Weather

Weather *describes the conditions in Earth's atmosphere at a given place at a given time. Temperature, precipitation, humidity, and cloud formation are aspects of weather, and they can be measured and predicted using appropriate tools and models.*

The **Sun** is the primary source of energy that drives the weather on Earth. The weather that an area experiences depends on many things, including atmospheric conditions, movements of air masses in the atmosphere, and the geography of an area. Geography is a place's location on Earth and the place's features, such as landforms and bodies of water.

Meteorologists use weather maps and other models to plot and predict the movement of high and low pressure systems that lead to changes in weather.They also use many different tools to take direct measurements of weather conditions and how they are changing over time.

Weather Conditions

Weather is the combined effect of a variety of measurable conditions in the atmosphere. The following is a list of some important weather conditions and the tools used to measure them.

- **Barometric pressure**, or air pressure, is the weight of the air above a certain point. High pressure air is denser than low pressure air. Air pressure is measured using a *barometer*.
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- **Relative humidity** is a measurement of the amount of water vapor present in the air. Humidity is measured as a percentage using either a *hygrometer* or a *sling psychrometer*.
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- **Wind** is the air moving over the surface of the Earth. Wind speed is measured using an *anemometer*. Wind direction can be measured using a *wind vane*.
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- **Precipitation** is any form of water coming from the atmosphere to the Earth's surface. The amount of precipitation can be measured using a *rain gauge* or a*snow gauge*.
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- **Temperature** is the degree of hotness or coldness of the air. Air temperature is measured using a *thermometer*.

Predicting Weather

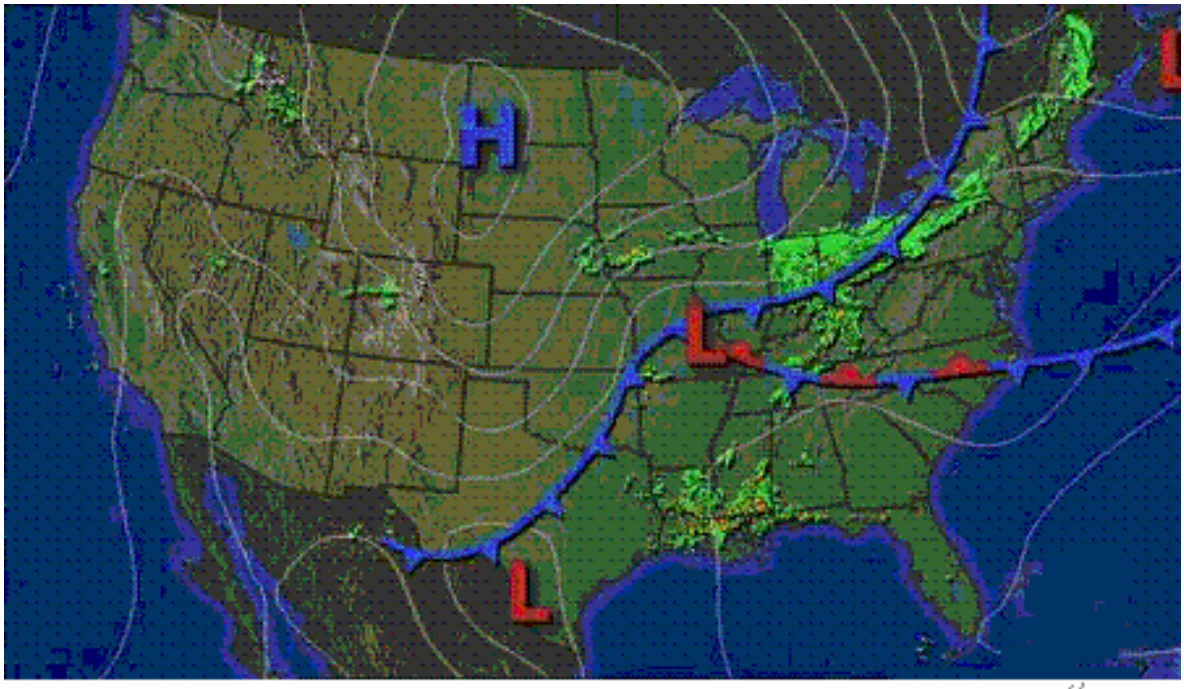
As the Sun heats our atmosphere, water evaporates and warm air rises. This rising air cools off and condenses to form clouds. When the clouds become too heavy, the moisture falls back to the earth. This precipitation can be in the form of rain, snow,

sleet, or hail. When the air becomes very humid, and especially if the air cools at the same time, it would be reasonable to predict that it might rain.

As the Sun heats the ocean, water evaporates and then forms clouds.
An air mass may be warmer or cooler and contain more or less water depending on where the air mass is coming from. **Maritime air masses** form over water, so they tend to hold more water vapor. **Continental air masses** are drier because they form over land. Similarly, air masses that are coming from the poles are colder while air masses from the equator are warmer.
Hurricanes are most likely to form from maritime air masses that formed near the equator. Since warm air is able to hold more humidity than cool air, these air masses can collect large amounts of moisture as they move north over the ocean. In a hurricane, areas near the center of the storm, except for in the eye, generally receive the heaviest rainfall.

Weather Maps and Pressure Systems

Meteorologists commonly use maps to observe the movement of air masses, which interact with each other and cause changes in weather. Weather tends to move from west to east across the United States, so a weather map can show where severe weather will be hitting next. An example of a weather map is shown below. The light green, spotty areas represent rain. The darker the shade of green, the more intense the rain.



Areas of higher and lower pressure cause air masses to move. A **high pressure system** is a local region of air that is at a higher pressure than air masses around it. It is labeled on a weather map with a capital **H**. High pressure systems tend to be made up of cooler air. Air tends to **diverge**, or spread out from high pressure systems.

A **low pressure system** is a local region of air that is at a lower pressure than air masses around it. It is labeled on a weather map with a capital **L**. Low pressure systems tend to be made up of warmer air. Air tends to converge toward, or move into low pressure systems. Low pressure systems are often at the center of severe weather.

Weather Fronts

*An **air mass** is a large body of air that is characterized by similar physical properties throughout, such as temperature, humidity, and pressure. A **front** is the area in which two types of air masses meet.*

Air Masses

The following chart shows the five major categories of air masses:

Air Mass
Symbol
Characterisitcs/Comments
Continental Arctic
cA
Form exclusively in the Arctic and Antarctic regions and descend toward the equator. Bitterly cold and extremely dry in the winter, cool and dry during the summer.

Continental Polar
cP
Form over dry lands. Cold and dry during the winter, mild and dry during the summer.
Continental Tropical
cT
Form over deserts and plains. In the United States, a flow into the US out of Mexico often sends a cT air mass northward. Typically hot and dry during the summer and mild and dry during the winter.
Maritime Polar
mP
Marine type humidities with cool or cold weather.Typically provide for miserable, damp, gray days.Mild to cold and humid with low stratus clouds and precipitation is often the rule with Maritime Polar air masses.
Maritime Tropical
mT
Hot, humid, sticky weather. A good example of when mT air masses affect the United States is during the summer with the Bermuda High phenomena. A southerly flow of hot, humid, sticky weather is circulated northward into the US. Rarely will mT air masses affect the US during the winter.

Table reproduced from: https://www.fas.org/irp/imint/docs/rst/Sect14/Sect14_1b.html.

Maritime air masses form over the ocean. Continental air masses form over land.

Fronts

Cold fronts form when cold air masses move under warm air masses and push the warm air up. Cold fronts tend to push the warm air up suddenly and form vertical cumulonimbus clouds. This is why thunderstorms and heavy rain usually accompany cold fronts.

Warm fronts form when warm air masses move over cold air masses. The warm air gradually replaces the cold air and forms stratus clouds. This is why a continuous drizzly rain usually accompanies warm fronts.

Occluded fronts form when warm air masses are stuck between two colder air masses. Cooler temperatures and large amounts of rain and snow usually accompany occluded fronts.

Stationary fronts form when cold air masses meet warm air masses but neither air mass has enough force to lift the warm air up. Many days of cloudy, wet weather usually accompany stationary fronts.

Weather Tools

Meteorologists use weather tools to extend their senses and gather data about the weather.

Meteorologists are scientists who study weather. They use several different types of tools to measure different characteristics of weather.

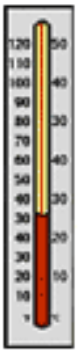
Weather tools can extend the senses. By using her sense of touch and sight to see and feel that the ground is wet, a meteorologist can tell if it has rained. But a **rain gauge** can measure exactly how much rain has fallen. A person's sense of touch

can tell if it is warm or cold outside, but a **thermometer** can measure the exact temperature.

Weather tools can also be used to make measurements in places that are not safe for a meteorologist to go. For example, thermometers can measure temperatures in places where it may be too cold or too hot for humans to survive.

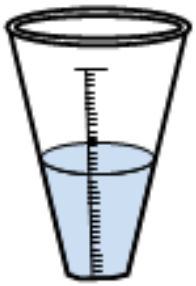
Some common weather tools and their functions are shown in the list below:

Thermometer



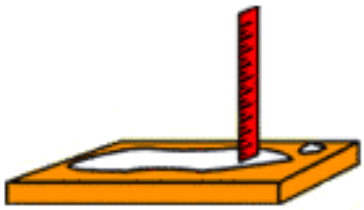
A thermometer is used to measure temperature in degrees Fahrenheit or Celsius.

Rain Gauge



A rain gauge is a piece of equipment designed to measure the amount of rain that falls in a given period of time.

Snow Gauge



A snow gauge is used to measure the amount of snow that has fallen. A meter stick can be used as a snow gauge.

Wind Vane

A wind vane or a flag can be used for measuring wind direction.
The *wind direction* is the direction that the wind is blowing from.

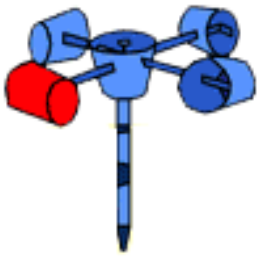
The vane points toward the direction from which the wind is blowing. In the picture shown, the vane is pointing west, so the wind is coming from the west.

Wind Sock

A wind sock points in the direction toward which the wind is blowing. It also gives a rough idea of how hard the wind is blowing. The stronger the wind is, the closer the

wind sock will be to horizontal.If there is no wind, the sock will hang straight down. The wind sock to the left is being blown by a strong wind from the left.

Anemometer



An anemometer is used to measure wind speed in one area.

Barometer

A barometer is used to measure air pressure.

Hygrometer

A hygrometer measures humidity.Humidity is the amount of water vapor in the air. *Relative* humidity is a measure of how much water vapor is in the air compared to how much the air could hold.

Weather - Sling Psychrometer

*A **sling psychromter** is a device that allows meteorologists to measure relative humidity.*

Using a Sling Psychrometer

Relative humidity (expressed as a percent) is a measure of the amount of water vapor in air compared to the maximum amount of water vapor the air could hold. The amount of water vapor that air can hold varies with air temperature.One way to estimate the relative humidity is with a *sling psychrometer*.

This device has two thermometers attached to a board that is swung through the air. One of the thermometers has moistened gauze wrapped around its bulb. By determining the temperature of the dry bulb and the temperature difference between the dry bulb and the wet bulb, the table below can be used to estimate relative humidity.

Relative Humidity %

Temperature difference between dry and wet thermometers

LOW LEVEL CLOUDS

Cumulus clouds are puffy and white and have flat bottoms. They generally indicate fair weather. If, however, the cumulus cloud grows vertically to form a cumulonimbus cloud, thunderstorms will be likely..

Stratus are mostly found lower in the atmosphere. They are grow across the sky in layers. Stratus clouds are often gray and block out much of the Sun.They may carry precipitation.However, it is usually light rain or drizzle.

Cumulonimbus clouds are heavy storm clouds that grow vertically.Though they are found in the lower atmosphere, they can grow up, into the middle atmosphere. These clouds look tall, puffy, and gray.Cumulonimbus clouds are often called storm clouds and are often associated with thunder and lightning.