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Meteorology

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PHILOSOPHY

Weather is one of the most common topics of discussion and it effects all aspects of our student's lives. A unit on meteorology can thus be a welcome "attention getter" to increase interest in science. Students need to relate to what they are learning, and weather, with its severe storms, temperature fluctuations, and changeability makes an ideal topic for a unit.

I teach meteorology at the beginning of the year, right after a unit on the atmosphere, for several reasons. First, weather occurs in the atmosphere and concepts become clearer when the two units are taught back to back. Second, hurricane season normally runs from June through November, and odds are that a hurricane/ tropical cyclone will be happening somewhere, at some time during the unit. This gives a lesson on hurricanes added impact.

Also, a unit on meteorology provides ample areas where science experiments, demonstrations, charting, graphing and record-keeping can be done. All of these are vital elements of the 8th grade curriculum, and much needed preparation for high school science.

Furthermore, a two week weather log is a key part of the unit. Students will be able to chart local/ Connecticut weather conditions, and see connections, as well as trends. In addition, this unit is adaptable to students of differing abilities.

For this unit, I am not going to be spending much time on general meteorological information that can be found in earth science textbooks, but on supplemental materials. Emphasis will also be on hands-on activities as they relate to weather forecasting. I plan to cover and concentrate on the following; weather lore, severe storms, the history of meteorology and modern weather forecasting.

THE HISTORY OF METEOROLOGY

The Greeks were the first meteorologists (7th century B.C.). Thales of Miletus associated weather with movement of the stars and planets. He considered water to be the basic element of all matter. Anaximander thought that wind was moving air. This idea was later rejected by Aristotle. (Farrand, 1991)

Aristotle wrote “Meteorological” about 340 B.C. His ideas included the four elements (earth, wind, fire and water). He said that they were arranged in separate layers, but they could mingle. Aristotle also believed that heat could cause water to evaporate. He deduced many things about weather, both wrong and right, but was the first to explain it. Thus, Aristotle is considered the founder of meteorology. For 2000 years, no one added anything significant to his findings. (Farrand, 1991)

One of the first weather instruments was designed by a German-Nicholas deCusa. In the 15th century, he hung out some wool and noticed that it was heavier when moisture condensed on it. (Farrand, 1991)

Around 1593, Galileo was the first to realize that gases and liquids expand when heated, and he invented the first thermometer. Also, in 1643, Evangelista Toricelia invented the barometer. Very close to this time, wind and calibrated rain gauges were invented. (Farrand, 1991)

In 1686, Edmund Halley (the English astronomer who discovered Halley’s Comet) proposed that air is heated by the sunrises and winds are caused by air flowing in to replace air that has risen. In the 1740’s, Ben Franklin proposed that storms move from place to place. In 1768, John Heinrich Lambert developed the hygrometer. (Farrand, 1991)

In 1830, William Redfield, a Connecticut peddler discovered the circular path of a hurricane. He noticed that after a hurricane, trees in eastern Connecticut fell in one direction, while those in the western part of the state fell in the other direction. (St. Onge, 1990, Farrand, 1991)

In 1918, Vilhelm Bjerknes and his son Jacob discovered that many weather phenomena result from the meeting and interaction of warm and cold air masses. Also, Carl Gustaf Rossby (U.S. Weather Service) discovered the jet stream and that it governs the easterly movement of most weather. (Farrand, 1991)

Weather makes headlines all the time. “The weather is always doing something said Mark Twain-always coming up with new designs and trying them on people to see how they will go. (Ludlum, 1986)

At the beginning of the 17th century, the colonists had little information about our weather. Many myths controlled the location of settlements. one misconception was that temperatures along the same parallel of latitude were equal the world over. A common complaint by the colonists was that there were six months of winter over here. Due to weather conditions, 32 out of 105 of the original settlers at Jamestown died. A rule of thumb was that if a colonist could survive a full year in the New World, he/she was seasoned and should live for many more years. (Ludlum, 1986)

Eventually, the colonists started keeping track of the weather. Until 1717, no weather instruments were kept in the United States. Benjamin Franklin urged establishment of a network of observers. In 1675, the Farmer’s Almanac added weather information. (Ludium 1986)

In 1846, the Smithsonian started collecting and studying weather reports from all over the country. Later on, a breakthrough with weather balloons occurred when the vacuum tube was developed so there could be

communication between the balloon and ground. (Ludlum, 1986)

In the 1940's and beyond, radar, weather stations, satellites, and computers were developed, which has helped to increase forecasting accuracy. Also, the above mentioned items are constantly being upgraded to collect and analyze more detailed information. (Ludlum, 1986)

MODERN METEOROLOGY

The current weather and forecast is constantly repeated by the media. The weather channel provides information 24 hours a day. Regular programming on television is interrupted for severe weather updates. Meteorologists are constantly called upon as key witnesses in trials where weather may have effected the events in question.

Throughout the centuries, Americans have tried to change the weather by cutting trees, explosions, starting fires, planning to divert the Gulf Stream, and by cloud seeding. None of these methods have been very successful. (Meyer,1986)

Forecasting is the real challenge of meteorology, and as can be seen in the section on history, it has come a long way. The government agency responsible for weather forecasting is the National Weather Service, which is part of the National Oceanic and Atmospheric Administration. There are 5000 employees. The National Weather Service conducts research, predicts and gathers information. This agency works closely with the other parts of NOAA (National Oceanic and Atmospheric Administration) to provide a whole picture of the earth and its environments—as they are part of one big system. (National Weather Service, 1992)

The National Weather Service has helped to predict and provide early warnings with regards to severe storms and has saved thousands of lives. NOAA's and the NWS's information service (NESDIS—the National Environmental Satellite, Data and Information Service) is the world's largest environmental data storage and distribution facility. It provides weather data and is responsible for the polar orbiting and geostationary satellites. (National weather Service, 1992)

The National Weather Service also works closely with the World Meteorological Organization (WMO), a United Nations agency, in order to share worldwide information. (Ahrens, 1993)

The N0AA Weather Radio provides continuous broadcasts of the latest weather information from the National Weather Service. Taped messages are repeated every 4-6 minutes, frequently revised, and most stations that carry this operate 24 hours a day. NOAA Weather Radio broadcasts are made on one of seven high-band FM frequencies ranging from 162.40 -162.55 megahertz. (NOAA, 1988)

The National Weather Service provides information to companies like Accu Weather and WSI, which interpret it, then supply the information to the media (tv., radio, newspapers, etc.) (NOAA, 1988)

With all the high tech equipment available, the National Weather Service still believes that spotters, be they civil or military, help to play an essential role in advance warning. For example, a Texas tornado in 1979 had more than 18,000 people in its path, but only 44 people died. It is believed that spotters, with their advanced warnings helped to save many lives. (National Weather Service, 1982)

The National Weather Service now uses a Doppler radar detection system called NEXRAD (Next Generation Weather Radar). This allows forecasters to see inside storms and to detect wind-driven precipitation. It also helps to give a clear indication of wind rotation and enables meteorologists to detect severe storms such as tornadoes in earlier stages then they were previously able too. The National Weather Service is also increasing its forecasting automation. (National Weather Service, 1993)

In addition, there is more day-night photo imaging and atmospheric soundings from satellites. A new Geostationary weather satellite has just been launched, There is now more dual satellite coverage form both the Atlantic and Pacific which has helped to improve forecasting accuracy. A new computer system will allow quicker assimilation of data. The National Weather Service is also combining local offices into 116 regional ones. There will be 13 river forecast centers. Lastly, experimental research is underway on a wind profiler. It is hoped that this will provide near continuous data on wind speed and direction from the ground up to ten miles high. (National Weather Service, 1993)

There are several types of weather forecasts;

1. Persistence forecast—predicts that the future weather will be the same as the present.
2. Analoque Method—relies on the fact that existing weather features may resemble features that produced certain weather conditions in the past.
3. Weather Types—weather patterns are categorized into similar groups, using for instance the position of the subtropical highs and the upper level flow.
4. Long—range weather forecasting (4- 6 weeks into the future) This only shows very broad features, not specific weather. The National Weather Service issues extended forecasts of 6-10 days, 30-day-outlook, and 90-day outlook.(Ahrens, 1993)

When the National Weather Service issues a forecast that says that there is a 60% chance of rain, it means that at any random place in the forecasted area, there is a 60% chance there will be measurable rainfall. Today, 12-24 hour forecasts are quite accurate, 1-3 day forecasts are fair to good, and after five days forecasts are not so accurate. (Ahrens, 1993)

To help with forecasting, radiosonde are sent up into the atmosphere with a balloon. These measure a variety of atmospheric data such as temperature, humidity, air pressure, etc. At most sites, radiosondes are sent up twice a day—at midnight and noon Greenwich mean time. (Ahrens. 1993)

Weather satellites are vital in gathering national and global weather information. There are two types. First, the Polar Orbiting Satellites parallel the meridian lines and passes over the north and south poles on each revolution. As the earth rotates to the east, each satellite pass monitors an area to the west of the previous pass, eventually covering the earth. This satellite photographs the clouds, and provides especially sharp pictures of the polar regions. Polar orbiting satellites fly at lower altitudes than GOES and provide more detailed information on such things as violent storms and cloud systems. (Ahrens, 1993)

Geostationary Satellites (GOES) orbit the equator at the same rate as the earth spins. They remain at an orbit

of about 36,000km. (22,300 miles) above a fixed spot on the earth's surface. This is a geosynchronous orbit and allows for continuous monitoring of a specific region. Also, the pictures are transmitted to the ground as soon as they are taken. They then can be put into a time lapse sequence to show cloud, front, or storm movement-Wind direction and speed can also be approximated from this. A new GOES satellite has recently been launched. (Ahrens, 1993)

Satellites also give us the following information; infrared measurements (for temperature and moisture), snow cover, ice fields, movement of icebergs, crop conditions, deforestation information, where droughts are occurring, they can pick up distress signals, and provide us with other valuable information. (Ahrens, 1993)

While we can predict weather and its consequences, sometimes pollution can make things even worse. on October 26, 1948 (a Tuesday morning), an anti-cyclone (cold surface) moved over the United States. This was not out of the ordinary, yet the jet stream was more west than normal. This helped to cause the anti-cyclone to remain stationary for five days. (Ahrens, 1993) For a small valley town called Donora, Pennsylvania, which is surrounded by hills, this spelled disaster. Fogs for this town were not unusual, but a temperature inversion occurred at the same time. This trapped polluted air from the nearby factories (ex. sulfur dioxide and particulates) This fog/ inversion lasted for 5 days. By the third day the fog was so thick, and you could barely see across the street. Overall, 22 people died and about 7000 people became ill. (Ahrens, 1993)

What will be the status of Connecticut/ New England/the United States weather in the future? We know that from about 1350-1875 the world overall was much colder. In Connecticut, the first snow came in October and the last snow came as late as may. Long Island Sound occasionally froze, and the Connecticut River was solid all the way across every winter. Many scientists expect storms to become severe more frequently and think that an ice age may occur in 5000-7000 years. (Bell, 1985)

Weather is the most common topic of casual discussion and a subject that every student can relate to. All students have experienced severe storms of one type or another, and everyone has had to change their plans due to weather. Thus all students can become active and willing participants in every part of this unit.

TEACHER RESOURCES

Hopkins, E.J., PhD. (1993, March).

Resource Listing For Weather/ Climate Instruction.

University of Wisconsin-Madison.

NOAA

Daily Weather Maps Climate Analysis Center

Room 808

World Weather Building

Washington, D.C. 20233

NOAA Educational Affairs Division

Universal South Building

Suite 627

1825 Connecticut Ave., NW.

Washington, D.C. 20235

NOAA/ NESDIS

Federal Building 4

Washington, D.C. 20233

NOAA Public Affairs

U.S. Dept. of Commerce

Herbert C. Hoover Building

Room 6013

Washington, D.C. 20230

National Weather Service

NOAA

Silver Springs, MD 20910