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Write the Book on Weather Metrics

What country do you think has the wildest weather in the world? Which is the one with the most hurricanes, floods, tornadoes, blizzards, hail storms, droughts, and lightning strikes? It is the USA! Does that surprise you? With two coastlines exposed to storms that form at sea, plus frequent masses of cold, dry air coming down from the north meeting up with moist, warm air from the south, plus several mountain ranges to mix things up, the USA has all the right stuff to whip up plenty of weather excitement.

What does all this weather have in common? First of all—air! After all, weather is really all about the thin blanket of air surrounding Earth and what any particular part of it is doing. What is its temperature? How much water does it contain? How fast is it moving and in what direction? How dense is it? What gases are in it? What particles are in it?

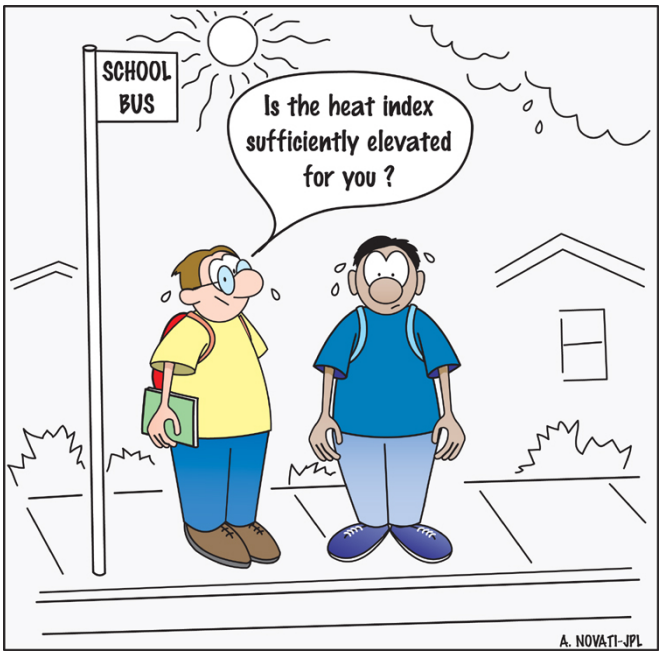
A Fragile Gauze

Our atmosphere, at least the lowest part of it that is dense enough to breathe, is really quite thin—about 6 kilometers (about 3.7 miles) thin. The few hearty souls who climb Mt. Everest (nearly 9 kilometers or 5.5 miles high) without oxygen are rare—and they often get very sick from the low air pressure and lack of oxygen. Ninety-nine percent of our atmosphere is in the 30 kilometers (19 miles) nearest the surface. If Earth were the size of a beach ball, its breathable atmosphere would be as thin as paper (Ahrens, p. 4) . Makes you think twice about smudging it all up and poking holes in it!

Earth's atmosphere is the source of life-giving oxygen for animals and carbon dioxide for plants. It is the blanket that protects us from either frying during the day or freezing to death at night. It is also the shield that keeps out most of the harmful radiation from the Sun, as well as meteoroids that would be raining down upon us from space. If not for the atmosphere, the oceans, lakes and rivers would soon boil off into space.

Our atmosphere is fragile, though. It reacts to energy being poured into it every day from the Sun, and, to a much lesser extent, to energy from Earth's rotation. And it reacts to gases and particles being pumped into it by modern human civilization. Understanding how the atmosphere behaves in response to all these influences is important if we are to live safely within it and learn to take care of it.

Entertain Your Friends: Talk about the Weather!



You may think weather makes for boring conversation—a topic of last resort if you can't think of anything else to talk about. But, understanding something about weather gives you more than just a nerdy way to ask "Hot enough for you?" If you know what causes different kinds of weather, how your local weather fits into the global picture, and how scientists study and mea-

sure weather, you will have lots of interesting and helpful information to share. Maybe someday you yourself will be able to help predict the weather or help protect our precious atmosphere.

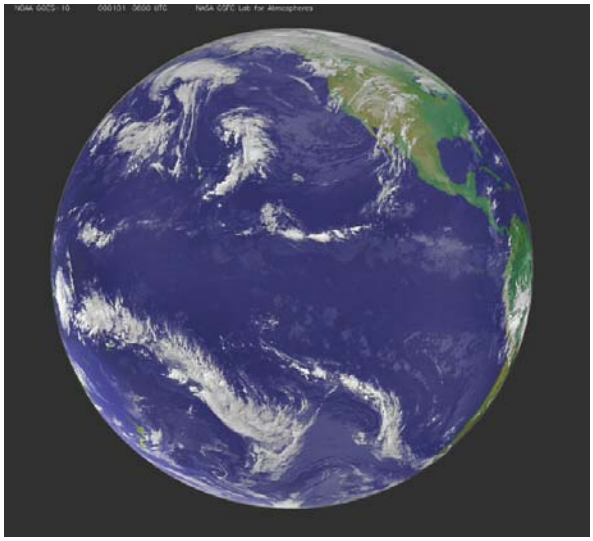
A meteorologist is a scientist who studies the atmosphere and weather. The first thing a science of anything does is figure out how to measure whatever it is trying to study. Weather presents quite a challenge. What can we measure in this complex, swirling soup of air we call our atmosphere?

To start, you can find out what the weather is like right now by going outside. Without knowing any weather words at all, you can see whether the temperature is just right or cool or downright cold. You can tell whether it is raining or snowing, whether the air feels dry or damp. You can tell whether it is windy and, by the way your hair or the trees are moving, what direction the wind seems to be going. After you have been observing for a while, you will be able to tell small differences in these conditions from day to day and hour to hour. You will notice that even when there are clouds, they are constantly changing and moving.

Giving Names and Numbers to the Air

Meteorologists measure all these characteristics very precisely, using all different kinds of instruments. They also have instruments to measure conditions that you may not be able to detect with your five senses. For example, air pressure can change ever so slightly from day to day, which can be a sign of clear weather or storms on the way. The amount of ultraviolet light (the culprit responsible for sunburns and skin cancer) coming through the atmosphere from the Sun can vary depending on the time of year, cloud cover, pollution, solar storms, and other factors.

Meteorology, like most other sciences, relies on technology to do its everyday work of forecasting weather. Technology is also necessary for understanding long-term climate changes and the effects of human activity. Technologies used by meteorologists range all the way from simple thermometers to very advanced and complex satellites, such as GOES (Geostationary Operational Environmental Satellites).



This is the full-disk view GOES-west has of Earth. A map has been added underneath the GOES image to make it easier to see the continents.

Two GOES are in Earth orbits so high over the equator (35,800 km or 22,300 miles) that they orbit Earth only once per day. This means, of course, that they are always stationed "over" the same spot on Earth as Earth rotates on its axis once per day. The GOES take pictures and movies of Earth and the clouds and storms brewing in the atmosphere. GOES can also measure what is going on at different levels of the atmosphere by way of temperature, moisture content, wind speed and direction, and ozone distribution. (Ozone in the atmosphere helps shield us from harmful ultraviolet radiation from the Sun.)

How Many Whats?

Scientists must agree on the units they will use to measure things. For example, length may be measured in meters or feet, distance (longer lengths) in kilometers or miles. Weight (or mass) may be measured in kilograms or pounds. Time is measured in seconds, minutes, hours, days, and so on. Speed is measured in kilometers per hour, miles per hour, meters per second, and so on.

Meteorologists also have units for everything they measure. We are all familiar with temperature units like degrees Celsius or degrees Fahrenheit. We know precipitation (like rain or snow) is measured in inches or feet (or millimeters or centimeters). But what kind of units are used to measure atmospheric pressure or UV (ultraviolet radiation) index? Or pollution in the air?

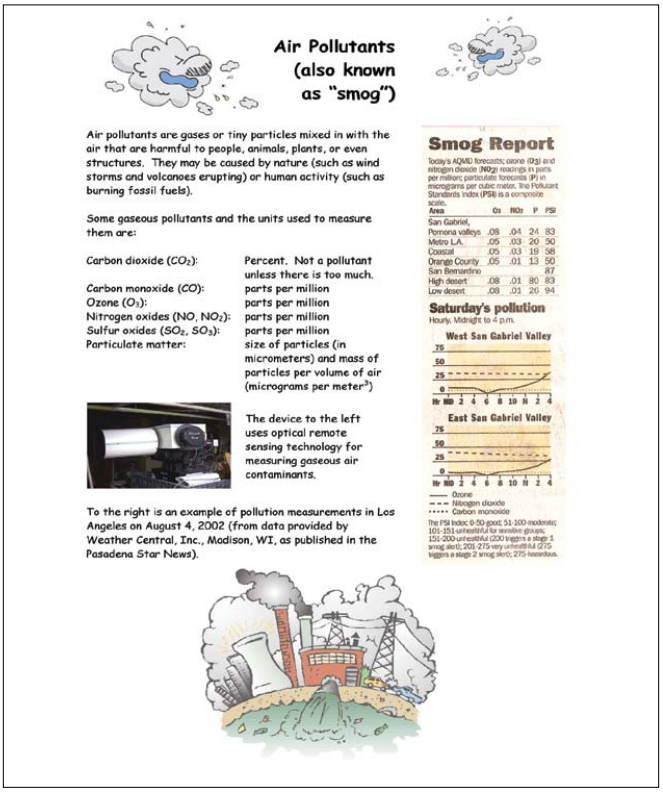
Write the Book on Quantifying the Weather

Here's a project you can do that will give you a chance to find out more about the different types of things meteorologists measure and how. In doing this project, you will go on a kind of scavenger hunt, using books, the internet, newspapers, magazines, and your own imagination. Your finished product will be a book of weather terms that you have made yourself.

Each page of the book will be about one of the weather terms in the list below. Your teacher will help you decide how many pages to put in your book. At the end of this article is a list of suggested sources for information, including books and web sites.

For each page of the book:

1. Write the name of the **weather term** at the top of the page.
2. **Define** the weather term (use the dictionary).
3. Tell what kind of **unit** is used to measure this characteristic of the weather.
4. **Describe** and, if you can, **show or draw a picture** of an instrument or device used in measuring this characteristic of the weather, or what different kinds of data must be combined to calculate the measurement. For example, you will find that heat index depends on both temperature and relative humidity.
5. For the rest of the page, do one (or more) of the following:
   - Show how the measurement is calculated. Or show how to convert from one type of unit to another. For example, you could show how to convert a temperature measurement from degrees Celsius to degrees Fahrenheit or the other way around.
   - Include a clipping of an article from the newspaper, magazine, or the internet that has a story about this characteristic of the weather. For example, "precipitation" could include a news story about the devastating effects of drought on the farmers in Iowa. Or, including a clipping of an article that mentions the same unit of measurement used for this characteristic of the weather.
   - **Draw a picture** that you think illustrates something about the characteristic. For example, you could draw pictures of different types of clouds.
6. Last, design a nice, weather-related **cover** for your book



Sample page for Weather Book.

Choose Some Weather Terms

Here's a list of weather terms from which to choose and some hints about what you might like to investigate to fill up your page (after you have defined the term, given the unit of measurement, and described the instrument(s) used to measure it).

Temperature: What unit is normally used in the U.S.? In Canada and Europe? How do you convert from one to the other?

UV index: What kinds of measurements are used to come up with this number? Why is this measurement so important to our lives? What do the "Sun Protection Factor" (SPF) numbers mean on sunscreen lotions?

Barometric pressure: What are some different technologies and units used to measure this

characteristic? What causes it? What makes it change?

Wind speed: What turns a tropical breeze into a hurricane?

Heat index: Why is this number, which is calculated from the real temperature and relative humidity, sometimes very important to know?

Wind chill factor: What two measurements are used to calculate this number and why is it sometimes very important to know?

Relative humidity: Why does this number change as the temperature changes? How does it affect our comfort level?

Dew point: If this number goes up, what other measurement has also gone up?

Precipitation: What's the difference between the units used for different types of precipitation?

Probability of rain: What does this really mean? Is it dependable as an absolute predictor of what will happen?

Hurricane scale: How do meteorologists decide how to rate a hurricane using this scale?

Tornado scale: How do meteorologists decide how to rate a tornado using this scale?

Solar radiation: What are some characteristics of the atmosphere (or Sun) that would cause this measurement to vary?

Sunrise/sunset: Why do these measurements vary throughout the year? Can scientists predict these accurately?

Cloud types: What altitudes do these different kinds of clouds occupy: stratus, cirrus, cumulus, cumulonimbus, nimbus, altocumulus, lenticular. Can you foretell anything about the weather by looking at them? What do they look like?

Air pollutants (gases and aerosols): What are some of the pollutants caused by human activity? What are their sources? What are "greenhouse gases"? Where are the highest concentrations?

Acid rain (acidity): What kinds of effects does acid rain have? How can scientists figure out where this stuff comes from?

Pollen count: Who cares about this? Could this also be a form of pollution caused by human activity?

Visibility: Who cares about this?

Suggested references

Books:

USA Today's The Weather Book: An Easy-to-understand Guide to the USA's Weather by Jack Williams. Vintage Books, ISBN: 0679776656; 2nd Rev edition (July 1997).

Essentials of Meteorology: An Invitation to the Atmosphere by C. Donald Ahrens. ISBN 0-534-37200-7. Brooks/Cole, Thomson Learning, 2001.

Web sites:

SciJinks Weather Lab, **scijinks.nasa.gov .**

The Space Place, **spaceplace.nasa.gov** (search for "weather"), including "Become a Weather Wizard" at **spaceplace.nasa.gov/teachers/weather_maps.pdf** , originally published in *The Technology Teacher*, May/June 2002.

National Oceanic and Atmospheric Administration (NOAA), **www.noaa.gov/**, plus NOAA's Weather Education site, **www.education.noaa.gov/cweather.html** .

NOAA's Photo Library, **www.photolib.noaa.gov/** .

USA Today Weather Basics, **www.usatoday.com/weather/basics/wworks0.htm** .

WW2010™ University of Illinois Online Guides, Meteorology, **ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/home.rxml** .

Or, just go to your favorite Web search site and search for the weather term!

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