a decade of the invention of the musket!

The job of restoration began with the soil. Here, Europe had some heritage to draw upon. Humus, accumulated on the forest floor during the long fallow period, had restored the soil's high fertility and helped reestablish the agricultural base. Europe also emerged from the Dark Ages with an agricultural technology not available to the Romans and probably introduced by some of the nomadic peoples. The iron plow, horseshoes, and, about the year 1000, a new form of harness for horses made it possible to work the soils north of the Alps more effectively.

As people began settling back into the normal routines of life, trade began once again to flourish and construction programs were initiated. Laborsaving devices such as water mills were built in large numbers to serve the sparsely populated continent - the *Domesday Book* recorded 5624 water mills in England in 1086! When reports of wind-driven mills in the East filtered into Europe with the returning Crusaders in the early 12th century, the technologies used in the European water mills and sailboats were adapted and windmills became an increasingly common sight in Western Europe after 1200. Windmills helped make power cheap and readily available, for not everyone could afford land near a swift stream. Anonymous inventors transformed these grinding mills into powerful pumps, saws, hammers and bellows. The same games played with the gearing and motion-changing mechanisms of the mills were also played with the mechanical clock, which first appeared in the 12th century and put Europe on a schedule.

Wealth followed the wind and waters, for the waterways remained the best medieval highways. Both the Crusades and the growing demand for industrial labor encouraged peasants to leave the land and relocate in the growing cities. By 1200, cloth was Europe's most important industry, and placed Bruges, Ghent and Florence among the wealthiest European cities. The apprenticeship that Flemish and Italian painters served learning to represent the intricate folds and many colors of their fellow citizens' garments would later make it easy for them to decipher the complicated corrugations of the clouds.

Mediterranean port cities like Venice and Genoa also grew rich as they took over the increasingly busy Mediterranean trade routes from Byzantium in the aftermath of the Crusades. A host of fertile ideas accompanied the flood of goods from the East and helped open Europe's eyes.

It was through the Muslims that European philosophers such as Roger Bacon rediscovered the science of optics. But interest in optics was also due to a revived and greatly expanded European glass industry derived from Byzantium and Egypt. The widespread use of stained glass windows in the Cathedrals was but one of several important applications found for glass in the Middle Ages. About 1285, Salvino d'Amarto, capitalizing on the magnifying property of lenses that had been known since Ancient times, is credited with inventing spectacles, doubling our productive lifespan. Transparent glass windows were also becoming more common in homes at this time, replacing the opaque screens that had long kept Europe in the dark. It was through these windows that some of the early Flemish painters exhibited their first clouds.

Beginning about 1050, serious construction began on the great Cathedrals. Their airy vaults temporarily forestalled any urge to paint the sky. Nevertheless, artists were needed more than ever to paint the murals and design the stained glass windows that gleam in the light of day. Here Byzantium made perhaps its greatest contribution to landscape art. Byzantine artists brought their tired models but outstanding techniques with them to the churches of Italy. There they reintroduced Western Europe to the vestiges of classical art.

> Byzantium preserved Hellenistic figure art for Christian purposes against the pervasive abstraction and decorative symmetry of the East; it also preserved the dried remnants of classical landscape tradition for later revival.
>
> D. Pearsall and E. Salter: *Landscapes and Seasons of the Medieval World*. p. 33.

Despite these advances, the entire period up until the late 1200's - the Romanesque and early Gothic - was a vast wasteland for landscape art. The brilliantly colored stained glass windows, which might have been used to produce spectacular aerial effects, were almost invariably used to represent heavenly figures. The walls of the churches and cathedrals were also decorated with murals, but most done before 1300 have been destroyed or covered. The few surviving Romanesque murals also avoided landscape themes. Deep blue backgrounds were often used, perhaps in an attempt to imitate the deep lustre of the stained glass windows, but these backgrounds can seldom be identified with the sky.

One notable exception has recently been rediscovered in the small town of Grissiano, about ten miles northwest of Bolzano in northern Italy. Grissiano is situated on a plateau above the Adige River Valley with a stunning view of the towering Dolomites to its north (Fig. 5-1). It lay along one of the trade routes connecting Italy with the lands north of the Alps. Merchants traversing the difficult Alpine passes would occasionally stop at Grissiano and pause to pray in the modest Church of San Jacopo, where they were greeted by a religious scene in a setting they could identify.

Part of the mural on the chancel arch shows *Abraham and Isaac on Their Way to the Sacrifice* (Fig. 5-2). In this scene, the artist's love of and respect for the surrounding mountains vie for attention with his love of God. The scene follows the biblical text. Abraham and Isaac head up the mountains with a mule bearing a bundle of faggots. The mountains are depicted as steep, truncated spires. The polygonal tops are covered with snow, as are the higher peaks of the Alps, a consequence of the atmosphere's normal temperature decrease with increasing altitude.

Fig. 5-1. Aerial View of Grissiano facing north. Snow covered Alps mark the horizon on the left. Adige River Valley is below on the right. © Peer Srl.

Fig. 5-2. *Abraham and Isaac on Their Way to the Sacrifice*. Church of San Jacopo, Grissiano.

Close inspection of these starkly colored mountains shows that they are graced by small flowers that bless the alpine tundra. The coloring of the mountains, however, is still decorative; the blue mountain, which should be far away according to the rules of aerial perspective, appears in the immediate foreground, while the most distant and highest mountains are dark brown.

The sky is represented in accordance with the Romanesque tradition. It is far too deep a shade of blue, even considering the purity of mountain air, and is constant in tone. In the mountains it is easy to overlook the sky's color gradation, which is great at the horizon but almost unnoticeable when looking up at a large angle. The blue mountain suggests the artist did give some thought to the aerial effects he was surrounded by, but when he came to paint the *Abraham and Isaac* forgot to make a final check with nature.

The *Abraham and Isaac* also contains a few clouds that deviate from the flat-based, triangular medieval convention. They are small, uniformly white amoeboid cumulus, one of which might well be the Dove of the Holy Spirit. Such small cumulus are quite common in the forenoon and when sunlit, often lack well defined shape and shading. There is also a pronounced tendency for cumulus to form over mountains during the day since they are produced when the heated air of the mountain slope rises, as in Fig. 5-3. Indeed, the nearby peak in the center of Fig. 5-1 has sprouted exactly such a humble cumulus.

Fig. 5-3. Cumulus sprouting over Mount Moran in Grand Teton National Park, Wyoming.

The *Abraham and Isaac*, with its graceful flowers, small fair weather clouds and high snow line portrays the Alps in their most benevolent mood and anticipates a mountain traveler's prayers for a safe crossing. Such an outdoor scene was an anomaly in its time. The Church of San Jacopo was consecrated in 1142 and the painting probably dates from shortly after 1200. For the next 100 years there are pitifully few European paintings that touch upon the world of nature. But a love of nature was being kindled in Europe's heart.

Francesco de Bernadone, son of a wealthy merchant of Assisi, never showed much interest in his father's business. In 1207, after receiving a second vision of Christ, Francesco renounced his inheritance and abandoned all worldly wealth. From that time he led a life of purity and asceticism. But there was a new element in his devotion. Francesco found beauty in all the creations of God and, unlike earlier ascetics, rejoiced in the pleasures of the natural world. In his *Canticle of the Sun*, he writes,

> Be Thou praised, my Lord, of Brother Wind, and of the air, and the cloud, and of fair and all weather, by the which Thou givest to Thy creatures sustenance.

Had Francesco been born during different times, he might have become an artist or a naturalist. Instead, he became St. Francis of Assisi.

The life of St. Francis served as the inspiration for Giotto's great frescoes in the Church of Assisi, but the Saint's love of Nature hardly surfaces in these works with their bare rock piles and uniformly dark blue skies. Giotto did, however, turn a discriminating eye to the sky on at least one occasion. In 1301, Halley's Comet made one of its spectacular periodic reappearances in the night sky. Giotto painted this comet as the star of Bethlehem in *The Adoration of the Magi*, one of the frescoes in the Arena Chapel of Padua in 1304 (Fig. 5-4). Giotto was not the first artist to be taken with the comet. The comet's appearance in 1066 accompanied William the Conqueror's successful invasion of England and was represented in the *Bayeux Tapestry* (1073-1083), where it resembles a child's drawing of a rocket with a blazing Sun for a head.

In Fire and Ice: A History of Comets in Art, Roberta Olson points out that Giotto's depiction compares closely with a photograph of Halley's comet as it appeared in 1910 (Fig. 5-5). The painting and photograph both reveal the large, nearly circular coma or head with rays of light emerging from it and the long streaked tail whose brightness gradually fades with distance from the head.

Fig. 5-4. Giotto de Bondini. *Adoration of the Magi*. 1304. Arena Chapel, Padua.

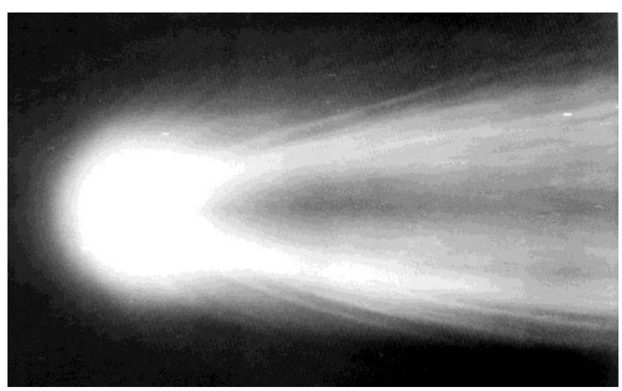


Fig. 5-5. Halley's Comet in 1910.

Halley's Comet startled the Europeans in 1301 and was interpreted in religious terms, appearing under the alias of the star of Bethlehem. When Petrarch climbed Mt. Ventoux in 1336 for the pure joy of it, he felt obliged to show contrition for such an act of heresy. On his climb to the summit he claims he carried along a copy of St. Augustine's *Confessions* and that his eyes chanced upon the passage,

> And men go about to wonder at the heights of the mountains, and the mighty waves of the sea, and the wide sweep of rivers, and the circuit of the ocean, and the revolution of the stars, but themselves they consider not.

Petrarch then tells us,

> I closed the book, angry with myself that I should still be admiring earthly things, who might long ago have learned from even the pagan philosophers that nothing is wonderful but the soul.

Bit by bit, Europeans grew less reluctant to admit their admiration for earthly things. Mountainous scenes were painted, although at first still according to a medieval formula that equated them with large rocks. Even the relatively dry Mediterranean region, with its long almost rainless summer, is far greener than the uncomfortably bare Gothic landscapes suggest. The scenes remained confined to rather shallow, piled-up settings but slowly the sense of perspective improved.

The few plants and animals (mythological beasts excluded) in these works did not suffer too terribly from stylization partly because they were familiar objects that served as ready, often stationary models. For example, Frederick II of Sicily wrote a treatise on *The Art of Hunting With Birds* that contained many illustrations drawn from life. Moreover, the symbolism attached to plants and animals brought them great attention.

The sky stood staunchly alone among all aspects of nature as the last, unwavering bastion of medieval otherworldliness[1]. There, symbolic associations continued to reign supreme. Medieval painters never dared to sunder the artificial walls and allow the real sky to pour onto the Earth, for had they done so they would never have been able to close the floodgates of dross materialism again. Any curtain that would keep the sky out was acceptable. At times the sky was rendered in a deep uniform blue following the stained glass and Romanesque traditions. At other times a geometrically patterned background was used.

Most often, the sky symbolized the empyrean and was painted gold. In fact, in the 14th century, the reliance on gold for the sky became an addiction among the overzealous Gothic painters and patrons. How else could sacred issues continue to command the thoughts of their increasingly worldly audience?

It was only under the cover of night that the sky was permitted to appear. In 1319, Pietro Lorenzetti showed a star-filled sky with a meteor shower and the crescent Moon in *The Betrayal* (Lower Church of San Francesco, Assisi). Almost a century later the Limbourg Brothers would show a similar meteor shower in the *Arrest of Jesus* from the *Tres Riches Heures of Jean, Duc de Berry*.

As the depth and realism of paintings increased, the censorship of the sky grew ever more inappropriate and awkward. In 1338, the elected Town Council of the Republic of Siena commissioned Ambrogio Lorenzetti to execute a fresco showing how the city thrived as a result of its government. The result was the *Allegory of Good Government* (Fig. 5-6), the first known attempt in European art to portray an actual scene realistically. In it, Siena's streets and buildings, and even the surrounding

[1] This is not quite true, for the *unabashed* nude was also excluded from medieval art.

countryside can still be identified. Only a convincing sky is missing.

Fig. 5-6. Ambrogio Lorenzetti. ***Allegory of Good Government*****. 1338-39. Palazzo Publico, Siena.**

The *Allegory* failed to inspire a landscape tradition in its own time, and remained an anomaly for decades. It finally began to exert an influence when landscape art came alive early in the 15th century. In 1444, Konrad Witz added a famous work to the topographic tradition in European art when he located the *Miraculous Draught of Fishes* (Musee d'Art et d'Histoire, Geneva) at the end of Lake Geneva. The view faces southeast and shows the city of Geneva on the right and the snow-covered Alps around Mont Blanc in the background.

In the *Miraculous Draught*, a convincing sky is occupied by realistic cumulus that tower above the entire scene. In the *Allegory of Good Government*, all attempts at realism ended abruptly at the horizon since no sky was allowed. The sliver reserved for sky was appropriated by a blank gray-black backdrop - the main signpost of its medieval outlook.

The contrast between the airless *Allegory of Good Government* and the aerial *Miraculous Draught of Fishes* is shocking. And indeed, 14th century Europe needed some shocks to break from its mold of intransigent exclusion of the sky.

The 14th century in Europe proved to be a century of shocks. Halley's Comet came and went as only a signpost of things to come. Then the climate began to play a more serious game. Outbreaks of famine had long been common in medieval northern Europe as a result of the swelling urban population and its dependency on a steady farm surplus. Bad years, which occur in the best of times, almost invariably had dire consequences during the Middle Ages, when agricultural practices were still primitive, transportation unreliable and no effective programs existed to transport food from a region with a surplus to one suffering famine.

Between 1310 and 1340, Europe suffered adverse climate conditions. Bad years with poor harvests or crop failures attended by widespread famine occurred more frequently and were more severe. Many farms and villages were abandoned during this time as the snow line lowered, and the population of northern Europe decreased. The rash of outbreaks of St. Anthony's fire was probably caused by the ergot fungus, which contaminated the grain during the wet harvests of this period with traces of the hallucinogen, LSD.

Thus the Black Death struck a weakened Europe in 1348. News of this gift from Asia preceded its arrival in Europe by about two years. In 1346, a Tartar army attacked and besieged the Crimean port city of Feodosiya, trapping a group of Genoan merchants. When Tartar ranks were decimated by an outbreak of plague, the Tartars used catapults to hurl the diseased and rotting bodies of their own dead soldiers into the city. The people in the city frantically disposed of the bodies but they too became infected. Once the siege was lifted the Genoan merchants fled, carrying the plague back home with them. This, according to one version, is how the plague reached Europe.

Once the Black Death reached Europe it crossed the continent like a brushfire over the next three years, killing about 1/3 of the population. The clergy, who administered to the sick and dying, suffered even more grievously. Clerical replacements were on average less qualified and resented by the general population when they shirked their duties. This seriously eroded the prestige and authority of a Church already reeling from schism and relocation. Religious fervor itself may actually have increased, but there was a new openness about and emphasis on the importance of life on Earth. The bawdy tales told by the refined young men and women who fled the primarily urban ravages of the Plague in Boccacio's *Decameron* attest to this worldliness. A contemporary Florentine chronicler, Matteo Villani reported disparagingly on the breakdown of morals that followed in the wake of the plague.

> But no sooner had the plague ceased than...since men were few, and since, by hereditary succession, they abounded in earthly goods, they forgot the past as though it had never been and gave themselves up to a more shameful and disordered life than they had led before.... Men dreamed of wealth.... Lawsuits and disputes and quarrels and riots rose elsewhere among citizens in every land....
>
> *The Black Death*, p. 270. Philip Ziegler

Civilization apparently had been shaken to its core. Commerce and agriculture temporarily came to an almost complete standstill but then vigorously revived. Wholesale movements shifted the surviving populace. For a few years, laborers were in relatively short supply and thrived, but after 1380, there was a widespread renewal of serious labor disputes. The Plague returned periodically over the next century to provide a constant reminder of the physical presence of death. Everyone was impatient for the good life and no one was willing to postpone it for the hereafter, but the constant threat of death produced a callous indifference toward the value of life.

The Hundred Years War was conducted in the harsh spirit of the times and formed a constant uprooting influence. It pitted nation against nation, Church against State, and class against class. The resulting political vacuum was partly filled by bandit companies, which roamed the land almost at will, looting and contending with kings and nobles where possible. The political turmoil spurred a growing sense of realism by revealing the advantages of modern strategy and the power of the cannon, and by exposing the ideal of chivalric behavior as an ineffective charade.

It was in this atmosphere of industry and ferment that the real atmosphere made its grand reappearance in art. It is a historical phenomenon that can be traced reasonably well but not quite pinpointed.

There were a few subtle hints that a new day was about to dawn. In 1365, Andrea da Firenzi was commissioned to paint the Spanish Chapel in Santa Maria Novella in Florence. He finished the enormous fresco by 1368 and gave it a heightened sense of naturalism complete with a blue sky that whitens irregularly toward the horizon (Fig. 5-7). Clouds also appear in one of the attendant scenes, *Christ Walking on Water*, where the sky is a uniform blue.

Convincing, color-graded skies were most likely revealed through a more humble and intimate vehicle than the grand murals. The increasing level of literacy as well as the influx of Byzantine and Persian texts, some based on Ancient Greek and Roman books that had disappeared from Western Europe during the Dark Ages, sparked a resurgence of production of illustrated or illuminated manuscripts. Religious themes probably dominated in these books but there were many secular manuscripts as well. Some of these dealt with the idea of the seasons and, as Pearsall and Salter pointed out, proved to be an important means of reintroducing landscape motifs into European art.

Fig. 5-7. Andrea da Firenzi. *Christ Walking on Water*. 1368. Spanish Chapel, Santa Maria Novella, Florence.

Occasional clear breaks began to tear through the golden or brocaded overcast of several Parisian manuscripts in the late 14th century. Around 1370, a scene illuminated for the poet, Guillaume de Machaut, *Guillaume Visited by Nature* contains some cloud streaks, in a graded sky that wrongly darkens toward the horizon. Around 1390, a sky that brightens slightly at the horizon was depicted in the *Bearing of the Cross*.

However, none of the few tentatively color-graded skies painted before 1400 succeeded in arousing marked interest in the sky. More often, following older traditions, a small blue and sometimes color graded opening in an otherwise gold or patterned sky was included to allow God or some other celestial figure extend a hand or convey a message or miracle from heaven.

Then, shortly after 1400 the gold and diapered curtains that had blocked the Sun for centuries were suddenly swept away, and it quickly became all the rage to paint the sky. This was one craze that expanded the human horizon.

In early 1402, Philip the Bold commissioned Pol and Jean de Limbourg to illustrate a *Bible Moralisée*. The illustrations may have been completed by 1404 when Philip died. The brothers based their work on a bible that had been illustrated around 1350 and contained many two-dimensional scenes with white backgrounds framed by dark fringes at the top. Pol and Jean added depth to the scenes and filled them with meteorological miracles from the Bible. Their repertoire included fog, hail, crepuscular rays, and even a few clouds. But the most pronounced aerial development appears in scene after scene, where clear sky tapers sharply from deep blue above to white at the horizon. The sky's color grading is presented so strikingly and repeated so frequently in the *Bible Moralisée*, it suggests an ongoing love affair with the observation. Thus, we have not quite caught the cat in the bag.

An error of a year or two could be crucial for establishing aerial priority. At virtually the same time, in late 1403, Christine de Pisan commissioned an artist to paint color-graded skies in her *Epitre d'Othea* (Fig. 5-8), and the work was completed by January 1404.

Fig. 5-8. Christine de Pisan. *Ulysses Blinding Polyphemus in Epitre d' Othea* c. 1403. Bibliotheque Nationale, Paris.

All Paris was astir with the news. The entire artistic community almost immediately cast off the golden pall and, by 1410, was routinely painting color graded skies. Since manuscripts were not signed and their dates, which are inferred from records of contracts, are tentative, it is possible credit for making sky painting fashionable does not belong to Pol and Jean de Limbourg.

Leaving behind the unresolved question of priority, let us turn to a landmark painting by the Limbourgs from the *Tres Riches Heures* (1413-1416) of Jean, Duc de Berry one of the great art patrons. The *Tres Riches Heures* shows views of a few of the duke's castles and is a testimony to his great wealth. It is also testifies to the worldly activities that transpired in the French countryside and to the annual cycle of climate that molded these activities.

Fig. 5-9. Pol de Limbourg. *February* from the Tres Riches Heures. 1416. Bibliotheque Nationale, Paris.

February (Fig. 5-9) from the *Tres Riches Heures* puts us right in the middle of a severe winter cold wave. The ground is covered with a shadowless blanket of pure white snow. The degree of cold is indicated by the behavior of several of the people. A trail of steam forms from the breath of a man in the farmyard on the right. The man is apparently not prepared for the cold. His legs are uncovered and the shawl wrapped around his shoulders is obviously a poor substitute for a good winter coat. Inside, two of the three people warming themselves by the fireplace have no underwear.

The shivering, exposed peasants suggest in a comical way that this cold snap really caught people by surprise. The scene may have been inspired by the unusually severe winter of 1407-8. It was reported that wolves crossed from Norway to Denmark over the ice-covered North Sea. Most winters in France and the Low Countries are quite cloudy but few are cold enough to permit a prolonged snow cover. There are, of course exceptional years, such as the winter of 1986-7, when frigid air consistently works its way southwestward from Russia and the Arctic, but such winters were even less common prior to 1416 than now.

The February miniature, the earliest known completely snow covered scene in Western Art, also seems to contain a weather forecast. If so, this would make it the first of many European paintings to chronicle changes in the atmospheric environment and thereby subtly add the dimension of time.

All the meteorological evidence in the *February* scene suggests that yet another winter storm is on the way! Only the topmost edge of the sky is clear and deep blue. Immediately below this is a narrow zone where the cloud deck is broken and translucent, much like cirrostratus clouds that often produce halos and mark the leading edge of winter storms. This translucent cloud zone quickly congeals into a solid sheet of gray altostratus that covers the horizon and points to the storm beyond it.

These clouds merely indicate the proximity of another storm but do not tell if it is approaching. Other signs add to the evidence. A smoke plume rises almost vertically from the chimney of the house in the foreground as it typically does on calm days when a winter storm is approaching. The slight drift of the plume to the right indicates light winds from the left. Are these the first gentle east or northeast winds of a coming storm? All the tree trunks at the edge of the forest say so. They have been plastered by snow on the same side, betraying that the wind also blew from the left during the last snowstorm. During snowstorms, the wind typically blows from the east or northeast. Thus, the snow-plastered trunks serve as compasses and imply the scene faces south or southwest. Since the cloud shields of snowstorms usually approach from the southwest (see §7.2), the clouds on the horizon most likely belong to the next storm. More snow should soon be falling.

The sky occupies only the top $1/9^{th}$ of the *February*. Max Friedlander noted in *Landscape - Portrait - Still-Life* that, "a low horizon is always and everywhere a sign of advanced contemplation of nature". The development of sky painting in the centuries that followed the Limbourgs can be closely related to a gradual although erratic lowering of the horizon line, an increasing fraction of the canvas given to the atmosphere, and simultaneously, an expanding field of vision.

The Parisian artists had other meteorological shortcomings. Their few clouds were still tiny and essentially decorative. Aerial perspective was employed for the distant hills on occasion, in particular by the Boucicaut Master, but never in a consistent manner. (Jean Colombe's illuminations in the *Tres Riches Heures*, executed around 1485-89 can be immediately distinguished by their superior use of aerial perspective.)

The aerial shortcomings of the Parisian artists were soon to be corrected. In 1415, the British crushed the French in the Battle of Agincourt. This set the French economy reeling and sent many of the Parisian painters scurrying back to their homeland in the Low Countries. There, within a decade, painting was revolutionized and Europe finally confessed to modernity.

5.2 The Ideal Forms of Clouds

15th century artists were the first people to study cloud forms in any detail. Virtually every other aspect of the world of nature had already been named, classified or painted by antiquity. Even the wandering planets had been distinguished from the fixed stars. Only clouds, the eternal paradigm of formlessness and ceaseless change, remained unclassified and even unnamed until shortly after 1800.

Even though ancient literature reveals a ceaseless concern with the weather and is full of references to meteorological phenomena, the lack of a cloud taxonomy retarded both the transmission and progress of knowledge about clouds and weather, and left us with only a few vague descriptions that suggest people knew how to distinguish clouds and use them to foretell a change in weather. Theophrastus of Eresus, a follower of Aristotle wrote in his *On Winds and Weather Signs*, "when the clouds are like fleeces of wool, it indicates rain."

As we have already noted, artists had, from very early times, effectively identified cumulus, the cloud puff. Cumulus did command some attention even though it remained unnamed. A good description of cumulus was given in a 10th century encyclopedia written by a secret society of Basra called the 'Brethren of Purity'.

> If the air is warm, these vapors rise to a great height, and the clouds collect one above the other stepwise, as is observed in spring and autumn [summer being the dry season in Basra]. It is as if they were mountains of combed cotton, one over another.

The Ancients also distinguished the humble clouds that settled near the base of the mountains (valley fog) and heralded days of good weather from those that hovered over the peaks and foretold a change for the worse.

Indeed, before Jean-Baptiste de Monet Lamarck and Luke Howard gave names to the different cloud genera in 1802, a few fleecy adjectives were all that existed in the written record to hint that various clouds could be distinguished. But in the 15th century, painters compiled a mute but highly visual cloud taxonomy that closely matches the cloud classification system used today. According to this system, which evolved from Howard’s original scheme (see Table 9-1), there are ten cloud genera, which are distinguished by shape, base height, and whether or not they produce precipitation (Table 5-1, Fig. 5-10).

Base Height	**Structured Individuals**	**Layers**	**Structured Layers**
Low (< 2 km)	Cumulus (Cu) **Cumulonimbus (Cb)**	Stratus (S) **Nimbostratus (Ns)**	Stratocumulus (Sc)
Middle (2 → 5 km)	Altocumulus (Lenticular)	Altostratus (As)	Altocumulus (Ac)
High (> 5 km)	Cirrus (Ci)	Cirrostratus (Cs)	Cirrocumulus (Cc)

Table 5-1. Names and Classification of Cloud Genera. Precipitating clouds are printed in red.

Chinese artists showed us that clouds trace the flowing winds of time (recall §4.2). But how are clouds created?

Clouds are born when excess water vapor in a region of the atmosphere condenses on minute aerosol particles to form billions of droplets or ice crystals. Even the clearest, driest air always contains a small amount of aerosols and a small percentage of invisible, gaseous water vapor molecules. Warm air, consisting of rapidly moving and energetic molecules, can 'hold' far more vapor molecules than cold air. As temperature falls, air molecules slow down. Fewer of the vapor molecules then have sufficient energy to overcome their large chemical affinity. If air cools enough, vapor capacity falls below content. The excess vapor molecules then clump together or condense into droplets or ice crystals and a cloud is born. Thus, the secret of all clouds is that they are produced by lowering the temperature.

Several processes lower air temperature and so, lead to clouds. The processes include contact with a cold surface, loss of heat by radiation (mainly at night), and rising air. Conversely, when air sinks or touches hot ground or absorbs solar radiation, its temperature rises. Droplets or crystals then evaporate and clouds disappear.

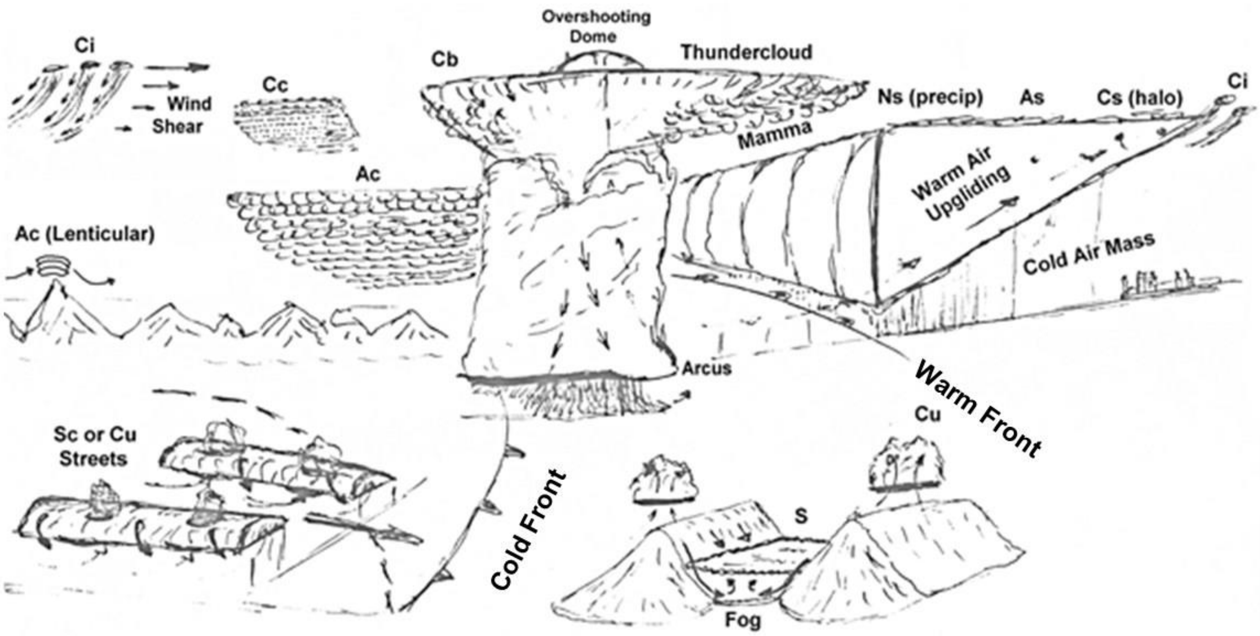


Fig. 5-10. Schematic picture of clouds showing characteristic structures and air motions. Horizontal scale of the stratiform, upgliding clouds associated with warm fronts of winter storms should be roughly 50 times larger.

When warm, humid air blows over cold land or a cold ocean current, the air is cooled by contact to stratus that can linger for days. Fog or stratus also forms on clear nights if the land cools enough by radiating heat to space. Radiational cooling also produces thin clouds at the top of humid air layers as the Sun goes down. Cooling by these processes is usually confined to thin layers of atmosphere and rarely exceeds 1°C/hour.

The fastest way by far to lower air temperature is to make air rise. Thus, rising air produces most clouds (except fog and low stratus) and virtually all precipitation. Since air pressure decreases with height, rising air expands. As it does, air molecules slow, so temperature falls. Rising air cools by 10°C per km (5.5°F per 1000 ft) when unsaturated. and roughly 6°C per km once condensation begins. Still, for typical vertical velocities in winter lows (0.1 m/s), hurricanes (1 m/s), and thunderstorms (10 m/s) cooling rates due to rising air in these storms exceed 1°C/hr, 10°C/hr, and 1°C/*minute* respectively, and this cooling takes place over great heights.

Because the tiny droplets and crystals are swept along as the air moves, clouds represent the signature of the winds and their forms are due to the patterns of rising and sinking air. There are only a few basic cloud forms because there are only a small number of distinct patterns of air motions.

When a hot, buoyant puff of air (thermal) rises through an otherwise quiescent atmosphere, the resulting cloud, a cumulus, looks like a puff. When the thermal's upward progress is slowed by the surrounding quiescent atmosphere, the cloud will spread out at top into a mushroom cap or anvil, as when Vesuvius erupted or as in most thunderstorms.

Cumulus, the cloud puff, is probably the most universally acknowledged cloud form. It was the first cloud to be painted in a recognizable manner and is the only cloud that most children and adults draw. Most sizable, growing cumulus have puffy sides and tops and may be shaped like cauliflowers or mushrooms (see Fig. 4-17) but have bases that are flat and horizontal (Fig. 5-11). A flat base, seemingly so inappropriate for such freely swelling clouds, marks the condensation level, the height at which the temperature of the rising air has fallen to the saturation point. Below this height the rising air and vapor remain invisible although the wetting of the many salt particles that serve as nuclei for the droplets renders the air hazy roughly 50 to 100 meters below cloud base. Immediately above the condensation level, droplets or crystals begin growing in earnest and the cloud appears.

Fig. 5-11. Flat-based cumulus.

Above the flat bases, no two cumulus clouds are exactly alike but their general outlines have only a few basic variations. Simple rising thermals resemble upright mushrooms, as in Fig. 4-17. Since most cumulus consist of tightly packed clusters of turbulently rising thermals they resemble cauliflower heaps rather than mushrooms.

Each thermal continues to accelerate upward so long as it is buoyant, i. e., warmer than the surrounding air at the same level. When a thermal enters warmer surroundings only a short distance above its condensation level, it soon stops rising. The result is a layer of stunted and flattenerd, almost pancake-shaped stratocumulus.

But when the ambient temperature decreases rapidly all the way to the stratosphere the entire troposphere is unstable and the cumulus will tower overhead before spreading out at its top as the king of all clouds, the cumulonimbus or thundercloud. Since not one cumulonimbus appeared in the storm-proscribed 15th century, they are described and displayed in Chapter 6 (§6.1), which treats the more turbulent 16th century.

The common cumulus has long been the artists' favorite cloud, perhaps because it is so forgiving. By contrast, Europeans are not often granted unimpeded views of the highly distinctive cumulonimbus. But European thunderstorms are not freakishly rare so, it is strange that her artists have so ignored them. Clearly, painters have not chosen their clouds entirely on aesthetic grounds for then they would not also have so neglected the delicately beautiful (and very common) cirrus.

Cirrus, the wispy cloud fibers, are trails of falling ice crystals twisted by the winds. Except in Polar Regions or the dead of winter, cirrus typically forms above 20,000 feet, where the atmosphere is permanently refrigerated and where strong winds, such as the jet stream, are common. Each streamer contains a small kernel or head where ice crystals or droplets that quickly freeze are produced, followed by a long, downward sloping tail where the falling crystals slowly evaporate (Fig. 5-12). Since wind speed generally increases with height, the tails lag behind the heads (Fig. 5-13), so that cirrus clouds serve as the wind vanes of the jet stream. When the winds are turbulent or change direction with height, they can twist the tails into fantastic swirls.

Fig. 5-12. Cirrus uncinus with heads and falling tails.

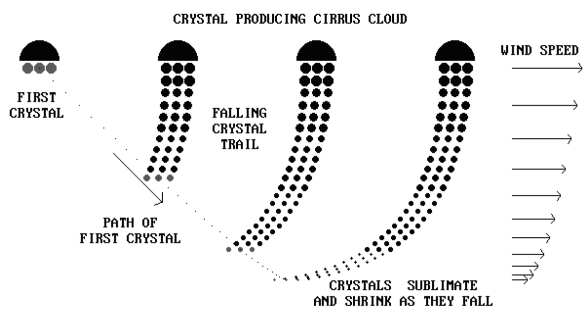


Fig. 5-13. Air motions for cirrus, with wind from the left. Crystals fall more slowly as they evaporate and shrink, making the trail bottoms more horizontal.

When a warm air mass glides over the dome of a colder air mass as part of a large storm system (Fig 5-10 and §7.2) or ascends sloping highlands, the sky is covered by a cloud sheet. If the storm approaches the cloud sheet lowers, changing in order from cirrus at the sheet's edge to halo-woven cirrostratus (Fig. 3-9) to altostratus of dull, gray days (Figs. 7-6, 7-7) to nimbostratus of dismal rainy or snowy days (Fig. 5-14). But cloud sheets that cover the sky were few and far between in the century that devoted such energy to uncovering the sky.

Thin cloud sheets are often broken into a variety of patterned forms. These are the stratocumulus, altocumulus or cirrocumulus, depending on the height of the cloud layer and the apparent size of the individual elements. If the individual cloud elements occupy more than 5º of the visual field, i. e., appear larger than fist size when the arm is fully extended they are stratocumulus. Cirrocumulus elements occupy less than 0.5º of the visual field and appear smaller than pinky nail size, while altocumulus elements are intermediate in size.

Fig. 5-14. Nimbostratus over Chittendon, VT at the beginning of snowstorm of 03-04 October 1987.

The patterns of the structured cloud sheets include honeycomb cells, rows of cloud cells, long bands or ripples or, on rare occasion, breaking waves (see Figs. 4-13, 4-15, and 7-28d). Combinations of intersecting waves and bands can occur simultaneously, leading to the so-called mackerel sky (see Figs. 7-27, 7-28c).

When the top of a cloud layer cools or the bottom is heated enough so that the layer becomes unstable, gentle convective motions (called Bénard or Rayleigh convection) begin. If the wind changes little with height, the convection breaks thin cloud sheets into a honeycomb pattern of closely packed cells, as in Fig. 5-15. The cooler, denser air at the top of each cell sinks while the warmer, lighter air at the bottom rises.

Cellular clouds can assume two basic forms. When the layer is cooled from above the sinking motion is more intense and thus narrower than the gentle rising motion. Closed cells (Fig. 5-15) then form, with rising air and clouds in the centers and sinking, clear fringes

(Fig. 5-16). Open cells, the less common variant, form when the cloud layer is heated from below (see Fig. 5-27). Open cells are marked by narrow cloudy fringes of rapidly rising air and broad clear centers with gently sinking air. Open cells often form over tropical oceans, where the cell fringes consist of interlaced rings of individual cumulus, but they then occur on a scale so large that the cellular pattern can only be deciphered from space.

Fig. 5-15. Closed-cell altocumulus over Keene, NY.

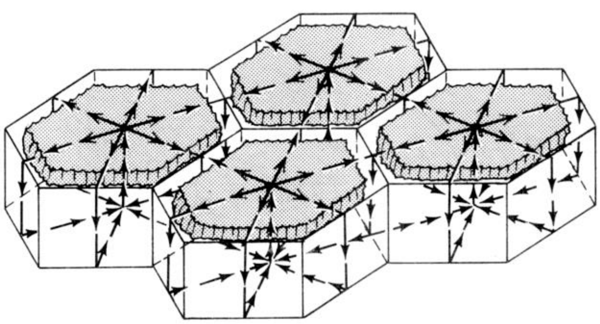


Fig. 5-16. Motions and clouds of closed cellular convection. For open cells and their clouds, reverse motions and cloudy and clear areas.

Vertical shear, the change of wind speed or direction with height, orients the randomly packed honeycombs (see Fig. 7-28). Moderate shear in unstable air marshals the cells into bands or streets aligned with the wind. Strong shear in stable air generates trains of wavelike ripples that cross the wind. On occasion the sky can be filled with a cloud matrix consisting of cells, rows and ripples.

Two early 15th century painters (Sassetta in Italy and Jan van Eyck in Flanders) realized the glory of altocumulus flocks and depicted them in several of their paintings. But that utterly failed to spawn a Cambrian efflorescence of multi-celled clouds. Incredibly, later 15th century artists turned a blind eye to such glorious cloud multitudes. Perhaps individual clouds will always monopolize attention in a new age of heroes.

One extraordinary cloud that appears alone or in small convoys captured the attention of a few 15th century painters. Altocumulus lenticularis (lentil-shaped) or mountain wave clouds are distinguished by their smooth outlines. They appear strikingly different from most other clouds, which are corrugated, irregular or amorphous.

No clouds pose more patiently than mountain wave clouds. They form when air is forced to ascend a mountain peak or ridge (see Figs. 5-17, 5-39) hovering almost motionlessly despite strong winds because they are fixed by the flow pattern, which is fixed to the mountain. Even though the cloud remains in place its composition is constantly changing. New droplets form on the upwind side when the air first rises above the condensation level. The droplets move through the cloud with the air, growing as the air ascends and cools. Once past the crest, the air sinks and warms, so the droplets shrink and disappear on the downwind side when the air passes back down below the condensation level. If, however, the droplets freeze, the ice does not evaporate unless the air sinks somewhat lower. In that case cloud may even occupy the wave troughs, as Fig. 5-17 shows.

The cloud outline is smooth when the flow is laminar. This occurs when the rising air is colder than the surroundings, i. e., not buoyant. The cloud's outline mimics the shape of the mountain - long ridges produce cigar-shaped clouds while isolated peaks produce lens or saucer-shaped clouds (Figs. 5-38, 5-39).

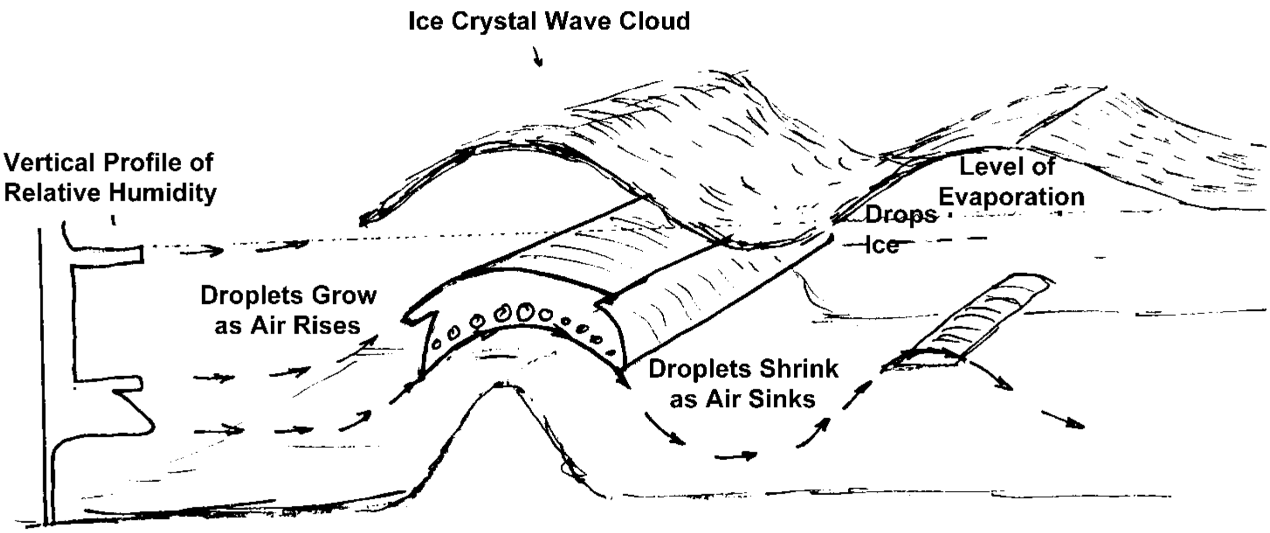


Fig. 5-17. Air motions, humidity profiles and cloud particles for multiple layer mountain wave clouds. If droplets freeze to ice, clouds will extend below the condensation level for liquid water and may fill wave troughs.

After the air stream surmounts the mountain crest it freely descends on the lee or downwind side, where its momentum carries it below its original level. It is then warmer than the surroundings, and rises again. The end result of this process is a series of waves with diminishing amplitudes downwind of the mountains. A cloud occupies each crest that extends above the condensation level.

The cloud base arches upward in its center like a wing when the humid layer is distinct, while if humidity varies gradually with height, the base curves down in the center to give the cloud the appearance of a lentil bean or lens.

In the sacred tradition of the religious, symbolizing 15th century, artists appeared to vest mountain wave clouds with celestial significance. In more recent times, people have attributed different otherworldly qualities to the strange, hovering saucer-shaped clouds.

5.3 The Celestial Curtain Rises North of the Alps

When 15th century artists began exploring the sky, there were no convincing physical explanations for sky color or clouds. They had to start from scratch, by disregarding any preconceived medieval notions and then relying solely on their observational powers. Their aerial accomplishments are indeed, profound!

Shortly after 1420, two Flemish artists, the Master of Flemalle, most often identified as Robert Campin, and Jan van Eyck began to paint the first realistic, cloud filled skies with drastically improved geometric and aerial perspective. How did this miraculous revolution originate and proceed? Was it original with each? What contacts were there among artists? It seems the changes were in the air, so to speak, just as it seems they were for the almost simultaneous development of the Calculus by Newton and Leibnitz.

Can we even establish aerial priority? Scholars have debated for centuries the dating and attribution of their works because Robert Campin did not sign any of his works and Jan, who was the first painter to do so, usually signed and dated only the frames.

Jan van Eyck and Robert Campin almost certainly met. Jan made two documented trips to Tournai, in October 1427 and March 1428, where he was a guest of the Painter's Guild of which Campin served as dean. But no matter what they learned from each other, each staunchly maintained his own distinct aerial viewpoint. Most of Campin's scenes face the Sun and contain cumulus with sunlit tops and sides but shaded sides and bases blocked by buildings or lost in haze near the horizon. Jan van Eyck's aerial viewpoints were more diverse but his later scenes are oriented about 90º from the Sun, with deep blue skies that highlight entire clouds.

Robert Campin was born about 1375, possibly near Valenciennes. In 1408 he bought a house in Tournai and was elected dean of its Painters' Guild in 1423. His earliest remaining works date to about 1415 and have patterned backgrounds that exclude the sky, but the human figures and landscape features are handled with a sense of realism that surpasses anything produced by the Parisian artists.

Fig. 5-18. Robert Campin. *The Nativity*. c. 1425. Musee des Beaux-Arts, Dijon.

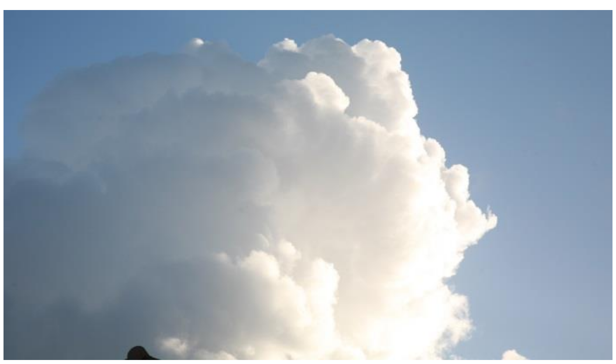


Fig. 5-19. Cumulus with prominent sunlit right side and almost camouflaged shaded left side.

When Campin finally began to paint the sky he did it admirably. *The Nativity* (Fig. 5-18) is just about the earliest convincing landscape panel by a European artist, and its sense of perspective far exceeds anything Roman or Greek painters produced. The scene also is true to the Christmas season with leafless trees. Still, it is a mild winter, as Hans Neuberger noted in *Climate in Art*, for no snow covers the ground and the manger sheltering the Virgin and Child is an open structure.

The Sun, sporting a face, has just risen over an almost bare and somewhat medieval rocky outcrop in the middle ground. The trees cast long shadows opposite the Sun. Delicate golden rays that emanate from the Sun and from the infant Jesus (not shown in Fig. 5-18) disrupt the otherwise naturalistic mood of the work and keep us from forgetting the divine presence.

The sky and the treatment of aerial perspective in *The Nativity* are compelling. A light green carpet of grass interlaced with golden paths in the foreground grades to light blue distant low-lying hills. The sky, which occupies only the top 7% of the work, grades from a milky blue at the top to almost white at the horizon. In the distance at the far right are cumulus with bright sunlit sides and tops that contrast sharply with the sky, but shaded sides and bases that are almost indistinguishable from the background sky and seem to emerge from it much as the mountains emerge from mist in Chinese paintings. This is characteristic of distant cumulus seen in the general direction of the Sun even on days of moderately high visibility, as in the *Nativity*.

Similar cumulus are frequently seen in the part of the sky near the Sun on hazy summer days, as in Fig. 5-19. It is little matter that, except in the tropics and Mediterranean climate regions, towering cumulus are not common in winter, when solar heating is weak, particularly at dawn, and when skies are seldom hazy.

About 90º from the Sun the sky is most highly polarized and deepest blue. Here, the contrasts between sky and opaque cumulus, and between the brightly sunlit and deeply shaded sides of all the clouds' protuberances are greatest so that their essential form is displayed to maximum advantage. And this is the part of the sky Jan van Eyck faced when creating his textbook skies and clouds.

Jan van Eyck was born about 1390, presumably in Maaseyck, and achieved widespread fame within his lifetime. He was apparently already an artist of stature in 1422 when he was employed in the Hague by John of Bavaria, Count of Holland. During Jan's tenure there, which lasted until the Count's death in 1424, he illuminated manuscripts and almost certainly painted the remarkable landscape scenes identified as those done by "Hand G" in the *Turin-Milan Book of Hours* (Museo Civico, Turin). However, the earliest of Jan's signed works is the Ghent Altarpiece, which was presumably begun by Jan's shadowy brother, Hubert in 1426 but definitely completed by Jan in 1432.

Fig. 5-20. "Hand G" (Jan van Eyck). *Finding of the True Cross Turin-Milan Hours*. 1422-1424.

The earliest of the textbook flat-based, multi-turreted cumulus that later became a signature of Jan van Eyck fill the sky of *The Finding of the True Cross* from the *Turin Milan Hours* (Fig. 5-20). Here, they mix with thin, immature cumulus. Such thin cloud veneers reflect sunlight poorly while blocking background skylight. Therefore they appear dark even if sunlit when they are seen 90° or more from the Sun. Van Eyck never again allowed such imperfect, obstructionist cloud fragments to appear with their perfect brethren.

Two other cloud genera were depicted for the first time in the history of art in this miraculous work and also became van Eyck trademarks. A small field of cellular altocumulus subtly occupies top center and cirrus streamers that slope downward appear beyond the mature cumulus at the far left.

The *Finding of the True Cross* is remarkable in other respects. Both aerial and geometric perspective are well developed. The clump of trees in front of the castle form a unit that resembles a grove. Virtually all other 15th century artists painted individual trees and individual clouds rather than coherent groups.

Fig. 5.21. "Hand G" (Jan van Eyck). *Baptism of Christ. Turin Milan Hours*. 1422-1424.

The forest of *The Baptism of Christ* in the *Turin Milan Hours* (Fig. 5-21) is even more convincing. It has a continuous appearance that would not be depicted again for a century. This breathtaking illumination also shows an almost photographic surface of water for the first time in a painting - shimmering and reflective. After all, there is not a breath of wind; two smoke plumes rise vertically before encountering warmer air aloft and spreading symmetrically.

The time is twilight. The full Moon rests in a rosy sunlit sky opposite the Sun just above Earth's shadow, the dark blue strip on the horizon, as it should (see Fig. 9-16). Caspar David Friedrich is the only other artist who may have depicted Earth's shadow (Fig. 9-3).

A few small flat-based smoothed cumulus and flattened stratocumulus dot the *Baptism's* sky. They (and the plumes) are characteristic of dusk, when convection from daytime heating has subsided, and should soon evaporate.

These extraordinary miniatures show that Jan van Eyck was fully prepared to paint the *Ghent Altarpiece*. After the death of the Count of Holland, Jan lived in Bruges from 1425 serving Philip the Good, Duke of Burgundy in several capacities including ambassador. Most of Jan's known paintings were produced during breaks in his employment with the Duke.

The *Ghent Altarpiece* is Jan van Eyck's first documented painting. It is difficult to look at this cornerstone of human genius with dry eyes. It may represent the closest approach to a compendium of creation that has ever appeared in paint and reveals an artist who achieved almost single handedly complete mastery of tromp l'oeil. Trees, flowers, jewels, the organ, the human figure, cities, the countryside, and the atmosphere are rendered so realistically that it is almost necessary to touch the panel to be convinced it is nothing but a flat painted surface. How van Eyck attained such technical mastery and what gave him such probing eyes to uncover nature's long hidden secrets will probably remain mysteries for all time.

The *Ghent Altarpiece* has a long and intriguing history. An inscription rediscovered in 1823 states that Jan's brother, Hubert, was originally commissioned to paint it and Jan took over after Hubert’s death in 1426. It was completed in 1432 after many interruptions and received immediate acclaim for its unprecedented magnificence. It has since been moved, damaged and restored several times. One of the two panels stolen in 1934 has not been recovered and has been replaced by a copy. At present, the *Altarpiece* once again hangs in St. Bavo's Cathedral where it is constantly attended. Every few minutes a guard alternately opens and closes its doors to reveal both inner and outer panels.

The sky appears in the five lower inside panels. The four side panels present a more or less continuous scene interrupted only by the frames and by the distinct meteorological setting of the central panel, the *Adoration of the Lamb* (Fig. 5-22). Two sources of divine illumination appear in the *Adoration* but do not affect the landscape features. An aureole resembling a corona surrounds the Dove of the Holy Spirit while threadlike rays emanate from both the Dove and the Lamb. The shadows on the buildings and clouds all point to the natural source of illumination for the five panels and show that the Sun lies behind and to the right.

Fig. 5-22. Jan van Eyck. *Adoration of the Lamb, Ghent Altarpiece*. 1426-1432. St. Bavo's Cathedral, Ghent.

The painting provides enough information to conclude that the astronomical setting matches that of the theological (the Feast of the Annunciation, March 25). Given that cathedral towers face west, the scenes face ENE. The waxing half Moon is rising just below the central cumulus in the *Warriors of Christ* (Fig. 5-23). The Sun is located across the celestial hemisphere from the Moon's bright side, in the ESE about 40º above the horizon line. This fixes the time at shortly before noon and, given Ghent's latitude, near one of the equinoxes.

Fig. 5-23. Jan van Eyck. *Warriors of Christ: Ghent Altarpiece*. 1426-1432. St. Bavo's Cathedral, Ghent.

Fig. 5-24. Cumulus with a mushroom protuberance.

The botany of the *Ghent Altarpiece* is profuse. The *Adoration* presents a world of flowering and fruited plants that appear simultaneously, an eternal growing season, a true Garden of Eden. Identifiable trees include palms, cypresses, pomegranates, figs, olives and oranges. Flowers include lilies and roses.

Sky color of the *Adoration* differs from the skies in the four wing-panels. The *Adoration* has a blue-green, sky while the sky of the four wing-panels is deeper blue, as if after a cold front has passed.

The clouds also imply a different setting for the *Adoration* than the wing panels. The *Adoration*'s clouds are small, smooth edged, dying cumulus often seen near sunset, as in Fig. 5-21 and Fig. 5-32. The feeble lighting on these clouds suggests that the Sun is near the horizon and that it has been weakened by its oblique passage through the atmosphere. Similar clouds occasionally occur in early morning, but are unusual shortly before noon, except perhaps in the dead of winter when the Sun is quite weak.

The cumulus of the four side panels are larger, more active, and more appropriate for a midday, summer setting. They are accurate enough to be used as illustrative examples in meteorology textbooks. Their bases are horizontal and almost flat while their distinctly corrugated sides and tops show they are growing. Most are boxlike and modestly sized, less than a mile across and not quite as high.

Jan van Eyck painted similar cumulus in each of his works that contain sky, so that they almost constitute a signature. Such clouds are called fair-weather cumulus, especially when seen in mid to late afternoon, because they tend to dissipate as the Sun descends and often disappear around sunset. North of the Alps they are also most common in late spring and summer, for that is when the sky is least often overcast and the Sun is strongest.

A mushroom-shaped turret sometimes seen in active cumulus emerges from the right side of the central cumulus in the *Warriors of Christ*, as in Fig. 5-24. This is its only appearance in van Eyck's art and it is extremely rare in European art. Chinese artists fell in love with the flowing mushroom form, but prior to 1900 this dynamic property of clouds caught the eye of only two other European artists - Leonardo da Vinci and Vincent van Gogh.

The *Ghent Altarpiece* also contains cirrocumulus and altocumulus. The *Pilgrims* panel contains a tiny patch of cirrocumulus although its identification is only tentative. A small patch of cellular altocumulus occupies the upper right corner of the *Warriors of Christ*. The few cells are polygonal with rounded edges, and appear to be randomly packed. Such altocumulus occur most frequently during hot weather when the jet stream has been displaced far north and when there is little vertical wind shear to impart a sense of orientation or banding. An almost identical patch of cellular altocumulus appears in the placid summer sunset sky of the *Madonna of Chancellor Rolin* (1436, Louvre) Altocumulus can be seen at any time of day, but are less common around midday when the Sun’s heat tends to evaporate them.

Fibrous streaks of cirrus weave their way between the altocumulus and cumulus in all four side panels. Cloud streaks and wisps suggesting cirrus had appeared in Campin's *Merode Altarpiece* (c. 1426, Cloisters Collection, Metropolitan Museum of Art, New York), and they have been used by painters ever since, but van Eyck was the first to represent them unambiguously. Even so, the cirrus of the four side panels appear somewhat fuzzy. This may be a consequence of the summer setting with its slight haze and weaker winds aloft, but more likely is a result of all the restorations and cleanings the Altarpiece has endured. A sorry example of loss of clarity and detail is the decidedly inferior treatment of the clouds in the *Just Judges* panel, a copy based on a photograph of the stolen original. The cirrus in this panel are blurred streaks while the cumulus have lost their flat bases.

The clouds of the *Crucifixion* (Fig. 5-22) are not one bit fuzzy, but because the panel is unsigned, its origin remains controversial. On the basis of its meteorology, I agree with those who attribute it to Jan van Eyck. To begin with, it exhibits many of the atmospheric features seen only in van Eyck's other works. But the deciding factor may be that the *Crucifixion* contains unique and original meteorological insights so profound but so much in character with the insights shown only in van Eyck's other signed works that the likelihood of even the most skillful imitator is remote.

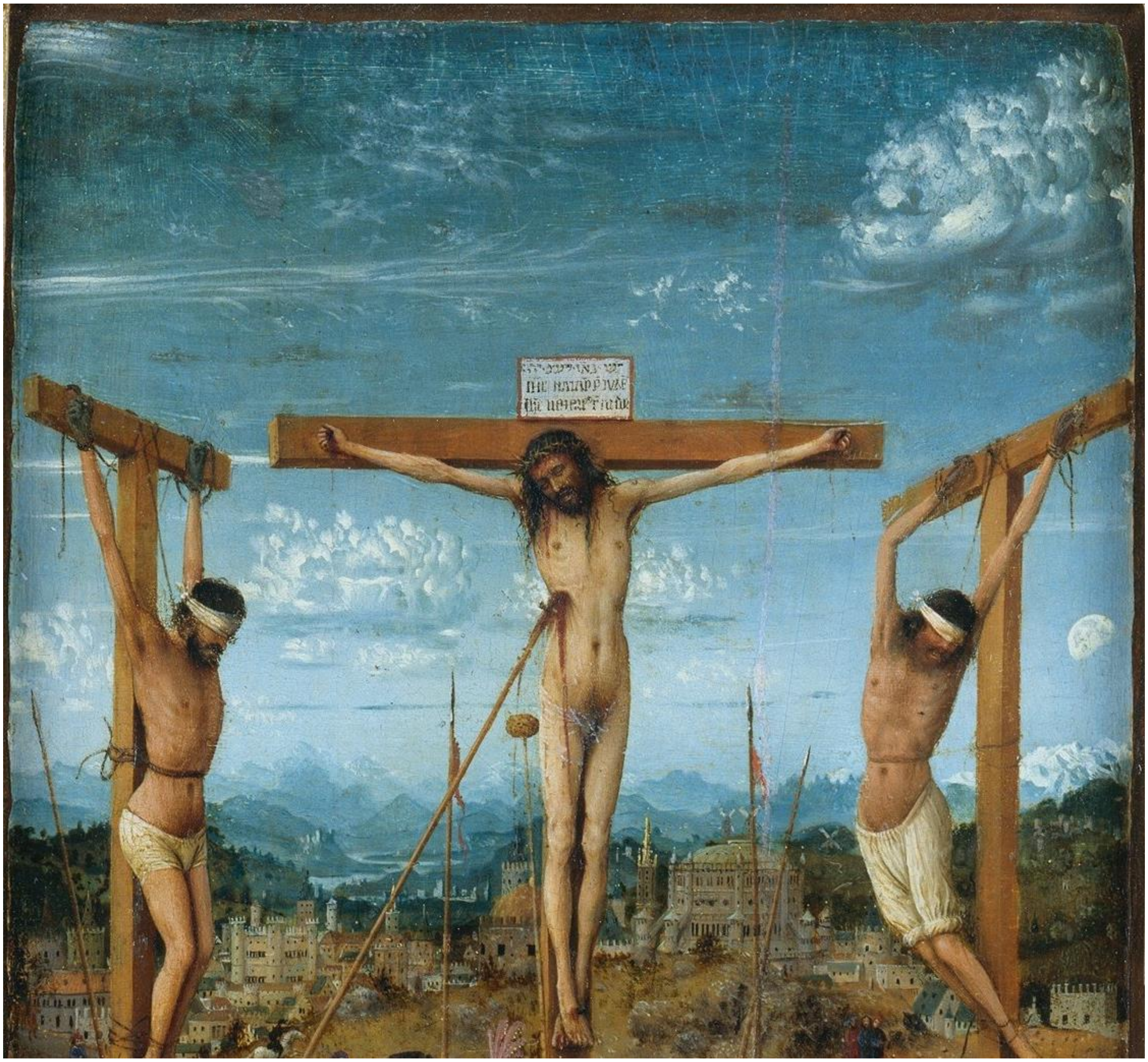


Fig. 5-25. Jan van Eyck. *Crucifixion* c. 1435. Metropolitan Museum of Art, New York, Fletcher Fund.

The *Crucifixion* shows the moment a Roman soldier lanced Christ's side. This fixes the panel's temporal reference point to the month after the vernal equinox and the week after the full Moon, somewhat after 3:00 in the afternoon on Good Friday, when Christ expired and the sky finally began to clear after three hours of darkness. Together with the lighting on the Moon, it helps establish the compass setting. The late afternoon spring Sun is located in the WSW. Even though (as David Lynch pointed out) the last quarter Moon should already have set in the southwestern sky, the Moon has been resurrected as a symbolic compass to point to the Sun and establish that the scene faces north.

The landscape is laid out according to a basic pattern Jan van Eyck used in a number of paintings. The foreground serves as the stage for the main action, invariably a religious event. The middle ground is occupied by a medieval city. A meandering river connects this city with the background, which is ringed by an unbroken range of Alpine mountains. Although the city has not been identified, the northerly viewpoint of the Crucifixion suggests an Italian setting just south of the Alps.

The rendition of aerial perspective in the *Crucifixion* is flawless and more advanced than in the *Ghent Altarpiece* where van Eyck employed an abrupt color change between the middle ground and distant landscape, allowing it to take place within a few blocks in the city. In the *Crucifixion*, no vegetation covers the brown foreground, for it is a place of death. But beyond the city, green forest grades to blue and ultimately to almost white in the furthest distance, even where the mountains are not covered by snow. There is more snow on these peaks than on any other of van Eyck's mountains, probably as a consequence of the season. The sky, which is almost white near the horizon, grades to a deep blue above.

Four cloud genera - cumulus, cirrus, altocumulus lenticularis and cirrocumulus lacunosis - populate the *Crucifixion*'s sky. The boxlike cumulus are the solid textbook van Eyck cumulus, with flat bases and corrugated sides and tops, still actively growing, but never large or threatening.

The cirrus in the *Crucifixion* is perhaps the paradigm of painted cirrus before John Constable's cloud studies. Individual streamers converge just above the inscription on the Cross and slope downward toward the left at a gentle, 2.5º angle, similar to the cirrus in Fig. 5-26 (where the bases of the cumulus are hidden in the haze layer). This indicates the wind at the level of the cirrus in the *Crucifixion* is blowing from the left, or west, considering the painting's compass orientation. This is the jet stream's prevailing direction over the Low Countries in spring.

Fig. 5-26. Cirrus above and cumulus below, with bases largely hidden in haze over Spring Valley, NY.

Fig. 5-27. Cirrocumulus lacunosis over Upper Saddle River, New Jersey.

A small patch of cirrocumulus with open cells (lacunosis) similar to that in Fig. 5-27 appears just above the cirrus in the top center of the Crucifixion. Finally, the miniature cloud at extreme upper left consists of a stack of about 7 smooth veneers that arch prominently upward in the center like an eyebrow. This is probably a mountain wave cloud (see Figs. 5-38 and 5-46) produced by the west wind as it crosses the mountains. When the atmosphere contains veneers of alternating humid and dry air, the resulting mountain wave clouds assume the appearance of stacks of plates.

The *Crucifixion* was meticulously designed to tell a meteorological tale that is both consistent with the mandated guidelines of Scripture and true to the observed behavior of north Europe's weather. On the day of the Crucifixion the sky was dark from the sixth to the ninth hour – noon to 3:00 PM. Shortly after that a Roman soldier lanced Christ. The *Crucifixion* has no dark or stormy clouds but it provides compelling meteorological evidence that the sky had been dark and stormy a short time before and that a slowly moving cold front had just passed through the region.

Slowly moving cold fronts are often associated with unbroken cloud shields that last for several hours after frontal passage and then clear out abruptly. The high visibility and deep blue sky of the Crucifixion are associated with a cold, dry air mass that always follows a cold front. The arrested vertical development of the cumulus shows that the cold air mass is shallow and implies that the front is not far off and has passed by quite recently. When cirrus and mountain wave clouds are seen in crystalline skies they indicate the presence of thin humid layers aloft in an otherwise dry atmosphere - this typically happens in the hours immediately following the passage of a slowly moving cold front. The surface wind direction is also consistent with dramatic clearing following the passage of a slowly moving cold front. The direction is determined from the three windmills located just beyond the Temple of Jerusalem. These all face the right and into the painting, or to the northeast if the northward viewpoint of the painting is accepted.

Ironically, Van Eyck's imposed sense of meteorological order so far exceeds anything normally encountered in nature that it indicates a strong element of idealism. Rarely do cirrus have such long, distinct fibrous trails, for as the trails lengthen they often overlap and merge into a rather amorphous tail. Jan's cumulus are also too perfectly formed and displayed. While such model cumulus clouds certainly do exist, skies filled with cumulus invariably contain clouds at all stages of development, as in *Saint Helene Finding the True Cross* (Fig. 5-20). In real skies, amorphous shreds of juvenile cumulus appear side-by-side with well-formed mature cumulus and smooth, rounded or fuzzy-edged aged, dissipating cumulus. Furthermore, haze often obscures or disguises the flat bases, while seldom are the few perfectly developed specimens fully visible in profile, for a host of cloud fragments are almost certain to either partially obstruct their view or cast them in deep shadow.

Van Eyck's perfectly formed and impeccably displayed individual clouds helped to establish a model that guided most 15th century sky painters. Almost every 15th century sky shows small clouds in profile, high atmospheric visibility, and rather serene weather. But the cloud fields of cirrocumulus and altocumulus, which derive their beauty from the organized multitudes of cells, rows, columns or fibers, proved to be beyond the capacities of all 15th century artists except Jan van Eyck and Sassetta, while storminess or turbulent elements suggesting motion were also never portrayed effectively to the modern eye. A few of the early Renaissance painters did attempt to paint cloud fields and storm scenes (and forests rather than just trees), but as the Renaissance penchant for individuality and rationality hardened into a brittle dogma, almost all such attempts were abandoned.

By the time Jan van Eyck died in 1441, patrons were frequently demanding to see landscape backgrounds. This obliged Flemish artists to paint color-graded skies whether they wanted to or not. An artist not particularly interested in landscape would have appreciated any time saving technique for treating the sky and its clouds.

Rogier van der Weyden, a painter often regarded as not primarily interested in landscape, created an enduring short cut for representing cumulus. The center panel of his *Adoration of the Magi Altarpiece* (Fig. 5-28), shows only the linings of the cumulus without some of the cloud bases. This is inconsistent because the sky of the *Adoration* is so crystal clear and deep blue, and has such high visibility that every cloud detail should be unmistakable. Nevertheless, the effect is charming and the device has been used ever since by artists and cartoonists as an effective caricature of cumulus.

Fig. 5-28. Rogier van der Weyden. *Adoration of the Magi Altarpiece*. c. 1460-62. Alte Pinakothek, Munich.

The painter of the *Pearl of Brabant Altarpiece* (Fig. 5-29) sought no such aerial short cuts. This miraculous anomaly of 15th century Northern painting, attributed to Dirk Bouts the Younger, is one of the landmark pieces of sky painting.

The *Pearl*'s central panel contains one more of the innumerable clear, color-graded skies of that century. But the skies of each of the two side panels are strikingly original and beautiful and give a foretaste of the 19th century American works of the Hudson River School (see §9.3). They are unlike the skies in any other 15th century Northern European painting I know of.

The milky blue sky of *St. John the Baptist in the Wilderness* (Fig. 5-29 top) with swelling cumulus suggests a summer afternoon. The cumulus are flat-based and one of the turrets is anvil shaped, suggesting it has penetrated a layer of warmer air. This cloud has the form but lacks the imposing size of a cumulonimbus (see Fig. 6-2) and the sky beneath its base is not darkened by falling rain streaks, a feature artists other than the 17th century Dutch seldom bothered with before 1800. The anvil-topped cumulonimbus has been a much neglected cloud and has received pitifully little attention until a few 20th century American artists finally realized its dramatic potential.

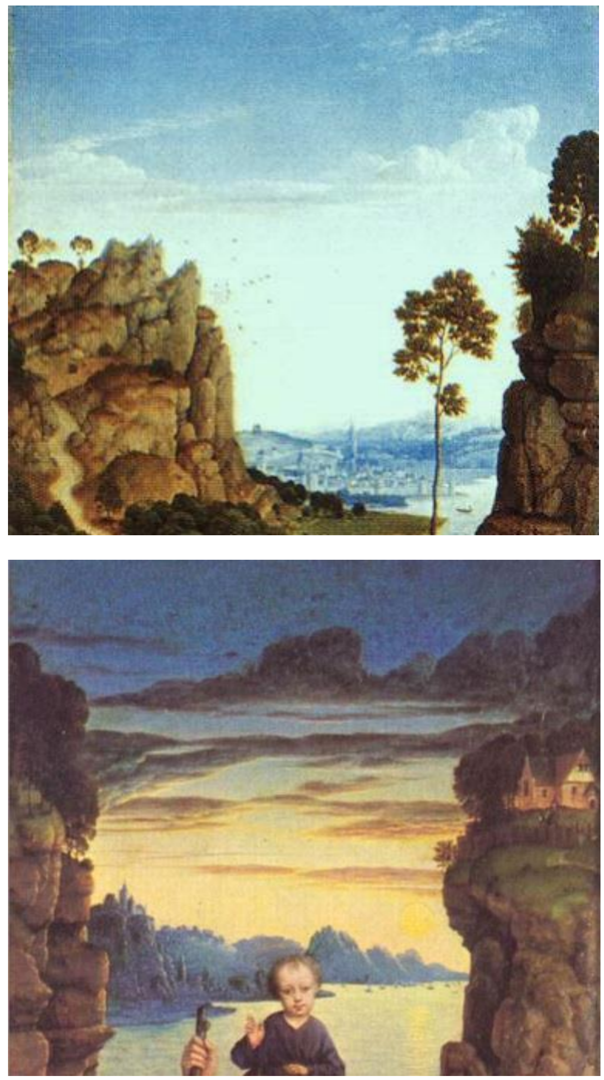


Fig. 5-29. Dirk Bouts the Younger (?). *St. John* (top) and *St. Christopher*, from the *Pearl of Brabant Altarpiece*. c. 1475-80. Alte Pinakothek, Munich. Note illuminated corrugations on stratocumulus bases.

The *St. John* panel also contains some delicate higher clouds. A band of cirrus with streamers stretches across the sky on the upper left while a small patch of altocumulus or cirrocumulus cells appears beyond and to the right of the cloud anvil.

The *St. Christopher* panel is based on the legend of the giant who sought to serve the most powerful ruler on Earth. Discovering that this was Christ, Christopher learned from a monk that he could serve best by ferrying people on his back across a dangerous stream. One day, he was awakened by a child who asked for passage. Christopher placed the child on his back and began to ford the stream. Quickly the current rose to a raging torrent and the child grew immeasurably heavy. St. Christopher was deeply troubled but did not buckle under the load or try to save himself by casting off the child. After an arduous trial, Christopher delivered the child safely on the far shore. Before disappearing, the child revealed himself as Christ and told Christopher he had borne upon his shoulders the entire weight of the world's troubles. He had earned his glorious sunset.

In the panel, the Sun is a golden sphere just above the horizon. The blazing sunset sky has the characteristic color sequence of crisp, dry days - yellow at the horizon grading through the spectrum to a deep blue above. The light of the setting Sun tinges the clouds' lower fringes golden and red while the shaded portions of the clouds are purple.

The stratocumulus in the *St. Christopher* panel form a series of parallel rows or streets. On windy, crisp days some time after the passage of a cold front, the wind aligns cumulus, stratocumulus or altocumulus into streets that act as cloud-level wind vanes. From ground level a glimmering of the pattern may be possible (Fig. 5-30) particularly near sunset, when the air near the ground is no longer heated and no longer rises, so the vertical development of the individual cloud turrets is less prominent and distracting. A compelling view of the larger scale pattern of cloud streets is offered from space whenever arctic air pours out from the land, as over the Atlantic Ocean and the Gulf of Mexico (Fig. 5-31). Over the water, the arctic air acquires vapor and heat, and rises to form clouds that the wind aligns.

Fig. 5-30. Stratocumulus rows (streets) parallel to the west wind over New York City at sunset.

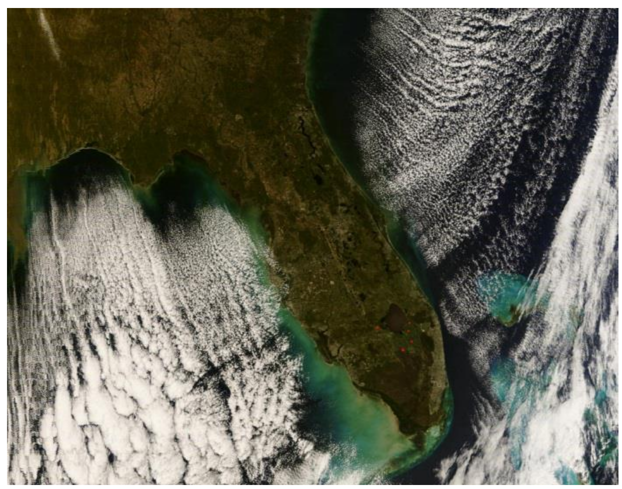


Fig. 5-31. Satellite view of cloud streets due to cold dry air from the north warmed and moistened over the water around Florida and aligned by the wind. Cloud on the East edge marks the cold front.

The magnificent *St. Christopher* panel was certainly not the only 15th century sunset or dawn scene. Various biblical events transpired either at dawn or dusk and the beautiful colors of the sky at these times have always provided artists with good material.

One of the most famous dawn scenes of 15th century Northern art is Hugo van der Goes' *Portinari Altarpiece* (Fig. 5-32). The triptych was commissioned by Tommaso Portinari, an agent of the Medicis and a distant relative of Dante's inspiration, Beatrice.

Tommaso took the *Altarpiece* back to Florence, where it strongly influenced many Italian Renaissance painters.

Fig. 5-32. Hugo van der Goes. *Portinari Altarpiece*. c. 1476. Uffizi Gallery, Florence.

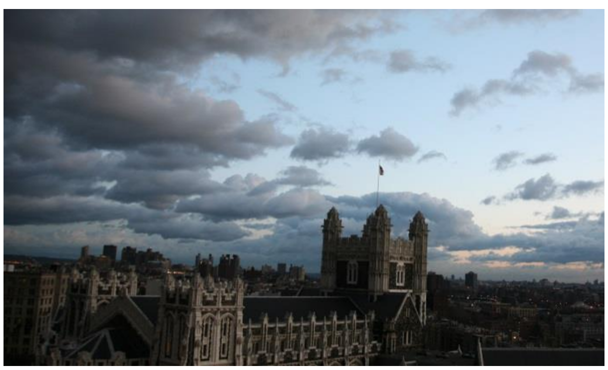


Fig. 5-33. Cumulus at sunrise over CCNY with the Sun 90º to the right, 03 Dec. 2009.

The arresting feature of the skies in the two side panels of the *Portinari Altarpiece* is the subdued gray and pale yellow coloring. Hugo van der Goes was a deeply religious and melancholy figure. Shortly after completing the triptych he retreated to a life of seclusion in the monastery of the Red Cloister, near Brussels, where he continued to paint. There he died in 1482 following attacks of religious mania and profound depression.

The muted sky colors of the side panels of the *Portinari Altarpiece* may reflect the personal psychology of a deeply melancholy soul but are taken faithfully from nature. The brilliant hues of sunrise or sunset are usually confined to the part of the sky near the Sun, while about 90º to the left or right the colors are typically muted (Fig. 5-33). Since only the left fringes of the solid cumulus (more common at sunset except over tropical water) are illuminated by the Sun, it is apparent that van der Goes chose this more sober part of the sky for his *Altarpiece*. The sky has a face to suit any choice we make in life.

5.4 The Aerial Renaissance in Italy

Italy created the Renaissance but lagged behind the North in sky painting. The Italians began hesitantly to paint the sky early in the 15th century, following by only a few years the lead of the Parisian artists. Around 1410, the color-graded sky made its humble Renaissance debut in the *Thebaid* (Fig. 5-34), attributed to Gherardo Starnina.

Fig. 5-34. Attributed to Gherardo Starnina. *The Thebaid*. c. 1410. Uffizi Gallery, Florence.

Fig. 5-35. Cappadocia. Cones of Ürgüp.

A few tiny cloud wavelets done in the manner of Andrea da Firenzi grace its sky and suggest greater things to come. The rough monastic landscape of the *Thebaid* seems totally fantastic because it comes complete with the Gothic sense of disproportion and stacked perspective. In fact, the scarp is modeled after the Cones of Ürgüp in Cappadocia (Fig. 5-35), where monks hewed caves out of deeply eroded pinnacles of soft volcanic material capped by overhanging blocks of more resistant rock.

The *Thebaid* failed to launch a revolution in Italian sky painting. The sky next appeared almost surreptitiously more than a decade later. Gentile da Fabriano completed his Gothic masterpiece, the *Adoration of the Magi* in 1423. The Altarpiece consists of a large central panel and a predella beneath with three small scenes. The sky in the main panel is still blocked by an Iron Curtain of gold. Only in the small, almost inconspicuous scenes of the predella has the curtain been lifted to reveal blue sky and liberate Italian artists.

Small wavy cloud lines cross the color-graded sky of the predella scene, the *Flight into Egypt* (Fig. 5-36). The clouds, appearing above hilly terrain, seem to be prototypes of mountain wave clouds. But mountain wave clouds never occupy the troughs of the waves unless the clouds consist of ice crystals. And in the warm climate of Italy, no ice crystal cloud would ever come so low as to collide ungraciously with a castle atop a small hill.

Fig. 5-36. Gentile da Fabriano. *Flight into Egypt*, from the *Adoration of the Magi Altarpiece*. 1423. Uffizi Gallery, Florence.

Rome's climate is so warm that snow is even rare in winter, while in summer Rome never gets snow. However, hail can fall during a severe summer thunderstorm and there have even been a few freak cases where flakes of snow have been observed mixed with the falling hailstones.

Legend tells of a miraculous summer snowstorm (more likely a hailstorm) that led to the founding of the basilica of Sta. Maria Maggiori. On the night of 3 August 352 the Virgin appeared in visions to the pope and to a patrician named John, telling them to build a church where they would find newly fallen snow. John rushed out to see fresh snow outlining the floor plan of a church.

Renewed attention was drawn to the legend after Pope Martin V stayed at Sta. Maria Maggiori between 1421 and 1423 and decided to refound the church. Possibly as early as 1423, but no later than 1428, Maso di Cristofano Fini, better known as Masolino, was commissioned to paint the *Founding of Sta. Maria Maggiori* (Fig. 5-37).

Fig. 5-37. Masolino. *The Founding of Sta. Maria Maggiori*. c. 1425. Museo di Capodimonte, Naples.

Snow has already marked the floor plan of the church, enabling Pope Liberius to trace it. White dots of snow are still falling from a large loaf-shaped cloud that supports Jesus and Mary, who preside over the entire proceedings.

The feeling of a supernatural presence in the *Founding* is reinforced by the small, saucer-shaped clouds. One line of these streams from the convincing mountain range in the background. Either this or Sassetta's *St. Anthony the Hermit Tortured by the Devils* (1423, Pinacoteca Nazionale, Siena) constitute the first indisputable example of mountain wave clouds in the history of art. Although the clouds are slightly stylized, they possess the essential upward central arch and the serial alignment of wave clouds.

Fig. 5-38. Mountain wave clouds, Mt. Washington, NH from Israel River. Al Saucier, Photographer.

Fig. 5-39. Air motions for mountain wave clouds over a solitary peak.

To Masolino, such fantastically shaped clouds may well have suggested the presence of the deity; today, almost six centuries later, the same clouds still inspire otherworldly thoughts, for they have often been misinterpreted as flying saucers. Indeed, the first documented 'sighting' of a UFO was made in 1946 over Mt. Rainier in Washington, where saucer-shaped mountain wave clouds form quite often. Similar clouds form when strong winds surmount many mountain peaks such as Mount Washington in New Hampshire (Fig. 5-38). The airflow that produces saucer clouds is shown in Fig. 5-39.

Why do so many of the small clouds that act as trademarks of 15th century Italian paintings resemble mountain wave clouds? All Italy is steeped in mountains. The Alps are its skullcap, protecting it from barbarians and from arctic air, while the Apennines are its backbone. Masolino, who was born in the Umbrian highlands in the tiny village of Panicale, surely saw heavenly displays of saucer-shaped clouds above his hilly homeland that matched the ones he painted.

Masolino still felt compelled to put his saucer-shaped clouds in a sky of gold but inserted a circular halo around Jesus and the Virgin that faintly hints the real sky has some other color. So long as Italian artists obtained their commissions from the Church or State, they remained understandably reluctant to tear down the timeless walls of gold.

New horizons were rapidly opening. Worldly patrons arose in Italy as in the North to demand new forms of art. The concept of linear perspective based on a vanishing point at infinity, credited to the architect, Filippo Brunelleschi in the opening years of the 15th century, was put into practice by the sculptor, Donatello in 1425. The Gothic world of golden heavens then simply melted away and was replaced by profane blue sky. By 1435, Leon Battista Alberti merely bestowed official opprobrium on a practice even religious painters such as Fra Angelico had already abandoned when he wrote,

> There are some who make excessive use of gold, because they think it lends a certain majesty to painting. I would not praise them at all.
>
> *On Painting and On Sculpture.*

And so, the real sky burst into Italian Renaissance paintings.

Masolino's young friend and sometime collaborator, Masaccio, was the first painter to employ the principles of linear perspective in *The Tribute Money* (c. 1425, Brancacci Chapel, St. Maria del Carmine, Florence) (Fig. 5-40). The sky in this work remained little more than a thin strip at top but the clouds look realistic. Large, wafer-thin patches of smooth altocumulus or stratocumulus glow faintly in the nighttime sky beyond the bare mountains. Masaccio might have painted even grander skies and clouds had his life not been cut short in 1428.

Fig. 5-40. Masaccio. *The Tribute Money*. c. 1425, Brancacci Chapel, St. Maria del Carmine, Florence.

The new, expansive sense of perspective spread like a brushfire across Italy, quickly engulfing the hills of Siena. There the missionary, Sassetta (Stefano di Giovanni) had already begun to paint almost ecstatic skies over hilly landscapes that remained primitive by comparison. Because it was too early to dispense with gold in the main panel of devotional murals, Sassetta’s most extraordinary clouds are consigned to small predella scenes.

The predella scenes from the *Virgin of the Snows Altarpiece* (Uffizi Gallery, Florence 1432) recount in serial form the events surrounding the founding of the basilica of Sta. Maria Maggiori. The clouds appear in two adjacent scenes, the *Foundation* and the *Building of Sta. Maria Maggiori* (Fig. 5-41). In the *Foundation,* Sassetta captured the multifaceted nature of altocumulus as did no other 15th century artist other than his assistant, Sano di Pietro. A large sheet of parallel altocumulus bands separated by thin clear fringes covers the entire sky except for a clearing at the horizon. The bands are smooth and lenticular, and resemble a cluster of small-amplitude wave clouds sometimes seen on windy days shortly after a cold front passage. Fifteen years later, Sano included a similar, although more ragged patch of altocumulus in his *Saint Bernadino Preaching in the Campo* (c. 1447, Cathedral, Siena). No other Italian Renaissance artists ever attempted to paint such an extensive cloud matrix.

Fig. 5-41. Sassetta. *The Foundation and the Building of Sta. Maria Maggiori*. 1432. Uffizi Gallery, Florence.

Its companion, *The Building* contains just about the only cirrus in 15th century Italian art. Its streamers closely resemble those of Fig. 5-12 and race across an otherwise clear sky from left to right and toward the viewer as indicated by their tilt (recall Fig. 5-13). But if a storm was on the way it did not arrive until the next century.

The remnants of stormier weather can be seen in Fra Angelico's *Descent from the Cross* (Fig. 5-42). This early and anomalous painting contains two tiny patches of cellular altocumulus supporting some angels and a streak resembling cirrus. The main meteorological tale of the *Descent* is the retreating wall of cumulus that had darkened and covered the sky a short time earlier. The cumulus is a solid but modestly sized cloud with two striking features normally attached only to huge and severe thunderstorms. A smooth, dark appendage resembling an arc cloud extends from its flat base while smooth mamma-like protuberances project from the overhanging right side.

Fig. 5-42. Fra Angelico. *Descent from the Cross*. c. 1434-1443, Museum of S. Marco, Florence.

Fra Angelico must have seen a thunderstorm marked by such features, but his cumulus fails to convey the awe inspiring power and towering height of thunderstorms. Fra Angelico, like almost all other painters of the 15th century, seems to have been incapable of portraying the occasional monumentality of nature. The 15th century miniaturized renditions of storminess seem to be little more than detached reflections of storms made from a great and safe distance.

It is little wonder then that virtually all the clouds in Fra Angelico's other works are small. All look alike and tend to resemble wavy versions of the stylized, but flat-based clouds introduced by the Early Christian and Byzantine artists.

A good example of Fra Angelico's clouds stretch across the *Stories of St. Nicholas* (Fig. 5-43). The painting describes two related adventures from the life of St. Nicholas. At the left the saint requests a shipload of grain for his famine-stricken city and on the right he protects the ship during a storm at sea. Since two stories are being told there are two skies in the work. On the left the weather is fair and the color grades from a clear blue to nearly white at the horizon. On the right the sky is dark, seemingly covered by a deck of stratus. The stylized wavy clouds weave the two tales together and provide a sense of static unity that once again fails to convey the potential power of storms at sea.

Fig. 5-43. Fra Angelico. *Stories of St. Nicholas*. 1437, Pinacoteca, Vatican City.

In 1437, Sassetta came to Sansepolcro to negotiate the contract for an altarpiece in the Church of San Francesco. The work was finished in 1444. During his visits to hilly Sansepolcro, he may have met Piero della Francesca and shown the young painter the potential of mountain wave clouds.

Piero's paintings have been described as "masterpieces of static repose", most likely because his figures are upright. Fittingly, no 15th century artist painted the dynamic but motionless mountain wave clouds as often or as well. Few, even among the Italians, could have felt more at home in the mountains than Piero, for he was born in Sansepolcro in the heart of the Apennines, and spent the greater part of his life there or in nearby Arezzo.

The *Baptism of Christ* (Fig. 5-44), is a topographic work of Sansepolcro (Fig. 5-45). The Convento di Montecasale founded in 1192, lies almost hidden just to the left of Christ's right hip. The mountain wave clouds appear above the hills to the north of town and are reflected in the still water below.

Some of the wave clouds assume the form of a pile of plates (Fig. 5-46) that results when several thin humid layers alternate with drier layers in the atmosphere, as illustrated in Fig. 5-17.

Fig. 5-44. Piero della Francesca. *Baptism of Christ*. c. 1450. National Gallery, London.

Fig. 5-45. The Convento di Montecasale on the hills to the north of Sansepolcro. Agriturismo Il Poggio

Fig. 5-46. Arched Pile of Plates mountain wave clouds with alternate veneers of humid and dry air from Montalbert in the French Alps. © Claudine Roques, Photographer.

Piero not only made the mountain wave clouds of the *Baptism* faithful to nature, he also imbued them with religious and artistic significance. The white of the clouds, likely symbolizing purity, matches the color of Christ's skin, the feathers of the Dove of the Holy Spirit and the trunk of the walnut tree. The clouds' upward arch mimics the curved wings of the silently hovering Dove.

Piero may even have deliberately chosen the smooth and motionless mountain wave clouds to reinforce the still and timeless quality of the *Baptism*. He could not have done better, for altocumulus lenticularis is virtually the only cloud that does not move. But mountain wave clouds are produced by a brisk wind that would almost surely ruffle the water surface. Total consistency is elusive.

After about 1480, mountain wave clouds fell from artistic grace and since then have seldom been painted. Why have these strikingly beautiful clouds been so neglected? The reason may lie in their motionless quality. Until recently, most artists fled the rural stillness they might have known in the more carefree days of youth for the frenzied pace of urban life. For such busy artists and patrons the roughly corrugated and turbulent cumulus are spiritually more compatible than the unruffled altocumulus lenticularis.

Piero della Francesca seems to have been largely immune to the lures of the city. In the changeless, hilly countryside of his childhood, Piero remained immersed in an atmosphere of spiritual serenity that called him to paint mountain wave clouds.

Even so, Piero was very much a child of his times. Like many of his fellow artists he travelled widely and was well aware of current trends. (He wrote treatises on mathematics and perspective and was a much admired mentor.) So, his clouds remain modestly sized and cover only a small fraction of the sky, and the air remains pure, with almost infinite visibility.

In the early Renaissance view, nature is an open book incapable of obscuration or danger. But concomitantly, nature is precluded from exhibiting any of its wondrous apparitions. The fringes of mountain wave clouds seen near the Sun often display glorious iridescence that can be likened to the burning bush of the atmosphere (Figs. 5-54, 11-38, 11-39), yet no one of Piero's generation was privileged to witness or reveal it.

A host of other 15th century Italian painters dotted their mostly clear and unpolluted skies with small, high-based cumuliform clouds. Almost all these clouds are charming, but many possess stylistic peculiarities that amount to signatures.

Giovanni Bellini's clouds defy signature. Giovanni lived long enough to witness and even participate in the demise of the pristine early Renaissance vision of the sky. He was born in a family of artists and received his first lessons from his father, Jacopo.

Fig. 5-47. Jacopo Bellini. *Madonna and Child with Donor*. c. 1441. Louvre, Paris.

Around 1441, Jacopo Bellini completed the *Madonna and Child with Donor* (Fig. 5-47). Although the scene shows some depth, its perspective is still basically Gothic. The donor is miniaturized to keep everything in spiritual proportion. Each cluster of buildings possesses its own vanishing point. The mountains near the horizon resemble gumdrops. The setting Sun, which should illuminate only the west facing walls and slopes, seems instead to be located a short distance behind the Virgin.

The sky redeems the *Madonna and Child*. A layer of flattened, decaying stratocumulus marks day's end. The dull blue sky scarcely contrasts with the shaded gray parts of the clouds. But the clouds' bottom fringes are lit by the golden light of the setting Sun.

Fig. 5-48. Giovanni Bellini. *The Agony in the Garden*. c. 1455-1460. National Gallery, London.

Fig. 5-49. Trade wind cumulus at sunset with underlit bases over Pacific Palisades, CA.

Giovanni inherited his father's cloud fringes and improved them in *The Agony in the Garden* (Fig. 5-48), one of the most exquisite dawn or sunset scenes in the history of art. The sky and clouds of the *Agony* possess a suffused glow that, two centuries later, Claude Gellee would devote a lifetime to capturing. The first rays of the rising Sun tinge the corrugated bases of a row of flat-based trade wind cumulus (Fig. 5-49); later in the day such corrugations are masked by shade. The extended cloud line, a Giovanni Bellini trademark, represents a departure from the standard 15th century practice of painting only separate cloud elements. It is an early indication of a maturing Renaissance vision.

The *Agony* is probably topographic. The scene matches the view to the east from Orgiano, 30 km west of Padua (Fig. 5-50).

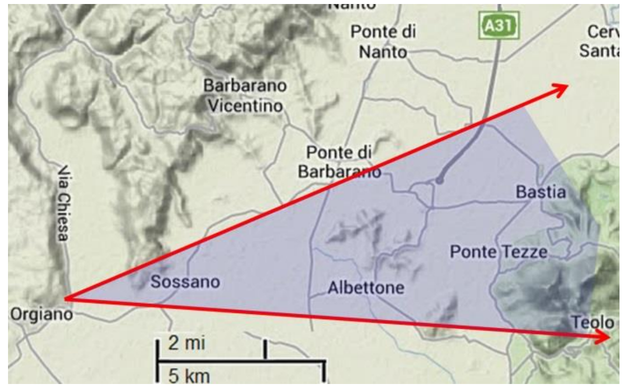


Fig. 5-50. Likely location and viewpoint range (between red arrows) of Giovanni Bellini's *Agony in the Garden*. Padua is located 30 km east of Orgiano.

Fig. 5-51. Giovanni Bellini. *Transfiguration of Christ*. c. 1488. Museo di Capodimonte, Naples.

Two of the *Agony's* tallest cumulus turrets rise like smoke plumes from a chimney and resemble so-called trade wind cumulus (Fig. 5-49). In the region of the trade winds, humid air fills the lowest mile of the atmosphere, but is topped by a layer of warmer, dry air. The resulting interface, known as the Trade Wind Inversion, forms an effective barrier for most of the cumulus that form in the humid air layer. Only a few of the larger clouds have sufficient buoyancy to puncture the inversion. Their turrets then continue rising exuberantly until they finally mix with the dry surroundings and dissipate. Bellini's rising cloud turrets thus match the *Agony*'s uplifting spirit.

Bellini also chose the appropriate clouds for the emotionally wrenching day of the *Transfiguration of Christ* (Fig. 5-51). The Sun is blocked by a broken layer of altostratus that has dulled most of the sky but allows some heavenly light through to illuminate a line of small, white cumulus hovering just beyond the hills at the horizon. This is probably a common enough view in Italy; Camille Corot, a great admirer of Giovanni, also painted such clouds early in his career, during and shortly after his Italian sojourn.

Higher in the sky, lines of flattened stratocumulus are shaded by the altostratus. The stratocumulus over Christ is framed by an orange glow that suggests an opening in the altostratus. Sunlight penetrates this opening and emerges from the bottom of the stratocumulus as crepuscular rays. The rays, which are painted as short line segments, shine down on Christ, perhaps as a symbol of divine light but do not contribute to the illumination. They point to a Sun well above and behind Christ, where the sky is dark while the light source for the rest of the painting lies behind and to the left of the viewer. This is just one more example of the failure of 15th century artists to convincingly depict any atmospheric optical phenomenon. Still, these rays contribute to the painting's mixture of darkness and light that befit the ambivalent mood of the *Transfiguration* - Christ is dead but has risen.

Fig. 5-52. Giovanni Bellini. *The Falsehood*. c. 1490. Gallerie dell'Accademia, Venice.

Giovanni Bellini, more than any other painter of his century, chose clouds and skies to match the painting's mood. Normally he took great care to give his clouds sharp outlines (a mark of youth), but around 1490, he painted a series of allegorical scenes, one of which calls for an indistinct, deceptive sky. *The Falsehood* (Fig. 5-52) depicts the vice of dishonesty. A man wriggles out of a snail shell, his arms wrapped by a serpent, the embodiment of deception. Behind the scene is a sky with the most flaccid, dissipating clouds Giovanni ever painted. These altocumulus or stratocumulus vanish into the sky like formless, evaporating mists. They are totally out of character with the 15th century's youthfully delineated clouds, but served as a prototype for generations of later painters. Although Bellini left no written testimony, it seems that he methodically invested his clouds with symbolic significance.

During the Renaissance, animals and plants were still assigned to a highly developed symbolic dictionary. Thus, the owl symbolized Satan, the fly, pestilence, the bee, industry, the apple, evil, and the lily, the purity of the Virgin, to mention a few. No corresponding map of symbolic associations could possibly have been assigned to the different cloud forms, for they were neither distinguished nor named until 1802. If an artist created a symbolic cloud map he had no words to assign to it and no amount of documentary research could prove it. Yet, when we compare the clouds to the themes of Bellini's paintings, it seems more than likely that he used his own extraordinary vision of the sky to create a private symbolic cloud map. The *Agony*'s youthfully ecstatic cumulus, the *Transfiguration*'s ambivalent sky, the *Pieta*'s (c. 1470, Brera, Milan) somber altostratus, and the dissipating clouds of *The Falsehood* all befit their painting's themes. Few other artists before 1800 could possibly have invested clouds with such a rich symbolism, for few had a sufficiently varied cloud repertoire.

Andrea Mantegna, who became a Bellini by marriage, also used his clouds to great effect. Most of Mantegna's early works contain crystalline, deep blue skies with infinite visibility that mark the apex of Renaissance clarity. The clouds in these works are quite attractive but often remain somewhat stylized. Sometimes they serve as platforms for cherubs or other divine figures. On one occasion - *Saint Sebastian* (1459, Kunsthistorisches Museum, Vienna) - Mantegna carved a bas relief out of a marble-like cumulus. Most of his cumulus bases are flat but on occasion they are as rounded as the cloud tops. The clouds in the *Crucifixion* (Fig. 5-53) have corrugated bodies and smooth tails that suggest altocumulus castellanus but still appear to be some hybrid form of cumulus and either cirrus or altocumulus.

The two-tailed cumulus of Mantegna's *Crucifixion* were no strangers to Italian Renaissance art. One possible natural counterpart for these smooth tails may be the cap cloud, pileus (Fig. 5-54). Pileus always occurs as an accessory or attendant to other clouds. It forms fairly often around towering cumulus but is not often noticed because it lasts only a few fleeting moments. Artists often paint cloud streaks that suggest pileus but indisputable examples of painted pileus are extremely rare. And yet they can be spectacular when the nearby Sun is blocked by the main cloud, because they can then become brilliantly iridescent, as in Fig. 5-54.

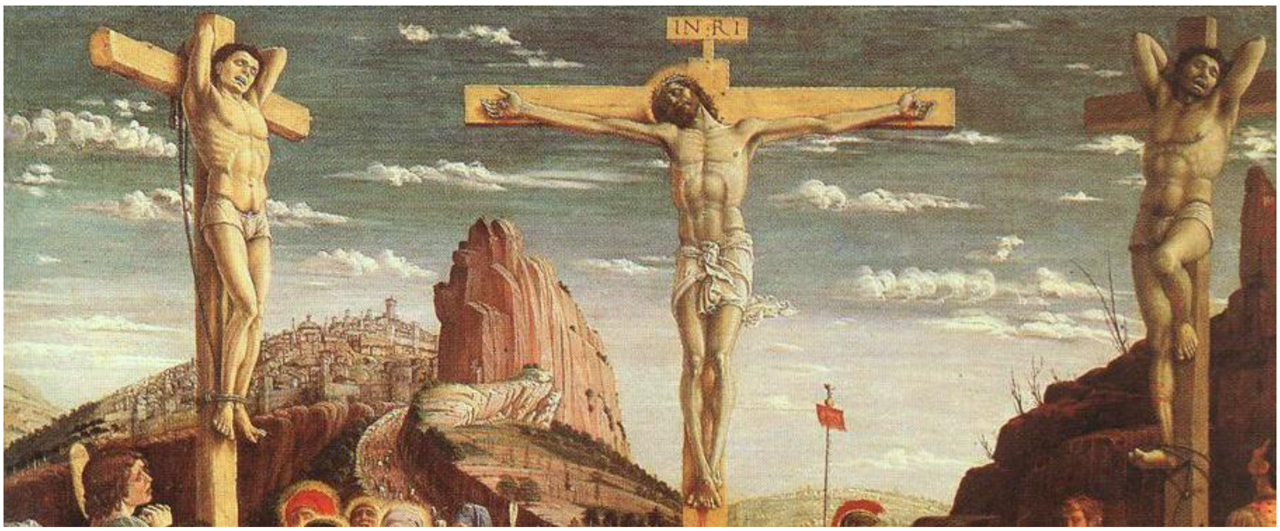


Fig. 5-53. Andrea Mantegna. *Crucifixion*. 1456-1459. Louvre, Paris.

Fig. 5-54. Iridescent Pileus revealing a humid layer lifted by a growing cumulus in Delray Beach, FL, 11 Aug 2011. Ken Rotberg, Photographer.

Pileus is a cloud that can only be only produced by another cloud! It is produced in much the same way as mountain wave clouds, but with pileus the role of the mountain has been replaced by a large swelling cumulus. As the cumulus grows it forces the rather quiescent air above it upward and outward. If the humidity is high enough in any layer of this quiescent air, a smooth cloud resembling a cap forms when the rising cumulus is about to reach it. As the cumulus continues to expand upward it often punctures the pileus cap, which then becomes a ring that girdles the cumulus. (In 1838, Thomas Cole painted such a scene - *Clouds*, Metropolitan Museum of Art, NY.) Downdrafts at the side of the cumulus then rapidly evaporate the pileus.

In 1474, Mantegna painted a new view of cumulus on the ceiling of the Camera degli Sposi (room of the bride and groom) for the pleasure of Ludovico Gonzaga and his wife (Fig. 5-55). The *Ceiling Fresco* reveals a good sense of humor but don't let that hide its revolutionary qualities. It is a masterpiece of trompe-l'œil, designed to create the illusion of an oculus or circular opening to the sky. Naked cherubs, convincingly foreshortened, relax on a narrow inner ledge of the parapet while other figures peer down as we do at fish in a pond. A large flowerpot supported only by a pole projects precariously over the edge of the parapet and threatens to come tumbling down on the people below without warning.

Fig. 5-55. Andrea Mantegna. *Ceiling Fresco*. 1474. Camera degli Sposi, Palazzo Ducale, Mantua.

The ceiling fresco may represent the first instance in which cumulus are depicted from below rather than from the side. (Fields of altocumulus and cirrocumulus, and stratiform clouds are invariably portrayed from below - we can only see their bases.) The central regions are the cloud bases, which Mantegna rendered darker than the fringes because little light reaches the bases of thick cumulus.

The view of cumulus from below is how lovers, as they lie on a grassy meadow on a bright spring day and gaze upward, see them. It is a view without a horizon - all hint of the solid Earth has been erased. It is a view of freedom, even license, which can be sustained only at the height of passion; the instant we reflect on it we are returned to our earthly fix.

Conceived perhaps as an innocent joke, Mantegna's fresco served as a prototype for all later works showing gods sporting in the sky. Mantegna's *Ceiling Fresco* thus captures the very moment of awakening from childhood innocence. Thereafter the elusive search for beauty or ugliness in art began to replace the stark and simple search for 'truth'.

Ultimately such playful, clouded ceiling frescoes would become a sign of excessive luxury and decadence, as in Andrea Pozzo's, *Allegory of the Jesuit's Missionary Work* (1791-94, Sant'Ignazio, Rome), François Le Moyne' *Apotheosis of Hercules* (see Fig. 8-3) and a host of seductive painted ceilings by Giovanni Battista Tiepolo.

But even in Mantegna's times the ceiling frescoes indicate a new spirit of freedom from old moral bounds, a freedom that no society can long sustain. In 1475, the year after Mantegna completed the fresco, the young Girolamo Savonarola fled that licentious world for the spiritual stability of a Dominican monastery. In darker times the world was to hear from him again.

CHAPTER 6
THE TURBULENT AND MYSTERIOUS SUBSTANCE OF AIR

Quarantine the world of the Mediterranean and its wealth, its inspiration, its resources - even its sea will dry up. The Mediterranean is an arid region. So much water evaporates from the Sea that all the rain falling on it and all the rivers running into it cannot keep it full, and Atlantic Ocean water flows in continuously through the Straits of Gibraltar.

About 5.96 million years ago, Africa collided with Europe at the Straits of Gibraltar and the two continents became one. The Alps were created by this union. Once the Straits were closed, the Mediterranean was cut off from its supply of Atlantic Ocean water and began evaporating. Over the next 700,000 years, the Sea almost completely dried up. Then, about 5.33 million years ago the Straits reopened and Atlantic waters poured down onto the dry Sea floor to produce what must have been the greatest flood of all times.

Much geologic evidence for this event is still with us. As the water evaporated, huge deposits of salt accumulated on the dry sea floor. In some places these deposits were buried by dunes and protected from redissolving once the Sea filled again. Cores of sediments from the sea floor still contain thick and extensive layers of this sealed off salt. The rivers also left their mark on the sea floor. As the waters evaporated the rivers had to plunge downward over newly exposed land to reach the shrunken sea. In the process they carved deep canyons that have since been covered by water and largely filled with sediments. Echosondes now reveal the profiles of these choked and buried canyons.

At the height of its Renaissance, the Mediterranean was once again cut off from the surrounding world. For centuries Italy had used the Mediterranean as her private river to transport the current of expensive goods, such as pepper, from the Orient. Then, in 1453, the Turks conquered Byzantium and blocked access to the East. Overnight, prices of Oriental spices skyrocketed and the rest of Europe groaned. The exorbitant costs of these goods gave new impetus to the European voyages of discovery that had already begun under Prince Henry the Navigator.

In 1415 the Portuguese had crossed the Straits of Gibraltar and looted the Moroccan city of Ceuta. Lured by Moslem reports of even greater riches further south in the heart of Africa, Prince Henry of Portugal launched a program of exploration down Africa's Atlantic coast in 1420. In 1434, Gil Eannes rounded Cape Bojador at latitude 26º North, long the southern terminus for superstitious sailors, and discovered lush vegetation beyond the southern fringe of the Sahara. Aristotle had maintained the climate would be unbearably hot in the tropics, but Portuguese sailors and their dreams of wealth proved him wrong.

For the next half century, the Portuguese worked their way further down the coast of Africa. In 1486 Bartholomew Dias rounded the Cape of Good Hope. The fabled wealth of the Indies finally seemed within his grasp but his crew, weakened by scurvy, refused to go further. A few years later, in 1492, Columbus set out to reach the Indies by sailing westward. His discoveries only goaded the Portuguese to further adventure. In 1497 Vasco da Gama began an expedition, commissioned by King Manuel of Portugal, to round Africa and bring back the spices of India. In an arduous voyage that lasted two years, Vasco opened a new trade route and began to transform the Indian Ocean into a Portuguese sea. Overnight, European warehouses were overflowing in pepper and prices plummeted. Northern and Western Europe could finally bypass the Mediterranean. From this time though, the coffers of Italy slowly began to drain.

Politics compounded Italy's tribulations. Jealous of Italy's accumulated wealth and sensing opportunity from her continuous internecine strife, King Charles VIII of France crossed the Alps in 1494 and inaugurated a series of invasions from the north that wasted and plundered Italy for half a century. Spain carved out her own claim to the Kingdom of Naples and tenaciously held on to her gains.

The Church's need for cash increased drastically and transformed the selling of indulgences into a flagrant violation of any religious principle. In Germany, the locus of power and wealth shifted northward toward the Atlantic as a result of the Portuguese and Spanish discoveries. There, far from Rome, resentments over the Church's financial exactions and landed wealth grew to such a pitch that the Reformation became inevitable. In 1516, the year before Luther's famous theses, the papal nuncio, Girolamo Alessandro reported many Germans spoke plainly that they were merely waiting for "some fool" to open his mouth against Rome.

In the tumultuous atmosphere that characterized much of the 16th century, man's vision began to turn myopic and parochial. The liberal and far seeing spirit of humanism that the Church had winked at degenerated into a wanton egotism later brought under control by a reactionary and repressive puritanism. Amid these changes, the painters' simplistic and clear vision began to blur. Haze and nightfall darkened and obscured the once pristine Renaissance skies. The air itself became a solid, obstructing entity capable of producing awesome winds and storms, torrential rains and wondrous optical phenomena. An entire world that had lain hidden was now revealed in the death throes of the Renaissance.

6.1 Storm and Smoke

Who first noticed the obscuring mists and towering storm clouds that heralded the twilight of the Renaissance? It was none other than Leonardo da Vinci, perhaps the incarnation of the Renaissance spirit.

Leonardo, the illegitimate son of Piero da Vinci and a peasant woman named Caterina, was born in 1452. From an early age, he showed an artistic talent. In 1469, Piero took the boy to Florence where he was apprenticed to Andrea del Verrocchio. The first documented work from Leonardo's hand is the angel and a piece of the landscape background on the far left of Verrocchio's *Baptism of Christ* (c. 1470-73 Uffizi, Florence). The angel at left already possesses the famous Leonardo smile. Vasari relates the apocryphal legend that when Verrocchio saw this angel he realized Leonardo had already surpassed him as a painter and thereafter never painted again.

During Leonardo's years in Verrocchio's workshop there is little hard evidence of his activities. The *Annunciation* (c. 1475, Uffizi Gallery) is an exercise in single point perspective but also contains the seeds of certain elements that became central to Leonardo's later masterpieces. The atmosphere is decidedly hazier than in any other contemporary work and distant Apuan Alps rising precipitously on the right are all but obscured by light of the intervening atmosphere. Curiously, the sky contains one small cloud that resembles the decorative cumulus found in many of Domenico del Ghirlandaio's later works (the *Annunciation* has been attributed to Ghirlandaio and may have been a joint effort), while most of Leonardo's later paintings are cloud free.

Leonardo led a double life as a meteorologist. He purged all ephemeral effects and all disturbing influences from his paintings. These have no storms and only a few unobtrusive clouds, while a haze called sfumato (smoke) reduces glare, softens shadows, and fills all space with diffuse light. But in his drawings, all the power and fury of the weather is unleashed. The thunderstorm is shown in full outline for the first time, and in his series of 11 drawings entitled, *Deluge*, swirling clouds fill the air, releasing torrents of rain that so arouse the elements it is difficult to distinguish air, water, and earth. In all his meteorological works Leonardo portrayed the atmosphere in ways no earlier European artist had even dimly conceived.

What led Leonardo to these revolutionary vistas? In 1912, a German art historian argued that Leonardo's sfumato was inspired by landscape scenes painted on Chinese pottery he had presumably seen in the Medici collection (since lost). The Chinese had long focused on two of the atmospheric phenomena, eddying motion and mist, that most interested Leonardo. It is possible that da Vinci began by imitating, and indeed, many of his mechanical drawings are copies or modifications of devices then manufactured by others. But Leonardo's atmospheric repertoire contains discoveries that evolved gradually as a result of observation and experiment, and bespeak a spiritual brotherhood with his Chinese brethren.

Now the air around Florence is much clearer and the atmosphere far more placid than in hazy, stormy China. Had Leonardo remained in Florence he may never have developed his meteorological themes so fully. But in 1482 he left sunny Florence to serve Lodovico Sforza in Milan. There, at the doorstep of the Alps he saw and reflected on atmospheric wonders seldom encountered in the Mediterranean world.

Milan is only 160 miles northwest of Florence yet climatically it is part of another world. Florence lies in the Italian peninsula, which protrudes into the Mediterranean and is ruled by summer drought. Milan lies just north of this peninsula. There the humidity is decidedly higher, the air thicker, and large cumulus more common. The Alps rise within sight of Milan and, like most mountain ranges, give birth to thunderstorms that grow to vent their fury on the Earth below.

Like many Chinese landscape painters, Leonardo was a confirmed mountaineer and climbed the mountains for inspiration. He saw the atmosphere tinge the distant lowlands and mountains so that they appeared as if seen through a blue film. He saw petrified seashells encased in rock on the highest peaks and realized that no Biblical Flood could ever account for their origin. He also witnessed the storms that tear away at the mountains and divide the Earth into two zones - a lower zone of darkness beneath the storm clouds and an upper zone still bathed in the light of the Renaissance.

> And I saw the sky above me quite dark and the sun as it fell on the mountains was far brighter there than in the plains below.

Fig. 6-1. Leonardo da Vinci. *Storm Breaking Over a Valley*. c. 1500. Royal Library, Windsor. # 12409.

Leonardo never presented such a stormy vista in any of his major paintings, but around 1500 he executed a powerful stormscape in a drawing, a *Storm Breaking Over a Valley* (Fig. 6-1) that divides the world into two zones. The brightly illuminated cloud tops slosh against the mountain peaks like waves breaking against a steep shore. Shafts of rain fall from the flat-based cumulus onto the darkened valley floor below and obscure all that lies beyond it. Leonardo noted,

> When the rain begins to fall, it tarnishes and darkens the air, giving it a dull colour.... Objects seen through the rain appear confused and of undetermined shape.

The *Storm Breaking Over a Valley* has a dramatic impact not previously encountered in any work of art. It heralded a new age in which nature finally emerged as a monumental force free from any divine presence. Nevertheless, its cumulus is too small to produce such darkness and such a downburst. Only the modest stratus of morning remains so neatly encased within valley walls. The towering cumulonimbus of afternoon dwarfs any mountain peak it sprouts from (Fig. 6-2). A mountain crest, ravished by lightning and buffeted by high winds, is almost never bathed in sunlight and is the worst imaginable place to weather out a storm.

Fig. 6-2 Cumulonimbus (viewed from the west) with mushroom anvil and overshooting top. Paul Neiman, photographer.

But Leonardo also witnessed and envisioned such grand storms, revealing aspects of their secret structure that meteorologists would not rediscover for centuries.

> In the creation of the cloud it attracts to itself the surrounding air, and so becomes condensed, because the damp air was drawn from the warm [upward] into the cold region which lies above the clouds...On one occasion above Milan toward Lake Maggiori, I saw a cloud shaped like a huge mountain, made up of banks of fire, because the rays of the sun which was then setting red on the horizon had dyed it with their color. This great cloud drew to itself all the little clouds which were about it. And the great cloud remained stationary, and it retained the light of the sun on its apex for an hour and a half after sunset, so enormous was its size. And about two hours after night had fallen there arose a stupendous storm of wind. And this [cloud], as it became closed up caused the air which was pent up within it, being compressed by the condensation of the cloud, to burst through and escape [downward] by the weakest point.
>
> *Notebooks of Leonardo da Vinci*, 761.

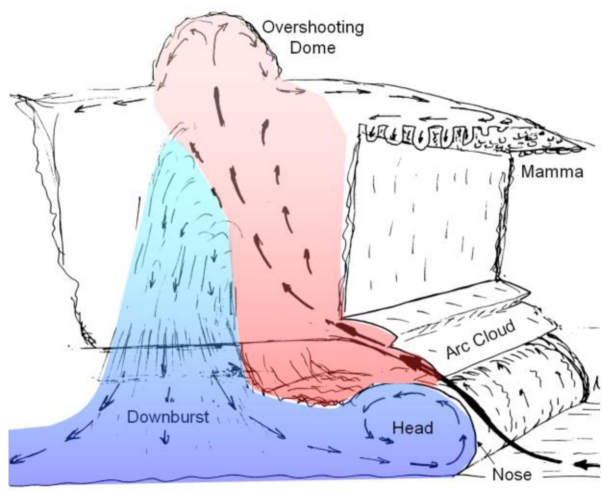


Fig. 6-3. Structure, air motions, and appendages of a squall line thunderstorm moving toward the right.

Cumulonimbus, the thundercloud forms when hot, buoyant air rises rapidly from ground level to the upper troposphere or stratosphere. When it loses buoyancy it spreads out into an anvil-shaped mushroom cap (Fig. 6-3). Anvils have a smooth fuzzy appearance because their fringes have a low concentration of evaporating particles. Strong winds of the jet stream can stretch the anvil several hundred miles from the parent cloud, thin it to high clouds such as cirrostratus or altocumulus, and warn people living downwind of its approach.

As the air inside the updraft rises and cools, a great weight of water and ice accumulates. Downdrafts form as the weight of these particles drags the air down. When the updraft is tilted, the particles fall into drier air outside the cloud. The evaporating particles intensify the downdraft by cooling the air, increasing its density. The dense, chilled and soaked downdraft air then hurtles toward the ground, where it splays out and undercuts the updraft.

Several awe inspiring appendages protrude from severe thunderstorms. A cauliflower-shaped, hemispherical overshooting dome may protrude like a fountain as much as two miles above the anvils of thunderstorms with strong, active updrafts.

Thunderstorms that punch up into dry air develop smooth, breast like pouches called mamma or mammatus that extend down from the underside of the anvil. Some of this dry air is entrained into the anvil and mixes with the cloud air. Droplets and crystals evaporate to smooth the cloud edges and cool the air, which then sinks in dense blobs to form the mamma (see Fig. 6-12). The mamma extend downward until all the liquid water or ice has evaporated.

Mamma sometimes line up like strings of pearls as the air on the underside of the anvil curls back in toward the central updraft. Located high above the ground, mamma can be seen from miles away and therefore serves as a precursor of an impending severe thunderstorm that may be accompanied by large hail and even a tornado.

Fig. 6-4. Hans Memling. *Crucifixion*. 1491. Szépművészeti Múzeum, Budapest, Hungary

Even though 15th century artists did not depict violent weather, a few precursors, such as Fra Angelico's *Descent from the Cross* (Fig. 5-42) show cloud features in otherwise placid skies that closely resemble mamma. Hans Memling, must also have seen protuberances hanging from the dark base of an approaching thunderstorm, for he painted darkened Crucifixion scenes as early as 1470 (The *Passion of Christ*, Galleria Sabauda, Turin) and continued doing so until his death in 1491.

Memling's *Crucifixion* (Fig. 6-4) is a typical example. The dark cloud base is marked by a bright fringed corrugated underside. It has descended almost to the level of the cross while the clear background sky, so distant that it should appear orange, remains an unaltered and undisturbed blue with high visibility.

A distinctive, wedge-shaped straight shelf cloud or curved arc cloud forms at the leading and/or trailing edge of the base of some severe thunderstorms. It marks the nose or edge of the cold downdraft that has struck the ground, splayed out and turned back up into a vortex that moves out from the storm. When the dark underside of the arc cloud is ragged with gross, rapidly moving protuberances, it consists of rain-soaked air from the downdraft that formed cloud when it turned up inside the nose. When the top of the arc cloud is smooth it resembles a mountain wave cloud, because it consists of warm, humid air that has been forced to surmount the nose. A different, local lowering of cloud base from which a tornado often extends (see Fig. 11-31) is called a wall cloud.

The potentially violent air motions that take place in the outflow below arc clouds cannot be seen unless the air is rendered visible by some tracer such as dust. This is precisely what Leonardo did in his *Deluge* drawings (Fig. 6-5).

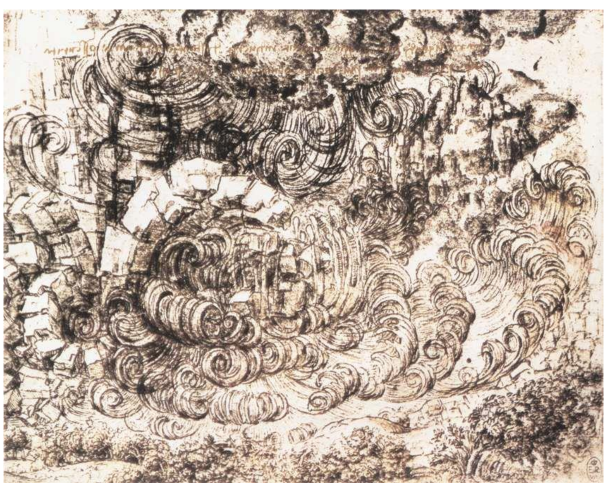


Fig. 6-5. Leonardo da Vinci. *Deluge*. c. 1515. Royal Library, Windsor. # 12380.

Deluge scenes represent the consummation of Leonardo's study of fluid motions and vision of storms. Here, the placid bright zone above the cloud tops is gone. The neat distinctions between air, water and earth have practically been obliterated, and all nature appears on the verge of crumbling into chaos. Only the flow patterns, the cold rain-filled downdrafts issuing from the bases of clouds, remain unmistakable.

Similar whirling spirals appeared in the waters of Assyrian art (Fig. 4-2) and on the capitals of inverted Ionic columns (Fig. 4-3), while Chinese artists went so far as to depict the swirling flow of air in clouds (Figs. 4-12, 4-25). But only Leonardo and an Olmec artist at Chalcatzingo (see Fig. 11-21) showed the flow of invisible air. Leonardo first depicted such flow patterns in water poured into a reservoir (c. 1505). To render the flow visible, he poured dyed water into reservoirs of clear water, or spread sawdust on the surface of water flowing around obstacles. Then he extrapolated the flow patterns of water to those of the air beneath the clouds, noting "that in all cases the motion of water conforms to that of air." The result is the descending jets of air in the *Deluge* that splay out and then curl up and back like a vortex ring when they encounter the ground.

Meteorologists should have studied Leonardo more carefully, for Tetsuya Fujita did not rediscover the thunderstorm downburst until 1975 (after many airline disasters), and Fernando Caracena did not hypothesize its vortex outflow pattern until 1982. Photographs (Fig. 6-6) then quickly confirmed what Leonardo had visualized centuries before.

Fig 6-6. Photographic profile of a downburst showing the nose. NSSL. Bill Bunting, Photographer.

Leonardo also learned to appreciate atmospheric obscuration more fully during his stay in Milan. Not only is Milan stormier than Florence, it is the fog capital of Italy. Fog often condenses or drains into the Po River Valley, where it gets trapped if winds are light. Even when the fog burns off, many afternoons in Milan remain hazy. But interestingly, Leonardo did not introduce the thoroughly smoky or hazy quality to Renaissance painting until about the time he returned to sunny Florence. And the work he chose to introduce this revolutionary vision was the *Mona Lisa* (1503, Louvre).

During Leonardo's years in Milan, when his interest in science grew, atmospheric obscuration and fog concerned him deeply, and he wrote repeatedly about their effects in his *Treatise on Painting* and elsewhere in his *Notebooks*. He understood why obscuration caused by mist can add to a painting's sense of monumentality (recall §4.3). He realized that the sky is whiter near the horizon as a result of its greater thickness there. He even had some inkling of why the sky is blue, noting,

> …as an illustration of the color of the atmosphere I will mention the smoke of old and dry wood, which as it comes out of a chimney, appears to turn very blue when seen between the eye and the dark distance.

Leonardo's explanation of why distant mountains appear blue remains unsurpassed.

> Whatever be the colour of distant objects, the darkest... will appear the most tinged with azure....The air tinges with its own colour more or less in proportion to the quantity of intervening air between it and the eye....

He also observed correctly that,

> Buildings or towns seen through a fog, or the air made thick by smoke or other vapours, will appear less distinct the lower they are.... The inferior or lower extremities of distant objects are not so apparent as the upper extremities. This is observable in mountains and hills, the tops of which detach from the sides of other mountains behind. We see the tops of these more determined and distinctly than their bases; because the upper extremities are darker, being less encompassed by thick air.

Leonardo used these discoveries in the *Mona Lisa* and in the *Virgin and Child with St. Anne* (Fig. 6-7). He labored over the *St. Anne* for many years, doing a cartoon for it in 1501, and returning to it sporadically about a decade later. It is almost certainly unfinished. The transition between the brown foreground and the blue - gray mountains of the background is abrupt. Even so, there is enough to revel in. We are raised to the gateway of the Alps of da Vinci's mind. The mountains consist of the vertically thrust strata he loved so much and knew so well. Ridge after ridge rises in ranks that dissolve in the distance. The nearest ridges are darkest while the furthest are scarcely distinguishable from the sky. All the remote valleys are filled with an obscuring light gray mist that almost disguises a misty lake nestled against the edge of the mountains on the left. Not one cloud disturbs the breathless sky.

Fig. 6-7. Leonardo da Vinci. *Virgin and Child with St. Anne.* c. 1508-1513, Louvre.

The painters of the Middle Ages had omitted the sky because it always served to place the events within a prescribed time and space frame. In the *Virgin and Child with St. Anne*, Leonardo showed how the motionless substance of air could bring the eternal and infinite within reach.

Leonardo's great works of sfumato, the *Mona Lisa* and the *St. Anne* remained in his private possession until his death. His notebooks and drawings did not become part of the public domain until long after that. Still, the next generation of painters including Raphael, Giorgione and Titian were aware of Leonardo's aerial innovations and their works show it. Once Leonardo focused attention on atmospheric obscuration and storminess, the next generation saw hazier skies and larger, more amorphous clouds. After Leonardo blurred the distinction between air, water and earth, the younger generation outgrew the need to conceive of nature as a static assemblage of separate objects. Increasingly, the separate, individual 15th century clouds congealed into cloud fields while continuous walls of greenery overgrew the lollipop trunks that had marked the edges of so many painted forests. John Ruskin noted these changes, remarking

> The dignified and simple forms of clouds in repose are often by these 15th century painters sublimely expressed, but of changeful cloud form they show no example.
>
> *Modern Painters*. Volume 1. p 76.

The stylistic transformations that took place largely between 1500 and 1550 involved a de-emphasis of form. Italian clouds became less identifiable as they grew more massive. Gradually, visibility began to decrease.

Leonardo may have accelerated these changes but they would have come about without his influence. The changing tenor of society finally allowed the artists to see the corporal and disturbed nature of the atmosphere. Heinrich Wölfflin noted that the evolution of artistic style always involves a transition from the so-called linear, in which the outline and form of objects are stressed, to 'painterly', in which form is downplayed or even dissolved and shading or tonal differences are emphasized.

Even the techniques of painting underwent a parallel evolution. Giorgione was apparently the first to dispense with detailed underlying preparatory drawings and to apply paint directly to the blank canvas. Later, Tintoretto and Titian began freely applying paint with broad brushstrokes that were no longer disguised.

The weather also helped to cloud and to obscure the skies and to blur the sharp outlines in Italian paintings. Even before haze was 'discovered', Andrea Mantegna, Giovanni Bellini and Vittore Carpaccio, working in and around Venice, produced larger and more convincing clouds than most of their more southerly compatriots. After 1500, when the economies of Florence and Rome began to suffer, the main center of painting shifted northward where it was nurtured by the cloudier climate of Venice.

Venice was at her zenith in 1500 and, despite the opening of the Atlantic, remained wealthy throughout the century. But the times were certainly stormy. After being routed by the French army in 1509, Venice briefly relinquished most of her mainland possessions and retreated to her watery fortress. While imprisoned there by the French or by wealthy patrons, her artists made one of the periodic rediscoveries of the pastoral ideal. This was a time that cities all around Europe were growing large and crowded enough to generate a mood of scenic longing. As Frederick Hartt has observed

> It is a curious fact that at the moment when the aged Bellini and the young Giorgione were bringing landscape and the beauties of nature closer to us than ever before in the history of artistic endeavor, Venice herself then possessed little nature to enjoy. It may well be that an essential ingredient of romantic interest in landscape is the absence of landscape from daily experience.
>
> *History of Italian Renaissance Art*. p 528.

In any event, some time between 1505 and his death in 1510 from the plague, Giorgione painted the *Tempest* (Fig. 6-8). Here are two mysterious, solitary figures. An innocent young man stands wrapped in a daydream while an almost naked woman suckles her infant. Both seem unaware they are about to be engulfed in the a thunderstorm that has already darkened the sky. This is one of the first storms shown from below rather than in profile. The storm has not arrived, for the scene is still sunlit and no rain impedes visibility. The *Tempest* thus captures the instant between the first bolt of lightning and the thunder that follows on its heels. It is an allegory of the initial response of Venice, and indeed of all civilizations, when first confronted with the prospect of annihilation by barbarians.

Fig. 6-8. Giorgione. *The Tempest*. c. 1505-10. Accademia, Venice.

North of the Alps, smoke and storm clouds were also filling the air. Superstition and irrationality had been cleansed from painted skies during the century of light and clarity but continued to pervade everyday life. Toward 1500, protests rose against the excesses of witchcraft, demonology, Satanism, sorcery, and other occult beliefs and practices that remained so common among the populace despite all advances of knowledge. One of the express purposes of the Inquisition was to root out these various heresies and heretics, for all but the most enlightened minds of the time believed them to possess magical powers.

No one better expressed the paradoxical and contradictory aspects of the times than Hieronymus van Aken, better known as Bosch. Born around 1453 and dying in 1516, he was almost an exact contemporary of da Vinci, but otherwise not much is known about him. Both his father and grandfather were painters so that art was in his blood from birth. He was probably born in the Dutch town of 's-Hertogenbosch where he remained until his death. From that somewhat provincial but not isolated vantage point Bosch visually confirmed the world's irrationalities.

Around 1475 Bosch painted a table top entitled the *Seven Deadly Sins* (Prado, Madrid). In most of the scenes the sky is treated conventionally. Each scene in a circular annulus illustrates a different sin while circular scenes at each of the four corners provide further moral lessons. All but one of these have the clear, color graded skies and high visibility of the 15th century. The sole exception is the scene of Hell. In it, infernal fires near the horizon produce dark smoke plumes and cast an orange glow that offsets the subterranean darkness. Bosch was to rework these fires throughout his career.

Bosch often used his skies to illustrate the duality of human nature - that the adventurous and inquisitive spirit responsible for much human creativity and progress is accompanied by a darker, irrational side we may hide but cannot exorcise. A sky with such a dual nature appears in the center panel of the *Temptation of St. Anthony* (Fig. 6-9). On the right side of the panel the sky is clear and visibility is almost infinite. In the distance on the left a town is consumed in fire and all that lies beyond is hidden by an impenetrable curtain of smoke. On the right, all is clarity and light; on the left, all is obscurity and night.

Two examples from The *Temptation*, analyzed by Dirk Bax in *Hieronymus Bosch:*

His Picture Writing Deciphered, suffice to show how Bosch operated. St. Anthony, the central figure, has just been confronted by a beautiful queen, who is really Satan in disguise. The queen's true nature is betrayed by the long train and serpentine tail of her gown, which also satirizes the then current fashion of long trains. The queen is dispensing charity to an old woman merely to tempt the Saint to carnal love. The woman is identified as a procuress by her sharp nose and chin, features Bosch used elsewhere to mark women of that calling. At the time, these physiognomic features were associated by the common man with evil, according to the rhyme,

> Pointed nose and pointed chin,
> There sits the devil in!

Fig. 6-9. Hieronymus Bosch. *The Temptation of St. Anthony*. c. 1500, Museo Nacional de Arte Antigua, Lisbon.

The Saint is not the least bit fooled by these professed acts of charity. He turns away from the corruption and holds up two fingers in an act of exorcism.

The fire and smoke are also permeated with symbolic significance. To Bosch, fire represented carnal love, while smoke represented impurity. A host of symbolic objects also clogs the air. A toad carrying a banner of Carnival sits astride a winged egg and is followed by a flock of crows as it is propelled through the sky. To this day toads are often thought of as poisonous, diabolic animals, while the egg was a symbol of licentious revelry, folly, and sexual incontinence. The crows represented the devil and often appeared in Carnival scenes. Bax maintains further that the scene parodies the revelry that took place during Carnival on Shrove-tide, the evening prior to Lent.

Despite all the fire and smoke and all the monstrosities, Bosch's works fail to terrify the modern viewer. Perhaps there is too great an element of humor in the detailed depiction of disembodied freaks or impaled anuses. But what is more crucial is that each perversion occupies its own well-defined niche, remaining out in the open and seemingly under control. All the fires and smoke are restricted to the distant horizon and do not threaten to spread very far. The lovely farmhouse in front of the burning town is situated in a precarious position but not a trace of smoke approaches it, so its doom has not been foreordained.

Bosch thus failed to capitalize fully on the principal atmospheric ingredient that marks all true nightmares - obscuration. More than 250 years after Bosch painted the *Temptations of St. Anthony*, Edmund Burke, drawing from the first century Roman work, *The Sublime* of Pseudo-Longinus, diagnosed the crucial elements of all painted nightmares in his essay, *On the Sublime and Beautiful*. In it he wrote,

> Hardly anything can strike the mind with its greatness which does not make some sort of approach toward infinity. When painters have attempted to give us clear representations of these very fanciful and terrible ideas, they have almost always failed... all the designs I have chanced to meet of the Temptation of St. Anthony were rather a sort of odd, wild grotesques, than anything capable of producing a serious passion...
>
> Edmund Burke. *On the Beautiful and Sublime.*

Burke was probably not aware of the paintings of Matthias Grünewald. Mathis Gothart Neithardt (i. e. Grünewald) took up where Bosch left off and produced some of the most nightmarish spectres in the history of art. Grünewald was also an architect and engineer, so a strongly practical side cohabited with the visionary. Like Bosch, he was aware of the advances of 15th century European civilization yet he remained deeply religious. He too produced a series of scenes involving St. Anthony in the *Isenheim Altarpiece* (c. 1510-1515).

The *Isenheim Altarpiece* contains three layers of panels and includes one the most horrifying of all Crucifixion scenes. The Altarpiece was displayed prominently in the chapel of the lodge of the Hospital Order of St. Anthony to be viewed by its patients as part of their treatment. Many of these were suffering from syphilis, an epidemic that spread through Europe like wildfire after 1493 and had already claimed many victims. It was Grünewald's express purpose to depict in remorseless detail the unparalleled magnitude of Christ's physical suffering. The emaciated body of Christ, full of purulent and festering sores and wounds, is twisted to the breaking point.

The *Crucifixion* prepares the viewer for the *Temptation of St. Anthony* (Fig. 6-10). The *Temptation* is seen when the Altarpiece is fully open. In the right panel the Saint lies prostrate, utterly incapable of warding off the attacks of the grotesque monsters that surround him. The one at bottom left is suffering from a syphilitic outbreak. These monsters are workers of the devil and are depicted in minute detail.

The landscape setting adds greatly to the overall effect. It seems to suggest that St. Anthony has been completely cut off from the world of the living. The foreground is brown and lifeless. Moss drips down from bare limbs, symbolizing a condition of swampy decay. Behind these dead limbs rise mountains reminiscent of da Vinci's *St. Anne* or *Mona Lisa*. These however, dissolve more rapidly in mist than any work of the Renaissance. The contrast between the explicitness of the immediate foreground and the obscuration of the background is one of the shocking aspects of the work. It is precisely this atmospheric effect that provides the intimation of infinity that Burke thought painting lacked. After Grünewald, painters would make only refinements in the visualization of terror.

Fig. 6-10. Matthias Grünewald. *Temptation of St. Anthony* from the *Isenheim Altarpiece*. c. 1510-1515. Musée d'Unterlinden, Colmar.

Fig. 6-11. Lucas Cranach. *Crucifixion*. 1503. Alte Pinakothek, Munich.

Grünewald drew on several sources for the composition of the *Temptation of St. Anthony*. The idea of the monsters encircling the saint was based on a woodcut done in 1506 by another German artist, Lucas Cranach. Even so, the work of Cranach was worlds apart from Grünewald's unrelieved intensity. Throughout a long career, Cranach maintained almost infinite visibility in his landscapes and most of his skies are crystal clear. If clouds are present they are tiny shreds, much like the thin wisps of gossamer he used to cover his playfully seductive young maidens.

But Cranach was also an artist of the Reformation, aware of the religious turmoil then seething throughout Germany. In 1503, he painted a *Crucifixion* (Fig. 6-11). As in most of his works, the visibility is almost infinite, but the boiling underside of a severe thunderstorm arches over Christ. Fantastic, swirling globular mamma extend from the overhanging cloud base. The mamma have been stylized to match the folds and knots of Christ's windblown garment, but Fig. 6-12 strongly suggests that Cranach witnessed such a severe thunderstorm and was stamped with a lifelong impression.

Fig. 6-12. Mammatus beneath a cumulonimbus anvil. Howard Bluestein, Photographer.

Fig. 6-13. Lucas Cranach. *Crucifixion with Cardinal Albrecht of Brandenburg*. c. 1523. Alte Pinakothek, Munich.

Cranach painted several other crucifixion scenes with mamma including The *Crucifixion with Cardinal Albrecht of Brandenburg* (Fig.

6-13), long after he had moved to Wittenburg, the seat of Luther's activities. In 1515, Albrecht had taken out a huge loan to purchase three high Church offices. To repay his debts and make good his investment, Albrecht greatly increased the sale of Papal Indulgences right in Martin Luther's backyard.

No scene could better illustrate the Reformation's gathering storm clouds. The scene advertises an eerie sense of stillness, for the sky has been darkened by a thick cloud that has covered all but the distant horizon. A glow with touches of pink from this distant but still blue clearing counters the darkness and highlights the lower fringes of some of the mamma hanging down from the cloud base. Visibility is appropriately high since mamma form only when the air surrounding the cloud is dry. The mamma lack the boiling intensity present in Cranach's earlier Crucifixion, but are less stylized. They are rounded and modestly sized, their coloring is correct, the setting is darker and the storm is imminent. The clarity and simplicity of the 15th century was about to be washed away in an uncontrollable deluge.

6.2 Atmospheric Optical Phenomena: No Beauty without Disturbance

Can there be beauty without disturbance, passion without restraint and wonders without obstruction? Scattering is the generic term for how objects disrupt the course of light. If air molecules and aerosol particles did not scatter light as it penetrates the atmosphere, the sky would be as black as night and would not display any of its magnificent colors. If ice crystals did not scatter (i. e., refract and reflect) sunlight there could be no halos. If tiny cloud droplets did not scatter (i. e., diffract) sunlight there would be no coronas or glories. And, if raindrops did not scatter (i. e., refract and reflect) sunlight there would be no rainbows.

Throughout 15th century art, atmospheric clarity remained too high to produce optical phenomena such as rainbows. As a result hardly any progress was made in the representation of atmospheric optical phenomena. When 15th century rainbows were painted, as in the right wing of Hans Memling's triptych, *St. John the Baptist and the Evangelist* (Fig. 6-14), they were invariably ethereal misfits, grafted onto otherwise natural settings. These bows are riddled with such a host of errors as to make even the most devout of souls burn.

Fig. 6-14. Hans Memling. *St. John the Evangelist on Patmos*. 1479. Hospital of St. John, Bruges.

Despite all the errors in 15th century bows, a few words can actually be said on their behalf. They usually formed parts of circular arcs, as in reality, and the color sequence of the primary bow, progressing in some manner through the spectrum from red on the outside to blue or violet on the inside, was generally presented in the correct order. In many of the paintings, two rainbows, still compelled to serve as Christ's seat and footstool, are properly shown as concentric circular arcs.

When a rainbow arches across the sky it is often accompanied by a second bow (Fig. 6-15). The inner or primary bow is almost always far brighter than the outer or secondary bow. Casual observers easily see the primary bow, but don't always notice the fainter secondary.

Fig. 6-15. Double rainbow and reflected rainbows. Paul Neiman, Photographer.

The primary bow often has pronounced coloration. It is always red on the outside and grades almost imperceptibly through the spectrum to violet on the inside. The colors of the secondary bow appear in reverse order with red on the inside, but are much fainter.

The rainbow also affects the overall brightness of the sky. The sky is brightest beneath the primary bow and darkest between the two bows. The relatively dark region between the two bows has been named Alexander's dark band after Alexander of Aphrodisias, head of the Lyceum from 198-211, who first commented on it.

Sometimes an unusually bright halo, such as the circumhorizontal arc, will be mistaken for a rainbow. But virtually all halos are seen when facing the Sun, while rainbows always appear on the opposite side of the sky from the Sun. In his Opus Majus (1266-1267), Roger Bacon was the first to note that the primary rainbow is always found at a 42º angle in any direction from the shadow of the observer's head. The secondary bow appears 51º away from the observer's shadow. Bacon also observed that as the Sun goes up the observer's shadow and rainbow simultaneously go down.

Since there are seldom many raindrops between your eyes and the ground, rainbows cannot be seen much below the horizon unless you are standing on a lofty perch or are flying or the background is hilly. Thus, if the Sun is more than 42º above the horizon it is too high to produce the primary rainbow. As a result, rainbows are not seen around midday during spring and summer. But when the Sun goes down, shadows lengthen and the rainbow rises. Thus, the largest rainbows are seen at dawn or sunset, when they are semicircles that reach almost half way to the zenith. When the Sun is above the horizon, the rainbow forms less than a semicircle but its large angular radius of 42º remains the same.

The fact that rainbows appear opposite the Sun indicates they consist of reflected sunlight. It was suspected for centuries that rainbows are produced when sunbeams that enter raindrops get reflected inside the drops.

The main geometrical features of the rainbow were first explained by Rene Descartes in 1637. He began by accepting the argument that it is only necessary to consider how light passes through a single spherical raindrop! This argument had first been put forward independently by Theodoric in Europe and Qutb al-Din in Persia shortly after 1300. Descartes carried this reasoning a crucial step forward, expanding on the approach taken by Johannes Kepler to explain the optics of the human eye. Descartes traced the paths light beams can take as they strike different points on a raindrop. Then, after an ingenious experiment with a water filled glass globe, and many calculations, he finally provided the first convincing explanation of the rainbow.

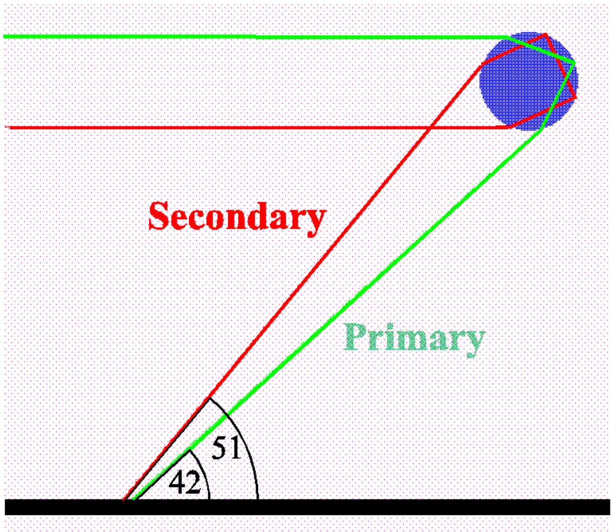


Fig. 6-16. Paths of light through drop for the primary (green) and secondary (red) rainbows. This diagram shows why the secondary appears above the primary.

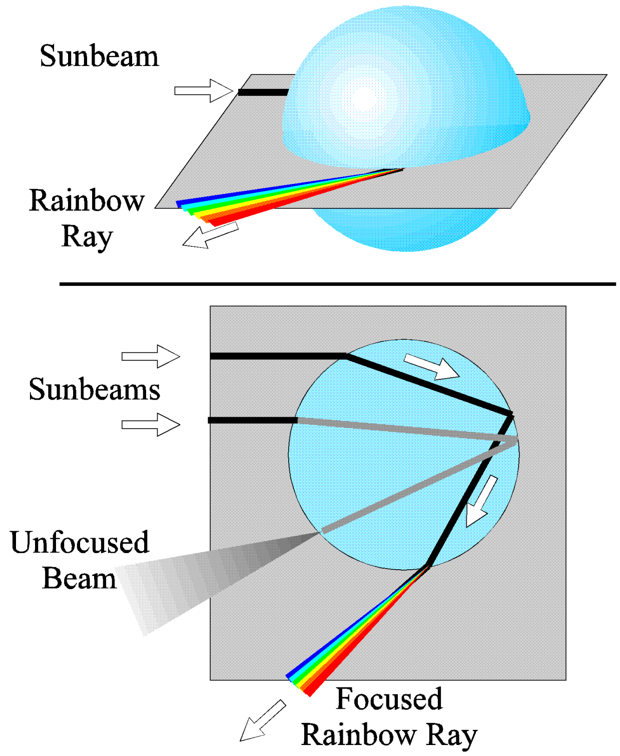


Fig. 6-17. The rainbow ray - most deflected - most focused.

Descartes correctly assumed that raindrops are spheres (contrary to the popular image, they are not tear-shaped except when sliding down a face or mirror) and that the light will pass through a circular cross section of the drops. In making this assumption Descartes had obtained a spherical flask and filled it with water. This was his raindrop. He then aimed a narrow beam of light at various points on the drop and produced a rainbow at the correct location, 42° from the shadow of the light beam.

The paths that light must take through each raindrop in order to produce the primary and secondary rainbows are shown in Figs. 6-16 and 6-17. The beam for the primary bow (green line in Fig. 6-16) is refracted as it penetrates the drop. The light then proceeds to the back of the drop where it is reflected. Finally, the light is refracted a second time as it leaves the drop. A fraction of the light is lost to the bow at each of these junctures and limits the bow's intensity.

The secondary bow is produced by light that has been reflected twice within the drop (red line in Fig. 6-16). The additional spreading and light lost at the second reflection render the secondary bow both fainter and broader than the primary.

In order to calculate the location of the bows, Descartes had to know both the geometry of the circle and the law of refraction. The geometry of the circle had been understood since the time of Euclid but the correct law of refraction had eluded Greek and Muslim scientists for 2000 years. It was finally discovered by 1621 by Willebrod Snel van Royen and is called Snell's law everywhere except in France, where it is named for Descartes. Snel never completed his manuscript, but Christian Huyghens used it and it may have been available to Descartes. Descartes, however, claimed he discovered the law independently, and certainly published the first account of it in 1637 in the second of the three appendices to *A Discourse on Method*. The third appendix, *Les Meteores*, contains Descartes' solution to the rainbow problem.

As soon as Descartes began the calculations, he must have realized that the problem was not going to be so simple. The angle of deviation of a light beam through a drop is not constant but depends on where the light strikes the drop. A beam that strikes the drop exactly in the center will not get refracted at all. After penetration and reflection, the beam will return directly back toward the light source.

Descartes overcame the obstacle to solving the rainbow problem. He noted...

> The principal difficulty still remained, which was to determine why, since there are many other rays which can reach the eye after two refractions and one or two reflections when the globe [raindrop] is in some other position, it is only those of which I have spoken which exhibit the colors.
>
> I then took my pen and made an accurate calculation of the paths of the rays which fall on different points of a globe of water to determine at what angles after two refractions and one or two reflections they will come to the eye and then I found that after one reflection and two refractions there are many more rays which come to the eye at an angle of forty-one to forty-two degrees than any smaller angle and none which come at any larger angle. I found also that, after two reflections and two refractions there are many more rays which come to the eye at an angle of from fifty-one to fifty-two degrees than at any larger angle, and none which come at a smaller angle.
>
> Appendix to *A Discourse on Method*

The bows are thus produced by the least divergent (i. e., most highly focused) rays of light that reemerge from the drop (Fig. 6-17). Furthermore, by showing that some light is deflected by less than 42º and some by more than 51º from the antisolar point, but none between these angles, Descartes simultaneously explained Alexander's dark band.

Despite all his laborious calculations, Descartes could never explain the colors of the bow. This was a job left to future generations of scientists. Isaac Newton, who some 30 years later performed his famous experiments with light and prisms, took the next giant step. Newton realized that the drops act like prisms when sunlight passes through them, refracting each color of the spectrum by a slightly different angle. The rainbow is about 2º degrees wide because the red appears about 42º from the observer's shadow and the violet only about 40º. Newton also invented the Calculus and, when he applied it to Descartes' problem, solved it more accurately and with infinitely greater ease.

But there were certain discrepancies that Newton could not explain. Both the coloration and angular width of rainbows vary. Some rainbows have one or more additional bands, known as supernumerary bows, inside the main bow. If raindrops acted exactly as prisms then all bows should have identical coloring and width and there should not be any supernumerary bows.

In 1803, Thomas Young, a physician who was concerned with the physiology of vision, followed his seminal work on diffraction (see Fig. 6-32 and pp. 135-37) by demonstrating that variations in the rainbow prove that light consists of waves. He then stated correctly that the width and color sequence of the bows depends on the size of the drops (Fig. 6-18).

Impacts of the wave properties of light are negligible for large drops (radius $\geq$ 0.5 mm = 500 μm), which produce narrow bows with pronounced spectral coloration. As drop size decreases, the wave properties of light grow more pronounced, so it is no longer possible to treat light simply as a ray. The supernumeraries appear and the bows whiten and broaden to fogbows, (Fig. 6-19) and ultimately disappear. This is why rainbows are almost never seen within clouds. Typical cloud droplets are much too small (radius $\approx$ 5-10 μm) to produce rainbows because they are only a few times larger than visible light waves. But the tiny cloud droplets are optically active; they produce coronas, cloud iridescence, and glories. Thus as the rainbow whitens and fades, a small glory appears around the observer's shadow, as in Fig. 6-19.

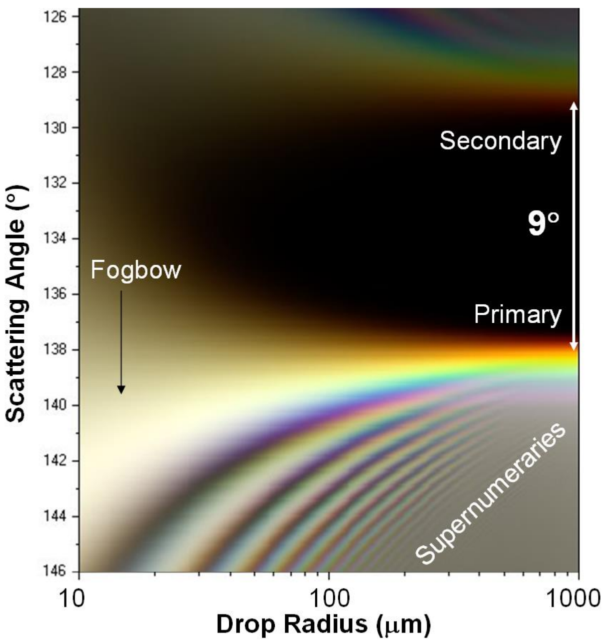


Fig. 6-18. Lee diagram of theoretical color and light of bows as a function of drop radius and scattering angle. Figure modified from Philip Laven.

Fig. 6-19 A fog bow and glory seen from the Golden Gate Bridge. Mila Zinkova, photographer.

The sunlit sides of clouds are also simply too bright to produce rainbows. Too thick a veil of sunlit drops drowns out the bows by disproportionately increasing the background illumination. The most spectacular, vivid rainbows are therefore produced by modest veils of raindrops falling under the cloud and through which a dark backdrop can easily be seen. This makes rainbow a translucent apparition, and all the more wondrous and alluring.

When 15th and 16th century artists began to paint their rainbows, the state of knowledge was so rudimentary and uncollated that they effectively had to rediscover everything about bows on their own. Their paintings may even have helped focus scientific attention on the rainbow, and it is not surprising they made mistakes when transcribing their impressions of these fleeting visions.

Memling's *St. John the Evangelist on Patmos* is a good starting point for a diagnosis of painted rainbows. The Saint is seated in the foreground and is at work composing the book of the *Revelation of Saint John the Divine*. Above and beyond the Saint is an almost literal transcription of his apocalyptic visions.

> 7. The first angel sounded, and there followed hail and fire mingled with blood, and they were cast upon the earth: and the third part of trees was burnt up, and all green grass was burnt up.
>
> 2. And he opened the bottomless pit; and there arose a smoke out of the pit as the smoke of a great furnace; and the sun and the air were darkened by reason of the smoke of the pit.
>
> *King James Bible*. *Revelation of Saint John the Divine* Chapters 8 and 9.

In *Early Netherlandish Visions*, Shirley Blum pointed out that this was the first time an artist had recorded Saint John's visions in such naturalistic detail. Because of the nature of the Saint's visions the work contains much fire and smoke, thereby placing it in a class with some of Bosch's earliest fiery works. Still, Memling held reins on his imagination for he was tied to the placid 15th century.

The *Revelation* also tells of a rainbow surrounding the Enthroned One and another bow upon the head of a mighty angel.

Depending on how the various rings and arcs of light are interpreted, it is possible to count as many as seven bows! The two main bows are the ones surrounding the entire heavenly host. Part of the outer bow is reflected in the water of the foreground. There is another angel in the sky surrounded by an oval ring of light and seated on a bow. At the horizon the mighty angel is standing under a bow and a reflection of this bow appears in the water.

Every one of the *Revelation's* bows is saddled with errors. Artists have routinely repeated some of these rainbow errors. The two main bows of the *Revelation* are opaque and striped. They are depicted as blocked-out bands of color through which nothing can be seen. Assuming that the outer bow corresponds to a secondary bow, it should not be so bright and its color sequence should be reversed. The bow at the horizon is also miniaturized. Since the rainbow always appears at the same 42º angle from the observer's shadow, its apparent size is the same no matter its distance.

Because rainbows occupy the same angular size no matter their distance, they behave as if they were located an enormous distance away (at the Sun)! This paradoxical property leads to some surprising and unexpected consequences and provides a test of whether an artist relied on his observations or on his intellect.

Rainbows, like the Moon or the Sun, do not get larger as you approach them. They also seem to move with you, even if they are produced in the spray of a hose a few feet away. The rainbow's reflection in a body of water such as a pond also acts strangely. If you are standing above the pond at an elevated vantage point, the rainbow's reflection will appear just as far below the horizon as the bow appears above it. By contrast, the reflection of any other nearby object, such as the flag in the top panel of Fig. 6-20 will appear further below the horizon than the object appears above it.

Sunbeams that are reflected from a smooth water surface can also produce rainbows in the sky. These bows are called reflection rainbows. (I do not know a single painting of a reflection rainbow.) Since sunbeams reflected from smooth water bodies would cause shadows of objects to appear in the sky, reflected rainbows are centered above the horizon and so are more than semicircles. The usual and reflection rainbows join at the horizon where they reinforce each other and may be very bright (Fig. 6-21).

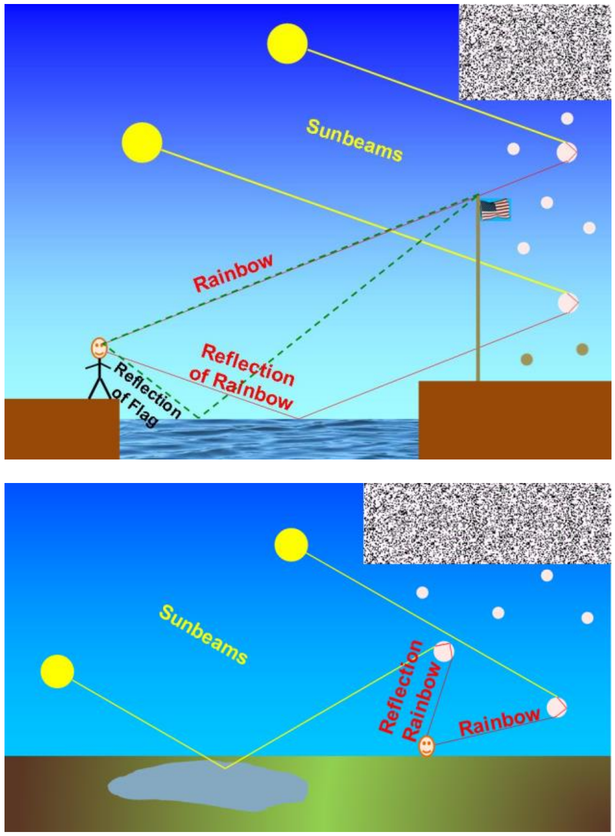


Fig. 6-20. Paths of light for the primary rainbow and reflection of the bow and of a nearby flag (top) and or a reflected light (reflection) rainbow (bottom).

Reflection rainbows are relatively rare. They cannot be produced by a rough water surface, which reflects light incoherently. They are brightest just above the horizon unless the water surface covers a large area, in which case it is unlikely to be smooth. They are also brightest when the Sun is low in the sky; for water reflects efficiently only when the light strikes it at a glancing angle.

Fig. 6-21. Primary, Secondary and Reflection Rainbows. Patricia Burt, Photographer.

In the water of the foreground of *St. John the Evangelist on Patmos*, Memling was presumably trying to depict a reflection of the lower right portion of the outer main bow. He apparently misused the law of reflection by treating the bow as if it were located at a finite distance, and incorrectly placed the image much further below the horizon than the bow is above it. He also painted the impossible when he showed the reflection of part of the rainbow below the horizon.

All 15th century bows were misplaced inserts into the landscape. Pisanello arched a small bow over two hanged men in the otherwise black sky of his *St. George and the Princess*, (c. 1435, Church of Sant'Anastasia, Verona). Even Paolo Uccello's *Sacrifice of Noah* (c. 1446-1448, Sta. Maria Novella, Florence), which shows the aftermath of the flood, divorces the rainbow from a naturalistic sky so that it can arch over God the Father.

The first artist to convincingly integrate a rainbow into the landscape was Bernadino di Betto, or, Pinturicchio. Pinturicchio showed an interest in rainbows as early as 1486 when he included one as a misplaced afterthought in a miniature of a *Crucifixion*. In 1502 he was commissioned to paint a series of ten episodes from the life of Aeneas Silvius Piccolomini prior to his election as Pope Pius II and used the opportunity to paint a real rainbow.

The rainbow mural is the *Departure of Aeneas Silvius Piccolomini for Basel* (Fig. 6-22). The likely setting is the more or less topographic view of the port of Talamone, facing SW to the faint, distant profile of Monte Capanne on the Island of Elba. Together with the rainbow that strikes the ground vertically indicates that it is early in the morning around the summer solstice.

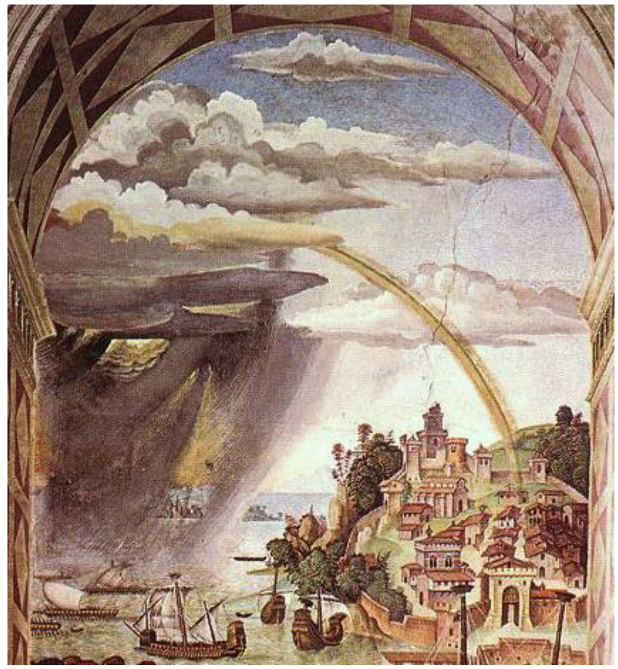


Fig. 6-22. Pinturicchio. *Departure of Aeneas Silvius Piccolomini for Basel*. 1502-1508. Piccolomini Library, Cathedral of Siena.

The rainbow was transplanted from a storm that Aeneas had encountered somewhat earlier at sea. The storm appears in the left distance where it disrupts the otherwise infinite visibility characteristic of 15th century art. It is not exactly a raging storm but still represents a significant departure from earlier paintings. At last, something besides an infernal fire was allowed to disturb the atmosphere.

The storm consists of a cluster of modestly sized, flat-based, triangular cumulus. These clouds are too small and thin to produce heavy showers but that is exactly what they are doing. Dark, comma shaped rain swaths fall from their bases, almost completely obstructing the view of the distant town across the bay. The sky both below and in the gaps between the clouds assumes the dull orange color commonly seen when an advancing thundercloud has covered all but the distant horizon.

The rainbow, presumably due to clouds above the painting, arches over all the theatrical darkness and bluster. It consists of part of a circular arc and is also translucent, but is a bit small and is composed of three almost neutrally colored stripes. The shadows of the figures in the foreground point to the right but should point to the center of the rainbow circle. The sky is also no brighter below the bow. Apparently, Pinturicchio painted the sky first and then added one of fine art's many inserted rainbows. Despite these errors, Pinturicchio had disturbed the atmosphere and it reacted by yielding a pearl.

Pinturicchio was assisted by the young Raphael, who contributed to the murals in the Piccolomini Library before heading out on his own. Wherever he went, Raphael learned like a sponge, absorbing and appropriating the techniques of other Renaissance masters. He was apparently never plagued by the doubts and hesitations that haunted Leonardo. His output was prodigious; what might he not have accomplished had he lived past 37?

Raphael arrived in Florence in 1504, saw the works of Leonardo, and began to paint clouds with indistinct outlines. In 1509 he went to Rome. Soon thereafter his skies began to grow a bit hazier. Then, perhaps in 1511, he was commissioned by Sigismondo de' Conti, monsignor of Pope Julius II to paint the *Madonna of Foligno* (Fig. 6-23), a votive picture to commemorate the miraculous incident in which de' Conti's house was struck by lightning or by a meteorite yet not harmed.

The *Madonna of Foligno* shows either a small shooting star or comet about to strike one of the larger houses in the town of Foligno while divine protection appears in the sky above. The Virgin and Child are seated on a throne of unconvincing cotton puff cumulus. High in the sky the cloud puffs have been miraculously transubstantiated into a web of gray angels.

Fig. 6-23. Raphael. *Madonna of Foligno*. 1511. Pinacoteca, Vatican.

In 1511, the cloud-angel was still a relatively young creature. Clouds had been associated with divine figures since at least Roman times. Most often they served as seats or footstools. Sometimes the clouds would hide part or most of the figures. In all these cases the exposed portions of the divine figures were portrayed as solid bodies. It was only around 1470 that the divine figures emerging from the clouds were themselves composed of clouds. The *Coronation of the Virgin* (Pinacoteca, Siena), attributed to Francesco di Giorgio, wove a web of nebular angels that is barely distinguishable from the misty cloud.

In the *Coronation of the Virgin*, atmospheric visibility is severely reduced in the cloud near the top, while visibility below the cloud remained at high Renaissance levels. The idea of placing two regions of different visibility in the same work to distinguish the sacred from the profane or the hero from the masses was one that would thenceforth be utilized by many artists. The technique became especially popular and was brought to perfection in the 17th century under the care of masters including Murillo and Rembrandt (Chapter 7).

The *Madonna of Foligno* also contains two regions of different visibility. Obscuration reigns in the sky behind the Virgin and Child, but visibility is high on the ground below.

Sky and ground in the *Madonna of Foligno* are linked by a golden miniaturized rainbow. The bow appears to support some unrealistic cumulus puffs that serve as seat and footstool to the Madonna, for their weight squashes the bow as if it were a metal hoop. Raphael also did not make the sky brighter below this bow.

The subtlest error in Raphael's bow results from a fundamental misconception. Just under the Virgin's left foot, the golden bow emerges from behind the base of a cloud puff to illuminate the nearby sky. Raphael apparently conceived of the rainbow as a self-illuminating phenomenon. Rainbows are merely scattered sunlight. Therefore, precisely where Raphael's bow illuminates the sky, the cloud should have blocked the sunlight and left a gap in the bow.

Fig. 6-24. Matthias Grünewald. *Madonna in the Garden, Altarpiece of Our Lady of the Snows*. c. 1517-1519. Church, Stuppach.

A few years later, around 1518, Matthias Grünewald included a new rainbow observation in his *Madonna in the Garden* of the *Altarpiece of Our Lady of the Snows* (Fig. 6-24). A few segments of a faint secondary rainbow appear outside the primary bow, making this the first example of double rainbow in which the primary bow is more intense. The Madonna is seated under a miniaturized and striped rainbow that doubles as a halo. A golden light surrounding the Madonna's head is largely confined to the part of the sky under the bow. This is the first painted hint that the sky may be brighter under the primary bow.

The *Madonna* also includes a divine light in the sky and what appears to be a multiple ringed corona surrounding what may be the face of God. But coronas cannot be seen near rainbows. Coronas surround the Sun; rainbows appear on the opposite side of the sky.

One of the ugliest rainbows appeared in Dosso Dossi's *Jupiter, Mercury, and Virtue* (Fig. 6-25). But this unimaginably broad, ugly, discolored bow does have a redeeming feature - Dossi rendered the sky distinctly brighter inside the bow, perhaps the first artist to do so.

Fig. 6-25. Dosso Dossi, *Jupiter, Mercury, and Virtue* c. 1528. Lanckoroński Collection, Wawel Castle.

Artists have insisted on waging war with the rainbow and have usually come away defeated. There are several reasons rainbows have proven so difficult to paint accurately. First, rainbows conform to a set of rather rigid specifications. Clouds, by contrast, can assume almost any shape so an artist has some justification for whatever clouds he may splotch on the canvas. But the primary rainbow always appears 42º from your shadow and the red is always on the outside. It is always about

2º wide and the sky below it is always brighter than above it. When the secondary bow appears it is always 9º outside the primary, is always broader, almost always fainter, and its color sequence is always reversed.

Before the invention of photography the artist did not have an adequate opportunity to carefully observe and precisely record all the rainbows' features. In places like Hawaii, where showers are often fixed to the mountains, rainbows may occur often and last for a long time, but few 16th century European artists vacationed there. Since rainbows in Europe are not only fleeting apparitions but rare events as well, appearing only a few times a year, European painters would have had little opportunity to amass a detailed catalog of their properties even if they had been constantly on the lookout.

Therefore European artists seldom got a good look at rainbows. Instead, they had to take quickly formed impressions back to their studios and then paint from a memory burdened with preconceptions. At that time, artists did not exhibit the antipathy toward science and technology that became so common among more recent generations of their brethren. Nevertheless, they remained uninformed about rainbows because there were few accurate descriptions available until the time of Descartes. Furthermore, artists were not often privy to the latest scientific discoveries. As a result, the preconceptions they relied on were seldom scientific or objective and, as with Memling and Raphael, painted rainbows were doomed to contain errors. After all, who could possibly imagine that anything appearing only a short distance away must be treated as if it were located at the distance of the Sun?

So, artists continued unwittingly down the path of error, groping towards knowledge and beauty at a snail's pace. Their errors usually proved to be costly, for the beauty of rainbows cannot be separated from the laws that shape them. Those errors transformed most painted rainbows into the graffiti of the sky.

The atmosphere sports a host of other optical phenomena, which artists of this time began noticing. The painting of the spectacular halo display seen in the sky above Stockholm on 21 April 1535 was described at the end of Chapter 3 (recall Fig. 3-16). Otherwise, 16th century artists ignored atmospheric halos but did pay somewhat more attention to coronas.

Albrecht Dürer, who treated the landscape with more freedom in his watercolor sketches than in his formal paintings, painted a huge corona around the Sun in the *Nativity* from the *Paumgartner Altarpiece* (c. 1502, Alte Pinakothek, Munich). This corona appears in a cloudless part of the sky and so must be relegated to the realm of the solar and heavenly aureoles for which there was already a hallowed tradition. More convincing coronas had to wait until another German Albrecht began to paint the sky.

Albrecht Altdorfer was one of the great sky painters. He was certainly an anomaly in his own times. Although Leonardo da Vinci and Albrecht Dürer had excluded people from their landscape drawings or watercolor sketches, Altdorfer was the first to omit people from a painting. His *Landscape Near Regensburg* (c. 1522-25, Alte Pinakothek) also contains the first convincing forest since Jan van Eyck - a mixed forest of evergreen and deciduous trees complete with undergrowth - giving the appearance of a continuum rather than an arboreal cluster of individual lollipops. In this and in some of his other major works, Altdorfer succeeded in transforming the sky into a temple of wonders as few others have.

The *Battle of Alexander at Issus* (Fig. 6-26) is the culmination of Altdorfer's sky art. It may not contain the most beautiful of his skies - that honor may go to *Susanna at the Bath* (1526, Alte Pinakothek) with its field of swirling flecks and cells of cirrocumulus floating in crystalline, deep blue polar air. But the *Battle of Alexander* has the cirrocumulus and more. The ostensible theme of the painting is the victory of Alexander's troops over the far larger army of Darius at Arbela on the Issus River in 333 BCE. Two armies have flowed together like rivers. Each contains hundreds of antlike soldiers locked in mortal but anonymous combat, a possible reflection of the peasant uprisings that had just been ruthlessly suppressed throughout Germany.

Fig. 6-26. Albrecht Altdorfer. *The Battle of Alexander at Issus*. 1529. Alte Pinakothek, Munich.

The Battle of Alexander alludes to a grander theme, the first circumnavigation of the world by the survivors of Magellan's crew. It offers a vantage point that has been termed cosmic but basically represents an extrapolation of a mountaintop view. Its perspective is thus one that the naturalist Altdorfer, who lived in Regensburg about 100 miles from the Austrian Alps, surely experienced.

In the distance of *The Battle*, a river (the Nile?) meanders lethargically on its way to the bay (the Mediterranean?) before dispersing into the multiple channels of a classically braided delta. Beyond the bay alpine mountain ranges are seen from a bird's eye view that only Leonardo, also a mountaineer, had attained. The vantage point is so elevated that the armies and the city behind it are dwarfed by the landscape background. The entire background appears blue as a result of its great distance. Even the Earth's curvature, so recently established by Magellan's circumnavigation, can be discerned.

Then there is the sky! It is just before sunset at the end of the battle when Darius and the Sun are fleeing. At far right, golden crepuscular rays emanate from the setting Sun and pass through a long cavern in a cumulonimbus (Cb). The cavern's ringed walls are alternately golden where directly illuminated and orange elsewhere. Mamma protrude from the Cb’s towering wall and anvil while a field of cellular cirrocumulus appears high in the clear air just outside the Cb. At upper left a corona around a crescent Moon (aimed too low for the Sun) appears in a form of cumulus or altocumulus

The cumulus no longer consist of the well separated, individual elements of 15th century paintings, but form an impenetrable wall at the horizon that defines our earthbound limits and places the entire scene in the eye of a storm. Altdorfer was probably the first northern painter to emphasize entire fields of clouds rather than randomly spaced, isolated cloud elements, just as he depicted forest groves rather than widely separated lollipop trees. This approach made it natural for him to treat altocumulus and cirrocumulus, for these often consist of organized ranks and rows.

The crepuscular rays, formerly reserved exclusively for religious scenes, now appear in a secular context, and Altdorfer was careful to show that they emanate from the Sun. Crepuscular rays are sunbeams that have been illuminated by aerosol particles and, to a lesser extent, air molecules. They never emerge from the Sun in perfectly clear skies and almost all artists have noted this well. They form when sunlight passes by the edges or through the gaps of a dark cloud or the canopy of leaves in a dense forest and can even be seen in a darkened room when the shade is slightly raised. When the Sun is high in the sky, crepuscular rays appear just beyond the fringes of opaque clouds (usually cumulus) that barely block the Sun and are also seen in small openings of an almost complete cloud cover. Most commonly, they are seen in the general direction of the Sun when the Sun is low in the sky (they are translated as twilight rays) and the sunbeams have managed to pass through gaps or low points in a wall of clouds. Sometimes at sunset or dawn, tall mountains can cast large enough shadows to cause crepuscular rays.

Since crepuscular rays emanate from the Sun, they can be used to pinpoint the Sun when it is below the horizon or hidden by clouds, as in Fig. 6-27. Crepuscular rays, like sunbeams, are all parallel. Their apparent divergence is simply a result of perspective (Fig. 6-28).

Fig. 6-27. Crepuscular rays over New Brunswick, NJ.

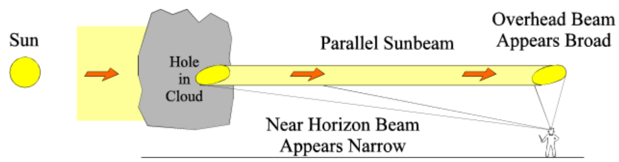


Fig. 6-28. Crepuscular rays are parallel sunbeams that appear to widen because of perspective.

Fig. 6-29. Jan van Scorel. *Christ Preaching on the Sea of Galilee*. c. 1528. Museum of Fine Arts, Boston, MA.

Altdorfer's crepuscular rays are short, pencil-thin lines that followed a long, unsatisfying artistic tradition. More often, crepuscular rays are broad, spreading beams of light. Perhaps one year before Altdorfer painted the *Battle of Alexander*, Jan van Scorel became the first artist to show convincing crepuscular rays in his *Christ Preaching on the Sea of Galilee* (Fig. 6-27). Although the view is not topographic, Scorel may have seen such rays during his pilgrimage to the Holy Land in 1520.

Altdorfer painted coronas around the Moon on several occasions. The corona in *The Birth of Christ* (Gemäldegalerie, Staatliche Museen, Berlin-Dahlem) is a blazing apparition that rings an enormous Moon. Its corona gives the impression of being a divine rather than a naturalistic presence, but it properly resides in a patch of altocumulus. It gives us a better idea of the potential beauty of the corona than does the humbler and more secular ringed colorless corona of the *Battle of Alexander*.

Fig. 6-30. A multiple-ringed corona over Nederland, CO, Paul Neiman, Photographer.

Fig. 6-31. Computer simulated coronas for thin and thick clouds with uniform size drops (left and center), and thin cloud with larger range of drop sizes (right).

Most coronas are rather pedestrian affairs that consist of little more than a bright aureole surrounding the Sun or Moon. But at times, coronas and iridescent clouds, their irregularly shaped siblings (see Figs. 11-38, 11-39), light up like the opals of the sky (Fig. 6-30).

Coronas are produced when sunlight or moonlight is scattered as it passes through thin clouds of tiny water droplets, or nearly spherical ice particles. The most accurate computer simulations of coronas apply the Lorenz-Mie scattering theory (recall §2.1) to thin clouds of water droplets, as in Fig. 6-31.

Even though scattering theory provides the most accurate model for coronas, diffraction of waves provides the simplest way to explain and envision coronas. When sunlight passes by a solid object of finite size the shadow *appears* to have a sharp edge with no visible diffraction pattern. It was partly on the basis of this understandable but inadequate observation that Newton mistakenly rejected the idea that light consists of waves. But in the 1650's Francesco Grimaldi had sent a narrow beam of light into a dark room, placed a thin rod in the light beam, and saw colored bands both inside and outside the rod's shadow. He thereby demonstrated that light does bend slightly into the shadow zone and that it exhibits undulations of both intensity and color. His experiments were published posthumously in 1665. Newton, repeated and verified Grimaldi's experiments for himself, but somehow failed to make the link with a wave theory of light. Then the authority of Newton's name helped put the wave theory of light into a deep, long sleep, like Sleeping Beauty.

More than a century passed before Thomas Young revived the wave theory of light with his diffraction experiments. In 1801-1802, he demonstrated that the undulations of light intensity and color at the edge of the shadow zone are large and pronounced only when the objects obstructing the light are tiny. As we have seen, he realized these findings explain supernumerary rainbows.

Diffraction can be visualized easily with water waves, which represent alternate elevations and depressions of the water surface. Ocean waves are diffracted when they pass through a gap in a breakwater. If the waves continued to travel in a straight line after they passed the gap, they would produce abrupt discontinuities in the elevation of the water surface (Fig. 6-32). Since nature cannot tolerate such discontinuities, the waves are forced to diffract or spread in all directions.

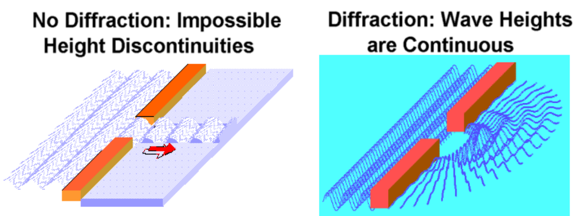


Fig. 6-32. Waves passing through a breakwater. a: without, and, b: with diffraction.

Diffraction diverts wave energy from some directions and focuses it in others. Thus there are directions where the water surface is not disturbed at all, while in other directions the waves may be amplified. These directions depend solely on the ratio of the wavelength to the size of the gap in the breakwater.

When a cloud droplet blocks sunlight it produces a diffraction pattern that resembles the one produced when ocean waves bend into the shadow zone of relatively quiet waters behind a narrow breakwater. Thus, when light of a single wavelength strikes a cloud droplet it will be dark in certain directions and bright in others near the edge of the shadow zone. The directions are determined by the ratio of the droplet's diameter to the wavelength of the light. The smaller this ratio, the larger the resulting rings of light. Thus, smaller drops and longer waves produce wider rings.

Coronas are colored because sunlight covers all wavelengths of the visible spectrum. Each wavelength has its own diffraction pattern around the cloud droplets. Shorter light waves are diffracted by smaller angles. Thus diffraction segregates the colors into separate rings. Immediately around the Sun the colors mix and their intensity is so great that the light appears white with perhaps a faint bluish tint. The inner colored ring grades quickly from pale yellow to red. The red ring is located not where the red light is most intense but rather where the blue light is least intense. Similarly, the blue ring occurs where red light is least intense. For cloud droplets 10 micrometers in diameter the inner red ring appears about 3º from the Sun and the inner blue ring about 4.5º from the Sun. Droplets with twice the diameter produce coronas only half as large. Coronas, which are generally much smaller than halos, therefore provide a way to determine the size of cloud droplets without flying into the cloud and without a microscope.

Two conditions are necessary to produce brilliant and colorful coronas, 1: the cloud must be optically thin to allow light to pass through coherently and, 2: the droplets along any sunbeam must be nearly the same size. If the cloud is optically thick, most light will strike several droplets before emerging and will be incoherent. If the cloud has a wide range of droplet sizes then each droplet produces a different diffraction pattern, so the light emerging from the cloud is incoherent and the colors and rings get washed out. The simulations shown in Fig 6-31 illustrate how even moderately thickening the cloud and broadening the range of droplet sizes washes out the corona.

The need for all droplets to have the same size makes it far more difficult to produce a bright corona than a bright rainbow, for the angles of the primary rainbow's colors are almost independent of the size of the drops. Coronas are therefore produced most easily by thin clouds such as altocumulus or cirrocumulus. Mountain wave clouds and other thin, smooth wave clouds come closest to satisfying these stringent conditions (see Fig. 5-17) and this is why their fringes are so often beautifully iridescent.

Most coronas are far smaller than halos, but on occasion, irregular segments or patches of coronas called iridescence can occur more than

30º from the Sun (see Fig. 11-39)! Iridescence is most common around the edges of altocumulus cloud elements or lenticular clouds because that is where the droplets are smallest.

Fig. 6-33. Elliptical corona over Nederland, CO. Paul Neiman, photographer.

Fig. 6-34. Tintoretto. *St. George and the Dragon*. c. 1560-1570. National Gallery, London.

Artists have frequently depicted coronas but, to my knowledge, did not depict cloud iridescence until Edward Wilson, the chief scientist on Scott's ill-fated South Pole Expedition painted the iridescence he observed in lenticular clouds downwind from Mt. Erebus on 09 August 1911 (see Fig. 11-37).

On occasion droplet size changes gradually from one part of a cloud to another (see Fig. 5-17), so that the corona becomes elongated into an ellipse (Fig. 6-33). (Elliptical coronas are also produced in cloudless skies by pine pollen grains, which resemble Mickey Mouse ears.)

Jacopo Robusti, called Tintoretto, painted an elliptical corona in St. George and the Dragon (Fig. 6-34). This corona emanates from the divine figure who is coaching St. George. It is elliptical only because Tintoretto was mistakenly trying to represent it obliquely in perspective. The sky is also filled with the wrong clouds for a corona. Lumpy cumulus may have iridescent fringes but never produce well defined coronas. Nevertheless, Tintoretto needed this divine light, for the world around him was growing darker and colder.

6.3 Twilight and The Little Ice Age

We always kiss in the shadows. And many shadows had come to darken the ripened Renaissance spirit. The Reformation and the invasions of the 1520's left Italians feeling a profound sense of decline. In response they abandoned the purer, sunlit search for truth, and replaced it with the pursuit of beauty, pleasure and pastoral joy under twilight skies. A sense of sin then returned full force to the human scene and did battle to restrain our 'human' side. The forces of chastity were aided greatly in this effort by the fear of syphilis, which had reached epidemic proportions through Europe shortly after Columbus returned from America.

The lost sense of innocence was also felt north of the Alps. Waves of puritanism and brutal tyranny swept over northern Europe in the wake of the Reformation. Simultaneously, and for completely unrelated reasons, the physical climate north of the Alps began to deteriorate. The Little Ice Age cast one more damper on the spirit of liberalism and license. It is not sensible to cavort naked in winter.

Shortly before 1500, Francesco Vecellio, arrived in Venice with his brother, Tiziano or Titian. Francesco apparently made little mark in the world of art but the precocious Titian more than fulfilled any early promise. He would soon show the world how, when, and where to love.

The brothers were born and grew up in the small village of Pieve di Cadore, nestled amid deep alpine lakes in the towering Dolomites. Flat, tidal, cosmopolitan Venice served as home to both for most of their adult lives (Francesco quietly and faithfully assisted Titian until his death in 1559) but the brothers never lost spiritual contact with their rugged alpine birthplace and often returned there.

Titian began as an apprentice to the mosaicist, Zuccato, but then in quick succession worked under Gentile Bellini, Giovanni Bellini and finally Giorgione. Giovanni may have taught Titian the many faces and moods of clouds while Giorgione probably brought Titian's artistic attention to matters of profane love. Titian was so greatly influenced by Giorgione that their themes and styles around 1508-1510 are almost indistinguishable. It is still not known whether such works as the *Fˆte Champˆtre* (c. 1510, Gemaldegalerie, Dresden) and the *Sleeping Venus* (c. 1510, Louvre) are by Titian, by Giorgione, or whether they are collaborative efforts. But Giorgione died young in the plague of 1510 and Titian soon became the undisputed master of Venetian painting.

Bacchus and Ariadne (Fig. 6-35) reveals that Titian was already an accomplished sky painter. Ariadne, deserted first by Theseus and then by Bacchus is walking despondently along the beach. The painting captures the moment Bacchus returns to her after conquering India and confers on her the gift of immortality. She will become the constellation Corona or the Cnossian Crown, seen in the sky and painted with utter disregard for astronomical veracity.

The dramatic setting and the poses of the characters in the *Bacchus and Ariadne* owe much to Raphael but the sky is all Titian. It is the deep blue and purple sky of dusk, the time when stars reappear and passions reawaken. As Leonardo had observed, dusk or twilight is also the time that the Earth is dark and only the highest cloud tops project upward enough to receive direct sunlight. At the upper left of the *Bacchus and Ariadne* the topmost fringes of the towering cumulus congestus are touched by sunlight while the bulk of the clouds lie deeply shaded. Titian repeated this setting so often throughout his career that it became one of his trademarks.

Fig. 6-35. Titian. *Bacchus and Ariadne*. 1520-1523. National Gallery, London.

Another Titian cloud trademark in the *Bacchus and Ariadne* is the monochrome and undifferentiated altocumulus. Titian had already painted such clouds several years earlier in his *Sacred and Profane Love* (c. 1516, Villa Borghese, Rome) and would do so frequently throughout his middle years. In the *Bacchus and Ariadne* they are represented by several broad, almost horizontal bands while in later works they tend to occupy large areas of the canvas. Since these smooth, 'filler' clouds almost complete lack any fine scale structure they could be painted quite rapidly, and so, were used indiscriminately by many other notable and time-pressed artists including Veronese, Nicolas Poussin and even Rubens.

The unaesthetic, flattened sheets of altocumulus, ironed into countless canvases in the century beginning with Titian, are truly the most nondescript clouds in the history of art. Nevertheless, there is some meteorological justification for painting them this way. Almost all clouds possess some fine scale structure that may be masked if atmospheric conditions are not right. Contrasts of light and color of shaded objects are markedly reduced around twilight, when the lighting is feeble and also on hazy days, when visibility is markedly reduced.

During summer, a deep layer of warm, humid air often covers Venice. Cumulus clouds form in this layer during the day and pump great quantities of heat and moisture upward. This warms and thickens the humid layer even further. Sometimes the air gets so hazy that it is impossible to distinguish cloud from clear air! Later, this Venetian trademark gained the attentions of Canaletto and Guardi.

Fig. 6-36. Twilight masking structure of altocumulus.

When evening approaches, the warm, humid layer radiates away the accumulated heat of the day. The largest temperature drops occur both near the ground, where fog results, and at the top of the humid layer, where the altocumulus of twilight forms. The vast majority of altocumulus possesses fine scale structure, but it is masked by thick haze and by the feeble light of deep twilight (Fig. 6-36).

Fig. 6-36 offers any artist who painted such clouds an excuse for his laziness. Twilight had become a favorite setting among the Venetian artists of the 16th century and it is startling to contrast the darkness of their paintings with the brightness of early Renaissance paintings. The twilight settings help explain why the century beginning with Titian was the time of the most nondescript clouds in the history of art. Still, the artists who joined this conspiracy to deface clouds can not be fully exonerated, because in most of their works they kept the atmospheric visibility too high to mask so much of the detailed cloud structure. But neither can they be entirely blamed - they had commissions to fulfill, yards to cover, and deadlines to meet.

Veronese's *Marriage at Cana* (Fig. 6-37) is one of the more realistic examples of Venetian cumulus and altocumulus. The *Marriage* takes place at the height of the day in reasonably clean air. Cumulus fill the lower part of the sky while a thin layer of altocumulus covers a large area higher up. The cumulus exhibit little small scale structure except at their upper fringes.

Fig. 6-37. Veronese. *The Marriage at Cana*. 1562-1563. Louvre.

Veronese rendered the altocumulus more effectively. They also do not possess much fine scale structure, but this is acceptable because altocumulus are frequently smoother than cumulus. What little structure Veronese did include was taken faithfully from nature. The thinner, more translucent cloud fringes appear whiter than the cores of the cloud elements because they transmit a larger fraction of the incident sunlight. Veronese also was careful to make the sunlit cumulus whiter and brighter than the altocumulus. The sunlit sides of cumulus are brighter than all altocumulus except those right near the Sun, because the more massive cumulus generally reflect more sunlight than the altocumulus transmit. Monet would later relish and embellish this observation (see Fig. 10-10).

Oddly enough, some of the most well-formed 16th century Italian clouds serve as seats or platforms for heavenly figures. Painted clouds had faithfully served divine figures in a variety of capacities since at least Roman times. In *Jupiter and Io* (Fig. 6-38) Correggio gives cumulus a new role as a convenient disguise for the philandering king of the gods.

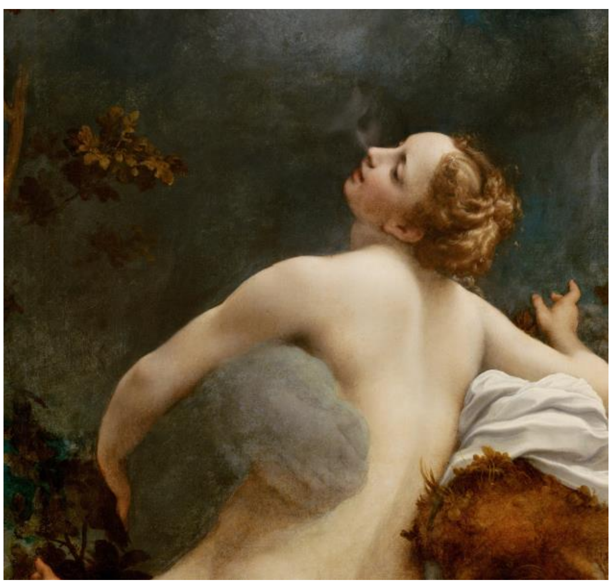


Fig. 6-38. Correggio. *Jupiter and Io*. c. 1533. Alte Pinakothek, Munich.

The god-cloud is a remarkable piece of anatomy. Jupiter's face emerges faintly from the almost uniform dark gray to plant a kiss upon Io's lips. At the same time, he firmly holds the ecstatic maiden with a broad hand and fingers composed of cloud. The billowy top of the god-cloud is plainly seen but its base has been hidden or eliminated. After all, it would have been most unbecoming to give Jupiter flat feet!

The humorous image of the cloud-god in *Jupiter and Io* points to something fundamentally new in painting. Artists were dissolving form right in front of their patrons' eyes. As a result, after about 1520 in Italy and somewhat later north of the Alps it became exceptional for any painter to expose the flat base of cumulus. Look back at Titian's *Bacchus and Ariadne*. Its swelling cumulus congestus betrays no hint of a flat base nor indeed of any base. The cloud emerges from an unseen source off to the left. Titian designed the *Bacchus and Ariadne* to hang next to his *Bacchanal of the Andrians* (c. 1520-23, Prado, Madrid) in a small room of the Duke of Ferrara. When the two works are placed side by side, their cloud fields merge, but still there are no bases. Yet no matter how the works are hung we do not miss the cloud base. In the heat of passion we all forget our origins.

Thirty years after the *Bacchus and Ariadne*, Titian began to work for Philip II of Spain, the principal patron of his later years. It appears that the intensely religious Philip wanted two distinct categories of works from Titian. Devotional paintings sufficed for public viewing while erotic, even voyeuristic 'poesies' were directed to his private rooms. The poesies involve romantic or sexual themes taken from Greek and Roman mythology. Even though Titian had Philip in mind when he painted them, the artist apparently was accorded complete freedom so the poesies can be viewed as Titian's own fantasies. Not surprisingly, they contain some of his most wild and sensually beautiful skies.

One of the poesies involves the *Rape of Europa* (Fig. 6-39). Titian began this in 1559 and did not complete it until 1562 when he was almost 75. Rubens made a copy of it in the winter of 1628-9 in Madrid and called it "the first painting in the world". According to the myth, Jupiter spotted Europa, daughter of King

Agenor, playing on the beach with her Tyrian maidens, and desired her instantly. Even as king of the gods, however, he needed some ruse to effect his conquest. He had his son, Mercury, drive Agenor's cattle from their mountain pastures down to the beach. He then assumed the form of a bull whose beauty and gentleness made him stand out from the rest of the herd. In this form he enticed the princess onto his back. Then he immediately plunged into the waters and swam away with her to the 'beached mountainside of Crete' where he revealed himself and had his will of her.

Fig. 6-39. Titian. *The Rape of Europa*. 1559-1562. Isabella Stewart Gardner Museum, Boston.

Titian chose to paint the moment after the abduction, when the bull is surging through the waters. Europa holds the bull with one hand following Ovid's text, but with the other she clutches the part of her gown that the wind has torn from her body. She looks back at her playmates who stand helplessly on the beach. Already the bull has covered a considerable distance, for the shoreline is viewed from afar.

But the perspective is way off. The viewer is placed at the level of the bull's shoulder, barely two feet above the water, yet the distant shore and the mountainous background scenery appear as if viewed from a great height. This inconsistency did not bother Titian one bit, for the work is a poesy and a feeling of reckless abandon is better portrayed from the air than from sea level. Titian was transporting all of us to a dreamland in the sky.

And what a sky it is! The clearings are deep blue while all the clouds have been set ablaze by the fiery colors of dawn or dusk. The clouds above are confined to a rather thin layer and, appropriately for dawn or dusk, are either stratocumulus or altocumulus. Toward the horizon the cloud forms grow indistinct and grade imperceptibly into an amorphous mist that hugs the distant Earth. There, Earth, sea and sky almost blend in such a whir of colors the elements can scarcely be distinguished.

Titian's *Rape of Europa* is the youthful dream of an old man who still loves life robustly.

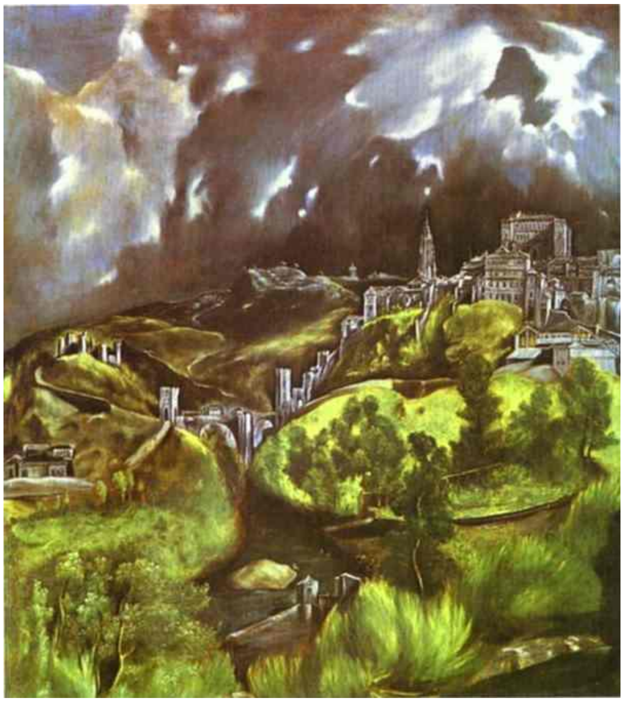


Fig. 6-40. El Greco. *View of Toledo*. c. 1599. Metropolitan Museum of Art, New York.

Fig. 6-41. Panorama of Toledo seen from across the River Tagus.

Neither the twilight dreams and reveries nor the misty heavens of Italian painters suited Domenikos Theotokopoulos. El Greco had his own austere vision with its own uniquely distorted perspective to bestow upon Spain. In 1568, El Greco came to Venice from his birthplace in Crete as an established painter trained in the Byzantine icon tradition. He apparently spent a brief time in Titian's workshop and later moved to Rome before trying his luck in Spain, where competition among painters was not so intense.

Fig. 6-42. Stark lighting contrasts in a field of cumulus.

El Greco is known primarily as a visionary who painted grossly elongated figures. He did few landscapes but his unique *View of Toledo* (Fig. 6-40) is one of the world's best known paintings. In this panorama of the city seen looking north from the highlands south of the Tagus River, El Greco successfully integrated the Byzantine or Gothic sense of perspective of his youth with the more modern viewpoint.

Photographs of Toledo’s skyline (Fig. 6-41) reveal that El Greco’s *View* is simultaneously accurate and monumental. The city is perched like a medieval fortress atop gullied badlands in this semiarid region of Spain. The landscape has a piled up, Gothic appearance. The impression of cosmic grandeur is enhanced by a curved horizon line that suggests are we viewing the Earth from a great height.

Stark lighting contrasts redouble the impact of the *View of Toledo*. The Earth's surface, covered by a bright green mat of vegetation in the foreground, contrasts sharply with the dark, desiccated brown of the distant defoliated hillsides and sterile gray of the city's walls and buildings.

The almost infinite visibility only heightens the painting's sense of monumentality. This is the contrapositive of Leonardo's observation that objects appear larger when seen through a fog. El Greco achieved the identical effect for the topography with stark lighting contrasts, which require high atmospheric visibility. Shafts of light of the late morning Sun strike this landscape with an unrelieved, almost lunar glare wherever they pierce the dense mat of cumulus clouds. And wherever the light falls, it ferrets the features out of a gloomy anonymity.

The drama on Earth takes place under an even more morose sky. El Greco has elongated the cumulus clouds just as he did most of his human figures. He then gave these clouds the most exaggerated range of lighting - from bright white to pitch black - ever seen in a painted sky. In the real world such extreme lighting contrasts can only be produced in a sky of high visibility when sunlight strikes parts of towering cumulus or cumulonimbus but leaves other parts deeply shaded (Fig. 6-42). El Greco bestowed extreme reflecting and shading properties upon his modestly sized cumulus and thereby made them appear as monumental as the features of the landscape below. The starkly lit and shaded cumulus are impostors - although they may seem like storm clouds no rain will fall from them, for they lack the form and massiveness of cumulonimbus.

I believe the *View of Toledo* is one of the most eloquent indictments of the Inquisition. A few stick figures have inconspicuous fun swimming in the foreground, but within the city walls not a soul dares appear to challenge the authority of the Grand Inquisitor. El Greco had no need to resort to blood and gore to convey the dark mood of fear that hovered over Spain. The silence of total desolation within the cities of mankind is enough.

Spain's attempt to impose her intolerant beliefs upon Protestant Europe met with less success than her efforts at home or in the New World, but she still managed to inflict a bitter portion of misery and travail on many innocent people in the Old World.

Philip II of Spain became sovereign of the Netherlands in 1555. At his accession the people were still overwhelmingly Catholic but their brand of religion was far more liberal and enlightened than the Spanish variety. Philip wasted little time in his attempt to bring the Inquisition to the Low Countries and root out heresy forever. Facing growing resentment and resistance to his plans, in 1565 he issued the following blunt directive,

> As to the Inquisition, my will is that it be enforced....Let all condemned prisoners be put to death, and suffer them no longer to escape through the neglect, weakness, and bad faith of the judges. If any are too timid to execute the edicts, I will replace them by men who have more zeal.
>
> quoted from Will Durant, *The Age of Reason Begins*. p 441.

Philip's edict backfired by transforming a once clandestine opposition movement into a Protestant cause celebre in the struggle for independence from hated Spain. In 1567, Alva, the Duke of Alba, arrived in Brussels to execute his king's orders to cleanse the Netherlands of heresy. This ardent butcher served a bloody term and, before he retired to Spain in 1573, managed to initiate a war that dragged on until the Peace of Westphalia in 1648!

The brief painting career of Pieter Bruegel the Elder was confined to the years of growing troubles between Philip's accession and Alva's retirement. Bruegel's art contains many cryptic allusions to the politics of the day, but the overriding message in his works is that of a chronicler of incredible visual range and acuity.

The *Tower of Babel* (1565, Kunsthistorisches Museum, Vienna) may foretell the impossibility of the Spanish dream of total dominance over the tiny Netherlands, but H. Arthur Klein has left no doubt that it is an invaluable guidepost to technology then used in the ports of the Low Countries. Likewise, in the *Blind Leading the Blind* (1568, Gallerie Nazionale di Capodimonte, Naples) it can be said that Bruegel is satirizing the blindness of the Spanish rulers, but Dr. Anthony Torrilhon, a physician, has identified a different type of blindness in each of the five men whose faces can be seen - pemphigus, atrophy of the eyeball due to glaucoma, corneal leucoma, amaurosis and enucleation.

Bruegel's remarkable powers of observation reached the sky. In the *Tower of Babel*, he employed a lazy altocumulus to show how high the tower was getting. Bruegel also cleared the haze that had drifted in from Italy and revived the flat-based cumulus. Then the winter of 1564-65 struck Europe and Bruegel became its chronicler.

Fig. 6-43. Pieter Bruegel the Elder. *Hunters in the Snow*. 1565. Kunsthistorisches Museum, Vienna.

The winter of 1564-5, as Hubert Lamb noted in *Climate, History and the Modern World*, was the coldest since the 1430's and "the first of the great winters of the next two hundred years". Bruegel's *Hunters in the Snow* (Fig. 6-43) served as its baptismal painting.

Snow covers everything but the frozen waterways, and all is locked in the icy grip of an outbreak of arctic air. Long, thick icicles hang from the building at the lower right and testify to prolonged cold. The opaque covering of a uniform stratus deck is no stranger to the winters of the Netherlands, which have sky cover averaging about 80%. Indeed, it is almost astonishing that no other artist since the Limbourgs had seen fit to display this all too common wintery canopy. The green tone of the stratus may simply have been designed to mirror the color of the ice below; green overcasts are reported at the edge of some severe, tornadic thunderstorms but otherwise lie outside my experience.

Bruegel showed that snow covered every bit of exposed land, right down to the small rocks and rubble that protrude from the frozen stream in the right foreground, but he also showed that all the frozen waterways were bare. This is a strong meteorological statement, for it implies the water did not freeze until after the snowstorm and therefore that mild weather had reigned prior to the storm. Thus, the *Hunters in the Snow* may represent a pictorial document of the snowstorm that launched the Little Ice Age.

The Little Ice Age is often defined as the period from roughly 1550 to 1850, when temperatures in Europe and North America were about 2ºF cooler than today. Its cause is not certain. Culprits include the minima of sunspots from 1460-1550 and 1645-1715, indicating reduced Solar output, and reduction of the Greenhouse effect when CO_2 was removed from the atmosphere by reforestation that followed the decimation of Native American population.

Whatever the cause(s), the Little Ice Age was a period marked by some notorious winters, and by significant advances of North Atlantic sea ice and glaciers in Greenland and the Alps. This minor climatic perturbation had profound effects on European civilization.

Warm conditions from Europe to North America characterized the period from about 800 to 1200 AD that preceded the Little Ice Age. The warmer and less stormy Atlantic weather encouraged exploration. During this time the Vikings settled on Iceland, discovered and colonized Greenland and even reached North America. The Viking sagas record two settlements on North America shortly after the year 1000. One of these locations, L'Anse aux Meadows, was rediscovered in 1961 in northern Newfoundland and the second was presumably located further south. The American settlements were abandoned because of the Vikings' own murderous behavior and because of their troubles with the 'Skraelings', most likely an Eskimo people. The Vikings then returned to their homes in Greenland.

The climate of southern Greenland began to deteriorate shortly before 1200. From this time, reports of Atlantic sea ice became much more common and the voyage between Iceland and Greenland became increasingly hazardous. Eventually the people on Greenland lost contact with Iceland and Europe and were abandoned to an icy fate. Failing to adapt like the Eskimos, the Greenlanders finally succumbed to the harsher conditions about the time of Columbus. From their skeletal remains we have a pathetic record of a people literally shrinking away. The average height of grown men in Greenland decreased from about 5' 10" around 1000 CE to 5' 5" after 1400.

During the period of medieval warmth, greatly increased reports of storm floods along the North Sea and English Channel coasts between 1000 and 1300 AD suggest a fraction of the polar ice sheets melted and raised sea level slightly. In Europe the medieval warmth lasted until shortly after 1300 when a series of cool, wet summers caused crop failures that weakened the populace and set them up for the Black Death. After 1300, the maximum possible altitude to raise crops also decreased so that much elevated land routinely cultivated in the 1200's thereafter became too cold to support crops.

Nevertheless, the climatic deterioration was not continuous. The climate from about 1490 to 1560, although somewhat erratic, was rather warm in Europe and probably set the stage by contrast for the dramatic winter of 1564-5. After that, crop shortfalls or failures and famine once again became familiar visitors throughout Europe, and Alpine and Scandinavian glaciers advanced down the valleys to give the Little Ice Age its name.

The coldest and worst years of the Little Ice Age came in the decade of the 1690's. Temperatures averaged well below normal in every season, but the gravest damage was done during the shortened and stunted growing seasons. In the highlands, snow remained on the ground so long into the spring that planting had to be delayed, and frost returned earlier in the fall to plague the harvests. Many farms were abandoned. Famine grew so widespread and severe that the population of northern Europe may have decreased by over 25%! The spread of sea ice and colder waters drove entire fish populations well south of their normal grounds. In 1695, Iceland was completely icebound for many months and suffered greatly from starvation.

For the most part, Bruegel shows the lighter side of the snow. W. J. Burroughs pointed out that Bruegel painted all his snow scenes between 1565 and 1567, while the memory of the severe winter was fresh in his mind. These works cover the range of emotions of cold weather. They include the *Winter Landscape with Bird Snare* (1565, Musées Royaux des Beaux-Arts, Brussels) with its hazy, overcast orange sky and orange ice that served many later artists as the archetypal European snow scene, the *Massacre of the Innocents* (c. 1567, Kunsthistorisches Museum, Vienna) with a green overcast resembling the *Hunters in the Snow*, the *Census at Bethlehem* (1566, Musées Royaux des Beaux-Arts, Brussels) with its pale blue clear sky, and the *Adoration of the Magi in the Snow* (1567) (Fig. 6-44). Snow also covers the higher elevations in the *Dark Day* (1565, Kunsthistorisches Museum, Vienna).

Fig. 6-44. Pieter Bruegel. *The Adoration of the Magi in the Snow*. 1567. Oskar Reinhart Collection, Winterhur.

The *Adoration* is Bruegel's only painting of a snowstorm in progress. The falling snowflakes are represented by white dots that cover the canvas. The sky is a featureless light gray and visibility has been reduced by the snow to only a few hundred feet, judging from the indistinct church and trees a mere block away. Prior to 1565, Bruegel had always painted skies with high visibility (except where fires raged) but apparently the weather of that year (or the explosive political situation) sensitized him to the obscuring powers of the air. Thereafter, a number of his works contain hazy and even discolored skies, and none of these have flat-based rows of cumulus he had previously shown some fondness for.

Despite the onset of the Little Ice Age, summer still returned every year. Bruegel showed this in the *Harvesters* (1565, Metropolitan Museum of Art, New York), where some of the peasants are fagged out by the heat. Visibility is reduced by haze, so that it is not possible to tell if it is clear or overcast.

Lucas van Valckenborch also showed the snows of winter and the return of warm weather. Valckenborch is one of the lesser known Flemish artists but was an outstanding sky painter who accurately represented weather in every season. His *Winter Games on the Scheldt at Antwerp* (Fig. 6-45) is a topographically accurate view of the city from the western bank of the ice-covered river and seen from the SSW late on a winter afternoon. It is also a meteorologically accurate view of a departed winter storm. The visibility is quite high, as is typical after winter snowstorms and the windmills point to the SW. The rather featureless altocumulus represents a torn membrane of altostratus often seen at the extreme western edge of departing winter storms, and particularly during late afternoon. A final brightening touch is added by broad *anti*crepuscular rays (see §9.1 and Fig. 9-16), which penetrate openings in the cloud sheet at center and far right and converge at a point well below the eastern horizon.

Fig. 6-45. Lucas van Valckenborch. *Winter Games on the Scheldt at Antwerp*. 1590. Frankfurt Stadelsches Institut.

Valckenborch was also fascinated by spring and summer storms, which he recorded with an accuracy seldom encountered until the 19th century. The *Spring Landscape* (Kunsthistorisches Museum, Vienna) shows a flat-based towering cumulus or cumulonimbus capped by a dome. A shower falling from cloud base is located directly beneath the cloud's dome, as is often the case. The cloud's sunlit top and left side is bright white while the rest is a gray-blue. The detailed structure is not apparent, presumably because it is lost in haze. The *Spring Landscape* is one of the more literal skies of the 1500's and must have been based directly on a storm Valckenborch witnessed.

Valckenborch witnessed more than his share of storms. His Protestant sympathies forced him for many years to keep on the move, a fate he shared with many of his contemporaries. In those years, the forest was welcome to Flemings for it sometimes brought safety.

Artists like David Vinckboons and Gillis van Conixloo may well have used the forested landscape as an allegory of political sanctuary but they also made a meteorological discovery deep in the forest that the Chinese had appreciated for centuries.

In Conixloo's *Forest Landscape with Heron Hunters* (Fig. 6-46) a narrow path leading into the distance is illuminated by a dim light but covered by an almost black canopy. An orange glow from the early morning sky weakly works its way through a misty atmosphere and a tiny opening in the canopy. In such a setting, you can obtain meteorological inspiration by looking down. And, hovering just above the stream on the left is a veneer of fog, so common in the early morning. A few feet higher along the stream bank the fog thins to a mist that tinges the trees slight blue and blurs the foliage just as 18th century French painters would later rediscover. Both had good reasons to hide.

Fig. 6-46. Gillis van Conixloo. *Forest Landscape with Heron Hunters*. 1598. Historisches Museum der Pfalz Speyer.

Nightfall brought more complete darkness and protection. Painters since Pietro Lorenzetti had occasionally treated nocturnal scenes because many biblical events had transpired at night. Around 1468, an artist known only as the Master of the *Munich Taking of Christ* (Alte Pinokothek, Munich) may have been the first to let the Moon illuminate the fringes of altocumulus or cumulus in an otherwise black sky. Moonlit cloud fringes have ever since remained a favorite technique among painters for suggesting the nighttime sky.

Jan Gossaert employed moonlit cloud fringes masterfully in his rendition of the *Agony in The Garden* (Fig. 6-47) after his return from a trip to Rome in 1509. Gossaert may have borrowed some elements of composition from Andrea Mantegna's *Agony in the Garden* (c. 1460, National Gallery, London), but Gossaert's nighttime sky was unique. The bright side of a crescent Moon points down to a Sun not too far below the horizon. The Moon has illuminated the fringes of some altocumulus and the distinct outlines of the sizable and active cumulus

Fig. 6-47. Jan Gossaert. *The Agony in the Garden*. Dahlem Gallery, Berlin.

While Gossaert was reveling in the clouds of the nighttime sky, Nicolaus Copernicus, working near the stormy Baltic Sea, wished all nocturnal clouds away so that he might see even further into the heavens. Copernicus revived Aristarchus's ancient idea that the Sun lay at the center of the Solar System, but did so in such a compelling manner (using Occam's Razor) that his ideas could not long be overlooked. Privately he circulated a preliminary manuscript in 1514. At first all Europe could do was yawn. But the idea was now out in the open and it was a time in which authority was being challenged on all fronts.

Calvin and Luther, who were themselves devoted to opposing an entrenched authority, (but replacing it with their own) were appalled at the heliocentric hypothesis while the rather tolerant Renaissance Catholic Church initially winked at it. Around 1530, Luther vehemently rejected Copernicus's ideas as contrary to Scripture - after all, the Bible states that Joshua commanded the Sun and not the Earth to stand still. Rebuffed in public, Copernicus put aside his revolutionary book, *On the Revolutions of the Celestial Orbs* and the work was not formally published until he lay on his deathbed in 1543. It was recorded that he saw the title page, smiled and, within the hour, died.

Needless to say, Copernicus's ideas did not die with him. Overnight there were many others who came forth to carry the heliocentric banner and put the Earth in its proper place in the Solar System. The calendar was revised under the direction of Pope Gregory XIII and now bears his name. Johann Kepler inherited the meticulous observations of Tycho Brahe and used them to formulate the heretical notions that 1: the orbits of the planets were not circles but rather ellipses and 2: the planets move faster when they are closer to the Sun. He published these first two laws in 1609, and added his third law regarding the orbital periods of the planets a decade later.

In the same year, Galileo Galilei aimed his newly built telescope at the heavens and discovered a new universe beyond the universe visible to the naked eye. This proved more upsetting to authoritarian figures than all the earlier astronomical theories put together. It is always possible to dismiss theories as mere harmless hypotheses but it takes a far greater effort to deny the evidence of the eyes. For this reason, a professor of philosophy at the University of Padua refused to look through Galileo's telescope, saying,

> There are seven windows given to animals in the domicile of the head.... From this and many other similarities in nature, such as the seven metals, etc., which it were tedious to enumerate, we gather that the number of planets is necessarily seven. Moreover, these [alleged satellites] of Jupiter are invisble to the naked eye, and therefore can exercise no influence on the earth, and therefore would be useless and therefore do not exist.... Now if we increase the number of planets this beautiful system falls to the ground.
>
> quoted from W. T. Jones, *A History of Western Philosophy*. p. 622.

In March, 1610, Galileo rushed his early astronomical discoveries into print in a pamphlet entitled, *The Siderial Messenger*, and its contents became known all across Europe almost instantly. In it, Galileo announced the existence of the moons of Jupiter, the craters of the Moon, the phases of Venus, and a host of new stars spotted all across the sky. He also took a close look at the Milky Way, which had usually been thought of as a continuum of light, and found,

> By the aid of the spy glass...all the disputes that have tormented philosophers through so many ages are exploded at once by the irrefragable evidence of our eyes, and we are freed from wordy disputes upon this subject, for the galaxy is nothing else but a mass of innumerable stars planted together in clusters.

And this is the way the German painter, Adam Elsheimer, living in self imposed exile in Rome depicted the Milky Way in the *Flight into Egypt* (Fig. 6-48).

The *Flight into Egypt* is probably the most famous of all painted night scenes and is an astronomer's dream come true. It was signed and dated 1609, but its treatment of the Milky Way as a band of stars suggests Elsheimer retouched it between March 1610 when the *Siderial Messenger* first appeared, and December, when he died.

Fig. 6-48. Adam Elsheimer. *The Flight into Egypt*. 1609-1610. Alte Pinakothek, Munich.

The Milky Way stretches from the upper left corner to the exact center of the nocturne and directly above the Holy Family. At the upper right is Ursa Minor, with the Little Dipper and the North Star, Polaris at the tip of its handle. Directly beneath Polaris and therefore due north, the full Moon lies just above the horizon and casts its yellowish light on the fringes of the nearby stratocumulus or altocumulus. The moonlight and the nearby clouds are reflected in the still waters. The mood is peaceful and undisturbed but the *Flight Into Egypt* is astronomically inconsistent. A full Moon always lies directly opposite the Sun. When the full Moon is in the north the Sun must be in the south. But at the latitude of Italy or even Germany, this can only happen at noon. It therefore should be broad daylight. If the full Moon had been placed properly in relation to the stars, we might have been able to determine the time of day and the day of the year. As it is, Elsheimer probably inserted the stars after the picture had been essentially completed and thus, we have no way of telling if it is shortly before sunrise or just after sunset. We know only that it is night.

But this is night with a new source of illumination. The *Flight into Egypt* derives much of its power from the lighting. Torchlight lifts The Holy Family from the background darkness while a fire blazes on the left and the Moon glows on the right. Elsheimer utilized the revolutionary lighting techniques that Caravaggio had recently introduced into Italian painting. A powerful new beacon had pierced the twilight and musty darkness of the 1500's to announce the imminent arrival of a new dawn. Perhaps this alone is enough to make the *Flight into Egypt* a fitting symbol of the transition from the troubled 16th to the enlightened 17th century.

CHAPTER 7
A MEASURED WORLD OF LIGHT AND MOTION

Other interests were luring Tycho Brahe from his true love, astronomy, when on 11 November 1572, he noticed a bright new star in the constellation, Cassiopeia. Tycho demonstrated that this fading supernova lay beyond the sphere of the Moon, and thus that changes could take place in the heavenly realm official dogma had reserved for the immutable stars.

The supernova changed Tycho's life and the course of Western thought as well. Rededicated to astronomy, Tycho spent the next 20 years building his observatory, Uraniborg, designing the most precise astronomical instruments of the time, and compiling the most accurate and detailed records of heavenly positions and motions to that point. On his deathbed, Tycho bequeathed these astronomical observations to Johannes Kepler with instructions to find the sense of order hidden in them. They were the raw data Kepler needed to formulate his laws of planetary motion.

Before Tycho's data could be used to obtain the laws of planetary motion, errors caused by the refraction of light in the atmosphere had to be eliminated. Kepler had the genius to treat this nuisance as one aspect of the more general problem of light transmission, and in a modestly titled treatise, the *Supplement to Witelo* (1604), laid the foundations of modern geometric optics. Here he obtained an approximation to the law of refraction, and provided the first satisfactory explanations of the optics of the eye, the camera obscura, and spectacles. Seven years later, in 1611, when asked to comment on Galileo's astronomical discoveries, Kepler expanded on his findings to explain the optics of telescopes and microscopes.

Tycho, Kepler and Galileo worked in a world increasingly devoted to obtaining the measure of all things. World maps appeared within a few years of the discovery of America, and cartographers such as Gerardus Mercator transformed them into pieces of art with sufficient accuracy to facilitate both commerce and further exploration. The scientific revolution followed on the heels of the period of exploration and mapping, and was accompanied by a profusion of new scientific instruments, which began to appear around the year 1600.

So, light and motion were scientifically betrothed in the presence of a newly mapped world and charted sky. The great scientists of the 17th century - Kepler, Galileo, Descartes, Newton, and Huygens - found that most of their important work revolved around the two issues of light and motion, and hinged on accurate measurements.

Artists were strongly affected by the triumphant discoveries of 17th century scientists and explorers. Paintings require effective means for representing light and motion, and, like maps, are two-dimensional transcriptions of three-dimensional scenes. The attentions of 17th century artists were redrawn to solving these problems anew. Their solution represented a new synthesis.

7.1 The Enlightened Dutch Overview

New artistic approaches to representing space, light and motion arose all over Europe in the 17th century, but it was in Holland, where the sky, an eternal symbol of human aspirations, rose to its greatest heights. How appropriate that the preeminent landscape invention of the century - the panoramic view under a spacious sky filled with noble clouds - was a home brew concocted in the open and newly freed fields of cosmopolitan Holland!

Holland's costly revolt against Spain

dragged on from the 16th century and continued with breaks until 1648. But after the defeat of the Spanish Armada in 1588, the seafaring Dutch began to prosper, while Spain's economy declined. By 1609, the threat of bankruptcy finally forced Spain to sue for a temporary cessation of hostilities.

The truce, which was essentially a public acknowledgement of Dutch sovereignty, ushered in a new age of prosperity and optimism. No longer were the Dutch compelled to conduct their affairs surreptitiously confined to tidal inlets and forests, or under cover of darkness. Now they were free to roam the high seas, reclaim and survey their own land, and paint their open skies in broad daylight.

As the Dutch ventured abroad their sea pilots began to map the world and its weather. They pieced together a good picture of the prevailing winds over the oceans and used that knowledge to commercial advantage. In 1611, Captain Hendrik Brouwer cut six months or 50% from the year-long route to the East Indies that hugged the east coast of Africa. After rounding the Cape of Good Hope, he used the prevailing westerly winds to sail due east for 4000 miles before turning north to reach the Spice Islands.

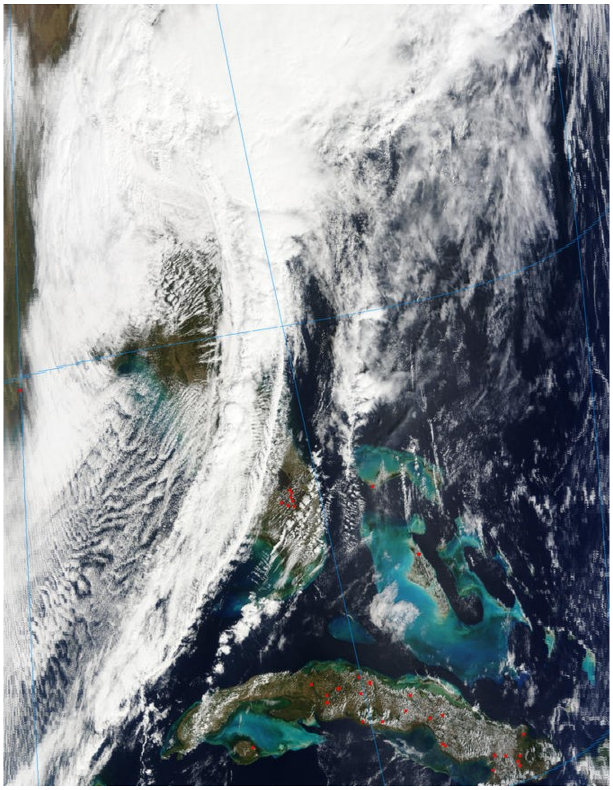
The Dutch also gained early glimmerings into the nature of storms. They learned that hurricanes are large moving whirlwinds, as Varenius indicated in his classic, *General Geography* (1650). They also knew the sky and weather conditions that attended and preceded extratropical cyclones (winter storms, Nor'Easters, or lows), although no one in the 17th century, except perhaps a few secretive sea pilots, had even the vaguest idea of their structure or indeed, of their very existence.

7.2 Weather and Clouds of Extratropical Cyclones

Extratropical cyclones remained unknown because of their large size, complex structure, and rapid motion and evolution. Nevertheless. the 17th century Dutch painters somewhat unwittingly began to reveal that they are organized cloud systems with both standard spatial patterns and temporal sequences (Figs. 5-10, 7-1, 7-2). Earlier artists, such as Jan van Eyck had applied knowledge of local sky conditions and implied weather forecasts in their paintings, but the 17th century Dutch (and Flemish) painters did so with such frequency and insight that their works can be compiled into an atlas of the skies and weather around extratropical cyclones. The likely approximate locations for many of the paintings in this chapter are shown by the numbers in Fig. 7-2.

The first step in the long task of discovering lows and deciphering their structure began in the 17th century when the necessary meteorological instruments were invented and calibrated (see §8.3). But a coordinated effort to collect and map simultaneous weather measurements at a number of locations was also needed and this proved to be a more difficult task. Descartes broke ground on this front also. He realized the need for taking simultaneous measurements and proposed doing so on 13 December 1647, in a letter sent to his friend, Marin Mersenne along with a barometer. In 1657, Ferdinand II of Tuscany actually established a weather observation network in Italy that operated for ten years. But no maps were constructed and no coherent picture of extratropical cyclones resulted from these efforts, which then lay dormant for another two centuries.

Only in the 19th century did a coherent picture of extratropical cyclones begin to emerge. Heinrich Wilhelm Brandes was apparently the first to construct weather maps to determine the geography and movement of storms. In 1820, Brandes published a few weeks of daily weather maps for the year, 1783! This work attracted so little attention that the idea of constructing weather maps had to be rediscovered once again in the United States around 1840.



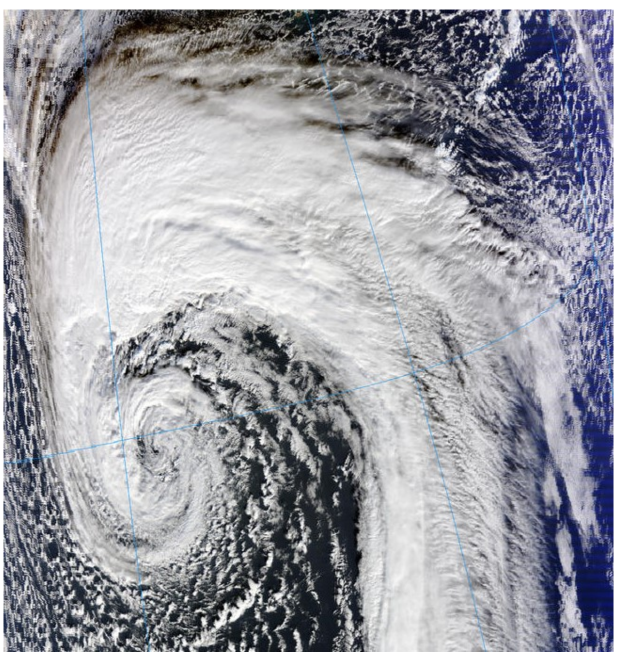


Fig. 7-1. **MODIS Satellite image of a mature extratropical cyclone (low) over the Eastern United States on 01 Mar 2009 (top) and a highly wrapped up (occluded) low over the North Central Pacific Ocean on 01 Jan 2014 (bottom).**

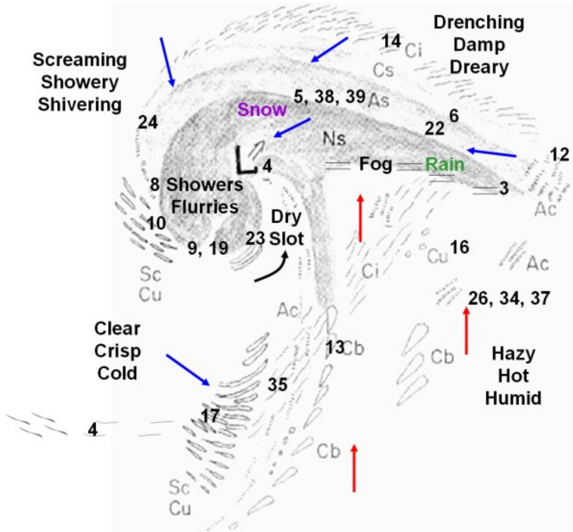


Fig. 7-2. Schematic view of a mature low with its wind, weather, and clouds in quadrants. Double arrow shows the direction of motion of the low. Ac = altocumulus, As = altostratus, Cb = cumulonimbus, Ci = cirrus, Cs = cirrostratus, Cu = cumulus, Ns = nimbostratus, Sc = stratocumulus. Figure numbers indicate likely approximate locations of paintings.

Weather maps finally came of age in the late 1840's, when the telegraph made it possible to construct maps using real-time data from Portland, Maine to New Orleans and from New York to St. Louis. Almost immediately, Benjamin Franklin's century-old proposal that lows move from west to east was confirmed by telegraph operators who noticed the eastward progress of weather-related transmission problems. Soon thereafter, several nations established weather services that produced daily weather maps and began the slow, arduous task of unraveling the structure and behavior of these cyclonic storms.

Meteorologists then began to assemble many of the pieces of the cyclone puzzle. They applied the laws of physics to explain air motions and precipitation processes. They deciphered the ground-level wind patterns and even obtained some idea of the winds aloft by combining physical principles with careful observations of the motions of higher clouds. They identified the typical patterns of weather and cloud types in relation to the cyclone.

They pointed out the existence of lines of discontinuity which we now identify as cold fronts and even began to incorporate these lines into their cyclone models.

The culmination of these efforts came in the 20th century with the conquest of the air and of space. In 1919, 21 year old Jacob Bjerknes proposed the frontal model of moving cyclones. Over the next few years, Jacob, together with several colleagues, continued to investigate the movement and life cycles of these storms and the associated cyclone wave patterns. In the 1930's routine use of instrumented balloons began to provide measurements for maps of temperature, humidity and wind above ground level.

The essentially modern, three-dimensional view of extratropical cyclones was largely completed by 1950 – a short time after a global network of upper air weather stations was established. But not until 1960, when TIROS, the first meteorological satellite was launched, were the magnificent extratropical cyclone vortices finally seen in their entirety and at all stages of their life cycle (Fig. 7-1). Since then, satellites have revealed additional features and phenomena associated with extratropical cyclones but have, for the most part, confirmed the outstanding detective work of earlier meteorologists.

Young and mature lows are asymmetric storms with standard cloud patterns that can be roughly divided into quadrants (Fig. 7-2). The NE quadrant contains the storm's main clouds and prolonged precipitation. This is the damp, dreary and drenching quadrant that earns lows their nickname as Nor'Easters because the wind blows from the NE. Warm air is confined to the SE quadrant, the warm sector. It is often hazy, hot and humid. Violent thunderstorms are possible, particularly near the SW quadrant. Crystal clear, crisp, dry and cold air dominates the SW quadrant, but showers are possible. The NW quadrant is essentially an extension of the SW quadrant in weak or young storms, but in intense or mature cyclones steady precipitation of the NE quadrant extends westward, and blustery, shivering, showery weather marks the storm's northwest fringe. Intense storms sometimes draw an anomalous warm, dry slot just to the west of the low center.

As the storm continues to spiral it wraps up into pinwheel form. The cold, dense air runs under much of the warm air and pinches or occludes it aloft. This severs the storm from its primary (potential) energy source, and the storm enters its dissipating or occluded stage. Many of the extratropical cyclones that reach the western shores of Europe and North America are these aged, occluded storms whose warm sectors lie far to the south.

So, geography clearly modifies storm structure. In winter the coldest and driest air is always located over polar lands. Therefore, in Holland, northwestern Europe and the west coast of the United States, the coldest air of winter is located in the NE quadrant where wind blows from the frigid landmasses to the northeast, while the air to the west is warmed as it passes over the ocean. In the central and eastern United States and East Asia, the coldest and driest air is located in the NW quadrant where the wind blows from the arctic wastes of Canada or Siberia to the north and northwest.

The character of each storm sector also changes somewhat with the seasons. In the warm sector, tropical air, which is often hazy and humid, moves up from the south. Morning fog, especially in autumn, and afternoon cumulus or cumulonimbus with thundershowers, especially in spring and summer, form in this air, while cirrus and altocumulus are common all year.

Poleward of the warm sector, the ground is covered by a huge dome of cold, dense polar air. When the tropical air encounters this dome, it slides over it and covers it with an extensive shield of stratiform clouds and precipitation, all the time slowly forcing the dome's edge back to form a warm front. Steam or frontal fog is common just poleward of the warm front as warm rain falls into the cooler air below. As the warm air moves poleward and ascends the dome it veers eastward and cools to produce a standard pattern of clouds and precipitation (Fig 7.2 shows a bird's eye view, Fig. 5-10, a panorama). Rain is located nearest to the warm front. Moving poleward we find in order, freezing rain, ice pellets and snow. As the warm air continues overrunning the dome, the low-based nimbostratus evolves into the progressively higher and thinner altostratus, cirrostratus and finally, cirrus, furthest poleward and east.

In the west half of the cyclone, cold, dry, sinking polar air advances across the ground. In the NW quadrant, some of this air passes under the western fringe of the cloud shield, which it lifts or sunders into rounded, shower producing clouds that resemble smooth cumulus while it increases visibility. In the SW quadrant, the weather is crisp and often clear. This allows a bright Sun to heat the ground vigorously and make puffs of heated air rise except in the dead of winter. If the air has acquired enough vapor afternoon cumulus or stratocumulus are common. Brisk W or NW winds often align these clouds into long parallel rows or streets. Such cloud streets are particularly common over Northwest Europe, where the polar air has just been charged with vapor from its passage over the North Sea or Baltic Sea, and also over the oceans just to the south and east of Greenland, Canada, the United States and China or Siberia.

The cold front extends southwest from the low center to mark the polar air's leading edge. Along the front the advancing cold air dome wedges the warm air aloft and, particularly on spring and summer afternoons, can produce lines of severe thunderstorms.

The jet stream flows directly over the low center and can produce long, aligned bands of altocumulus or cirrus that grace any openings in the sky. West of the cold front, in mostly crystalline skies, the altocumulus can display spectacular coronas or iridescence.

Lows seldom stay in place for long, but are steered by jet stream winds from west to east. Once the low moves, its pattern of wind, weather and clouds becomes a sequence at any fixed location that gives warning of weather changes. There are two standard sequences of weather that were recognized from ancient times, depending on whether the storm center passes to the north or to the south of the location. These sequences formed the basis for an arsenal of practical weather rules well known to 17th century Dutch sky painters.

Both sequences begin the same. Cirrus are the sentinels of the approaching low. They advance across the sky from the west followed by a lowering and thickening cloud mantle that grades almost imperceptibly to halo bearing cirrostratus, to altostratus with a watery Sun or Moon and finally, to nimbostratus. The entire sequence of clouds and precipitation typically lasts more than a day.

After this start, the cloud and weather sequence depends on whether the storm center passes by to the north or to the south of the location. If the storm has occluded or if its center passes to the south, so does the warm air. The weather then remains cold and snow is likely in winter. Finally, so long as no other storm is right behind, the storm sputters out and the sky clears fitfully. A fresh wind begins to gust from the north. For a few hours, ragged cloud shreds may race across the sky beneath a lifting overcast, or clearings may alternate with brief and sometimes intense showers or flurries. These clearings contain some of the deepest blue skies because the cold, dry air above the cloud deck is sinking and the air below has been swept clean of pollutants and purified by the fallen precipitation. Within hours, especially as the Sun goes down, the blast of cold, dry arctic air either drives the cloud remnants away or else evaporates them completely, revealing the limitless frigid blue firmament.

If the storm center passes by to the north of a point, so does the coldest air. Precipitation may begin as snow, but usually changes to rain. The cloud mantle gets progressively lower, sometimes reaching the ground as frontal fog. Then the warm front passes and southerly winds with rising temperatures and clearing skies follow.

In the warm sector's often hazy air, cirrus, altocumulus and cumulus are common. Some cumulus may grow into cumulonimbus – thunderstorms – that may be severe. Squall lines of thunderstorms may plow across the land, ensuring that every place gets a deluge. Eventually, perhaps with a final shower or thundershower, the cold front passes overhead. The wind begins to blow from the northwest, the air turns colder and drier, and the sky clears dramatically. Within hours, long bands of altocumulus or streamers of cirrus might whiz by in the jet stream overhead, while small cumulus sprout up in the limpid air.

7.3 The Dutch Weather and Cloud Atlas

The Dutch sky dawned cautiously, overcast, cold, and misty. In 1608, after one of the more memorable Dutch winters but still a year before the truce, Hendrick Avercamp revived the Dutch snow scene with *A Winter Snow Scene With Skaters Near a Castle* (Fig. 7-3). This is modeled directly after Bruegel's prototypes. It uses an elevated viewpoint from which we look down on snow-covered ground and frozen waterways. The narrow gauge view, high horizon line and restricted visibility focus attention on the goings on at ground level while diverting attention from the unlimited space in the sky above. Nevertheless, the mood is expansive for happy ice skaters swarm all over the place, as in virtually all Avercamp's works, and the cold but calm and misty sky just north of the warm front holds out hope of warmer weather, as Franz Ossing and Pieter Roelofs pointed out in *Avercamp's Skies*.

People in Holland were beginning to have fun again and expand their horizons. And as they did, their painters learned to turn their eyes skyward and depict more panoramic, wider angle views.

Fig. 7-3. Hendrick Avercamp. *A Winter Snow Scene With Skaters Near a Castle.* 1608. National Gallery, London.

In 1609, the year of freedom and one year after his *Winter Snow Scene With Skaters Near a Castle*, Avercamp painted a far more panoramic winter scene with a lower viewpoint and 50% sky. The panoramic viewpoint was introduced to Dutch art around 1603 by Hendrick Goltzius. Many of the views seem so photographic they suggest the use of or inspiration by the camera obscura. The Dutch showed off their low-lying land the way a person sees it - from ground level or perhaps from a sand dune. Looking across the largely open fields, only the steeples and towers of distant towns break the line of the horizon. And over this newly freed, precious land one monarch alone could claim dominion - the sky, attended by its royal court of clouds. Some Dutch painters increased the sky's domain so much that the land was confined to a narrow strip at the painting's bottom. This love of sky became so fashionable after midcentury that the Dutch 'updated' many older paintings by grafting an extra panel of sky to their tops.

Despite their aerial acrobatics, Dutch sky painters remained bound to the Earth by the dictates of their climate. Avercamp's paintings and the various Dutch winter scenes of the next sixty plus years serve as a reminder that the Little Ice Age had not gone away. Following both Bruegel and the climate of Western Europe, Dutch artists covered many of their winter skies with an almost uniform deck of stratus and frequently used either mist or a light snowfall to reduce visibility. In skating scenes yellow or pink highlights brightened the overcast, misty skies, transforming the stratus into its higher, thinner cousin, altostratus.

Whenever Europeans revived the snow scene they did so under cloudy and misty skies. By contrast, American and Canadian snow scenes painted by artists not encumbered by European influence often show deep blue skies with unlimited visibility. These choices are dictated by the prevailing climate, which quietly compels our aesthetics

East of the Rocky Mountains most snowstorms end with a dramatic clearing. Crisp, dry Arctic air sweeps down from northern Canada, and for several days the pure white snow sparkles under deep blue skies with almost unlimited visibility.

But in most of Western Europe and along North America's West Coast north of California extratropical cyclones do not come one at a time. Instead, they form links in a cyclone wave train. The cyclone wave train lies along a boundary known as the Polar Front that separates huge masses of tropical and polar air, and contains the temperature contrasts that drive both the cyclones and the jet stream. The individual cyclones are located at the northerly crests of the waves. Each forms a low pressure area about 1000 miles across, a gyre into which the winds spiral counterclockwise. As the air converges it rises to produce the clouds and precipitation associated with lows.

When a cyclone wave train passes overhead, misty, overcast skies of can become entrenched for two or three weeks. Each succeeding storm in the wave train can cloud the sky for several days and each follows closely upon the heels of its predecessor, moving along almost the same path or track. Clearings between storms are at best brief interludes in an otherwise interminable epoch of overcast. Only when the last storm in the wave train passes by does a cold front sweep through with westerly winds and clear the sky convincingly.

Esajas van de Velde's panoramic *View of Zierikzee* (Fig. 7-4) suggests such a dramatic clearing. The painting presents a view to the north as seen from the dredged river just south of the city. Two smoke plumes at far right reveal the clearing westerly surface wind. In *Dutch Landscape Painting of the 17th Century*, Wolfgang Stechow used this work to demonstrate van de Velde's compositional genius. Van de Velde created a small bank for the fishermen on the lower left while using the sky's 'ascending light streaks' to counteract the 'falling diagonal of the town silhouette'. But the ascending light streaks are long bands of jet stream cirrus blowing in from the northwest perhaps a day after a cold front. Unlimited visibility is also common after a cold front, and the air is apparently too dry for cumulus. The jet stream clouds have thus inserted the element of time into a work whose sense of quiet would otherwise have imparted a timeless, static quality.

Despite its increasing allegiance to the sky and its compositional precocity, the *View of Zierikzee* represents a meteorological dead end in Dutch art, for almost never did the Dutch allow high clouds to fly solo in a limpid sky. Shortly after the *View of Zierikzee*, clouds from the next storm on the Polar Front began to lower and thicken once again.

Interestingly, the cloud mantle set in soon after 1621 when the Spanish resumed hostilities, and did not clear out convincingly until shortly before the Peace of Westphalia (1648), which brought the Eighty Years War between the Dutch and Spanish to its official conclusion. Dutch painted skies from 1625 to 1643 are both meteorologically compelling documents and lyrical sublimations of the winds of war and skies of strife.

Fig. 7-4. Esajas van de Velde. *View of Zierikzee*. 1618. Dahlem Gallery, Berlin

Just as most battles of the protracted war were shunted to the fringe of Dutch soil, so the ever vigilant Dutch painters kept their skies at the fringe of the storm. The higher cloud layer remained in constant attendance although the Sun was sometimes allowed to thin it to a milky blue translucence. The air beneath the stratiform covering filled with a delicate mist that slightly reduced visibility but added greatly to the sky's earth tones. Low clouds invariably appeared in this humid air layer, but almost all of them had indistinct edges since they were engendered in mist and set against the gray or tan of the higher clouds, and were either produced by weakened sunlight or else caught in the process of evaporating. It was only after 1643, when the threat of invasion had largely evaporated, that the Dutch painters began to cleanse the sky and allow robust clouds to sprout up.

Every Dutch artist who painted the sky in this generation was conscripted to paint tonal skies and vapid clouds. Jan Porcellis may have led the pack with some earlier works but returned to the theme with a vengeance after 1625. Even Rembrandt kept his cloud edges indistinct despite the dramatic lighting of his skies. Hercules Seghers, whose landscapes served as models for Rembrandt, rendered clouds so tenuous that one good puff of dry air could dissipate them. But Segher's clouds are paradigms of solidity in comparison with the almost indiscernible nebulae of Isaac van Ostade, who specialized in tonal winter skies during a brief career. Jan van Goyen and Salomon van Ruysdael painted both winter and summer scenes, but for two decades could not clear their tonal skies at any season. Even the tropical summer sky was unable to arouse a true convective cloud in Dutch art during these years. Frans Post, who worked in northeast Brazil from 1637 to 1644, came home to graft vapid, high-latitude cumulus onto his near equatorial scenes.

As always, a firm physical foundation underlies good cloud paintings corralled by convention. Dissipating or slowly forming juvenile clouds often have such low droplet concentrations at their edges that the cloud boundary is not well defined (recall §4.3). During winter the Sun in Holland is too weak to rouse buoyant convective clouds with sharp edges. Instead, air radiates its heat away slowly, thereby producing misty clouds with indistinct edges.

The overcast generation was launched fittingly in 1625, when the Spanish took Breda and threatened Amsterdam. This represented the low water mark of Dutch fortunes and Pieter van Santvoort marked the occasion by painting the advancing storm in his *Landscape with a Road and Farmhouse* (Fig. 7-5).

Santvoort's *Landscape* is one of few paintings with two layers of stratiform clouds. Such broken lower layers of altostratus, stratus, or stratocumulus often appear beneath altostratus when precipitation is imminent or has begun aloft (Fig. 7-6). They form as discrete layers of humid, air slide upward. As the storm approaches the cloud layers tend to thicken, merge and lower to nimbostratus.

The lower attendant cloud layer constitutes one of three classical distinguishing features of altostratus. Before such layers appear the undersides of altostratus are often marked by striations or wavelike corrugations, as in Fig. 7-7. The corrugations are produced the same way as the ripples and rows of altocumulus, but with the clear gaps between the cloud elements filled in. They appear most striking when the air beneath cloud base is dry. Once rain or especially snow begins falling from the cloud base, and up to an hour before it reaches the ground, visibility is reduced and the cloud base assumes a smooth, often blurred appearance. It is usually around this time, when precipitation is imminent, that lower cloud layers appear in the moistened air.

Fig. 7-5. Pieter van Santvoort. *Landscape with a Road and Farmhouse*. 1625. Gemaldgalerei, Staatliche Museen Pruessischer Kulturbesitz, Berlin.

Fig. 7-6. Altostratus with watery sun above darker stratocumulus and darkened by shadows of Ci extending from upper left over Cliffside Park, NJ.

The third dramatic attendant feature of altostratus is the watery Sun or Moon. This glows like a dim light shining through ground glass, as in Fig. 7-6, but is a phenomenon few artists have ever captured. One exception is Nicolas Poussin's *Deluge* (Fig. 7-38).

A gleaming patch of sunlit ground stands out from darkly shaded surroundings in the *Landscape with a Road and Farmhouse*. Breaks in the cloud fields and openings in the woodlands allowed Dutch painters to draw patches of ground from the shadows with invisible shafts of sunlight. Artists had discovered that clouds cast shadows around 1500, when their clouds first grew large. El Greco had worked a miracle with this discovery in his *View of Toledo* (see Fig. 6-40), but it was the Dutch, who were more at home with partly sunlit ground, who learned to treat those two imposters, sunlight and shade, with equanimity.

Fig. 7-7. Altostratus with wavy, corrugated underside over City College of New York.

Since altostratus almost always covers the sky from end to end and is invariably too thick to allow sunbeams to reach the ground, the sunlit patch in Santvoort's *Landscape* is most likely a compositional feature. The painting is an exercise in both lighting and diagonals. The diagonal path and the field of tilted wheat that rise as they lead into the distance are brightly sunlit, while the falling diagonals of the distant rain streaks, the line marking the tree tops, and the matching edge of the lower cloud layer have been cast into a profound darkness.

Santvoort's *Landscape* is also an early exercise in tonality. The brown cloud layers echo the golden and brown wheat and dirt paths, while the trees are too deeply shaded to be green! Blue was a fleeting phantom in the skies of this overcast generation. Sky paintings became monochrome or tonal with yellows, tans and browns dominating. Convective clouds, with their pronounced lighting contrasts and corrugated edges, were largely suppressed or smoothed.

The master of earth tone skies with severely repressed convective clouds was Jan van Goyen. At first, I neither liked nor trusted van Goyen's skies because they lack the limpid air with pronounced cloud forms in a deep blue sky I had been trained to look for. But his skies are legitimate as I discovered much to my surprise when I walked out of Bruges' Groeninge Museum on a day of breaking clouds. As I looked up at the sky near the Sun before my eyes had grown accustomed to daylight, I learned in one blinding flash what Jan van Goyen is all about.

Jan van Goyen often faced the Sun on humid days and allowed its light to saturate his retina and flood the canvas. This viewpoint gives van Goyen's works their almost monochrome tan quality and helps blur the cloud outlines, even if van Goyen did overstate the earth tones and place the Sun off to the side. More than two centuries earlier, Robert Campin had shown that the sky is bleached or reddened and cloud forms are more difficult to distinguish amid the general glare in the vicinity of the Sun (see Figs. 5-18 and 5-19). Van Goyen built upon this knowledge by choosing humid days and either nascent or dissipating cloud fragments rather than robust cumulus. On humid days, aerosols become engorged with moisture and scatter more sunlight, further reddening the sky and blurring cloud outlines even more.

By the time Jan van Goyen came to paint his *View of the City of Arnhem from the NW* (Fig. 7-8) in 1643, the Spanish threat had withered, and peace negotiations began. Tonal colors still dominate this work. The ground is predominantly brown and the clouds are laced with yellow, but some pale blue sky has finally managed to filter through the mist and there are hints of convective activity.

The *View of the City of Arnhem* is a topographic work from which a weather forecast can be ventured. The painter shows the city from the area near Zypendaal Castle and an altitude of 60-70 meters above the city since the 93 m high tower of the St. Eusebius Church breaks the horizon line. The view faces up the northern branch of the Rhine River, while the Issel River flows into it in the right background but lies just out of sight in the distant left. The scarp on the horizon line marks the southern edge of a hill called the Hettenheuvel, about 15 miles ESE. The windmill faces NE, making that the most likely surface wind direction.

Fig. 7-8. Jan van Goyen. *View of the City of Arnhem from the NW*. 1643. Gemaldegalerei, Berlin-Dahlem.

The lighting on the clouds and shadows on the ground show that the Sun lies about 70º to the left, or north of east. This makes it early morning around the summer solstice.

The sky in the *View of the City of Arnhem from the NW* is often seen at the end of lows whose centers pass by to the south. The broken lower cloud layer has little vertical development and appears to be evaporating. Even the central turret has very smooth edges and a top that fades so gradually into the background sky it cannot last much longer. The pale, milky blue sky appears to be filled with a translucent veil of sun-weakening cirrostratus, seen more commonly when winter storms approach but also as they take their leave. Although the storm is departing, the NE wind and the morning setting create doubts about clearing. The NE wind shows that either the storm has not yet moved away or the outer fringe of the next storm in the cyclone wave train has already arrived. Furthermore, if the air at the edge of a storm does not sink vigorously, the Sun will revive a breaking stratocumulus layer and give a few more hours of renewed gloom. Van Goyen and the Dutch could not trust that years of war-torn overcast would end.

Fig. 7-9. Isaac van Ostade. *Frozen Ice Landscape with Carriages and Boats,* c. 1645. Gemäldegalerie, Berlin, Germany

It is even more difficult to distinguish clearing up from clouding over in the works of Isaac van Ostade. His *Frozen Ice Landscape with Carriages and Boats* (Fig. 7-9) contains his trademark mist (whether outdoors or indoors) and nebulous, stratiform clouds with smooth or indistinct edges. In all of Ostade's landscapes, no matter the season, the Sun's feeble light is too weak to rouse convective clouds, so cooling or warming by the relatively slow process of radiation prevails. But in the debate between clearing and clouding, we lean toward clearing because in the last landscapes of Isaac's short life the clouds are gone and only mist remains.

The titillating prospect of a definitive clearing drew closer with Aert van der Neer. His *Winter Landscape in a Snowstorm* (Fig. 7-10) is a textbook example of a showery sky at the western edge of a winter storm (Fig. 7-11). The snow that dots the canvas falls from one of several showers that comprise an evaporating layer of stratus. A seemingly opaque upper layer of altostratus appears to fill the gaps between the low clouds but still allows bright crepuscular rays to beam down from the left and alternate with dark fall streaks from snow showers near the horizon.

Fig. 7-10. Aert van der Neer. *Winter Landscape in a Snowstorm*. 1655-60. Private Collection.

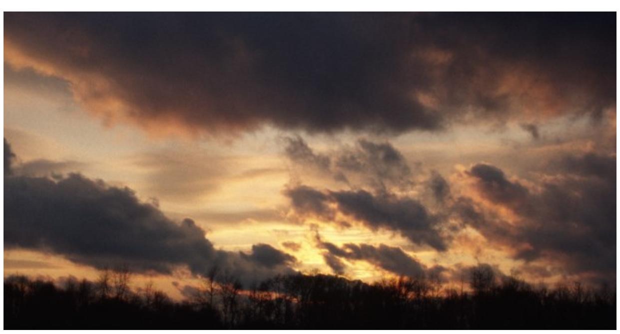


Fig. 7-11. Clouds at sunset as sky clears from a storm near Louisville, KY on 21 Jan 1995.

The crepuscular rays and shadows cast by the people at lower left provide the key to the forecast by fixing the painting's compass orientation. They point to a Sun high enough in Holland's winter sky for winter that the time must be just about noon despite the dark ground and pink highlights on the bases of the nearby stratocumulus. Since the Sun is in the south at noon the scene faces SW. Now the wind comes into play. The tilting trees show that a brisk wind is blowing from the right or NW, the classical direction of clearing.

Aert van der Neer even had a hard time clearing his night skies. Shreds of fractostratus below altocumulus or possibly cirrus appear in the *River by Moonlight* (Fig. 7-12). What may be the first painted moon pillar extends down from the full Moon about 5º above the horizon. Moon (and sun) pillars are halos produced when moonlight (sunlight) is reflected by plate or star-shaped ice crystals that tilt a few degrees from the horizontal (see §3.2).

Fig. 7-12.Aert van der Neer. *River by Moonlight*. c. 1645. Rijksmuseum.

Most Dutch sky painters experienced difficulties clearing their sky, but still managed to reveal some bright blue patches of sky by the time the Peace of Westphalia was signed.

Rembrandt van Rijn was one of the pioneers in clearing the Dutch sky. Even so, he began his landscape career steeped in fog and mist. Before 1630, he had learned to highlight foreground actions and relegate the background to darkness and obscuration with the most extreme form of chiaracscuro ever employed in Dutch art. This he first applied to the landscape in the *Abduction of Prosperine* (1632, Dahlem Galery, Berlin), with visibility so low that the foliage of the nearby trees is blurred. No one else would render such indistinct verdure until Watteau and Fragonard in the next century.

With such fog and luxuriant foliage,

Rembrandt carried Dutch art into the warm sector. There, the swelling cumulonimbus transforms light into a religious experience as it beams down onto a few select spots of land through aerial openings of blinding intensity, while the rest of the sky and Earth is cast into the almost Stygian gloom of an impending Deluge. In the *Landscape with a Stone Bridge* (Fig. 7-13), two trees near the bridge have been chosen as the blessed recipients of God's light in the midst of a world seemingly doomed to everlasting darkness.

Fig. 7-13. Rembrandt van Rijn. *Landscape with a Stone Bridge*. c. 1638. Rijksmuseum, Amsterdam.

Rembrandt's apocalyptic landscapes were all done in the mid to late 1630's. By 1640, Rembrandt admitted a few patches of blue, but only after the prospect of peace and a cold front washed war's storm and mist away did he clear the sky. The *Winter Landscape* (Fig. 7-14) is unique in Dutch sky art. Its deep blue sky, debuting over frozen ground, is streaked with cirrus, cirrostratus (and a hybrid form of altocumulus?), but not tainted by so much as one tiny cumulus, and visibility is unlimited.

Other Dutch artists used the warm sector weather of Italy to help clear Dutch skies. Herman van Swanevelt settled in Rome by 1629, where he specialized in hazy golden sunsets, and may have actually influenced Claude Lorrain. Jan Both, who lived and worked in Rome from 1638 to 1641 brought these placid sunsets back to Holland and helped popularize them among his countrymen.

A generation of Dutch painters arose who used Italianate skies whether or not they ever left Holland, even placing them above ice skating scenes on occasion. Several of the Italianate Dutch painters were wise enough to fleck patches of altocumulus across their sunrise or sunset skies. Nevertheless, few Dutch painters devoted anywhere near the measure of discriminating attention to the higher clouds that they lavished upon the cumulus or stratocumulus.

Fig. 7-14. Rembrandt van Rijn. *Winter Landscape*. 1646. Staatlische Gemaldegalerie, Kassel.

Cumulus rose to its greatest height in Dutch art soon after the sky cleared. Clouds full of motion and life tower overhead and splotch the sunlit ground with shadows. Sky color grades subtly from pale blue in the gaps between clouds near the horizon to a deeper blue in the gaps above. Clouds near the top of the paintings are shown from below while those nearer the horizon are displayed in profile. The percentage of sky blocked by cloud increases toward the horizon, where the oblique viewing angle makes it more likely to see the sides of adjacent clouds than the clear gaps between (Fig. 7-15).

Something is usually amiss in these tantalizingly real cumulus-filled Dutch skies.

Discrepancies between real and painted Dutch skies gradually surface and help expose Dutch sky art as a lure to naturalism deliberately infiltrated and permeated by a subtle world of artifice. The Dutch developed an arsenal of stylistic devices for treating cumulus, some of which acquired the status of law and constrained the skies of a generation of painters.

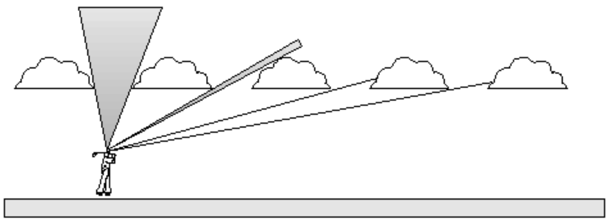


Fig. 7-15. Perspective showing the visible narrowing and eventual elimination of equal size cloud gaps near the horizon.

Fig. 7-16. Meindert Hobbema. *A Woodland Road*. c. 1670. Metropolitan Museum, New York.

The vast majority of later Dutch cumulus were displayed in their youth, with corrugated, swelling tops that contrast sharply with the color and brightness of the clear sky. George Siscoe pointed out that turrets of Dutch painted cumulus often appeared to diverge upward from some significant landmark such as a church spire in the same way exploding puffs of smoke erupt from a cannon blast. Many cumulus were designed to sprout upward in an almost arboreal manner plainly intended to mirror crowns of deciduous trees. This was a favorite trick of Meindert Hobbema, as in his *Woodland Road* (Fig. 7-16), where wind has tilted the central cumulus and tree.

A major aim of these devices was to disguise or block a view of the clouds' flat bases. The almost total censorship of the flat base of cumulus was the single most insidious Dutch cloud convention. After a few early portraits of flat based cumulus by Salomon van Ruysdael, the feature virtually disappeared from Dutch painted skies. Any excuse was used to justify the practice. If no nearby trees or buildings could be strategically located to offer their services, the irregular cloud fragments that 15th century Flemish artists had routinely exterminated could be resurrected on the spot to interpose themselves between the main cloud and the observer. In stormy scenes the clouds sometimes had no bases, and terminated at the ground or sea surface. When all else failed, as George Siscoe noted, the cloud base was stretched into a long, tapering 'tail' that merged inconspicuously with the distant cloud field, an artifice used repeatedly by the young Jacob van Ruisdael.

Why the Dutch purged the flat bases of cumulus and stratocumulus is a question I can only answer partially. Surely, the Protestant Dutch did not want to be associated with their Catholic Flemish predecessors, whose static view of cumulus required flat bases and excluded irregular cloud fragments. The Dutch also strove to emphasize the dynamism and almost infinite spaciousness of their skies, qualities apparently reinforced by swelling corrugated tops and cloud shreds, but seemingly denied by motionless flat bases. In a way, nature even seems to condone these associations, for in many dynamic skies, particularly those seen at the end of lows, the cloud puffs are tilted or even torn and the flat bases are inconspicuous or absent.

Jacob van Ruisdael was one of the artists who never painted a flat-based cumulus yet few artists have known the weather or the tricks for representing it as well. He depicted a variety of weather situations in all seasons with profound insight and sometimes revealed enough pertinent information for us to venture a weather forecast. He included several optical phenomena, painting a sun pillar in a winter scene and a double rainbow with the sky brighter below the primary bow in a storm at sea. He portrayed optically thick clouds such as active cumulus as solid bodies but duly noted that optically thin cloud shreds and dissipating stratocumulus are translucent. (Aelbert Cuyp failed to make this distinction and reduced his opaque cloudlets to personal signatures.)

Fig. 7-17. Jacob van Ruisdael. *View of Haarlem with Bleaching Grounds*. c. 1670-1675. Zurich, Kunsthaus.

Seldom was fact and artifice interwoven as masterfully as in van Ruisdael's *View of Haarlem with Bleaching Grounds* (Fig. 7-17). Its exuberantly convincing sky represents a profound meteorological document riddled with aerial improbabilities. The sky occupies more than 2/3 of the canvas. It has the slight purple tinge favored by Ruisdael and often seen west of lows in cool or cold air with a humid air layer near the ground. The gradation from a pale horizon sky to a much deeper blue above is also impeccable.

Three parallel cumulus cloud streets cross the sky diagonally from the left foreground to the distant right horizon. The furthest street hugs the horizon and is seen in profile while the nearest street towers overhead and is seen from below. The street occupying center stage consists of towering cumulus turrets that dwarf the city in the distance. The most impressive turret has been strategically placed exactly in the center of the sky. The turrets appear to diverge upward explosively from narrow focal points rather than broad bases (Fig. 7-18).

Fig. 7-18. A towering cumulus cloud street at Jacob Lake, AZ with a flat base partly hidden by trees.

The cloud streets remain faithful to the skies over Holland and reveal van Ruisdael as an unsurpassed artistic narrator of weather changes. The *View of Haarlem with Bleaching Grounds* shows a topographic view of the city as seen from the northwest. The horizon is dominated by the great Church of St. Bavo, which is oriented like a compass. Sunlight streams in from the right, striking the right half of the cloud turrets and the western face of the church but not its northern side. This places the Sun slightly south of west and sets the time as mid-afternoon, prime time for cumulus.

The cloud streets are aligned north-south. They are almost parallel to the northerly surface wind, shown by a single small smoke plume emanating from the chimney of a cottage on the left that is half hidden by trees. But the varied orientations of the windmills suggest a recent wind shift.

Cumulus cloud streets are produced as cool, moist air arrives from the North Sea, gets heated by contact with the sunlit ground of summer (also used for bleaching) and rises. In the name of efficiency, the helical wind pattern aligns the clouds in rows or streets parallel to the airflow (see Fig. 7-28a).

The *View of Haarlem with Bleaching Grounds* therefore takes place on a cool, brisk summer day with northerly winds probably a little less than 24 hours after a cold front has swept across Holland, clearing the skies in the wake of an extratropical cyclone. The cold front is probably some distance to the south because the cumulus are well developed and there are no high clouds.

But there is also design in the sky. There is little chance that the base of a long cloud street would exhibit profound curvature. Yet the base of the central cloud street dramatically sweeps upward on the left after hugging the horizon on the right. There is even less chance that nature would fit the edges of the cloud streets so perfectly as to leave a long, narrow clear corridor between the base of a nearby cloud street and the turrets of a more distant street. But there is no chance at all that any cloud shred extending across this corridor from the top of a more distant cloud could touch or block part of a nearby cloud base. Yet this is precisely what van Ruisdael did. A few shreds from the nearby cloud base just touch the right edge of the central turret while just to the right of St. Bavo's, an extension of the furthest cloud street obstructs the view of a piece of the darker base of the central street.

Van Ruisdael was highly original in his flirtations with the paradoxes of perspective. What was his purpose in these games? When he extended cloud threads improperly from the base of a nearby cumulus to the top of a more distant one, he wove the cloud matrix into an unending fabric that confused the ordered concepts of the intellect. Almost a century later, William Hogarth jokingly did much the same thing in his frontispiece, *Perspectival Absurdities*, to Joshua Kirby's, *Dr. Brook Taylor's Method of Perspective Made Easy* (1754), where nearby store signs and fishing rods extended deep into the landscape background. Two centuries after Hogarth, Maurits Escher brought the absurdities of perspective to their illogical conclusion with endlessly spiraling staircases and tumbling waterfalls. But while Escher and Hogarth blatantly challenged viewers to find the paradoxes inherent in representing three-dimensions on a flat surface, van Ruisdael's prescient skies quietly drug the critical faculties and lure you unwittingly into the imagined depths of the canvas.

Jan Vermeer's *View of Delft* uses a strip of golden beach to lure you into the distance (Fig. 7-19). This quiet work may represent the consummation of 17^{th} century Dutch sky painting, for it involves all the major issues of the time. Its dynamic sky is impeccable and contains an implicit forecast. It incorporates an up to date knowledge of optics. It is also a topographic work of the city.

The scene faces north, showing Delft from the Rotterdam Gate with almost photographic accuracy. Vermeer has even pinpointed the time of day. The clock on the central building shows it is 7:10, while the illumination and shadows show that the Sun lies behind and to the right, or in the SE, thus making it morning.

The large, smoothed, rounded cumulus of the *View of Delft* irked me for quite some time before it dawned on me that they are not cumulus! Rather, they are the disintegrating remnants of a deck of stratus, often seen at the western edge of lows. As the openings in the cloud deck are widened by evaporation, the pure blue sky above seems to pour through, sundering the cloud mass into large but separate elements.

The landscape appears unusually bright for good reason. The air is just about as pure and deep blue as it ever gets because it has recently been swept clean by rain and is sinking from on high. This makes the sunlight reaching the ground far brighter than usual so that everything it strikes is illuminated with an exceptional intensity. A close look even reveals glistening, almost microscopic dots that cling like recently fallen raindrops to the woodwork of the ship, the masonry of a number of the brick buildings, and in the nearby trees. This is the precise meteorological moment that Vermeer has captured.

Fig. 7-19. Johannes Vermeer. *View of Delft*. c. 1661. Mauritshuis, The Hague.

My colleague, Margaret Winslow, observed a similar clearing on Unga Island of Alaska's Shumagin Islands (a branch of the Aleutians) after four days of solid overcast (Fig. 7-20). The sky was deep blue and the clouds were rounded and smoothed, much as in the *View of Delft*.

Despite the similarities, there are profound differences between the photograph and the painting. Even though the tundra on Unga Island is bathed in direct sunlight it still seems quite dark. In photographs, especially those facing the Sun, the sky is so much brighter than the land that the land appears black. Except near sunrise or sunset, cool tones dominate the skies of most photographs. By contrast, in most landscape paintings, no matter how much space is devoted to the sky, the artist imposes a neutral density filter, distributing light more equably between air and land. Painters also apply generous quantities of the warmer colors - pinks, yellows, light greens and earth tones - to the foreground objects and even to the sky.

Fig. 7-20. Fractostratus of clearing skies on Unga Island. Margaret Winslow, Photographer.

It was by comparing the *View of Delft* to my sky photographs that I first learned that it is aesthetically pleasing to include some bright, warmly colored sunlit objects in the foreground to counterbalance the brilliant blue and white of the sky when photographing the landscape. In the *View of Delft*, Vermeer did this by giving the nearby beach and buildings a golden glow that keeps the cool sky in check. He even warmed the shaded sides of the clouds with an extra dose of earth tones. The shaded sides of low clouds do reflect light of the ground (see Fig. 11-18) but Vermeer overdid the earth tones. Landscape painting is a most subtle and delicious artifice.

Everything in the *View of Delft* contributes to the morning's brightness. Not only do the buildings around the Nieuekerke gleam in the light of a bright shaft of sunlight, but even the part of town cast into shadow has a suffused glow. A final glitter is added by the few leftover sparkling drops of rain. No painting could have better conveyed the reigning Dutch spirit of light.

Although Holland played a leading role in this dynamic century of light, the foundations for the times can be traced to Italy, where scientists and artists began experimenting with optical instruments such as the camera obscura in the 16th century.

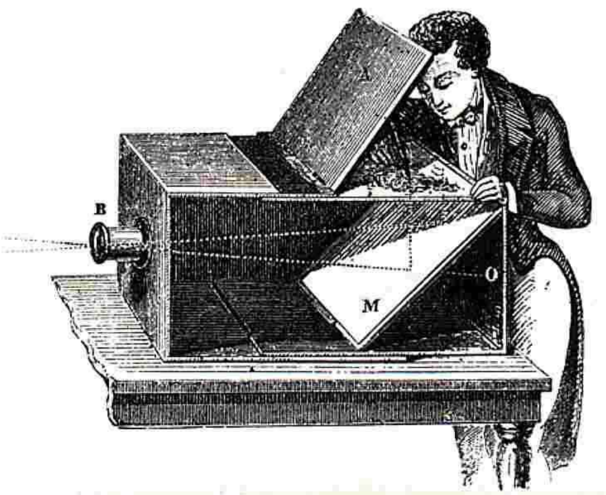


Fig. 7-21. Model of a camera obscura.

The camera obscura, or dark room (Fig. 7-21), is the direct predecessor of the camera. Its principle was described by Mozi in China (c. 400 BCE) and by Aristotle. During the Middle Ages the Arabs worked with it and it was a plaything of Chinese artists by the 11th century. It was known to artists by the middle of the 16th century. It may have played a far greater role in the mastery of realistic depiction of scenery than we suspect.

The camera obscura consists of a closed box with a narrow opening, often equipped with a lens. Light from the outside passes through the opening and strikes the far side of the box, where it produces an image of the scene outside. In early versions, the camera obscura really was a room or tent, and an artist standing inside would trace the image of the scene on paper. Later versions were typically boxes equipped with a mirror to reflect the image upward to a transparent plate on which the artists could trace the outlines of the scenes.

Around 1510, Leonardo da Vinci compared the camera obscura to the human eye and may even have placed a spherical lens at the opening. Descriptions of glass lenses used for the camera obscura were given by Maurolico in 1521 (not published until 1611), Geronimo Cardano in 1551, Daniello Barbero in 1568 and Giovanni Battista della Porta in 1589. In his *Magia Naturalis*, della Porta even anticipated the telescope and microscope when he wrote,

> With the concave lens you can see distant objects as small but distinct, with the convex lens you…can see near objects bigger but not well defined; if you know how to combine properly these types…of lenses you will be able to see distinctly and enlarged both near and distant objects.

Della Porta later used this quote as evidence that he had invented the telescope, but the Dutch seem to have brought the ideas to fruition, making the first known telescopes and microscopes. It was news from Holland in 1608 of Hans Lippershey's telescopes that first focused Galileo's attention on the instrument. Ironically, Lippershey failed to obtain a patent for his telescope since the Dutch government argued the instrument was already well known.

The Dutch fascination with light and lenses led Willebrord Snel van Royen to his discovery of the law of refraction in 1621. Seven years later the other claimant to the law of refraction, Rene Descartes, moved to the Netherlands where he could have freedom and quiet amid the bustle. There he worked out his explanation of the rainbow. Christian Huygens, a contemporary of Newton, proposed the wave theory of light and gave good reasons for it. And in Delft, Anton van Leeuwenhoek devoted much of his long life to revealing new worlds seen through a microscope.

How did these discoveries and inventions about light influence Vermeer? The artistic possibilities of the camera obscura were rapturously praised by Constantijn Huygens and were familiar to 17th century Dutch draftsmen and painters. Even Kepler, who designed a camera obscura to observe eclipses, was inspired to use the device to trace the outlines of a few buildings.

All Holland was touched by them but Vermeer had an inside line. Leeuwenhoek was his neighbor, friend, and even executor of his will. Vermeer had the opportunity of looking into his friend's newly revealed world. It may be that Leeuwenhoek designed a camera obscura complete with lenses for Vermeer.

Did Vermeer use a camera obscura to create the *View of Delft*? There is not a single document on the matter, but there are compelling reasons to believe he (as well as many of his contemporaries) did. To begin with, the *View of Delft* stands apart from Vermeer's other known paintings and it would indeed be remarkable for anyone to achieve such immediate command of landscape art unaided. There is also some evidence of a technical nature. The tiny sparkling dots of light I somewhat facetiously attributed to raindrops correspond closely to so-called circles of confusion that form around highlights of unfocused images seen through the camera obscura.

After Vermeer's paean to light the wellspring of Dutch innovation in sky painting took a decided turn to bleaker prospects. The Dutch were still rich, even richer than before, but Holland's youthful adventure was coming to an end. France was sniping at her from the land and England was clipping her wings on the high seas. More and more, the Little Ice Age's wintry gloom occupied Dutch thoughts while the British toasted their growing fortunes with frost fairs on the frozen Thames River.

Holland awoke to find that her cloudy, wintry skies were no longer a source of gaiety in any season. In 1672, the year France invaded Holland, Gerrit Berkheyde, the "sober poet of the town view" according to Stechow, painted at least two topographic views of the *Bocht van de Herengracht, Amsterdam* (Fig. 7-22) facing SE at the Nieuwe Spiegelstraat. Berkheyde's earlier view of the Bocht at the Golden Bend has a bright sky but the sky in Fig. 7-22 is a subdued gray streaked with a thin, broken layer of altostratus reflected in the canal water below. Even though the weak afternoon Sun illuminates the south and west-facing sides of the buildings, the joyless sky seems overcast.

Fig. 7-22. Gerrit Berkheyde. *Bocht van de Herengracht, Amsterdam*. 1672. Rijksmuseum.

Even if altostratus remains sterile it often foretells the next winter storm blast. In 1672, the year of Berkheyde's altostratus, French armies, coveting Dutch soil, blasted their way across the low-lying countryside. The Dutch responded in desperation by opening the dikes and allowing the sea to reclaim their hard-won efforts. This did succeed in sending the French scurrying back home but it helped darken the buoyant spirit of Holland

This new gloomy side to the Dutch spirit was captured with poignant accuracy in a number of Jacob van Ruisdael's winter scenes. Several of these scenes are dimly lit by the feeble winter Sun and have dark, almost brown skies and clouds. Van Ruisdael's *Winter Landscape* (Fig. 7-23) has been cited as evidence of a turn to more sinister prospects.

> There is no trace here of the traditional gaiety of Avercamp's or even van Goyen's and van der…Neer's scenes nor of the lyrical elegance of van de

Cappelle's; it would be altogether absurd to…think of skaters before this picture; the real topic is the forlorn, tragic mood of a winter day, of nature in shackles.

Wolfgang Stechow. *Dutch Landscape Painting of the 17th Century*. p 97.

Fig. 7-23. Jacob van Ruisdael. *Winter Landscape*. c. 1667. Amsterdam, Rijksmuseum.

The *Winter Landscape* does seem to convey an impression of bleak meteorological prospects. The ground is covered with dirty snow. In the perpetual dusk, the sky is no longer blue but is too washed out and dirty to be golden or rosy. The feeble Sun, like a dying ember, is barely able to pierce a thin, translucent veil of altostratus or cirrostratus and is certainly too weak to lift cumulus clouds. In their place, black stratocumulus cloud streets darken the dull sky even further.

But with van Ruisdael there is always some meteorological ambiguity. The smoke plume tilts away from the winter Sun to suggest that a south wind has sprung up to combat winter's relentless grip.

Van Ruisdael's *A Winter Scene* (c. 1670, Philadelphia Museum of Art) also contains evidence of warming and was, in fact, the first painting ever subjected to a detailed meteorological analysis. The analyst was none other than John Constable, who greatly admired van Ruisdael and who argued in his *Lectures on Landscape* (1836) that *A Winter Scene* represents a faithful transcription of a typical winter weather sequence - the warming we now identify as a warm front passage.

This picture represents an approaching thaw. The ground is covered with snow, and the trees are still white; but there are two windmills near the centre; the one has the sails furled, and is turned in the position from which the wind blew when the mill left off work [toward the east]; the other has the canvas on the poles, and is turned another way, which indicates a change in the wind. The clouds are opening in that direction, which appears by the glow in the sky to be the south (the Sun's winter habitation in our hemisphere), and this change will produce a thaw before the morning.

Fig. 7-24. Jacob van Ruisdael. *Winter Landscape with Two Windmills*, c. 1675, Private Collection

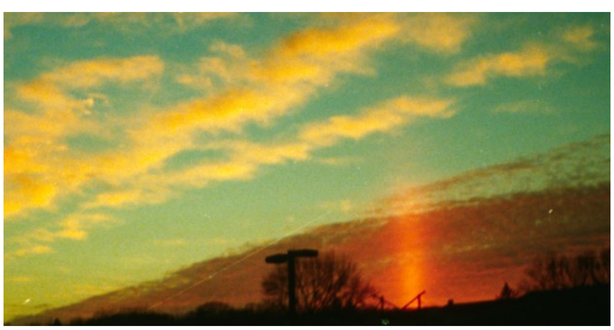


Fig. 7-25. Sun pillar in altocumulus at sunset. Suffern, NY. Sandra Rosenberg, photographer.

Several other of van Ruisdael's winter scenes are also amenable to meteorological analysis. One of these, the *Winter Landscape with Two Windmills* (Fig. 7-24), contains a sun pillar. (Constable, the inspired analyst, also painted one!) This beams up from a dim Sun penetrating a veil of cirrostratus and a gap in stratocumulus near the horizon.

It is surprising to see sun pillars associated with altocumulus or stratocumulus (but recall Fig. 7-12), which usually consist of droplets. But when the cloud temperature is about -15°C enough classical snow crystals can form, grow, and fall from these clouds to produce sun pillars (Fig. 7-25).

Thus the evidence of Ruisdael's *Winter Landscape with Two Windmills*, namely, the sun pillar, the clouds, and the windmills facing NE all strongly suggest frigid conditions will continue since the coldest air in the Dutch winter comes from the NE (Russia) and an approaching winter storm with yet another blanket of snow is likely.

Despite the pillar of hope, the dark skies of van Ruisdael's winter scenes testify that the Little Ice Age had finally become serious business. Note that the people on the ice in Fig. 7-24 are not skating for fun but ice fishing for food. All in all, these scenes make it seem that the moody darkness of Rembrandt had become a physical presence to snuff out the candle of innovation in Holland.

7.4 Pastoral Restraint and Beauty

Gloomy thoughts also prevented Don Quixote from rousing himself from his deathbed and leading Sancho Panza to a new life as shepherds.

The Arcadian ideal was all the rage in early 17th century Europe. Stories about the love between shepherds and their maidens were second in popularity only to the adventures of knights and their ladies. Renaissance Europe had helped to give form to these romances. It had paid homage to the classical cultures and had begun to unearth ancient Greek and Roman art treasures. The European countryside had also been tamed and no longer housed the terrors of the wilds.

In 1635, toward the end of his full life, Peter Paul Rubens purchased the Het Steen, a country estate near Antwerp. There he could live and work in a pastoral setting, removed from the city's ceaseless clamor. He must have loved that place dearly for it forms the setting of one of the great sky paintings, the *Autumn Landscape with a view of Het Steen in the Early Morning* (Fig. 7-26).

Fig. 7-26. Peter Paul Rubens. *Autumn Landscape with a View of Het Steen in the Early Morning*. c. 1636. National Gallery, London. (Detail of the sky.)

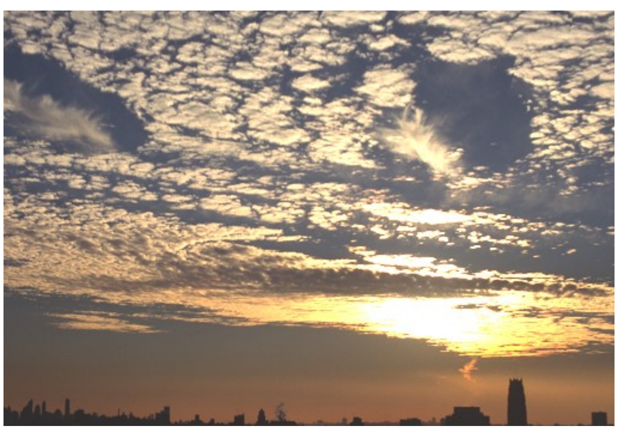


Fig. 7-27. A mackerel sky of cellular altocumulus over NYC shortly before sunset. Ice crystals formed and grew in the midst of the water droplet cloud and fell out, leaving two fallstreak holes.

The right side of the sky is filled with almost textbook cellular altocumulus – the so-called mackerel sky (Fig. 7-27). The near dawn setting is appropriate, for sunrise and sunset are the times when altocumulus and cirrocumulus are most common and most breathtaking. These clouds often form near the top of humid air layers that have cooled by radiation (recall §5.2). When the Sun is high in the sky, such high thin clouds, like fog, tend to 'burn off'.

The altocumulus of Fig. 7-27 has two cirrus fallstreak holes. This is a mostly modern phenomenon, almost exclusively produced by planes passing through clouds of supercooled ($T < 0°C$) droplets. The resulting ice particles then grow and fall from the cloud. (I do not know of any painting with fallstreak holes.)

Closely packed hexagonal cells (recall Fig. 5-15 and Fig. 5-16) dominate only when the wind has no vertical shear. Shear orients the cells into ranks and rows, or wavelike ripples. When convection dominates, as is often the case in cold air outbreaks, helical motions align the clouds into long rows, bands, or streets that tend to parallel the shear (Fig. 7-28a and recall Figs. 5-29 and 5-30). When shear dominates, wave motions relocate cloud elements to the crests. The clouds then line up in rows or ripples perpendicular to the shear (Fig. 7-28b).

Sometimes the atmosphere supports two or more trains of waves that cross each other. These cloudy wave trains occur when there are two layers with distinct wind shear. The air motions at cloud level are then a superposition of the individual motions of the two wave trains and the cloud elements assume the checkerboard appearance of Fig. 7-28c.

Finally, there are times that the shear is so great the waves become unstable (Kelvin-Helmholtz instability). The waves amplify, curl over and break like ocean waves, as in Fig. 7-28d. Capturing clouds at the fleeting moment of breaking is a rare privilege.

Variations of the cells, streets and waves are innumerable. Yet for another 200 years, most artists would remain almost blind to the possibilities of altocumulus. Then, suddenly, and shortly after the invention of the camera, altocumulus attained a pinnacle of popularity. We will meet them again in Chapter 9.

Fig. 7-28 a. Helical airflow in cumulus cloud streets. b. Wavy airflow in banded altocumulus. c. Two wave trains crossing in altocumulus. d. Kelvin-Helmholtz breaking waves.

Fig. 7-29 Jan Siberechts. *Landscape with Rainbow: Henley-on-Thames.* c. 1690. Tate Gallery, London.

Fig. 7-30. Henley-on-Thames seen from the NE.

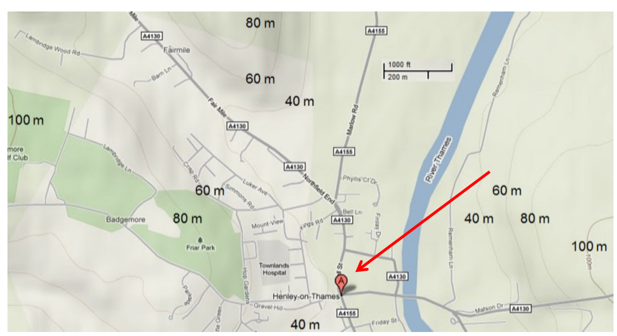


Fig. 7-31. Topographic map of Henley-on-Thames. Red arrow shows Siberecht's viewpoint.

Artists never neglected cumulus. In at least two paintings, Jan Siberechts allowed cumulus to tower and produce rainbows. His *Landscape with Rainbow: Henley-on-Thames* (Fig. 7-29) is a more-or-less topographical panorama of the town seen from the northeast. Comparing the painting with photographs (Fig. 7-30) and a topographic map (Fig. 7-31) shows that Siberechts greatly magnified the hill, whose relief is only about 75 m from river to summit. He also added a tributary to the Thames.

In the painting, the east face of St. Mary's Church is illuminated while the north face lies in shadow. This plus the location of the almost vertical rainbow arcs show that the Sun is just south of east and almost at the horizon and so, has just risen. The Sun rises south of east between the Autumnal Equinox (≈ Sept. 21) and the Vernal Equinox (≈ March 21). Combining this with the observation that the trees in the painting are in full leaf indicates that the season is early autumn. Furthermore, given that weather systems almost always move from west to east outside the tropics means that the storm is approaching. Showers are far more common in the afternoon, but are quite possible in the morning.

A few features of the rainbows show that the artist certainly observed them. The bows stand out brightly against the dark background. The secondary bow extends a bit into the hill, indicating that the shower is quite close. The spacing between the two bows is also reasonably accurate

Still, there are two problems with the rainbows. First, Siberechts failed to show that the sky is darkest between the two bows and brightest inside the primary bow. The bows were simply painted over the uniformly dark background sky. The second error is even more glaring. In nature, the primary bow is always brighter and more colorful than the secondary bow, but Siberechts made his secondary bow brighter.

Fig. 7-32. Peter Paul Rubens. *Rainbow Landscape* c. 1636. Wallace Collection.

One of the most prolific rainbow painters was Peter Paul Rubens. Most of the bows in his commissioned paintings were ugly grafts included because of symbolic associations.

Rubens showed more tender care to rainbows in his landscape paintings, as in the *Rainbow Landscape* (Fig. 7-32), which includes a double bow and even a spot of a reflected bow in the stream to the right of the herdsman. But Rubens did commit a number of errors. He made the primary bow wider on the right hand side where the shower is closer to the viewer. But the rainbow's angular width is independent of its distance. Thus, it appears that Rubens allowed a preconception regarding perspective to overrule the imprecise memory of a fleeting observation.

In *Modern Painters*, John Ruskin took a few more swipes at this bow before excusing the errors as a sacrifice of a 'truth of actuality' to a 'truth of feeling'. He noted that the light incorrectly comes from the side. But when he criticized Rubens for making the blue part of the bow too dark, he missed the mark. The dark blue band, as George Siscoe has pointed out, is the narrow gap between the primary and supernumerary bows. This is confirmed in Fig. 7-33 and Fig. 6-18 for small raindrops.

Fig. 7-33. Supernumerary rainbow with faint secondary. Wrangell-St. Elias Park. Eric Rolph, Photographer

Fig. 7-34. Peter Paul Rubens and Pieter Snayers. *Henry IV at the Battle of Arques*. 1628-30. Alte Pinakothek, Munich.

Alistair Fraser has shown that the slight flattening of falling raindrops tends to make supernumerary bows brightest near the top of the rainbow arc, precisely where Rubens located his supernumerary. Thus, despite any rainbow errors, the *Rainbow Landscape* betrays the eye of a remarkable observer, and is just about the only painting of a supernumerary until the 20th century.

Rainbows are often produced by thunderstorms. One of art's few anvil topped cumulonimbus appears in *Henry IV at the Battle of Arques*, Fig. 7-34. The anvil is small and no rain falls from the flat base, but Rubens, who most likely painted the sky (Pieter Snayers specialized in battle scenes) surely saw it for it cannot be the product of any “random felicity of invention”.

Neither can the early morning scene Rubens captured in the *Landscape with a Bird Catcher* (Fig. 7-35). Thick tendrils of steam fog rise from the stream. The fog reduces visibility so much that it almost blots out the dim orange Sun just above the horizon and the nearby church. A strong wind from the left tilts the fog, bends trees, and fills the sails of the windmill. How can we tell the time is shortly after dawn? Steam fog (also called arctic sea smoke) forms when frigid air pours over much warmer water and gets charged with vapor. It is therefore most common by far at dawn, the coldest time of day and on days of cold air outbreaks with brisk northerly winds that follow periods of unseasonably warm weather. (as in Fig. 7-36, a frigid December morning in New York City when temperature fell from +16°C the afternoon before to -12°C). Indeed, a dawn setting makes meteorological sense. Then, the painting faces the rising Sun (east) making the wind from the left a north wind. Finally, the season cannot be late in the fall, because the deciduous trees are still in full leaf.

Fig. 7-35. Peter Paul Rubens. *Landscape with a Bird Catcher*. c. 1635. Louvre, Paris.

Fig. 7-36. Steam fog over the Hudson River on the morning of a cold outbreak.

Rubens' small elegy to steam fog is doubly extraordinary. European painters have long treated mist and smoke but with few exceptions such as the sylvan fogs of Rubens' Flemish compatriots, Conixloo, Vinckboons, and Jan Bruegel (*The Way to Market*, Kunsthistorisches Museum, Vienna), have seemed largely oblivious to the glories of fog until Friedrich and Turner resurrected fog in the 19th century.

Virtually no other artist until the 19th century exhibited such a sensitivity to the varied moods of the weather as Rubens. Since only a tantalizing glimpse of the output of many early artists remains, it is possible some portrayed a wider range of weather situations than we are aware of. But most artists appear to have been content to find some method for treating the sky, which they then stuck to for the remainder of their careers. This holds true for some of the greatest artists, including Titian who painted more or less the same skies over and over. Even Jan van Eyck seemed to grow satisfied with his idealized cumulus and, after a certain point, no longer looked to the sky for further inspiration. Rubens was one of the few who never stopped seeking new aerial discoveries.

Claude Gelee or Lorrain may also never have stopped looking at the sky, but he looked primarily for one thing. No artist has contributed more to picturing the Arcadian ideal than Claude, and he did so with almost inconceivably beautiful atmospheres. I have loved Claude's works from the first moment I saw them, long before I 'knew' anything about art. His popularity among the viewing public has never faded. Claude has not always been praised by art critics, but landscape artists seem to have held him in awe. Adulation of his art peaked in the 19th century when nature was romanticized. Who could say more on Claude's behalf than Goethe did?

> There for once you see a human being of perfection. His thinking and feeling were concerned with beauty. He saw a

> world with his inner eyes as is not readily encountered elsewhere outside. His pictures are of the highest truth yet contain no trace of actuality. Claude Lorrain knew the real world by heart, down to its minutest details. He utilized it as a means of expressing the harmonious universe of his soul.

Ruskin chided Lorrain for his repetitiveness and his restriction to tame waves and tame skies but begrudgingly admitted, "His aerial effects are unequalled". Ruskin was compelled to praise Claude - after all, Ruskin's idol, J. M. W. Turner, admired and competed with Claude.

Claude's *The Disembarkation of Cleopatra at Tarsus* (Fig. 7-37) contains the same general features as many of his other works. The time is most likely sunset, when golden and pink overtones enrich the moisture charged, hazy summer air and tinge the fringes of the clouds. The Sun often appears in these works, glowing richly but careful never to glare. Claude's clouds are almost always the fragmentary dissolving cumulus, stratocumulus or altocumulus of late afternoon whose structured form is purposely deemphasized. After all, isn't it the nature of clouds to be soft? These soft clouds seem to be on the verge of disappearing and so, contribute to the dreamlike mood in many of his works.

The mood of Claude's works may be termed 'classical nostalgic'. Most of the landscapes with the exception of his port scenes are sparsely populated with widely spaced structures. Claude and his fellow countryman, Nicolas Poussin tried to recreate and idealize the classical world in their paintings. Both lived in Rome (amidst a community of Italianate painters), never wishing to return to their native France. The city they were familiar with was much smaller than the hectic metropolis it once had been in Roman times. The ruins stood here and there, spaced widely and out of the mainstream of all the 17th century action. Judging from these ruins, one would have thought the classical civilizations were built by societies of enlightened villagers living in benignly ordered countryside settings where nature knew her bounds and rarely, if ever tried to exceed them. What urban prisoner, subjected daily to an atmosphere of coal dust, would not wish to enter these landscapes and live there forever?

So, Claude cheated! And he cheated more than a little. The sky can certainly be every bit as beautiful as Claude has shown it but even his greatest admirers knew somehow that Claude had cheated in his landscapes. That is why it became a fashion among the French nobility to walk around viewing the world with a darkened convex mirror known as 'Claude glass'. Edgar Allen Poe, who also knew that Claude had cheated, noted that, "No such paradises are to be found as have glowed on the canvas of Claude".

Fig. 7-37. Claude Gelee. *The Disembarkation of Cleopatra at Tarsus*. 1642. Louvre, Paris.

What is the key to Claude's fraud? In nature the possible range of light intensity is enormous. Direct sunlight is thousands of times brighter than dark soil in the shade of a tree, and the directly illuminated sides of objects are tens of times brighter than their shaded sides. The ability to record such ranges of light intensity has not been granted to painters because of the nature of the materials they must work with. Paintings are seen by reflecting light only. They all appear pitch black in a darkened room. The darkest color paints will reflect nearly 5% of the light that falls on them while the lightest reflects about 95%. Thus the greatest possible range of intensities for a painting is about a factor of 20.

So painters work within a restricted world and must make the best of it. But Claude purposely restricted this world even further. If you take a photograph facing the setting Sun, all other objects will appear black. The human eye is partially able to adjust by viewing the landscape piecemeal. When we focus on the sunlit sky our pupils contract. An instant later we look at the shaded sides of objects and our pupils quickly dilate to allow more light in. But when we look at a painting, we take it all in at once. Somehow, Claude knew he had to provide his sunset scenes with double vision and so he illuminated the shaded sides of the buildings far more than they should have been. They tend to appear rather as the sunlit sides of buildings that reflect the golden and pinkish light of the late afternoon. Claude has not given us the truth, but rather the truths of light. He was not the first to do this – look back at Giovanni Bellini's *Agony in the Garden* (Fig. 5-48) - but no one did it better.

Nicolas Poussin, Claude's fellow expatriate in Rome, cheated even more when it came to the sky yet Poussin has been called one of the greatest landscape painters. According to Bonaventure d'Argonne,

> One day I asked him how he had attained this degree of perfection, which had won him so high a rank among the great painters of Italy. He answered modestly: "I have neglected nothing".

But Poussin sorely neglected the sky, which routinely refused to conform to his classically ordered world. Only the cloud-dimmed watery Sun of his *Deluge*, the ominous winter scene of his *Four Seasons* (Fig. 7-38) gives a hint of greater atmospheric possibilities.

The great contrast between the 'soft' Claude and the 'harsh' Poussin, pointed out repeatedly for over three centuries, shows up in their skies. Poussin's skies have high visibility but often a leaden blue color. His cumulus look all too solid (they are often used as platforms for mythological figures) and lack the detailed scalloping and shading that might have made them convincing.

Fig. 7-38. Nicolas Poussin. *Deluge*. c. 1662, Louvre, Paris

Far more convincing skies and humble human scenes were portrayed by another Frenchman, Louis Le Nain. Louis and his two brothers offer us some of the rare glimpses of peasants before the French Revolution and perhaps the first done without mockery. Peasants have been shown at work in the fields from the time of the *Tres Riches Heures* of the Limbourg brothers, but were always depicted as ugly, gross caricatures. Bruegel moved among the peasants but remained above them, often showing them as crude and even laughable. But the emergence of the Arcadian ideal in the 17th century allowed Louis Le Nain to portray his 'shepherds' with a human touch amid their sober natural setting.

Louis Le Nain was obviously not carried away by classical idealism. Sunny Italy was not the fount of his inspiration, as can be seen from his *Landscape With Peasants* (Fig. 7-39). The sky is overcast, not with raging storm clouds but with delicately striated, sobering altostratus that often deck the skies of northwest Europe. Altostratus is seldom dramatic, and that may account for why it has been so underrepresented in art. But altostratus illuminated and shaded the labors, leisure and lovemaking of real Flemings and Frenchmen, and there is love in the *Landscape With Peasants*.

Fig. 7-39. Louis Le Nain. *Landscape With Peasants*. c. 1640. Washington, DC, National Gallery of Art, Samuel Kress Collection.

The Le Nains came from Laon, near Belgium, where altostratus is a way of life. Only a person brought up where the sky is so frequently gray could have rendered such clouds so lovingly. It is crucial to observe that despite the overcast a rich, suffused light still falls on the fertile countryside, which almost seems to emit a luminous gray-green glow. Altostratus is seldom very thick, and a considerable amount of diffuse light usually does filter through unless the Sun is low in the sky. Nevertheless, one ineradicable falsehood has been retained - each boy has been allowed to keep his shadow even though altostratus does not permit enough sunlight through to cast shadows.

7.5 Misty Undercurrents

Although it was primarily a century of light and clarity - the unlimited visibility and unmistakable horizon line in Louis Le Nain's preindustrial, overcast French countryside was typical of the times - not all activities of that very diverse century took place in such unadulterated air. The visibility of Dutch landscape paintings underwent great oscillations and Claude bathed his scenes in haze. There was also a significant undercurrent of smoke, steam and obscuration that refused to go away and sporadically surfaced.

Throughout the 16th century, background mists used in religious paintings attracted at best a limited following. Then, shortly before 1600, Caravaggio, apparently a troubled and violent man, developed a striking method for highlighting the main characters and their actions. A brilliant light shines on them while the background is cast into utter darkness. This technique is particularly suited to indoor settings dimly illuminated by candles or oil lamps. But Caravaggio's chiaroscuro was adapted and modified for some outdoor scenes as well, as in Elsheimer's nocturne, *The Flight into Egypt* (see Fig. 6-48) and Rembrandt's *Landscape with a Stone Bridge* (see Fig. 7-13).

For several decades many artists went through a Caravaggiesque stage. But there were always a few souls that preferred the vagueness of mist and smoke to the finality of darkness. A Genoese artist, Giovachino Asseretto painted a scene of *Moses Striking the Rock* (c. 1630, Prado). Moses appears distinctly in the foreground but some of the figures a few feet behind him are paled by mist. Meteorologically the work is suspect, for such thick mist is quite uncommon in the desert of Sinai. But the painting apparently had a great effect in almost equally arid Spain on several Spanish artists, including Bartolome Esteban Murillo.

Murillo was intensely religious and the background sfumato suited him to a tee. He used it repeatedly throughout his career with minor variations to suit the mood of the work. Usually, the air is so misty that figures and buildings on the other side of an open square are barely visible. In a number of his paintings, Murillo utilized the dual view of a universe that includes both the sacred and the profane, and therefore both low and high visibility. The divine figures that appear in the sky are always separated from the terrestrial events around them by a brightly illuminated but dense mist that acts like a curtain, just as our intensely personal and private mystical (and even illicit) visions are worlds apart from our noble public actions and declarations.

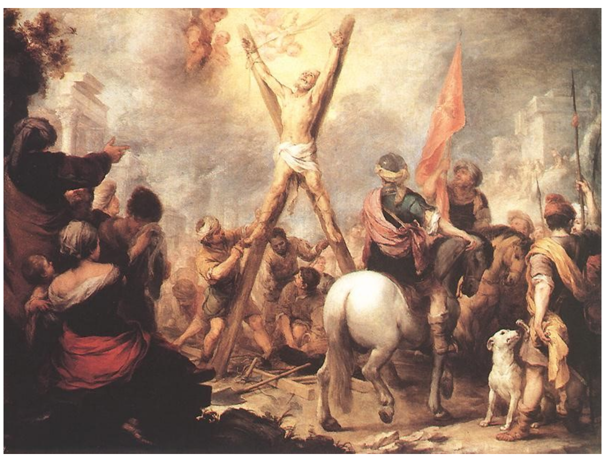


Fig. 7-40. Bartolomeo Murillo. *The Martyrdom of St. Andrew*. c. 1675-1682. El Prado, Madrid.

Never had visibility on Earth been so restricted as it was in Murillo's *Martyrdom of St. Andrew* (Fig. 7-40), one of the last painted hurrahs of revealed religion. The *Martyrdom* is one of Murillo's later and most dramatic paintings. The saint is being tied to an x-shaped cross. An angelic vision appears within a golden aureole in an otherwise gray and misty sky to distract him from his physical agony. All foreground figures are rendered distinctly and are colored brightly with red and gold highlights so as to stand out all the more sharply from the barely visible, fogbound people and classical buildings a few feet behind the main action.

Many of the 17th century's misty scenes involved more pleasurable pastimes. In 1593, Cornelis Cornelius helped inaugurate a Dutch tradition by painting *The Wedding of Peleus and Thetis: The Banquet of the Gods* (Frans Hals Museum, Haarlem), a Dionysiac revelry in which the distant horizon virtually disappeared. Even Rembrandt got into the act with his *Rape of Prosperine* (1632).

Fig 7-41. Jacques Blanchard. *Angelica and Medoro*. 1631-33. Metropolitan Museum of Art, NY.

In France, Jacques Blanchard lived long enough to paint some lyrical love scenes such as his *Angelica and Med*oro (Fig. 7-41). Never before in painting had lovers been so safely hidden from the rest of the world. The two lovers carve their names in the trunk of a tree in a misty forest that cuts off a view of the horizon. Blanchard's *Angelica and Medoro* and Rembrandt's *Rape of Prosperine* both prefigure the great misty love scenes of 18th century French art.

David Teniers the Younger was a Flemish landscape and genre painter of some stature. His *Scene with Bocci Players* (National Gallery, London) contains some of the most convincing painted crepuscular rays. However, it is not his paean to light but in his dark, smoky scenes of witchcraft and alchemy, as Svetlana Alpers pointed out, that he showed the greatest prescience.

In *The Witches' Initiation* (Fig. 7-42) Teniers took the selective obscuration in scenes of religious or amorous ecstasy and transmuted that angelic gold to diabolic lead. For where once angelic or saintly figures emerged from bright shining mists, Teniers revealed, fiendish monstrosities emerging from filthy smoke.

Fig. 7-42. David Teniers the Younger. *The Witches' Initiation*. c. 1648. Akademie der bildenden Künste, Vienna

We see a revolutionary rendition of a then popular superstition. The scene is set indoors. Two women in the brightly lit foreground look up warily from the books (on sorcery?) they have been reading as monsters emerge from the indistinct background and crowd around them or flit through the air. This medley of brown monsters barely emerges from the indistinct brown smoke wall. At the same time in the background, illuminated by a fire, a naked initiate with a broomstick between her legs is about to take off. Viewers of the painting were treated as VIP's, for only they knew what was going on in the satanic setting. As long as the monsters remain quiet, no one outside could possibly be aware of was going on within. Only Goya would rise to such depths.

Under Louis XIV, French painters avoided all such mists and smoke. Their job was to keep the beloved monarch clearly in the limelight and make monarchy appear as God's choice of government. Henry IV, Cardinal Richelieu and Mazarin had paved the path for the Sun King, whose long reign began in a stew of uprisings but lasted until 1715. When Louis finally took over the affairs of state he became one of history's greatest and most ardent patrons of all the arts.

But while it was a highly creative era for most of the arts, the specific task assigned the painters of the French court narrowed their focus and suppressed independent creativity. Painters took care to conform to the 'classical' style Louis favored because he had plenty of work for them. Distrusting Paris ever since he had been forced to flee during the second Fronde, Louis decided to build a countryside palace at Versailles that would serve as a fitting symbol of the apotheosis of the French Monarchy. Work began in 1661 and from that secure and magnificent vantage point Louis oversaw a revolution that placed France at the forefront of the world's culture.

The painters hired to decorate Versailles were men of remarkable talent but they initiated no revolution in the way we see the world. Their job had been set before them and they carried it out to a tee.

But toward the end of his reign, Louis XIV no longer did his job well. After consolidating France, he entertained expansionist notions in the east that only succeeded in winning enemies and troubles. For 40 years his armies labored through a desert wilderness of battles in a fruitless search of a promised land of conquests. When the mud finally settled, France was bankrupt and its population had dwindled by over 20%. Louis' extravagance in Versailles, his expenditures on the battlefield, and especially the failed harvests during the brutal Little Ice Age weather of the 1690's exacted an immense toll on France. Thenceforth France would be a little less martial. With its guard relaxed, the classical spirit waned and a variety of subversive elements including the lure of the life of dissolute pleasure reared their seductive heads once again. This freed French art for new discoveries.

CHAPTER 8
THE CAPTIVE SKY

In 1651, Thomas Hobbes offered the world a new definition of religion,

> Fear of power invisible, feigned by the mind, or imagined from tales publicly allowed [is] Religion; not allowed, Superstition
>
> *Leviathan*.

This curt definition abrasively dismissed and summarily rejected any objective basis for religion. Humankind was completely on its own, living in a mechanistic universe whose laws Isaac Newton would soon reveal.

In the 18th century the conviction grew that if the current state of the universe were measured, its future course could be predicted for all time to come. This conviction, combined with the quickening 18th century pace of discovery and invention, lifted expectations of human potentialities and conferred a sense of omnipotence. Thus, where the 17th century discovered the laws of motion, the 18th created a workable steam engine that began to move the world. Where the 17th century learned that air had weight, the 18th imprisoned that air in balloons and launched itself into the skies. And, where the 17th century preached atheism, the 18th began to practice it by acting as if it were its own creator.

Eighteenth century sky painters actively participated in this cavalcade of creation. Fear and ignorance no longer compelled them to view the atmosphere from afar as passive observers. Instead, they were free to create their own laws. They could cross the once forbidden Alps on the Grand Tour, measure the globe on sponsored expeditions of discovery, and frame the skies within the confines of the camera obscura. They could transform the world to a stage and make a thick, enveloping atmosphere its backdrop. They could dive in the midst of the maelstrom and laugh in the face of storms they themselves had created.

When 18th century artists assumed the role of creators and showed scenes as if viewed from within they necessarily abandoned the search for cloud forms. But the absence of well-formed clouds was a signpost that something fundamental was missing from 18th century sky painting. As Edmund Burke noted, what was lacking was a feeling of the infinite. The cultured world had so recently rid itself of one sense of wonder - the supernatural - that it was not yet ready to embrace and deify another - the natural. Without a breathless sense of wonder about the natural world, landscape art must fare poorly.

The artistic storms of the 18th century art have their dramatic moments and the thick painterly mists have their sense of theatrical ecstasy, but for the most part they are contrived and theatrical hyperbole intended either to distract a bored, privileged class or certify a rising middle class longing for aristocratic status. Nature does not show herself well when she is confined on a stage. It is ironic - when the world appears utterly overwhelming and mystifying, sky painting is not possible, but when nature is viewed with a certain smugness, as it was during the 18th century, sky painting is by necessity contrived.

Still, 18th century artists played a vital role in the history of sky painting. Their unquestioning faith in rationality gave them the courage to stare into the teeth of storms with a sense of impunity and then document all they saw, even if they felt compelled to transpose their findings to classical settings. They thus oversaw the transition from the pastoral to the sublime. And when the unexpected irrational events following in the wake of the French Revolution and Reign of Terror descended on Europe late in the 18th century, it was the artists who dissolved the mists to reveal the surprises that would erupt from the long dormant depths of the human soul.

8.1 Pleasures and Monsters of the Misty Womb

The great painted mists of the 18th century spread first over the face of France. For years, France had fruitlessly sought to annex territory in the east. Instead, it was Antoine Watteau that she annexed. Watteau introduced the mist that taught France and Europe to be content with the small space of an enclosed garden. A century and a half before Tolstoy, Watteau pondered the same question - what is "land enough for a man" - and gave a similar answer.

Watteau was born in 1684, in Valencienes, which had alternated between French and Flemish hands. Perhaps it was the Frenchman in him who was a great and poetic romantic, quite likely it was the Fleming who was the great and poetic sky painter. In 1802, the 18 year old Watteau came to Paris as the apprentice of an obscure scene painter for the Paris Opera. But his master left town, abandoning Watteau to his fate. Claude Gillot, who was associated with the French theatre, rescued Watteau from poverty and may have introduced him to mist. In 1708, Gillot shipped Watteau on to his final apprenticeship under Claude III Audran, who did much delicate decorative work in the French royal residences. Watteau assisted on projects in the Luxembourg Palace. There he was warmed by the color of Rubens and Titian and cooled in the beautiful gardens. There too he may have discovered the thick morning mist that could block out all unwanted distractions of surrounding urban blight as effectively as any stage backdrop. Then, his training complete and sensitivities enflamed, Watteau set off to transform the world of art.

Watteau showed the world the meaning of wistful love and elegant refinement. It may well be that we owe to this shy, frail and reserved dreamer the absurd divorce rate of modern times, for how long can such high pitched and intense passion be expected to last in real life? In all his works, nature has been purged of any sign of violence or decay. There can be no rain or storms to interrupt the atmosphere of the world of emotions. The world to Watteau is the enclosed universe of the stage, where actors pause to play their brief roles. What need is there for a vast expanse of space. A garden has space enough, particularly if it comes with a high wall of vegetation or a thick veil of mist to ensure privacy and encourage intimacy.

Watteau employed a range of atmospheric visibilities in his works and did allow a glimpse of distant prospects so long as they were pastoral or classical. The visibility is high enough in his first version of the *Embarkation From Cythera* (comp. 1717, Louvre, Paris) to reveal mountains resembling da Vinci's aerial peaks rising in the distance.

Fig. 8-1. Antoine Watteau. *Le Faux-pas*. 1717. Louvre.

But in the same year, Watteau also painted a scene of almost zero visibility - the *Faux-pas* (Fig. 8-1). Here an ardent young man has lured a hesitating maiden to the most remote part of a garden. Too soon he has let his intentions be known and she puts up an arm to ward off his first advance. We do not know the ultimate outcome of this tryst. As for the rest of the world, it cannot even suspect the tryst ever took place, for a thick, dematerializing mist has blurred the foliage of the enclosing grove and blotted out everything beyond.

After these works, Watteau left for London to seek a cure for his worsening tuberculosis. There the suffering induced by London's notorious acidic fogs more than offset any benefits of the medical treatment he received. Returning to France, he died on July 21, 1721 at the age of 37. It has been suggested he never experienced love first hand.

Watteau's spirit was not allowed to rest in peace but was appropriated by the times and exploited till the eve of the French Revolution. A veritable cavalcade of painters swarmed in Watteau's wake, thickening the atmosphere and blurring vegetation until all hints of the outside world had been obliterated. Scarcely had Watteau been laid to rest when Nicolas Lancret and Jean Baptiste Pater found an eager clientele for their steamy painted dalliances and daydreams. Francois Boucher and Jean-Honore Fragonard followed not long after and were all the rage for many years. Feminine charms saturated the universe while innocent, playful coquetry oozed from even the bark of the most gnarled trees. Naked femme fatales draped their glistening bodies on the softest blankets or the most cooperatively conforming clouds. Never were the ladies lewd, but neither were they shy, except by design.

Consider *The Swing* (Fig. 8-2). This is perhaps Fragonard's most famous work and it is certainly representative. The young nobleman at lower left is seeking secret visual delights under the dress of the fair femme on the swing. She, of course, is fully aware of where his eyes are focused and cooperates by playfully lifting one of her legs to reveal a multitude of petticoats and possibly more. Behind her, cooperatively manning the swing, and mostly hidden in mist and shade is her unwitting, older husband.

Fig. 8-2. Jean-Honore Fragonard. *The Swing*. 1766 or 1767. Wallace Collection. London.

All of this takes place in a fenced-in, forested garden with nary a hint of a world beyond. Great distance is required to turn objects blue. Still, the nearby foliage is given pale gray-blue tints that radiate a feathery soft aura, for Fragonard and his contemporaries had learned this was one of the pleasant effects of an injudicious use of aerial perspective. The atmosphere, of course, is very misty - too misty in fact for clouds.

Boucher, and especially Fragonard did have great sensitivity for landscape and the atmosphere. On occasion they did admit glimpses of the real world, as in Fragonard's other version of the *Swing* (1775-80. National Gallery of Art, Washington), which contains a towering cumulus worthy of any of the Dutch masters. But this apparently was not what the French aristocracy primarily hungered after.

They were on the twilight of a joyride and did not wish to see the world beyond their daydreams. Their world had been transformed to a carefree and sensual, fluff-lined womb.

Painters like Boucher and Fragonard thus filled a definite need and served an eager market so that some of the harsh criticism aimed their way was misplaced. The art was criticized on moral grounds as a signpost of French decadence. Denis Diderot, prime mover of the French *Encyclopédie*, fixed his critical claws with particular venom into the paintings of Boucher.

> This man has all but truth....The degradation of taste, of color, of composition, of character, of expression, has followed step by step the debasement of morals....This man takes the brush only to show me buttocks and breasts. He knows not what grace is....Delicacy, honesty, innocence and simplicity have become strangers to him. He has never seen nature for an instant...
>
> Diderot, *Salons*.

Diderot helped inspire a classical reaction from a number of artists such as Jacques Louis David, whose great early works, such as the *Oath of the Horatii* (1784, Louvre, Paris) and the *Death of Socrates* (1787, Metropolitan Museum of Art, NY) stressed the masculine virtues of martial heroism and stoicism. Women in these works were shown as weak creatures swept away by emotion while their men, epic in stature, determined the course of events. David was letting France know he was sick of the Society of the Salon where men were reduced to effeminate and whimpering lap dogs, groveling at women's feet for a few tender tidbits of love.

David deliberately cleared the mist from these stark and highly ideological works. As winner of the Prix de Rome in 1774, he got to spend a year in Italy where he saw paintings with clear air. This apparently struck him for, when he returned from Rome in 1775, he said he "felt as if he had been operated on for cataract". But, like so many of his contemporaries, David also did not want any part of the real world. He yearned only for a return to the golden days of classical valor, and he too confined the world to a stage. David's classical backdrops summarily exclude the vagaries of the sky, blocking the view to the outside world just as effectively as do the mists of Fragonard and Boucher.

Later artists and art critics also came back to swipe at Boucher again and again. In his *Notes of Six Lectures on Landscape Painting*, delivered in 1836, John Constable wrote,

> But the climax of absurdity to which the art may be carried, when led away from nature by fashion, may be best seen in the work of Boucher,

and Constable's biographer, C. R. Leslie added, "Boucher is Watteau run mad."

Despite all these later protestations, French influence spread across Europe like a wildfire. England, forever France's opponent on the world's battlefields and marketplaces, slavishly inhaled all the French mist she could. Joshua Reynolds, and especially Thomas Gainsborough sacrificed much of their spontaneity regarding nature in order to satisfy "all these fine ladies and their tea drinkings, dancings, husband huntings, etc.," and to make their works conform to the prevailing French style. And was there ever a painter that could approach the grace, ease, and random regard for realism with which Giovanni Battista Tiepolo shaded the fluffiest of solidified cumulus that seated his Venetian goddesses?

When the view was upward, as on innumerable ceiling paintings, visibility was high enough to see massy cumulus propping the teetering nobility. François Le Moyne's *Apotheosis of Hercules* (Fig. 8-3) is a magnificent example of the seductively lavish paintings that adorn the ceilings of the royal palaces and chateaus, where Nature always takes a back seat to artifice in studio-produced reveries. Here, Iris reclines on a randomly colored miniature rainbow while the Greek Pantheon lounges on randomly illuminated cumulus, albeit with appropriately darkened bases. Such works (and there were a host of them) might well be called the Apotheosis of Arrogance. Oh, were Jack's giants in for a fall!

Fig. 8-3. François Le Moyne. *Apotheosis of Hercules*, 1736, Salon of Hercules, Versailles.

Yes, all good things must come to an end. France's Ancien Régime teetered downward throughout the century. In 1756, after years of incessant urging by William Pitt the Elder in the British Parliament, England managed to prod foolish France back into war. England wanted control of the seas and that is exactly what she got. France lost Canada and India, and the trade with her colonies dropped from 30 million livres in 1755 to 4 million in 1760. So France helped mold the British Empire! Then, in December 1776, Benjamin Franklin arrived in Paris to solicit French aid in the American War of Independence. Franklin charmed the French to the ultimate tune of 1 billion livres, which proved invaluable to the American cause but helped to bankrupt France. The next War of Independence France financed was her own.

It didn't take much more doing. Marie Antoinette was as unpopular a queen as could be imagined. The French Bourgeoisie had rapidly amassed enough wealth (often at the expense of government coffers) to want and expect a commensurate degree of political power, which the encrusted nobility stingily withheld from them. The bulk of the citizenry were the peasants and indigent workers who tried to remain "God-fearing", but freedom and atheism were shouted from the rafters at the nation's cultural vanguard until their vegetable passions were stirred to stampede proportions. And without God there can be no divine right of kings.

The final series of blows to the French monarchy began in 1788 and was greatly aided by the weather. It was a horribly hot and dry summer that year in France and the spectre of a famine began to stalk the already humbled masses. Near Paris, always a focal point of popular uprisings, the drought was briefly interrupted by a devastating hailstorm that cut a wide swath of total destruction across the fields of withered grain.

As if that were not enough, the winter of 1788-89 was one of the worst in France's history. The Seine froze solid from Paris to Le Havre. The cold killed about one third of all olive trees of Provence while the survivors bore no fruit that season. When the snows finally melted, floods were widespread across France and especially severe and prolonged in the Rhone River Valley. Then, abnormal heat and drought returned once again in the summer of 1789, drying out the streams and the grape harvest. Although outright famine was averted by last minute measures to import and redistribute grain, shortages were widespread and prices of foodstuffs rose to riotous levels.

The French Revolution and its irrational aftermath caught Europe off guard and shook it to its foundations. It is easy to see in retrospect how even the most conservative of voices had unwittingly conspired to bring about the fall of their Age of Enlightenment. Hadn't Edmund Burke soberly called for obscuration and an unfathomable and infinite sense of wonder in his essay, *On the Sublime and Beautiful*. And wasn't it the rather delicate David Hume, speaking with the calm voice of reason in his *A Treatise of Human Nature*, who began the rigorous and brutal dismantling of reason's hitherto unopposed reign? "Reason", wrote Hume in 1737, "is, and ought to be, the slave of the passions."

And so, as the rest of the world discovered over 50 years later, it was! If indeed the universe were God's timepiece, its workings suddenly were no longer quite so regular, reliable or comprehensible. Once again, the irrational and unforgiving course of events would send people scurrying to find some protective faith to clutch at. The problem for the disoriented artists was compounded by being deprived of their former sources of financial support. A few painters such as David did remarkably well (barring a brief hitch in jail), for his works were suddenly seen as embodying the spirit of and even heralding the Revolution. Others, such as Henry Fuseli who painted the shocking *Nightmare* (1781, Detroit Institute of Art), were already beginning to explore the hallucinatory world of the subconscious. Most, however, including poor old Fragonard, were caught on the wrong side of the fence and were lucky if they lived to fade into obscurity.

The Revolution swept away enough of the obscuring mists to reveal a previously hidden world of horrors. We can take it almost as a law of nature that a society whose art is marked by excessive devotion to mist and atmospheric obscuration is particularly fragile. The aristocracy had imagined themselves safely immersed in a womblike mist but the prophets of the new age were about to demonstrate how myopic their vision had been.

Foremost among the mist-clearing prophets was Francisco de Goya y Lucientes, a Spaniard whose macabre genius seems to have been directly provoked by the irrational turn of events in Europe. Goya was able to view the proceedings from a safe vantage point because Spain did not become directly embroiled in the turmoil until Napoleon's invasion in 1808. In fact, throughout the entire period, Goya remained a favorite of the Spanish Court and his career shows a certain duality. In 1783, he received his first major commission to paint a portrait of the Spanish Royal family. Not surprisingly, this was quickly followed by a flood of other commissions to paint portraits of Spain's finest and richest citizens. Goya infused many of these portraits with the same aristocratic mist that had spread the length and width of Europe, and he continued to do so long after he had embarked on the job of informing the world of its irrationalities.

It was on the eve of Revolution that Goya began the job of clearing the 'protective' mist and exposing the monsters it had hidden so long and well. In 1788, he received a commission to paint a Christian deathbed scene for the Borgia Chapel in Valencia Cathedral. His sketch for *St. Francis Borgia Exorcising a Dying Impenitent* (Madrid, Collection of the Marques de Santa Cruz), is a mere precursor of the direction his later art would take. The pain wracked body of the dying man serves as a battlefield between the forces of good and evil. The satanic spirits crouching just over the dying man emerge from dark shadows that contain a touch of mist.

Prior to 1792, Goya merely hinted at the potential for brutality and evil in the universe. But in that year he contracted a severe illness that temporarily paralyzed him, made him deaf, and left a permanent imprint on his art. It was as if his fate had merged with Europe's. From that point, his forays into the dark world of the subconscious grew more regular and pronounced. In 1797-8 he painted *The Devil's Lamp* (Fig. 8-4), a scene from a series called the *Forcibly Bewitched*. The *Devil's Lamp* revealed that a century of mist had succeeded only in providing protective cover for looming monsters. No longer could there be any doubt about the pathetic fate of the Age of Enlightenment.

Fig. 8-4. Francisco de Goya. *The Devil's Lamp*. 1797-98. National Gallery, London.

8.2 From Efficiency to Exploration: Fire, Fury and Ice: Waterspouts and Lightning

The dark, irrational undercurrents that resurfaced at the end of the 18th century could not oust the bright realm of reason entirely, for reason had borne too many fruits.

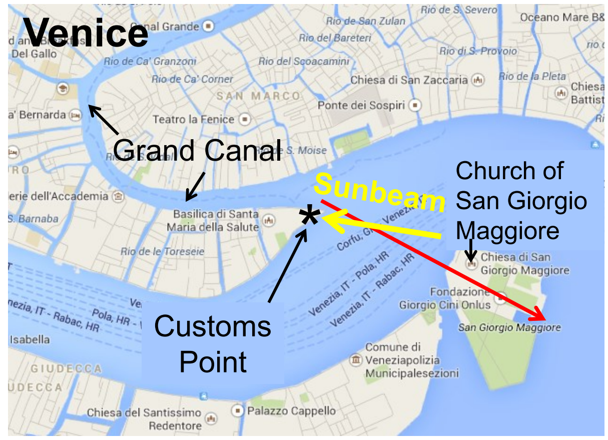


Fig. 8-5. Map of Venice showing the viewpoint (red arrow) and location of features in Fig. 8-6.

Fig. 8-6. Canaletto. *The Customs House Promontory*. 1740. Kunsthistorisches Museum, Vienna.

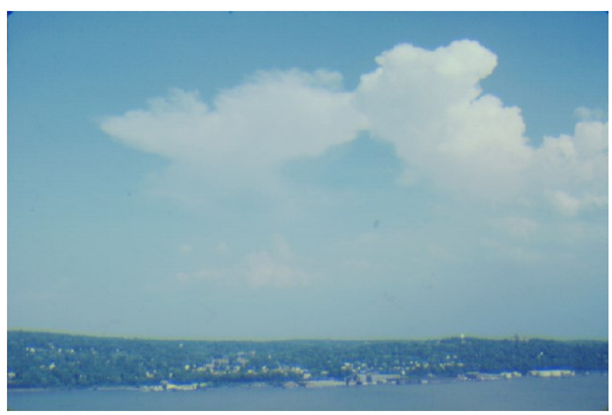


Fig. 8-7. Disintegrating anvil of a dead cumulonimbus at left, with an unrelated tilted cumulus at right.

Reason guided the lifelong efforts of Canaletto (Antonio Canale). Canaletto was trained by his father to be a scene painter for the theatre, but abandoned the stage for the world of Venice. He was not the founder of Venetian view painting, but redefined it so effectively that his name will forever remain linked with painted scenes of Venice.

If Canaletto's paintings create any impression at all, it is one of precision. They seem to be almost photographic documents of particular places at specified times, and it is almost certain that he used the camera obscura to help outline the architecture and possibly even the clouds.

A map of Venice (Fig. 8-5) shows that Canaletto faced ESE toward the verdigris colored tower of the distant Church of San Giorgio Maggiori in *The Customs House Promontory* (Fig. 8-6). The illumination and shadows on the pillars show that the Sun is pretty high in the sky and just south of east, making it mid-morning near the summer solstice.

A line of towering cumulus has formed over the water to the SE. The cloud outlines lack the distinct cauliflower protuberances of youthful cumulus as in Fig. 8-7, perhaps because cumulus often sprout over water at night when the land is cold and die during the day when the land gets heated. To confirm the geriatric nature of the maritime cumulus, a faint anvil has been almost severed from its vitiated parent by strong SW winds of the jet stream winds. A washed out, pale blue sky, which makes it difficult to distinguish cloud from clear, completes the picture of a hazy, humid summer day.

Canaletto's success inspired followers such as Francesco Guardi, who labored in relative obscurity throughout a long life. Guardi's skies are often darker and perhaps more foreboding than Canaletto's but are essentially cut from the same mold. The scene painters were not out to discover nature's exciting new possibilities - their job was restricted to documenting and mapping the expanding empire of controlled human enterprise.

And where else but in England was there a more rapidly expanding Empire? For many years Joseph Smith, a British businessman and Consul stationed in Venice, served as Canaletto's principal agent. Therefore, it should come as no surprise that almost all of Canaletto's paintings wound up in England. In 1746, the artist himself set out on his own Grand Tour, and arrived in London to give the British firsthand pictorial documentation of their architectural accomplishments. His extended stay was successful, for the British apparently liked his imported Venetian skies over their cloudy land, but he, like Jan Siberechts before him, could not usher in a new era of sky painting in England. It seems his patrons were too busy remaking the map of the world and the chart of the universe to notice the beauty of the skies overhead.

England's conservative universities were slow to see and reluctant to accept the new changes in the world about them. They doggedly held on to the old classical curriculum, seldom admitting that anything besides Greek and Latin was worthy of study. In 1645, John Wallis, who had discovered the power of mathematics only as a grown man, began a series of weekly meetings to provide a better forum than the universities for enlightened minds to discuss the latest discoveries and ideas. By 1662 this had become the Royal Society, by chartered approval of King Charles II.

The Royal Society oversaw the intellectual modernization of England. Its early members included such outstanding figures as Isaac Newton, the architect Christopher Wren, the chemist Robert Boyle, the universal experimentalist Robert Hooke, the poet John Dryden, and the astronomer - meteorologist Edmund Halley, who used his charm to encourage and his own personal funds to finance the publication of Newton's *Principia*. Eminent foreigners such as Leibnitz (coinventor of calculus) and Leeuwenhoek were admitted to membership, in accordance with the international spirit of the times.

The Royal Society created or certainly fostered a new form of human activity - the deliberate, premeditated scientific investigation of all aspects of the world of nature. Every branch of natural learning profited greatly from projects which the Royal Society guided and financially supported.

The third book of Jonathan Swift's *Gulliver's Travels* is a testimony to the Royal Society's ever widening circle of influence. Swift, of course, brutally satirized the concerns of scholars and the significance of their projects. When Gulliver arrived on the floating island of Laputa (the harlot) he was almost completely neglected by its absentminded, sexless mathematicians and musicians, whose principal worry was,

> that the Earth very narrowly escaped a brush from the tail of the last comet, which would have infallibly reduced it to ashes; and that the next, which they have calculated for one and thirty years hence will probably destroy us.
>
> *Gulliver's Travels*.

This comet was none other than Halley's comet, the one Edmund Halley identified as periodically reappearing in the heavens every 75 years, and which has once again faded from our skies without destroying the planet. Neither Halley, who predicted it, nor Swift, who satirized it, lived to see the comet reappear in 1758. The reappearance proved to be far more momentous an event than either had anticipated. In 1757, Alexis Clairaut used Newton's laws and the Calculus to calculate that Halley's comet would be delayed by 618 days as a result of passing near Jupiter and Saturn. The actual delay was 586 days but the prediction was a tour de force of the new science and made Clairaut a darling at the Salons. What an immense advance in human understanding had taken place since Giotto. Here was one more proof that after 2000 years, humankind had convincingly surpassed the world of the Ancients once and for all.

But let us return to Gulliver and the projects of the Royal Society. Somewhat later, back on solid earth, Gulliver was treated to a tour of the Grand Academy of Lagado. Here he had the opportunity of seeing firsthand the workers and workings of science,

> The first man I saw was of a meagre aspect, with sooty hands and face, his hair and beard long, ragged and singed in several places....He had been eight years upon a project for extracting sun-beams out of cucumbers.... He told me he did not doubt in eight years more, that he should be able to supply the Governor's gardens with sun-shine at a reasonable rate; but he complained that his stock was low and entreated me to give him something as an encouragement to ingenuity....I made him a small present, for my Lord had furnished me with money on purpose, because he knew their practice of begging from all who go to see them.
>
> I went into another chamber, but was ready to hasten back, being almost overcome with a horrible stink. My conductor pressed me forward, conjuring me in a whisper to give no offense, which would be highly resented; and therefore I durst not so much as stop my nose. The projector of this cell was the most ancient student of the Academy. His face and beard were of a pale yellow; his hands and clothes dawbed over with filth. When I was presented to him he gave me a very close embrace (a compliment I could well have excused.) His employment from the first coming into the Academy was an operation to reduce human excrement to its original food...

Gulliver's Travels

The workings now overseen by the National Science Foundation and other similar agencies can be satirized in an almost identical manner. Swift then took aim at the world of art with words that have acquired new worlds of meaning in the past century.

> There was a man born blind, who had several apprentices in his own condition: their employment was to mix colours for painters, which their master taught them to distinguish by feeling and smelling. It was indeed my misfortune to find them at that time not very perfect in their lessons; and the Professor himself happened to be generally mistaken: This artist is much encouraged and esteemed by the whole fraternity.
>
> *Gulliver's Travels*

The particular project that now concerns us would seem at first thought remarkably good fuel for Swift's fire. The Royal Society lobbied vociferously to get the British Government to fund and equip a voyage to the Southern Seas. The primary purpose for this voyage was to serve as a crucial part of a global effort to observe the transit of Venus across the face of the Sun. This rare celestial event had occurred on 6 June 1761, and was calculated to occur on 3 June 1769 and then not again until 1874. It was an opportunity not to be missed.

What could possibly be the significance of such an event? At the time, the distances of the Moon, the Sun and the planets were not accurately known. The transit of Venus across the face of the Sun provided a unique opportunity to obtain more precise values of these distances. Because of the Earth's rotation, the transit takes slightly different times at different latitudes. From these small differences it is possible to calculate the distance from the Earth to the Sun. Knowing astronomical distances accurately would also provide a more precise calibration of Newton's Laws and therefore of the entire universe.

An earlier global effort had been organized to observe the 1761 transit but that project failed because of war and cloudiness. Determined not to fail again, the scientists designed their experiment meticulously. All people directly involved in the project had to be highly trained in making precise scientific measurements. Care was taken to choose observation sites in regions with as little cloud cover as possible, for it was imperative that the sky be clear during the observation.

The first job was to find the cloud-free areas. In 1697 Halley had prepared the way by publishing the first chart of the global winds from the logs of countless sea voyages. This work provided a greatly improved picture of the world weather patterns. The least cloudy region in the South Seas was determined to lie between 5° and 35° South Latitude and 130° West to 170° East Longitude, which is the region we know to be dominated by the fair weather of the subtropical South Pacific High. We would pick the same location if we had to make the choice today. Shortly before the voyage was to begin, Captain Samuel Wallis returned from the South Seas and announced the discovery of Tahiti, near the center of the approved area. Exotic Tahiti was immediately selected as the logical and scientific choice for the observatory. Thus, by the mid 1700's, the world was being traversed with carefully measured steps.

The man assigned to lead this rather delicate expedition was one James Cook. Cook had not been the Admiralty's first choice but was finally awarded the commission largely because of his experience with cartography and expertise in handling scientific instruments. The First Voyage proved so successful, despite Cook's failure to find the Southern continent, that he was sent on a second.

And it was on Captain Cook's Second Voyage that a promising young landscape artist named William Hodges was employed to document all the marvelous sights. Hodges was also an almost last minute choice but proved equal to the great task ahead. He had trained under Richard Wilson and had then gone on to become a competent view painter with some talent for portraits. His early scenes are mostly from his native England although he did paint an Alpine view after spending two summers on the continent.

The responsibilities and visual experiences of the Voyage quickly transformed Hodges into a greater artist. His painting of *Table Mountain at the Cape of Good Hope* (1772, National Maritime Museum, Greenwich, London) already shows an increased sensitivity to the luminosity of the landscape. After rounding the Cape, Cook aimed for the Antarctic and entered the sea of ice, giving Hodges new material. To Hodges we owe some of the earliest paintings of icebergs, complete with their impressive array of shapes and colors. One of Hodges' paintings shows the ice blink, a whitening of the horizon sky that announces the presence of ice fields at or just beyond the field of vision.

Hodges not only painted but rhapsodized on the magnificence of nature. On board he found willing ears and kindred spirits. Cook was all for taking calculated risks in the name of science, particularly when one of the rewards was aesthetic.

> Great as these dangers [from ice] are, they are now become so very familiar to us that the apprehensions they cause are never of long duration and are in some measure compensated by the very curious and romantic views many of these islands exhibit and which are greatly heightened by the foaming and dashing of the waves against them and into the several holes and caverns which are formed in the most of them, in short the whole exhibits a view which can only be described by the pencil of an able painter and at once fills the mind with admiration and horror, the first is occasioned by the beautifulness of the picture and the latter by the danger attending it, for was a ship to fall aboard one of these large pieces of ice she would be dashed to pieces in a moment.
>
> Wednesday, 24 February 1773. *Journals of Captain Cook* p 98-99.

After wandering among the ice fields of the polar seas for four months in a fruitless search for a Southern Continent, Captain Cook reluctantly turned north for a respite from the relentless harassment by the elements. It had been a time of constant cold, with one storm after another that thickly coated the ship and its riggings with ice. Most of the interludes between storms brought not clear skies but dense fogs. Although no continent had been discovered this part of the voyage still had its value. Cook's Journals and Hodges' paintings of these polar experiences later helped fuel the imagination of the next generation of poets and painters.

Once Cook turned north, he aimed straight for New Zealand where the next meteorological adventure and proof of his scientific spirit was to take place. On 17 May, 1773, a day after a cold front passed,

> at 4 o'clock in the afternoon being then 3 leagues to the westward of Cape Stephens, having a gentle gale at west by south and clear weather. The wind at once flattened to a calm and the sky became suddenly obscured by dark dense clouds, which occasioned us to clew up all our sails and presently after six water spouts were seen....the sixth...passed within fifty yards of our stern without our feeling any of its effects. The diameter of the base of this spout I judged to be about fifty or sixty feet, that is the sea within this space was much agitated and foamed up to a great height....I have been told that the firing

> of a gun will dissipate them and I am now sorry I did not try the experiment as we were near enough and had a gun ready for the purpose, but as soon as the danger was past I thought no more about it, being too attentive in viewing these extraordinary meteors.
>
> 17 May 1773 *Journals of Captain Cook* p 141-142.

Hodges also viewed these 'extraordinary meteors' attentively and, three years later, after his return from the Voyage, produced the first painting of waterspouts, *A Storm and Waterspouts off Cape Stephens*, New Zealand (Fig. 8-8). This meteorological document shows four spouts in various stages of their life cycle. In the left foreground we only see the very bright turbulent base of a spout that is violently agitating the sea surface and sucking spray upward into the black cloud above. Further in the distance one of the spouts is threatening the Resolution while flashes of lightning streak across the sky. Joe Golden's photograph of a waterspout near the Florida Keys (Fig. 8-9) testifies to the documentary quality of Hodges' work.

George Forster, the naturalist on board, also carefully observed the structure and evolution of the waterspouts and wrote a description any meteorologist would be proud of.

Fig. 8-8. William Hodges. *A Storm and Waterspouts off Cape Stephens, New Zealand*. 1776. National Maritime Museum, Greenwich.

> In the afternoon, about four o'clock.... On a sudden a whitish spot appeared on the sea in that quarter, and a column arose out of it, looking like a glass tube, another seemed to come down from the clouds to meet this and they made a coalition, forming what is commonly called a waterspout. A little while after we took notice of three other columns, which were formed in the same manner as the first....Their base, where the water of the sea was violently agitated, and rose in a spiral form in vapours, was a broad spot, which looked bright and yellowish when illuminated by the sun. The column was of a cylindrical form

rather increasing toward the upper extremity. These columns moved forward on the surface of the sea, and the clouds not following them with equal rapidity, they assumed a bent or incurvated shape....In proportion as the clouds came nearer to us, the sea appeared more and more covered with short broken waves, and the wind continually veered all round the compass, without fixing in any point. We soon saw a spot on the sea, within two hundred fathoms of us, in a violent agitation. The water, in a space of fifty or sixty fathoms, moved toward the center and there rising into vapour, by the force of the whirling motion, ascended in a spiral form towards the clouds. Some hailstones fell on board about this time, and the clouds looked exceedingly black and lowering above us. Directly over the whirlpool, if I may so call the agitated spot on the sea, a cloud gradually tapered into a long slender tube, which seemed to descend to meet the rising spiral, and soon united with it into a straight column of a cylindrical form. We could distinctly observe the water hurled upward with the greatest violence in a spiral, and it appeared that it left a hollow space in the centre....After some time the last water-spout was uncurvated and broke like the others, with this difference, that its disjunction was attended with a flash of lightning, but no explosion was heard.

Journal of George Forster. Quoted from *The Art of Captain Cook's Voyages*. R. Joppien and B. Smith. 1985.

A waterspout is a narrow tube-shaped vortex that consists largely of rapidly rotating, rising air (Fig. 8-10). The first sign that a waterspout is forming is the light spot on the water. This is surrounded by a darker region apparent only when viewed from the air. Once the spout gets going, its lower part is rendered visible not by vapor but by the liquid water it sucks up. The spout quickly tapers from this agitated region just above the ocean surface to a rather smooth tube. This tube usually broadens toward the top, and is always affixed to the base of a cumulus or cumulonimbus cloud. The top of the spout may be rendered visible by condensation due to the reduced pressure within the vortex. The air in a waterspout may spin either clockwise or counterclockwise.

The typical waterspout is less than 20 yards wide and has peak winds and updrafts less than 30 mph. Most waterspouts are therefore, rather innocuous despite all their apparent furor. However, the largest and most furious waterspouts can have winds that exceed 60 mph and have been known to damage or overturn small boats. There are also a few recorded cases in which small children were picked up by a waterspout and dashed to the ground but these are extremely rare. In general, waterspouts can be considered weaker and smaller cousins of the larger and more devastating tornadoes (see §11.3).

Waterspouts are most likely to appear in rows of modestly developed cumulus clouds when the wind is light and the water is much warmer than the air above. This is often the situation a day or so after a cold front passage (see Fig. 5-31). At such times the atmosphere is prone to unstable, showery weather, since the warm water heats the air directly above and makes it rise buoyantly to form a number of active centers within the cloud rows. Along these cloud rows there is often enough horizontal wind shear to provide the initial spin for the rising air and so a series of spouts can form almost simultaneously along the line, one underneath each active cloud. In New Zealand, May is a particularly active time for waterspouts since the Southern Ocean is still warm, and because the autumnal outbreaks of Antarctic air have begun.

The life cycle of a waterspout is dictated by the dynamics of the parent cloud.

Waterspouts begin as almost vertical columns in the converging and rising air beneath the bases of youthful cumulus and cumulonimbus. Downdrafts begin to form as the clouds age. The downdrafts burst through the cloud base, bringing precipitation and spreading outward when they strike the ground. Whenever a spreading downdraft encounters a waterspout it pushes the spout aside. This often makes the spout move faster at the surface than at the cloud base, so that it is tilted from the vertical and elongated until it finally breaks apart and dissolves. And while the spouts are whirling away, all the updrafts, downdrafts and spinning motion ensure a fitful wind that may come from any direction.

Fig. 8-9. A waterspout off the Florida Keys. Joe Golden, photographer.

The hollow core or eye is seen in many waterspouts. It consists of drier, descending air with light winds. This core is created by much the same forces that produce eyes in dust devils, tornadoes, hurricanes, and all violently whirling storms. The rotating air outside the core spins faster and faster as it is drawn toward the center of the whirlwind, much like an ice skater who pulls in her arms and legs. At a certain distance from the center the air is rotating too fast to be drawn in any further and then rises rapidly. This leaves an undisturbed core region. Air at the fringe of the core gets entrained into the updraft so that air deeper and higher in the core must descend to replace it. This descending air keeps the core clear and dry. For some reason, possibly the long delay between sighting and painting, Hodges did not include the hollow core in his painting.

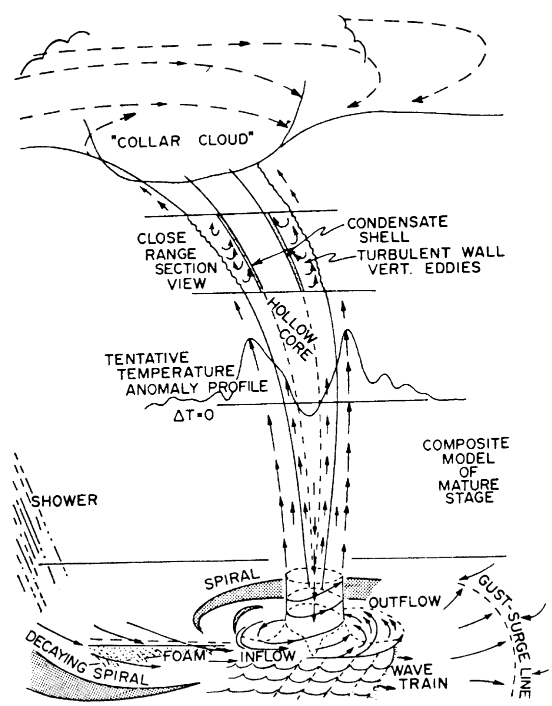


Fig. 8-10. The structure of a waterspout. Tornado structure is similar.

Hodges did include land in *A Storm and Waterspouts off Cape Stephens*, and showed the Resolution tossed about near the rugged coastline by one of the hyperbolic, 'classical' storms of 18th century art. But Hodges' rendition does not fit the facts since the spouts were actually encountered a considerable distance offshore and since they scarcely perturbed the ship. Isabel Stuebe pointed out that the right foreground of *A Storm and Waterspouts* is modeled after Richard Wilson's *Ceyx and Alcyone*. (1768, National Muesum of Wales). What made Hodges alter the facts and follow an earlier model? It was the 18th century dogma that a painting suffered without a classical motif. Manufacture a healthy storm and the recipe was complete, for the confident 18th century had plumbed the depths of nature and knew no fear.

Eighteenth century man now felt almost able to compete with God. Hodges may have had this idea in mind when he superimposed two events that actually occurred a day apart. The burning Hippah (Maori fortress) atop the cliff at right was set ablaze by the men of the Adventure as a welcome to the Resolution, but not until the latter had reached Queen Charlotte Sound, the day after the spouts were sighted. Rudiger Joppien and Bernard Smith have suggested that Hodges used the burning Hippah to symbolize the fact that the lights of man (as a result of the advances of science and technology) could finally compete with the lightning of nature or God.

This so-called 'two lights' idea was an 18th century addendum to the 1st century CE Roman treatise *On Elevation of Style*, once attributed to Longinus. The English translation appeared in 1740, just when Herculaneum and Pompeii were being vigorously excavated. The Roman author had noted,

> While the useful thing should be, or must be, at ready command, it is always the extraordinary thing that makes us marvel.

On Elevation of Style had an immediate, strong impact on a receptive Europe, and inspired Edmund Burke to write his essay, *On the Sublime and Beautiful* (1757). But it may have been the newly gained control of lightning, the ancient scourge of the gods that finally gave Burke, like Hodges the courage to quietly dissect the Sublime.

Lightning, a terrifying but sublime weather element, had been portrayed by artists since ancient times (Figs. 1-3, 1-12). Even so, it seldom appeared in paintings until Benjamin Franklin guided its forked fury harmlessly into the ground.

In 1746, Pieter van Musschenbroek of Leyden, Holland invented a device that could store electrical charges. This immediately inspired Franklin, who heard of it the same year and named it the Leyden jar, to begin his famous electrical experiments. By July of 1747 Franklin commented on the "wonderful effect of pointed bodies, both in drawing off and throwing off the electrical fire". Two years later he compiled an extensive list enumerating the many similarities between electric sparks and lightning. These observations would lead him to the lightning rod.

At first, the electrical experiments were just games. Cultured Europeans used electric devices as toys to administer shocks to their unwitting guests or to execute animals at their social gatherings. Even Franklin played such pranks. Once, while explaining at a party how he would electrocute a turkey, he accidentally shocked himself so severely he almost died. But these games were not enough for Franklin, who always sought to exploit the practical value of inventions. During the summer of 1749, he wrote of being "chagrined a little that we have been hitherto able to produce nothing in this way of use to mankind" regarding the electrical experiments and toys.

By May of 1750 he found a use. He realized that it might be possible to protect structures from lightning. Shortly thereafter he proposed to the Royal Society to

> Fix on the highest parts of the edifices upright rods of iron, made sharp as a needle, and gilt to prevent rusting and from the foot of these rods a wire down the outside of the building into the

> ground, or down the shrouds of a ship and down her side, till it reaches the water. Would not these pointed rods probably draw the electrical fire silently out of a cloud before it came nigh enough to strike and thereby secure us from that most sudden and terrible mischief.

Franklin was right about the nature of lightning and we have come to understand it somewhat better. Lightning is a giant spark that releases an excessive accumulation of electrical charges in the atmosphere.

This excessive charge is created within cumulonimbus clouds by several patient process including one first described by Julius Elster and Hans Geitel in 1885. Even in quiet weather, there is always a modest background electric field in the atmosphere because the ground carries a net negative charge and the upper atmosphere, a net positive charge. This background electric field affects every precipitation particle that forms within a cumulonimbus. Since opposite charges attract, the negative charges (electrons) of each precipitation particle are drawn to the top of the particle in order to be as close as possible to the positive charges in the atmosphere above the cloud. At first the particles have no net charge but are polarized, the excess positive charge at the top of each particle offset by an equal excess of negative charge at the bottom.

The individual particles do acquire a net charge when they collide with one another. When a large graupel particle falls on top of a smaller, a few of the more mobile positively charged ions at the bottom of the larger graupel 'jump' to the smaller graupel. When the two graupel do not adhere after the collision, the larger is left with a net negative charge while the smaller has a net positive charge. This is known as charging by induction.

Gravity then sorts the graupel in the cloud, sending the smaller ones, which tend to be positively charged, toward the cloud top while the larger, negatively charged ones fall toward the bottom. This increases the electric field within the cloud, and further enhances the efficiency of the induction process. Within minutes, an enormous concentration of negative charges can accumulate near the base of the cloud with a counterbalancing total of positive charges in the cloud's upper portions.

A gradual leakage of charges in the atmosphere acts as an escape valve that prevents lightning in small clouds, where the electrical charging process is slow. But in the cumulonimbus, the generating process takes place too rapidly for the escape valve to be effective. Violent updrafts and downdrafts standing side-by-side then bring unlike charge concentrations in close proximity and thereby increase the electric field above a critical value. Suddenly, the normal insulating properties of air break down, and a channel of lightning is opened. In an instant, the air all along this electrical conduit is superheated to as much as 30,000 °C and expands explosively, sending a terrifying clap of thunder reverberating through the heavens. But though we may cringe from the thunder's fearful noise, it is the lightning that packs the wallop.

Franklin's lightning rod provided a protective shield. But even though it won immediate acclaim, for years many doubted its virtues. The vaults of the unprotected church of St. Nazaire in Brescia, Italy continued to serve as a storehouse for gunpowder long after Franklin's announcements. The church steeples projected proudly into the sky, acting as fuses for a gigantic bomb. When lightning struck in 1769, 100 tons of gunpowder was instantly detonated. The resulting explosion killed 3000 people and levelled 1/6th of the city. This and similar incidents ultimately convinced people to accept new truths. Lightning rods went up everywhere. Finally, we could channel the lightning bolts aimed at us by the gods and, in relative security, paint their jagged and romantic course.

So, Hodges and other painters were freed to play with lightning, but were also compelled, by the incessant clamor of the times, to fill their skies with sublime meteorological effects. The pivotal word, effects, is heard again and again in the 18th and early 19th centuries, and illustrates the 18th century approach to sky painting.

One relevant and often repeated incident that uses the word, effects, involved Claude-Joseph Vernet, the preeminent storm painter of the 18th century. Caught at sea during a real storm, Vernet had himself lashed to the mast like Odysseus in order to witness the spectacle. And during this time he is reported to have said, "Give me my brushes so that I may paint these superb effects before I die."

Fig. 8-11. Claude-Joseph Vernet. *Storm*. 1777. Musée Calvet, Avignon, France.

Vernet's *Storm* (Fig. 8-11) is characteristic of 18th century stormy scenes. It is set along a precipitous shoreline. The wild sea sends towering waves smashing against the cliffs while the storm wind drives helpless ships shoreward to their doom. Tilted rain streaks issue from dark mammatiform cloud globules at cloud base to pelt the rocky shoreline and the wreck. A few of these globules are far too small to produce rain, but this did not trouble Vernet or his admirers. A distant flash of lightning, strategically placed directly over the wreck, provides a single weak source of light over the sea. The flash emits a dull yellow-orange hue and, like the storm, poses no threat whatever to the viewer.

Vernet's *Storm* drips with irony. While the sky is dark and stormy over the sea it is strangely bright and placid inland. It is as if we have been returned to the dual but shielded universe of Fra Angelico's *St. Nicolas* (Fig. 5-43). The viewer is able to stand just outside the maelstrom and watch its contrived fury with a supercilious sense of security.

Yes, the privileged people of the Age of Enlightenment were more than willing to concede a stormy side to nature, but only one that was staged and framed in snuff-lined nostrils. Thus they applauded and sought out the more histrionic 'effects' of Vernet, who,

> Swamped with commissions from French and foreign collectors, the victim of his own success,... painted innumerable melodramatic storm scenes..., done mechanically - one might almost say by the gross. In the end his talent became shipwrecked like his boats.
>
> Louis Reau. *French Painters and Paintings from the 14th Century to Post Impressionism*, p. 247.

So Hodges' *Storm and Waterspouts*, with its cloud effects, took its place in a long line of 18th century storm scenes. Fortunately, Hodges had received too strong a dose of reality during the Voyage to confine his skies and clouds to mere effects. After leaving New Zealand he pictured the intense tropical sunshine of volcanic Tahiti and the silent and massive monuments of Easter Island. One of his works even contains a morning sky full of cirrus. Hodges' generation did acknowledge his efforts, but apparently more for their supposedly imaginative effects than for any documentary value. Later in life he wrote to a friend that

> I have sometimes secretly quarreled with the world for allowing me the character of a man of genius in the display of fanciful representations than that of accurate observations.

Once the cultural world realized how literal Hodges had been, his name was erased from the ranks of creative artists and he was downgraded to the status of 'mere' illustrator. Recently, however, his reputation has been resurrected, for we are again acknowledging the importance of nature as a primary sourcebook for artists. And so, we are now finding that the dusty works of Hodges lie among the hitherto buried roots of 19th century Romanticism.

Other 18th century explorer artists are also being rediscovered. Among these, patiently preserved by the Alpine glaciers of his native Switzerland, is Caspar Wolf. In 1774, the year before Hodges returned from the Southern Ocean with his iceberg paintings, Caspar Wolf was commissioned to paint Alpine scenes. Wolf was not the first painter to represent the Alps and their glaciers but he painted them as never before.

His *Rhone Glacier*, (Fig. 8-12) captures the structural features and colors of the glacier with an almost scientific eye. Note the terminal moraine and drumlin at glacier's base, and turquoise crevasses. You can almost see the glacier gouging out a classical U-shaped glacial valley as it deforms and flows down from its birthplace high in the mountain cirques.

Today the nose of the Rhone Glacier (Fig. 8-13) is but a pitifully shrunken, dirt darkened remnant of the grand ice river Wolf painted, a testimony to the climatic warming that has taken place since the Little Ice Age ended.

Fig. 8-12. Caspar Wolf. *Rhone Glacier Seen from the Valley at Gletsch*. 1778. Private Collection Aarau, Aargauer Kunsthaus.

Fig. 8-13. Photographs of the Rhone Glacier's retreat, 1900 (top) and 2005 (bottom).

Although Wolf tromped clear across the high mountains, and so, touched the meeting point of Earth and sky, he remained content to continue the tradition of cloud effects. While these effects can be particularly awesome in the mountains, Wolf conformed too religiously to stylistic conventions to discover any new aerial vistas. In *Rosenlaui* (1778, Offentliche Kunstsammlung, Basel), he soiled the base of a chasm underneath a natural ice bridge with an almost microscopic rainbow. But Wolf's *Rhone Glacier* still remains a child of the clouds, and this Swiss Moses deserves credit for pointing the way to a promised land of mountain skies that he himself was never permitted to enter.

The movement toward the mountains predated Wolf. In 1729, at the age of twenty one, Albrecht von Haller was returning home to his native Bern from studies abroad. Looking up, he rediscovered the Alps he had known as a child. In that year he issued a volume of poetry, *Die Alpen* which anticipated Rousseau in almost every way. Haller praised the virtues of a simple and pure life in the rugged and untainted countryside and urged people to leave the corruption of the filthy, overcrowded cities. Haller was a prophet in another sense for he was also the premier physiologist of his century, credited with discovering arteriosclerosis, a disease of our clogged cosmopolitan diets. Others followed in Haller's footsteps. The Grand Tour sent young aristocrats, sons of wealthy businessmen, and even Thomas Jefferson on pilgrimages that took them over the Alps to Italy. No longer would mountains be treated as places to avoid. In 1760 Horace-Bénédict de Saussure (inventor of the solar greenhouse oven) visited Chamonix and offered a prize to the first men to summit Mount Blanc. This prodded interest while his *Voyages in the Alps* (1779) added to our knowledge of mountains and meteorology. His estimate on the Earth's antiquity was a factor that helped Darwin formulate his theory.

Of course, we must not neglect Jean Jacques Rousseau, another sometimes Swiss citizen. If ever there was a malcontent it was Rousseau, yet his writings struck key chords in the society he felt so rejected by. He called for a naive return to the womb of nature but helped awaken his century to its impossibility.

Rousseau's romantic novel, *Heloise* (1761), set among the Alps, was an instant success. Rousseau praised the pristine beauty of the Alps so persuasively that mountain climbing became a rage through Europe. In *Emile* (1762), his essay on the ideal education, Rousseau would send his breast-fed children out, "to regain in the open fields the strength lost in the foul air of our crowded cities." Rousseau then added a daydream of a physically weak and often indisposed man. Summer and winter, the vegetarian Emile bathes himself outdoors. In each succeeding year as Emile matures, the water is heated less until he is finally steeled to the icy cold of the Alpine streams. The society that read *Emile* began to dream the same dream in their heated parlors.

Fig. 8-14. Goya. *Winter: The Snowstorm*. 1786-1787. The Prado, Madrid.

Those who were obliged to pass through the snowy mountains during winter had no spare time for tepid daydreams of icy baths. And who could better show us the stark reality of winter's unforgiving frigid blast than Goya in his *Winter: The Snowstorm* (Fig. 8-14). The overcast sky allows no Sun through to brighten the scene or melt the snow. A howling wind makes the leafless tree bend in obeisance and keeps the peasants bundled up and huddled together. Before Goya, only the Chinese and a few Dutch had so effectively shown the sombre power of winter. How curious that such a painting was produced in sunny Spain! Then again, some of the worst years of the Little Ice Age lay in the future.

8.3 Conquest of the Air

Naturalistic sky painting remained almost frozen in the century preceding the American Revolution. But all through the Age of Reason, scientists and inventors were clearing the air so that a new generation of artists could see new skies.

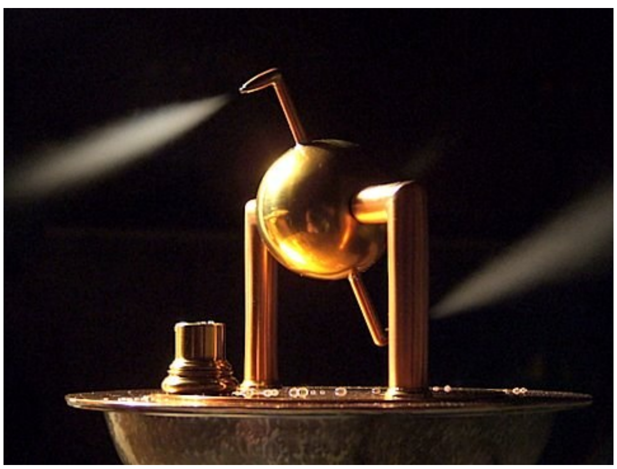


Fig. 8-15. An aeolipile or steam turbine. John R. Bentley.

The conquest of the air came in several stages. It all began long before the Scientific Revolution. The steam engine or aeolipile (Fig. 8-15) was described by Hero of Alexandria around 60 CE and may have been invented 400 years earlier. It consists of a sphere with two canted nozzles mounted on an axle so that it can rotate. The sphere is filled with water and then placed over a fire. When water in the sphere boils to vapor it expands by a factor of roughly 1000 (as all liquids do when they boil to gas) and rushes out of the canted nozzles, transforming the sphere into a rotating rocket.

The aeolipile was a toy, but as technology revived, so did the idea of using steam power. In 1606, Jerónimo de Ayanz y Beaumont was granted a patent for a steam engine to pump water out of flooded mines. Progress in steam engines almost seemed to accompany the discoveries about air made by scientists.

The thermometer and barometer finally allowed us to capture and study air. The expansion of air when heated had been known since at least the time of Philon of Byzantium in the 3rd century BCE. But the thermometer, which measures the expansion, was not invented until around 1612, when Santorio Santorio or Giovanni Sagredo added a temperature scale to Galileo's thermoscope.

When Torricelli invented the barometer in 1643 or 1644, he realized that air has weight. He found that a fluid will rise into an evacuated tube until its weight balances the weight of a column of air with the same cross sectional area. In 1647, Blaise Pascal reasoned that there would be less air above the top of a mountain so the mercury in the barometer should rise less than at sea level. In 1648 he had his brother-in-law carry a barometer to the top of Puy de Dôme in central France. When the mercury rose less at the peak than at the base, modern science had registered one of its first great predictions.

Other scientific games with air followed quickly. In 1654, Otto von Guericke invented the famous Magdeburg Hemispheres. Its two hemispheres fit tightly but could not be clamped. When the air was pumped out of the hemispheres (by the vacuum pump that Otto had invented four years earlier) two teams of six horses were not able to pry them apart, but when a stopcock was opened to allow the air back in they fell apart at a child's touch.

Von Guericke also designed an experiment that could weigh air and determine its density. He balanced two equal hollow spheres on a scale and then pumped the air out of one. The evacuated sphere became lighter and rose on the balance beam. Even though Von Guericke did not publish his results until 1672, word of his experiments 'leaked out' and soon reached England. There, in the sober halls of science, it inspired the fundamental researches of two of the Royal Society's founding members, Robert Boyle and Robert Hooke, on the effect of pressure on the density of air.

Word also reached the religious community, who, perhaps appropriately were the first to use air to reach for the sky. The conquest of the third dimension was the final prize of 17th and 18th century explorations of air. In 1670, a Jesuit priest named Francisco De Lana-Terzi extrapolated the work of von Guericke. This visionary realized that it should be possible to create a container that weighs less than the air it encloses. Once the air is evacuated, such a container should be buoyant and rise through the atmosphere. He therefore proposed an airship consisting of four thin copper spheres, each 20 feet in diameter, from which the air could be evacuated. The spheres would be tied to a gondola, which they would carry aloft. De Lana-Terzi apparently did not realize that the pressure of the atmosphere would crush his spheres but he did realize the potential military consequences of such an invention, arguing teleologically that,

> God would surely never allow such a machine to be successful, since it would cause much disturbance among the civil and political governments of mankind.

Another Jesuit priest, Lorenco de Gusmao, apparently felt that God would allow such a machine to be successful, for he actually designed a small toy hot air balloon in 1709 to entertain the King of Portugal. It was known that hot air was less dense than colder air - Varenius had written of it in his General Geography (1650). The hot, light air of Guzmao's balloon was supplied by a small fire in the carriage beneath the balloon.

The launch was successful. The balloon slowly rose and drifted innocently toward the wall, where it burned some expensive drapery and brought the curtain down on the evening's entertainment. Gusmao's indiscretion was graciously forgiven and foolishly forgotten, but would be repeated by a continent of curious scientists and inventors.

So experiments with air went on as scientists ploddingly transmuted alchemy into chemistry. Chemists began to separate air into its elemental components. In 1766, Henry Cavendish isolated hydrogen and realized it was lighter than air. Soon thereafter, Joseph Black speculated that a bag filled with hydrogen might rise. In 1772, Karl William Scheele, a Swedish pharmacist, discovered oxygen without the recognition that came to Joseph Priestley, who unknowingly repeated the work two years later and who also invented soda water in 1767. Scheele also showed that sunlight reduced silver chloride to silver and thus paved the way for photography.

Priestley described the discoveries about air in *Experiments and Observations on Different Kinds of Air*, which was translated into French in 1776. His book inspired a paper manufacturer, Joseph Montgolfier to make a hot air balloon.

Montgolfier had noticed that air heated in a fire rose. The thought probably occurred to him that if he used a balloon to trap the rising air, the balloon itself might rise. He built a prototype consisting of a small nylon bag that had an opening on the bottom to allow heated air to enter. Naturally, he heated the air by burning paper. When this balloon rose to the ceiling, he and his brother set about making a larger balloon, which was constructed of cloth and lined with paper to reduce leakage.

On 4 June 1783, the first public demonstration was given in Annonay, France and the balloon rose 6000 feet. Then, after some more testing with live subjects (a sheep, a rooster and a duck) the fancy of manned flight finally became fact. Balloon technology was improved so fast that on 7 January 1785, two men crossed the English Channel in a hydrogen-filled balloon even though leakage forced them to shed their clothes as ballast.

Artists were not exactly swept aloft by the new invention but Antonio Carnicero did commemorate an early *Ascent of a Montgolfier Balloon at Madrid* (Fig. 8-16). And the bright fringed, cigar-shaped mountain wave clouds portrayed obliquely in the limpid sky above (Fig. 8-17) show that Carnicero was thoughtful enough to provide a good wind with steady, reliable updrafts for the launching of a new balloon and a new Age.

Fig. 8-16. Antonio Carnicero. 1784. *Ascent of a Montgolfier Balloon at Madrid*. Prado.

Fig. 8-17. Long mountain wave cloud over a ridge in Nederland, CO. Paul Neiman, photographer.

CHAPTER 9
THE CROWNING OF NATURE

The 1780's was a wonderful decade for fireworks. The nighttime skies of Northern Europe and America were illuminated by the most spectacular and frequent displays of the Aurora Borealis in over 150 years. In 1783, two great volcanoes erupted - Laki in Iceland from June to November, and Asama in Japan in August. Together, they filled the stratosphere with enough dust to hide the Sun across Europe until it was about 17° above the horizon. For months, the dust laden stratosphere produced glorious, deep red twilights and lowered mean northern hemisphere temperature by 1°C.

Manmade fireworks added to the fun. In 1781, London was treated to the opening of Philippe Jacques de Loutherbourg's entertainment palace, Eidophusikon, a series of dioramas, complete with audiovisual effects that simulated nature's powers and wonders over the course of a day. It included an English sunrise, a London thunderstorm complete with manmade lightning, an Italian sunset and even the roaring Niagara Falls.

Fireworks were also set off in the political arena. The decade ended with the opening of the French Revolution, which spread until it enflamed all the skies of Europe.

These fireworks enraptured Europe's youth and revealed Nature to them as a vibrant, romantic organism rather than an impersonal, regulated clock. They watched their elders struggle with failing powers to hold the reins of the world, and knew they could do better. When their time came the youthful generation impetuously opened whole new romantic vistas. It is no coincidence that most of the earliest romantic devotees of nature - William Wordsworth, Samuel Taylor Coleridge, Ludwig von Beethoven and the painters, John Mallord William Turner, John Constable, and Caspar David Friedrich - were born between 1770 and 1775 and were youths of the 1780's.

The Romantics were not wanton profligates. Although some expressed disdain for the failed synthesis of Newtonian rationality, they worked deliberately and with scientific discipline to imbue their artistic creations with an aura of cosmological mystery. In the fall of 1797-1798, the poets, Coleridge and Wordsworth undertook a literary project to accomplish just this aim. It was designed to capitalize on

> the power of exciting the sympathy of the reader by a faithful adherence to the truth of nature....and to excite a feeling analogous to the supernatural by awakening the mind's attention from the lethargy of custom and directing it to the loveliness and the wonders of the world before us; an inexhaustible treasure, but for which, in consequence of the film of familiarity and selfish solicitude we have eyes, yet see not, ears that hear not, and hearts that neither feel nor understand.
>
> With this view I wrote *The Ancient Mariner*.
>
> Samuel Taylor Coleridge. *Biographia Literaria*. From *Coleridge: Selected Poetry and Prose*. pp 247-248.

The Romantic painters had the same aims. Detailed knowledge of science and intimate contact with nature were central to all their creative efforts, so that it was the explorers, naturalists and scientists who first opened their eyes. Coleridge is a prime example, for he never saw any of the exotic places his mariner described. In *The Road to Xanadu* (1926), John Livingston Lowes proved that Coleridge depended entirely on accounts or journals of sea voyages for virtually all the natural observations and even some of the expressions used in *The Rime of the Ancient Mariner*.

The artists eagerly absorbed all they could from the scientists they were so wary of. Thus, we find that in 1816, Goethe wrote poems praising Luke Howard, one of the two scientists who independently derived the first cloud classification schemes in 1802-1803. And this brief but intense love affair worked two ways, for it was an artist who finally used the chemists' light-sensitive silver salts to invent photography.

The camera resulted from a deliberate effort to improve the sense of realism in art. In its turn, it exercised an immediate and profound impact on painting. It freed the artist from reliance on the frail memory of a fleeting scene by providing a complete record of the moment that revealed whole new worlds of form and detail. Its impartial eye redoubled the call to 'realism', or detailed objective description, in all the arts.

The mere existence of the camera warned artists to examine and describe everything more carefully. Painters were forced to treat the camera as an informer that could expose their ignorance of nature's infinite wealth of form and detail. Thus, even without camera in hand, artists' probing eyes grew more discerning than ever before. They quickly discovered many of nature's long kept secrets and revealed them for all to see. During these years of discovery, Nature came to be venerated more than ever, and during these years the crown she wore was the sky.

9.1 Infinite, Romantic Skies

The young romantics of 1800 were not the first romantics. They got their ideas directly from James Thomson, Burke, Hume, von Haller, Rousseau, Goethe, Schiller and a host of other poets, philosophers and even scientists.

Unwittingly, the botanist, Carl Linne, better known as Linnaeus, planted one of the first seeds of the Romantic flowering. From early childhood Linnaeus had been fascinated with flowers and, by the age of eight, was dubbed the little botanist. In 1735, aged 28, he issued his *Systema Naturae*, the first modern plant classification. A confirmed classifier, he later extended his method to the animal and mineral kingdoms as well.

Soon after the early biologists mastered the Linnaean method they began to use it to categorize other aspects of nature. Thus, it was through biology that scientific order was first brought to the chaos of clouds. Two scientists thought of a scheme almost simultaneously. The first, in 1802, was Jean-Baptiste de Monet Lamarck, the man who coined the term, biology. The second was a British chemist named Luke Howard, who independently devised a similar cloud classification system in the winter of 1802-1803.

Lamarck named the cloud forms according to their morphology - clouds in sweeps, dappled clouds, sheet clouds, heaped clouds and clouds in flocks. His scheme is eminently sensible but was overlooked and never adopted for a variety of extraneous reasons. To begin with, he made the tactical error of using French names rather than Latin. Then, he published his scheme in a rather disreputable journal that included astrological weather forecasts. Lamarck's forecasting techniques were also discredited by the scientific community even though he actually established a network of weather stations and suggested the need for weather maps. Napoleon himself joined the majority, bluntly telling Lamarck to give up his meteorological researches and stick to natural history.

Luke Howard's scheme was given a better reception. Howard was born in 1772, during the same five year period as so many of the other Romantics, and was also a child of the 1780's. Years later, he recalled how, as a youth, he had been guided toward meteorology by…

> the many Northern Lights, the passing phenomena of the meteor of the year 1783 as well as the summer haze of the same year [due to the eruptions of Laki and Asama].

Howard decided to classify clouds and other atmospheric phenomena "for the benefit of Agriculture and Navigation". His approach was to apply to the sky the Linnaean method he had mastered during his studies. He saw his work on clouds as only a preliminary effort intended to facilitate further improvements in weather forecasting, but it was to have a fundamental impact in fields no one anticipated.

Name	**Description**	**Base (km)**	**Howard's Name**
Cumulus	Puffy often with flat base	< 3	Cumulus
Cirrus	Trails of falling ice crystals twisted by winds	> 5	Cirrus
Stratus	Cloud layer with low base	< 2	Stratus
Stratocumulus	Flattened cumulus confined to a thin layer	< 3	Cumulostratus
Altocumulus	Patterned high layer of small cells or waves	2 – 5	Cirro-cumulus ?
Cirrocumulus	Patterned higher layer of tiny cells or waves	> 5	Cirro-cumulus
Altostratus	Layer clouds with ripples and watery sun	2 – 5	Stratus or Nimbus
Cirrostratus	Layer clouds often with halo	> 5	Cirro-stratus
Cumulonimbus	Towering thundercloud with anvil top	< 2	Nimbus
Nimbostratus	Layer cloud producing precipitation	< 2	Nimbus

Table 9-1. Luke Howard's and Present Cloud Genera

Howard presented the scheme to his friends of the Askesian Society during its winter session of 1802-1803. The resulting paper, *On the Modification of Clouds*, appeared in several installments during the summer and fall of 1803, but did not begin to attract worldwide attention until about a decade later. His scheme (Table 9-1) still forms the basis for the cloud classification system used today.

In 1815, Howard's work was translated into German and appeared in the *Annalen der Physik*. This brought it to the attention of Johann Wolfgang von Goethe and made a lasting impression on the poet-scientist. Goethe had always counted Linnaeus as one of the three most influential thinkers in his life (the others were Shakespeare and Spinoza) and he appreciated the value of applying the Linnaean method to other fields. Many years earlier, he had made drawings of rare cloud shapes but the fact that clouds had classifiable forms escaped him. To Goethe, Luke Howard

> was the first to hold fast conceptually the airy and always changing forms of clouds, to limit and fasten down the indefinite, the intangible and unattainable and give them appropriate names.

Perhaps Goethe should have given Jan van Eyck, Piero della Francesca, Albrecht Altdorfer, Peter Paul Rubens, Jacob van Ruisdael and other painters a bit more credit, for they had discerned many of the basic cloud forms long before Howard and Lamarck were born. Still, Howard was the first scientist to methodically categorize and draw attention to the existence of order in the phenomena between the Earth and the heavens.

Armed with his new knowledge, Goethe felt the time had come for painters to capture the sense of atmospheric order. He began to lobby for an improvement in sky art. In the following year (1816) he tried to commission Caspar David Friedrich to execute a series of cloud studies. Friedrich rejected the offer, possibly fearing that such a methodical approach might diminish his power to capture the mystical essence of nature. Undaunted by this and other rejections, Goethe was finally able to enlist Johan Christian Clausen Dahl for the job. Despite these early signs of a growing emotional rift between artists and scientists, Howard's work had a documentable effect on painters, for never again could they deny the existence of cloud forms.

But the Romantic artists had glimmerings about the cloud forms before they learned of Luke Howard. In the last quarter of the 18th century, a number of British painters began to look at the skies above their native land and were impressed by the forms they saw. In 1785, Alexander Cozens published and illustrated a treatise that drew attention to the natural forms in the landscape. He also drew *The Cloud* (c. 1775-85), an excellent rendition of a towering white cumulus surrounded by some dark stratocumulus. In France, Pierre Henri de Valenciennes executed some interesting studies of clouds and fog even while maintaining the primacy of history painting.

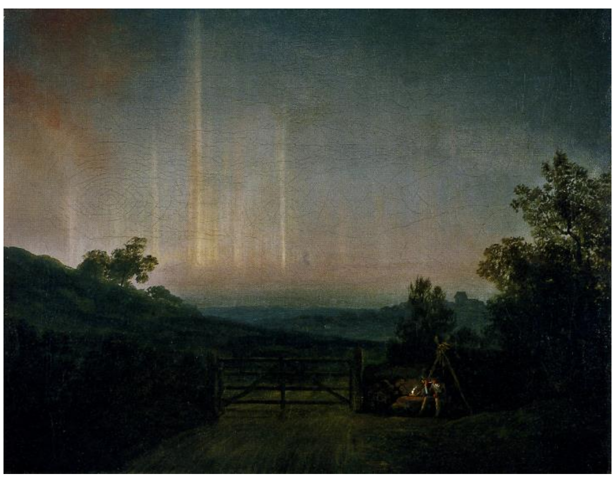


Fig. 9-1. Jens Juel. *The Northern Lights*. c. 1790. Ny Carlsberg Glyptotek, Copenhagen.

In Denmark, Jens Juel, who may well have been inspired by the active skies of the 1780's and who taught a number of Romantics including Caspar David Friedrich, painted vertical rays at the top of an auroral curtain in his *Northern Lights* (Fig. 9-1). This view makes it likely that he was well south of the main display, a donut-shaped region around the Earth’s North Magnetic Pole.

Philippe de Loutherbourg, creator of the *Eidophusikon*, and an accomplished landscape painter, was an immediate predecessor of the Romantics. He seemed to accept the primacy of nature unleashed, as in *An Avalanche in the Alps* (1803, Tate Gallery, London) where the scale of human effort is dwarfed by the workings of nature. But de Loutherbourg also maintained that technology resulting from human ingenuity was beginning to move the world. His *Coalbrookdale by Night* (1801, Science Museum, London) is one of the few landscapes of the early Industrial Revolution. It shows the fires of man lighting the night sky and producing smoky red billowing industrial cumulus that dominate nature's cumulus. The manufactured clouds soon created an atmospheric pall that dampened enthusiasm about the blessings of industrialization.

Fig. 9-2. Philippe de Loutherbourg. *A Distant Hailstorm Coming on and the March of Soldiers with Their Baggage*. 1799, Tate Gallery, London.

De Loutherbourg also helped redirect attention from cloud effects to cloud forms. An immense, towering cumulonimbus fills the sky of *A Distant Hailstorm Coming On and the March of Soldiers with Their Baggage* (Fig. 9-2), yet is still growing. The incipient anvil and ragged cloud fragments called scud, which are created as they are drawn upward into intense thunderstorm updrafts, are among the classical signs of a growing cumulonimbus. Sunlit hail swaths (which can be distinguished from the crepuscular ray just above the tree on the left because crepuscular rays never cross each other) brighten the sky beneath the growing cloud's flat base, obscuring all that lies beyond. Any soldiers who cross one of the hail swaths will at best emerge battle scarred. De Loutherbourg, master of effects, was exposing a clearly defined cumulonimbus about to enter its most violent phase. It was surely a scene he had encountered.

Hail is a truly romantic (i. e., devastating) meteorological element. It is one of the noble offspring of intense thunderstorms and admits no other parent. Hailstones are usually less than an inch across but can grow larger than grapefruits and kill the animals or people they fall on. The largest documented single hailstone, 20 cm in diameter, fell at Vivian, South Dakota on 23 July 2010. The heaviest single stone, 1.0 kg, fell in Gopalganj District, Bangladesh on 14 April 1986. A few unverified reports tell of even larger stones and many accounts attest to the incredible damage of these storms.

The Bible contains one of the earliest reports of damage caused by hail, one of the ten Egyptian plagues. In his autobiography, Benvenuto Cellini also gave a vivid account of a hailstorm he witnessed when travelling through France.

> One day when we found ourselves a day's distance from Lyons (it was nearly two hours before sunset), we heard the crackling of thunder and noticed how very clear the sky was: I was a bow's shot in front of my companions. After the thunder we heard such a tremendous, fearful noise reverberating in the skies that I was convinced it must be the Day of Judgment. I paused for a while, and there was a fall of hail, without a drop of water. The water was bigger than pellets shot from a blow-pipe, and when it hit me it was very painful: little by little its size increased till it was like the bullets from a crossbow....The hailstones grew to the size of large lemons. I sang a Miserere and while I was praying to God in this devout way a hailstone fell that was so large that it smashed a very thick branch from the pine under which I thought I was safe....
>
> In the same way one of them fell on poor old Lionardo Tedaldi who, as he was kneeling down like me, was forced onto his hands....The storm continued some while, and then stopped: we had all been given a pounding....Then a mile in front we found such a spectacle of ruin so much greater than our own misfortune that it defies description.
>
> All the trees were stripped and smashed; all the animals around had been killed, as well as a good number of shepherds. We saw a mass of stones which were so large that it was impossible to get both your hands round them.
>
> *Autobiography of Benvenuto Cellini*.

How is it possible for the atmosphere to produce and support such large meteors? Hailstones grow by accretion, reenacting the way the Earth formed 4.56 billion years ago. Intense thunderstorms have violent updrafts of warm, moist buoyant air that may exceed 100 miles per hour (50 m/s). Droplets produced in these updrafts are swept aloft, cooling with the air to temperatures far below freezing. Despite the subfreezing temperatures, only a select number of the larger droplets freeze into ice pellets, or graupel. The larger graupel have larger terminal velocities and so, are not swept aloft quite so rapidly. The rapidly rising small droplets then collide with the graupel, freezing to them on contact and adding to their mass. As the graupel grow larger their terminal velocity increases, so that they collide with droplets more frequently and grow more rapidly. Within minutes, graupel can grow to small hailstones.

Once hailstones grow large enough they either fall out of the updraft or fall despite it. On the way down they encounter warmer air and begin to melt or evaporate, but they will reach the ground if they grew large enough in the first place and so long as the warm air layer is dry and not too deep. Then they will convince people of the divinity in nature.

Caspar David Friedrich sought through his paintings to reveal the divinity in nature. Using a complex iconography, he wove deeply religious and natural themes into a single fabric. A ruined cathedral in Friedrich's iconography symbolized that...

> the splendor of the Church and her servants is a thing of the past; a different time, a different yearning for clarity and truth have emerged from her ruins.

Friedrich wrote these words to explain a now lost early painting in which a Protestant clergyman was "gazing thoughtfully up at the clouds floating lightly in a blue sky" while standing on the cathedral's ruins. God was now revealed to man through the cathedral of nature. Friedrich once remarked to a friend who was examining one of his studies of reeds, "God is everywhere, even in a grain of sand. Here I have revealed him in the reeds." More often, he chose the sky.

Friedrich was extremely sensitive to the grandeur of the sky and had an uncanny ability to enlist meteorological phenomena to reinforce or even establish the mood of his paintings. Frequently, that mood had sad overtones.

Friedrich was born in 1774, the year Goethe's *Sorrows of Young Werther* launched the German Romantic movement. Goethe had been inspired to write *Werther* by a friend's suicide. Friedrich suffered deeply from an even sadder, more personal loss. On December 8, 1787, the parish Register of St. Nicholas in his hometown of Greifswald records that Caspar's brother, Johann Christoffer, "drowned while trying to save his brother who had fallen into the water."

It is easy to read a feeling of loneliness or isolation into many of Friedrich's works; often a solitary spectator or small group is shown with backs to the viewer, surveying the infinite panoramas before them. A number of other themes, such as the ruins of Gothic Cathedrals, blasted oak trees stripped of leaves, dusk, fog, and almost inconspicuous Crucifixions atop the vast mountains appear with haunting frequency to reinforce an almost mystical mood even though they are rendered with seeming photographic accuracy.

Early in his career, Friedrich made a few notable errors in meteorology due to preconceptions and injudicious scientific reasoning that he would later correct as he fit his incisive observations to his iconography seamlessly. Notably, his meteorology improved after 1816, when he learned of Luke Howard's work. He began to devote far more care to the detailed form of his beloved altostratus and altocumulus.

In the *Tetschener Altar* or the *Cross in the Mountains* (1807-08, Gemaldegalerei Neue Meister, Staatliche Kunstsammlungen, Dresden), the Crucifixion takes place under a sky filled with pink altocumulus that reflect the light of the setting Sun. The scene has been transplanted from Golgotha to a German hilltop, complete with pine trees. The hill blocks the Sun, which seems to be the source of three glaring crepuscular rays. The rays diverge correctly from a single point behind the hill, but fade as if they had been produced by the spreading beacon of a searchlight. Since crepuscular rays are parallel sunbeams they do not fade with apparent distance (or angle) from the source according to the inverse square law, but rather in a complex manner that depends on the angular distribution of light scattered by dust and air (recall §2.1).

In the *Mountain Landscape With Rainbow* (c. 1810, Museum Folkwang, Essen), Friedrich contaminated the meteorology with an opaque, crescent-shaped bow inserted into the moonlit scene as an unfortunate afterthought. The moonlight appears behind the bow through gaps in a deck of stratocumulus, an error considering the source of light for all rainbows is behind the viewer. Most bows are brightest near the horizon but Friedrich's bow tapers to obscurity and thins improperly on both sides.

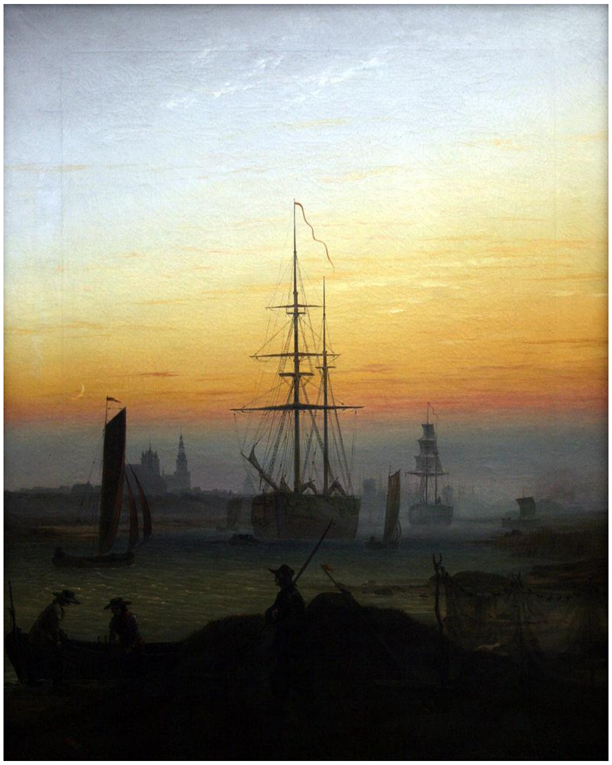


Fig. 9-3. Caspar David Friedrich. *Ships in Greifswald Harbor*. 1818-20. Alte Nationalgalerie, Berlin.

Even after 1816, Friedrich's skies could be problematic. *Ships in Greifswald Harbor* (Fig. 9-3) seems to be almost photographic but contains a glaring inconsistency. The view of the city's skyline with the distinctive tower of St. Nicolas Cathedral faces SW. The time is after sunset because the thin crescent Moon points to a Sun below the western horizon. But the dark strip of sky above the SW horizon is either Earth's shadow, which only appears opposite the Sun, or a distant fog bank or haze layer, which is unlikely considering how clear the air seems. Above the dark strip, the sky's color gradation from orange to yellow to blue and the indiscriminate white flecks of high clouds also show that the scene faces the Sun, for the sky and clouds just above Earth's shadow are rosy (recall Fig. 5-21 and see Fig. 9-16).

Such superb inconsistencies did not trouble Friedrich, for he saw the very act of artistic creation as a religious experience.

> It is not the faithful representation of air, water, rocks and trees which is the task of the artist, but the reflection of the soul and emotions in these objects.

This is reminiscent of the words and spirit of the 11th century Chinese painter, Fan K'uan. And so are Friedrich's mountains, which always seem to be trying to emerge from fog.

Because so many of Friedrich's meteorological and philosophical themes resembled those of Chinese painters, it is tempting to ask if they inspired him. Where else but in Chinese art had men so routinely retreated to the mountains and where else had they been portrayed contemplating the Moon? The Chinese had long thought of the universe in terms of a throbbing organism, a concept that resonated with the increasingly biological European viewpoint of the Cosmos. Indeed, Friedrich may well have fallen under the spell of the various oriental religions and philosophies that were beginning to fascinate Germans about that time.

By 1800, Chinese art had worked its way along all the highways of Europe, and it is reasonable to assume that Friedrich had access to some samples of Chinese landscape painting. Chinese art first began to pour into Europe in the 17th century. Cardinal Mazarin of France amassed a significant collection of Chinese art and antiques between the 1620's and his death in 1661. These Chinese artifacts remained popular through the reign of Louis XIV. During the Rococo reign of Louis XV, chinoiserie was elevated to the level of a cult.

Landscape motifs appeared prominently on many painted Chinese screens. Nevertheless, prior to 1800, the cult of chinoiserie did not have a noticeable effect on European landscape art, for at first Europeans almost unanimously disparaged the lack of proper perspective and shading in Chinese painting. Chinese landscape art simply did not conform to the accepted scheme of things.

But the Romantics grew up in a world where the ancient scheme of things was disintegrating. As a devoted landscape painter, Friedrich was also committed to overturning the established moral hierarchy of art subjects by placing the once lowly landscape at the top of the scale. Mountains emerging from fog provided an excellent vehicle for overturning the old hierarchy by inverting the normal rules of perspective and eliminating the horizon line.

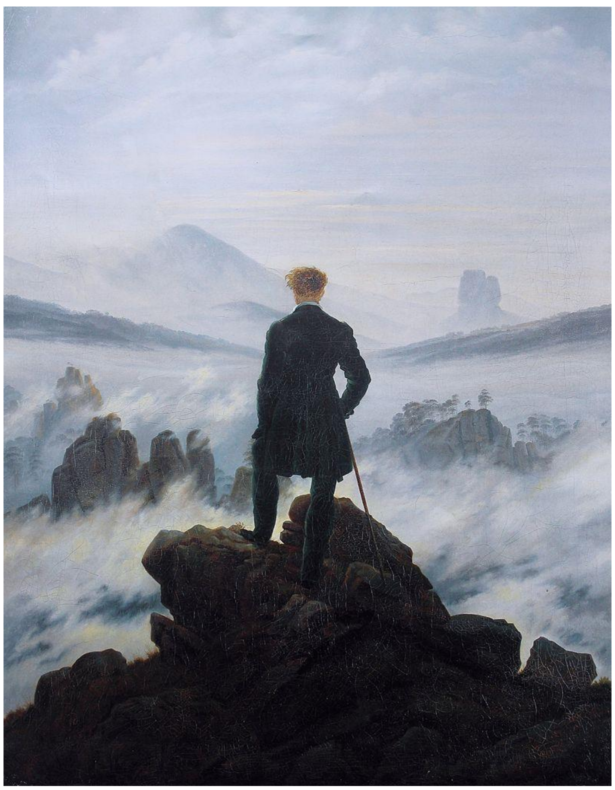


Fig. 9-4. Caspar David Friedrich. *Wanderer Above the Sea of Fog*. c. 1817-1818. Hamburger Kunsthalle.

Mountains were a major inspiration for Friedrich. Though he avoided the Alps he often traveled to the more modest mountains near Dresden. There, he revealed more truths about fog to the Western World than any artist before or since in a series of paintings beginning with the *Morning Fog in the Mountains* (1808, Staatliche Museen Heidecksburg, Rudolstadt).

Friedrich's iconic fog ode, whose location can be pinpointed, is *The Wanderer Above the Sea of Fog* (Fig. 9-4). Friedrich, the Wanderer, stands atop the jagged rocks of the Kaiserkrone in the Elbe Sandstone Mountains, with the Zirkelstein, a butte or inselberg in the right background, off to the SE, surveying the sea of fog below and the ocean of clouds above.

Fig. 9-5. Fog pouring down a cirque at Mont Blanc.

The sky is covered with altocumulus that grade to altostratus at the horizon. Friedrich periodically restated the observation that even a thin layer of middle clouds can block the low, feeble Sun of Germany and dim its land. Such skies occur in more tropical climes but do not last long enough to inspire poetry or create a philosophy, for a high, healthy Sun soon burns them out of the sky and erases them from the memory. Friedrich was a child of the North and may have been saying that we may witness and contemplate nature's dark forces only while she remains broods quietly; should she ever choose to unleash herself, we would surely be engulfed in the Gotterdammerung.

But on the day of the wanderer's hike, nature chose to show a gentle face. After a quiet night, fog has filled all the valleys. Only the peaks, aggrandized by comparison with the almost microscopic trees, emerge into the clear air and appear more distinctly than their bases.

Friedrich shows that visibility in the mountains often depends more on altitude than on distance. When fog fills the valleys, distant mountain peaks are often perfectly visible while nearby slopes and valleys are obscured. Chinese painters had been celebrating this inverted variant of atmospheric perspective for centuries but Friedrich went several extra steps by revealing the wavy or shredded structure often seen at the top of seas of valley fog, particularly if there is strong wind shear, as occurs when foggy air pours down through the gap in a cirque at Mount Blanc (Fig. 9-5).

Fog is a regular occupant of valleys during mornings around the autumnal equinox. At this time of year, the prevailing westerly winds transport relatively warm and humid air over Europe from the nearby Atlantic Ocean. The ocean, with its enormous capacity to stir heat up from its depths, remains warm long after the Sun has started south, while the motionless ground cools rapidly as the nights lengthen. Even before the Sun sets, the mountainsides begin to chill the air they touch. When this air is humid, even slight cooling will quickly bring it to its condensation point and produce fog. Then the cool veneer of dense, foggy air drains downslope into the valleys.

By dawn the valleys can be filled with a veritable sea of fog, from which only the mountain peaks emerge. And while the Sun is still low in the sky it will be too feeble to penetrate even a relatively thin layer of clouds, giving the entire landscape a gray tone. In the distance the gray fog will seem to merge with the gray clouds and can obliterate the normally distinct division between Earth and sky. On most days the Sun will heat the mountainsides and burn off the fog by noon. For a few hours, however, the early riser in the mountains may well compare himself to Noah or think in terms of the vastness or ultimate unity of the cosmos because the scale seems truly colossal and the solid Earth has essentially merged with the firmament. So, the *Wanderer Above the Sea of Mist* is a religious and philosophical landscape.

Across the English Channel, Joseph Mallord William Turner was engaged in much the same task and used many of the same tools as Friedrich. Born and raised in London, where de Loutherbourg chained the fury of the elements on stage and Luke Howard found order amidst the chaos of the clouds, the young Turner groped his way through the sulphurous fogs of a rapidly industrializing inferno. All the elements of his environment conspired to make him one of the great sky painters.

London's coal thickened fogs had been cloaking the gasping city for a long time. The recorded history of British air pollution goes back to at least 1257, when Queen Eleanor left Nottingham Castle because of the choking air produced by the burning of coal in the town below. The pollution got so bad that by 1661 John Evelyn was commissioned to conduct a study of London's air. In his report, entitled *Fumifugium*, Evelyn wrote,

> The immoderate use of...coal...exposes London to one of the foulest inconveniences and reproaches...While these [smokestacks] are belching [smoke from] their sooty jaws,...London resembles rather the face of Mt Etna...or the suburbs of hell than an assembly of rational creatures...The weary traveller, at many miles distance sooner smells than sees the city to which he repairs. This acrimonious soot...carries away multitudes by languishing and deep consumptions, as the bills of mortality do weekly inform us.

Evelyn was not exaggerating. During the evening of December 4, 1952, a high pressure area with fair skies, light winds and slowly sinking air settled over London. At first, this air was reasonably warm and humid because it had originated over the Atlantic Ocean. But no sooner did it come into contact with the ground than cooling commenced, for under the clear skies the ground rapidly radiated its heat to space. That night, droplets of fog began to condense onto the water-loving, sulphurous soot continuously pumped into London's atmosphere. By the morning of December 5, Londoners awoke to one more late autumn day of fog. Painfully inhaling the droplets of sulfuric acid, they went to work as usual even though they could scarcely see thirty feet.

Like most autumn and winter fogs this one had a most unfortunate side effect - it was self perpetuating. Fog, like most clouds, reflects a fairly high percentage of the sunlight that strikes it. Beginning on the morning of December 5, 1952, the fog's bright upper surface reflected most of London's weak December sunlight directly back into space, wasting valuable heat that would otherwise have raised the temperature and burned off the fog. Instead, the lack of solar heating depressed the temperature at ground level to 27º F while 1000 feet up it was 40º F! The classical temperature inversion so often associated with severe pollution outbreaks had formed. The cool, heavy air, with its unnatural burden of pollution, was too dense to rise, so it hugged the ground like a leaden cloak. Friction at ground level then slowed the wind to an almost complete standstill so pollutants could not even drift away. Within this stagnant air, the chilled and choking populace stoked their coal burners more vigorously than ever to keep warm, unwittingly stoking the fog as well. At times, visibility fell below ten feet.

Finally, on December 9, brisk winds swept the fog away, but by that time 4000 people had died and there were 8000 extra deaths over the next 2 months. As a result of this anthropogenic catastrophe, England finally passed their Clean Air Act in 1956. London now gets 50% more sunshine during the winter, her citizens lead healthier lives, and no longer accidentally walk into the Thames River because poor visibility keeps them from seeing down to their feet.

These noxious fogs were transformed in Turner's soul to things of great beauty and came to assume a cosmic aspect. No one before Turner ever thought of painting fog as he did in *Norham Castle, Sunrise* (Fig. 9-6).

The immediate inspiration for *Norham Castle* was one of Turner's many trips to the countryside in the north of England. Turner had first seen the old ruins of the castle in 1797 and the scene remained fixed in his mind's eye for over 40 years. On his last trip past it he commented how the subject had taken so much of his time, for he had painted it a number of times before he finally got it right. What may have helped him get it right was a new interest in the sunrise.

Fig. 9-6. J. M. W. Turner. *Norham Castle, Sunrise*. c. 1840-1845. Tate Gallery, London.

Fig. 9-7. Alaska sunset with fog and crepuscular rays through trees. Takeshi Ohtake, photographer

In the 1840's, Turner transferred his primary allegiance from sunsets to sunrises. He purchased a number of houses situated so that he could see the Sun rise over water, and often woke early to watch the 'yellow morning' Sun go to work invading 'gray dawn'.

During the clear night preceding *Norham Castle, Sunrise*, the surface cooled enough to produce an unpolluted veneer of ground fog only a few feet thick. The fog layer is so thin that the grazing animals emerge from it like mountains in Friedrich's and Chinese fog paintings. Turner's fog partly transmits and partly reflects the vividly colored light of sunrise, forming a diffuse mirror image of the sky above. This transmutes the entire scene into a symphony of light and color in which land can hardly be distinguished from air, and all the elements partially dissolve into one another. This vibrant but placid dissolution of the elements is also quite real, and resembles the magnificent Alaska sunset of Fig. 9-7, above a fog-drenched forest near Fairbanks.

Norham Castle, Sunrise is an organic synthesis of much of Turner's life and art. It integrates Claude's exquisitely illuminated sunsets, the Chinese painters' formless mists, the latest color theories, and Leonardo's dissolution of the elements.

Almost from the beginning, Turner was destined for landscape but it would be many years before he could say, "indistinctness is my forte." Trained classically to master line and tackle tempestuous subjects in the 'sublime' manner, Turner slowly evolved into the painter of *Norham Castle*. From his youth in London, he had been strongly attracted to the dramatic effects of the Eidophusikon and this shows up in a number of his early paintings such as the *Fifth Plague of Egypt* (1800, Indianapolis Museum of Art).

Turner accompanied these cataclysms with some equally cosmic but quieter landscape moments such as *Buttermere Lake* (1798, Tate Gallery, London). An invisible shower from dark, indistinct clouds produces an almost monochromatic rainbow over the misty landscape and its reflection in Crummock Water, the foreground lake. (Turner loved reflected rainbows.) Les Cowley's incisive analysis of *Buttermere Lake* (atoptics.co.uk) shows that the scene takes place near sunset around the summer solstice and faces SE, but that the rainbow (which Turner only hinted at in the study) is less than 40% of the proper size and is centered 35° too far to the right.

Turner *was* careless with his bows. Many are too small, too broad, too opaque, and too nearly monochrome inserts. Why did Turner so often downplay the rainbow's colors? First, Raymond Lee's and Alistair Fraser's color analyses of real rainbows in the *Rainbow Bridge* show that even brilliant bows are far from spectrally pure. Second, James Heffernan argued in the *Re-Creation of Landscape*, that one of Turner's (and other Romantics') aims was to restore a synthetic approach to nature he felt Newtonian analysis had ousted. Recombining the spectrum was the just the first act in a lifelong quest to rebel against Newtonian rationalism and rescue chaos from the rigid confines of order. Perhaps! But the evidence is ambiguous. At the time it was standard practice for painters to use quotations to accompany their entries in exhibitions. Why then did Turner choose for *Buttermere Lake* a selection from James Thomson's revolutionary poem, *The Seasons* (1726-1730) that adulated Newton for unfolding the rainbow's prism "from the white mingling maze"?

In any event, incipient chaos is one theme of Turner's *Snowstorm: Hannibal and His Army Crossing the Alps* (Fig. 9-8). Turner had first travelled through the Alps in 1802 and had made many drawings, but the concept of *Hannibal* took years to ripen. The crucial moment of inspiration was meteorological. During the summer of 1810, while staying in Yorkshire, Turner witnessed a thunderstorm and sketched it as it passed overhead.

> One stormy day at Farnley, says Mr. [Hawkesworth] Fawkes, Turner called to me loudly from the doorway, 'Hawkey - Hawkey! - come here - come here! Look at this thunderstorm! Isn't it grand? isn't it wonderful? - isn't it sublime?'
>
> All this time he was making notes of its form and colour.... He was absorbed - he was entranced. There was the storm

rolling and sweeping and shafting out its lighting over the Yorkshire hills. Presently the storm passed and he finished. 'There,' said he, 'Hawkey; in two years you will see this again and call it Hannibal crossing the Alps'.

Fig. 9-8. J. M. W. Turner. *Snowstorm: Hannibal and His Army Crossing the Alps*. 1812. Tate Gallery.

Snowstorm: Hannibal is a highly dramatic work showing how unleashed nature overwhelms and outshines the doings of man. The Sun, which brilliantly illuminates the valley in the distance (as in *Buttermere Lake*), has been dimmed by the storm's first swirling rain shaft and will soon be blotted out.

Swirling motions occur at the leading edge of many thunderstorms (recall da Vinci's *Deluge* scenes, Fig. 6-5) where violent updrafts and downdrafts stand side by side. Here, the curvature of the rain shaft helps trace the vortex at the storm's edge. On the right the air ascends to produce the cloud. High overhead the air spreads out to the left (possibly the anvil), carrying with it the raindrops that fall out into the clear. The rain streaks then curve back toward the cloud as they fall into the storm's inflow region.

A remarkably similar scenario occurs in so-called low precipitation thunderstorms of the Great Plains (Fig. 9-9). Here, the smooth, almost vertical edge of a pedestal cloud or wall cloud traces the updraft of a thin layer of humid air originating just above the ground, while on the left the rain shaft falling from the overhanging cloud base high above reveals the presence of the invisible inflow as it curves toward the pedestal cloud (Fig. 9-10).

Fig. 9-9. Low precipitation cumulonimbus in Limon, Colorado. Susan Henry, Photographer.

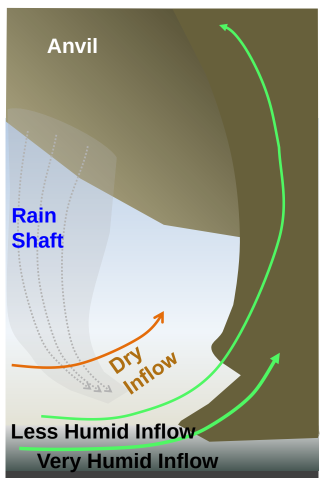


Fig. 9-10. Structure of the thunderstorm of Fig. 9-9.

The pedestal or wall cloud is an appendage commonly affixed to the base of tornadic thunderstorms. The storm's main shaft sometimes rotates visibly, in which case it is often marked by helical streaks. A tornado may extend down to the ground from the base of the pedestal cloud, as it later did in this storm.

The *Hannibal* left its imprint in John Martin's *Seventh Plague of Egypt* (1823, Museum of Fine Arts, Boston), and then, through that and other similar pieces, in Thomas Cole's *The Course of Empire IV - Destruction* (1835, New York Historical Society). Martin's *Seventh Plague* simply adds hail and lightning to what is an obvious graft from the storm in Turner's *Hannibal*.

Fig. 9-11. J. M. W. Turner. *Entrance of the Meuse*. 1819. Tate Gallery, London.

Now let us flash back to Turner. He first saw a painting by Claude in 1799 and was immediately inspired to reverence. His friend, Farington reported - "he was both pleased and unhappy while he viewed it, it seemed to be beyond the power of imitation." Still, Turner's palette remained rather subdued until sixteen years later. Then, in the spring of 1815 the huge volcanic explosion of Tambora on the island of Sumbawa, Indonesia filled the stratosphere with micrometer size particles that scatter red light more efficiently than blue light (recall Fig. 2-2 top). This reddened the entire world's twilights for months and provided Turner with the material and impetus to vie with Claude. What followed was a lifetime profusion of light and color. Turner even heightened the colors of his rainbows, as in the 1824 *Arundel Castle: with Rainbow* (British Museum).

While Turner was working on his Claudian or Tamboran sunsets, he began to show a new interest in clouds. Around 1818, he executed a series of cloud studies and from 1819, the clouds in his paintings reveal greater attention to form. This is particularly true of his altocumulus and cirrocumulus, but applies to the good old cumulus as well. Although there is no documentary evidence, the timing suggests that Turner's interest in cloud forms was probably sparked by Luke Howard's work.

In 1813, the first edition of Thomas Forster's *Researches About Atmospheric Phaenomena* was published. A good part of the book is devoted to a version of Howard's cloud classification. The modest printing quickly sold out so a revised second edition was given a much larger printing in 1815. It was this edition that brought Howard's work before a wide audience. John Constable owned a copy of this edition, and used it as a source book on clouds, adding many comments in the margins.

Turner's only comments must be judged from changes in his skies. In 1817, Turner was off for his first trip to the continent since 1802. The Napoleonic Wars were finally over and the rivers of Germany beckoned. Two years later he produced one of his best cloudscapes, the *Entrance of the Meuse: Orange Merchant on the Bar, Going to Pieces* (Fig. 9-11).

The meteorological setting shows the trip certainly had its rough and exciting moments. I will never forget the strong initial impression this painting had on me. I was disturbed by the yellow tone of the towering wall of cumulus, but in a matter of seconds the coloring and shading began to impart an impression of unbounded size to the convoluted clouds.

An advancing squall line of towering cumulus stretches diagonally from the left background across the painting, rising from the obscurity of bases lost in foam, rain streaks, and crepuscular rays, to great prominence of swelling cauliflower tops that gleam proudly in daylight. The squall line is crowned by a deck of rippled altocumulus rows, possibly due to moisture expelled from the tops of other nearby towering cumulus or cumulonimbus.

The coloring and illumination of the clouds tells that the Sun is near the horizon. Only when the Sun is low in the sky do high clouds reflect light more efficiently than the directly illuminated sides of cumulus. Furthermore, subtle gray shadows, possibly cast by the higher clouds, fall on the cumulus in the foreground. The yellow highlights that even tinge the cumulus also suggest a low Sun. Yellow cumulus is certainly not a common sight, but has been photographed (as in Robert Greenler's book *Rainbows, Halos and Glories*).

The features of Turner's works that still startle us the most occasionally prompted vicious attacks from some of his offended contemporaries. It was one such attack, directed against Turner's *Juliet and Her Nurse* (1836) that inspired John Ruskin to champion Turner's cause. The ultimate result was Ruskin's classic, *Modern Painters*, which appeared in five volumes beginning in 1843. This is the first work after Leonardo's *Treatise on Painting* to carefully inform painters what to look for and do when painting the sky.

But Ruskin began with a grudge. He set to work, savagely and methodically tearing apart the skies of most other painters, and then arguing how his hero, Turner, was virtually alone in capturing the essence of nature. Turner apparently did not like *Modern Painters*, for he was reluctant to attack other artists, and, moreover, greatly admired some of the painters that Ruskin so cavalierly and sarcastically dismissed with lines such as,

> Now watch for the next barred sunrise, and take this [work of Turner's] to the window and test it by nature's own clouds. And with whom will you do this except with Turner? Will you do it with Claude, and set that blank square yard of blue, with its round, white, flat fixtures of similar cloud, besides the purple infinity of nature with her countless multitudes of shadowy lines, and flaky waves, and folded veils of variable mist? Will you do it with Poussin, and set those massy steps of unyielding solidity, with the chariot-and-four driving up them, by the side of the delicate forms

> which terminate in threads too fine for the eye to follow them, and of texture so thinly woven that the earliest stars shine through them? Will you do it with Salvator, and set that volume of violent and restless manufactory smoke beside those calm and quiet bars, which pause in the heavens as if they would never leave it more?
>
> *Modern Painters*. Vol. I (1843) p. 212 John Ruskin

The fact is that, more often than not, Ruskin was right. Supplementing Howard's scheme with his own acute observations, Ruskin pinpointed the meteorological limitations of even some of the great artists. Ruskin had been born to an age that deified nature. He knew the cloud forms intimately and could neither remember nor tolerate a time when artists had little alternative but to paint the 'effects'. But even in Ruskin's time, many artists still refused to go to the source, and these the young author particularly scathed.

> Still, if artists were more in the habit of sketching clouds rapidly, and as accurately as possible in the outline, from nature, instead of daubing down what they call the 'effects' with the brush, they would soon find there is more beauty about their forms than can be arrived at by any random felicity of invention, however, brilliant, and more essential character than can be violated without incurring the charge of falsehood.
>
> ibid. p 206

Despite all of John Ruskin's unmitigated praise, the altocumulus cloud lines of Turner's Meuse are a bit too saw-toothed. But with time Turner improved even here. Many of his later works, such as the Venetian scenes, show the upper clouds subtly, with small patches of delicate ripples of cirrocumulus or shreds of cirrus. Turner's skies tend not to be the ones that meteorologists include in their textbooks because they only hint at the underlying cloud forms. Nevertheless, they are seen far more often than skies covered from end to end with textbook examples of cirrus mare's tails or the well ordered rows and ranks of the cirrocumulus or altocumulus that make a mackerel sky.

Ruskin came back to consider the sky again and again. With time he gained more respect for its possibilities. In Volume I he named a chapter, *On the Truth of Skies* while by Volume V he had acquired enough humility to call the appropriate entry, *On the Beauty of Skies*. He was also drawn to the sky because of its ceaseless variability and noted that the sky "is the only part of the picture of which all, if they will, may be competent judges". This is because, as Thomas Forster had noted in the preface to his *Researches About Atmospheric Phaenomenae*,

> The atmosphere and its phaenomenae are everywhere,...and we may view them whether it may be out lot to dwell in the frozen countries of polar ice, in the mild climates of the temperate zone, or in the parched regions which lay more immediately under the paths of the sun.

John Constable never left his native England, but knew that all the sky's infinite moods would eventually visit him. And while Ruskin had little patience for Constable's art, Constable had anticipated Ruskin in establishing the format for meteorological analysis of paintings in his *Lectures on Landscape Ar*t, and in realizing that the sky is the "keynote, the standard of scale, and the chief organ of sentiment" of the landscape.

Most of Constable's subjects were taken from East Anglia, the flat countryside of Suffolk and Essex counties along the River Stour in eastern England. In many of his works, as in his homeland, a great expanse of sky holds court above the flat farmland.

More has been written about the meteorology of Constable's art than of any other artist, largely because so many of his meteorological thoughts and notes have been preserved. Constable began a practice of noting the accompanying weather and sky conditions on the back of some studies when visiting the Lake District in northern England in 1806. That practice enabled John Thornes to confirm the dates of many of his cloud studies of 1821 and 1822 in his book, *John Constable's Skies*.

Fig. 9-12. John Constable. *Study of Cirrus Clouds*. 1822. Victoria and Albert Museum.

One of Constable's prime goals of the cloud studies was to rectify an early inability to make the sky emphatic but not obtrusive. In this effort he was helped by knowledge of Luke Howard's work, probably acquired through his copy of Forster's *Researches about Atmospheric Phaenomena*. The *Study of Cirrus Clouds* (Fig. 9-12) proves how well Constable knew his cloud forms. There, the unmistakable trails of cirrus slope down across a deep blue sky. His study of cirrocumulus would also win any meteorologist's praise.

But Constable's meteorology went beyond concern solely for the static forms of clouds. His notes on the back of the studies include comments on preceding and subsequent weather conditions, for Constable knew well that the sky of any given instant contains evidence of its past and future. As a result, it is not surprising that he greatly admired Jacob van Ruisdael and modeled some of his own skies on Ruisdael's ever changing skies, which, as we have seen in Chapter 7, Constable well understood.

The issue of change may help explain why the meteorological repertoire of Constable's finished works is so limited and why the forms of individual clouds are so downplayed. We are treated time and again to busy fields of cumulus with an occasional rainbow and hints of the higher clouds. Little more can be dredged from his finished skies.

In 1937, the meteorologist, L. C. W. Bonacina, pointed out that Constable's fields of cumulus are indeed quite common in the summer skies over East Anglia. But I have also seen these cloud fields, and I find a bit of subterfuge in Constable's skies. Constable was almost as averse to showing the flat bases of cumulus as were his beloved Dutch. Indeed, following in Dutch footsteps, he sought a variety of devices to hide the flat bases, using trees or cloud fragments of various shades. But the mature Constable went beyond the Dutch in using the overall lighting or chiaroscuro of the cloud web to submerge the form of clouds.

The distracting play of light on the cloud field makes it almost impossible to distinguish the individual clouds of the *Whitehall Stairs, June 18, 1817 - The Opening of Waterloo Bridge* (Fig. 9-13). This, of course, is precisely what Constable aimed at and achieved – the ultimate end product of atmospheric evolution in the long march from simplicity to complexity, from the heroism of isolated individuals of 15th century art to the anonymity of the 19th century's growing industrialized, collective masses. After that, artists would have to step beyond 'mere' representation.

Only facing the Sun or in a very misty atmosphere can lighting effects so effectively submerge the individual cloud forms of a field of cumulus (Fig. 9-14). Far from the Sun on days of high visibility, cloud outlines are easy to distinguish. Constable knew this when he painted the *Waterloo Bridge*, yet even though he looked away from the afternoon Sun (to the NE and St. Paul's Cathedral in London down the Thames) and kept the visibility high, he still disguised the cloud forms.

Fig. 9-13. John Constable. *Whitehall Stairs, June 18, 1817 - The Opening of Waterloo Bridge*. 1832. Private Collection.

Fig. 9-14. Sundrenched cumulus near Savannah, GA.

Constable began working on *Waterloo Bridge* in 1819, two years after presumably witnessing the ceremonies. Before he finished it thirteen years later, he had learned about the cloud forms, executed his cloud studies, and studied the rainbow. In 1831, he executed a watercolor, *View from Hampstead with a Double Rainbow* (Fig. 9-15), in which a shaft of sunlight illuminates a small segment of the opaque primary and secondary rainbows. Paul Schweizer has pointed out that Luke Howard illustrated two rays crossing a rainbow in his *Climate of London* (1818-1820). These are all anticrepuscular rays, rendered with scientific precision. All cross the bows at 90° angles and converge toward the antisolar point at the center of the bow's circle.

Anticrepuscular rays appear beneath the clouds in the *Waterloo Bridge* and properly converge toward a point below the horizon.

Fig. 9-15. John Constable. *View from Hampstead with a Double Rainbow*. 1831. British Museum, London.

This is probably the second major painting to represent the phenomenon (recall Fig. 6-39). Several of Frederic Church's rainbows have bright spots, which are actually pieces of anticrepuscular rays, but Church never depicted the rays themselves.

Anticrepuscular rays are produced the same way as crepuscular rays, but are seen opposite the Sun. Their apparent convergence is also a result of perspective. They are less common than crepuscular rays because aerosols are poor reflectors, scattering very little light more than a few degrees from its initial direction. Anticrepuscular rays are best seen on days when the air is pure and clouds cast distinct shadows. A dramatic example was produced by the exhaust cloud of the Space Shuttle Atlantis on 07 Feb 2001 after sunset at 1832 EST (Fig. 9-16), which extended above the Earth's shadow. By coincidence, the dark ray points to the full Moon, which is always situated very near the antisolar point.

So, why was Constable willing to divulge with scientific accuracy the precise form of anticrepuscular rays when he routinely masked the form of clouds? Constable may have loved the play of light on the landscape even more than the cloud forms. He annotated several of Forster's statements regarding the lighting of clouds, circling one paragraph in his copy of *Researches about Meteorological Phaenomena* and putting a double line under the following statememt - "All clouds are capable of becoming brighter and darker, according to their relative position with respect to the Sun." To this he added his own comment, "as seen opposite or under the Sun".

Fig. 9-16. Anticrepuscular ray from the cloud of the Space Shuttle Atlantis, 07 Feb 2001. The Moon appears just above Earth's shadow at the base of the rosy Belt of Venus. Pat McCracken, Photographer.

What is the source of Constable's love of the play of light? Constable wrote that in much of his art he attempted,

> to arrest the more abrupt and transient appearances of the CHIAR'OCSURO IN NATURE; to shew its effect in the most striking manner, to give 'to one brief moment caught from fleeting time', a lasting and sober existence, and to render permanent many of those splendid but evanescent Exhibitions, which are ever occurring in the changes of external Nature. [This artist] seeks perfection at its PRIMITIVE SOURCE, NATURE.
>
> *Lectures on Landscape* from John Constable's Discourses p 9-10.

The play of light enabled Constable to keep the moment, arrest the ravages of time, and perhaps, revive memories of the freedom of boyhood. The play of light on a field of clouds made each cloud seem indefinite. Coleridge had noted - "The moderns revere the infinite and affect the indefinite as a vehicle of the infinite." A field of indefinite clouds or misty air helped impart an aura of the infinite to the entire scene. And this could release life from its finite bounds.

The lure of the infinite gripped young Samuel Palmer. In 1819, fourteen-year old Palmer had been greatly taken by Turner's *Entrance to the Meuse* (Fig. 9-11) and had executed some of his own cloud studies. Palmer's most creative and highly visionary period came early in his career, after he had moved from London to the small village of Shoreham in Kent in southeastern England in 1826. There in the peaceful valley, he painted scenes of superabundant nature, often beneath a huge Moon whose image had been poetically burned into his mind at the age of four by his nurse. One vision of a growing, mushroom-shaped cumulonimbus briefly attended by pileus drew his attention around 1833 and led to several versions of *The Bright Cloud* (c. 1834, City of Manchester Art Galleries).

But the uncountable flocks of altocumulus and cirrocumulus that frequented the sky day and night and echoed flocks of sheep below impressed Palmer first and left him with a more enduring image. In *A Kentish Idyll* (Fig. 9-17), Palmer filled the sunset sky with myriad elements of art's first truly convincing field of cellular altocumulus, properly foreshortened near the horizon, as in Fig. 9-18.

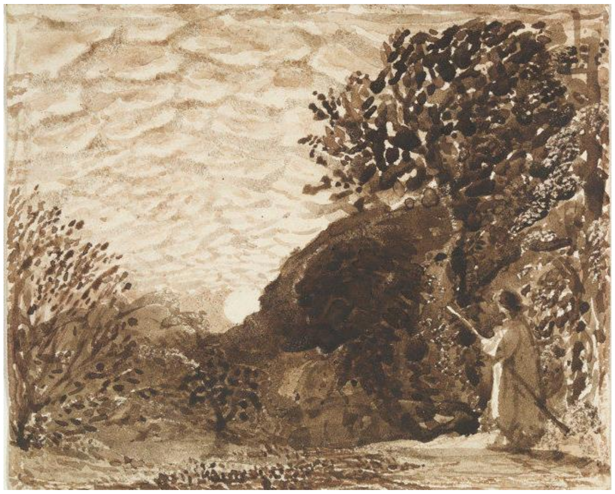


Fig. 9-17. Samuel Palmer. *A Kentish Idyll*. c. 1830.

Fig. 9-18. Perspective view of altocumulus over Boynton Beach, FL, 18 Jan 2014.

Years later, long after the visionary quality of his art was diluted by a more factual sense of sobriety, altocumulus and cirrocumulus (as well as vivid sunsets) could still stir memories of youthful ardor. In 1845 he dubbed one sighting of a mackerel sky the 'Margate Mottle' and left its traces along with streaks of cirrus in several works.

Palmer, Friedrich, Turner, Constable, and a host of other Romantic painters combined the romance and science of the sky in a new way during the early part of the 19th century. Still, as much as these devotees revered the sky they did so because, as Carl Gustav Carus put it, "the sky...is the real image of the infinite." Focusing on the particular aspects of the sky's countless faces they felt most effectively conveyed a sense of the infinite, they either ignored, downplayed or suppressed the sky's other faces. Thus, the Romantics were early contributors to the creeping intellectualization that so strongly marked so much of late 19th and 20th century art.

The Romantics were apparently looking as much to confirm and strengthen their concept of the infinite as to discover new worlds in the sky. But they did herald the dawn of an even greater age, for as their vision began to dim, a new, all-seeing eye was finally pointed at the sky. That eye would come to reveal everything the sky had to show.

9.2 Realism: The Camera, a New Eye

For a generation, France's infatuation with Napoleon blinded her to nature's grandeur. Jacques Louis David portrayed the diminutive *Bonaparte Crossing the Alps* (1801, Kunsthistorisches Museum, Vienna) as an invincible colossus, bound for victory and glory in Italy. The wind roars through the snowy pass under overcast skies and his steed rears, but Napoleon appears to disdain or even hold sway over the raging elements. He would certainly have taught Hannibal a thing or two!

David's painting is a fantasy from beginning to end. To begin with, Napoleon flatly refused to pose for the artist. So too did the sky. Benign weather accompanied thesoldiers army when they crossed the St. Bernard Pass riding on mules. Once past the summit, Napoleon used his own rear rather than a rearing steed to slide down the snowfield. His troops and all France joined the joy ride. Those who can create reality make their own facts.

Then came the Russian Expedition! The Russian commander in chief, Mikhail Ilarionovich Kutuzov, realizing his troops were no match for Napoleon's trained armies, chose the unpopular but wisest course - retreat. Deeper and deeper into Russia he fled, and Napoleon followed. Finally, on September 6, 1812, Kutuzov bowed to political pressure.

The two armies met with disastrous losses on each side. The Russian ranks were so decimated that Kutuzov was forced to revert to his tactic of retreat. Thereafter, the French would do battle only with the unforgiving winter of Russia. They got to Moscow in time to see her burned. After a few days in the deserted city, they sadly turned back home. Kutuzov and winter followed close behind, allowing no rest and showing no mercy. Finally, Napoleon deserted his own troops, stopping long enough in Warsaw to observe, "From the sublime to the ridiculous is but a step." Nature dethroned Napoleon.

A few months after Napoleon's step to the ridiculous, Joseph Nicephore Niepce began his quest to give France and the world a better way to immortalize the sublime. In 1813, Niepce, already an inventor, learned of lithography and went into business with his son, who provided the designs until called for military service. This forced the unartistic father to think of a way to reproduce designs automatically.

He began with the camera obscura. The popularity of this and related devices was then greater than ever, for they satisfied the call for faithful reproductions of scenes and objects. Even relatively inexperienced draftsmen could trace the outlines of objects appearing on the glass plate of a camera obscura more accurately than well trained artists could draw freehand.

But there was one trouble with the camera obscura. The image disappeared the instant the lens or peephole was covered. Niepce was not the only person who dreamed of fixing that elusive image forever. But to do that he had to become a chemist.

In the previous century the chemists had discovered that various salts of silver are affected by light. Johann Heinrich Schulze began all this work in 1727. He filled a flask with chalk, nitric acid and silver and obtained a white mixture containing silver nitrate. He then covered the flask with a stencil and exposed it to bright light. Wherever the sunlight shone on the mixture, it chemically separated the silver nitrate. This released tiny flecks of pure silver, turning the illuminated parts of the surface purple while the rest remained white.

As early as 1796-1802, Tom Wedgewood had coated paper and glass with silver salts in an effort to obtain permanent images of objects. But although he was able to produce an image, he could not stop the reaction in the presence of light. The coated paper proceeded to turn entirely black and the ephemeral image disappeared. The chemist Sir Humphrey Davy, who communicated Wedgewood's findings, wrote,

> Nothing but a method of preventing the unshaded parts of the delineation from being coloured by exposure to the day is wanting, to render the process as useful as it is elegant.

However, neither Wedgewood nor Davy was ever able to carry the work beyond this point. Niepce succeeded where Wedgewood failed. Niepce had also quickly realized that

> I must succeed in fixing the colors; this is what occupies me at the moment, and it is the most difficult.

It was not until 1935 that two accomplished musicians doubling as inventors (Leopold Godowsky and Leopold Mannes) adequately solved the problem of color film, but by 1822, Niepce was able to fix a shaded image. His earliest known print dates from 1826 and contains a faint image with contradictory shadows that resulted from the required exposure time of eight hours. Obviously, Niepce's method still needed a few improvements!

In January, 1826 Louis Jacques Mande Daguerre wrote to Niepce, telling him that he had been working along the same lines and suggesting they collaborate. Daguerre was a landscape painter, who designed *Diorama*, an illusionistic theatre, Always searching to improve the verisimilitude of his theatre, Daguerre had also thought of fixing the image of the camera obscura. Almost four years later, on December 4, 1829, Daguerre finally convinced the secretive and reluctant Niepce to enter into partnership. Progress was slow so that Niepce, who died only four years later, never did get to see himself in pictures.

By 1837, Daguerre had improved the process to the point where he could announce it. Within a few months of his announcement in January, 1839 the news had spread around the world. Daguerre's process initially required an exposure time of at least five minutes in bright sunlight. Then the mathematicians, engineers and chemists went to work, introducing drastic improvements in lens and camera designs as well as faster chemical reaction rates. Within two years, the necessary exposure time had been reduced to less than a minute and the daguerreotype became a rage.

The atmosphere remained less patient than the typical subject. Clouds could not stand still for even half a minute and Daguerre's chemical processes had a spectral bias that overexposed the sky. Thus, no clouds appear in the smoky skies of the early daguerreotypes. Landscape painters were influenced by these skies for they created very 'artistic' effects, but the daguerreotype was not to be the final word in photography.

A faster process was required to capture the instant and reveal the sky. The wet collodion process, invented by Frederick Scott Archer in 1851, reduced the exposure time to as little as four seconds and made cloud photography a reality. In 1856 Gustav Le Gray used this process to produce the first cloud photographs - some blurred cumulus. By 1858, after further improvements, photographic exposures had become virtually instantaneous. Artists showed great interest in this new tool and some even began to carry cameras with them or travel with photographers. Sky painting would never again be the same.

The camera was the chief vehicle that launched France on her greatest century of sky painting but other forces also aimed French eyes skyward. Napoleon had bequeathed to France the 'Orient' with all its erotic possibilities. This 'Orient' was not China and Japan but rather North Africa and what we now call the Middle East.

The first painters of the Orient, such as the Baron Antoine-Jean Gros, used their baggage of French fog and mists as a European parasol to protect against the searing Sun and roasting sands. Some of these early Orientalists, including Gros, never actually saw the lands they painted. Their works were products of second hand information, preconceived notions about the 'uncivilized' Turks and Arabs, and strongly romantic imaginations.

Many Orientalists, especially after France's successful military foray into Algeria in 1830, finally did, like Muhammad, go to the mountain. There the desert Sun burned a new religion into their eyes and dispelled the fanciful, 'Napoleonic' clouds. There they learned that fact was often stranger and more fascinating than fiction. The French also recognized the camera's documentary value in the lands of Antiquity. Within months of Daguerre's announcement, Horace Vernet took a camera on his trip to Egypt.

Prosper Marilhat set out for the Orient in 1831 as a member of a scientific expedition, but it was probably the prospect of being outdone by a camera that prompted him to dig out his old drawings of Egypt and transform them to paint. His *Ruins of the El Hakem Mosque in Cairo* (Fig. 9-19), is based on these Egyptian drawings and is one of the earliest Orientalist works in the documentary tradition.

A few lingering, infertile altocumulus have shown up in the mostly clear desert sky of the Ruins to tease any European hoping for rain. Such altocumulus is surprisingly common in the desert, especially when the Sun is low in the sky. The sky is blue above but a thin layer of dust turns the horizon sky golden and reduces visibility. Gold and red tones dominate the sun-baked setting while the stark contrasts between sunlit and shaded parts of the landscape are unforgettable to eyes accustomed to the weaker light north of the Alps.

Fig. 9-19. Prosper Marilhat. *Ruins of the El Hakem Mosque in Cairo*. 1840. Louvre, Paris.

Jean-Baptiste Camille Corot's vision was also tempered under a more blazing Sun than his native France could boast. His father wanted him to join the family business but, like St. Francis of Assisi, Camille had no inclination for such mundane affairs. When Camille's younger sister died in 1821, his parents gave him her small allowance, freeing him to pursue his career as a painter. Right away he began his love affair with the sky and land. The evaporating stratocumulus of northern France, a bit of Richard Bonington, and the indistinct verdure of his earliest works gave a hint of things to come. But Corot was convinced that a landscape painter must learn directly from nature and set off for Italy in September 1825.

Corot's early Italian works show his sensitivity to the Italian landscape and sky. The stark lighting and predominance of tan and both dark and dull green coloring lets you feel the uncompromising sun of the long, hot, dry Mediterranean summer. In most of these Italian works the skies are dry and sparsely populated with small clouds. The *Bridge at Narni* (1826, Louvre, Paris) has a line of small cumulus over the distant hills that looks as if it had been lifted from *Bellini's Transfiguration of Christ* (Fig. 5-51). Above the cumulus are wavy cloud lines that resemble altocumulus; Corot willingly admitted several different cloud types into a single painting.

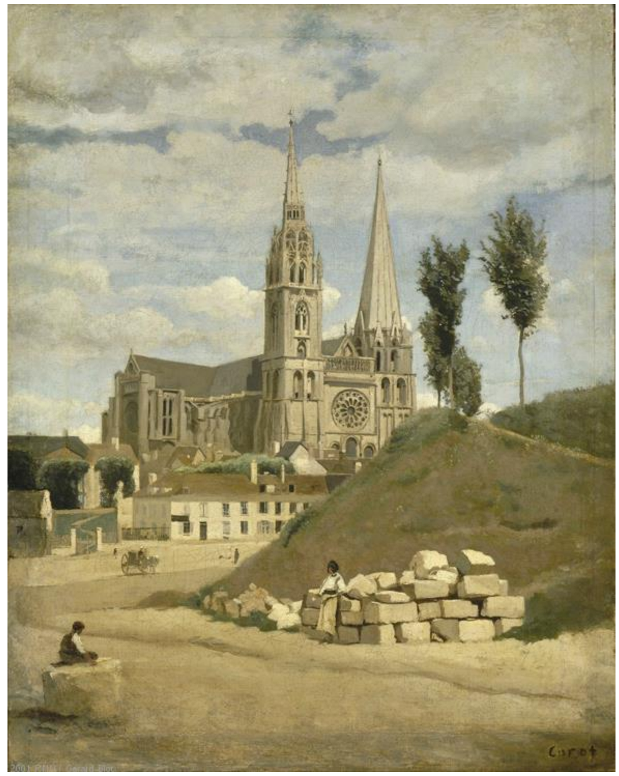


Fig. 9-20. Camille Corot. *Chartres Cathedral*. 1830 (retouched 1872). Louvre, Paris.

Fig. 9-21. Cumulus at lower right projecting into a deck of stratocumulus on a day of weak convection in Chartres.

Northern European clouds blossomed in Corot's skies the moment he returned to France even though for years he retained the dry, Italian palette. In July 1830, while avoiding the Paris Revolution, Corot quietly painted *Chartres Cathedral* (Fig. 9-20). He designed it with several pairs of objects, perhaps to provide employment for future generations of art historians. Two tall trees on the mound seem to be nature's symbolic response to the cathedral's unique towers. In the foreground, a man and a woman almost seem to grow out of the rocks. Corot may have added these people in 1872 when he retouched the work. At the same time, he may also have added two types of clouds in the sky above the cathedral.

It is mid-afternoon, for the Sun boldly strikes the western face of the Cathedral yet still casts short shadows. Near the horizon, some small cumulus with smoothed outlines show that convection has been barely able to lift the heated air from the ground to its condensation level. A short distance above the condensation level the rising currents encounter a layer of warmer air that stifles any further ascent. The cumulus are abruptly capped and are forced sideways. As a result, some of the cumulus have spread out into almost pancake-shaped stratocumulus, so often seen on afternoons of suppressed convection. On such days, widely spaced cumulus chimneys frequently project from lower bases into a stratocumulus deck they have produced, as in Fig. 9-21, but Corot has not shown this.

When convection is weak, gaps will be left in the stratocumulus deck. But even if the stratocumulus do spread to cover the sky, internal convective circulations soon fracture the sheet into the classical pattern of narrow-fringed closed cells (recall §5.2).

The cumulus behind Chartres Cathedral are brighter than the stratocumulus above because optically thick cumulus reflect more light from their sunlit sides than flattened stratocumulus can transmit through their bases. Later, the young Monet would take great delight in capturing the small lighting differences between different cloud types - perhaps he first learned to do so from Corot.

Fig. 9-22. Camille Corot. *Ville d'Avray*. c. 1867-1870. National Gallery, Washington.

After working with a number of skies of varying cloud cover but invariably weak convection, Corot developed the poetic style that brought him wealth and public acclaim. *Ville d'Avray* (Fig. 9-22) is a classic example of this style. It evokes the feeling of a misty, Elysian landscape but is a seductive sham designed to keep you off balance. The mass of grass, reeds, and foliage appear as indistinct as if seen through frosted glass, but a sprinkling of bright spots (ala Constable) and sharp edged limbs and branches that terminate with a few distinct leaves intercede to provide substance. Not a single ripple can be seen on the water, yet its unpolished surface only permits a delicately blurred reflection of the chateau. It would seem not only to be absolutely calm but also misty, yet if that were the case why are the buildings in the *Ville d'Avray* so distinct?

What led Corot to such dreamy views (Souvenirs)? His vision came at an age that is often critical for men and may have been prodded by the loss of his parents. But Corot was also indebted to Watteau and Fragonard for their gelatinous verdure, to the camera for its various tricks (and shortcomings), and to Charles Daubigny, a painter of the Barbizon school, for his love of mist and light. Corot well knew the process was complex, noting, "One has to give the mists time to rise."

After the July Revolution of 1830, a number of painters had fled Paris for the peace of the countryside near Fontainebleau and the village of Barbizon, where they learned to revel in nature. The Forest at Fontainebleau faithfully served several generations of French landscape painters. Photographers were welcome and sought out. From there, troops of painters and photographers set out on forays to France's north coast, another favorite artistic setting.

On one such trip, Corot was taken by Daubigny's overriding concern with the effects of mist and light. There he also succumbed to the spell of the camera's potential charm. (Corot's fascination with the camera was enduring - in later years he frequently visited the studio of the photographer, Gaspard-Felix Tournachon.) Early photographs required such a long exposure time that leaves swaying in the wind would produce frosted images and tiny waves would give water a matte finish. Blurred images could also be produced by changing the focus. The Barbizon painters (who refocused French attention on the sky) and photographers found such effects aesthetically appealing and cultivated them further by coating the glass plates with dust films. Corot took the camera's technical limitations and distortions and transformed them into a new form of poetic art.

In most of the Souvenirs, Corot faded his skies unobtrusively into the background. In the *Ville d'Avray*, only the tiniest cumulus gives a hint of structure to a sky otherwise filled with an amorphous, translucent cloud layer. But out of the midst of his reveries, Corot would occasionally recall his old cloud friends. In the *Souvenir of Lake Nemi* (1865, Art Institute of Chicago), a delicate layer of stratocumulus or altocumulus glow white overhead but reflect the pink tones of the horizon sky.

Intoxicating as these impossibly poetic visions are, Corot was never satisfied with his own ability to capture the beauty of the sky. As he lay dying, new visions came to him.

> You have no idea of all the new possibilities I see - a host of things I never noticed before. It seems to me that I have never been able to do a sky.

Jean-François Millet and Jean Desire Gustave Courbet came closer to capturing some of the atmosphere's exquisite possibilities. They were among a host of landscape loving artists brought out of the woodworks by the Revolution of 1848 and stamped by its radical politics. But while the political (and other) subjects broadcast from Millet's and Courbet's foregrounds kept them embroiled in dated controversy, the unsurpassed beauty of their background skies will vault them through the ages.

Millet was born of successful peasant stock in the seaside hamlet of Gruchy in the village of Greville, about ten miles west of Cherbourg. There earth, sea and sky meet. Millet remained a man of the earth, ever sensitive to the vibrancy of the rural sky. As a child he witnessed an intense coastal storm on All Saints' Day (November 1) that may first have tuned him in to the power and majesty of nature. The storm roused the congregation from church to the edge of the sea for a rescue effort that proved fruitless. Years later, Millet vividly recalled the storm and its effects,

> Though I was quite a child it seemed to me that I was looking on at death playing a ghastly sport with a handful of doomed and helpless creatures, before dashing them upon the rocks and whelming them at last beneath the waves.
>
> An immense billow towering aloft like a mountain enveloped the ship and swept it close to where we were standing, when another wave even bigger than the first hurled it upon a reef just hidden beneath the surface of the waters. Immediately the sea was covered with wreckage of every description....We spent the night trying to protect our own houses. Some covered their roofs with

> boulders, others brought up ladders and long poles which they made fast to the roof to keep it from being carried away. Trees, bowed to the very earth, cracked and broke in two.
>
> *Millet*. Paul Gsell 1928, p 10.

Millet, who is known primarily for his sympathetic portraits of country folk, is actually one of the great and overlooked sky painters. During the last decade of his life, he grew particularly intent on capturing the faces of the sky, observing that, "Art began to decline from the moment that the artist did not lean directly and naively upon nature."

Millet preferred to shelter his peasants under the placid sunset skies of summer, but no mood of nature escaped his eye. He used the cellular altocumulus to broaden his horizon and prove that the world continues beyond the *End of the Hamlet of Gruchy* (1865-1866, Museum of Fine Arts, Boston). After nightfall he encircled the Moon above the *Farmyard by Moonlight* (1868, Museum of Fine Arts, Boston) with one of art’s few coronas, while in his *Starry Night* (c. 1855-1867, Yale University Art Gallery, New Haven) there were no city lights to drown out a shooting star flashing across the sky. When the weather turned harsh, Millet was there to show how the wind can sweep across the landscape to make the trees bow before it, and how winter's desolate and snowy grip puts to sleep the land's fertility, as in his *Farmyard in Winter* (1868, Museum of Fine Arts, Boston).

Millet also stayed to greet the king of clouds. *Coming Storm* (Fig. 9-23) represents an almost literal transcription of the weather at the edge of an approaching severe thunderstorm (Fig. 9-24). The base of the storm is advancing from the left and has already covered everything but the distant horizon. Below the general base of the storm is a pendant shelf or arc cloud or arcus, and in the darkness below rain streaks tilted by the outflow pelt the ground. The painting captures the moments before the deluge. The air in the foreground is still warm and humid, the wind is light, and not a drop of rain has fallen. But the plowman sees what is about to break upon him. He has unhitched his team and is dragging it towards shelter, following the lead of two birds that are fleeing at upper right. In a few moments, violent wind gusts will arrive from the left to whip dust into the air, the temperature will drop abruptly, lightning will flash, and intense rain or possibly hail will pelt the Earth.

Fig. 9-23. Jean-François Millet. *Coming Storm*. 1867-68. Museum of Fine Arts, Boston.

Fig. 9-24. Arc cloud beneath a severe thunderstorm.

The curved arcus advancing like a plow from the left marks the leading edge of the cold outflow from the thunderstorm's downburst where the cold air turns abruptly upward and then curves back on itself to form a vortex (see Fig. 6-3), much as Leonardo envisioned in his *Deluge* scenes (see Fig. 6-5). When the downburst is rain-soaked, even the small amount of lifting at the front of the vortex cools the air to the point of condensation. Ragged cloud fragments then trace the unforgettable rolling motion at the base of the arc cloud that surely inspired da Vinci in his *Deluge* scenes and Soga Shohaku in his silkscreen, The *Chinese Immortal, Ch`en Nan Causing a Rainstorm* (see Fig. 9-52).

The arc cloud's ragged underside is often the darkest part of the thunderstorm. Much of the illumination then comes from the distant sky and can produce the orange-brown color that Millet has shown. Rayleigh scattering (see §2.1) has removed the blue light from the distant illuminated horizon, and the earth tones are further enriched by light scattered by dust raised into the air or reflected from the ground.

Fig. 9-25. Jean-François Millet. *Spring*. c. 1867-1873, Louvre, Paris.

Millet's stunningly beautiful *Spring* (Fig. 9-25) acts as a fitting sequel to *The Oncoming Storm* and is perhaps the final synthesis of his natural vision. Now, the thunderstorm has ended and is retreating in the east although a fine rain may still be falling. The pristine air and glistening vegetation have been cleansed by the rain that has filled the ruts in the path with elongated puddles. The Sun has come out once again. It shines intensely on the glorious late springtime landscape and on the retreating veil of rain to produce a double rainbow that stands out against the backdrop of the dark storm cloud. Cloud fragments called scud form in the rain-washed air and race after the parent cloud, as they often do after rain has soaked the ground and the air just above it. At the extreme upper right, fragments of altocumulus occupy a small patch of blue sky, reconfirming the rainbow's promise of redemption. The birds, seeing all is safe, once again are soaring joyously. The man, who has miraculously survived the storm beneath a tree in the distance without being electrocuted, will soon follow their lead and walk freely once again.

The alteration between storms and calms drew the attention of the omnispective Gustav Courbet. This founder of *Realism* (and likely coiner of the term) seemed to see and render everything. In the *Origin of the World* (1866, Musée d'Orsay, Paris), Courbet exposed explicit details of a woman's genitalia that had been in effect paved over by artists and sculptors for two millennia, and he was an equally explicit and expert guide to the Earth and waters below and the sky above.

Courbet took great joy in depicting raging storms and their impact on the sea at the coast of Normandy. Like Millet, Courbet knew as well that no matter how violent the storm, the sea and sky eventually return to their normally quiet summer ways, as he has shown in the *Cliffs at Étretat After a Storm* (Fig. 9-26).

The scene faces west on the Normandy coast. A bright afternoon Sun illuminates the light green grass, the white sand, the white foam of the breaking waves, and the pink and white cellular altocumulus that brightens and fills the turquoise sky. Even the east face of the white cliffs, mostly shaded by the afternoon Sun, shares the luminous quality. The cliff is composed of the same chalk as England's White Cliffs of Dover and was deposited at the same time – late in the Cretaceous, the Age of Chalk. It is strange that while Courbet rendered the altocumulus cells in such loving detail he almost completely erased the prominent horizontal layers of the chalk cliff (Fig. 9-27).

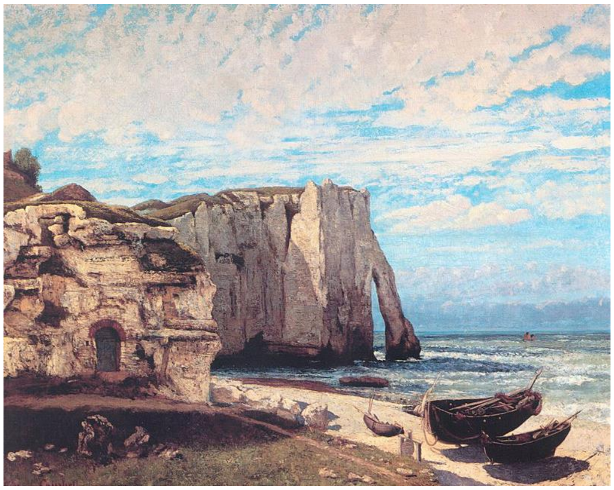


Fig. 9-26. Gustav Courbet. *The Cliffs at Étretat After a Storm.* 1870. Louvre, Paris.

Fig. 9-27. Cliffs at Étretat from the east. Christella.

This bright painting gives signs that the forces of darkness lurk everywhere. A line of overcast darkens the western horizon, making it possible that another storm is on the way. Short-crested waves, toppled by a brisk NW wind, spill far out from the shore. Ironically, the seeming innocent and innocuous layer of altocumulus may be the most prominent signpost of recent storminess because such cloud layers are often born as the shredded anvil outpouring of the thunderstorm’s violent excesses.

Several artists including Altdorfer and Turner had already hinted that some altocumulus and cirrocumulus are the residues of cumulonimbus, which eject a significant fraction of their water from their anvils. Altocumulus may briefly form as the spreading tops and anvils of convective clouds are stretched thin and shredded by strong jet stream winds aloft. The shredded anvils soon evaporate to form invisible, humid layers that continue moving downwind. Then, when evening approaches the humid layers cool to the point of condensation and altocumulus often magically reappear far downwind from the parent thunderstorm and long after it gave up the ghost. As a result, it is not strange at all to see sheets of altocumulus simultaneously invading all quarters of the sky from late afternoon onward. Similar altocumulus often form at the top and leading edge of thick layers of warm, humid air to herald the onset of warm weather, but then the sky tends to be washed out and hazy, as in Friedrich's, *Wanderer Above the Sea of Mist*.

Courbet first recorded altocumulus and its thicker, duller cousin, altostratus years earlier, on one of his frequent visits to his birthplace, Ornans, in the Loue River Valley of eastern France. Judging from his many portraits of its topography and skies, he obviously loved the beautiful setting of the town in the valley and the surrounding plateaus lined with limestone cliffs. Three of these paintings done in the summer and fall of 1849 can be pinpointed (Fig. 9-28) and arranged to illustrate successive frames of a standard weather sequence of an extratropical cyclone (recall §7.2).

Grape-picking at Ornans (Fig. 9-29, Winterhur, Oskar Reinhart Collection) faces NE and the cliff of Roche du Mont. Assuming that weather moves from west to east, we see the leading edge of a deck of altocumulus, altostratus or cirrostratus advancing from the SW. Such clouds are often the first sentinels of an approaching low. The afternoon is still bright but it is wise to pick the grapes quickly, for time is short!

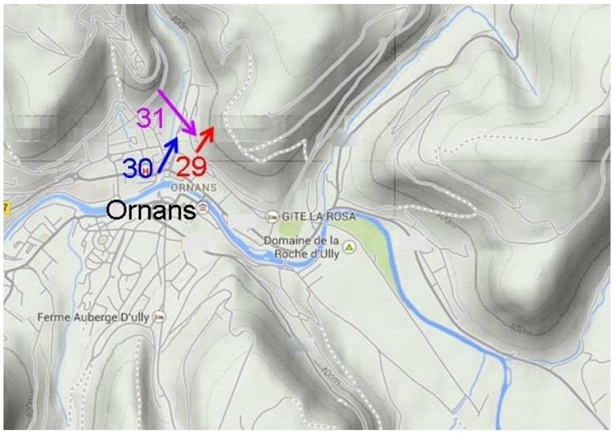


Fig. 9-28. Topographic map of the Loue River Valley around Ornans with settings and viewpoints of Figs. 9-29, 9-30, and 9-31.

Fig. 9-29. Gustav Courbet. *Grape-picking at Ornans.* 1849, Winterhur, Oskar Reinhart Collection.

The putative forecast of *Grape Picking* might well be confirmed by the more famous and far more controversial *Funeral at Ornans* (Fir. 9-30, Louvre, Paris). Here, Courbet covered the sky with a somber double-layered altostratus – an overcast upper deck and a broken but likely filling lower deck that darkens the sky further. This he may have done as a gesture of respect for the dearly departed, but it surely suggests a more dismal weather outlook. Rain should soon follow this funeral.

Fig. 9-30. Gustav Courbet. *Funeral at Ornans*. 1849. Louvre, Paris.

Fig. 9-31. Gustav Courbet. *The Valley of the Loue in Stormy Weather*. 1849. Strasbourg Museum.

The Valley of the Loue in Stormy Weather (Fig. 9-31, Strasbourg Museum) could well be the next meteorological frame in the series, and is so literal it surely contains a weather forecast. The scene faces SE down the Loue Valley with the NW face of the cliff of Roche du Mont shining in the afternoon Sun. Some of the leaves have already turned color, so that it is probably early fall. Despite the sky’s overall darkness, it has the classic appearance seen at the end of a winter storm. Shreds of scud race (and tilt upward) from right to left (SW to NE) beneath the broken and lifting layer of altostratus. Visibility is unlimited, indicating the invasion of cold, dry air further cleaned by recent rain. We will see a less 'realistic' but more poignant rendition of such an impending clearing with some of Van Gogh's last works (see Fig. 10-26).

Apart from a funeral and a storm or two, the mid 19th century was the grand era of altocumulus. Attention had first been focused on the infinite ranks and rows of altocumulus at the beginning of the century by Luke Howard and the Romantics. By mid-century it had become the time of the masses and the *Communist Manifesto*. And what cloud could better represent such times than the assembled, proletarian masses of altocumulus? But perhaps it was the camera's all encompassing eye as much as any inchoate Romantic yearning for the infinite or any communist or democratic sympathy for the rapidly proliferating population that alerted artists to all the potentialities of the altocumulus. For it was not until Courbet's *Cliffs at Etretat after a Storm* that a European painting really showed the altocumulus in full glory and photographic detail. And it is not surprising that Courbet, the 'realist', unabashedly used the camera from the time of the *Funeral at Ornans*.

The close association of the camera and altocumulus was not limited to the European side of the Atlantic. The new worlds of detail effortlessly revealed by the camera demanded of all artists an unprecedented commitment to close scrutiny of nature and a greater level of awareness of everything in the world around us. This heightened consciousness of nature and new dedication to revealing its faces brings us across the ocean to America.

9.3 America's Banner in the Sky

In 1818, America was still a land of unclaimed skies when Thomas Cole, enchanted by images of America's natural scenery touted in travel books, convinced his parents to leave behind the smoky pall of industrial England. Prior to Cole, most American painters had attempted with little success to adapt European themes to the American scene, and would leave for Europe to disappear there forever the moment the opportunity presented itself. British born Cole would help change all that.

At first, Cole earned his bread painting portraits. But in the spring of 1823, he heard the call of America's Wilderness and went out to do studies from nature. Moving to Philadelphia the next year to study the Masters, Cole saw a few of Thomas Doughty's and Thomas Birch's early works of scenic America. This brought his days as a portrait painter to an abrupt end. In 1825 he moved to New York. There he heard about the magnificence and untrammeled beauty of the Catskills, and in the fall set out to paint in the vicinity of the celebrated Catskill Mountain House.

The Catskill Mountain House had opened in 1823 and quickly became one of America's premier resorts. Perched on a ledge atop the east face of the Catskill Mountains overlooking the Hudson River Valley (see Fig. 9-36), the Mountain House served as the gatepost to America's sublime wilderness, then embodied by the Catskills. In the decade before the Mountain House was erected, writers such as Washington Irving, James Fenimore Cooper and William Cullen Bryant helped initiate America's love affair with its natural beauty by praising the sublime qualities of the American wilderness. The east face of the Catskill Mountains around the Mountain House and Palenville, New York served as the focus of their attentions. Years earlier, Rip Van Winkle fell asleep to the tune of a summer thunderstorm in Sleepy Hollow, one and a half miles north of the site of the future Mountain House. Artists were drawn like flies to the site so that an astonishing number of works by Cole and other members of the so-called Hudson River School show topographic or composite views at or within two miles of the Mountain House.

Cole's first landscapes, based on views near the Mountain House, immediately struck a responsive chord. At the end of 1825, John Trumbull noticed three of Cole's works in the window of a New York frame shop and remarked, "This young man has done what all my life I have attempted to do in vain." Cole was forthwith adopted by New York's leading cultural and business figures as the champion of a new, American art form. Four years later, Cole's departure for Europe so worried William Cullen Bryant that the poet composed the following verse as a plea that Cole not succumb to Europe's lure and not defect from the new American cause,

To Cole, the Painter, Departing for Europe

Thine eyes shall see the light of distant skies:
Yet, Cole! Thy heart shall bear to Europe's strand
A living image of our own bright land,
Such as upon thy glorious canvas lies.
Lone lakes - savannahs where the bison roves -
Rocks rich with summer garlands - solemn streams -
Skies where the desert eagle wheels and screams -
Spring bloom and autumn blaze of boundless groves.

Fair scenes shall greet thee where thou goest - fair
But different - everywhere the trace of man.
Paths, homes, graves, ruins, from the lowest glen
To where life shrinks from the fierce Alpine air.
Gaze on them, till the tears shall dim thy sight,
But keep that earlier, wilder image bright.

Bryant had no need to worry. Cole absorbed the lessons of Europe, meeting with Turner, Constable and John Martin among others. Then two years later he returned, with unflagging dedication and better equipped to paint America's land and skies.

The contrast between mature, cultured Europe and coarse, youthful America deeply impressed Cole and provided him with the material for a serial allegory of paintings showing civilization's evolution from its savage beginnings through its zenith to its ultimate demise. About a year after his return he began *The Course of Empire* (compl. 1836, New York Historical Society).

Cole designed *The Course of Empire* as a meteorological odyssey that takes place at a particular spot over the course of a single day. The first painting, the *Savage State*, is set in an almost primeval forest just emerging from the mists and fog of night. The rosy hues of dawn break through an opening in the cloud cover and are splashed all over the canvas. Civilization has arrived by the second scene, the *Pastoral State*. This is set in mid-morning when the last heated and evaporating remnants of fog are slowly rising up the distant mountainside.

The third scene represents civilization's *Consummation*. A few small disorganized patches of altocumulus drift across a milky blue summer sky of mid afternoon above a thriving classical port. It appears as if nothing could possibly disturb such a society. But distant, inconspicuous and growing cumulus, almost invisible through the haze and hidden behind the monument in the center, provides a subtly ominous note.

There is nothing subtle about the fourth scene, *Destruction*. This is a cataclysm lifted directly off the canvases of Turner and Martin, a swirling late afternoon thunderstorm that accompanies destruction and rapine.

The final scene is *Desolation*, a moonlit view of the crumbled and abandoned city, now being reclaimed by forest and ivy. Above this setting of disintegration and vegetative proliferation, a veneer of stratocumulus or altocumulus clouds is overgrowing the gray-blue moonlit sky of dusk.

The Course of Empire is tinged by Cole's penchant to stress cloud effects at the expense of cloud form. Cole was deeply religious and committed to showing the presence of the divinity in the American wilderness. As a result he included more than a random share of blasted tree trunks, precipitous crags and gorges, stark lighting effects, and hyperbolic storms. But on numerous occasions, he made quite literal paintings and statements about the landscape, the sky and its clouds. His ecstatic 1836 *Essay on American S*cenery not only shows his great sensitivity, knowledge and awareness of his art and its significance, it gave the title to this book

> The sky will next demand our attention. ***The Soul of All Scenery***, in it are the fountains of light and shade and color. Whatever expression the sky takes the features of the landscape are affected in unison, whether it be the serenity of the summer's blue or the dark tumult of the storm....The climate of a great part of the United States is subject to great vicissitudes, and we complain, but nature offers a compensation. These very vicissitudes are the abundant source of beauty - as we have the temperatures of every clime so we have the skies...the blue unsearchable depths of the northern sky;... the upheaped thunderclouds of the torrid zone;...the silver haze of England and the golden haze of Italy....For variety and magnificence American skies are unsurpassed....The American summer never passes without many sunsets that vie with the Italian, and many still more gorgeous, that seem peculiar to this clime. Look at the heavens when the thundershower has passed, and the sun stoops below the western mountains - then the low purple clouds hang in festoons around the steeps - in the higher heaven are crimson bands interwoven with feathers of gold; and still above is spread that interminable field of ether, whose color is too beautiful to have a name.

Cole’s *Notch of the White Mountains* (Fig. 9-32) is about as literal as you can get. It faces SSE to Mount Jackson and the opening of Crawford Notch. It is late afternoon in September, with another of Cole’s dramatic thunderstorms moving off to the east, clearing the sky. But in the Notch is a fractostratus no one could have dreamed up without seeing. Vapor condenses as rain-soaked air streams up the notch to form a shredded cloud that hugs the ground, just as it is wont to do (Fig. 9-33).

Catskill Creek (Fig. 9-34) may be the crystallization of Cole's natural vision of the sunset sky's "crimson bands interwoven with feathers of gold", while Fig. 9-35, a late winter sunset, fittingly observed along the Hudson River at Palisades, New York, confirms that the painting’s sky and clouds are near photographic.

Fig. 9-32. Thomas Cole. *Notch of the White Mountains*. 1839, National Gallery of Art, Washington, DC.

Fig. 9-33. Crawford Notch with scud moving up the valley shortly before the end of a storm.

Catskill Creek is a composite. The artist stands at a section of the meandering creek just west of the town of Catskill that faces WSW across the 8-mile wide plain to what should be the Catskill Escarpment or the Great Wall of Manitou. But the purple wall of mountains in the background is an accurate topographic view that can only be seen facing SW from an elevated location such as Artist’s Rock, a bit north of the Catskill Mountain House (Fig. 9-36). The high point in this wall, which is reflected in the still waters of the creek, is the asymmetric Kaaterskill High Peak.

Fig. 9-34. Thomas Cole. *Catskill Creek*. 1845. New York Historical Society.

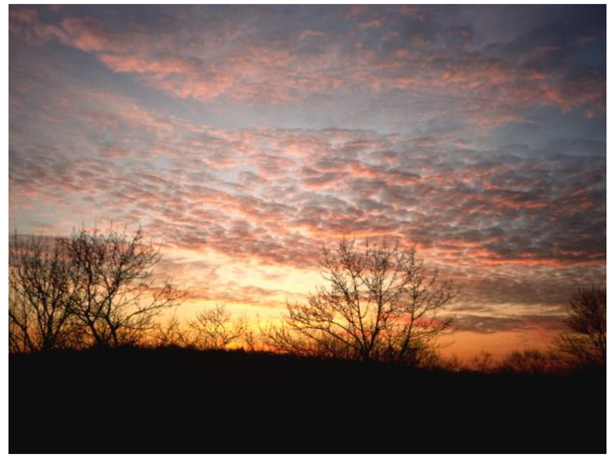


Fig. 9-35. Sunset with Altocumulus, Palisades, NY.

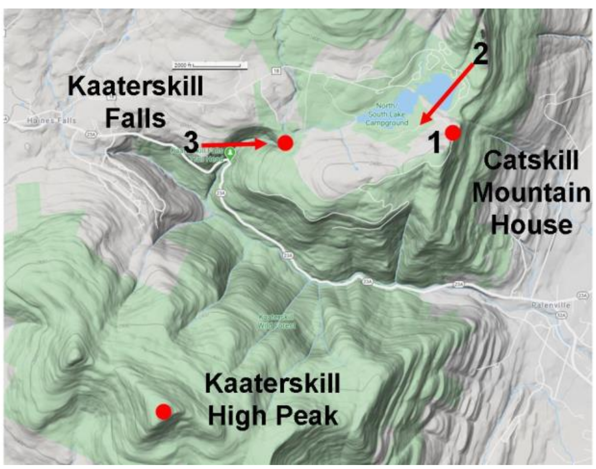


Fig. 9-36. Topographic map showing 1: Catskill Mountain House, 2: *Catskill Creek* (Fig. 9-34) part of composite view facing SW to Kaaterskill High Peak from Artist’s Rock, 3: *Kauterskill Clove* (Fig. 9-39) facing E to Kaaterskill Falls.

One very unusual fact about *Catskill Creek* is that the study, in the National Gallery, based on a view from Artist’s Rock, treated the sky and its clouds (which includes a streak of cirrus omitted from the finished painting) while leaving the foreground dark and nondescript. This contrasts with almost all landscape studies, which leave the sky blank or nondescript. This suggests Cole’s inspiration for *Catskill Creek* was its cloud-laced sky.

There is one likely artifice in *Catskill Creek* – the almost inconspicuous smoke plume just beginning to taint the distant atmosphere near the foot of the purple peaks. As a boy, Cole knew the impact of England’s smoke plumes all too well and made it a point to warn America of this subtle but unyielding incursion of civilization into the sublimely innocent American scene.

But when we look at its clouds, we must affirm that *Catskill Creek* is, quite simply, the first photographic rendition of sunset altocumulus cells in the history of art, predating Millet's and Courbet's by two decades. Cole painted almost identical altocumulus in only one other work, *The Hunter’s Return*, Amon Carter Museum of American Art - Fort Worth, TX, also in 1845. It therefore raises an intriguing question. Was Cole aided by the camera? There is no evidence that he worked from a photograph when he created *Catskill Creek*; in fact, the camera was simply not able to capture details of cloud structure until after 1851, when the wet collodion process reduced exposure time to a matter of seconds. Recall that the first known photograph of clouds was taken by Gustave Le Gray in 1856, and the first known photograph of altocumulus was a striking shot taken in 1857 by Frederic Church.

The mere awareness of the camera's ultimate potentiality may have redirected Cole's eyes from the effects to the details of the world of nature. Cole first learned of the camera within days of the time Samuel Morse brought news of it to America in 1840. Cole had himself photographed in 1841, and in 1844 even tried to obtain a photograph of Albany to help in a panorama of the city.

The spectre of the camera's potential was only one of the forces that brought Cole's attention to the forms of clouds. From 1841-2 Cole was again in Europe and in 1843 the first volume of Ruskin's *Modern Painters*, with its call to carefully observe the cloud forms, made its grand appearance. Also, in 1845 Frederic Church was studying with Cole, and Cole may even have created *Catskill Creek* as a primer for his promising student on how to follow nature. Church later used Cole's technique (used earlier by Claude) of highlighting the bases of the altocumulus cloud elements with short wavering horizontal lines of crimson or gold in many of his own spectacular sunset scenes.

By the time of Cole's illness and sudden death in 1848, America had begun to tire of symbolism in landscape. Thus, Asher B. Durand's testimonial to Cole, *Kindred Spirits* (1849, Crystal Bridges Museum of American Art, Bentonville, AK) represents a transitional piece. The painting shows Cole and Bryant standing on a rocky outcrop in the Catskills during one of the hazy summer afternoons so common in the Eastern United States. The view faces east up the Kaaterskill Clove, and includes the Kaaterskill Falls, but the shadows imply a Sun in the north, which is impossible. Durand freely juxtaposed various separate elements of nature, but joined his contemporaries in insisting that painters begin by studying from their true master, Nature.

> Yes! Go first to Nature to learn to paint landscape, and when you shall have learnt to imitate her, you may study the pictures of great artists with benefit....True art teaches the use of the embellishments which Nature herself furnishes, it never creates them.

A pressing concern with the unyielding and rapid westward advance of American civilization gave painters the mission of recording the wilderness's disappearing remnants. Artists replaced sublime `effects' with detailed natural records of exotic places that the public eye quickly learned to admire. Jasper Cropsey, perhaps the premier painter of the fall foliage and a marvelous sky painter as well, put it succinctly -

> The axe of our civilization is busy with our old forests....Yankee enterprise has little sympathy with the picturesque, and it behooves our artists to rescue from its grasp the little that is left before it is ever too late.

Anything that assisted American painters in this noble task was welcome. For two decades, art and science walked hand in hand. When the new, brilliant metallic pigments such as cadmium yellow became available after 1850, painters eagerly used them. Samuel Morse, inventor of the telegraph but an artist by training, immediately recognized the camera's value. American painters, even more than their European colleagues, embraced the camera as an essential tool in their art and welcomed its every improvement. Many eagerly consorted and travelled with, or even served as their own photographers.

The American public was so receptive to the realism of American landscape paintings that they viewed them through optical tubes or opera glasses to minimize distractions and feel as if they were transported into the scenes. Even Mark Twain succumbed to the fad and wrote about the pleasure he experienced in viewing a Church landscape in that manner.

Fig 9-37. Fitz Hugh Lane. *Salem Harbor*. 1853. Museum of Fine Arts, Boston.

Fig 9-38. A cirriform anvil diverging from a thunderstorm in Bali.

The expectation that paintings be faithful to nature proved to be a boon for the sky, which received an unprecedented degree of attention. And even when American painters traveled to the far ends of the Earth in search of new natural wonders, they never forgot Cole's admonition that the sky is "the soul of all scenery".

Fitz Hugh Lane was forced by polio to restrict his travels to the coastal indentations of his native New England. There he focused his attention (and later, his camera as well) on the varied moods of the sea and sky. He produced storm scenes with raging seas and days with tranquil skies and unlimited visibility. Most of his scenes have very little wind, for the waters below are bright and barely ruffled. As a result, his paintings possess an unmistakable lustre and mood of stillness and silence that have been recognized as hallmarks of the so-called Luminist school. In them, time seems to have been suspended. On several occasions, Lane allowed an oncoming storm to darken the distance but still retained the high visibility and the smooth waters. No one more effectively captured the quiet before the storm.

Lane, like Cole, stressed meteorological effects but sometimes turned his attention to the secrets of cloud form. *Salem Harbor* (Fig. 9-37) seems at first glance to be just one more tranquil harbor scene. The sky, which occupies 75% of the painting, does not have particularly vivid coloring or stark lighting effects, while the clouds are not the grossly billowing behemoths that overwhelm the scene and imprison the eye. But in its quietly compelling way, *Salem Harbor* is a revolutionary piece of sky painting.

Haze and shade partly mask an approaching line of cumulus congestus. The cloud line in turn hides the base of an even higher wall of cumulonimbus that will surely bring a raging thunderstorm within an hour. Although the thunderclouds have not yet come into view, their approach can be inferred from the leading top edge of their anvils, which consist of cirrus. At the upper right we get one of the few indisputable views of cirrus uncinus or mares' tails since Jan van Eyck. But it is the cirrus at the extreme upper left that heralds the coming thunderstorm. Such diverging cirrus (also called false cirrus) spreads in fanlike form from the evaporating forward edge of some thunderstorm anvils (Fig. 9-38) but had never before been represented in art.

Lane painted several thunderstorms without ever exposing their full profile. This was no mere Victorian gesture. In the Eastern United States it is unusual to see the complete outline of thunderstorms because they are almost always embedded in a thick layer of humid, hazy air. Thus, it is remarkable Lane was able to observe as much of their anvils as he did. For an unexpurgated painted view of the giant thunderstorm, we will have to cross the Mississippi and wait almost another century.

Sanford R. Gifford allowed the summer haze of the Eastern United States to ripen into a rich autumn mist in his *Kauterskill Clove* (Fig. 9-39). Here is a painting Leonardo or any Chinese master would have admired. The scene faces just north of east up the Clove beyond the distant Kaaterskill Falls (see Fig. 9-36). The Clove is less than 1000 feet deep at this point but mist so reduces visibility that the scene assumes almost cosmic dimensions.

Fig. 9-39. Sanford R. Gifford. *Kauterskill Clove*. 1862. The Metropolitan Museum of Art.

Despite the mist, *Kauterskill Clove* remains faithful to the American cause, for innumerable details appear when you look carefully. But the apparently documentary quality is misleading. The Sun has just risen to left of center, just north of east. This makes it August, the time Gifford executed several studies. But the trees are draped in the fading autumnal colors of mid-October and the illumination of the right fringe of the tree trunks comes from an October Sun to right of center and therefore in the southeast.

No such mists were allowed to intrude upon Frederic Church's youthful sunset scenes. Church learned to paint his sunsets from Thomas Cole between 1844 and 1846. Then he set out on his own, making such rapid progress that he assumed the mantle as America's leading landscape painter upon Cole's death.

Fig. 9-40. Frederic Church. *West Rock, New Haven*. 1849. New Britain Museum of American Art, CT.

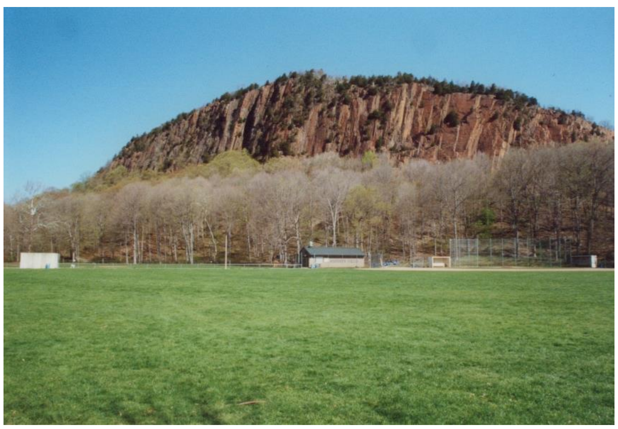


Fig. 9-41. West Rock, a diabase outcrop counterpoint to the NY-NJ Palisades.

Church based his first scenes on local settings, as in his photographic rendition of *West Rock, New Haven* (1849), (Fig. 9-40). This topographic work is marked by the simplicity and clarity of youth. The late afternoon view of the diabase cliff of a volcanic sill (Fig. 9-41) is from the SSW while a WNW wind in the wake of a cold front has cleared and dried the air and herded distinct, flat-based cumulus into fleeing lines.

Soon after reading Baron Alexander von Humboldt's *Cosmos*, first published in 1845, Church embarked on global travels with his incisive view. In this way he became the self-appointed painter-companion Humboldt had long wished for.

Frederic Church was not only the archetype and most successful American landscape painter of the mid-19th century, he was also one of the greatest sky painters of all time. He was rightly known for the detailed and scientific study he put into all his works. He was an avid collector of photographs, which he used largely to help with the details. He photographed interesting cloud formations, then colored them and traced their outlines. These remarkable qualities, which first propelled Church to fame and later consigned him to near oblivion when artistic fashions changed, were recalled by a former student, William Stillman,

> Church in many respects was the most remarkable painter of the phenomena of nature I have ever known....His retention of the minutest details of the generic or specific characteristics of tree, rock or cloud was unsurpassed....His mind seemed a camera obscura in which everything that passed before it was recorded permanently.
>
> William Stillman. *Autobiography* pp 114-115. from *Influence of Photography on American Landscape Painting*. p 122.

Thus, it was neither Titian, nor Rubens, nor Turner, nor Constable, but rather Church who was the first, in his *Niagara Falls* (1857, Corcoran Gallery of Art, Washington DC), to capture in paint the shimmering spectral translucence of the rainbow. It was Church, who in his recently rediscovered *Icebergs* (1861, Dallas Museum of Art), first froze on canvas the emeralds of the Arctic. And few have ever captured the magnificence of sunrise and sunset as well as Church.

Fig. 9-42. Frederic Church. *Twilight in the Wilderness*. 1860. Cleveland Museum of Art.

Church began his homage to the sunrise and sunset by 1848 with a dawn scene entitled *Morning* (1848, Albany Institute of History and Art) that faces eastward down into the Hudson River Valley from the vicinity of the Catskill Mountain House. Later trips to Maine's rocky coastline and Mount Katahdin produced even more spectacular sunrises and sunsets. Most of these featured cellular or banded altocumulus with occasional wisps of cirrus in a supporting role, and all in pristine skies.

The archetype Church sunset, *Twilight in the Wilderness* (Fig. 9-42), was apparently inspired during a trip to the Adirondacks although its precise location, which may be Acadia, Maine, has not been identified. One year later, with the outbreak of the Civil War, Church transmuted the banded altocumulus sunset into a patriotic work, *Our Banner in the Sky* (1861, Olana State Historic Site, NY).

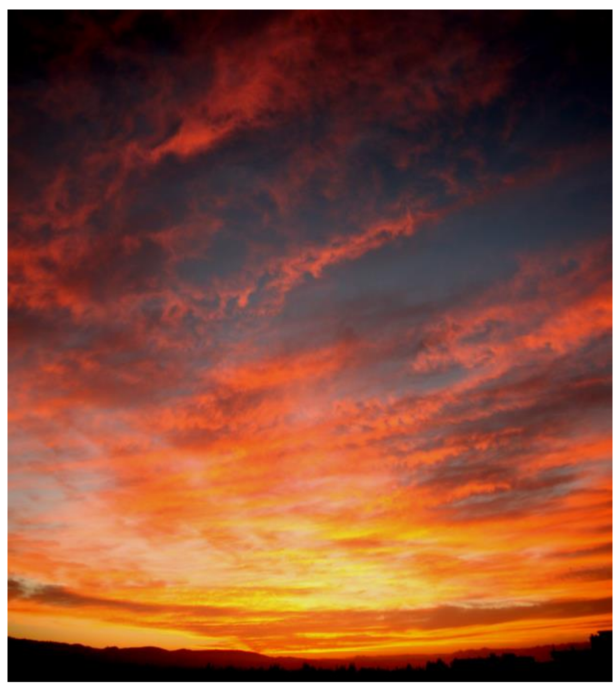


Fig. 9-43. Twilight sky over San Mateo, CA.

Twilight in the Wilderness dazzles without resorting to hyperbole. Church used a black and white photograph of altocumulus bands to help construct its cloud elements, while many color photographs of flaming sunset altocumulus, such as Fig. 9-43, attest that Church remained meticulously, albeit selectively, faithful to nature. The Sun has already set on the darkened Earth but the day's death still colors the bloodied vermilion cloud bases and lake water. The spirit of the departed Sun lingers in the sky, for the clouds reflect all its colors and the clear sky grades from pure yellow at the horizon to a deep, turquoise blue above. Even the vivid yellow horizon is proper, for it seems to be a product of twilight on dry days when a cloud layer such as altocumulus covers most of the sky except the horizon.

Fig. 9-44. Frederic Church. *The Aurora Borealis*. 1865. National Collection of Fine Arts. Smithsonian Institution, Washington.

Church's day did not end with twilight. In 1862 he composed a nocturne describing the *Meteor of 1860* (private collection) that briefly flashed across the American sky one night.

But the long polar night has more durable lights to relieve the darkness, and these Church saw when he toured the coasts of Labrador and Newfoundland in June 1859. Then, on December 23, 1864, in the waning days of the Civil War, an extraordinary display of the Aurora Borealis was seen in the United States. This was widely interpreted as a favorable omen to the Union Cause and spurred Church to paint *The Aurora Borealis* (Fig. 9-44).

Church transported the auroras he had seen to a sterile arctic landscape described to him by his friend the polar explorer, Dr. Isaac I. Hayes. The symbolic ship of state lies icebound in the frozen sea while the aurora lights up the sky and brings down the curtain on the Civil War. The bursts, spokes, wheels and curtained rays of the aurora may first have been revealed to us by Ezekiel, but it was Church that first let us share the vision. Now, of course, the camera has also immortalized the beauty of the aurora (Fig. 9-45).

Fig. 9-45. Aurora Borealis, 08 Dec. 2013, Andøya Island, Norway. Frank Olsen, photographer.

What causes the aurora? The aurora is parented by outbursts from the Sun's corona and by the Earth's magnetic field. The Sun's corona is so hot that its matter is continuously ejected in a solar wind. The solar wind consists largely of hydrogen that has been ionized, i. e., split into protons and electrons by the heat. Every day the solar wind bathes the Earth with a constant low level supply of protons and electrons to produce modest auroras. But roughly every eleven years the Sun goes through a cycle in which its surface becomes disturbed. Sunspots appear, tied together by giant flares that dwarf the Earth, turning the solar wind into a torrent of protons and electrons that hurtle earthward through space.

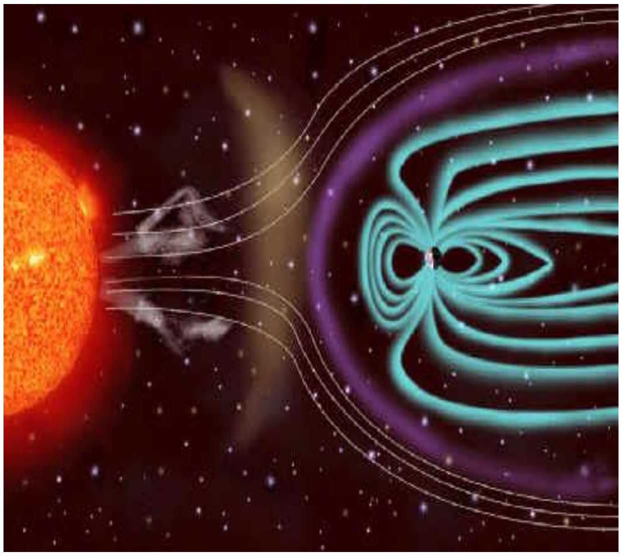


Fig. 9-46. Extensive auroras form when the Earth's magnetic field diverts energetic electrons ejected from solar storms toward the magnetic poles. NASA

If Earth did not have a magnetic field these charged particles would smash directly into the sunlit side and do their work invisibly in broad daylight. But the magnetic field creates a shield called the magnetopause that diverts these particles and captures them on the night side of our planet. The particles are then further energized and constrained to spiral like moths around the magnetic field lines, oscillating between the north and south magnetic poles (Fig. 9-46).

During most of their transit between the magnetic poles, the protons and electrons are so high above the surface that they travel through a near vacuum and do not collide with any atmospheric particles. But as the charged particles approach the magnetic poles they spiral down to much lower heights where the atmospheric density is much greater. Then, about 90 to 150 kilometers above the surface they collide with the molecules and atoms of the upper atmosphere. The collisions produce the auroral light by momentarily exciting the upper atmosphere's oxygen and nitrogen atoms. Light is released an instant later when these atoms spontaneously deactivate. The colors of the aurora are determined by the particular atoms involved - for example, auroral green light is characteristic of the deactivation of oxygen atoms.

The region where the aurora is seen most frequently is an oval ring centered about 1000 miles from each magnetic pole. Since the magnetic poles have been closely aligned with the geographic poles throughout historical times, the aurora has been almost exclusively a phenomenon of the high latitudes. Only during times of extremely high solar activity are auroras seen at lower latitudes, where they may stupefy the local residents.

Church may have insisted on limpid clarity for his American sunsets and polar vistas, but he allowed mists and volcanic plumes to spread across a number of his scenes of the 'steamy' South American tropics. In *Rainy Season in the Tropics* (Fig. 9-47), a beautiful double rainbow arches across the rain and mist soaked sky. This double rainbow is a model of scientific accuracy in almost every respect. The bows are translucent, their color sequence is correct and, as Constable and Luke Howard noted earlier, bright spots on the bow are observed at times. The sky is also brightest beneath the primary bow and darkest between the bows. But there is one gross error.

Church squeezed the two bows too close together, allowing only half the spacing Nature demands (recall Fig. 6-15). Why did he do this? It was certainly not from ignorance. Church had remarkable powers of observation and a visually photographic memory. He was mathematically precise. He even included two properly spaced bows in a study for the *Rainy Season*! It is, of course, possible that he neglected to leave adequate space for a secondary bow after first painting the primary too large, for a stereoscopic view of his studio shows the work in progress with only a single bow visible and not much room for a second. But such carelessness seems totally out of character. Somehow, the error seems almost deliberate.

Fig. 9-47. Frederic Church. *Rainy Season in the Tropics*. 1866. The Fine Arts Museums of San Francisco, Mildred Anna Williams Collection.

If the error were deliberate what was Church's motive? In April 1865, both his children died of diphtheria. Perhaps the bows served as a linked cenotaph for his lost babies.

It is also possible that Church was perpetrating a hoax at the expense of the gawking public and carping critics who blindly bleated the rhetoric of realism while seldom, if ever, looking at nature for themselves. In *That Wilder Image*, James Flexner pointed out that Church was normally quite an exuberant fellow, much given to practical jokes.

If Church did intend a joke, he had a precedent. In 1860, after years of unfulfilled promise, critical acclaim finally came to the epileptic, George Inness, as a result of several bold landscapes. One of these, *A Passing Shower* (Fig. 9-48), contains a beautiful and convincing double rainbow for which Inness inverted every one of nature's decisions.

The color sequence of each bow has been reversed and Alexander's dark band has been replaced by a light band. George Siscoe argued that this inversion is too perfect to be accidental or random, but rather represents a deliberate practical joke by Inness, who was a notorious trickster and a rather contrary individual. Not surprisingly, critics, who wouldn't have recognized a rainbow if they were sitting on one, praised Inness to the sky for the objectivity of this work.

Fig. 9-48. George Inness. *A Passing Shower*. 1860. Private Collection.

Unlike some of his more successful contemporaries, Inness preferred the cultivated or civilized landscape to that of the wilderness. This naturally drew him to Europe. In 1852, his first trip abroad ended unceremoniously when he was expelled from Rome and Italy for scuffling with soldiers after refusing to take off his hat to the Pope. On his next trip to Europe, in 1854, Inness wisely chose an itinerary that bypassed Italy. This brought him into direct contact with painters of the Barbizon school, whose works greatly impressed him. He allowed the Barbizon approach to cloud his horizon for six years. It was only in 1860, when he moved to Medfield, Massachusetts (about 15 miles from Boston) that he received the spark that transformed his skies into inspired masterpieces such as *A Passing Shower* and *Clearing Up* (Fig. 9-49).

The cultivated countryside setting of *Clearing Up* faces north along the upper reaches of the Charles River near Medfield. The brightly illuminated tree trunks testify to Inness's Barbizon debt. But the moment the sky was involved the American in Inness took over. Quite simply, the meteorology of *Clearing Up* is too explicit and too good to have been done by any of the Barbizon painters except Millet.

The fisherman's long shadow and the purple color of the clouds betray an early morning Sun low in the eastern sky. A cold front has passed, and through the clearing in the west the lifting and disintegrating edge of a stratiform cloud layer can still be seen. The stratocumulus cells have been herded into long cloud lines (recall Figs. 5-30, 5-31 and 9-40) that parallel the west winds in the wake of the cold front. For some reason Inness showed no signs of wind at the ground, but he made the visibility extremely high, the air pure, and the light as sparkling as in Vermeer's *View of Delft*.

Fig. 9-49. George Inness. *Clearing Up*. 1860. George Walter Vincent Smith Art Museum. Springfield, Mass.

Scores of other American artists succeeded in capturing on canvas the wilds of their native lands and skies. Martin Johnson Heade tinged his marshy sunsets with the most exquisite dying stratocumulus and in so doing, created aerial poems of unsurpassing beauty. John Kensett's sunsets vied with Church's, while his New England coastal scenes were even more luminous than Fitz Hugh Lane's. Kensett even recorded cirrocumulus, displaying them in the hazy summer sky above *Lake George* (1869, Metropolitan Museum of Art, New York). Worthington Whittredge's altocumulus would have made Rubens, Turner or van Eyck stop to admire. Thomas Moran brought the untamed radiance of Yellowstone's earth and sky back to civilization. All of these and more labored for appreciative audiences until a change in the winds of sentiment cast them down to nearly a century of thankless oblivion. But their works have recently been exhumed and restored to their former and rightful place in the sky.

Canadian sky painters are an even better kept secret than their American brethren. A Dutch immigrant, Cornelius Krieghoff first showed up in New York in 1837 before establishing himself and sky painting in Canada. In New York, Krieghoff may have seen some of Thomas Cole's paintings, for his works bear traces of Cole's style.

Krieghoff was also influenced strongly by Canada's weather with its snow-covered ground and smooth edged, broken stratiform cloud sheets. In *The Trapper's Return* (Fig. 9-50) a sun pillar gleams faithfully through altocumulus or stratocumulus over a snow-covered ground in an opening of the boreal forest, with its black spruce and birch.

Fig. 9-50. Cornelius Krieghoff. *The Trapper's Return*. 1861. Thomson Collection, Art Gallery of Ontario.

Fig. 9-51. Lucius R. O'Brien. *Sunrise on the Saguenay*. 1880. National Gallery of Canada. Ottawa.

Even in summer, Canadians do not forget that they live in a land of snow and ice. Lucius R. O'Brien's monumental *Sunrise on the Saguenay* (Fig. 9-51) makes several meteorological statements. A luminous glow fills the misty air of a summer morning while fog crowns the cliff tops above Cape Trinity. Flecks and bands of altocumulus share the sky with shreds of the fog, while both are reddened by the rising Sun over the fjord. Everything seems to herald a warm day of late summer, but rising vertically from the Sun, a sun pillar warns who really rules that wintry land.

9.4 Skies of Other Lands

By 1800 the entire world had learned to groan under Europe's heavy hand. Sometimes, however, this hand did bring a lighter touch to foreign skies.

In 1549, St. Francis Xavier visited Japan and weighed down their painted skies with Christian gold. But Japan expelled the Jesuits, threw off their golden cloak, and returned to a Chinese landscape style. While in this mode, Soga Shohaku (1730-1781) painted *The Chinese Immortal, Ch`en Nan Causing a Rainstorm* (Fig. 9-52). Here the ancient Chinese vortices are transformed into a surprisingly modern guise. The scene depicts the flow of air just beneath the edge of violent thunderstorm. A gusty wind from beneath the cloud blows down a few helpless mortals trying to stand with Ch`en Nan while a giant vortex, the thunderstorm downburst strikes the ground and curls outward like a dragon's tongue.

Shohaku's downburst shows that even if Japan remained closed to greedy European hands the Shoguns were unable to seal off the unruly sky. A stream of Western products and ideas were smuggled into Japan through a single port of entry, Nagasaki. There, eager Japanese artists could obtain science books filled with realistic illustrations or Dutch oil paintings that revealed a new way of depicting the landscape.

The marriage of European and Japanese art first reached fruition in the landscapes of Katsushika Hokusai. In a career that spanned seventy years, Hokusai took his time to become a great sky painter. During the first decade after his apprenticeship ended in 1779, he painted mostly actors and dramatic scenes in the Ukiyo - e (floating world) tradition. During the next decade he gradually shifted his emphasis to landscapes done in a traditional Japanese style. It was only after about 1800 that his art began to reveal a strong European influence. This shows up in the coloring, perspective, and attention to the details of cloud forms.

Fig. 9-52. Soga Shohaku. *The Chinese Immortal, Ch'en Nan Causing a Rainstorm*. c. 1770. Museum of Fine Arts, Boston, Fenollosia Collection.

Hokusai's sky painting culminates in the series, *Thirty-six Views of Fuji,* done around 1830. These prints show the venerated Japanese volcano from every conceivable viewpoint and in all types of weather. One of the most famous and most often reproduced scenes, *The Hollow of the Deep Sea Wave* shows a monstrous curling wave (a tsunami?) about to break on some poor sailors.

South Wind, Clear Sky (Red Fuji) (Fig. 9-53) is one of Hokusai's greatest meteorological statements. The towering volcano pokes up into the sky. The early morning sunlight highlights the red rocks above the sloped tree line. Ribbons of snow still remain in the eroded gullies near the summit, where they are most effectively shielded from the Sun's merciless rays. The deep blue sky supports infinite visibility and hosts myriad parallel rows of altocumulus castellanus.

This is surely based on a cloudscape that Hokusai observed. In fact, although the *Fuji in Fine Weather* owes something to European tradition, Hokusai recognized the potential of altocumulus several decades before most of his European and American colleagues. But Hokusai seemed ambivalent about the rules of perspective so fundamental in European art. Nearing the horizon, where clouds are seen obliquely, the cloud rows should grow narrower (which they don’t) and gradually appear to merge (as they do) as in Fig. 9-54.

Other Japanese artists rapidly followed Hokusai's lead. Hiroshige (Ando Tokitaro) also produced several series of landscape prints. In these he emphasized atmospheric effects more than Hokusai. The *Cloudburst at Shono* (Fig. 9-55), a scene from the *Fifty-three Stages on the Tokaido* shows how a driving rainstorm sends peasants scurrying in all directions. The wind-driven rain streaks, rendered by diagonal lines, have severely reduced atmospheric visibility. Hiroshige used successive rows of trees the same way the Chinese and Japanese had long been using successive rows of mountain ridges to show how rapidly objects fade with distance in the hazy East Asian summer atmosphere.

Fig. 9-53. Hokusai. *Fuji in Fine Weather*. c. 1830. British Museum, London.

Fig. 9-54. Oriented altocumulus cells appearing to merge at the horizon over Boynton Beach, FL.

The Japanese landscape artists also gave us a fresh look at snow. Unlike the dreary snow scenes of Europe, with their misty, overcast skies, Japanese scenes often take place under crystalline, deep blue skies with infinite visibility. This difference is due more to meteorology than philosophy since the sky clears so much more quickly after Japanese snowstorms than it does after European snowstorms. Snow scenes with clear skies are also common in the Eastern United States and in Eastern Canada, where skies also tend to clear dramatically after snowstorms.

Most of the Japanese landscape prints were simple and refreshing in comparison with European landscape paintings. Around mid century, Japan slowly began to send a trickle of exports to the west. In 1856, a French bookseller brought one of Hokusai's sketchbooks containing some colored prints to the attention of Manet, Degas, Fantin-Latour and Whistler. A year later the 16-year old Monet purchased his first Japanese prints.

Japonisme was soon all the rage and Japanese prints directly influenced a number of European painters.

Fig. 9-55. Hiroshige. *Cloudburst at Shono, from Fifty-three Stages on the Tokaido*. 1833-1834. Tokyo, National Museum.

One artist influenced by the Japanese prints was the primitive, 'Le Douanier', Henri Rousseau. Rousseau got his nickname from his job as an octroi official who collected the duty imposed on certain items entering at the city gates of Paris. He kept this job in order to support his hobby of painting. He apparently was a rather simple soul, often the victim of practical jokes and frauds, but one who was convinced of his own greatness and who very consciously cultivated a 'modern' naive style now recognized everywhere.

Rousseau is best known for his dreamlike jungle scenes. The first of these he called *Surprise* (Fig. 9-56). A crashing thunderstorm has invaded a botanical garden jungle to terrorize a tiger. Bolts of lightning strike the ground in several places. A driving downpour, quite possibly inspired by a Japanese print, pelts everything in the overcrowded scene.

Despite the overcrowding, Rousseau's jungle scenes represent a return to simplicity and clarity of form that many of his contemporaries were fleeing. Rousseau made it a point of stressing the outlines of all objects. Most of his leaves are clearly identifiable. So too are his clouds. These appear in his topographical landscapes in park-like settings in and around Paris. In a few of his earliest paintings, Rousseau's clouds resemble the small cumulus of European art prior to 1400. But then, as if telescoping several centuries of northern European cloud painting into a few years, some of Rousseau's clouds spread into decks of almost unbroken stratocumulus.

Fig. 9-56. Henri Rousseau. *Surprise*. 1891. National Gallery, London.

At Rousseau's post just south of Paris, a broken deck of stratus covers the *View of the Bievre at Gentilly* (Fig. 9-57). The breaks suggest improving but colder weather, as does the fractostratus below, so often seen near the end of rains in the wake of low pressure areas.

Visibility is high, for the air has been swept clean by the departing rain. Now, colder, dry air is moving in. The dark clouds indicate it is late in the afternoon and the red trees show it is Autumn In this scene, transcribed faithfully from observation, Rousseau succinctly captured autumn’s chilly mood, so common in northern Europe. Winter is on the way.

Far from Rousseau's imaginary tropical jungles but closer to the dreary French skies, a frigid winter wind blows across the heartland of Russia. Cold has etched its indelible insignia onto almost every great artistic creation in Russia, for bitter winter lies at the heart of the unfathomable Russian soul. In the 19th century, Russia attained cultural equality with the rest of Europe. Her novelists, poets, playwrights and composers are beloved by the entire world. But what about her landscape painters? We are finally recalling that Russia had these too; we had simply overlooked them.

Fig. 9-57. Henri Rousseau. *View of the Bievre at Gentilly*. c. 1895. Tate Gallery, London,

Consider *The Thaw* of Fyodor Vasilyev (Fig. 9-58). Thaws may come at any time during the winter but they are mixed blessings. While they last, the roads turn to mud and the sleds and troikas must be put to rest.

In Russia, thaws always mean mud. Every part of *The Thaw* has been daubed with mud. The melting snow is almost as muddy as the road and even the cloudy sky with its green cast seems muddy. But while mud is a filthy nuisance, in Russia it is also the fertilizer of approaching spring.

Learn from the crows and live! These hardy birds find their food softened in the mud. And what may their bonanza consist of? It may well be horse manure! But manure is far better fare than deep winter's sterile drifting pure white snow that inters everything edible.

Fig. 9-58. Fyodor Vasilyev. *The Thaw*. 1871. Tretyakov Gallery, Moscow.

At last spring comes even to Russia. Then the entire countryside acts as if released from a long prison term. The flowers burst into bloom where snows covered everything just a few weeks before. But there is carefully planned purpose in all this exuberance. The flowers must do their work quickly, for the warm days are numbered. Even in midsummer, winter's impending onslaught can be sensed in the air.

During the summer of 1893, Isaak Levitan resided near Lake Udomlya, midway between Moscow and Leningrad, and began painting *Eternal Rest* (Fig. 9-59). It is a dull summer day. The late afternoon Sun has tinged a thin mottled altocumulus with yellow highlights but its rays are too feeble to reach the ground. The altocumulus also darkens the shaded side of an advancing line of cumulus congestus.

Fig. 9-59. Isaak Levitan. *Eternal Rest*. 1893-4. Tretyakov Gallery, Moscow.

Several signs indicate that the line is approaching. The top of the highest cumulus slopes up to the left and toward the viewer, showing the direction the clouds are moving. The thin cloud veneer midway up the sky on the right also heralds an approaching thunderstorm. The cumulus cloud line has not yet begun to produce rain, for we can still see clear to the horizon, but it is only a matter of time.

There is evidence this will be no ordinary rainstorm. *Eternal Rest* seems to be a transcription of the Biblical Flood to Russian soil. Levitan has succeeded in conveying the spirit of the vast power that water and sky hold over the solid earth in Russia. There, rivers and lakes, swollen every Spring by melting winter snows and pent up behind stubborn, growling ice dams, overflow their banks and inundate the land, as in Fig. 9-60. In *Eternal Rest*, the church and its graveyard sit like Noah's ark on an isolated promontory, dominating a landscape with no other relief. The gray river that covers most of the Earth's surface seems poised to overflow its bounds. The small spitlike island which appears to be shrinking may have just lost its slender tie to the mainland. Even the vegetation contributes to the overall impression of flatness, for it consists of a smooth, almost monochrome dull green mat characteristic of a tidal flat on a cloudy day. When the rain finally arrives, it will carry all before it.

Levitan deliberated before achieving the mood of *Eternal Rest*. In a study, he placed the church atop a more elevated and extensive promontory, while the small island showed more relief and was still connected to the mainland. Even the vegetation in the study is more variegated and possesses some relief.

Eternal Rest is an elegy to nature's vastness. It is a work of one of civilization's geographical frontiers. By 1900, when Isaak Levitan and Frederic Church died, these frontiers were in full retreat, forcing artists to wander ever further in search of the shrinking wilderness. Other issues were flooding the mainstreams of artistic ideas in the world's 'cultural' centers. Insulated and protected from raw nature, urban artists had new tales to tell, tales that raised us to the verge of divinity and then cast us down to the dungeons of our own personal hells. Throughout this journey the sky, which faithfully reveals the soul of the times, would become ever more distorted and restricted. The lessons of the 19th century Romantics were then banished to the far corners of the globe, where they were rudely preserved only in remote enclaves of Russia, the United States, Canada and New Zealand. It would take time for the forces of sanity to demand their recall.

Fig. 9-60. Facing Denali, Alaska on the swollen west branch of the Susitna River.

CHAPTER 10
BEYOND NATURE

On July 24, 1804, Thomas Moore, a young Romantic poet wrote to his mother in England about his almost mystical experience at Niagara Falls.

> I felt as if approaching the very residence of the Deity; the tears started into my eyes....Here all its awful sublimities rushed full upon me. My whole heart and soul ascended toward the divinity in a swell of devout admiration, which I never before experienced. Oh! Bring the atheist here, and he cannot return an atheist....We must have new combinations of language to describe the Falls of Niagara.
>
> quoted from Robert Rosenblum, *The Northern Romantic Tradition*, p 19-20.

More recently, Superman's girlfriend, Lois Lane, experienced a different set of emotions at Niagara Falls.

> Clark Kent: Here you are standing in front of one of nature's most awesome spectacles and you're thinking about food. Aren't you impressed?
>
> Lois Lane: Once a girl's seen Superman in action, Niagara Falls leaves you kind of cold.
>
> quoted from the movie, Superman II.

After 1850, the dizzying pace of technological advance accelerated. Every aspect of life was affected by the new technology. The Industrial Revolution's promise of a better material life was beginning to be realized. The puny limitations of human and animal strength were grossly superseded by gargantuan engines and machines. The electricity that powered many of these machines overwhelmed the darkness of night and illuminated entire cities. The telephone began to transmit soft voices across the ocean. The railroad and steamship evolved into complex networks of huge and powerful vehicles that hurtled rapidly through space and linked the world more closely.

The train was perhaps the century's foremost symbol of progress and signpost of man's domination over nature. Even self-willed outcasts from society, such as Henry David Thoreau, who were wary of the ultimate impact of industrialism, were intoxicated by the train's power and regularity. In *Walden*, safely removed from civilization's hustle and bustle, but still touched daily by the railroad, Thoreau diagnosed the symbol with uncanny intuition.

> The Fitchburg Railroad touches the pond about a hundred rods south of where I dwell. I usually go to the village along its causeway, and am, as it were, related to society by this link....
>
> The whistle of the locomotive penetrates my woods summer and winter...When I meet the engine with its train of cars moving off with planetary motion, - or, rather, like a comet... - with its steam cloud like a banner streaming behind in golden and silver wreaths, like many a downy cloud which I have seen,...when I hear the iron horse make the hills echo with his snort like thunder, shaking the earth with his feet, and breathing fire and smoke from his nostrils,...it seems as if the earth had got a new race now worthy to inhabit it...
>
> I watch the passage of the morning cars with the same feeling that I do the rising of the sun, which is hardly more

> regular....The startings and arrivals of the cars are now the epochs in the village day. They go and come with such regularity and precision, and their whistle can be heard so far, that the farmers set their clocks by them, and thus one well conducted institution regulates a whole country. Have not men improved somewhat in punctuality since the railroad was invented? Do they not talk and think faster in the depot than they did in the stage-office? There is something electrifying in the atmosphere of the former place....We have constructed a fate, an Atropos that never turns aside.
>
> Henry Thoreau. *Walden* pp 86-88. (1854)

People felt they had created a fate, and that they could finally vie with the gods. By the late 19th century, people scornfully cast nature down from her throne and crowned themselves. It is little wonder Niagara Falls failed to impress Lois Lane.

But the mantle of divinity is never worn easily. The last half of the 19th century proved to be an extremely unsettling time. Fewer people were needed to raise the food for the world's growing population. Mechanization rendered obsolete many timeworn talents of local artisans. The excessed and unemployed populations emigrated to the overcrowded cities or to new lands like America, where they often became aimless automatons in the factories. As late as the 1860's a John Henry might compete with the machine and win but even then the cost would be his life. A few years later, even if Monet did convince the station manager to hold up the trains at the Saint-Lazare Station for a few minutes, no one would dream of challenging a machine.

The changes produced by technology provided material comforts but came at the expense of the soul. The revelations of religion retreated before the discoveries of science and the might of machinery. With religion fading from the scene, where was one to go for spiritual comfort or guidance? A plethora of divisive ideologies that catered to society's uprooted and deeply disturbed souls proliferated almost spontaneously.

These problems came to be reflected in all aspects of the arts as the 19th century wore on. For a few brief years, optimism reigned and many served proudly as self-appointed apostles of the new god of technology. Some did it with brash fanfare. Friedrich Nietzsche loudly proclaimed that God was dead and would soon be replaced by a new breed of Supermen. The message permeated the fabric of the arts. Even the apparently naive Impressionist landscapes constitute eloquent proclamations of the supernatural accomplishments of the Technological and Industrial Revolutions.

But this passionate love affair of the arts and sciences was quite fragile and soon came unwoven, its attempted synthesis shredded into a society of multiple cultures. Even though artists felt compelled more than ever to use the language (and paints) of scientists, never had the gulf between the two been greater. While scientists and inventors claimed the ever expanding domain of the rational and visible universe, the displaced artists were obliged to retreat step by step toward the invisible world of the irrational. Abstraction, distortion and dissonance then diffused throughout the fibre of the arts. These tendencies were exacerbated by a fundamental change in the type of people drawn to the arts. The loss of the old sources of patronage and their replacement by the Salon's rigid control over artistic tastes and sales meant that aspiring, rebellious creative artists would be drawn from the pool of people willing to forgo public acclaim or material advantage - society's malcontents.

As the century wound to its close in an increasingly mechanized and unforgiving universe, the outcast artists got their revenge. They deposed Nature and forced it to play a servant's role to their psyches. The painters' Nature became a mere roadmap to point the way to the 'beyond'. Humans were portrayed as weird and distorted misfits in an uncharted, hostile world. The feeling of many late 19th and early 20th century artists on such matters was expressed quite succinctly by Albert Ryder, the visionary landscapist, when he said, "I am trying to find something out there beyond the place on which I have a footing." One look at works such as Ryder's *Toilers of the Sea*, or Edvard Munch's *Scream* and there can be little doubt about what was meant. Who could have foreseen the hydra that evolved from the romance between Science and the Sublime!

10.1 Impressionism: Light in the Powder Puff Skies of Progress

By 1860, Western Europe was a fully settled continent with no vanishing frontier to lure her painters. Thus, while many Americans wandered ever further afield in search of untamed vistas, European painters were forced to scrutinize the familiar skies above their own backyards for fresh material. In doing so, they discovered new worlds of light.

James McNeill Whistler was expelled from the United States Military Academy after failing chemistry. He would later become one of art's premier atmospheric chemists. In 1855 he arrived in Paris to study art and was taken by Courbet's realism. But this influence gradually faded after 1859 when Whistler moved to London, where he had spent some time as a child and where he was to develop his unique style.

Whistler often went down to the Thames River to sketch. On Christmas Day, 1860 he chanced upon a setting that excited him and proved to be the precursor of his later tonal and abstract landscapes. Ice floating on the river offered areas of white that offset the brown tone of the Thames' polluted water and the leaden gray of London's misty and interminably overcast sky. The result was *The Thames in Ice* (Fig. 10-1), which Whistler completed in three days. The sky is covered with a featureless deck of stratus, while the edge of a dark, looping smoke plume drifts in at upper left. Visibility is reduced to barely one mile but is just high enough to reveal a number of smokestacks across the river. Only two of these chimneys are active - after all, even the hell fires of industry relax on Christmas day!

Fig. 10-1. James McNeill Whistler. *The Thames in Ice*. 1860. Freer Gallery of Art.

Whistler later spoke of the poetic allure evoked by the obscuration of London's atmosphere,

> When the evening mist clothes the riverside with poetry, as with a veil, and the poor buildings lose themselves in the dim sky, and the tall chimneys become campanili, and the warehouses are palaces in the night, and the whole city hangs in the heavens, and the fairy-land is before us...Nature...sings her exquisite song to the artist alone.
>
> *Ten O'Clock Lecture*. 1885.

The Thames in Ice served as a precursor not only of Whistler's own more abstract later works but of many Impressionist ideas as well. To begin with it reveals the dirt, dullness and obscuration of an industrially befouled atmosphere. The Impressionists were far more circumspect about showing industrial filth, but would still devote many canvases to the effects of mist and air pollution. Like Whistler, the Impressionists stressed tone and lighting while deemphasizing form and volume. Finally, although Whistler and the Impressionists continued to use nature as their starting point, they became progressively more concerned with the problems of visual perception and more poetic in their approach to nature.

The ascendancy of light over form was in the air. In 1866, August Schaefer, better known for a series of geographical landscapes that still grace the halls of Vienna's *Naturhistorisches Museum*, painted a cumulonimbus topped by cirrus towering above the trees in *Sunset in Hungarian Forest* (Fig. 10-2). The painting scarcely hints at the cloud's majesty or power, choosing instead to bask in the play of sunlight on its face.

Fig. 10-2 August Schaeffer. *Sunset in Hungarian Forest*, 1866. National Gallery of Art, Washington DC.

The entire cloud is bathed in direct sunlight yet its color grades from white at the top through yellow to pink at the base. This color gradation is a sunset phenomenon and not an inherent property of clouds. Clouds reflect whatever light falls on them. When the Sun nears the horizon its rays must pass obliquely through such a great thickness of atmosphere that virtually all the shorter rays are scattered and only the longer, red waves can penetrate the atmosphere in appreciable quantities (recall §2.1 and Fig. 2-3). But the tops of the tallest clouds extend into air so thin that little sunlight reaching them has been scattered, so they remain almost white even after the Sun sets at the Earth's surface (Fig. 10-3).

Striking color differences often occur on two sunlit clouds at different heights around sunrise and sunset, and a number of artists had recorded that observation. At such times, lower clouds such as cumulus appear pink or red while higher clouds, such as cirrus, are white. But before *Light in Hungarian Forest*, only Frederic Church had hinted that a single cloud could display a color gradation (*New England Scenery*, 1851, George Walter Vincent Smith Art Museum, Springfield, MA).

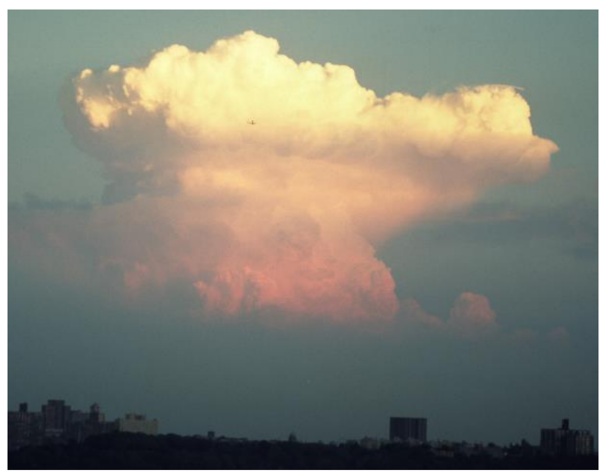


Fig. 10-3. Color gradation of a thunderstorm over NYC at twilight on 15 August 1988. The black spot high in front of the anvil is a commercial jet.

Two themes that concerned Schaefer preoccupied the Impressionists. They greatly expanded on the message that clouds reflect or transmit the light that strikes them by emphasizing how everything we see is tinted by the light that falls on it. Their landscapes are also topographic. Legions of art historians have retraced the Impressionists' footsteps to pinpoint the settings of their landscapes. In so doing, they have helped reveal the careful thought that underlies the disarmingly naive Impressionist vision. The Impressionists' poetic landscapes may well flood the senses with the light and color of sweet, intoxicating worlds of charm and seeming innocence, and this will always be their most alluring feature, but their vision was carefully cultivated.

All painters are propagandists. And, despite the Impressionists' almost legendary scorn for bourgeois tastes, their paintings constitute some of the most eloquent defenses of major bourgeois accomplishments - the industrialization of the world and taming of the elements by technology.

These causes célèbre echo silently through Impressionist skies. They may be overcast and may show rain, wind and snow, but there are few signs that nature contains any element of danger. Gone are unchained nature's dark swirling storms and sublime 'effects'. Human progress has conquered all.

When synthetic clouds began to fill the skies and obscure nature's clouds, the Impressionists duly included them, but often in a transformed manner. We know such clouds as the toxic plumes that pollute the globe, bringing discomfort and acid rain to all, but the Impressionists portrayed them differently. Many of their urban landscapes are so scrupulously sanitized they offer no hint of how dirty real conditions sometimes were. Their charming and endearing qualities not only account for their great popularity, but also have done more for Europe's image than all the European tourist bureaus combined.

Oscar Claude Monet, Impressionist par excellence, did not begin life as an Impressionist, and did not at first even give a thought to landscape art. He grew up in Ingouville, a fashionable hillside district of Le Havre that offered panoramic views and all the lures of the nearby water. Even so, he began his career as a financial success at the age of sixteen, drawing caricatures of prominent local citizens. It took some time for Eugène Boudin to convert Monet to the dual causes of poverty and landscape painting.

Boudin was Le Havre's itinerant landscape painter, who set out at dawn to absorb nature's lessons and returned after sunset. Boudin seldom ventured far from France's north coast and his skies show it. He was a gentle man who let the majority overrule the exceptional examples of violent weather or strident, towering clouds. As a result, his meteorology is quite restricted in scope, but within his milieu he was unsurpassed. What Boudin teaches is the moisture of a cool sea and the moderate action of the northern Sun. The lowest few thousand feet of his atmosphere are almost always humid and typically occupied by a layer of stratus or its disintegrating remnants. Dry air resides above, so that when the Sun does manage to burn openings in the humid layer it reveals clear blue sky, perhaps with hints of higher clouds. But the Sun is almost never strong enough to finish off the job, and leaves behind a field of vertically suppressed, smooth edged, slowly evaporating stratocumulus, as in the *Coast of Brittany* (Fig. 10-4). Even when Boudin traveled to Venice he could not relinquish his gentle, northern skies, and only near the end of his life did he acknowledge a hint of storminess.

Boudin's gentle landscapes were displayed in a storefront alongside Monet's caricatures. Boudin recognized Monet's talent and insisted he join him to paint outdoors. After refusing several invitations, Monet finally did follow Boudin to the countryside where his eyes were opened and he learned perhaps the most important lesson of his professional life.

> Everything that is painted on the spot has always a strength, a power, a vividness of touch that one doesn't find again in the studio.
>
> Quoted from Douglas Skeggs, *River of Light*, p. 12.

Fig. 10-4. Eugène Boudin *Coast of Brittany*, 1870. Collection of Mr. and Mrs. Paul Mellon 1983.1.11

Ten years later, in 1867, Monet was milking the sky around Le Havre for all it was worth. At this early point in his career, before he learned he was an Impressionist and before he decided to divide his skying time between innocuous puffs of fair weather cumulus, dulled layers of stratus or altostratus, or endless nuances of mist and fog, Monet recorded a wide range of meteorological conditions. He painted clear and placid skies, quietly brooding altostratus, dark nimbostratus of winter storms, unlimited visibility under broken layers of windswept stratocumulus from departing storms, towering cumulus on days with gusty showers, ominously silent leaden skies with sacrificial scud sucked into approaching thunderstorms, and even a rainbow grafted improperly onto a sunless winter sky.

Monet used Sainte-Adresse as the setting for two of his most insightful meteorological creations – the *Regata at Sainte-Adresse* (Fig. 10-5) and the *Beach at Sainte-Adresse* (Fig. 10-7). Both were executed in June 1867 and present almost identical views from the beach. Both face SE and include the same section of Le Havre in the background (Fig. 10-9). Both may well have been started the same day. But the bright *Regata* and the somber *Beach* contrast as sharply as the laughing and crying faces of the Tragedy Comedy Mask.

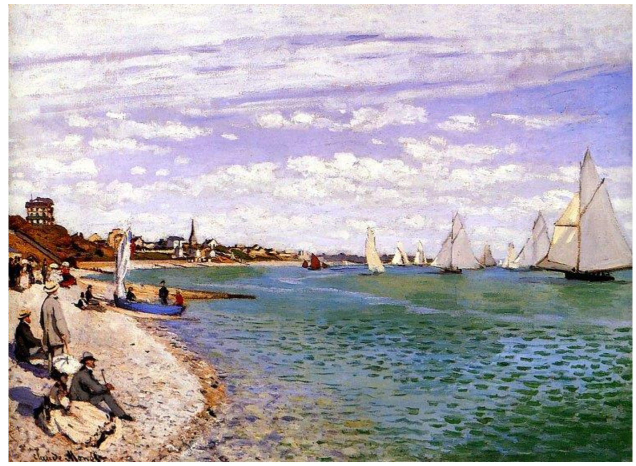


Fig. 10-5. Claude Monet. *The Regata at Sainte-Adresse*. 1867. Metropolitan Museum of Art, New York. Bequest of William Church Osborn, 1951.

Fig. 10-6. Cirrostratus over the City College of New York with cumulus over the distant land.

This meteorological mini series represents a precursor of Monet's later series of identical scenes such as the *Haystacks* or the Rouen Cathedral shown under a variety of lighting conditions. The sky of the *Regata* contains two cloud genera, as in Fig. 10-6, and enough meteorological information to venture a weather forecast. The shadows show that Sun is located behind and to the right of the viewer, which places it slightly north of west. Since it is near the summer solstice the time is about 4:30 PM. Small cumulus clouds have formed over the sunlit land to the southeast in a lower layer of the sky near the horizon. The cumulus are confined to a thin layer and, because it is so late in the day, will not grow any taller. The thin, broken cloud layer overhead is the leading edge of a cirrostratus deck moving in from the NW. And the sailboats are running with the NW wind.

Fig. 10-7. Claude Monet. *The Beach at Sainte-Adresse*. 1867. Mr. and Mrs. Lewis Larned Coburn Memorial Collection, 1987. Art Institute of Chicago.

Fig. 10-8. Altostratus with smooth upper layer and ragged lower layer advancing over Sarasota, FL.

Although a strip of clear sky appears to separate the two cloud types, the much higher cirrostratus actually overlies the nearest cumulus. The opaque cumulus are illuminated by reflected sunlight and appear brighter than the translucent cirrostratus, which is illuminated by transmitted sunlight.

The weather outlook for the *Regata* is not bright. Although cirrostratus usually advances from the SW (rather than the NW) the scenario strongly suggests an approaching low pressure area with prolonged rain, especially given the Beach's lowering sky.

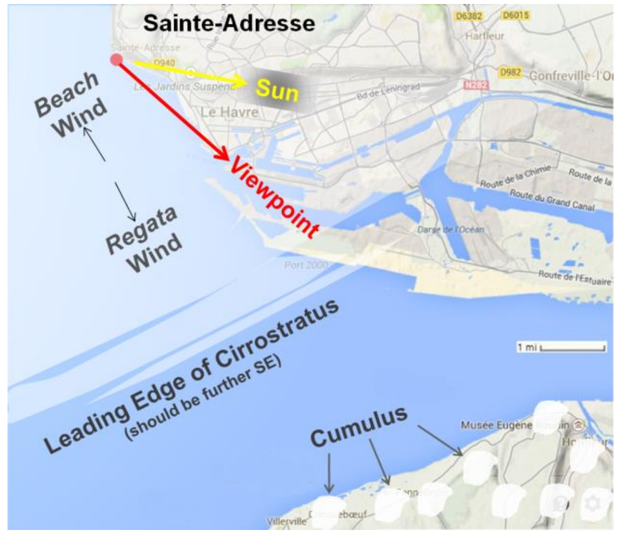


Fig. 10-9. Map of Sainte-Adresse and Le Havre. Red arrow indicates viewpoint of Fig. 10-5 and Fig. 10-7.

I hypothesize that Monet began the *Regata* under bright skies, not anticipating a second work. But as he was painting, the translucent cirrostratus overran the sky, lowering and thickening into opaque altostratus. Shade darkened stratocumulus spread from the earlier sunlit cumulus, to give the sky a mottled appearance, as in Fig. 10-8. A yellow-gray overcast extinguished the sunlit radiance of the sparkling water and gleaming solid surfaces; the water turned opaque gray, the buildings, glum, the sand subdued, and the once white sails turned black. Even the wind turned; the sailboats running with the wind now head from the SE. The artist had to hurry; rain was close.

These visual changes took place so rapidly (over a few hours) and were so profound they surely compelled the alert, opportunistic, and sensitive artist to start a second canvas. Thus, it was almost certainly a chance weather change that made the miniseries of the *Regata* and the *Beach* the original Impressionist primer for how clouds and shade affect the lighting and color of a scene.

Monet played with the subtle but visually pleasing lighting contrasts between different cloud genera in several paintings. *Sunday at Argenteuil* (Fig. 10-10) faces NE along the Seine. It is about 3:00 PM; the shadows of the tree trunks on the promenade show the Sun is in the WNW. The sky is populated with sizable cumulus overlain by altocumulus. The brightest clouds are the sunlit sides of the cumulus, which reflect light more efficiently than thin altocumulus 90° from the Sun transmits it, while the darkest clouds are the shaded sides and bases of the cumulus, which transmit little light. Fig. 10-11 validates these features.

Fig. 10-10. Claude Monet. *Sunday at Argenteuil*, 1872, Louvre.

Fig. 10-11. Cu and Ac over Boynton Beach, FL.

Whenever the Impressionists painted stratiform clouds, which they did quite often, particularly in winter, they dulled the tone of the landscape. In the winter of 1871-72, Monet returned from exile in time to paint the sombre *Pont Neuf* (Fig. 10-12). Here the scene approaches a state of complete tonal degradation. Hints of fractostratus provide the only variety in a sky covered by an otherwise gray, featureless deck of nimbostratus. The wet ground complements the mood by allowing almost specular reflections of the umbrella toting pedestrians. A fine mist or drizzle has reduced visibility while the plume from the smokestack of the boat on the Seine is greatly engorged by the saturated air.

Fig. 10-12. Claude Monet. *Pont Neuf*. 1872 Dallas Museum of Art. Wendy and Emery Reves Collection.

Fig. 10-13. Auguste Renoir. *Pont Neuf*. 1872. National Gallery of Art. Ailsa Mellon Bruce Collection.

It was only under the cloak of altostratus or stratus that the Impressionists allowed a view of the increasing urban pollution. Once the Sun broke through, it cleansed the Earth, water, and sky so that the scenes sparkled.

The contrast between winter's dull, tonal stratiform overcast and spring and summer's brilliant skies dotted with powder puff cumulus could not be illustrated any better than by comparing Monet's version of *Pont Neuf* to Auguste Renoir's (Fig. 10-13). Since the bridge points just west of south, the shadows show Renoir's work was done shortly after noon, near the summer solstice. Because the scene faces the Sun, Renoir made the thicker cloud cores darker than the thinner fringes, since the cores transmit less sunlight.

Fig. 10-14. Stratus (top) and powder puff cumulus (bottom) over the Brooklyn Bridge, 04, 05 July 2014.

Similar contrasting views of the Brooklyn Bridge under overcast conditions and powder puff cumulus skies are shown in Fig. 10-14. In the bottom photo, the Sun is far enough to the right so that the cumulus are lit by reflected light. Here, the thicker cores of the cumulus appear brighter because they reflect sunlight more efficiently than the thinner fringes.

Alfred Sisley recorded this feature of cloud lighting in the sparkling *Bridge at Moret* (Fig. 10-15), one of his many contributions to the Impressionists' portfolio of powder puff cumulus. Sisley discovered the picturesque and affordable town of Moret-sur-Loing in 1880, and later settled there. Forty miles upriver of Paris, at the juncture of the Seine and Loing Rivers, Moret's limpid waters glisten, its air, fresh and pure, and its sky, deep blue gleam. There is neither a trace of industry nor a hint of pollution. But, would you drink that water?

The scene faces WSW. The Sun is behind and to the left of the viewer, placing it in the SE. This makes it midmorning, prime time for pristine skies and baby cumulus. The sky is typical of a bright spring or summer morning in northern France. And the wavy streaks of higher clouds at top center make the sky seem even bluer by contrast.

Fig. 10-15. Alfred Sisley. *The Bridge at Moret*. 1893. Musee d'Orsay, Galerie du Jeu de Paume, Paris.

Morning's widely spaced cumulus powder-puffs are too tiny and immature to have flat bases. Afternoon cumulus congestus often rise to great heights and broaden so that their bases are plainly flat, they cover more of the sky and so, may merge. The difference between Jacob van Ruisdael's crowded skies of towering cumulus (Fig. 7-16) and Impressionist skies of scattered baby cumulus is meteorologically valid. Furthermore, mature cumulus congestus often impregnates the afternoon air with haze that saps the sky of its virginal blue.

The Impressionists liked the pristine sparkle and tame quality of morning skies so much they practiced the ancient art of bonsai on their cumulus. This fits with the story in which Monet hired workmen to restore an oak tree to its immature state by stripping its leaves after a week of spring rains had halted his work but not the tree's. Examples of this screening can be summoned at will. Even when Sisley showed the Seine above flood stage, as in the *Flood at Le Port-Marly* (1876, Louvre, Paris), he made sure that the ever so slightly ruffled, limpid waters glisten, while tiny cumulus, with a delicate hint of altocumulus, sparkle in the unpolluted sky above.

The real Seine and sky were not so clean. The Seine was the sewer of Paris. After two outbreaks of cholera (1831 and 1848-49) each claimed the lives of 19,000 Parisians, the sewers became a top priority item in the redesign of the expanding city.

Baron Georges Eugene Haussmann was chief architect for the new Paris and performed his job in exemplary fashion. The sewers were an engineering masterpiece. Every consideration was given to getting the waste waters far from the city with a minimum of inconvenience and backup. The sewers flowed into three major collectors which then were routed northward. After bypassing one large loop of the meandering Seine, two major man-made tributaries discharged their unwelcome fare a few miles downriver at Asnières-sur-Seine and at Saint Denis. There, even though human ordure had been legally banned from the sewers, the Seine became abruptly offensive. The waters were darkened by streaks of an unhealthy and fetid brew that none of the senses could fail to register. The city of Paris was obliged to periodically remove the most prominent deltas of sludge that amassed just below the outflow points, but this was small compensation for the wholesale degradation of the riparian environment.

At Argenteuil, a fashionable tourist Mecca 17 miles downstream from Paris, the Seine grew so intolerable that the mayor included the following description in a plea for relief,

> Between the highway bridge and the floating laundry houses which are along the promenade, sludge has built up all along the banks. Above these boats, the earth has been consolidated; even a garden was created and this garden completely stops up the part of the river between the bank and these boats;...the water for a rather long distance no longer moves; there is an accumulation of filth, dogs, and cats in putrefaction; the traffic on the promenades becomes unpleasant.
>
> from *Monet at Argenteuil*, p 176, letter to the department prefect, 23 July 1872.

Guy de Maupassant phrased the same basic sentiment a bit more poetically when he wrote in his reminiscences,

> For ten years my great, my only absorbing passion was the Seine, that lovely, calm, varied, stinking river, full of mirages and filth.

How did Monet picture this river of mirages and filth? So long as the Sun shone upon it and cumulus reigned above, Monet's Seine was a mirage of purity. Monet must have loved this river, for he spent most of his life along its banks. But in 1878, urged by Argenteuil's expanding industry and growing aroma and driven by poverty, he moved with the Hochschede family further downstream to

Vetheuil. Times were hard and the group knew hunger. Camille Monet died at the end of the summer of 1879. Claude was devastated and painted very little until the river brought him back to life early in 1880.

Early in the severe winter of 1879-80 the Seine froze solid. When a thaw came in January, Monet was there to record it in the *Ice-floes* (Fig. 10-16). The atmospheric envelop he spoke of so often and that conditions everything relaxed its embrace on the universe. During the brief period of partial clearing, delicate tufts of cirrus floccus drift above the pale, misty sky that envelops the horizon. Tranquility reigns below; not a breath of wind disturbs the mirror surface of the water. Monet and winter could not yet shut out the Sun. But the curtain will close fast.

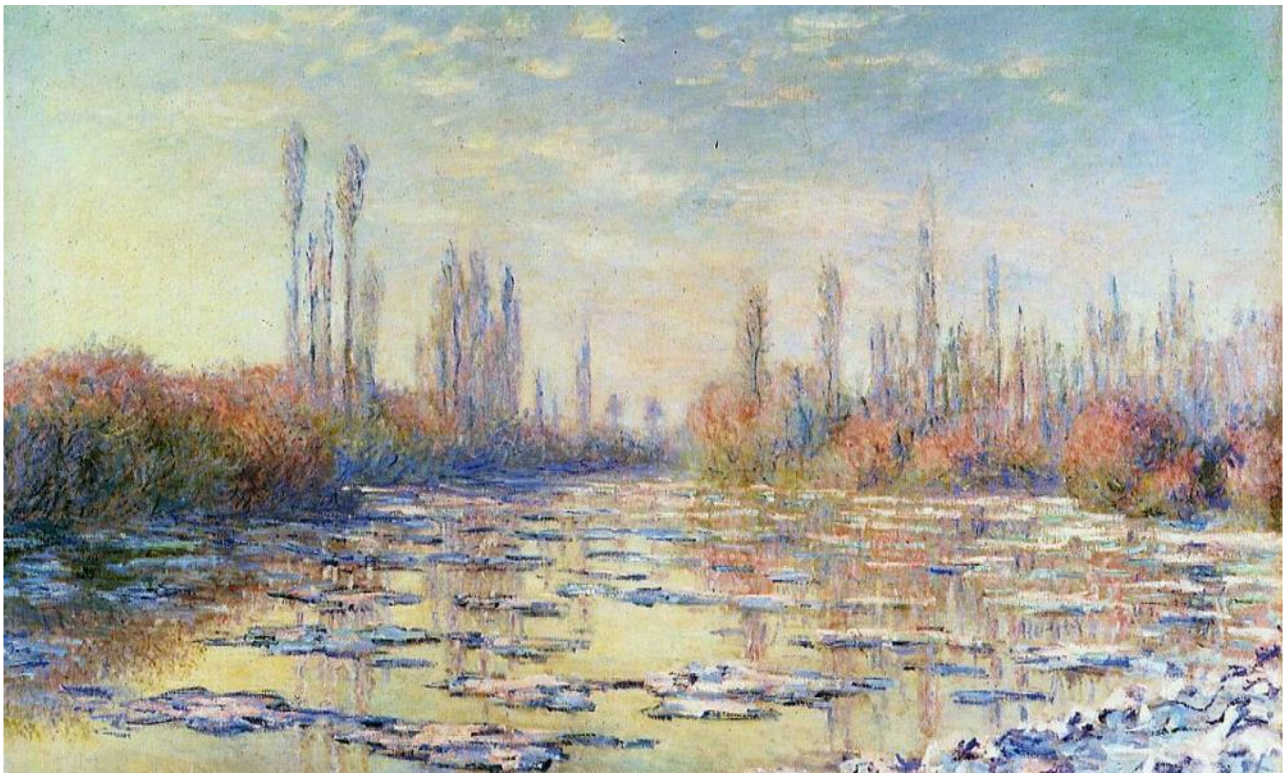


Fig. 10-16. Claude Monet. *The Ice-floes*. 1880. Shelburne Museum, Vermont.

Only the ice-floes break the reflections of the sky and vegetation. They and the snow on the river bank are all tones of pastel.

Consider the possibilities of ice and snow. We grow up with the expression, "as white as snow" imprinted in our mind's eye, and Renoir once called snow the "leprosy of nature". Still, it was the Impressionists who first revealed snow as a coat of many colors and continued to do so almost every winter from 1869 on. Any city dweller knows that within a day, snow begins to acquire a dirty film. But even when it is still pure, snow is not always white. Dig a hole in the pure white snow and you will find it to be blue. Watch carefully and you will notice that sunlit snow assumes the golden or rosy tints of the low winter Sun, while the shaded areas are tinged blue by skylight. Monet's various *Haystacks* (1891), amount to a compendium of the possible colors of snow.

Camille Pissarro's *Rabbit Warren at Pontoise, Snow* (Fig. 10-17) explores some of the possibilities of snow brought out by the severe winter of 1879-80. Pissarro lived and painted for many years in the village of Pontoise, at the junction of the Seine and Oise Rivers, some 30 miles downriver from Paris. In the *Rabbit Warren*, snow covers the ground and houses, and even coats the vegetation. Pissarro has extracted every square inch of lively coloring the drab scene could possibly have possessed. The tiny brick chimney tops show up as bright orange and, despite the cold, there are still a few vestiges of hearty green vegetation. Even the snow partakes in the parade of colors, for in the lower right foreground yellow highlights have emerged from the midst of the gray as if by magic.

Fig. 10-17. Camille Pissarro. *Rabbit Warren at Pontoise, Snow*. 1879. The Art Institute of Chicago, Gift of Marshall Field.

The yellow tint of the snow in the *Rabbit Warren* is reflected in the sky above. This yellowing constitutes the highlight of the otherwise uniform deck of gray stratus and is likely a byproduct of pollution. Not surprisingly, visibility is rather poor and the exposed surfaces of houses and trees beyond the immediate foreground appear dark gray and featureless. Here, without a single smokestack to disturb the quiet rural setting, Pissarro has painted a singularly incriminating piece of evidence about technology's unwanted but all too pervasive impact on the environment.

Smokestacks and their sanitized effluents abounded in Impressionist and Post-Impressionist canvases. In 1907, Paul Signac presented a candified panorama of the *Port of Rotterdam* (Fig. 10-18). The scene can be decomposed into myriad light blue, white, pink and purple dots in the pointillist style pioneered by Georges Seurat. Air pollution from the plumes has so reduced the contrasts of light and color that water below and sky above look almost the same. This is true of many Impressionist works with overcast skies.

Fig. 10-18. Paul Signac. *The Port of Rotterdam*. 1907. Museum Boymans-van Beuningen, Rotterdam.

Within a few miles from their source, all the distinct smoke plumes merged into an anonymous and almost uniform pall that cast a subtle film over the face of all things and created a new, softened atmospheric luminosity. This provided the Impressionists with new worlds of visual material. Their pastelled palettes and Monet's famous envelope were byproducts of the industrial environment. Gone were the sharp contrasts and substantial clouds of olden times, and in their place came much softer hues and delicate cotton puffs.

These changes did not go by unnoticed. In *The Storm Cloud of the Nineteenth Century* (1884), John Ruskin was probably the first to bemoan the decreased attention paid to cloud form as a result of all the pollution. Half a century later, Lewis Mumford, one of the founders of regional planning, redrew attention to the effect of industrial pollution on artists in, *Technics and Civilization*.

> But paleotechnic industry was not without an ideal aspect. The very bleakness of the new environment provoked esthetic compensations. The eye, deprived of sunlight and color, discovered a new world in twilight fog, smoke, tonal distinctions. The haze of the factory town exercised its own visual magic: the ugly bodies of human beings, the sordid factories and rubbish heaps, disappeared in the fog, and instead of the harsh realities one encountered under the sun, there was a veil of tender lavenders, grays, pearly yellows, wistful blues.
>
> Turner was perhaps the first painter to absorb and directly express the characteristic effects of the new industrialism... [which also] gave birth to its chief collective triumph, the work of the Barbizon school and the later Impressionists, Monet, Sisley, Pissarro, and most characteristic if not most original of all, Vincent Van Gogh.
>
> Lewis Mumford. *Technics and Civilization* p. 199-200. 1934.

What more can be said about the powder-puff skies of the Impressionists? The Impressionists chronicled certain atmospheric events with an accurate, poetic vision, and produced some sparkling jewels of light and color, but their self-imposed limitations cannot be ignored. The technique of using broad brushstrokes took a heavy toll on the sky, for that made it difficult to represent the fine clouds such as cirrus or cirrocumulus. But the most important restriction resulted from the domestication of nature. All storm and stress were purged, and along with them went the atmosphere's wondrous phenomena such as rainbows and halos. Only the practiced naïveté of forcibly becalmed skies remained to the Impressionists and then there was no wind left to sweep away the blurring envelope of pollution excreted by their beloved god of progress. In the end, Impressionism asphyxiated itself.

10.2 Nature's Roadmap to the Beyond

When the Impressionists opened the floodgates of light, color, and vision they tapped an ancient wellspring.

In 1666, when Isaac Newton tried his hand at the "celebrated phenomenon of the colors", it was already an ancient experiment. But Newton realized the importance of one feature that had eluded all his predecessors. For two thousand years, people had known that when a narrow beam of white light passes through a glass prism, the entire spectrum of colors emerges from the other end. Newton noticed that the emerging spectral beam was greatly elongated and wondered why. He conjectured that the elongated beam had split as it passed between air and prism. He then took the step of genius of successfully reuniting the colors of the beam with a second prism. What emerged from the second prism was a narrow beam of white light. From this, Newton deduced that white light is the integral of the colors of the spectrum.

Another experiment Newton reported in his *Opticks* served as the basis of Pointillism. Newton mixed powders of different colors and spread them on a flat dish in the sunlight. From a distance the mixture appeared to be white (but not as bright as a dish with white powder), because light reflected from the powders combined in the manner of spectral colors.

Newton also drew a diagram displaying the spectral colors around a circle. This color circle was the forerunner of chromaticity diagrams of light (Fig. 10-19) and color wheels of pigments.

Scientists recognized that vision has subjective components because light must pass through the eyeball, retina and optic nerve before the brain interprets it. In 1742, Georges-Louis Leclerc (Comte de Buffon) noted that shadows appear to have the complementary color (opposite on the color wheel) to the surrounding bright light. Using this discovery, Phillip Otto Runge, who was fascinated by optics, became perhaps the first artist to paint purple shadows in a yellow sunrise sky (*Morning*, 1808, Kunsthalle, Hamburg).

Primary colors also derive from the biochemical nature of human vision. The trichromacy theory was proposed around 1669 by Edme Mariotte and advanced by George Parker, Michael Lomonosoff, and Thomas Young. Young, a physician, theorized that we have three types of visual receptors in the retina, each sensitive to a different range of wavelengths. As a result, we need combine only three primary colors - red, green, and blue-violet - to see white light.

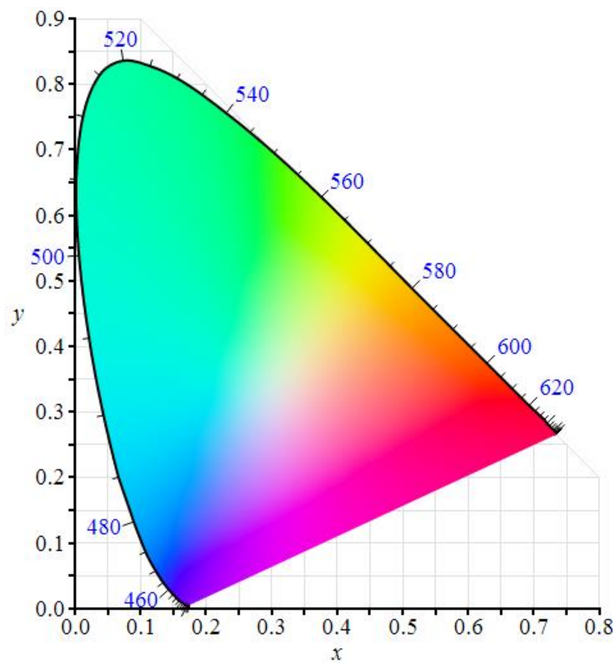


Fig. 10-19. Chromaticity diagram. Spectral colors of light occupy the perimeter, pastel colors inside. The central region is white because it includes all colors of light. Complementary colors appear on opposite sides of the white point.

Another sixty years passed before James Clerk Maxwell popularized the trichromacy concept in a public lecture with a compelling demonstration. He took three black and white photographs of the same scene, each through a filter of a different primary color. Each photograph was developed as a black and white transparency and then covered with the original colored filter. The three transparencies were then projected on a screen. When the images coincided, a full color reproduction of the original scene resulted.

Maxwell's demonstration greatly simplified the chemists' search for a solution to the problem of color photography even though his process proved impractical. But painters were initially confused by these findings, for when they mixed different pigments the mixtures only got darker, not lighter.

In 1867, Hermann von Helmholtz stated clearly for the first time the distinction between light and pigment. When different colors of light are combined, the effect is additive; the light gets brighter and whiter. When different pigments or dyes are combined, the effect is subtractive and the mixture becomes darker because it absorbs more light. Color film photography is based almost exclusively on the subtractive properties of chemical dyes.

Helmholtz's clear distinction between light and pigment reached the artistic community within a decade and bestowed an aura of theoretical justification on artists who used a palette of the spectral colors filled the canvas with broad brushstrokes of unmixed paint. When such paintings are viewed from a sufficient distance, the colored strokes appear to merge in the eye and lead to a third color, which is brighter than premixing the pigments and almost as bright as adding the colors of light, as Newton had found. Painters had finally found the best possible means to simulate the effects of light that paint would allow. The Impressionists were enraptured by this discovery, but others had gotten there first.

In 1824, Eugene Delacroix created a minor scandal by repainting his *Scene of the Massacre of Scio* (Louvre) after it had been accepted for display in the Salon. Delacroix was inspired to do this the moment he saw Constable's *Hay Wain*, which struck him as a revelation. Constable used dabs of different colors rather than blending the paints and grading color and tone continuously in the accepted French style of the day. Delacroix saw that Constable's approach added a vibrancy that was missing from French paintings. Delacroix continued to experiment with a variety of coloring techniques for the rest of his life. The Impressionists and post-Impressionists would acknowledge Delacroix's approach to coloring as crucial to their development.

It was also in 1824 that the chemist, Michel-Eugene Chevreul was appointed Director of Dyes at the Royal Tapestry Workshop of Les Gobelins in Paris. Assigned the problem of improving the color intensity of wool dyes, Chevreul rediscovered that the apparent intensity of a patch of color depends more on the color of its neighbor than on the inherent intensity of the color itself, called the law of simultaneous contrast,

> In the case where the eye sees at the same time two contiguous colours, they will appear as dissimilar as possible, both in their optical composition and in the height of their tone.
>
> Michel-Eugene Chevreul, *On the Simultaneous Contrast of Colors* (1839). Quoted from *Seurat and the Science of Painting*, p 67. Homer.

Chevreul stressed that the perceived color of an object is modified by the color of the light incident upon it. He also emphasized Buffon's discovery that we perceive shadows have the complementary color of the nearby bright region. At times, Chevreul carried his advocacy of physiological effects too far for he was wrong to reject the idea that skylight tints shadows blue.

> This colorization is not due to the colour of the sky, as many persons believe; for if instead of the bodies being struck by the orange light of the Sun, they were struck by red, yellow, green, or violet light, the shadows would appear green, violet, red, or yellow.

Chevreul served artists as a scientific guru. He urged artists to use his laws in a way that would remain faithful to nature. But his primary impact was to redirect artists' attention away from the form of objects and to stress the primacy of the perceptions. Thus, Chevreul's carefully formulated set of rules helped art grow more subjective and was one of the vehicles by which the floodgates of irrationality in sky painting were opened.

Georges Seurat was the leading practitioner of this calculus of color. He formalized the color techniques of his predecessors and codified in paint the color theories of the scientists. His dots were presumably elemental colors that our eyes integrated at a suitable distance into a coherent view of reality. Seurat's color scheme was carefully constructed according to Chevreul's and Ogden Rood's formulas. His compositions always included bright regions with adjacent shadows of complementary colors. Since we tend to see an aura of complementary color around an object, Seurat's approach redoubled the physiological effect.

Félix Fénéon, Seurat's bulldog, vigorously defended this approach to art. He growled, "The painter's artifice will have rigorously restored the process of reality."

But there are times when nature seems to be at odds with the way we see things, and then Seurat felt compelled to make nature give way a bit. In doing so, he was always careful to provide some theoretical explanation based on scientific principles. After Seurat, artists continued this trend toward rationalization but felt progressively less obligation to refer to nature. As a result, art technique was soon transformed into its own self-serving pseudoscience.

The call to science was only a gloss on the real influences that transformed sky painting after 1880. The uprooting changes that were transforming 19th century Europe allowed strange, irrational tendencies to creep across the horizon of humanity and diffuse into every walk of life. Even science (from 1900) made fundamental contributions to a picture of a universe so irrational as to be beyond the wildest imaginings of earlier day lunatics. Who, living in 1860, could possibly have anticipated the discoveries Max Planck of the quantum theory and Albert Einstein of relativity? We now live in a world where bodies get shorter and heavier but age more slowly as they move faster. According to Heisenberg's Uncertainty Principle, it is statistically possible for balls to roll uphill and perfectly accurate observation is impossible because light moves any object it has struck. And, as Sigmund Freud discovered, many of our actions and motives are inherently irrational.

The philosophers, poets and artists could not clearly foresee these changes but somehow felt compelled to present a picture of the way the world was becoming as the 20th century approached. They sensed that nature was no longer an end in itself but merely a roadmap to an ultimate reality that lay somewhere beyond the visible. It was during this brief transition period to the sterile myopia of pure abstraction that artists learned to distort nature in ways that would most effectively evoke the most visceral human responses.

The manipulation of nature to produce extreme psychological reactions was nothing new to art. Almost every period has had some exceptional figure whose distortions of nature haunt the psyche. Altdorfer, Grünewald and El Greco are just three of the more memorable earlier examples. At the beginning of the 19th century, William Blake created a phantasmagoric art, full of optical phenomena such as rainbows, which was specifically designed to counteract the rational Newtonian world he so detested. Blake was followed by Samuel Palmer, whose highly visionary and personal approach to sky painting prefigured Van Gogh. Other artists presented personal and unusual visions but, until the later years of the 19th century, they invariably remained outside the mainstreams of art.

The year, 1880 can be taken to mark a turning point. Prior to that, Arnold Böcklin painted nothing memorable although he did have a flair for the sky. His *Spring* (1870, Schackgalerie, Munich) contains an excellent rendition of stratocumulus. But in 1880, Böcklin created *The Isle of the Dead* (Kunstmuseum, Basel), a haunting, nocturnal vision that announced in no uncertain terms the passing of an era. This brought the artist such financial success that he repeated the theme four more times. The third version is shown here (Fig. 10-20).

Fig. 10-20. Arnold Böcklin. *The Isle of the Dead*. 1883. National Gallery, Berlin.

The rocky island cemetery looms like a fortress to dominate the picture. Cypresses, symbols of mourning, stand erect and seem to reach the clouds. A rowboat is delivering a casket to the isle. The casket is attended by a solitary, white robed spirit that stands as erect and still as the near black cypresses.

The Isle of the Dead is an homage to motionless silence that would have impressed Piero della Francesca. Böcklin wrote that *The Isle of the Dead* "must produce such an effect of stillness that anyone would be frightened at hearing a knock on the door." But behind the silence of the foreground in the 1883 version, a turbulent sky of dawn or dusk compounds the mood. A curtain of clouds and mist reaches all the way to the sea surface and severs the isle from any tie to the world of the living.

The lurid lighting contrasts add to the mood of the painting. Somehow, the horizon Sun breaks through to cast its rosy light upon the island and the clouds above. This light does not reach the sea surface so the lower clouds behind the island are shrouded in a Stygian darkness. Higher up, there are a few breaks in the clouds but these deep blue twilight clearings are also sources of darkness.

Something strange is going on in all versions of *The Isle of the Dead*. Nature has not been distorted or violated in these haunting visions of loneliness and isolation, yet somehow she has been made to serve some 'greater' purpose.

Fig. 10-21. Albert Pinkham Ryder. *Toilers of the Sea*. Before 1884. Metropolitan Museum of Art.

At the same time another strange spirit was beginning to conjure up lurid landscapes. Albert Pinkham Ryder was born in New Bedford, Massachusetts, the whaling town that served as home port in *Moby Dick*. Around 1870 Ryder moved to New York City and, aside for a few brief trips, remained there the rest of his life. In the 1870's he painted some pastoral landscapes with contented cattle, but like Melville's Ishmael, he could never wash the smell of salt water from his nostrils and was drawn back to the sea. Dates have not been established for most of Ryder's crucial works, but some time after 1880 he began to create his famous moonlit scenes that include the *Toilers of the S*ea (Fig. 10-21).

What is it that gives us such weird feelings when we look at the *Toilers of the Sea*? Age has added a veil of venerability to Ryder's nocturnes because he used pigments that have cracked and assumed a more sombre greenish tone with time. But these are not the crucial ingredients that make his skies the archetype for the greatest horror movies. Somehow, the feeble corona, the moonlit patches of undulating altocumulus and the sea foam unnaturally provoke night's normal darkness. These misplaced and almost unholy invasions of light in the rightful domain of darkness give the landscape its sinister aspect and place it somewhere in the 'Twilight Zone'.

Ryder painted his seascapes of the soul in a darkened and dusty Manhattan apartment during the long intervals between his few sea voyages. There, in the midst of the city's clamor, perhaps in the very year that the massive Brooklyn Bridge was completed, Ryder withdrew to a private world that acknowledged only the sea and sky.

At about the same time that Ryder was redefining his childhood phantom world, the power of the sea and sky also drew fellow New Englander, Winslow Homer, back to the world of his youth. Many of Homer's early landscapes seem innocent enough, but around 1880, Homer began to grow less social and the mood of his paintings underwent a subtle change. During the summer of 1880, he moved to the relative solitude of Ten Pound Island near Gloucester, Massachusetts, and painted the *Promenade Along the Beach* (Museum of Fine Arts, Springfield, MA). This shows the same stylish ladies he had long been painting. The ladies, armed with Japanese fans, were taking their same innocent, fashionable *Promenade Along the Beach* as before. But this time, behind their backs, the sky had grown strangely dark and menacing. Not much longer would their reprieve last. The elemental forces of nature were about to be unleashed.

Homer launched his transformation with a change of scenery. In the spring of 1881, he set off for the North Sea coast of England and spent almost two years at the mouth of the Tyne River where Turner had once served an apprenticeship to the raging sea. There, Homer watched the simple fishermen stoically confront the waters' mighty whims.

By the time Homer returned to America late in 1882, survival, not social status had become the central issue of his art. He moved to the water's edge at Prouts Neck, Maine. There, in direct contact with the ocean, but sequestered from seething humanity, he created his sagas of the sea. Now his fine and delicate ladies were swept, swooning helplessly, into the roiling waters by the most sociopathic storms. Only the heroism and strength of rugged men could save the ladies.

Fig. 10-22. Winslow Homer. *The Fog Warning*. 1885. Museum of Fine Arts, Boston.

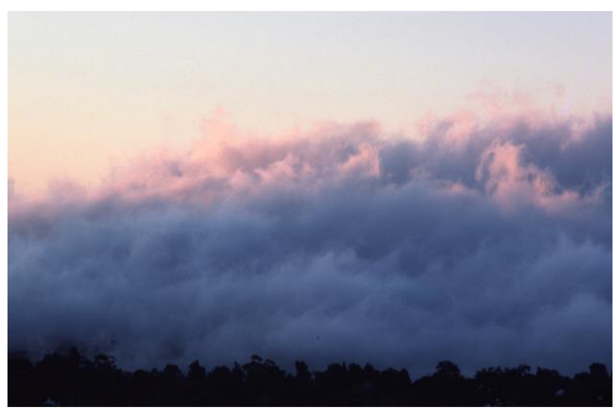


Fig. 10-23. The Wall of Fog. Pacific Palisades, CA, 6 January, 1986.

Storms might slacken from time to time, but some new vagary of the weather would always threaten to close. So it was in *The Fog Warning* (Fig. 10-22). The pale, late afternoon sky with a row of pink altocumulus seems to guarantee warm, placid weather. But then there is the advancing fog bank. The fisherman sees it and is rowing for all he is worth to get back with his day's catch to the safety of his ship before he is engulfed in zero visibility.

An approaching fog bank was no joking matter to the local fisherman. Fog is a frequent visitor to the cold coastal waters of Maine, and the adjoining Grand Banks of Newfoundland is the fog capital of the world. This fog is the child of two ocean currents that run side by side. The cold Labrador Current flows down the coastline from the northeast, while further seaward the warm Gulf Stream flows in the opposite direction. At the boundary between these currents, the color and temperature of the water both change abruptly. Whenever the wind blows from the much warmer Gulf Stream to the cold coastal waters the air is cooled by contact and a dense fog a few hundred feet thick frequently results. This happens roughly half the days of the year.

Fog does not always have such sharp edges as in *The Fog Warning*, but Homer's fog bank is no mere figment of the imagination (Fig. 10-23). Well defined walls of fog sometimes mark the leading edge of advancing cold air masses and have the same air motions as in the vortex at the edge of thunderstorm downbursts. Ragged coruscations in the fog bank will sometimes make these motions visible, so that you can see the air rising and then curling back on itself. Indeed, Homer astutely included two strands of fog that rise above the head of his fog bank and then tilt back toward its body.

If we look back to *The Fog Warning* we might ask if the fisherman will make it to the safety of his ship before the advancing wall of fog closes in. Homer might have smiled if we asked this question and we must cross the Gulf Stream for his answer. In 1898, Homer returned to the Bahamas and one result was his painting, *The Gulf Stream* (1899, Metropolitan Museum of Art, New York). The painting shows one of the waterspouts that form when polar air pours from the land over the Gulf Stream, gets heated by the warm waters, and swirls upward. In the Gulf Stream a black man reclines on the deck of a small broken-masted boat, tossed by the waves and surrounded by hungry sharks. Adding insult to injury, the spout whirls away in the distance although a large clipper ship can be seen at the horizon. After being repeatedly asked what the ultimate fate of the man would be, the taciturn Homer finally replied,

> You can tell these ladies that the unfortunate negro who is now so dazed & parboiled, will be rescued & returned to his friends and home, & ever after live happily.
>
> *Winslow Homer*. Lloyd Goodrich. 1959. p 162.

Perhaps that is what we should tell his ladies, but no one can deny the ominous tone in Homer's later works.

I chose to analyze the *Isle of the Dead*, the *Toilers of the Sea* and *The Fog Warning* solely because each uses meteorology to invoke from the depths a dark and hitherto unknown side of nature. It was only in retrospect that I noticed another striking parallel. Each is set on the sea with only a small boat. Ironically, this was the time that huge ocean liners first powered their way around the world. It was the time that massive bridges were first spanning the great rivers. It was the time that telephones were finally linking the world. It was the time that electricity was illuminating it. Nevertheless, something new, dark, and frightening was emerging amid all our technological conquests. The devices that facilitated communication were powerless to eliminate our sense of loneliness, and the massive structures and engines that we created left people feeling as powerless as ever in their daily lives. If anything, these advances merely heightened people's awareness of their own personal insignificance. The painters chose small boats under menacing or eerie skies far from the mainland because they wanted settings that best suited these uneasy feelings. In a world whose population was growing explosively, we no longer had the means to deny we are

> Alone, alone, all, all alone,
> Alone on a wide, wide sea!
>
> Samuel Taylor Coleridge. *Rime of the Ancient Mariner*.

Vincent van Gogh did not need the sea to show that we are all alone in a world rocked by a sea of violent emotions. He would, if need be, set sky and earth into convulsions to suit his purpose.

Despite van Gogh's personal convulsions, nature was his constant source of inspiration and he remained unwilling or unable to create scenes solely out of his imagination. No matter what distortions he introduced, everything van Gogh painted he derived almost directly from what he had seen, and his works remain a chronicle of the weather he experienced.

Van Gogh had art in his blood from an early age. His grandfather and uncle were successful art dealers. He began his career as a salesman in the London branch of the international art firm of Goupil & Cie, but improper behavior following an unrequited love soon led to a summary expulsion from the showroom. For the next few years van Gogh shifted almost aimlessly from one career to another. But only after his six month contract as an evangelist in an impoverished coal mining town in the Borinage district of Belgium was not renewed did he finally decide to be a painter. Then, with his brother, Theo, as his sole source of support, Vincent began to grope his way slowly toward mastery.

From 1880 to 1886, van Gogh lived in Belgium and Holland. There he painted mostly overcast skies ruled by stratiform clouds. Sometimes the weak north European Sun almost penetrated nearly translucent altostratus, but more often the cloud cover was opaque. About one third of his scenes were foggy and, true to the cold, dismal winters of the 1880's, many of these were covered by a mantle of snow. When openings appeared in the sky, the stratus gave way to stratocumulus or innocuous puffs or streets of cumulus.

When van Gogh moved to Paris in March, 1886, he was introduced to the light and color of the Impressionists, but this had no immediate effect on his meteorology. If anything, the atmospheric visibility of his early Parisian landscapes decreased, probably in response to Paris's polluted atmosphere. But the moment the horribly cloudy and cold winter and spring of 1887 gave way to an abnormally warm and sunny Parisian summer, van Gogh cleared his skies and adopted the Impressionist palette and techniques.

When dismal fall and winter weather returned, Vincent's skies clouded over once again. Then, after three weeks of almost solid overcast, wet weather in February 1888, Vincent abruptly fled south to find Sun and immortality in Arles.

Oddly, when van Gogh arrived in Arles, the ground was covered with a foot of snow and snow was still falling. The weather remained wintry in Arles for about a month and his first paintings there have almost Dutch skies. But late in March, spring burst into bloom and the Mistral evaporated the clouds.

Life around Arles must make obeisance to the Mistral. On clear nights, mostly in the winter half of the year, the highlands of central France radiate heat rapidly to space. As the air is chilled by contact it grows dense and pours down the Rhone River Valley towards the Gulf of Lyon, especially when low pressure over the Gulf beckons. Some distance upriver from Arles the valley narrows, funneling the moderate winds and accelerating them to hostile speeds. By the time the often cloudless Mistral reaches Arles, it can blow at full gale force.

So, the ever intense Van Gogh went out into the sunny, windswept fields around Arles and swept the Impressionist veil of powder and puffs from his canvases. His paintings in Arles have high visibility and little cloud cover. His cloud types also changed. The low-lying decks of stratus virtually disappeared to allow a view of the delicate beauty of cirrus. In Arles, Vincent's cumulus became the dominant cloud form almost by default but remained small and innocuous.

It was in Saint-Remy that van Gogh's cumulus grew to menacing proportions and his works attained the full measure of turbulent expressiveness he is best known for. While in Arles, he began to suffer from attacks that resemble epilepsy but which may have been brought on by an addiction to absinthe. Early in May, 1889, he voluntarily placed himself in the asylum at Saint-Remy.

From the barred window of his asylum cell, he watched the ceaselessly unfolding drama of the skies. The weather at Saint-Remy was unusually disturbed in May and June 1889 and may have prodded van Gogh to his new, turbulent vision. On May 8, he drew the rising *Sun over Walled Wheat Field* (Rijksmuseum Kroller-Muller, Otterlo) with a single large cumulus that fills the right half of the sky. Never before had van Gogh even hinted that cumulus could grow large.

A month later, when van Gogh was finally allowed outside his room, he apprehended a giant, hand-shaped cumulus retreating in the southeastern sky in the *Mountainous Landscape Behind the Asylum* (1889, Ny Carlsberg Glyptotek, Copenhagen). The distinct undulations of the cloud's base were almost certainly caused by wavy airflow over the Alpilles. They constitute crucial evidence that the cloud was derived from a specific observation. This was one of the few clouds that Vincent referred to, for in a letter describing the painting he wrote of

> a field of wheat ruined and hurled to the ground after a great storm....Then at the top of the canvas a great white and gray cloud floating in the azure.
>
> Vincent van Gogh, *The Complete Letters*, letter 594, c. 09 June 1889.

It was during the stormy weeks that followed, that van Gogh finally saw Earth and heavens move. Possibly on June 10th or 12th, each a day of clearing skies following heavy rain and a likely cold front passage with strong NW winds, Vincent first saw the wind bend gnarled olive trees in the *Olive Trees with the Alpilles in the Background* (Fig. 10-24). As the wind surmounted the craggy ridge due south of the asylum it generated mountain wave clouds, possibly with ice crystal tails (as in Fig 10-25) hovering in the sky above.

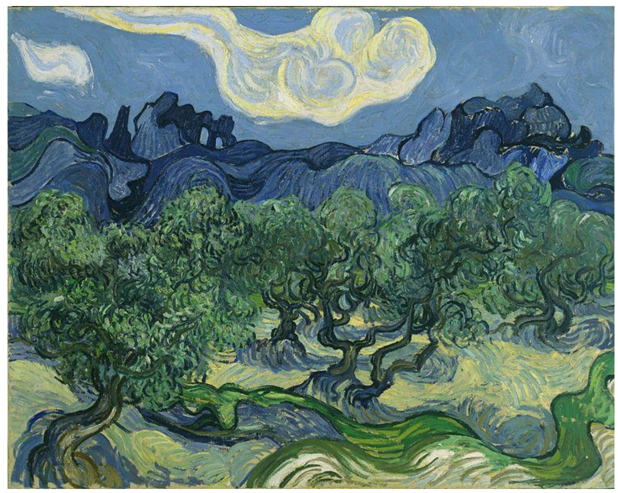


Fig. 10-24. Vincent van Gogh. *Olive Trees with the Alpilles in the Background*. 1889, Museum of Modern Art, New York.

Fig. 10-25. Mountain wave clouds with ice crystal tails over the Front Range of the Rocky Mountains at Littleton, CO. Robert Gedzelman, photographer.

The *Olive Trees* was the companion piece for the *Starry Night* (1889, Museum of Modern Art, New York), a tour de force whose astronomy has been analyzed in separate studies by Albert Boime and Charles Whitney.

The *Starry Night* is apparently a composite scene, done between June 16 and 18, during a lull between two periods of unusually stormy, overcast weather. It shows the sky at about 4:00 AM when the eastern horizon is first beginning to brighten. Vincent misrepresented the phase and location of the rising crescent Moon, which then was just past full, but correctly captured its orange glow when it rests just above the horizon. And the whirling star forms that give the painting its unique character might represent Vincent's vision of the Milky Way, or of the spiral nebulae that had recently been photographed for the first time.

An equally turbulent sky appears in *Cypresses* (1889, Metropolitan Museum of Art, New York), a painting he described in his letter of June 25. A writhing mushroom-shaped cumulus that punctures the sky mirrors the wavering form of the wind-blown cypresses. In this tortured sky, van Gogh revealed an aerial conflict no European artist other than Leonardo had ever dreamed of.

Vincent continued representing turbulent skies through the summer. Then, as summer faded into fall, the weakening Sun no longer raised great cumulus, while abating winds no longer sculpted mountain wave clouds, so Vincent's skies also settled down.

But Vincent didn't settle down! Several attacks, recurring at odd intervals left him physically and emotionally exhausted. Hoping to recover some sense of balance, the profoundly unhappy Vincent headed back north to the vicinity of Paris and settled in nearby Auvers-sur-Oise at the end of May, 1990.

Auvers was van Gogh's last stop. Here, his skies darkened in response to some inner calling and to the weather. June, 1890 was cloudier and colder than average but July turned truly miserable. Rain fell every day from June 30 to July 11, during which time it remained almost continuously overcast and much colder than normal. Under these woeful conditions, Vincent began to use the deepest cobalt blue to represent day as well as night and overcast as well as clear skies.

Around July 10, Vincent wrote he had painted three "vast fields of wheat under troubled skies" since returning from Paris on the 6th, and added, "I did not need to go out of my way to express sadness and extreme loneliness".

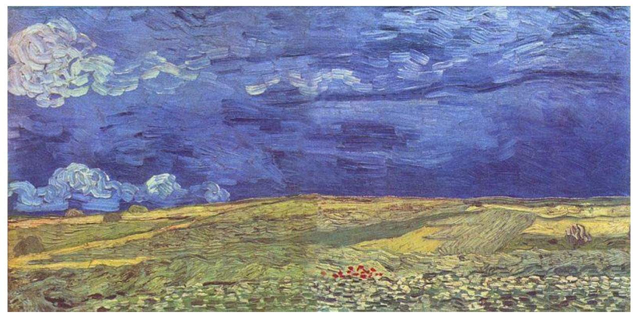


Fig. 10-26. Vincent van Gogh. *Wheat Field Under Clouded Sky*. 1890. Rijksmuseum Vincent van Gogh, Amsterdam.

Fig. 10-27. Altostratus with tilted scud below as cold dry air moves in from the north at the end of rains from a passing low pressure area.

The *Wheat Field Under Clouded Sky* (Fig. 10-26) is probably one of these, but is its sky troubled? With the exception of the cobalt blue horizon sky all the other signs indicate that van Gogh was representing the sky as it appears at the end of a winter storm (Fig. 10-27), when cooler, drier air is just beginning to lift cloud base. The sky darkens at the horizon as it can only when it is overcast or extremely hazy. White fractocumulus appear below the general cloud cover while scud hugs the ground as it does when cooler air comes in contact with warmer, rain-soaked ground. The air is so clean that every feature of the field can be seen distinctly up to the point where the cloud cover drops to the horizon like a curtain to terminate the view.

Vincent's letter is as ambivalent as the painting. Directly after mentioning sadness and loneliness, he added, "I almost think these canvases will tell you what I cannot say in words, the health and restorative forces that I see in the country." But when nature's restoring forces cleared the skies a few days later they no longer held any promise for Vincent, who took his life on a day of fine weather at the end of July.

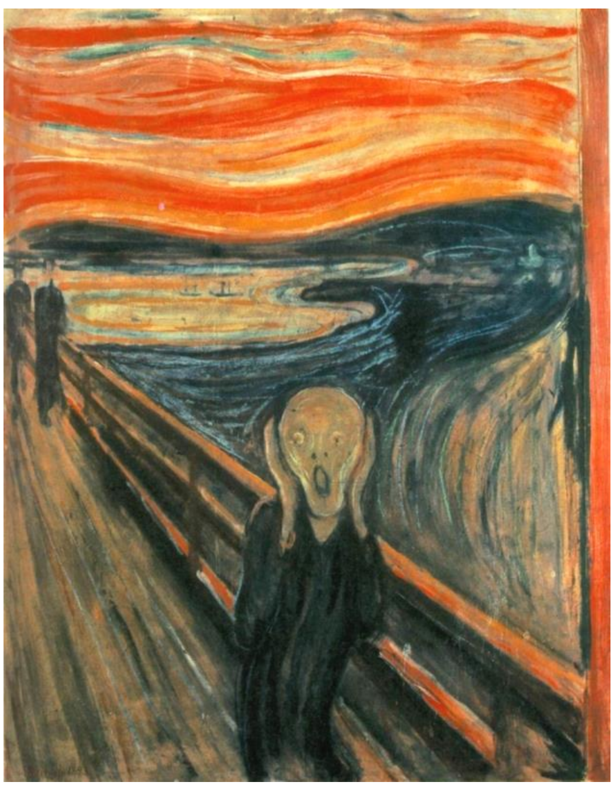


Fig. 10-28. Edvard Munch. *The Scream*. 1893. National Gallery, Oslo.

The tectonic force of van Gogh's universe was further metamorphosed in a single, extraordinary painting by Edvard Munch. Before Munch first visited Paris in 1889, he had painted pleasantly inoffensive landscapes but the art of the French and van Gogh began to etch its way into his troubled soul.

In April 1891, Munch encountered the convulsed world of Van Gogh for the first time at the Salon des Independents and returned to Oslo to begin painting troubled scenes of personal isolation and pubescent shame. Then, one evening in 1891 Munch witnessed a sunset that the world may never forget, and memorialized it in *The Scream* (Fig. 10-28).

The Scream is the incarnation of terror. In it, the tectonic but solid world of Van Gogh has been plasticized into an undulating universe whose only firm foundation, ironically, is the man-made bridge. *The Scream* may seem at first impression to be a purely personal vision, but it is a meteorological masterpiece (compare Fig. 10-29) with an identifiable view of Oslo and its fjord to the west (Fig. 10-30).

Fig. 10-29. Wave filaments of smoke at sunset from a fire during a Santa Ana at Malibu. David Lynch, photographer.

Munch described the moment of inspiration.

> I was walking along the road with two friends. The sun set. I felt a tinge of melancholy. Suddenly the sky became a bloody red.
>
> I stopped, leaned against the railing, dead tired [my friends looked at me and

walked on] and I looked at the flaming clouds that hung like blood and a sword over the blue-black fjord and city.

My friends walked on. I stood there trembling with fright. And I felt a loud, unending scream piercing nature; it seemed to me that I could hear the scream. I painted this picture, painted the clouds as real blood. The color shrieked –

This became *The Scream* from the *Frieze of Life.*

Fig. 10-30. Satellite Image showing Munch's viewpoint for *The Scream*.

Munch did not note the date of his inspiration when he wrote this account on 22 January 1892 during a stay in Nice. This makes it impossible to verify the actual weather, but there are a number of similar skies such as a scene of wavy filaments of smoke during a Santa Ana at Malibu, California (Fig. 10-29). The Santa Ana is a dry downslope wind well known to residents of the Los Angeles area. The dry air descending the western slopes of the nearby mountains evaporates clouds but often helps spread fires, whose smoke then traces the wavy air motions.

Oslo's fjord is ringed by hills high enough (400+ m) to produce wave clouds when a NW wind crosses them. Munch's singularly wavy vision is most likely the crystallization of mountain wave clouds at sunset.

An alternate theory of the sky of *The Scream* was proposed by Donald Olson, Russell Doescher and Marilynn Olson, who pinpointed where Munch stood. They attributed Munch's inspiration to the volcanic red twilights seen in the year after the eruption of Krakatau in 1883.

There are several problems with ascribing Krakatau's eruption as the immediate inspiration of *The Scream*. First is Munch's own testimony that refers to a recent, specific sunset. Second is the near decade-long delay between the eruption and the painting. During that long interval, most of Munch's skies are overcast, and the clear skies are either blue or have spectral green highlights near the horizon, which is only common around sunset when the air is not laden with volcanic (or other) aerosols. Third, it was only in 1892 that Munch first painted flaming red clouds in *Despair* (Thielska Galleriet, Stockholm) at the same spot as *The Scream*, and after his diary entry. Munch's other painted skies that year had his usual gentle palette. Fourth, the first time Munch depicted wavering clouds was in *Melancholy* (Nasjonalmuseet, Oslo), done somewhat later in 1892. Prior to that, all his cloud forms were benign.

Finally, the artist's fidelity to nature interposes. During volcanic twilights the clear sky turns red to a great height (recall Fig. 2.2 top) but between the flaming red clouds in *Despair*, a view just above the horizon, the clear gaps are yellow (as in Fig. 10-29), and in the different versions of *The Scream* Munch painted the clear gaps blue. It is curious, however, that *Despair*'s flaming red clouds resemble cirrus while *Melancholy's* wavy clouds are dark blue-gray in a light gray sky. It was only with *The Scream* that Munch combined the wavy clouds and flaming red.

In 1908, Munch suffered a nervous breakdown. After his recovery, he viewed life and nature as less 'red in tooth and claw', and this shows in his paintings, which include many pleasant and even attractive landscapes and skies. But as his torment subsided, his demon never again rose to the fever pitch needed to produce an iconic masterpiece such as *The Scream*.

Troubled Europe, however, had no shortage of troubled painters to take Munch's place and their various styles took off in all directions. One ultimate outgrowth was abstract art. Vladimir Kandinsky tells the story of a pivotal event in his life and presumably in the history of abstract art. One day in 1910, he returned to his Munich studio and was thrilled by the sight of one of his own works. It took him a few moments to realize the painting was standing on its side. From that point, Kandinsky considered himself released from the bonds of external reality.

In Kandinsky's manifesto, *Concerning the Spiritual in Art* (1912) he wrote, "Today we are seeking the road which is to lead us away from the external to the internal basis." Not only does it sound suspiciously medieval, it means that art could no longer be judged by objective criteria. Only the artist could place a value on his work - the damning public be damned. How very self serving!

Two years before Kandinsky's manifesto appeared, the novelist, Jakob Wassermann diagnosed the same tendency in avant-garde writers.

> The writers...sensing their isolation, their alienation, the absence of social coherence and an inner legitimacy based on myth, withdraw into their inner life as into a cave, or proclaim a tyrannical self-sufficiency without finding a bridge to their society and to mankind. On one side a people in feverish activity, all action, all drive, but also wholly without God; on the other side the poet in feverish torment, activated by his dreams, lonely, and deifying himself.
>
> quoted from Tannenbaum, 1900. p 377.

Fig. 10-31. Oscar Kokoschka. *The Tempest or Bride of the Wind*. 1914. Kunstmuseum, Basel.

No painting could confirm this dismal diagnosis better than Oscar Kokoschka's *The Tempest* or *Bride of the Wind* (Fig. 10-31), which simultaneously describes a spiritually shipwrecked world on the eve of the First World War and a failed love affair. The two intertwined lovers seemingly floating on some open shell and tossed about in the midst of the swirling chaos are Kokoschka himself and his former mistress, Alma Mahler, the widow of Gustav Mahler. Night has fallen on the scene and it is a dark night, indeed. Kokoschka, however, is wide awake and all tension while Alma sleeps gently and appears to be totally protected from the crashing waves. The lovers dwarf nature much as did Jesus, Mary and the various angels and saints in medieval paintings, but they certainly do not provide the viewer with any measure of comfort or solace.

In *The Tempest*, Kokoschka went a long way toward shutting out the sky. Very little light comes from the dark and almost medieval strip of sky above the wavy horizon that almost rises to the top of the painting. After 500 years of unrelenting, conscientious labor to lower the horizon and shed light on the human scene, Kokoschka, in a single step, pulled the shade down over much of our hard won rational heritage. *The Tempest* is either an attempt to return us to the Dark Ages or a damning assertion that we already have.

Look at the crescent-shaped Moon with its corona! Just as in van Gogh's *Starry Night*, these lunar features add to the weirdness of the scene. But whereas van Gogh made sure to aim the light side of the Moon downward towards a Sun below the horizon, Kokoschka aimed it upwards in defiance of natural law. With such a Moon, *The Tempest* should be taking place in broad daylight. Perhaps it is daytime, for the darkness may only be spiritual.

What could possibly have been the inspiration for such a possessed work? Kokoschka had depicted the gentle beauty of a moonlit corona the year before in the *Dolomite Landscape: Tre Croci* (1913, Hamburg, Prof. E. Horstmann Collection), during a trip with Alma through the Alps to Italy. It is a pleasant enough painting. But his ugly art emerged in Vienna, the musical capital of the world and one of Europe's great cultural centers. For Kokoschka saw another Vienna ready to erupt beneath the surface, and he later defended his prewar art, saying,

> My early black portraits arose in Vienna before the World War; the people lived in security yet they were all afraid. I felt this through their cultivated form of living which was still derived from the Baroque; I painted them in their anxiety and pain.
>
> *German Expressionist Painting: Origin and Evolution*. Jean Selz. p 165.

If, in fact Kokoschka exposed secret fears it was no wonder he was not universally liked. Most Viennese found his art to be highly offensive, and it was viciously attacked. The Austrian Crown Prince was so incensed by Kokoschka that he said, "every bone in his body should be broken."

But was Vienna's society as dissipated as Kokoschka implied in his words and in his works? This world capital of music and the waltz had been the home of Beethoven, Schubert, Johann Strauss Sr. and Jr., Richard Strauss and Johannes Brahms. Even Wagner spent some time there. It was a cultural magnet of the first order.

Vienna had not always been so favored. Since Roman times it stood at Europe's eastern gate and bore the brunt of attacks from Asian hordes. Vienna was besieged as late as 1684, when the Turks almost overran its walls. But after 1857, when the threat of attack had faded to a dim memory, the broad ring of walls and open fields surrounding the central city proved to be a bonanza for a carefully planned program of development and modernization of the city and its basic services. To this day, Vienna's character is largely defined by the parks, public buildings and luxury apartments that line the wide gently curving avenues of the famous Ringstrasse, the bequest of Vienna's walls.

The generation responsible for Vienna's metamorphosis was proud of its tradition of liberalism and its devotion to culture. Its children were raised to be artists but were kept from the reins of political power by the crumbling Hapsburg Monarchy and by the flood of impoverished and often homeless immigrants that swelled the city's population to two million. In this climate, where culture was put on a separate plane from real life, Vienna's politically impotent writers, musicians and artists responded by creating increasingly imaginary and irrational worlds. At the same time, nationalistic hatreds and suspicions were roused to the boiling point in the underclass cauldron that lived beneath the waltzing feet of the cultural elite. It was in this Vienna that Nazi rhetoric was first formulated and it was in this Vienna where Adolf Hitler, who had come as an aspiring artist in 1906, learned it.

All the basic forces that led to the increasing subjectivism of the arts were well represented in Fin de Siècle Vienna, and Kokoschka was certainly not that city's only advocate of the avant-garde. The sexual licentiousness and selective distortion of Gustav Klimt's art preceded Kokoschka by about a decade. Anton Bruckner and Gustav Mahler wrote highly romantic music that was increasingly dissonant and Arnold Schoenberg finally dispensed entirely with tonality. Viennese literature also had its modern spokesmen of alienation and absurdity. Fittingly, Sigmund Freud, the master of exposing the sexual and irrational core beneath the prudish facade of decorum, was a homegrown product of Vienna. All of these activities and discoveries were made in a paranoid Europe that had been frantically arming itself to the teeth since the 1880's in preparation for the inevitable struggle for survival of the fittest.

The Tempest is thus one of the great creations that mark the end of an age. Reason, though acknowledged to be indispensable for modern life, was seen as inadequate, and was despised. There are serious consequences, however, of living in a world without rational standards, as Joseph K sadly discovered in Franz Kafka's *The Trial* (1914), another masterpiece completed on the eve of the Great War. In *The Trial* a secret, inner world where normal rules of conduct have no meaning gradually ousted the outer, rational world, and Joseph K was doomed.

An unrelieved abstracting tendency in art has the same self-destructive characteristics. Even Kokoschka recoiled from it, saying, "Non-objective art is itself the worst of all our spiritual enemies." Freed from all rational constraints on subject matter, the sky disappeared from mainstream art on the eve of World War I. When that happened, the guiding light of rationality in human relations also flickered out. Vienna had dismantled its medieval defenses against the barbarians a bit too soon. But then again, those defenses weren't even relevant, for this time Vienna, as all Europe, was besieged and attacked by the barbarian within.

CHAPTER 11
THE IRREPRESSIBLE SKY

April 22, 1915 began as a beautiful spring day on the battlefield near Ypres, Belgium. It would not end that way. At 5:00 PM, the Germans launched canisters of poison chlorine gas into Allied territory. The deadly fumes, guided by the gentle afternoon breeze, drifted into the trenches, killing many unprepared soldiers on the spot and stampeding the gasping survivors out onto the open fields where they were mown down. Suddenly, gas warfare became serious business. The French, expressing great indignation at this flagrant violation of international law, lost no time in retaliating. Other nations quickly followed suit. Before long, a poisonous pall hovered over the battlefields of Europe. For a while it seemed as if Europe might exterminate itself.

World War I was the inevitable product of the collective hysteria that had gripped Europe from the closing years of the 19th century. Europe's mainstream artists reflected this sickness unto death in their creations. The real world was no longer their world. They chose a variety of alternatives. Many retreated into abstract worlds of their own making where they were undisputed rulers, while others such as Picasso sought to recapture the lost innocence of childhood through the art and life styles of primitive cultures. In these efforts, European artists abandoned the sky just as the future had abandoned them. And the Great War did create such an inferno on the land and in the sky it almost confirmed their most pessimistic predictions.

Eventually the War ended and rain washed the soluble poison gases from the battle-worn skies. Europe managed to survive but the ordeal had exhausted her. Gone was her sense of adventure. She became a continent of the past in an Age of the Future. European sky art, which had seemed to be dying on the eve of the War, also managed to survive, but only as faded embers of its past fires.

Consider the case of Oscar Kokoschka. In *The Tempest* (Fig. 10-31) he used nature as a vehicle to express his heightened fears and fantasies. During the Russian campaign of 1916, Kokoschka was shot in the head and bayonetted in the lung. For a year he was totally disabled and for some time after that was regarded as nearly insane. When he finally recovered, the wanton element of impending violence had been excised from his highly colored landscapes. Still, his horizon line remained high and he had little new to say about the sky. Kokoschka was grateful to have survived the ordeal but he had lost his wanton sense of adventure and misery.

Tempest-tossed Kokoschka chose to remain in Europe, but for years many other tempest-tossed Europeans had viewed their continent as a dead end and had set out for a new land of opportunity and fresh ideas across the seas, a land that opened its arms to them and called out to their governments to...

Give me your tired, your poor,
Your huddled masses yearning to breathe free,
The wretched refuse of your teeming shore.
Send these, the homeless, tempest-tost to me
I lift my lamp beside the golden door!
The New Colossus. Emma Lazarus, 1883.

After World War I, European painters might still find an occasional interesting wrinkle in the sky, but it was under the wide open spaces of America that sky painting gained a new birth of freedom.

11.1 The Slender Thread of Reality

During her darkest hour, sky painting held tenaciously to life by a slender thread, for there were always a few painters who continued to revel in nature. Even so, it became increasingly difficult for artists to paint realistically, for they were forced to come to terms with the strengthening abstract movements.

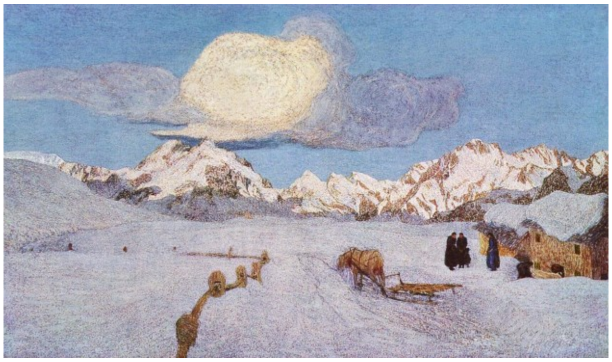


Fig. 11-1. Giovanni Segantini. *Death*: *The Triptych of Nature*. 1896-1899. Musee Segantini, St. Moritz.

Fig. 11-2. Lenticularis at sunset over the Mulhacen, Spain. Isabel Roblas, photographer.

Giovanni Segantini revered nature up to the moment of his premature death in 1899, feeling that its ennobling force held our only hope for salvation. Even so, he did not record nature faithfully in his later works, but used a variant of pointillism to incorporate spiritual images from the depths of his soul. *In Death* (1896-9), from *The Triptych of Nature* (Fig. 11-1), Segantini used a mid-winter setting in the high Alpine valleys of Switzerland's Engadin Region to convey a mood. A horse and sleigh wait to take a casket to the lowlands while the sky receives the rising soul of the departed. The massive but relatively undifferentiated cap cloud resembles a body with diaphanous wings. Cap clouds form when stable air is forced to surmount a mountain peak. The flat, shelf-like base results from the forced ascent of air above its condensation level, as in Fig. 11-2. In this respect, Segantini's rendition is convincing. Even the smooth cumuliform top is possible, particularly in winter, but it is unlikely. Cumulus turrets usually result when the rising cloud air suddenly becomes buoyant and surges upward through an otherwise stable atmosphere. But in such a case the motion would be turbulent and that turrets, corrugated.

Segantini deliberately smoothed the cloud outlines. He was, it seems, a co-conspirator in a surreptitious movement to replace the convoluted complexities of real clouds with the smoothed and simplified but ponderous dirigibles of the artists' minds. This trend began with the Impressionists, was advanced by Seurat, van Gogh, and especially Gauguin, and culminated in cartoon style flat-colored, amoeboid masses of a number of Art Nouveau illustrators or painters in loosely formed ideological groups such as the Fauves in France (led by Henri Matisse and André Derain) and die Brücke in Germany, shortly after 1900.

An exemplary painting in this style is Cuno Amiet’s *Moonlit Landscape* (1904), a transformation of a sky of cellular altocumulus that Amiet certainly observed and that must have impressed him. Fig. 11-4 confirms Amiet's striking cartoon rendition of a field of cloud cells with dark centers and bright fringes, shown in perspective. Too bad he omitted (or failed to observe) the corona or iridescence around the Moon always seen in such clouds. Sun-drenched altocumulus cells are often so bright they bleach any iridescence.

The Fauves and Expressionists used strident and sometimes arbitrary color schemes for two decades before they gradually returned to palettes that conformed more closely to nature. A beautiful example of the strident color peak that did fit nature is Max Pechstein's *Leba Harbor* (1922) (Fig. 11-5). Its flaming cirrus (and altocumulus?) and incandescent sky are reflected in the smooth waters below while the boats and houses of the port are tinted by the deep purple of dusk. The spectral block colors are appropriate for a twilight sky laced by bands of still sunlit higher clouds while the Earth below lies in the shadow of night.

Fig. 11-3. Cuno Amiet. *Moonlit Landscape*. 1904. Musee Segantini, St. Moritz.

Fig. 11-4. Altocumulus cells without clear alleys over Coulterville, CA 07 April 2009.

Expressionist paintings return us to a more primitive time of medieval stylization albeit with more mature insight regarding nature yet without an embracing Church to comfort and guide life. The troubled neuroses and psychoses portrayed by die Brücke artists prompted the kindred spirit, Edvard Munch to say "May God protect us; evil times are coming." And indeed, they were; a generation later the Nazis persecuted members of die Brücke for holding up such psychic mirrors.

Fig. 11-5. Max Pechstein. *Leba Harbor*. 1922. Stedelijk Museum, Amsterdam.

Even before World War I a few artists began to react against the increasing abstraction in art. These 'isolatoes' felt that pure imagination without the guidance of the real world must quickly end in sterility. In 1911, Giorgio de Chirico, who had been deeply moved by the art of Arnold Böcklin, realized that a painting can be made to appear starkly realistic and still be profoundly disturbing. Although none of de Chirico's paintings contain any new meteorology they helped give birth to Surrealism, and a few Surrealists turned out to be fine meteorologists.

Surrealism was officially baptized by Andre Breton in his *Surrealist Manifesto* (1924). Breton was initially inspired by reflecting on some of the images that ran through his mind at the moment of falling asleep. Such images can be quite realistic yet may be placed in absurd settings. Surrealism is the absurd, dreamlike juxtaposition of real elements - an analog to literature's Magic Realism. Its direct roots are often traced back to Hippolyte Taine and Sigmund Freud, but one look at a painting by Bosch shows that now and again through the centuries there were painters who toyed with surrealistic notions.

Curiously, the *Surrealist Manifesto* appeared the same year that Louis de Broglie proposed his revolutionary hypothesis regarding particle waves, namely, that solid particles such as electrons possess properties previously associated only with waves. De Broglie's idea constituted a crucial piece in one of nature's jigsaw puzzles. One year before, in 1923, A. E. Compton demonstrated that X-rays, long thought to be waves, also exhibit certain properties of solid particles. In 1905, Albert Einstein posited that the photoelectric effect implies that all forms of electromagnetic waves occasionally exhibit a corpuscular or particle-like nature as well. In that same year, Einstein also derived the equation, $E = mc^2$, showing that mass and energy are interchangeable.

Finally, scientists were demonstrating that dualities in the physical universe mirror the duality in the primitive world of our dreams. De Broglie's hypothesis quickly led to the formulation of quantum mechanics. From that point we learned that we live in a world where there are definite limits to certainty.

Shortly before experiments verified De Broglie's hypothesis on the elusive, wavelike nature of electrons a fellow Frenchman, Yves Tanguy, began to put some surrealistic ideas onto canvas. After his release from the armed services in 1922, Tanguy began sketching for fun. He continued treating art as a hobby until a fateful day in 1923 when he was riding on the runner of a bus in Paris. As he passed by Paul Guillaume's art gallery he was struck by a painting of Chirico hanging in the window. The story we are told is that he jumped from that moving bus into another quantum state - a confirmed surrealist painter.

Like many of the surrealists, Tanguy's method was to paint objects with meticulous care but place them in impossible situations so as to produce a hallucinatory or disorienting reaction. Tanguy did this by integrating geological and meteorological effects within a quantum mechanical universe.

In *I Await You* (Fig. 11-6), wavelike undulations propagate through the fibre of the quantum mechanical Earth and sky while oddly shaped objects cast distinct shadows. These elements first appeared in Tanguy's art in 1927 (the year Werner Heisenberg stated the Uncertainty Principle). Three years later, Tanguy travelled in North Africa and was deeply impressed by its rock formations, its intense sunlight and its endless repetition of dunes disappearing in the distance. After his return from Africa, the sharp distinction between Earth and sky in his paintings melted away. All objects are seen as if the atmosphere has infinite visibility, yet all hints of the horizon line have been deliberately obliterated. In fact, it is quite unsettling to find some object presumably above the horizon line casting a very distinct shadow. Tanguy made an artistic principle of uncertainty.

Fig. 11-6. Yves Tanguy. *I Await You*. 1934 Private Collection.

While Tanguy remained preoccupied with the elusive nature of the universe, Manuel Radnitsky (Man Ray) had a decidedly earthier use for meteorology in his one and only atmospheric masterpiece, *Observatory Time - The Lovers*, (Fig. 11-7). An enormous pair of lips spreads across a sky filled with an almost photographic field of aligned altocumulus cells on the left that congeals into altostratus on the right and near the horizon, a scenario (minus lips) so appropriate for Parisian skies. The lips are those of his former lover, who had deserted and devastated him. The twin domes of the Paris Observatory fix the geographic setting but are rife with sexual symbolism. The painting was executed in a period of great emotional pain and was the only way Man Ray felt that he could reunite with his former lover.

Your mouth becomes two bodies
separated by a long, undulating horizon.
Like the earth and sky, like you and me.

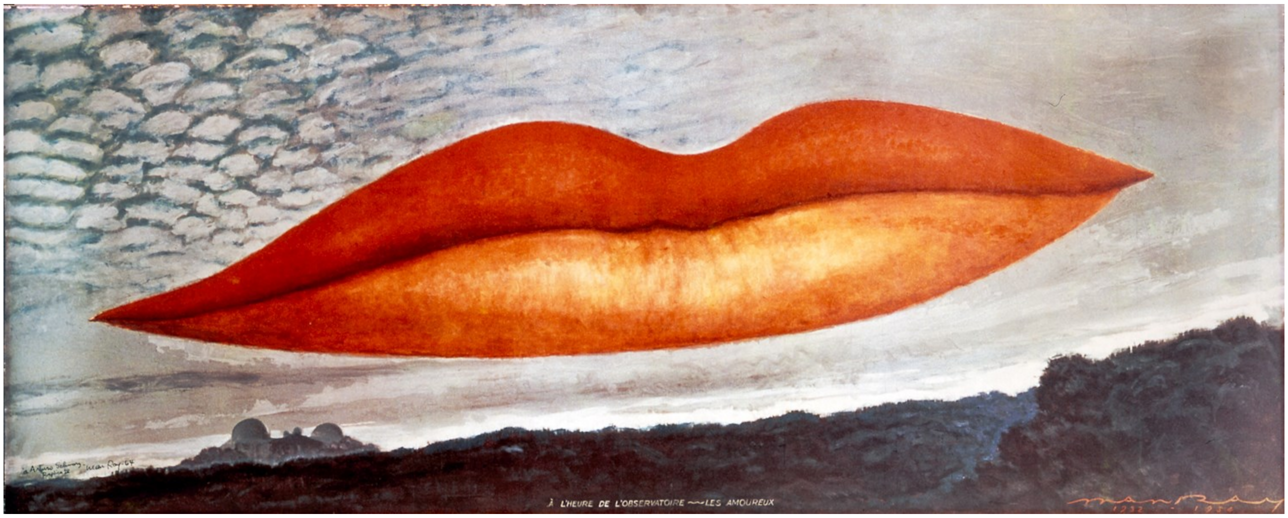


Fig. 11-7. Man Ray. *Observatory Time - The Lovers*. 1934.

Fig. 11-8. Rene Magritte. *The Empire of Light*. 1953. Museum of Modern Art, NY.

René Magritte juxtaposed human body parts as well as a host of other objects on almost photographic skies spotted with impeccably realistic cumulus. These are all fine works, but to me *The Empire of Light*, (Fig. 11-8), is Magritte's meteorological masterpiece. The Earth is enveloped in the still of night. A city street is dimly lit by a single street lamp. But above the darkened row of townhouses and deciduous trees a bright, milky blue daytime sky is filled with the most pleasant cumulus humilis. Here is surrealism at its gentlest and most persuasive. Most surrealist works almost bludgeon the viewer with their blatant impossibilities. The *Empire of Light* produces a slight, vague, and pleasant sense of disorientation that is humorously resolved once the paradoxical element is identified.

11.2 Casting off the Yoke of Europe

Europe exported its absurdities and abstractions free of charge to the far ends of the Earth. For the most part, the world willingly swallowed this meagre fare, humbly acquiescing to Europe's presumed cultural superiority. In America, it would take a great social upheaval to help artists exorcise the European incubus and relearn to paint the sky.

In 1906, Edward Hopper arrived in Paris. His first European tour lasted almost a year and left him with mostly positive feelings. He was particularly taken with Rembrandt's *Night Watch*, which he described as "past belief in its reality - it almost amounts to deception". Hopper's second trip to Europe lasted slightly longer - from May 1909 to July 1910 - and only increased his admiration for European art and culture. Nevertheless, this was Hopper's last trip abroad. Although he may not have revered America, America was the place where his genius could develop. Much later Hopper described his feelings on this matter. "[America] seemed awfully crude and raw when I got back. It took me ten years to get over Europe."

Hopper's fully evolved style emerged over a decade later and does indeed show America as a rather stark land. His human figures tend to be rather static and are often solitary. Strident contrasts of light and shadow add to the overall effect of barren flatness. These are, of course, well known characteristics of Hopper's art. They are so striking that it is easy to overlook the great touch of delicacy that began to adorn many of Hopper's landscapes after about 1925.

Fig. 11-9. Edward Hopper. *Ground Swell*. 1939. Corcoran Gallery of Art, Washington, DC.

The normally shy and withdrawn Hopper seems to have reserved his greatest artistic displays of tenderness for the sky. He is without doubt the greatest painter of the gossamer cirrus clouds. These can be seen in a number of works, mainly from the 1930's. One of the finest examples of cirrus uncinus (with hooks) appears in *Ground Swell* (Fig. 11-9).

In *Ground Swell*, several long parallel rows of cirrus stretch diagonally across a limpid sky. Each row occupies the crest of a wave in the jet stream produced by wind shear. Hopper even showed that the trails of falling ice crystals (and therefore the wind shear) line up at right angles to the rows. The frothy ocean swell below has probably been aligned with the clouds above for purely artistic reasons but the sky is based on one Hopper had to have seen, for it is a textbook example of cirrus.

Hopper readily acknowledged nature as an essential source of his inspiration. When asked to express his opinion on the direction of modern art, he observed,

> Great art is the outward expression of an inner life in the artist, and this inner life will result in his personal vision of the world. No amount of skillful invention can replace the essential element of imagination. One of the weaknesses of much abstract painting is the attempt to substitute the inventions of the intellect for a pristine imaginative conception.... Painting will have to deal more fully and less obliquely with life and nature's phenomena before it can again become great.

Some inner force kept Hopper from painting clouds for over a decade following his return from Europe and thereafter dictated the type of clouds he would focus his attentions on. Guy du Bois recalled Hopper telling him that "it had taken him years to bring himself into the painting of a cloud in the sky." When Hopper finally began to paint clouds, he would have almost nothing to do with the typical cozy but lowly European cumulus 'effects' he had once slavishly imitated. No, only the higher clouds allowed him a feeling of sufficient spaciousness! Hopper therefore painted mainly cirrus, but was also attentive to altostratus and several varieties of altocumulus. Some of his altocumulus are cellular, as in his *Route 6, Eastham* (1941, Sheldon Swope Art Gallery, Terre Haute Indiana), while he painted cigar-shaped mountain wave clouds on several occasions.

Hopper painted clouds discriminatingly, for he knew them intimately. For years he spent hours on many days sketching outdoors, particularly around his summer home on Cape Cod. But around 1944, Hopper grew tired of the constant assaults of insects during his outings, and retreated to his studio. Within two years his clouds had lost their sense of immediacy. They no longer exhibited the pristine beauty and vital structure he had lavished on them for two decades. Even the best photographic memory fades once it is cut off from the visual source.

Nevertheless, for over 20 years, Hopper's precisely drafted mid and high based clouds bore little resemblance to the broad cumulus brushstrokes of the Impressionists. It may therefore seem strange that, near the end of his life, Hopper said that he had always considered himself to be an Impressionist. Then again, much like the Impressionists, Hopper restricted himself to storm-free worlds.

Canadian artists used their country's stormy, harsh weather as a staunch ally in their stand against Europe's cultural sovereignty. In 1911, an exhibition of sketches of the Canadian landscape by British born J. E. H. MacDonald riveted the attention of some budding Canadian painters on the aesthetic value of their own land and sky. United by a common purpose, they headed out into the Canadian wilderness for new inspiration. The weather did not always cooperate. Too old to fight in World War I, Tom Thompson drowned when his canoe overturned on a dreary day on Canoe Lake in Algonquin Park in July 1917 after a brief but brilliant career as a meteorological artist.

Thompson began painting rather late in life but became an ardent convert to the cause of Canada's land and sky. His career was even shorter than van Gogh's, but into the few years between 1911 and 1917 he represented weather and skies of all the seasons from stratus or flattened stratocumulus overseeing snow covered ground, to summer thunderstorms with lightning and a rainbow. At night the stars came out for Thompson and even the Aurora Borealis posed for him.

World War I interrupted the careers of all Thompson’s Canadian artist friends. When they regrouped after the War, they formed the *Group of Seven* to represent Canadian themes with a Canadian flavor. J. E. H. MacDonald's *The Solemn Land* (Fig. 11-10) is a representative high point of the Group's meteorological efforts. Set in the now dammed valley of the Montreal River in the Algoma Region east of Lake Superior (Fig. 11-11), it portrays the first nip of winter, which usually arrives by the autumnal equinox.

Fig. 11-10. J. E. H. MacDonald. *The Solemn Land*. 1921. National Gallery of Canada, Ottawa.

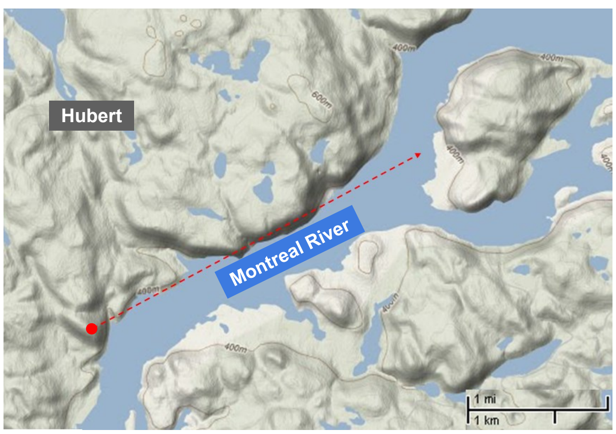


Fig. 11-11. Topographic map of the Montreal River and the setting and viewpoint of *The Solemn Land*.

The painter is standing on a bluff along the river facing ENE. The forest below is a mix of deciduous trees (mainly maples) that have already begun to acquire flaming autumnal colors and the black spruce that comprise much of Canada's vast boreal forest. Visibility is unlimited under a covering of boldly outlined, flat-based cumulus that often form when crisp, polar air surges southward after a cold front. Indeed, it is a NW wind that lines the cumulus at top across the painting. One oversight spoils the perfection. The small breaks in the cloud field that allow invisible sunbeams through to tease the chilling land and water should deepen from turquoise below to blue above.

Lawren Harris's world view was too stark to keep sunbeams invisible. Intellectually and spiritually restless, this master of crepuscular rays was perhaps the prime mover in the formation of the Group of Seven. In the fall of 1904, Harris went to Berlin to study art. There he was exposed to the design of Art Nouveau illustrators and doubtless encountered the starkly colored paintings of die Brücke. This exposure would help define his mature style some two decades later. But following his return to Canada, Harris showed nature's gentle side. There are few odes to snow as delicately touching as his *Snow II* (1915, National Gallery of Canada, Ottawa). Beneath a turquoise sky banded by smooth, horizontal lines of altocumulus, snow assumes both its sunlit and shaded colors.

The comic book simplicity hinted at in the clouds of *Snow II* reemerged in Harris's art abruptly, in full force almost a decade later. Harris wedded two experiences that influenced him profoundly. A series of eye opening trips beginning in 1921 to the stark country north of Lake Superior and later as far north as Baffin Island, provided the material for these works while the European influence revived by Kandinsky's essay, *Concerning the Spiritual in Art* freed Harris to create a new mode of meteorological expression. For more than a decade, before he gave way to abstractionism, Harris depicted scenes with infinite visibility of striking, almost geometric cloud and land forms (icebergs, mountains, and lenticulars), molded more or less to the dictates of unruly Nature. But, caving to Expressionist dictates, almost all his clouds were smoothed masses with dark cores and bright fringes.

North Shore, Lake Superior (Fig. 11-12) is a case in point. It overlooks the lake from a bare promontory. A bleached, stripped tree trunk gives a single, defiant sign that life, though tenuous, can indeed exist in such a forbidding place. Visibility is infinite in the brisk polar air. The cumulus cloud field has a flat base. The tops of the cumulus, which reflect sunlight and the lenticular clouds' fringes, which transmit sunlight are bright, while the shaded masses and bases are dark. Even the light on the water obeys Nature's dictates, shining on the left where it reflects the white sunlight, but glowing deep blue in the shaded recesses opposite the Sun on the right.

Fig. 11-12. Lawren Harris. *North Shore, Lake Superior*. 1926. National Gallery of Canada, Ottawa.

But the sky's color and the crepuscular rays in *North Shore* taunt nature. The sky brightens but yellows instead of whitening toward a Sun a short distance above and to the left of the painting. The crepuscular rays don't belong; they only form when some cloud interposes. And following a Harris trademark, the rays fail to converge to a single point. Finally, the beams match the turrets and grooves in the cumulus field below and are separated from it by a moat of shaded sky, which can only happen when rays emerge from a cloud that blocks the Sun (recall Fig. 6-27). These are all deliberate, scandalous errors.

A sexual scandal sent Harris to temporary exile in Santa Fe, New Mexico in 1938. There he met Georgia O'Keeffe, who had vested her painted skies with a different but equally stark sense of geometrical design and a far more intense sense of color.

Fig. 11-13. Georgia O'Keeffe. *No. 22 – Special*. 1916-17, Georgia O'Keeffe Museum, Santa Fe, NM.

Fig. 11-14. Georgia O'Keeffe. *Red Hills and the Sun, Lake George.* 1927, The Phillips Collection, Washington, DC.

Georgia O'Keeffe saw New Mexico for the first time in the summer of 1917 and was immediately seduced by its land and skies.

> When I got to New Mexico that was mine. As soon as I saw it that was my country. I'd never seen anything like it before, but it fitted to me exactly. It's

something that's in the air....The sky is different, the wind is different.

But it was the nearby Texas countryside around Amarillo that inspired her first notable vision of the sky, *No. 22 – Special* (Fig. 11-13) with its blazing sunset sky color sequence curved around a glowing red hill. That served as a precursor to her famous and revolutionary distillation of sky painting, *Red Hills and the Sun, Lake George* (Fig. 11-14), done a decade later. The white Sun is the principal character in this visionary landscape. When it touches the shaded hills at the edge of Lake George, it sets them ablaze with a blood red transfusion as it cloaks itself in a voluptuously colored, multi-ringed corona that almost fills the sky. O'Keeffe omitted the red ring that forms just outside the corona's yellow ring but there is more than enough red on the hills below to compensate for this omission.

Fig. 11-15 Georgia O'Keeffe. *Sky Above Clouds I.* 1962. Georgia O'Keeffe Museum.

At the tender age of 75, world fame took O'Keeffe on international flights, and you can be sure she always took a window seat. *Sky Above Clouds*, *I* (Fig. 11-15), first of a series of 4, is the one derived most directly from nature. Pancake-shaped cells of stratocumulus, foreshortened and miniaturized by perspective near the horizon, appear to float like water lilies on the blue sky or ocean below. The cloud cells have white centers and pink scalloped edges, as in Fig. 11-16. The clear sky grades sharply from blue above to a pink strip resting on the horizon. There is, however, one glaring discrepancy from nature - the tiny clouds near the horizon are depicted separately and with great clarity, as is the horizon line. In reality, the oblique view hides gaps between even flat clouds near the horizon and the horizon itself disappears in haze when seen from the air because it is viewed through an enormous thickness of atmosphere.

Fig. 11-16. Cellular stratocumulus from above.

Fig. 11-17. Georgia O'Keeffe. *Sky Above Clouds IV*, (1965) Georgia O'Keeffe Museum Santa Fe, NM.

As with *Red Hills, Lake George*, *Sky Above Clouds*, *IV* (Fig. 11-17) is the distillation of one of O'Keeffe's earlier natural visions. It is a gigantic work, 24 feet wide, packed with lines of white cloud amoebas whose scalloped edged have been planed smooth. The clouds, portrayed in perspective, extend to the distant horizon, again without a speck of obscuration. All this transforms *Sky Above Clouds, IV* into a grand cartoon.

Fig. 11-18. William Victor Higgins, *New Mexico Skies.* 1943, Snite Museum of Art, U. of Notre Dame.

When William Victor Higgins arrived in New Mexico in 1914 he had already served his apprenticeship in European Abstractionism. It took him years to come to terms with his cultural "exile" in the land of open skies but he finally did! In his later years he often hopped in his car and set out to find a scene worthy of painting in the region around Taos.

His topographic *New Mexico Skies, View of Picuris Mountains from the North Rim of the Rio Grande Gorge* (Fig. 11-18) may be his meteorological masterpiece. The Rio Grande Gorge separates the red rocks and red soil of the foreground from the distant green Picuris Mountains (Fig. 11-19). Visibility in the pristine New Mexico air is infinite and the clear sky grades from deep blue aloft. But in New Mexico, summer is the time of the Southwest Monsoon, and a field of cumulus mediocris is building. The clouds have prominent flat and dark bases, unmistakable features in New Mexico's crystalline skies, but Higgins may be the first artist to record that the nearby cloud dark bases can be tinted reddish brown.

Higgins was sensitized to color from boyhood by his father's love of flowers; now, he gave the cloud bases an appropriate bloom. They are tinted by light reflected from the bright, sunlit red foreground. The bases of more distant clouds are blue-gray because the intervening atmosphere has added its blue skylight.

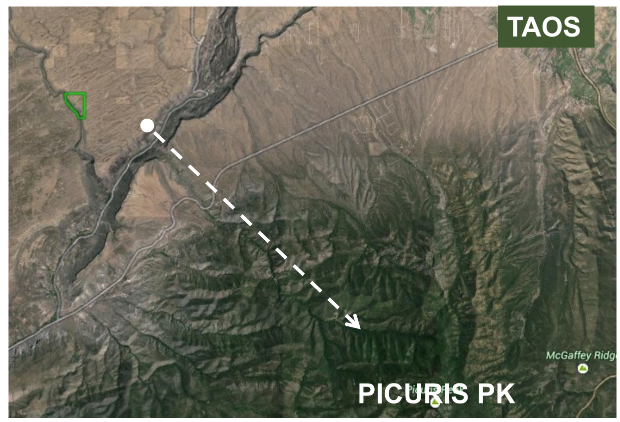


Fig. 11-19. MODIS Satellite image of the Rio Grande Gorge of the setting and viewpoint of Fig. 11-18.

Lawren Harris and Georgia O'Keeffe seemed quite at ease when adapting their own versions of European abstractionism into their North American landscapes. William Victor Higgins wrestled with his European baggage for two decades but largely discarded it in his last landscapes. Marsden Hartley had a much stormier time finding his artistic identity and never did sever the umbilical cord that tied him to Europe's cultural placenta. During his many European stays, Hartley's art would grow more abstract. Then he would return home and pump fresh blood into Europe's anemic cultural mold with a transfusion of American realism.

Earth Cooling, Mexico (Fig. 11-20), is such a work. The setting Sun casts its red light on the mesa tops. A thin, golden strip of sky just above the horizon serves as a backdrop for the mesas. Immediately above this strip is a deep blue twilight sky tinged with rosy highlights from some higher (cirrus?) clouds. The 'Europeanized' flattened, ellipsoidal, pink-fringed blobs of golden stratocumulus are the shrunken vestiges of the day's glorious cumulus. They will soon evaporate, for once the Sun nears the horizon the dry desert ground cools rapidly and chilled air ceases to rise.

Fig. 11-20. Marsden Hartley. *Earth Cooling, Mexico*. 1932. Amon Carter Museum of Western Art, Fort Worth, Texas.

The lighting on the mesa tops, the dull red cirrus, and the incandescent cumulus centers all suggest that the Sun is behind the viewer. If so, Hartley committed a meteorological faux pas, for the golden strip of sky at the horizon only faces the Sun.

But meteorology merely served as Hartley's launching pad in this landscape of the spirit. The mesas in *Earth Cooling, Mexico* do more than reflect the fading sunlight, they radiate visibly. Perhaps it is the dying red glow of a landscape that had been heated white hot by the brutal midday desert Sun. The clouds and horizon sky are still almost white hot while the truncated, mesa tops have cooled somewhat and so are only red hot. The shaded lowlands have cooled even further and only emit a few patches of dull carmine red light. Then again, rivers of dully glowing lava may be flowing from the volcanic mesas, slowly cooling and darkening as they inundate the playa.

No matter how you look at it, *Earth Cooling, Mexico* is a compelling statement of the starkness of the Wild West's land and sky.

11.3 Wide Open Skies of the Wild West

The starkness of the Mexican sky overwhelmed Hartley's hypersensitive constitution. In his autobiography, he said of it,

> The light will wear you down, the air will fatigue - height will oppress.... Perhaps you can learn the secret of all the dark living but you will change your whole being to do it.

But most American painters went west to escape the dark life of the congested cities and to revitalize their spirits in the light of open skies. There they learned to paint skies that Europeans could not have conceived in their wildest dreams, for not often does either forested northern, or dry Mediterranean Europe offer a glimpse of the towering summer thunderstorms that proudly display their burgeoning form day after day in Western skies.

They also came to a land that had its own venerable history of sky art. The towering thunderstorms of the Southwest United States and Mexico gave birth to aerial art in America long before transplanted Europeans ever showed up on the scene. Somewhere between 1100 and 700 BCE, an Olmec artist carved a meteorological petroglyph (Fig. 11-21) in the Mexican highlands at Chalcatzingo.

Rain streaks fall from three tiered and scalloped but flat-based cumulus (with legs of arcus?), possibly the first flat-based cumulus in the history of art. Several large vertically elongated (and therefore improperly) bullet-shaped raindrops and a few even larger round concentric circles that may represent hailstones with growth rings appear beneath the cumulus. These fall amidst corn stalks to betray the farmer's eternal preoccupation with weather. Lower in the petroglyph a meteorological deity sits in an alcove and blows the breath of life from the bowels of the Earth to the surrounding atmosphere. The vortices of his breath resemble the ancient Chinese cloud forms and the downbursts of da Vinci's *Deluge* scenes (recall Fig. 6-5). Apparently, a prescient Olmec da Vinci watched air motions with Oriental patience and incisiveness. Or did the insight derive from watching priests blow the smoke of tobacco, which was already cultivated and likely used in religious ceremonies.

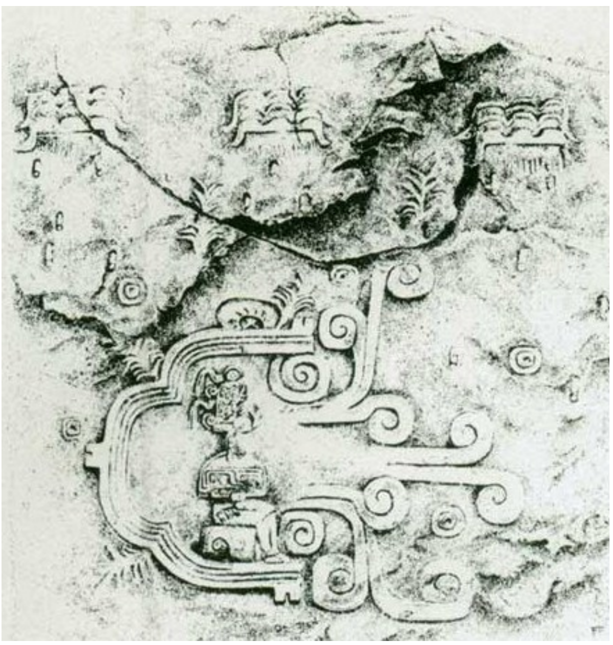


Fig. 11-21. *Olmec Rain-god petroglyph.* Drawing by Francis Pratt from *Chalcacingo*. Carlo T. E. Gay.

Religion notwithstanding, the Chalcatzingo petroglyph represents one more example of the ancient tie between an active commercial spirit and sky art. The Olmecs may have created America's first advanced civilization. The main Olmec centers were located in the lowland river plains south and east of Veracruz, Mexico. Chalcatzingo lies far from these, on a strategic setting in the highlands, over 150 miles to the west and about 60 miles southeast of Mexico City. Remains of an extensive system of dams and terraces reveal a highly advanced agricultural technology. But Chalcatzingo was probably established as a major Olmec trading post, because of its location at the gateway to the country further west where jade and other minerals for the Olmec carvings and artifacts were mined.

The Chalcatzingo petroglyph contains landscape elements with no hint of the third dimension. All pre-Columbian rock art lacks a feeling of depth, but what it lacks in depth it almost makes up for in height.

Thousands of rock surfaces in the Southwest United States are covered by petroglyphs (carvings) or pictographs (paintings), and many of these include fine examples of sky art. Most of this sky art deals with celestial themes and usually emphasizes the Sun or Moon. There are many astronomical calendars, which consist of spiral figures placed strategically on rock surfaces to coincide with the Sun's shadow on the equinoxes or solstices. There is even a convincing representation of the supernova that produced the Crab Nebula in 1054 with hatch marks indicating the number of days the phenomenon was visible.

The rock surfaces also contain hundreds of meteorological murals. Ken Sassen has scoured the Southwest in search of meteorological art. Rainbows were the most common aerial subject, sometimes appearing with rain streaks, lightning bolts, and cumulonimbus clouds consisting of pyramidal piles of blocks.

Fig. 11-22. *Rainbow petroglyph*. c. 2000 BP. Rochester Creek, UT. Randall Roberts, photographer.

One rainbow petroglyph in central Utah appears directly beneath a cloudlike discontinuity in a rock surface (Fig. 11-22). The bow is almost semicircular and consists of eight stripes. Only the two inner stripes do not reach the ground. This raises the intriguing possibility that the artist was attempting to represent supernumerary bows. Hatched lines indicating rain streaks extend downward at the bow's top while parallel wavy lines suggesting lightning bolts also extend groundward. One of the bow's stripes continues off to the right to end in a coiling snake-like form. Perhaps this is the electrical fuse that ignited the rainbow, or perhaps it shows that the artist, living about 2000 years ago amidst some of the most breathtaking scenery on Earth, really did find the pot of gold at the end of the rainbow.

All of these meteorological elements were vested with great symbolic significance to the peoples of the arid Great Basin, where water from a few brief thunderstorms can mean the difference between life and death. But, symbolism aside, the Southwest's summer thunderstorms tower overhead in clear skies with such regularity that it would be difficult not to pay them due attention and reverence.

Fig. 11-23. George Caleb Bingham. *Fur Traders Descending the Missouri*. c. 1845. Metropolitan Museum of Art, NY.

When the immigrant painters first crossed the Mississippi, they did not immediately paint the thunderstorms; they needed some time to get used to the glare of the wide open spaces of the Wild West. Beginning in the 1840's, George Caleb Bingham painted a number of scenes such as *Fur Traders Descending the Missouri* (Fig. 11-23). In these works he was sure to protect his unaccustomed eyes with the misty cumulus filled skies that are more characteristic of the eastern United States. This mist would soon be discarded as excess baggage.

Anyone who crossed the Mississippi did not have to wait very long for the wind to sweep across the Great Plains and reveal the infinite panorama. Here is how the immigrant Ole Edvart Rölvaag described it in the opening lines of *Giants in the Earth*.

> Bright, clear sky over a plain so wide that the heavens cut down on it around the entire horizon....Bright, clear sky, to-day, to-morrow, and for all time to come.
>
> And sun! And still more sun! It set the heavens afire every morning; it grew with the day to quivering golden light - then softened into all the shades of red and purple as evening fell....Pure colour everywhere. A gust of wind, sweeping across the plain, threw into life waves of yellow and blue and green. Now and then a dead black wave would race over the scene...a cloud's gliding shadow...now and then
>
> *Giants in the Earth*. Ole Edvart Rölvaag. p 3.

But Rölvaag and all residents of the Great Plains knew that the sky is not always clear. With spring come the towering thunderstorms that threaten death by hail, fire, brimstone, lightning and tornado, and leave behind only an ephemeral rainbow as meagre consolation for the victims of their fury. Then, autumn's shorter days and lower Sun bring on a chill closely followed by winter's unrelieved cold and unrelenting blizzards.

All winters on the northern Great Plains are brutal but some are worse than others. The winter of 1880-1881 introduced a decade of severe winter weather felt not only on the Great Plains, but across the Northern Hemisphere.

> They say it rained forty days and forty nights once in the old days, and that was terrible; but during the winter of 1880-81 is snowed twice forty days; that was more terrible. From the 15th of October, when it began, until after the middle of April, it seldom ceased. From the four corners of the earth it flew; but of all the winds that brought it, the south wind was the worst; for that whisked and matted the flakes into huge grey discs, which fell to the ground in clinging, wooly folds....And all winter the sun stayed in his house; he crept out only now and then to pack down the snow; that was to make room for more.
> Rolvaag. *Giants in the Earth*, p 426.

"The sun stayed in his house"! This is taken from an old Indian expression meaning there was a halo around the Sun. At other times, Rolvaag pointed out,

> If it cleared off for an afternoon, the sundogs were on constant guard. Everyone knew what that meant!

It usually meant that cirrostratus clouds were warning of the next winter storm. With such ominous signs in the sky it is no wonder that painters would quickly pack up their easels for the winter and leave the scene without recording a trace of the shimmering halo displays or of the winter weather that followed.

Newell Convers (N. C.) Wyeth, one of America's great illustrators, stayed outdoors long enough to view and portray art's first 22º halo in 400 years in his version of *Winter - Death* (Fig. 11-24). The figure of the Indian is based on George de Forest Brush's illustration, *Mourning Her Brave* (1883) but the halo is all Wyeth's. The halo surrounds the Indian, who stands at the edge of a cliff in a strong wind. The Indian blocks the Sun, at the center of the halo. The sky has the translucent, pale milky blue color typical of cirrostratus. The halo has a slight yellow tint. The 22º halo is slightly yellow or even greenish when the Sun is relatively low and the cloud is thick, but it has a reddish inner fringe that Wyeth neglected.

Fig. 11-24. N. C. Wyeth. *Winter - Death* 1909. Private Collection.

The unfortunate symbolic association of the halo with death is likely motivated by the bad weather that so often follows halos. The religious associations and negative symbolism have made ice crystal halos rather rare critters in art. Two exceptions are Franklin Arbuckle's *St. Lawrence River Barn* by (1954, exhibited Art Gallery of Toronto) and Peter Hurd's (N. C. Wyeth's son-in-law) *La Cita* (1962 private collection). In both paintings only the bottom half of the 22° halo fits on the canvas and both halos are slightly yellow. In the *St. Louis River Barn*, the halo appears over the snow-covered Canadian ground and promises more snow. In

La Cita the weather is warm enough to allow two lovers to rendezvous under the moonlit sky, for in the American Southwest halos tend to foretell rain rather than snow. Hopefully it will be a light rain that will not wash away the hopes and dreams of the lovers. But I am afraid stormy times lie ahead.

Some American artists relished harsh weather. With pioneer and cowboy blood racing through his veins, sixteen year old Charles Russell could hardly wait for the halos to dim and the snow to begin. Charlie's parents shipped him out to Montana territory in the summer of 1880 thinking that a sober dose of reality would cool his ardor for the wilds and prepare him to enter the family business. Life was tough out there, but Charlie stayed and became a cowboy who loved to draw and paint.

For a few years Charlie remained a painting cowboy because no one would pay much for his work. Then came the winter of 1886-67! Montana was treated to the worst blizzard in its history and many of the cattle under Russell's care were lost. In an attempt to justify this financial disaster to his employers he decided to paint his defense. *Waiting for the Chinook* (1887, Buffalo Bill Historical Center, Cody, Wyoming) proved to be such an eloquent summation, it found Russell a patron and freed him to be a painter of cowboys. *Waiting for the Chinook* was so popular that Russell repeated it several times.

Waiting for a Chinook, the Last of 5000 (Fig. 11-25) shows the Montana prairie buried under snow. A solitary, emaciated steer is surrounded by a pack of hungry wolves. For this sorry steer, the snow-eating chinook's warm, dry winds would arrive too late.

The chinook, like the foehn north of the Alps, is a warm and dry downslope wind that melts or more often evaporates snow like magic and gets grass growing. During winter on the High Plains, people and animals alike wait impatiently for the chinook to bring its breath of life from the Rockies. (In summer it's an unwanted scorcher that can desiccate the scrubby vegetation! I saw it blacken roses.)

Fig. 11-25. Charles M Russell. *Waiting for a Chinook, the Last of 5000*. 1903. Buffalo Bill Historical Center, Cody, Wyoming.

Russell was on the scene in Montana Territory when the 'schoolchildren's blizzard' struck unexpectedly shortly after some teachers dismissed their classes on January 12, 1888. Following an unseasonably warm morning the blizzard came on so quickly that dozens of the unprepared schoolchildren never made it home and the official death toll was 235. Russell's *Lost in a Snowstorm - We Are Friends* (1888, Amon Carter Museum, Fort Worth, Texas) does not replay the tragedy. Instead, it describes a scene from the same storm in which a group of Indians helped some lost cowboys. The snow is not yet deep but the wind is driving it into growing drifts that will soon bury the lowly clumps of grass. Blowing snow so reduces visibility that it is difficult to decipher up the horizon line. Despite this there is no difficulty making out two buzzards circling above.

After a day or so of intense, driving snow, American blizzards begin to sputter out. Clearings of increasing duration may alternate with weakening snow showers for several hours until finally the showers are gone. The sky then assumes an incredibly deep coat of azure, as Dale Nichols has shown in *Company for Supper* (Fig. 11-26).

Fig. 11-26. Dale Nichols. *Company for Supper*. 1934.

Departing blizzards open the floodgates that allow huge domes of frigid polar air from Canada or even Siberia to surge unobstructed across the flat prairie. High pressure and clear skies then dominate the weather scene for several days. On the northern Plains, the air directly over the snow covered ground remains so cold that ice crystals may condense and fall out of a clear sky to produce some of the best halo displays; as a result, the cold alone sometimes keeps the Sun in his house.

Ultimately, spring approaches and the Sun breaks out of its house in the south to warm the Plains. Overnight it seems, the grasses burst through the rich prairie soils and invite all who might think to farm the land. Here, much of the rejected refuse of Europe put down its roots. Soon these hungry immigrants would learn to feed the world.

Their approach was strictly American. Everything was done to subdue the land as rapidly as possible. When the wandering native Indian population got in the way they, along with their chief source of food, the buffalo, were almost exterminated. By 1880 the Plains were effectively cleared, and huts hacked from the Plains' own rich sod sprang up everywhere.

A belated, ineffectual wave of sentimental regret swept across the nation like a grass fire. Americans bemoaned the crimes they had committed against man and beast alike in their greed for land. They then offered the Plains Indian paternal advice on how to tame the land as they were doing. But the Indians refused to see the light and learn the new tricks of modern agriculture. Instead they responded,

> You ask me to plough the ground. Shall I take a knife and tear my mother's bosom? You ask me to dig for stone. Shall I dig under her skin for her bones? You ask me to cut the grass and make hay and sell it and be rich like white men. But dare I cut off my mother's hair?
>
> Smohalla. quoted in *History of the Indians of the United States*, p 213-14. Angie Debo.

This was part of the eloquent ballad of a disappearing people. It was also far more prophetic than anyone could have realized. Why didn't the Indian plough the Plains? Perhaps the climate provided the answer. The Great Plains now contains thick deposits of loess, the fertile, wind driven desert dust that still blows into China from the wastes of the Gobi. That loess tells of severe times when glaciers covered Canada and a desiccating west wind held sway over the Plains. Agriculture then would have been unthinkable.

But in time the icecaps vanished and the watered Plains were transformed into fertile grassland. By 1000 CE, Indians were growing corn all across the Plains. In Cahokia, Illinois, near St. Louis, there arose a city of 40,000 people who thrived largely on a diet of grain. But after 1200, when the soil's fertility may have been wasted by overuse, the west wind also strengthened and a more persistent drought once again reared her ugly head. By 1300, Cahokia was abandoned; so too were the cliff dwellings at and around Mesa Verde. Mother Earth was letting the Indian know how she resented having her skin cut and her hair torn out. Her winds turned the Plains Indians back into wandering hunters and gatherers.

The 1880's saw the last official onslaught of the ravages of the Little Ice Age. After that, the climate on the Plains grew distinctly more favorable for agriculture. The west wind weakened and temperatures rose. This led to a longer and wetter growing season across the Plains. Everywhere men busted and overturned the ancient sod, the very cement that absorbed the cutting edge of the rains and wove the Plains together. The Plains were roiled into amber waves of grain.

This merciless transformation was accelerated during World War I. It was then that the United States became Europe's granary. The Food Control Act of 1917 guaranteed farmers over $2.00 for each bushel of wheat. Farmers set out on their tractors and plowed their way into the sunset. There were, to be sure, a few voices in the wilderness that decried the wanton rape of the land. John Wesley Powell, explorer of the Colorado River and the Grand Canyon, and later director of the U. S. Geological Survey, had warned in the 1890's that the High Plains were too dry to support more than sparse grazing. But Wesley's wise counsel was drowned out in the frenzy to squeeze every last grain of wheat and every last cent of profit from the gasping ground.

This madness continued throughout the 1920's, for the weather graciously baptized each new harvest with ample rains, and Europe, still reeling from the effects of World War I, paid well to be fed. Eventually, however, agriculture in Europe was restored and grain prices began to fall. When the Great Depression struck the bottom fell out from under the grain markets. The worried farmer sat on his tractor, plowing even more land and wondering if he could ever produce enough grain to pay off his mounting debts.

In 1930 the rains began to fail. That year they failed in the Eastern United States. The next year the drought shifted west to the Great Plains, where it remained until 1941. The 1930's were also brutally hot years on the Plains, for there was almost no groundwater to evaporate and cool the parched earth. The little rain that did fall never had a chance to soak into the ground but quickly evaporated back into the scorched air. Then the dried out and exposed soil of the High Plains crumbled into dust and awaited the calling of the wind.

The wind took a year or two to marshal her forces. Dust storms began on a modest scale in 1932 and became an almost familiar nuisance during the growing season of 1933. From November 1933 onward, "black blizzards" raged across the Dust Bowl - the High Plains of Kansas, Oklahoma, Texas, Colorado and New Mexico. But it was on May 9-11, 1934 that the dust finally assumed the proportions of a Biblical plague. The wind swept up the dry, brown soil from Montana to Wisconsin, creating a wall of dust and sand-filled air that advanced across the countryside, casting it into darkness at noon. Millions of tons of the dust were lifted into the jet stream and transported eastward across the country at speeds of 100 miles per hour. In the East, from Maine to Georgia, it rained dust for two days.

After 1934, the storms seldom bothered to send their messages to the nation's cultural capitals in the Northeast, but there arose from the dust a new, homegrown breed of American writers and artists, often called Regionalists, to document and dramatize the effect of the Dust Bowl and the Depression on the local folk and the land.

Regionalism had its cultural roots in World War I. Initially, America wanted nothing to do with the War. An unprecedented program of anti-German propaganda was then promulgated by the government to propel us overseas. Nationalistic and often anti-German passions were whipped up to a maniacal level. Still, it took quite some time to convince Americans that their mission was to save democracy and civilization itself by uniting to "smash the Hun".

After World War I, things did not work out the way idealistic Americans had envisioned. The pettily vengeful European victors ignored Wilson's 14 Points and demanded impossible and humiliating reparations of the Germans. In Russia, the Communist menace became a terrifying reality. It seemed as if everything the United States had fought for was lost.

Thus it was a disgusted and somewhat paranoid America that turned away from Europe in the decade following the War. She certainly had enough work to keep busy. Propelled to the economic forefront by Europe's debilitation from the War, America only strengthened her position as the world's premier economic power during the Roaring 20's. The expansion of agriculture during this period was matched by the breathtaking growth of industry.

America really began to 'feel her oats' during the Roaring 20's. Not only did she work hard, she played hard, creating heroes like Babe Ruth. In such an atmosphere, it is not surprising that the call went out for America to free herself of cultural subservience to Europe, and to establish new, American forms of art. But the immense emotional effort it took for painters like Hartley and Hopper to wean themselves from European teat showed that this was no easy job.

Art critics eased the way. The first thing painters had to do, Thomas Craven repeatedly proselytized, was to cut out the cancer of European abstractionism and replace it with a healthy dose of American scenery and heroism. Craven pointed to the Mexican muralists, Diego Rivera, Jose Clemente Orozco, and David Siqueiros, as role models. In 1927, New York born and bred Lewis Mumford echoed this cry, insisting that each region of the country stop aping New York and begin to produce its own valid art forms.

These cries helped to fertilize the cultural soil of America. Even so, it still took the Depression and changed climate of the Dust Bowl to water that soil.

Nature ensured that the message of the Regionalists of the Midwest had a significant meteorological component. The Regionalist style may seem a bit hokey but don't let that home-grown farm flavor distract you for a single instant. The Regionalists were out to create an epic of life on the Great Plains. They wanted to show the heroism of the Plains' unassuming residents in the face of Nature's unleashed forces. Seldom has an art form dealt more intimately with the power of the climate and weather and their impact on people. The opening lines from John Steinbeck's, *The Grapes of Wrath* sets the dramatic stage for the epic scenes of the Regionalists.

> To the red country and part of the gray country of Oklahoma, the last rains came gently, and they did not cut the scarred earth. The plows crossed and recrossed the rivulet marks. The last rains lifted the corn quickly and scattered weed colonies and grass along the sides of the roads so that the gray country and the dark red country began to disappear under a green cover. In the last part of May the sky grew pale and the clouds that had hung in high puffs for so long in the spring were dissipated. The sun flared down on the growing corn each day until a line of brown spread along the edge of each green bayonet. The clouds appeared, and went away, and in a while they did not try any more. The weeds grew darker green to protect themselves, and they did not spread any more. The surface of the earth crusted, a thin hard crust, and as the sky became pale, so the earth became pale, pink in the red country and white in the gray country....
>
> In the roads where the teams moved, where the wheels milled the ground and the hooves of the horses beat the ground, the dirt crust broke and the dust formed. Every moving thing lifted the dust into the air....The dust was long in settling back again.
>
> When June was half gone, the big clouds moved up out of Texas and the Gulf, high heavy clouds, rain-heads....The rain-heads dropped a little

spattering and hurried on to some other country...

A gentle wind followed the rain clouds, driving them on northward, a wind that softly clashed the drying corn. A day went by and the wind increased, steady, unbroken by gusts. The dust from the roads fluffed up and spread out and fell on the weeds besides the fields, and fell into the fields a little way. Now the wind grew strong and hard and it worked at the rain crust in the corn fields. Little by little the sky was darkened by the mixing dust, and the wind felt over the earth, loosened the dust and carried it away. The wind grew stronger...

The dawn came, but no day. In the gray sky a red sun appeared, a dim red circle that gave a little light, like dusk; and as that day advanced, the dusk slipped back toward darkness, and the wind cried and whimpered over the fallen corn.

Men and women huddled in their houses, and they tied handkerchiefs over their noses when they went out, and wore goggles to protect their eyes.

John Steinbeck. *The Grapes of Wrath*. 1939. p. 1-4.

Fig. 11-27. Alexandre Hogue. *Dust Bowl*. 1933. National Collection of Fine Arts, Smithsonian Institution, Washington D. C.

Alexandre Hogue depopulated the land to emphasize its desolation, but otherwise painted the *Dust Bowl* (Fig. 11-27) much as Steinbeck described it. The sky is brown up to a considerable height except where the Sun has burned a a triangular wedge through the dust veil. The Sun is white but is fringed by an orange Bishop's ring. Above this, the cloudless sky is blue. And, why maintain barbed wire fences that could not stop the shifting sands?

No one dramatized the effects of erosion more vividly than did Alexandre Hogue. *Mother Earth Laid Bare* (1936, Philbrook Art Center, Tulsa, Oklahoma) shows the gullied landscape carved in the shape of a woman's body. *Drouth Survivors* (1933) depicts a rattlesnake and prairie dog as the drought's sole survivors. This painting so incensed a group of locals from Dalhart, Texas that they set out for Dallas to buy it and give it a public burning. Fortunately, they didn't have anywhere enough money, because Hogue was then in vogue.

These angry locals were sure that Hogue was "some upstart sent down from New York." Hogue wasn't, of course. He was born in Missouri and lived in Texas when he painted his Dust Bowl scenes. Most of the other painters of the midwestern scene in the 1930's were also proud native sons.

William C. Palmer, born in Iowa, caught the winds red handedly lifting the dust. It is a hot and windy day in *Dust, Draught, and Destruction* (Fig. 11-28). Several dust devils whirl across the landscape, like dervishes and genies in the deserts of the Arabian Nights.

Dust devils are right at home in a Dust Bowl scene. They are small and intense but usually harmless whirlwinds that form on almost calm days when the ground is baked by the Sun (Fig. 11-29). If the ground is wet, it is not so friable and some of the Sun's heat is "wasted" by evaporating water, so it does not get quite so hot. For these reasons, dust devils form most readily over very dry ground. Then, the buoyant, superheated air swirls upward. Where plants do not hold the soil together, dust is swept aloft and fills all but the devil's inner core, which, like all intense vortices, consists of sinking air.

Fig. 11-28. William C. Palmer. *Dust, Draught and Destruction.* 1934. Whitney Museum of American Art, New York.

Fig. 11-29. A dust devil with hollow core in a placid sky of cumulus humilis in Australia. John Roenfeldt and Ira Fehlberg, photographers.

In *Dust, Draught and Destruction*, Palmer tried to mislead us. As culpable as the dust devils seem, they did not topple the tree or the windmill and certainly did not destroy the farmhouse, for they are seldom violent. But the Plains are traversed by the dust devil's far larger and more violent cousin, the tornado, nature's most destructive whirlwind.

Even in the driest years, severe thunderstorms sprout up across the Plains to spawn tornadoes. A severe Great Plains thunderstorm is not your typical run-of-the-mill thunderstorm. It is carefully cultivated by the large scale atmospheric setting and the geography of the Midwest United States.

The stage for severe weather is set several days in advance. A broad 'tongue' of warm, moist air in the lowest mile of the atmosphere begins to drive northward from the Gulf of Mexico. The moist tongue is often bounded on its western edge by dry air from Mexico to form what is known as a dry line. At the same time, cold dry air at jet stream levels comes racing in from the west or southwest. Once the cold jet stream covers the moist tongue, severe thunderstorms begin to pop up, particularly if the Sun has added its input. The warm, moist air is highly buoyant and rushes upward, forming cumulonimbus that pierce the cold dry air layer above. The cold, dry and dense air aloft embraces the cloud and gets soaked for its effort. Rain evaporates in this air, cooling it further and hurtling it earthward as the thunderstorm downdraft.

Once a thunderstorm forms in this environment it serves as a springboard for further thunderstorm activity. The almost unending supply of warm, moist air is forced upward when it encounters the frigid air spreading out along the ground from a thunderstorm downdraft. This can lead either to the formation of a tornado in a supercell thunderstorm or a wedgelike shelf or arc cloud (Fig. 9-24) in a squall line. Arc clouds and squall line thunderstorms tend to occur when the ambient wind direction does not change much with height. Supercell thunderstorms that may spawn tornadoes tend to occur when the ambient wind turns sharply clockwise from south near the ground to almost west aloft and increases in speed with height. Squall line thunderstorms with their shelf clouds and supercell thunderstorms with their tornadoes are almost mutually exclusive.

Fig. 11-30. John Steuart Curry. *The Line Storm*. 1935. Philadelphia Museum of Art, Harrison Fund.

The shelf cloud is one of the squall line thunderstorm's classical signatures and was rendered masterfully by John Steuart Curry in *The Line Storm* (Fig. 11-30). Millet had already depicted a shelf or arc cloud in his *Coming Storm* (see Fig. 9-23) but on a less cosmic, European scale. In *The Line Storm*, flashes of forked lightning emerge from pitch blackness under the huge arc cloud that may be leading two thunderstorms. Ahead of the arc cloud, a few tattered fractocumulus or scud form in the gently rising warm air just before getting sucked violently inward and upward to join the main clouds.

The tornado (Fig. 11-31) forms along the supercell thunderstorm's flanking southern edge beneath cloud base at the boundary between the warm updraft and the cold downdraft. It often appears in the clear air as a sign for all to behold while rain or hail can be seen falling just to its north. Often, the pressure in the tornado is so reduced that cloud base is lowered and the tornado is fixed to a pendant wall cloud. The tornado funnel narrows toward the ground where its immense winds disperse a whirling cloud of debris.

Fig. 11-31. A tornado with ring of dust and debris near the ground and 'hollow' core of clear, sinking air aloft hanging from a wall cloud. (www.zoom.com)

Fig. 11-32. John Steuart Curry. *John Brown*. 1939. Kansas Statehouse, Topeka, KS.

This is exactly how Curry depicted the tornado in *John Brown* (Fig. 11-32). Never mind that John Brown's towering, bearded form dominates the foreground. He is only there to relay God's sacred commandment that there will be no slavery in the Promised Land of Kansas. It is not by chance that Curry modeled John Brown after Michelangelo's Moses, for with outstretched arms, windswept beard and hair raised by the electrical spirit of the storm John Brown is the Moses of the Great Plains. Behind him whirls the tornado, the pillar of cloud in which God reveals himself to his chosen people of the prairie.

When the fierce thunderstorms of the Regionalists finally rolled overhead, they opened their floodgates and interred the Dust Bowl under a sea of green. At about the same time, World War II roused the nation from its Depression lethargy. These changes doomed the Regionalist Movement, which died a quiet death shortly after 1940. Artists would need new vantage point to view thunderstorms.

11.4 Conclusion: New Skies to Conquer

World War II provided a new viewpoint of the atmosphere by accelerating our conquest of the sky. Today, of course, millions of people fly and are able to see clouds from both sides (like Georgia O'Keeffe), but this was not the case prior to World War II.

Thousands of pilots were trained during World War II. Meteorology was an integral part of their training, and as they filled the skies they added greatly to our knowledge of weather. American pilots, making no headway against fierce westerly winds on a bombing mission to Japan were forced to jettison their loads and turn back east. Whisked home by the wind in record time, the pilots brought first word of the jet stream.

At least one of those military pilots became an artist. During a post-war stint around Indonesia, Wilson Hurley looked down and saw many scenes like his *Isle in the Molucca Sea* (Fig. 11-33). The emerald island's volcanic peak crowned by a cumulus and ringed by coral reefs, gleams amidst a turquoise and sapphire sea. The water's color deepens with depth (recall Fig. 7-1 top), which increases in a convoluted manner away from the island's core.

Fig. 11-33. Wilson Hurley. *Isle in the Molucca Sea*. 1977. Private Collection.

The cumulus, crown of so many tropical island jewels, forms almost every day when the intense equatorial Sun heats the mountainsides and forces humid, tropical air to rise. Later in the day the cumulus may grow large enough to send rain down upon the island. Such rain is a mixed blessing, for although it brings life to the island, it also gullies the slopes in its downward rush and helps the waves slowly wash the island back into the sea.

Wilson Hurley took many years to return to his true calling. At the age of three, he was mesmerized by the entrancing colors of an Oklahoma thunderstorm but, with a father who wanted him to be President of the United States, a career as an artist seemed out of the question. After his military stint, Hurley passed the bar and moved to New Mexico, where he spent years as a successful, but unfulfilled lawyer. Then, on the summer day a young, terminally ill doctor asked him to formulate a will, Hurley walked out of his office, gazed up into the sky to find a nubile *Anvil Top* (Fig. 11-34), posing free of charge and was transformed into the artist he always wanted to be.

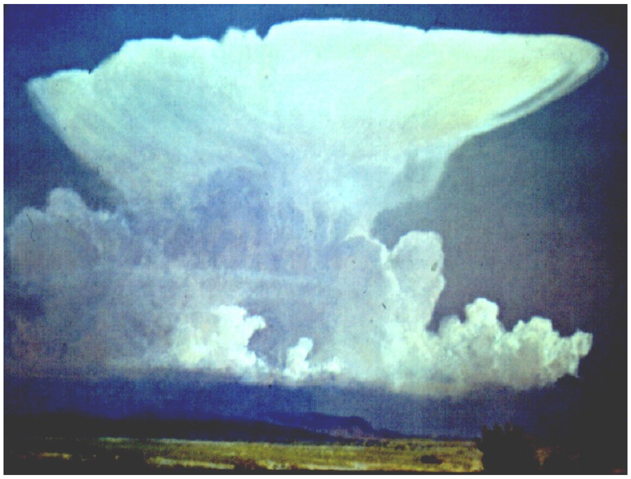


Fig. 11-34. Wilson Hurley. *Anvil Top*. 1977. Private Collection.

New Mexico offers as grand a view of thunderstorms as we get anywhere on Earth. The heated surface air contains just enough water vapor to kindle a thunderstorm, while the air surrounding the cloud at all higher levels is very dry and crystal clear. As Hurley noted,

> In New Mexico when our summer thunderstorms arrive, it is common to see a cloud such as this in the early afternoon isolated from other clouds and showing its complete anatomy in the clear air. In lower lands the storms are more massive, but the thickness of the air hides most of them from view.
>
> Wilson Hurley: *An Exhibition of Oil Paintings*.

Although thunderstorms are an almost daily treat during New Mexico's brief summer monsoon of late July and August the climate is still arid. *Anvil Top* faithfully shows the open patches of light, desert soil and the sparse, pale green or golden vegetation. The dry air that allows such magnificent views of the thunderstorms begrudges the Earth every drop of water by taking its toll on the rain falling beneath the cloud. Quite often, a shower will evaporate without a drop reaching the ground.

The spreading anvil top has a smooth, veil-like appearance that contrasts sharply with the massive, highly corrugated cauliflower shaped outlines of the brightly sunlit, burgeoning cumulus cells below. The swelling cumulus cells give the impression of solidity because they contain multitudes of minute water droplets with tremendous optical thickness that increases upward almost to the growing edges. By contrast, the spreading anvil appears smooth because it contains much lower concentrations of large ice crystals that thin out and evaporate near the anvil's sinking fringe and allow light to penetrate much deeper into the cloud.

Hurley has shown this disintegration process at work in *Anvil Top*. The spreading air at the anvil's edge turns downward and then loops back inward, forming a vortex that carries with it long, evaporating streamers of cirrus. The white cirrus streamer on the right of *Anvil Top* is easy to see, but look carefully on the shaded left underside of the anvil and you will decipher dark cirrus streamers in a similar state of decay.

The anvil-topped cumulonimbus is the monarch of all clouds, yet for some mysterious reason centuries of artists virtually ignored it. Surely, almost every artist must have glimpsed its noble and unforgettable outlines at some time in their lives no matter where they lived. But, as with the halo and a few other aerial phenomena of stupefying beauty, the cumulonimbus has been something artists until quite recently have either chosen not to reveal or refused to see.

For several centuries now artists have been learning to see new phenomena using eyes trained by science and technology. Wherever science has thrived, it has provided art with fertile breeding grounds of raw material for new vistas and fresh outlooks. Whenever science has failed, art's naturalistic sources have withered at the root.

Increasingly, direct links have been forged between art and science. The opportunity for employment as 'lowly' scientific illustrators has tempted more than a few hungry or curious or nature loving painters. Artists serving as scientific illustrators have been introduced to everything from the minute world of the electron microscope to the vastness of the cosmos. They have also accompanied explorers and scientists on their voyages of discovery around the globe.

One group of exploring artists including William Leigh, Matthew Kalmenoff, and James Perry Wilson were commissioned by New York's American Museum of Natural History to paint backgrounds for environmental groupings of plants and animals from selected sites around the world. During the expeditions scientists collected samples of the local fauna, flora, rocks and soil while artists photographed and sketched the landscape and sky so as to most faithfully represent the background scenes.

The painted backgrounds of the dioramas in the American Museum of Natural History are triumphs of tromp l`oeil and constitute some of the best sky art of the 20th century, and indeed of all time. They carry the viewer's eye far into the imagined distance with a minimum of disturbance, faithfully recreating the entire panorama from ground up. In the Hall of Asian Mammals, Mt. Fuji, with its snow line tilting upward on the north slope, emerges from a well-defined layer of misty marine air into the clear, dry upper atmosphere while lazy cumulus remain trapped below the discontinuity. Even Hokusai, who showed a sloping tree line in *Fuji in Fine Weather* (Fig. 9-53), neglected to show this marine layer.

A short walk away, in the Hall of African Mammals, the tropical skies above Zaire's Upper Vele River Basin are filled with towering cumulus congestus. The clouds' spreading mushroom-shaped tops are still white but the setting Sun has tinted their lower sides pink, more strikingly than in August Schaeffer's *Sunset in Hungarian Forest* (Fig. 10-2) but similar to Fig. 10-3. Further south, along the banks of the Zambezi River in Mozambique, cheetahs play under a sky of cumulus much like the one that Magritte later used in his *Empire of Light* (Fig. 11-8) albeit in full consistent daylight.

Some of the best clouds appear in the Hall of North American Mammals. Delicate cirrus streamers fall through the crystal clear skies of Wyoming above the extinct volcanic plug, Devil's Tower. Prior to this, only Jan van Eyck, John Constable, Fitz Hugh Lane, and Edward Hopper had painted such perfect, textbook cirrus. Steam fog that might have be lifted from a Rubens, Friedrich, or Turner rises from a lake in Ontario's Algonquin Park while further west, cellular altocumulus that Cole or Courbet would have gladly painted supervise squirrels playing in the trees above Oregon's Rogue River on a warm summer day.

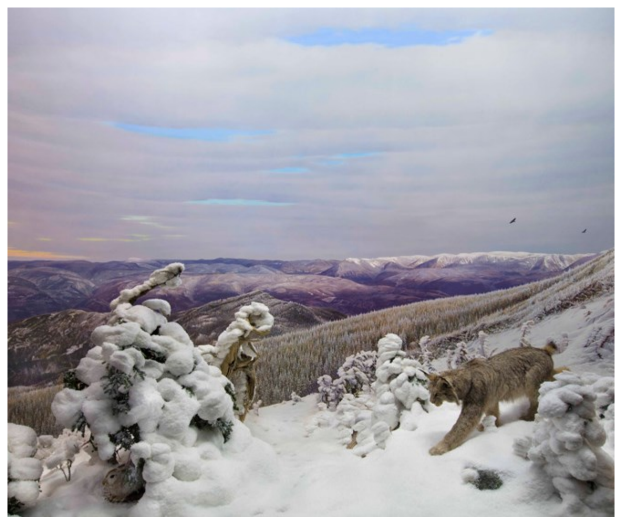


Fig. 11-35. James Perry Wilson. *Canada Lynx and Varying Hare*. 1951, American Museum of Natural History, New York.

Fig. 11-36. Setting for Fig. 11-35 including the wind at the time rime ice was deposited.

A more serious drama is played out high in the Shickshock (Chic Choc) Mountains of Quebec's Gaspe Peninsula. Under the skies of a departing storm in James Perry Wilson's, *Canada Lynx and Varying Hare* (Fig. 11-35) a lynx is about to flush a varying hare from its hiding place beneath the dwarf vegetation. The hunt temporarily distracts the eye from the panoramic view seen from an elevation of 3500 feet on Mount Albert (Fig. 11-36). The Saint Lawrence River appears in the distance to the north or far left, while Mount Jacques Cartier appears to the right in the east.

The scene represents a precise meteorological moment, late in the afternoon of 26 October 1950. The weather maps show that a low pressure area had produced snow in the highlands when it passed overhead, and drew cold northerly winds and stratocumulus clouds in its wake when it passed to the east. Indeed, the sky is filled with a thin, evaporating veneer of stratocumulus. In the breaks of the clouds, patches of pristine sky grade from deep blue above to turquoise and finally to orange at the distant horizon. (Compare the clear breaks in Fig. 11-10, which lack this color gradient.)

A coating of snow topped by glaze covers all features at the higher elevations as a result of the season's first snowstorm (which almost certainly surprised the expedition members), while the warmer lowlands got only rain. The temperature near sea level hovered around the freezing point, but was -3ºC at the site. The legend for *Canada Lynx* states that after the snow, a dense fog of supercooled water droplets swept up the mountain from the north and coated the north side of all exposed rocks and vegetation with a layer of rime ice. The fog was probably a low-lying cloud produced by ascent of the rain-soaked air up the slope.

In the days following the autumnal storm, the snow and ice around Mount Albert would surely melt. But there are places on our planet where snow and ice have not melted for the past several million years.

Indeed, the great hardships faced by the explorer-artists who portrayed the records of their expeditions for the American Museum of Natural History were child's play compared to the impossibilities endured by the members of the ill-fated Scott expedition to the South Pole. In their quest for immortality Scott's team witnessed wonders not seen in the settled parts of our planet. And despite all difficulties, Edward Adrian Wilson, the Expedition's naturalist and artist, executed watercolors of almost everything he encountered – the animal life, the geology, the sea, the ice, and the sky.

Midway through the winter before the assault on the South Pole, Wilson recorded a sighting of iridescent wave clouds over Mount Erebus 09 August 1911 (Fig. 11-37). The clouds were almost certainly nacreous or mother of pearl clouds, which form in the stratosphere toward the end of the winter over Antarctica. The stratosphere is normally too dry to support clouds, but during winter the Antarctic stratosphere cools so much (to ≈ -90° C) that tenuous clouds do form there. Seventy five years later, these Stratospheric Polar clouds would be, when contaminated with freons, the agents that produce the Antarctic Ozone Hole, but at the time that Wilson depicted them their beauty was untainted.

Nacreous clouds frequently exhibit spectacular iridescence, especially when they are lenticular. In that case, droplet and crystal size increases from the cloud fringes to the center, so the diffraction pattern and resulting color grades toward the centers. The iridescence is most pronounced during twilight when the stratosphere is sunlit but the surface below lies in the Earth's shadow.

Lenticular clouds in the troposphere also are frequently iridescent when seen near the Sun, and can be as spectacular as their Polar Stratospheric siblings (Fig. 11-39). Note how the color bands follow the corrugations of the wavy cloud edges. They are essentially tracing bands of constant droplet size.

Fig. 11-37. Edward Wilson. *Iridescent Clouds over Mt. Erebus*. 1911. Journal of Antarctic Expedition.

Fig. 11-38. Polar stratospheric (mother of pearl) clouds over McMurdo. SCINI Project Photograph.

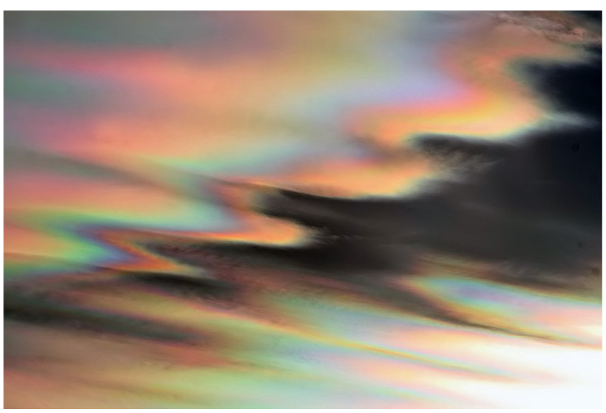


Fig. 11-39. Iridescent wave clouds, Port of Tarragona, Spain, 10 Feb. 2007, Ramón Baylina, photographer.

A far more deeply frozen world was depicted by Adolph Schaller, in his illustration, *Hunters and Floaters* (Fig. 11-40) from Carl Sagan's *Cosmos*. Here the gaseous Jovian planet is home to an impressive array of cloud (and life) forms much more likely on Earth - corrugated cumulus, smooth lenticular clouds, fibrous cirrus, a tornado-like funnel, and the swirling clouds of an extraterrestrial hurricane.

Fig. 11-40. *Hunters and Floaters*. Adolf Schaller. 1980.

The *Hunters* most poetic and delicate feature is the ice crystal halo complex produced by a cloud so optically thin that the sky remains deep blue. The complex includes a lower tangent arc and a sun dog that stands guard just outside the 22° halo in a manner consistent with a Sun 30° above the horizon. Ironically, this grand appearance of art's first accurate, shimmering halo complex has been grafted from Earth to an icy Jovian planet whose clouds consist of ammonia crystals, which are octahedral and which would produce very different halos, as Les Cowley has shown (www.atoptics.co.uk/halo/oworld.htm). A very similar and equally misplaced halo complex by Shigemi Numazawa, *The Upper Atmosphere of Jupiter* (1989) is displayed in the American Museum's Hayden Planetarium.

The beautiful but documentary skies of the murals in the American Museum of Natural History, as well as other examples of scientific illustration, are never mentioned in the same breath as the 'fine' art so proudly displayed across Central Park in the Metropolitan Museum of Art. This is the result of an unfortunate but all too prevalent attitude that fine art must consist of some elusively defined creation of the imagination or intellect that transcends a 'mere' transcription of mundane reality. In far too many cases, such judgments amount to subjective incantations that cannot stand the test of any objective criterion.

Nevertheless, the role of science and mathematics in art is winning increasing acceptance and is transforming the art world. Scientists and mathematicians have created whole new branches of computer art. Using the fractal geometry of natural forms discovered by Benoit Mandelbrot, vibrant, computer generate landscape vistas of mountains topped with cloud-filled skies (Fig. 11-41) are almost indistinguishable from the real thing.

Fig. 11-41. Benoit Mandelbrot. *Fractal Landscape*.

Fig. 11-42. Grandma Moses. *Rainbow*. 1961. Private Collection.

The intrusion of science and computers is but one of the factors that have led to better and more varied sky art. The flood of ideas in the world today compels art to transcend any limited set of ideologies. The materials and equipment available to the artist can be used to overcome any technical difficulties.

Sky art has also been broadened by the proliferation of professional and amateur artists. Thousands of people wade through lifetimes of business or busyness to emerge metamorphosed from their corporate cocoons as passionate painters. No one can tell these retirees what to paint - they paint for their own pleasure. And their works are filling the Web.

One of these retirees lived long enough to make art a second career. Anna Marie Moses was born in upstate New York where the seasons splash you in the eyes. Her childhood idyll ended at the age of twelve when she was sent off to work. At the age of twenty six she married and thereafter remained busy, giving birth to ten children and raising the five that survived infancy. She had only a few brief spare moments to paint. Finally, when her children were grown with children of their own, Grandma Moses returned home to upstate New York, free at last to recreate her visions of a childhood world of benevolent innocence. Snow-whitened sugaring skies, storm-darkened skies or placid, deep blue heavens with fair weather cumulus all met her 'naive' approval.

Grandma Moses continued painting the sky until June of 1961. In that month she began her final work, entitled simply *Rainbow* (Fig. 11-42). *Rainbow* is unfinished, just like its springtime setting when life returns to the Earth. The trees are just coming into leaf for another fruitful year. But Grandma Moses would shortly pass on to another vista. She added the pastel colored bow at the last moment, perhaps as her rite of passage, for even if we reach the age of 101, there will always be new skies to conquer.

Afterward

And now my long, marvelous voyage of adventure is over. I never imagined that I would labor over a single book on and off for almost 40 years. It is self published because publishers found the book not worthy of the great cost of permissions for images. So, it will never be a commercial product.

Here is a brief, spotty history of my work on *The Soul of All Scenery*. I can't remember when I got the idea. Hans Neuberger's 1970 article, *Climate in Art* in *Weather Magazine* may have alerted me to the subject. Certainly by 1976, I planned a chapter on Weather in History and the Arts in *The Science and Wonders of the Atmosphere*. My first work was in April, 1978, when I went to the Metropolitan Museum of Art to look at paintings as if they were meteorological documents. I was entranced and knew that the next book I started would be on Weather and Art.

Immediately after finishing the text in the winter of 1978-79 I began serious research for the . I soon came across John Ruskin's *Modern Painters*. It was an insightful, eloquent, but biased book and it took some gall to continue my research, but then again, I knew a lot more meteorology than Ruskin and much new weather art has been done since 1850.

During the summer of 1979 on the way back from sabbatical in Israel, we toured a good part of Western Europe and its art museums. I took careful but brief notes on the meteorology of many paintings.

I don't remember when I began writing *The Soul of All Scenery*, but the first draft was completed during my sabbatical year in UCLA in the spring of 1986. Attempts to sell the book failing, I started to write articles. My first article was rejected serially by two art journals. Realizing that I had tread on turf and would likely continue to be rejected serially, I submitted the article to 7 journals simultaneously. Two accepted - one the Bulletin of the AMS. The other journal, *Leonardo*, I pulled my article telling them that it needed revision and wrote another.

During the years from 1989 to 1992 I published several articles. At some point, probably in 1991 I turned back to the book and wrote a second draft, which I completed in 1992 or 1993. After that, there were minor revisions interspersed with long periods of almost nothing. But I have always carried my camera looking for skies that matched or illustrated paintings. And, at some points, due to the availability of better and more images including from the web, I changed and added images. Google maps also greatly helped in the cases where the paintings are topographic.

In the Fall semesters of 2010 and 2011 I taught a course on Weather and Art. Teaching forced me to be more careful and thorough. Some of the students provided some insights and corrected some of my errors. For example, it was a student who pointed out that the altocumulus on the left side of Man Ray's *Observatory Time: The Lovers* grades to altostratus on the right side.

Some time after retiring at the end of 2011 I turned back to finish *The Soul of All Scenery*. My self published book, *Calculus: Your Royal Road to Genius* took precedence for about a year until the spring of 2014, but in 2013 I began rewriting. Throughout I tried to retain the poetic tone of the earlier versions, but have added images and improved discussion, particularly of topographic aspects of paintings and atmospheric optics. I learned a little more during the process but can't believe how much I knew and how much I had forgotten. I thought of doing an index and putting in all the references, but decided it is too much work for too little pleasure. I've got the notes if anyone wants.

When I look at the book I feel that I have done something of value that is beautiful, and that gives me great joy. 24 Aug 2014

Another six years have passed. During that time I had the chance to find a few better photographs, notice and correct a few typos and several more serious errors, mainly of the geographic setting of paintings of Fig. 6.22, 9.4, and 9.34.

18 August 2020