# Ocean's Influence on Weather and Climate

## Reflect

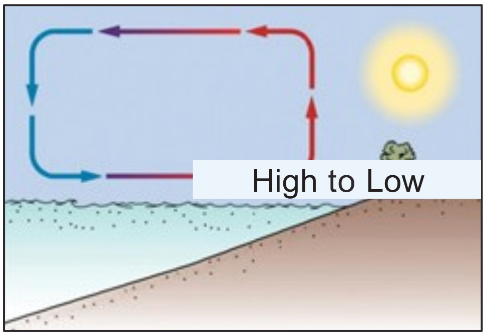
Earth is often called the "Blue Planet" because so much of its surface (about 71%) is covered by water. Of all the water on Earth, about 96.5%, is held in the world's oceans. As you can imagine, these oceans greatly influence our environment, including daily and long-term weather patterns. Most people associate weather with the atmosphere. How do oceans relate to weather and the atmosphere?

**Solar Radiation, Convection Currents, And Wind Currents**

The Sun is the driving force behind our weather, but our oceans play a major role in Earth's weather patterns. Earth absorbs energy called solar radiation from the Sun. Some of the energy is transferred from Earth's surface to the gases in Earth's atmosphere through **convection**. As the gas molecules warm up, they become less dense and rise farther into the atmosphere, helping to distribute heat. As the gas molecules higher in the atmosphere cool, they become denser. These molecules sink toward Earth's surface. This rising and sinking of warm and cool air creates **convection currents** in the atmosphere. We refer to these convection currents more commonly as **wind**.

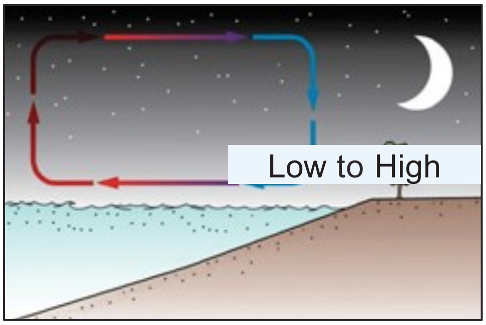
> **convection**:
> transfer of thermal energy in a fluid (gas or liquid), such as air or water; warm air rises and cold air sinks

Different areas of Earth's surface absorb varied amounts of solar radiation, resulting in temperature differences in the atmosphere. For example, during the day, land heats up faster than oceans. Above land, warm air is less dense, resulting in an area of low pressure. Warm air over land rises while cooler air over oceans sinks, creating wind currents.




Wind moves from high-pressure areas to low-pressure areas, so winds blow toward the coast. This is illustrated in the High to Low diagram and is called a sea breeze.

In contrast, during the night, land cools faster than oceans. Therefore, warmer air above oceans rises while cooler air over land sinks. Winds blow away from the coast. This is shown in the Low to High diagram and is called a land breeze.



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## Reflect

Earth's rotation also influences wind currents by deflecting wind as it moves over Earth's surface. Wind currents in the Northern Hemisphere are pushed to the right. Wind currents in the Southern Hemisphere are pushed to the left. This deflection of wind by Earth's rotation is called the **Coriolis Effect**.

## What Do You Think?

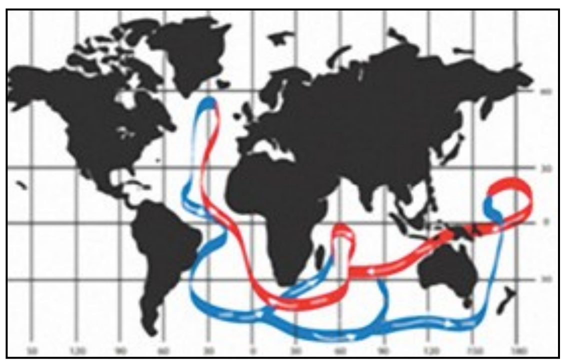
Look at the map of Texas at the right. Which areas do you think tend to experience more breezes? Explain your reasoning.


### Ocean Currents

In addition to circulating energy through the atmosphere, wind also influences ocean circulation. As wind blows along the ocean's surface, some surface water moves along with it. This creates ocean currents that move energy from the tropics (near the equator) to the poles. For example, wind is responsible for the Gulf Stream that moves warm, less dense surface water from the tropics, north along the eastern coast of the United States, and all the way to Europe.

**salinity**: a term used to describe the dissolved salt content of a substance

Temperature and **salinity** both affect ocean currents, particularly in deep ocean areas. This is because temperature and salinity affect water density. Warm water is less dense than cold water. Also, freshwater is less dense than saltwater. Water temperature and salinity vary with location. The **thermohaline** circulation is a major, deep ocean current that moves energy from the tropics to the poles. The Gulf Stream is part of this circulation. Recall that the Gulf Stream moves warm surface water from the tropics to the north. As this occurs, the heat energy in the water is transferred to the air.



The blue lines in this image show the movement of cold ocean currents and the red lines show the movement of warm ocean currents.

As the water moves north, it becomes cooler and denser, and sinks. This cold, dense water then flows back toward the equator.

## Reflect

Oceans play a vital role in regulating global climate and weather patterns. When warm ocean water flows into an area, some of the water **evaporates**, transferring thermal energy to the atmosphere. Rising water molecules cool and **condense** to form clouds. The increase in water vapor raises the humidity in the area, and the transfer of thermal energy raises the temperature. The opposite is true when cold ocean water flows into an area. The cold water absorbs thermal energy from the surrounding atmosphere, causing air temperature to decrease. When the temperature decreases, there is less evaporation and therefore, less humidity.

**evaporate**: to change from a liquid to a gas

**condense**: to change from a gas to a liquid

**Hurricanes**

Recall that solar radiation warms ocean water, causing some of the water to evaporate. As the water molecules rise, they cool and condense, forming clouds. If enough water condenses in these clouds, it will become too dense for the atmosphere to hold. This causes the water to fall from the sky as precipitation. When warm ocean water evaporates very quickly over a widespread area, clouds can form so rapidly that they result in large storms, such as hurricanes.

Hurricanes are violent storms that form when large amounts of ocean water evaporate. Hurricanes cannot form over land because they are fueled by warm, tropical water. Rapid evaporation and rising water vapor pull air away from the surface of the ocean water. This void of air leaves an area of low pressure underneath the mass of rising air. An imbalance in the surrounding atmosphere causes other air masses to be drawn into this low-pressure zone. This air warms up and rises too. The pressure gets lower and lower beneath the rising air as more and more warm ocean water evaporates and rises. As the cycle continues and air continuously rushes into the low-pressure area, and the system begins to spin with the movement of air.

Eventually, the rising air rises high enough in the atmosphere and cools. The water vapor condenses and forms massive clouds. These clouds continue to spin with the rest of the system.

In this photograph of a hurricane, the eye is a dark spot in the center of the storm. Although winds are calm in the eye, the area surrounding the eye is the most intense part of a hurricane.

## Reflect

Because there is so much moisture in the system, much of the condensation will lead to heavy rain. The differences in temperature and pressure result in so much air movement that wind speeds are very high. The temperature of the water and the rate of evaporation generally determine the size of the storm. The warmer the water, the faster it will evaporate, and the stronger the hurricane will be.

After a hurricane has formed, atmospheric winds can push the hurricane over land. Warm ocean currents can push the water that fuels hurricanes along the coast, providing a hurricane with fuel for longer travel. Once the hurricane moves over land, it no longer has a continuous supply of evaporating sea water. The hurricane will slowly die out, but not before causing significant damage to the area over which it passes. The intense wind and rainfall can knock down trees, cause flooding and power outages, and damage homes and other buildings.

## What Do You Think?

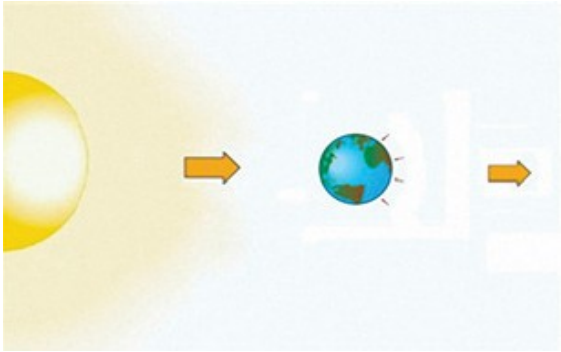
Are hurricanes more likely to form near the equator or near the poles? Explain your reasoning.

**Looking To The Future: Global Warming And Storms**

According to the Intergovernmental Panel on Climate Change (IPCC), there has been a warming trend of 0.8°C over the past 130 years. Both natural (increased solar radiation from the Sun) and human sources (air pollution from the burning of fossil fuels) are contributing to this trend.

An increase in solar radiation means that there is more radiation that can be absorbed by Earth. Some solar radiation is immediately reflected by Earth's atmosphere and surface back into space. The rest is absorbed by Earth's surface, warming it up. Eventually, this heat (thermal energy) is radiated back out into space. There must be a balance between incoming and outgoing solar radiation. Otherwise, Earth would become either too cold or too hot to support life as we know it.

Some gases in Earth's atmosphere block thermal energy from escaping back into space. These are called **greenhouse gases**. Greenhouse gases include carbon dioxide, methane, and other gases released by burning **fossil fuels**. Many of these gases are naturally found in the atmosphere.



Greenhouse gases, indicated by the gray curvy line, can block thermal energy. This energy then bounces back down to Earth.

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## What Do You Think?

Since humans began burning large quantities of fossil fuels, the amount of greenhouse gases in the atmosphere has increased. This disrupts the natural balance of incoming and outgoing solar radiation by preventing some radiation from escaping Earth's atmosphere.

Many scientists believe that the 0.8°C global warming trend has resulted primarily from human influence, through the release of greenhouse gases from burning fossil fuels. Natural causes, through the increase of solar radiation received on Earth, contribute only a small amount. Scientists hypothesize that the warming trend means more energy for evaporation to create more frequent storms and precipitation in some areas of the world. It could maybe even lead to more hurricanes!

**fossil fuels**: fuels formed over millions of years from dead plants and animals; coal, oil, and natural gas are fossil fuels

## Look Out!

Weather and climate are related to each other, but they are not the same thing. **Weather** occurs over short time periods, while **climate** relates to average weather conditions over longer time periods. Weather can change in a matter of minutes or even seconds. You can ask questions about weather such as, "Is it going to rain this afternoon?" or "Is it sunny and warm today?"

Climate describes the long-term patterns of temperature, precipitation, humidity, and wind patterns. Climate includes both the averages and extremes of these characteristics. We can talk about weather and climate over local and regional geographic areas.

# Ocean's Influence on Weather and Climate

## Try Now

**What Do You Know?**

Oceans greatly influence Earth's weather and climate. Read each statement in the top row of the chart below, and then decide whether you agree or disagree with the statement. Explain your response.

| In Florida, a city that is far inland is typically cooler and drier than a city near the Gulf of Mexico. | Alaska is surrounded by cold water, so the state experiences more hurricanes than most areas of the United States. | Ocean currents move cold water from the tropics to the poles where the water warms. | Hurricanes lose energy as they make landfall. |
|---|---|---|---|
| Agree or Disagree? Why? | Agree or Disagree? Why? | Agree or Disagree? Why? | Agree or Disagree? Why? |

## Connecting With Your Child

**Experimenting With Water and Weather**

To help your child understand how the oceans influence Earth's climate and weather, try conducting a few simple experiments together.

Evaporation from warm water transfers thermal energy to the atmosphere, causing the water vapor and warm air to rise. When they move higher into the atmosphere, these gases cool and condense to form clouds. This can be demonstrated by a simple experiment at home.

First, gather the following items:
- A clear glass jar
- A pot
- Some water
- A metal can with a base large enough to completely cover the mouth of the glass jar
- A few ice cubes
- A flashlight

1. Boil water and pour it into the jar, filling it only a centimeter or two.
2. Put the ice cubes in the metal can and place it on top of the glass jar.
3. Turn off the lights or bring the jar and can into a dark room.
4. Instruct your child to shine the flashlight on the jar.
5. Watch for several minutes as the steam from the hot water rises to the top of the jar, then cools and condenses as it approaches the ice, forming a small cloud inside of the jar.

Next, perform an experiment to help your child understand the manner in which the Coriolis Effect influences wind and ocean currents.

First, gather the following items:
- A light-colored balloon (yellow works best)
- A permanent marker

Blow up the balloon and tie it shut. Slowly rotate the balloon in a counter-clockwise direction. Instruct your child to draw a straight line, slowly, from the center of the balloon toward its top as you continue to rotate the balloon.

Once your child has drawn the line toward the top of the balloon, examine the path of the line across the balloon. [Note: Your child drew the line straight from the center to the top, but because the balloon was rotating, the line was deflected to the right.]

## Connecting With Your Child

Here are some questions to discuss with your child as you conduct and complete each experiment:

- Why does the steam rise to the top of the jar?
- Why does the cloud form inside the jar?
- How does this experiment relate to how warm ocean water creates clouds in Earth's atmosphere?
- How does the rotation of the balloon affect the direction of the line you drew?
- How does this experiment relate to the way the Coriolis Effect influences wind and ocean currents?