Influences of Weather and Climate

Reflect

Sunny days give way to rainy days. Storms appear and then fade away. Howling winds become gentle breezes. At 1 p.m. on an autumn afternoon, an outdoor thermometer reads 20°C (68°F). An hour later, the temperature has plunged to 10°C (50°F).

These weather events occur on Earth, but they are triggered by events far away—150 million kilometers away, in fact! What causes Earth's weather? How can we tell when and how weather will change?

The Sun's radiation produces weather on Earth.

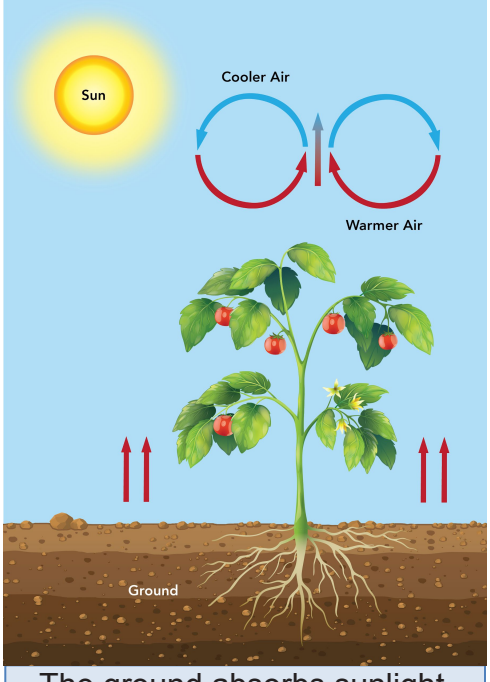
Earth's Weather Maker

Without the Sun, Earth would not experience weather as we know it. The Sun's **radiation** is electromagnetic waves, mostly visible light, UV, and infrared (heat).

radiation – energy that travels from a source

Some of this heat is reflected back into space by Earth's atmosphere and surface. Earth's atmosphere and surface absorb some of this energy from the Sun. Earth's surface absorbs almost half of the incoming solar radiation. The heat that is absorbed by Earth produces convection currents in the air. *Convection* refers to the transfer of heat through a liquid or gas, such as air. *Convection currents* in the atmosphere refer to the flow of air in circular patterns: air rises, flows parallel to Earth's surface, falls, flows parallel to Earth's surface, and rises again. What causes the air to move like this?

The ground heats up as it absorbs sunlight, warming the air near Earth's surface. As this air heats up, it becomes less dense than the cooler air above. This causes the warm air near Earth's surface to rise. As warm air rises, denser, cooler air rushes to fill in the area. The cooler air sinks toward the ground where it, too, becomes warmer. Eventually, it becomes less dense than the air above it and begins to rise. As this cycle repeats itself, convection currents form.



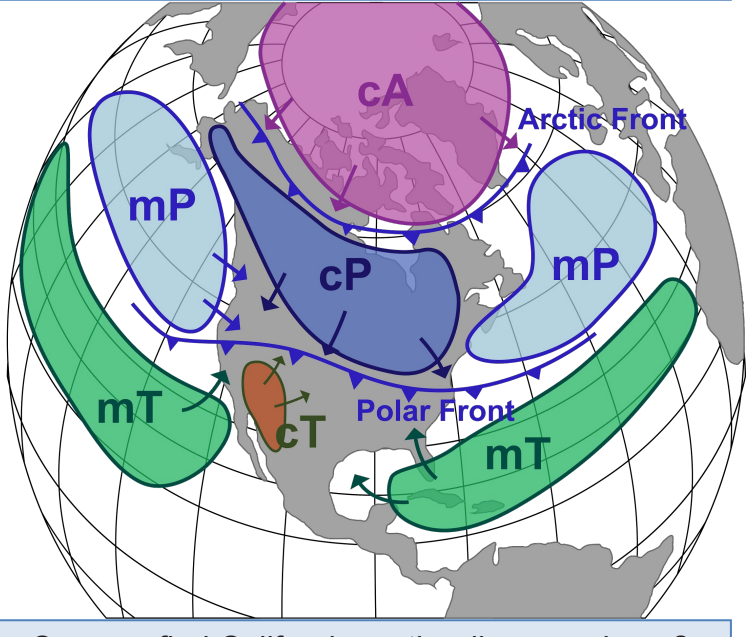
The ground absorbs sunlight. Convection currents form as warm air rises (red arrows), cools in the atmosphere, and sinks (blue arrows) toward the ground.

Reflect

Rising warm air creates a wind called an *updraft*. Sinking cool air creates a wind called a *downdraft*. Air in convection currents also moves parallel to Earth's surface. This produces *surface winds* as well as winds higher in the atmosphere, including the jet stream.

As air warms and cools, water in the air changes between a gas (water vapor), liquid (water droplets), and solid (ice). These *phase changes* produce other weather events. Heat near Earth's surface causes liquid water to evaporate from oceans, lakes, and rivers. As the water vapor rises and cools, it condenses to form clouds of water droplets or ice pellets. When the droplets or pellets become heavy enough, the water falls back to Earth as precipitation, such as rain, snow, or hail.

Several types of air masses influence the weather in the United States. Air masses that form over water are called *maritime* (m). They tend to be more humid than *continental* (c) air masses, which form over land. Air masses that form over the equator are called *tropical* (T). They tend to be warmer than *polar* (P) or *arctic* (A) air masses, which form closer to the poles.



Can you find California on the diagram above? California is known for its nice weather. This is because the cool ocean water off the California coast tends to create cool, high-pressure, less humid air masses. In contrast, the warm waters of the Gulf of Mexico tend to have the opposite effects, creating warm, low-pressure, humid air masses that affect the weather in the Gulf States.

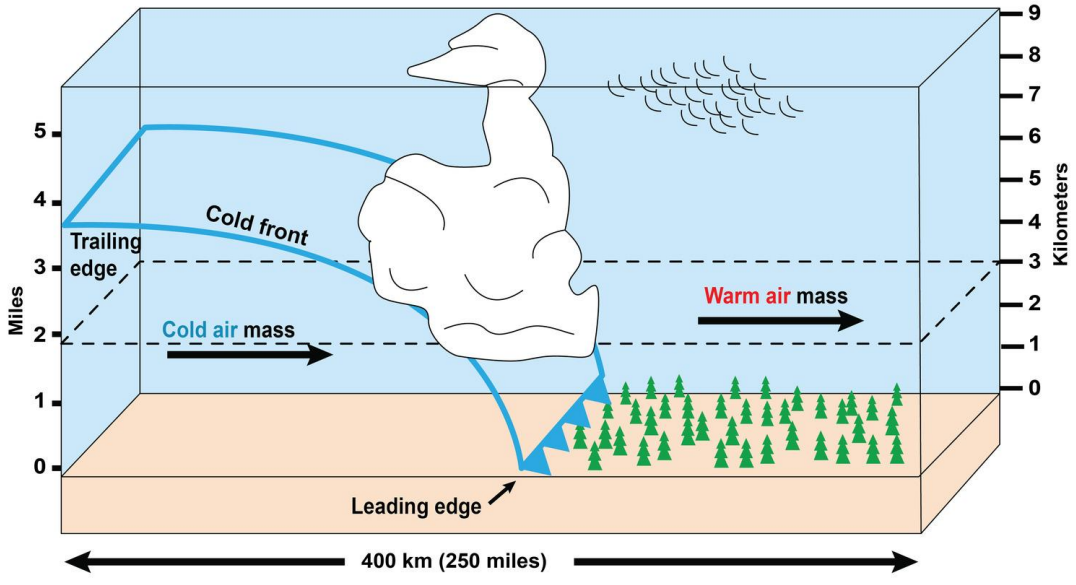
Air Masses and Fronts

Air moves across Earth's surface in huge volumes called *air masses*. Each air mass possesses a characteristic temperature: cold (arctic or polar) or warm (tropical). Air masses also possess certain pressures (high or low) and moisture contents (humid or dry). In various combinations, these properties can change the weather where the air mass flows.

The leading edge of an air mass is called a *front*. A front is also the boundary between two air masses, where weather often changes. Weather scientists, or *meteorologists*, identify three major kinds of fronts: cold fronts, warm fronts, and stationary fronts.

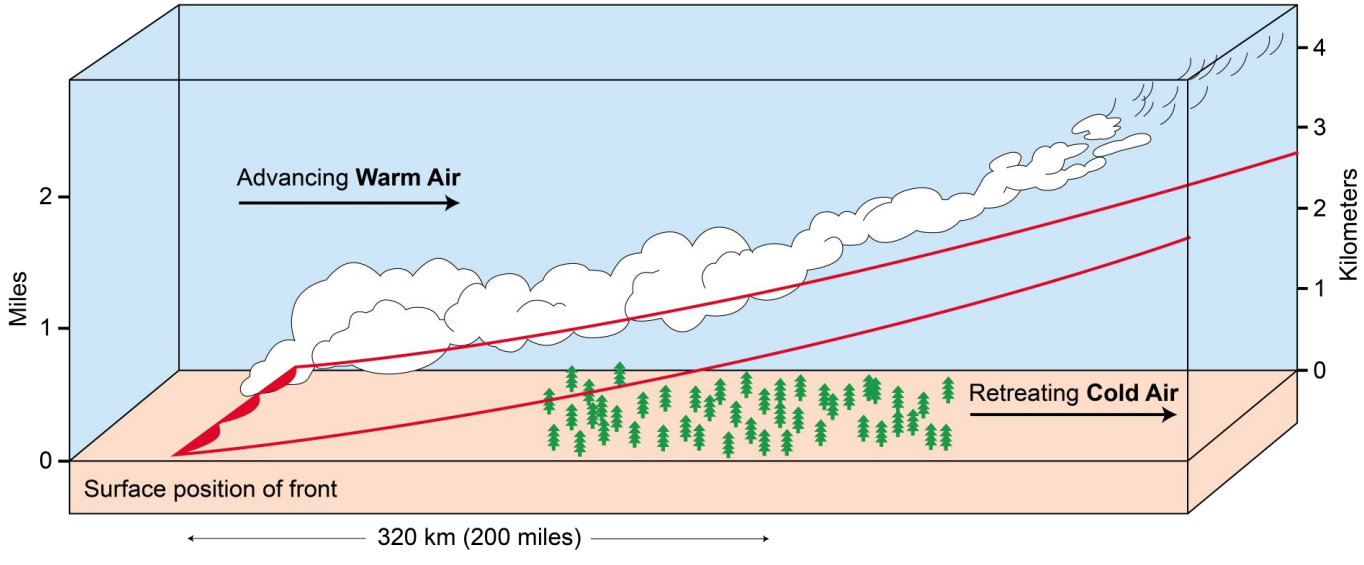
A *cold front* is the leading edge of a cold air mass that pushes against a mass of warm air. Because cool air is denser, it pushes the warm air up, usually very quickly. This collision between cold and warm air masses often produces strong storms. On a weather map, a cold front is usually indicated by blue triangles, as seen on the next page. The triangles point in the direction of the front's movement.

Reflect



At a cold front, a cold air mass forces itself beneath a warm air mass.

A *warm front* is the leading edge of a warm air mass that pushes against a mass of cold air. At a warm front, warm air flows over the cold air, because warm air is less dense. This collision between warm and cold air typically produces overcast skies and rain. On a weather map, a warm front is represented by red semicircles. The rounded portions of the semicircles point in the direction of the front's movement.



At a warm front, a warm air mass rises above a cold air mass.

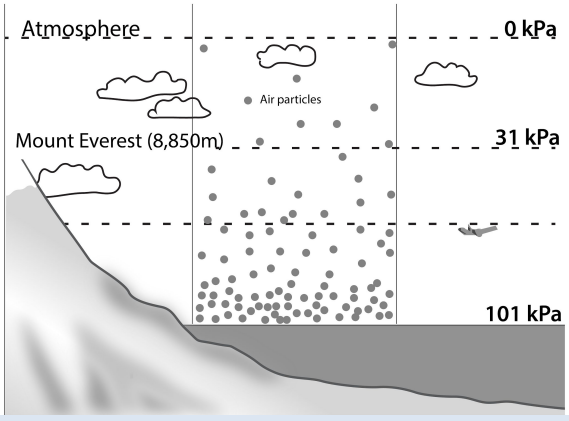
Sometimes a front may stall over an area. Such a front is called a *stationary front.* On a weather map, a stationary front is represented by alternating red semicircles and blue triangles that point in opposite directions. The weather at a stationary front tends to not change for as long as the front stays in place. Stationary fronts usually produce long periods of rain and can cause a flood to occur.

Reflect

Air Pressure and Weather

Air pressure refers to the weight of a column of air over a particular location on Earth. Denser air masses exert greater pressure because they contain more particles of air per unit volume. On a weather map, high-pressure air masses are labeled with the word *high* or the letter *H*. Low-pressure air masses are labeled with the word *low* or the letter *L*. Each type of air mass is associated with certain kinds of weather.

- Low-pressure air masses usually produce stormy weather.
- High-pressure air masses usually produce calm, clear weather.
- Low-pressure air masses contain winds that flow counterclockwise in the northern hemisphere and upward toward the center of the air mass.
- High-pressure air masses contain winds that flow clockwise in the northern hemisphere and outward from the center of the air mass.

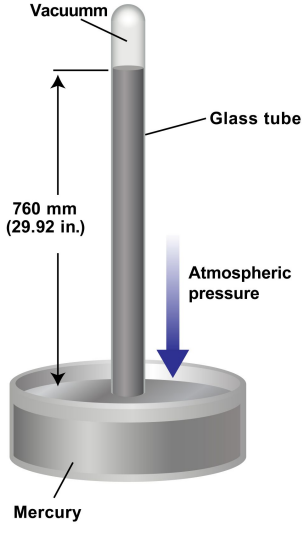


Particles of cool air sink, creating areas of high pressure. Particles of warm air rise, creating areas of low pressure. The air pressure at the top of Mount Everest (measured in kPa, or kilopascals) is more than three times lower than at Earth's surface.

Getting Technical: Mercury Barometer

The mercury barometer, once used by scientists to measure air pressure, was invented in 1643 by an Italian physicist named Evangelista Torricelli. It has a graduated glass tube with a millimeter scale. The tube, which is open at the bottom and closed at the top, is emptied of air, filled with mercury, and then placed with the open end down in an open container, or *reservoir*, which is also filled with mercury. The weight of air pressing down on the mercury in the open container forces the mercury up to a certain height in the tube. This measurement gives the air pressure in millimeters of mercury (mmHg). The chemical symbol for the element mercury is Hg.

At sea level and 0°C, the average air pressure is 760 mmHg. In other words, the column of mercury in the barometer will reach a graduation on the tube of 760 mm (approximately 30 in.). As air pressure increases, the column of mercury rises. As air pressure decreases, the column of mercury falls.



A mercury barometer is an instrument for measuring air pressure. Today, many meteorologists use new aneroid barometers. This is partly because mercury is toxic and partly because it is easier to take multiple measurements with aneroid barometers.

Reflect

Landforms and Weather

Landforms can also impact weather. For example, mountains tend to have more rain on the front side than the back side. Most rain will fall before reaching the top of the mountain, leaving the air mass dry as it moves down the back. Weather interactions also vary with latitude, altitude, living things, and local and regional geography, which can affect oceanic and atmospheric flow patterns.

Look Out!

Differences in pressure and temperature affect the movements of air masses. Air generally moves from areas of high pressure to areas of low pressure. Cool air generally moves toward concentrations of warm, rising air. However, heat moves only from a place of higher temperature to a place of lower temperature. For example, if you were to heat the head of a nail, the heat would gradually be transferred to the cooler tip of the nail.

Weather Maps

A weather map provides data about current weather conditions at a particular location. It also shows the movements and characteristics of air masses in that location. Meteorologists use the data to forecast upcoming weather conditions.

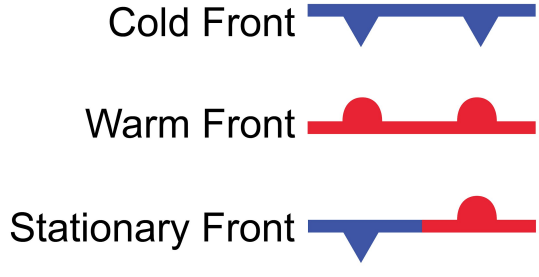
A weather map contains symbols, numbers, and words or letters that describe factors such as temperature, air pressure, wind speed and direction, cloud cover, fronts, and types of weather such as rain, snow, fog, thunderstorms, and hurricanes. Some of these symbols are below.

H

(High pressure)

L

(Low pressure)

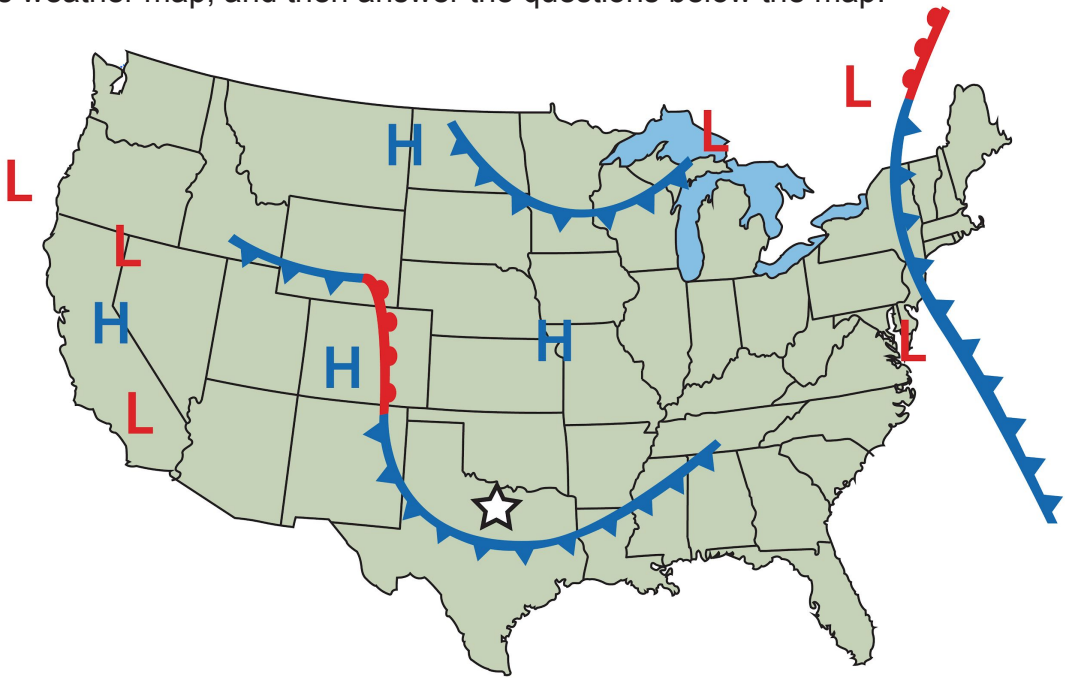


Areas marked with a high-pressure symbol (H) will have good weather and clear skies. Areas marked with a low-pressure (L) symbol, however, can have bad or stormy weather. Blue indicates a cold-front line that can bring rain and wind in the direction that the triangular marks point. Red indicates a warm-front line that can bring brief rain followed by warming in the direction of the semicircles.

Try Now

What Do You Know?

Examine this weather map, and then answer the questions below the map.



Questions	Answers
1. Which area of California is experiencing the highest pressure? Which city is more likely to have clear skies on the day shown: San Francisco or Los Angeles? Why?	
2. What kind of front is New York City experiencing? Based on this information, what kind of weather do you think New York City is experiencing?	
3. What kind of front is Colorado experiencing? Based on this information, what kind of weather do you think Colorado is experiencing?	