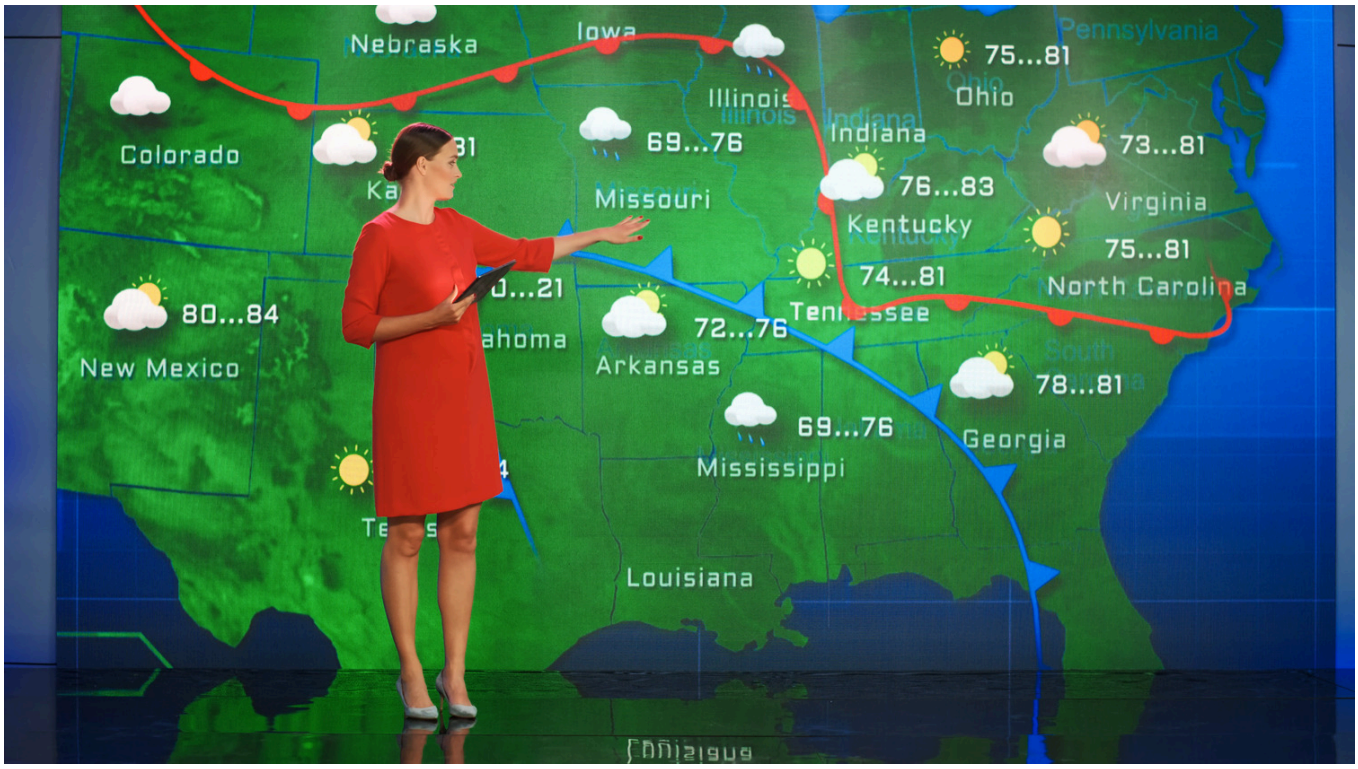
Predicting Weather

Reflect

Weather affects everyone because it is the day-to-day state of the atmosphere. The clothes we wear, our travel plans, our daily activities—all of these things depend on the weather.

To plan our day, we need to know what the weather will be. For this, we depend on the work of special scientists known as **meteorologists**. How do meteorologists do their work? How do they predict the weather?



Predicting the Weather

Predicting the weather is like predicting anything. To make a good prediction, it helps to know what has happened before and what is going on right now.

Let's use baseball as an example. Say a batter steps to the plate and we want to predict whether the batter will get a hit or strike out. It helps to know some things. What is the batting average of the player (how often does the player get a hit)? How is the player batting today? What about the pitcher? Has the pitcher been striking out many previous batters? Suppose we know that the batter has a low batting average and has struck out both times they were previously at bat during this game. Suppose we also know that the pitcher strikes out 7 out of every 10 left-handed batters and that the player at bat is left-handed. We might predict the batter will strike out, but will they? Maybe yes and maybe no. There are so many other things that might affect the outcome.

Predicting Weather

Predicting the weather is a lot like predicting the outcome of the baseball player at the plate.

To predict the weather, we need to know current conditions. What is the current temperature? How much water vapor is in the air (what is the humidity)? Is there precipitation and cloud cover, or is it sunny? What is the air pressure? Is there wind?

Knowing the answers to these questions and others will help us predict the weather. It also helps to know what kinds of weather have happened in the past when conditions were similar.

How Meteorologists Collect the Data They Need

Weather data such as wind speed and direction, humidity, temperature, and precipitation are recorded at weather stations located all over the world. The data is uploaded to satellites for meteorologists to access worldwide.

Weather balloons are launched globally two times each day to collect data concerning the upper atmosphere conditions by measuring humidity, temperature, air pressure, and wind speed. This data is also shared.

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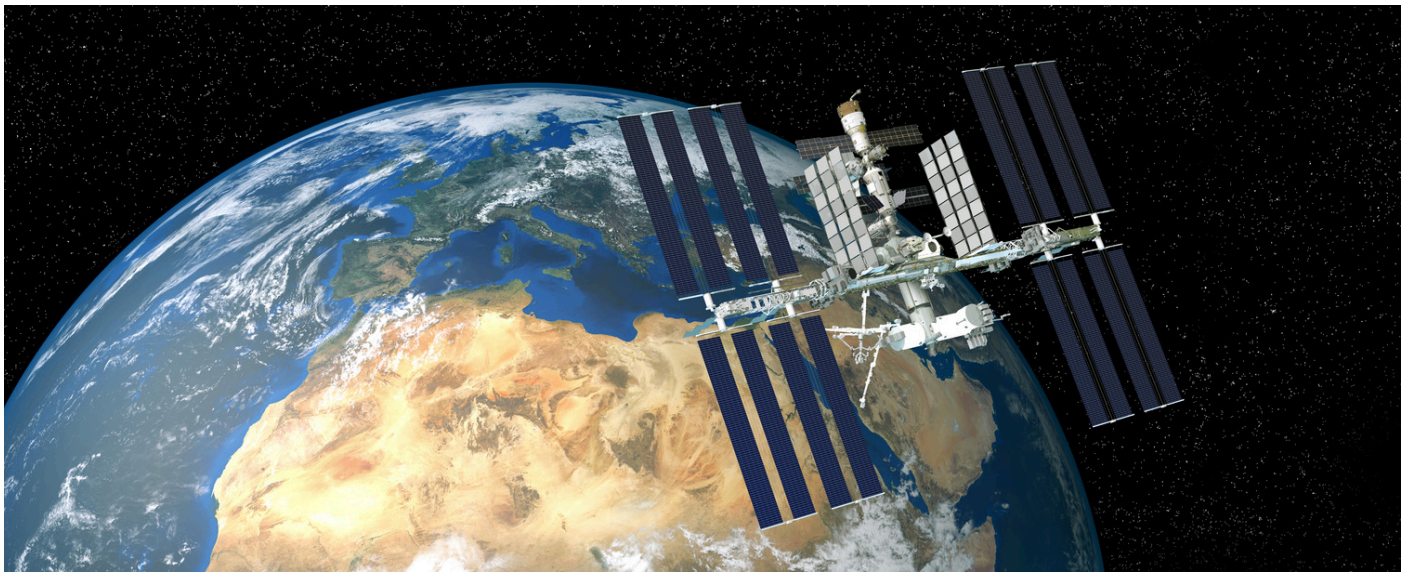
Satellite views show cloud cover and the movement of precipitation across the country. There are three different types of satellite images: infrared radiation, visible light, and water vapor.

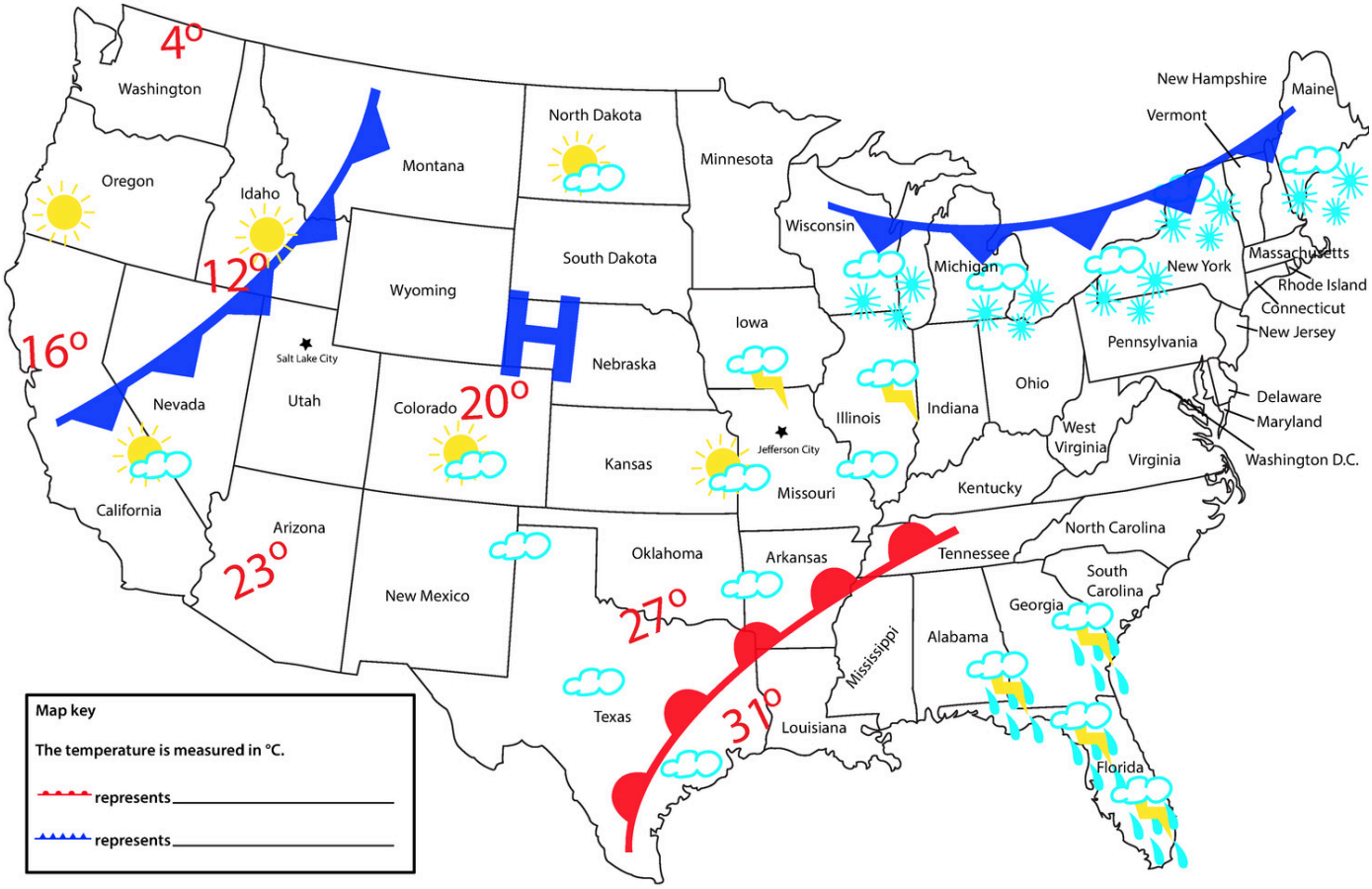
- Infrared radiation images indicate which objects are warmer than other objects. The images show warmer objects as darker than cooler objects. This gives meteorologists indications of the relative temperature of different levels of clouds.
- Visible light images are just what they sound like: images of what can be seen by the human eye. This view from space shows the pattern of movement of the cloud cover.
- Water vapor images indicate whether an area has high or low humidity. Areas with a high level of water vapor in the atmosphere appear bright while areas with a low level of water vapor appear black. Knowing the humidity level helps the meteorologist predict whether or not it will rain.



Weather **radar** maps indicate the location, type, and intensity of precipitation occurring in an area. Doppler radar data can be analyzed to determine the potential for severe weather to develop.

Predicting Weather

Weather maps are also created by plotting data such as temperature, wind direction and speed, and atmospheric pressure for weather stations at different locations on the map. By observing changes in these conditions at weather stations over time or differences between weather stations, we can track weather systems, such as storms and fronts, and predict what they will do next.



For example, since we know a cold front occurs when a cold, dry air mass pushes out a warm air mass, we know higher temperatures occur ahead of the front and lower temperatures behind. The cold air pushing out the warm air leads to storms, so stations, where there is precipitation, can indicate where the cold front is located. The locations of warm fronts are determined using similar indicators such as temperature, wind speed and direction, pressure, and precipitation changes.

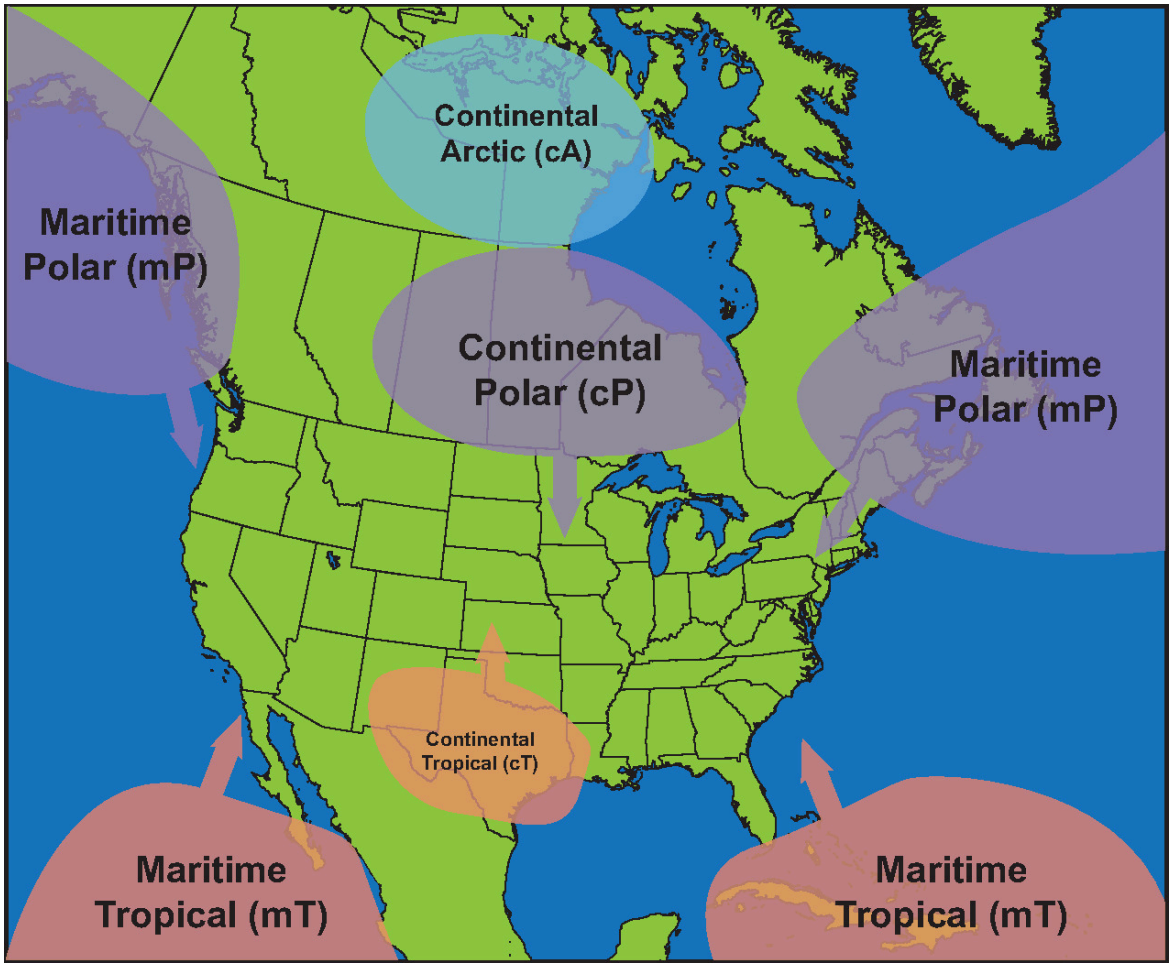
Meteorologists use weather maps to keep track of atmospheric conditions. This allows them to understand the large-scale global patterns of **atmospheric movement**, such as fronts or storms. These weather maps can be used to forecast or predict the weather at smaller scales, like for an individual city such as Nashville.

What Do You Think?

How do humidity, temperature, and air pressure influence the climate and the weather, especially local weather?

Air Masses

A body of air extending over a large area (1,000 miles or more) that develops and retains specific characteristics of pressure, temperature, and humidity is an **air mass**. You can determine the characteristics of the air mass based on where it originates. An air mass that originates in the Northern Pacific Ocean will be cold and moist or humid. An air mass that originates over the African continent will be dry and warm. The designations for air masses are continental or maritime and tropical or arctic. Continental air masses originate over land, and maritime air masses originate over water. Tropical air masses originate closer to the equator and arctic and/or polar air masses originate closer to the poles of Earth. Air masses can cover thousands of miles.

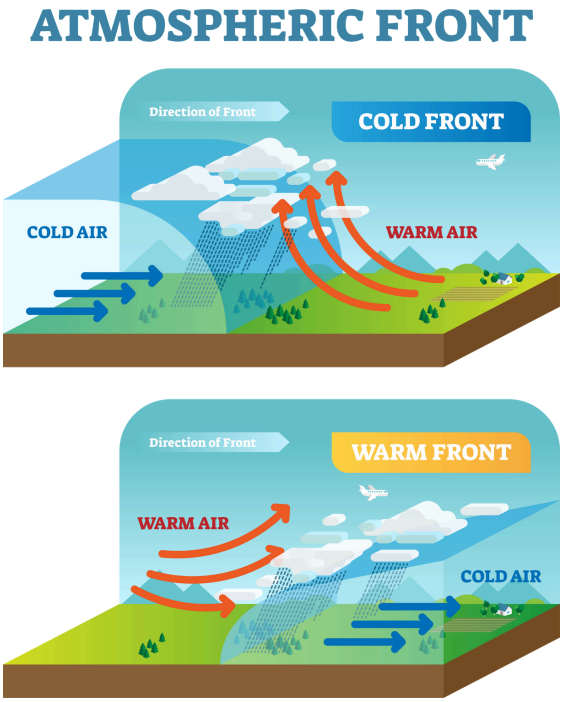


Cooler air masses tend to have higher pressure than warmer air masses, making them **high-pressure air masses**. The reason has to do with the closeness of the molecules of air. Think about how you feel when you are cold. You want to draw your extremities in and maybe huddle closer with others. Air molecules are similar—colder air molecules are closer together with less space between the molecules. This makes the cooler air masses have higher pressure due to the packing together of the air molecules. This means that warmer air masses are generally **low-pressure air masses**.

High-pressure air masses move faster than low-pressure air masses. This means that colder air masses move faster than warmer air masses. The air molecules primarily rise in a low-pressure air

mass, causing a buildup of clouds. Conversely, air molecules primarily fall toward the surface of Earth in a high-pressure system.

In addition to pressure, **humidity** is also a characteristic of an air mass. Water vapor molecules fit into spaces among the molecules that make up air. The amount of water vapor present in the air is called humidity. Humidity is measured by a hygrometer. Air doesn't always contain the same amount of water vapor. More water vapor can be present when the air is warm than when it is cool. The maritime tropical air masses can hold more water than the maritime polar air masses.



Air Masses and Local Weather

What does all of this mean for local weather? These air masses are in constant motion, and that motion puts them in contact with other air masses. The border or boundary where these air masses meet is called a **front**. If a warm air mass is moving up over a cold air mass, this is a **warm front**. Warm fronts tend to have lots of low stratus-type clouds and long steady rains along the boundary of the front. **Cold fronts** are caused by a cold air mass pushing up under a warm air mass. This generally creates a narrow band of showers or thunderstorms at the boundary. After a warm front passes, conditions will generally be warmer and more humid. After a cold front passes, conditions are generally cooler, clear, and windy. Below you can see how warm and cold fronts are represented on a weather map.

	Cold Front	Warm Front
Symbol		
Cloud Cover		
Type of Weather	Severe: heavy rain, tornadoes, snow	Rain and drizzle
Temperature and Humidity	Decrease	Increase
Weather after the Front Passes	Passes quickly; then good weather and clear skies	Passes slowly; then good weather and clear skies

Looking back at the weather map above, we can use what we know about fronts to determine the weather of a local area. A cold front is moving toward Salt Lake City, Utah. Notice that the triangles on the cold front's symbol indicate the direction the front is moving. As the border of the front passes, Salt Lake City may experience a thunderstorm or brief rain. After the border passes, it should be clearer and colder. A warm front is headed toward Oklahoma. Notice that the temperatures in front of the border of the front are cooler and the temperatures behind the front are warmer. As the front's border moves across Oklahoma, the area will experience some steady rain for a few days and then warmer and more humid conditions after the front passes. Air masses have a significant impact on the weather in our local area.

Why Weather Predictions Fail

The size and scale of weather predictions are much larger than for a single event, like a baseball player at bat. There are many conditions to take into consideration. All of these conditions interact with each other in complex ways.

In addition, meteorologists usually need to know the conditions over a very large area. Just trying to collect all the needed information is a difficult task.

After collecting huge amounts of data, meteorologists plug all the information into complex formulas, called algorithms, that help them predict future weather conditions.

Yet even with lots of data and very good algorithms, the number of conditions or factors, the complex ways they interact with each other, and the large areas covered make it impossible for meteorologists to say exactly what will happen with 100% certainty. They can tell us only what is likely to happen.

Look Out!

Because meteorologists can't tell us for certain what will happen, they usually provide information, including numbers, that help us put the information in context. Meteorologists often report the probability of precipitation. One common example of this is the phrase *percent chance of rain*. You might see a weather prediction that says we have a 50% chance of rain today. What does this mean? Many people are confused about this.

It does not mean, as some people believe, that rain will fall on half (50%) of the area for which the prediction was made.

It also does not mean, as others believe, that rain will fall for half of the time for which the prediction is made.

It is the chance of precipitation at any point in the area that day. It takes into account both the likelihood that it will rain somewhere in the area and how much of the area will get some of the rain.

Predicting Weather

Try Now

We can try to make our own weather predictions by using historical weather data and comparing it to current weather data. Below is a table of various weather conditions for the same location over many days, including specific weather that resulted (did it rain that day or not?). Use the historical weather data to assign a probability of rain for the day we are trying to predict.

Day 1	Day 2	Day 3	Day 4	Day 5
Winds: Easterly **Air pressure:** High **Clouds:** None **No rain**	**Winds:** Easterly **Air pressure:** High **Clouds:** None **No rain**	**Winds:** Easterly **Air pressure:** High **Clouds:** None **No rain**	**Winds:** Westerly **Air pressure:** Falling **Clouds:** Cumulus **No rain**	**Winds:** Westerly **Air pressure:** Low **Clouds:** Cumulus towers **Rain**

Today	**What is your best prediction for the probability of rain today? What type of air mass or front would explain these conditions? Explain.**
Winds: Westerly **Air pressure:** Low **Clouds:** Cumulus towers	

Predicting Weather

Connecting With Your Child

Starting a Weather Journal

The first step to predicting weather is to pay attention to it. With a simple spiral-bound notebook and a pencil, your child can become an amateur meteorologist.

Encourage your child to record the weather conditions they observe every day, maybe even more than once a day, such as in the morning and in the evening.

Some of these observations need no special tools. You can see the sky conditions just by looking up. If you happen to know which direction is north, you can easily record the wind direction. Note: meteorologists record wind direction by the direction from which the wind is coming. An easterly wind blows from the east to the west.

Other observations may require simple tools, such as a thermometer (to measure temperature) or a barometer (to measure air pressure). If you don't have access to special tools, you can always get information like this from several sources, either online or from television or newspaper forecasts.

Have your child look at satellite images and radar maps for your area. These images and maps can be found on the National Weather Service website.

After you record observations for several weeks, you can begin to look for patterns. What time of day is warmest? Coolest? What kind of weather usually follows a drop in temperature?

Here are some questions to discuss with your child:

1. What kinds of data are the easiest to collect? What kinds of data are the hardest?
2. Which observations are most helpful for making predictions?
3. What other kinds of data might be helpful?
4. Do animals behave differently in response to different weather conditions?