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Become a Weather Wizard!

In some places—maybe where you live—weather is a very important part of planning, especially leisure time planning. For example, in looking forward to your weekend, wouldn't it be nice to know it was going to be sunny and clear on Saturday, but rain buckets on Sunday? That way, you'd have a good reason for putting pleasure before business, planning something fun outdoors for Saturday and your homework for Sunday.

Weather is just about the most complex and unpredictable natural occurrence humans have to deal with. However, predicting weather is finally getting to be less of an art and more of a science. Using images and other data from the GOES* environmental satellites and other kinds of sensing technologies, and computers to analyze the data, scientists are beginning to make some sense of it all. For example, thanks in part to real-time (meaning right this second) information from the GOES, meteorologists (scientists who study the weather) have gotten very good at predicting what is going to happen in the next 12 to 24 hours. If it's a hurricane about to come ashore on the east coast of the U.S., 12 hours' warning can save hundreds of lives, giving people the opportunity to evacuate inland or go to higher ground. Of course, it is very important that such warnings be highly accurate, or people won't pay any attention to them. They will think that the weather forecasters are just crying "Wolf!" one more time.

On TV weather reports, you've probably seen weather forecasters point to maps and use terms like "cold front," "high-pressure system," "barometric pressure," and "jet stream" to describe the major trends and weather systems influencing our entire continent. In addition to showing satellite images of clouds, TV forecasters and newspapers sometimes uses lines and symbols on a map to help convey this big picture. Of course, this map of an area over 3,000 miles wide and just about as long will not tell you whether it is snowing right this second in downtown St. Paul or hailing in east North Hampton. It will tell you what kind of weather each of those local places is most likely having.

Let's learn to read one of these maps—or even draw one. First, we need to understand a little about what the symbols mean. Here are the most common weather concepts you will see illustrated on a weather map. There's a whole lot more to know about all these ideas, but these explanations may get you started.

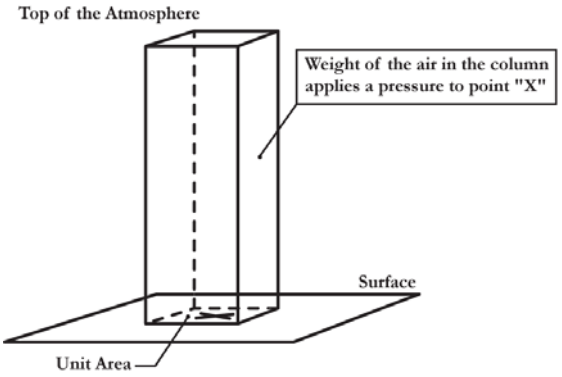
High and Low Pressure Areas:

Did you realize that you have hundreds of pounds of air pushing on your body all the time? Of course, your body evolved under all this pressure, so you can handle it! (That's why astronauts need pressurized space suits to do their space walks. Otherwise, they'd explode!—well, not really, but their blood would boil, which is just as unpleasant.) All the air above you in the atmosphere is being held near Earth's surface by grav-

* For Geostationary Operational Environmental Satellites

ity, just like everything else that doesn't float off into space. For every square centimeter of Earth's surface, the atmosphere above it, all the way up to space, weighs about 1.03 kilograms, which exerts a normal sea level pressure on you of 14.7 pounds per square inch! Earth's atmosphere extends up more than 150 kilometers (more than 100 miles), but half of it is in the lowest 5.5 kilometers (3.3 miles).

So, all these interesting statistics aside, the



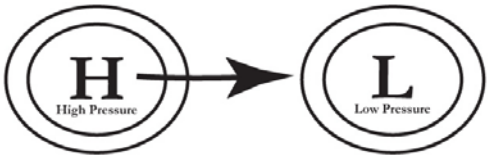
point is, air exerts pressure because of its weight. But it also exerts pressure because of its temperature. Molecules of air are in constant motion, bumping against each other and bouncing off in all directions. The warmer the air, the more active its molecules and the more pressure it exerts (provided its container doesn't expand).

Thus, because of gravity, the atmosphere near the surface is "heaviest," especially when it is cold, and would seem to exert the most pressure. But because of heat energy, the molecules of warmer air push out in all directions, serving to increase pressure. The important thing is, air does not exert the exact same amount of pressure everywhere. And from this fact, comes a lot of weather!

Remember this: Air tends to move from high pressure areas to low pressure areas.

The pressure difference between two points is called a *pressure gradient*. The force that moves the air from high to low pressure areas is called the *pressure gradient force*.

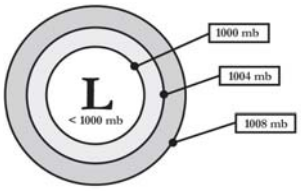
It is common for high pressure areas to have fair weather.



The influence of the pressure gradient force

Barometric Pressure:

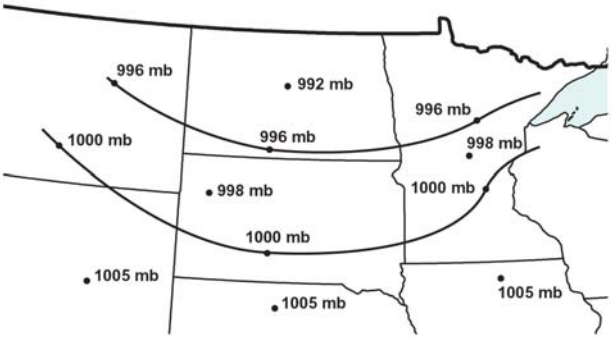
Barometric pressure means the same thing as atmospheric pressure, but it is an actual measurement taken with an instrument called a barometer. Barometers may measure pressure in *atmospheres* (atm), *inches of Mercury* ("Hg), *millibars* (mb), or other units. Weather forecasters on TV usually use "Hg, while meteorologists usually use mb. Normal atmospheric pressure at sea level is defined as 1 atm, which corresponds to 29.92 "Hg or 1013.25 mb. Barometric pressure readings are taken at many locations by the National Weather Service and combined to produce maps showing high and low pressure areas, thus helping to predict what the weather will do over large regions in the immediate future.



Region of LOWEST pressure relative to its surroundings

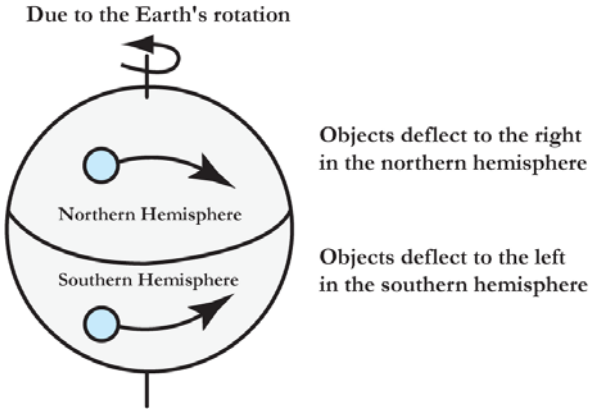
Isobars:

If many barometric pressure readings are taken and recorded on a map, and then the readings that match are connected by a line, you have an isobar. Maps showing isobars are very useful in locating areas of high and low pressure, which, in turn, help predict which way the air masses are and will be moving. This moving air is also what we call wind, and wind drives the major weather surface features, such as highs, lows, and fronts, which, in turn affect weather.



Warm Front:

A warm front is the transition area where a mass of warm air is moving in to replace a mass of cold air. But, the pressure gradient force isn't the only force acting to move air. Other forces come in and really complicate things. The biggest stirrer of the atmospheric soup is Earth's rotation. It causes the air north of the equator to tend to curve toward the right and the air south of the equator to curve to the left. This movement, of both air and oceans, is called the Coriolis effect.



So with air moving in curves, interference (friction) from such obstacles as mountains, trees, and buildings, plus the heating and cooling of the atmosphere from day to night, you can begin to see why predicting the weather isn't easy!

Warm fronts usually move from southwest to northeast, bringing higher humidity. Warm fronts are usually drawn on a weather map using a solid red line, with half-circles on the side that points toward the cold air being replaced.

Cold Front:

A cold front is the transition area where a mass of cold, dense (high pressure) air is moving in to replace warmer air. Cold fronts typically move from northwest to southeast. When a cold front passes through, the temperature can drop 15º F in an hour. A cold front is represented on a weather map by a solid line (usually blue), with triangles pointing toward the warm air it is replacing.

Jet Stream:

Jet streams are fairly narrow bands of very high speed winds in the upper atmosphere. They generally blow from west to east. Strong temperature differences cause great pressure differences (gradients) at high altitudes. These winds can reach 150 miles per hour or more. You can see why airline pilots flying across country from west to east like to take just the right route and fly at just the right altitude to get a kick in the tail (and save lots of fuel) from the jet stream—and why flying east to west, they try to avoid it!

Rain, snow, ice, and thunderstorms:

These terms need little explanation. These conditions are the end products of which we are all too aware! These forms of precipitation (water falling from the sky) result from the pressure gradients, cold fronts, and warm fronts, as well as ocean temperatures and currents, and a few dozen other factors.

Find Out More

The United States has the wildest, most extreme weather of any country on Earth. Learn more about how weather works by reading this book . . .

The Weather Book: An Easy-to-understand Guide to the USA's Weather, by Jack Williams, published by *USA Today*.

. . . and by visiting these websites:

NOAA (National Oceanic and Atmospheric Administration) website, http://www.noaa.gov/

The University of Illinois Online Guides: Meteorology, http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/home.rxml

NOAA's GOES Satellites home page, http://www.oso.noaa.gov/goes/ .

USA Today Weather, http://www.usatoday.com/weather/wfront.htm .

GOES Project Science page, http://rsd.gsfc.nasa.gov/goes/text/hotstuff.html .

Activity

Make photocopies of the map of North America on the next page. You will be drawing weather symbols on a copy of the map. Pick one of the weather situations described in the paragraphs below (quoted or adapted from reports in the *Los Angeles Times*) and using the symbols shown on the map's legend, draw a U.S. weather map for that day. After you've done a few of these, those TV and newspaper weather maps should look much more interesting!

Weather Day 1:

"High pressure strengthening over the eastern Pacific will maintain mostly sunny skies along much of the West Coast today. An area of low pressure will curve northward into Canada, creating cloudy skies above the Pacific Northwest. An upper-level disturbance cruising through the Southwest will trigger scattered rain and mountain snow showers, while low pressure developing east of the Rockies produces rain and snow through much of the Plains. Partly cloudy skies will cover the Great Lakes region and most of the Northeast. Thunderstorms will rattle parts of the Southeast."

L.A. Times*, March 11, 2001*

Weather Day 2:

"Warm and humid air spilling northward from the Gulf of Mexico will combine with a warm front to trigger widely scattered afternoon showers and thunderstorms across the Southeast today. Clouds will linger over western Washington; otherwise, mostly sunny skies and locally breezy conditions will prevail through the West. The Rockies will remain dry, except for a chance of afternoon storms in the southern sections. Sunny, dry weather will continue in the Midwest. A low-pressure system will produce showers and storms from the mid-Atlantic states to the lower Mississippi Valley."

L.A. Times*, July 29, 2001*

Weather Day 3:

"A low-pressure system . . . will slide down into the Southeast today, drenching much of the region with locally heavy showers and thunderstorms. The West Coast will continue to bask under sunny skies and seasonable conditions. Late-summer monsoonal moisture will produce partly cloudy skies and isolated afternoon storms over the Rockies and the Southwest. A cold front will advance into the Upper Midwest, triggering scattered showers and storms across the Plains and western Great Lakes. High pressure will promote sunny skies through the Northeast."

L.A. Times*, September 2, 2001*

Weather Day 4:

"High pressure will promote mostly sunny skies, dry conditions and locally gusty winds across the Southwestern states today. A few showers, however, will dampen the Pacific Northwest, with areas of rain and snow occurring above the central Rocky Mountains. Low pressure, coupled with an associated frontal system, will trigger scattered showers from the eastern Great Lakes to the central Appalachians. Another low south of this storm will set off scattered showers and thunderstorms over the central and southern plains. Partly cloudy skies will continue to cover the Eastern Seaboard."

L.A. Times*, October 12, 2001*

Weather Day 5:

"Mostly cloudy skies, light rain showers and higher-elevation snowfall will prevail along the West Coast from Central California northward today as a . . . [low pressure system] pushes in from the eastern Pacific. Skies will become cloudy over the northern Rockies, remaining partly cloudy to the south. High pressure will keep the Plains and the Midwest mostly sunny and warmer as winds become southerly. A few showers may develop in Texas. Mostly sunny skies, windy and cool conditions will continue through the Northeast, while sunny skies and mild weather grace much of the Southeast."

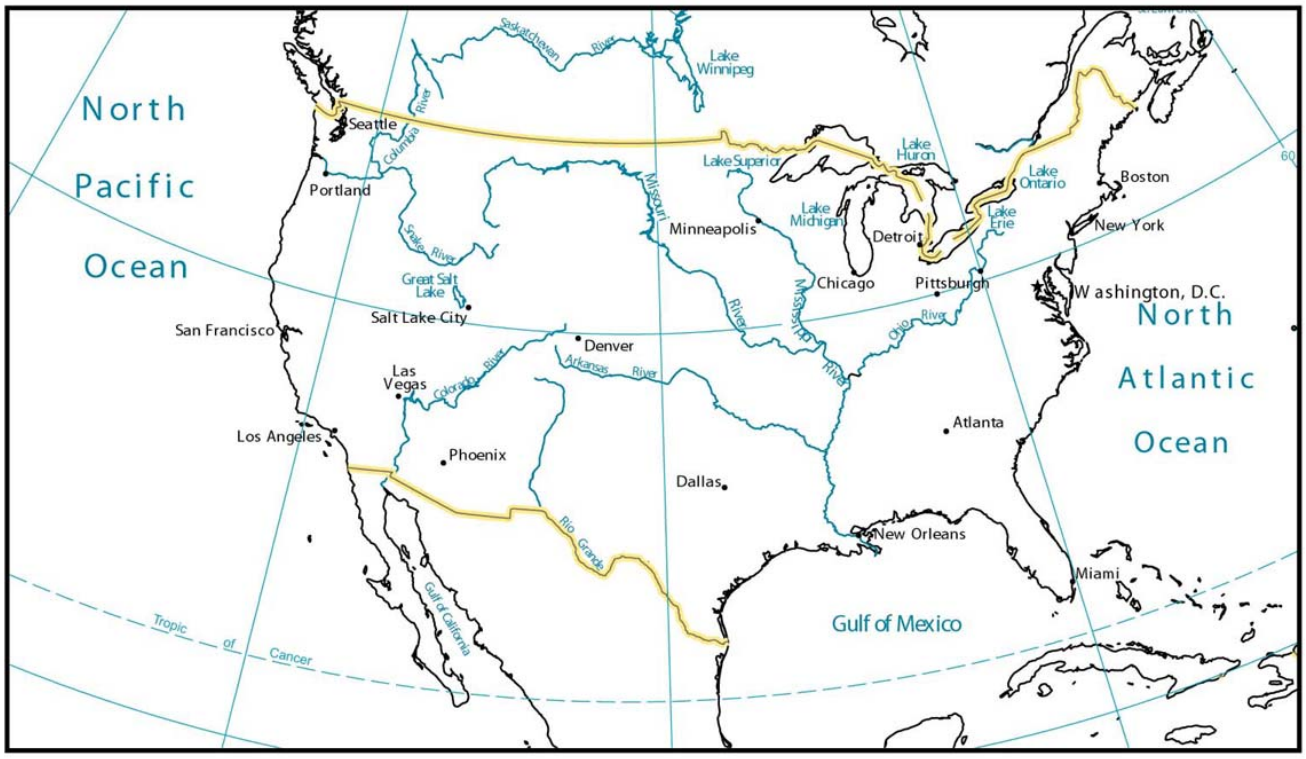
L.A. Times*, November 11, 2001*

Weather Day 6:

"Low pressure above northeast Canada will swing a cold front over the entire East Coast today, causing rain and cooler conditions along the region, and afternoon snow in western New England. High pressure ridging over the Pacific Northwest will maintain sunny to partly cloudy and seasonable conditions through much of the West. Snow showers may still fall in the north Rockies, while sunny, cool weather prevails in the Plains in the wake of the system that moved into the East. Thunderstorms may erupt in Florida. Jet stream curving south from over western Canada and into Montana. Also, jet stream curving northeast from New Mexico up over New England."

L.A. Times*, March 3, 2002*

This article was written by Diane Fisher, writer and designer of The Space Place website. Alex Novati did the illustrations. Thanks to Thomas Wrublewski and Ron Gird of the National Oceanic and Atmospheric Administration for technical help. The article was provided through the courtesy of the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, under a contract with the National Aeronautics and Space Administration.



High Pressure

Low Pressure

Barometric pressure with isobar *

Warm Front
Warmer air replacing cooler

Cold Front
Cooler air replacing warmer

Jet Stream
High altitude high speed winds

Rain

Snow

Thunderstorm

Ice

* Although isobars often appear on weather maps, they may not be mentioned in the word descriptions of the overall weather picture.