Foreword

We at the Daniels Faculty had the pleasure during the winter term of 2008 to host Jürgen Mayer H., the first European architect to hold the Faculty's Frank Gehry International Visiting Chair in Architectural Design.

Mayer developed an extremely interesting approach to his studio, bringing together not only Weather and Architecture, as this volume proclaims, but also industrial archeology and an extremely complex site on Toronto's waterfront. The talented group of students working with him and Neeraj Bhatia investigated a whole series of historical topics, and their research is published here under such themes as "weather and shopping," "weather and media," "weather and tourism," etc. Invigorated by these studies, the students in the studio went on to produce some of the most interesting design proposals the faculty has seen in recent years. These also are documented in the pages that follow.

We at Daniels are grateful to Jürgen Mayer H. for the enthusiasm and insight that he brought to this innovative studio, and are proud to have this permanent record of its accomplishments.

—George Baird
Dean, John H. Daniels Faculty of Architecture, Landscape, and Design; **University of Toronto**
March 2009

Weather + Science

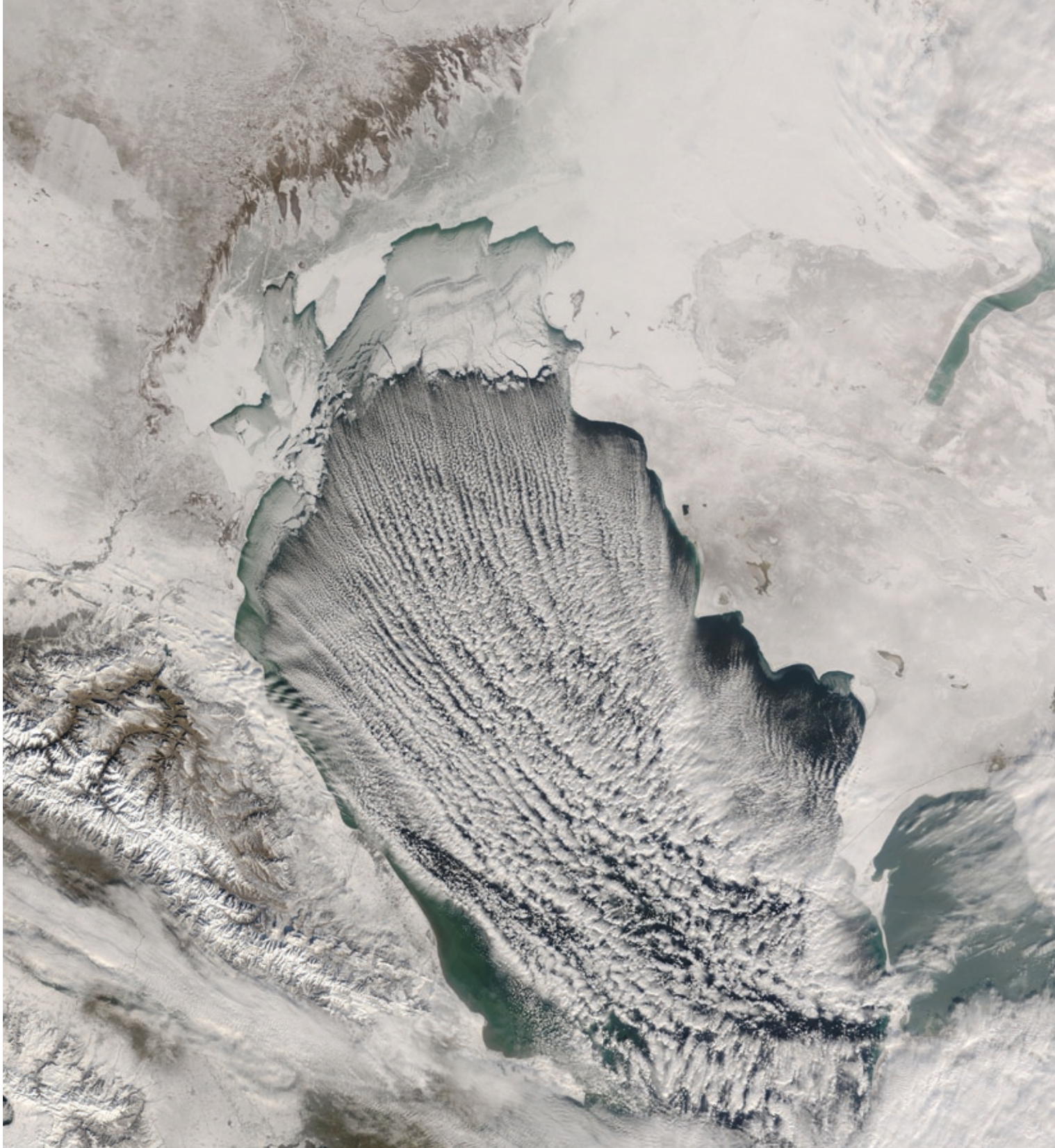
Tomek Bartzak

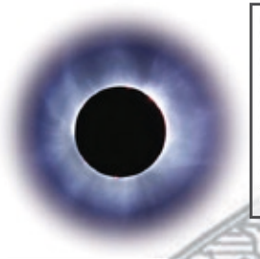
Human Interaction with Weather

To explain what fell from the sky has long been a preoccupation for man. The human struggle with weather, climate, and meteorology can chiefly be divided into six nonlinear categories, namely: mythology, theory, measurement, understanding, forecasting, and controlling. These subdivisions mark shifts in the perception of weather rather than denoting equal intervals of time. For thousands of years, civilizations have attempted to explain weather through mythology and religion. Emerging around the Age of Enlightenment and continuing to the present day, large scientific and technological advances have dramatically altered our perception and understanding of weather phenomena.

1. **Science from Above**
Aerial photograph of the Caspian Sea (facing page)

2. **Weather and Scientific Developments**
Maps the evolution of weather mythology, theory, measurement, understanding, forecasting, and control (following pages)





Weather Lore

For centuries, shepherds and sailors - people whose lives and livelihoods depended on the weather - relied on lore to foretell tomorrow's weather. They showed a keen sense of observation and quickly connected changes in nature with rhythms or patterns of weather.

Farmers watched cloud movement and the sky colour to know when to sow and reap. Mariners noted wind shifts and watched wave motions for signs of change. Hunters studied the behaviour of insects and animals and, through repeated observation, learned to foretell the weather. They recalled what they saw in the form of short sayings, often embodied in rhyme for ease of memory. The beliefs of thousands of people were passed down from generation to generation, altered by the wisdom of the times. They became part of culture and education and came to the New World and to different climates with the waves of migration.

Many weather proverbs are nothing more than familiar rhymes, lighthearted ditties or imaginative contradictions. Some have survived the test of careful observation and scientific reasoning to become reliable guides to coming weather change. Only those sayings that prophesy daily change, usually pertaining to sky appearance, cloud movement or wind change, have any hope of success. Lore involving key dates or anniversaries or suggesting monthly or seasonal change can only be right by chance.

Old weather proverbs and saws have their inception in atmospheric conditions. Properly interpreted, these conditions give accurate information on what is likely to happen in the next few hours. For instance, a red sky means rain or dry weather according to the time of the day it occurs. The principle is based on certain optics and conditions of the atmosphere. Another example: smoke hovering near the surface of the ground indicates heavy moisture in the air. When it ascends straight up there is little likelihood of rain.

Among the more reliable weather proverbs are:

David Phillips Senior Climatologist Environment Canada August, 1997

Chimney smoke descends, our nice weather ends.

When the night goes to bed with a fever, it will awake with a wet head.

When stars shine clear and bright,
We will have a very cold night.

When the ditch and pond offend the nose,
Then look out for rain and stormy blows.

Three days rain will empty any sky.

The farther the sight, the nearer the rain.

Rain long foretold, long last,
Short notice, soon will pass.

The sharper the blast, the sooner 'tis past.

If bees stay at home, rain will soon come,
If they flay away, fine will be the day.

The first and last frosts are the worst.

When clouds look like black smoke a wise man will put on his cloak.

A rainbow afternoon,
Good weather coming soon.
A rainbow in the morning, is the shepherd's warning
A rainbow at night is the shepherd's delight.

When the chairs squeak, it's of rain they speak.

Catchy drawer and sticky door,
Coming rain will pour and pour.

The winds of the daytime wrestle and fight,
Longer and stronger than those of the night.

Dust rising in dry weather is a sign of approaching change.

Sun sets Friday clear as bell,
Rain on Monday sure as hell.

No weather's ill if the wind be still.

The squeak of the snow will the temperature show.

When smoke hovers close to the ground, there will be a weather change.
When down the chimney falls the soot
Mud will soon be underfoot.

When the sun shines while raining,
it will rain the same time again tomorrow.

When the wind blows from the west, fish bite best.
When it blows from the east, fish bite least.

If salt is sticky,
And gains in weight;
It will rain
Before too late.

Red sky at night, sailor's delight;
Red sky in morning, sailor take warning.

When clouds appear like rocks and towers,
The Earth's refreshed by frequent showers.

When the wind is in the east, 'tis neither good for man nor beast.

The more cloud types present, the greater the chance of rain or snow.

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585 BC Thales of Miletus successfully predicts solar eclipse

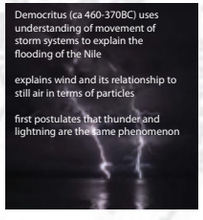
Anaxagoras known as the first scientist, correctly postulates the temperature, altitude relationship in order to explain hail in the summertime

The Ancient Babylonians are the first culture to attempt to determine a relation between astronomy and meteorology

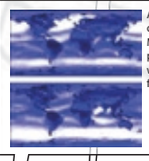
Democritus (ca 460-370BC) uses understanding of movement of storm systems to explain the flooding of the Nile

explains wind and its relationship to still air in terms of particles

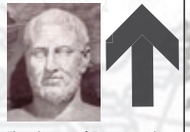
first postulates that thunder and lightning are the same phenomenon



Anaxamander of Miletus: posited that wind was "a flowing of air"



Empedocles (492-430 BC) postulates that the universe is made up of 4 basic elements: air, earth, fire and water



Theophrastus of Eresos was the first to attempt to predict the weather based on empirical rules.

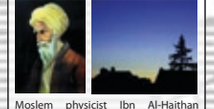
Nearly all of the still-popular empirical rules that still survive today come from his treatise called On Weather Signs

It is the oldest collection of weather signs to survive and was the basis for most later texts

It is in Earth's middle latitudes, between roughly 30° to 60° North and South, that a significant portion of humanity's daily activities take place. It is also within these rough boundaries that "weather" can be said to happen, that is, where meteorological phenomena do not persist over the long term, and where it may be warm, sunny, and calm one day, and cold and stormy the next.

A great percentage of the world's population lives in the equatorial regions, but for the most part, these regions do not experience weather as it is understood by this definition. The Sahara Desert, for instance, is almost uniformly hot and dry, whereas weather trends on the Indian subcontinent and in the western Pacific, for instance, the monsoonal belt, occur gradually over the very long term, and the diurnal weather patterns remain constant. - Wiki

Claudius Ptolemy of Alexandria (85-165AD) publishes Almagest. Considered the the basic authority on astrological prediction of weather phenomena



Moslem physicist Ibn Al-Haithan (965-1039) sought to explain atmospheric refraction and first to explain twilight

In 1450 C invented th measure air

600 BC 500 BC 400 BC 300 BC 200 BC 100 BC 0 AD 100 200 300 400 500 600 700 800 900 1000 1100 1200 130

Decline of the Roman Empire

start of the Renaissance in Europe

Most of the meteorological research in this time period focused on atmospheric optics and the interpretation of Aristotle's texts

By 1250 the earth is widely believed to be spherical by western physicists, astronomers and theologians alike

RELATED WORLD EVENTS

Induction or inductive reasoning, sometimes called inductive logic, is the process of reasoning in which the premises of an argument are believed to support the conclusion but do not ensure it. It is used to ascribe properties or relations to types based on tokens (i.e., on one or a small number of observations or experiences); or to formulate laws based on limited observations of recurring phenomenal patterns

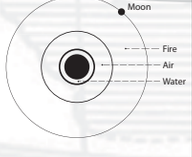
Aristotle (384-322BC) based his theory of weather phenomena on the exhalations of the earth: moist and dry

Coins the phrase "meteorology" literally: "things that fall from the sky"

First to apply the deductive method to weather

publishes Meteorologica. It is the earliest known effort at a systematic discussion of meteorology, and was the unquestioned authority on weather theory for over 2,000 years.

In fact, all textbooks on meteorology in Western civilization up to the end of the seventeenth century were based exclusively on Aristotle's Meteorologica



Aristotle's concept of the Universe

age of inductive reasoning

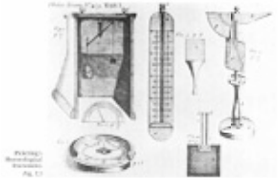
age of deductive reasoning

Deductive reasoning is dependent on its premises. That is, a false premise can possibly lead to a false result, and inconclusive premises will also yield an inconclusive conclusion

myth → natural philosophy

the Greeks were the first civilisation to regularly make meteorological observations

the ancients having no instruments to accurately measure phenomena were limited to qualitative observations



Scientists discover that sprinkling pure silver iodide into clouds would demonstrably boost the resultant precipitation. Led to 'cloud seeding' for both military and civilian use. From March 1967 until July 1972, the US military Operation Popeye cloud seeded silver iodide to extend the monsoon season over North Vietnam, specifically the Ho Chi Minh Trail. The operation resulted in the targeted areas seeing an extension of the monsoon period an average of 30 to 45 days

The High Frequency Active Auroral Research Program (HAARP) is an investigation project to "understand, simulate and control ionospheric processes that might alter the performance of communication and surveillance systems." Started in 1993, the project is proposed to last for a period of twenty years.

1593 Galileo Galilei invents the thermometer

It was not until the end of the sixteenth century that meteorology started to gain legitimacy as a natural science. The invention of instruments designed to measure the properties of the atmosphere (temperature, moisture, air pressure) enabled scholars to categorise and predict changes in the weather.

First Weather Satellite:
Named "TIROS" for Television Infrared Observation Satellite, it demonstrated the advantage of mapping the earth's cloud cover from satellite altitudes. TIROS showed clouds banded and clustered in unexpected ways. Sightings from the surface had not prepared meteorologists for the interpretation of the cloud patterns that the view from an orbiting satellite would show.

The idea of numerical weather forecasting-predicting the weather by solving mathematical equations—was formulated in 1904 by Vilhelm Bjerknes (1862-1951, Norwegian) and developed by British mathematician Lewis Fry Richardson

1752: First weather control tool: Benjamin Franklin's lightning rod.

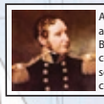
Fitzroy develops charts to allow predictions to be made, which he calls "forecasting the weather", thus coining the term weather forecast. Fifteen land stations are established to use the new telegraph to transmit to him daily reports of weather at set times. The first daily weather forecasts were published in The Times in 1860.

Using one of the earliest modern computers, the first public numerical weather forecast announced by a team of mathematicians and meteorologists for the Institute for Advanced Study in Princeton, New Jersey. By the mid 1950s, numerical forecasts were being made on a regular basis

Studies of the natural cycles of storm strength showed that what were thought to be the effect of seeding might have been natural. Scientists published a paper in 1985 demonstrating many of the flaws in the original STORMFURY premises. Hurricane modification studies and experiments were shelved for the foreseeable future.

In 1450 Cardinal Nicholas de Cusa invented the hygrometer, designed to measure air moisture.

Evangelista Torricelli invents the barometer



Adm. Robert Fitzroy appointed as Meteorological Statist to the Board of Trade to deal with the collection of weather data at sea. Birth of weather data collection

Radiosonde invented. Small lightweight box equipped with weather instruments and a radio transmitter carried into the atmosphere by a helium-filled balloon transmit temperature, moisture and pressure data back to a ground station.

1200 1300 1400 1500 1600 1700 1800 1820 1840 1860 1880 1900 1920 1940 1960 1980 2000 2020 2040

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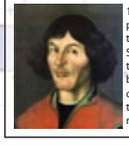
start of the Renaissance in Europe

Christopher Columbus discovers North America

Telegraph attains widespread use

First computers come into use

Climate change and human impact upon climate start to become an issue. "Global Warming"



1543 Nicolaus Copernicus publishes On the Revolutions of the Heavenly Spheres. First astronomer to formulate a scientifically based heliocentric cosmology. Generally heralded as the start of the scientific revolution

Rene Descartes (1596-1650)

Published *Discours de la Methode* in 1637, in which he expounds his theory on the scientific method
1. Never to accept anything as true unless one clearly knew it to be such
2. To divide every difficult problem into small parts, an d to solve the problem by attacking these parts
3. To always proceed from the simple to the complex, seeking everywhere relationships
4. To be as complete and thorough as possible in scientific investigations allowing no prejudice in judgement.

October 1957: The first satellite, sputnik is launched

1977 Environmental Modification Convention:
Weather control, as well as "weather tampering", are expressly forbidden dating from at least December 10, 1976, when the "United Nations General Assembly Resolution 31/72, TIAS 9614 Convention[13] on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques" was adopted. The Convention was: Signed in Geneva May 18, 1977; Entered into force October 5, 1978

age of instruments

age of information

scientific method

statistical data gathering

numerical computation

space observation