WHAT MAKES THE WEATHER CHANGE?

Atmospheric Processes in Weather and Climate

IQWST LEADERSHIP AND DEVELOPMENT TEAM

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Investigating and Questioning
Our World through Science
and Technology
(IQWST)

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Atmospheric Processes in Weather and Climate

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About the Publisher

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LESSON 1

What Is Weather?

ACTIVITY 1.1 – IDENTIFYING WEATHER CONDITIONS AROUND THE WORLD

What Will We Do?

We will analyze data to determine if the same weather conditions are present everywhere.

Prediction

Do you think all weather reports contain information on the same conditions, such as temperature, wind, humidity, precipitation, and clouds? Explain your prediction.

Procedure

1. Name of your group's city: ______________________________

2. Find your city on the world map. All groups will share their city's location when you go over this activity.

3. Check the weather conditions that are listed on all five days of the reports. List them here. (All cities have data on the following conditions: temperature, wind, precipitation, humidity, and air pressure.)

4. Was there a weather event that occurred in your city during the five days that you analyzed (for example, a storm)? If there was, describe what it was.

5. Did any of the conditions change during the five days? Describe any changes you noticed.

Making Sense

Why do you think it would be important to keep track of the weather conditions in a particular location?

Data

Buenos Aires, Argentina Weather Data

This data was collected between February14–February 18, 2011

Current Conditions F° | C°

Clear		77°F	
		Feels like: 77°	
Wind Chill:	77°	Ceiling:	Unl
Heat Index:	77°	Visibility:	6mi
Dew Point:	50°	Wind:	5mph
Humidity:	39%	Direction:	50° (NE)
Pressure:	30.12″	Gusts:	NA

(Feb. 14, 2011)

Current Conditions F° | C°

NA	NA	81°F	
		Feels like: 82°	
Wind Chill:	81°	Ceiling:	NA
Heat Index:	82°	Visibility:	6mi
Dew Point:	64°	Wind:	7mph
Humidity:	58%	Direction:	360° (N)
Pressure:	30″	Gusts:	NA

(Feb. 15, 2011)

Current Conditions F° | C°

Clear		81°F	
		Feels like: 83°	
Wind Chill:	81°	Ceiling:	Unl
Heat Index:	83°	Visibility:	6mi
Dew Point:	66°	Wind:	8mph
Humidity:	61%	Direction:	20° (NNE)
Pressure:	29.97″	Gusts:	NA

(Feb. 16, 2011)

Current Conditions F° | C°

Few Clouds		86°F	
		Feels like: 89°	
Wind Chill:	86°	Ceiling:	Unl
Heat Index:	89°	Visibility:	6mi
Dew Point:	68°	Wind:	3mph
Humidity:	55%	Direction:	70° (ENE)
Pressure:	29.97″	Gusts:	NA

(Feb. 17, 2011)

Current Conditions F° | C°

Light Rain		73°F	
		Feels like: 73°	
Wind Chill:	73°	Ceiling:	5000
Heat Index:	73°	Visibility:	3mi
Dew Point:	72°	Wind:	10mph
Humidity:	94%	Direction:	180° (S)
Pressure:	30.06″	Gusts:	NA

(Feb. 18, 2011)

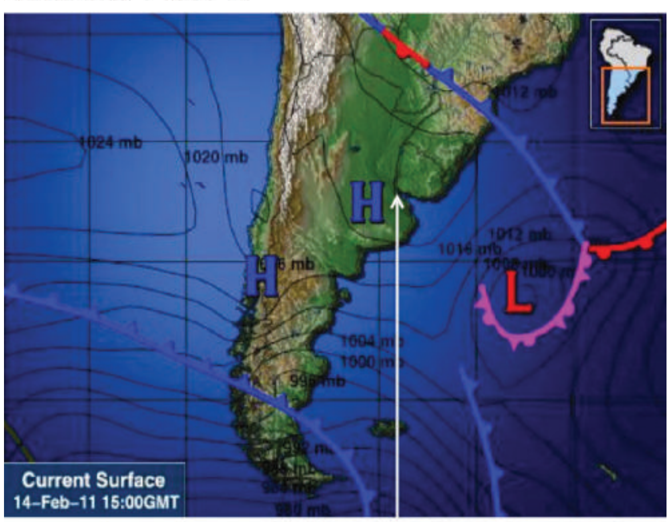
10-Day Forecast °F | °C

View the Detailed Extended Forecast >>

mon	tue	wed	thu	fri	sat	sun	mon	tue	wed
feb 14	feb 15	feb 16	feb 17	feb 18	feb 19	feb 20	feb 21	feb 22	feb 23
Sunny	Sunny	Sunny	Sunny	M Sunny	Cloudy	AM Clouds	AM Clouds	Sct Showers	P Cloudy
82° 65°	86° 67°	86° 66°	87° 67°	84° 67°	80° 67°	82° 66°	83° 66°	83° 64°	82° 63°

Buenos Aires Surface Area Map

February 14, 2011



Buenos Aires

Data

Belem, Brazil Weather Data

This data was collected between February 14–February 18, 2011

Current Conditions F° | C°

Light Rain **77°F**
Feels like: 78°

Wind Chill:	77°	Ceiling:	10000
Heat Index:	78°	Visibility:	3mi
Dew Point:	73°	Wind:	2mph
Humidity:	89%	Direction:	40° (NE)
Pressure:	29.8″	Gusts:	NA

(Feb. 14, 2011)

Current Conditions F° | C°

Moderate Rain **77°F**
Feels like: 78°

Wind Chill:	77°	Ceiling:	400
Heat Index:	78°	Visibility:	1.8mi
Dew Point:	72°	Wind:	3mph
Humidity:	83%	Direction:	120° (ESE)
Pressure:	29.88″	Gusts:	NA

(Feb. 15, 2011)

Current Conditions F° | C°

Broken Clouds **81°F**
Feels like: 85°

Wind Chill:	81°	Ceiling:	1500
Heat Index:	85°	Visibility:	6mi
Dew Point:	73°	Wind:	7mph
Humidity:	79%	Direction:	80° (E)
Pressure:	29.91″	Gusts:	NA

(Feb. 16, 2011)

Current Conditions F° | C°

Broken Clouds **79°F**
Feels like: 82°

Wind Chill:	79°	Ceiling:	10000
Heat Index:	82°	Visibility:	6mi
Dew Point:	73°	Wind:	2mph
Humidity:	83%	Direction:	270° (W)
Pressure:	29.77″	Gusts:	NA

(Feb. 17, 2011)

Current Conditions F° | C°

Broken Clouds **81°F**
Feels like: 85°

Wind Chill:	81°	Ceiling:	10000
Heat Index:	85°	Visibility:	6mi
Dew Point:	73°	Wind:	5mph
Humidity:	79%	Direction:	100° (E)
Pressure:	29.83″	Gusts:	NA

(Feb. 18, 2011)

10-Day Forecast °F | °C

10 Day Forecast- °F | °C — View the Detailed Extended Forecast >>

mon	tue	wed	thu	fri	sat	sun	mon	tue	wed
feb 14	feb 15	feb 16	feb 17	feb 18	feb 19	feb 20	feb 21	feb 22	feb 23
Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms
81° 76°	82° 75°	82° 75°	86° 75°	83° 74°	82° 74°	85° 74°	86° 75°	85° 75°	86° 75°

Belem Surface Area Map

February 14, 2011

Belem

Data

Oslo, Norway Weather Data

This data was collected between February 14–February 18, 2011

Current Conditions F° | C°

Clear **14°F**
Feels like: 6°

Wind Chill:	6°	Ceiling:	Unl
Heat Index:	14°	Visibility:	6mi
Dew Point:	7°	Wind:	5mph
Humidity:	73%	Direction:	70° (ENE)
Pressure:	30.24″	Gusts:	NA

(Feb. 14, 2011)

Current Conditions F° | C°

Light Snow **16°F**
Feels like: 9°

Wind Chill:	9°	Ceiling:	3500
Heat Index:	16°	Visibility:	4mi
Dew Point:	12°	Wind:	5mph
Humidity:	86%	Direction:	60° (ENE)
Pressure:	29.97″	Gusts:	NA

(Feb. 15, 2011)

Current Conditions F° | C°

Light Snow **19°F**
Feels like: 10°

Wind Chill:	10°	Ceiling:	1800
Heat Index:	19°	Visibility:	6mi
Dew Point:	16°	Wind:	7mph
Humidity:	86%	Direction:	60° (ENE)
Pressure:	29.94″	Gusts:	NA

(Feb. 16, 2011)

Current Conditions F° | C°

Rain Showers **16°F**
Feels like: 16°

Wind Chill:	16°	Ceiling:	7900
Heat Index:	16°	Visibility:	6mi
Dew Point:	10°	Wind:	2mph
Humidity:	79%	Direction:	90° (S)
Pressure:	30.33″	Gusts:	NA

(Feb. 17, 2011)

Current Conditions F° | C°

Rain Showers **16°F**
Feels like: 16°

Wind Chill:	16°	Ceiling:	7900
Heat Index:	16°	Visibility:	6mi
Dew Point:	10°	Wind:	2mph
Humidity:	79%	Direction:	90° (E)
Pressure:	30.33″	Gusts:	NA

(Feb. 18, 2011)

10-Day Forecast °F | °C

View the Detailed Extended Forecast >>

mon	tue	wed	thu	fri	sat	sun	mon	tue	wed
feb 14	feb 15	feb 16	feb 17	feb 18	feb 19	feb 20	feb 21	feb 22	feb 23
Light Snow	Light Snow	Light Snow	Light Snow	P Cloudy	P Cloudy	P Cloudy	M Sunny	Sunny	Sunny
11° 6°	17° 12°	19° 13°	20° –3°	9° –3°	9° 0°	12° 0°	16° 4°	17° 4°	23° 12°

Oslo Surface Area Map

February 14, 2011

Oslo

Data

Atlanta, Georgia Weather Data

This data was collected between February 14 – February 18, 2011

Current Conditions F° | C°

Few Clouds **60°F**
Feels like: 60°

Wind Chill:	60°	Ceiling:	Unl
Heat Index:	60°	Visibility:	10mi
Dew Point:	36°	Wind:	10mph
Humidity:	41%	Direction:	270° (W)
Pressure:	30.13″	Gusts:	21mph

(Feb. 14, 2011)

Current Conditions F° | C°

Broken Clouds **57°F**
Feels like: 57°

Wind Chill:	57°	Ceiling:	25000
Heat Index:	57°	Visibility:	10mi
Dew Point:	27°	Wind:	9mph
Humidity:	32%	Direction:	100° (E)
Pressure:	30.34″	Gusts:	NA

(Feb. 15, 2011)

Current Conditions F° | C°

Broken Clouds **48°F**
Feels like: 45°

Wind Chill:	45°	Ceiling:	2400
Heat Index:	48°	Visibility:	10mi
Dew Point:	36°	Wind:	7mph
Humidity:	63%	Direction:	110° (ESE)
Pressure:	30.38″	Gusts:	NA

(Feb. 16, 2011)

Current Conditions F° | C°

Clear **68°F**
Feels like: 68°

Wind Chill:	68°	Ceiling:	Unl
Heat Index:	68°	Visibility:	10mi
Dew Point:	40°	Wind:	12mph
Humidity:	36%	Direction:	190° (S)
Pressure:	30.19″	Gusts:	20mph

(Feb. 17, 2011)

Current Conditions F° | C°

Broken Clouds **59°F**
Feels like: 59°

Wind Chill:	59°	Ceiling:	1600
Heat Index:	59°	Visibility:	9mi
Dew Point:	54°	Wind:	7mph
Humidity:	82%	Direction:	270° (W)
Pressure:	30.24″	Gusts:	NA

(Feb. 18, 2011)

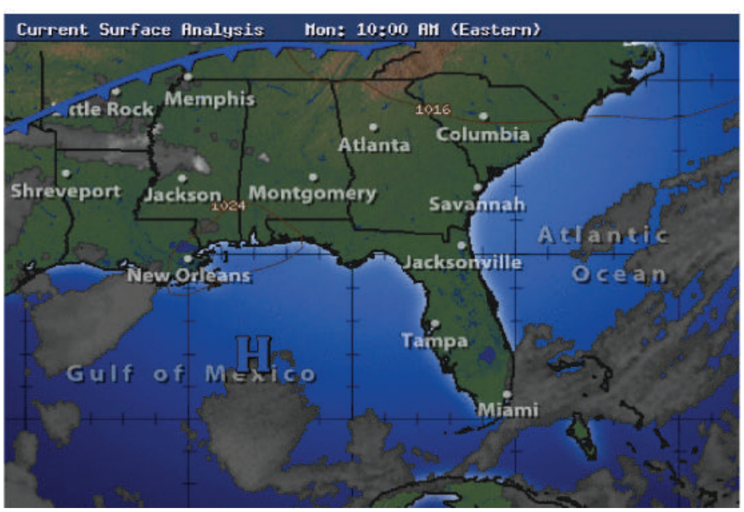
10-Day Forecast °F | °C

View the Detailed Extended Forecast >>

mon	tue	wed	thu	fri	sat	sun	mon	tue	wed
feb 14	feb 15	feb 16	feb 17	feb 18	feb 19	feb 20	feb 21	feb 22	feb 23
Sunny	P Cloudy	P Cloudy	M Sunny	P Cloudy	P Cloudy	P Cloudy	Few Showers	Showers	Showers
63° 34°	59° 35°	60° 44°	64° 46°	66° 46°	60° 39°	62° 41°	59° 43°	60° 42°	58° 43°

Atlanta Surface Area Map

February 14, 2011



Data

Singapore, Singapore Weather Data

This data was collected between February 14–February 18, 2011

Current Conditions F° | C°

Broken Clouds **81°F**
Feels like: 85°

Wind Chill:	81°	Ceiling:	30000
Heat Index:	85°	Visibility:	6mi
Dew Point:	73°	Wind:	9mph
Humidity:	79%	Direction:	10° (N)
Pressure:	29.83″	Gusts:	NA

(Feb. 14, 2011)

Current Conditions F° | C°

Broken Clouds **79°F**
Feels like: 82°

Wind Chill:	79°	Ceiling:	30000
Heat Index:	82°	Visibility:	6mi
Dew Point:	73°	Wind:	5mph
Humidity:	83%	Direction:	30° (NNE)
Pressure:	29.88″	Gusts:	NA

(Feb. 15, 2011)

Current Conditions F° | C°

Broken Clouds **81°F**
Feels like: 86°

Wind Chill:	81°	Ceiling:	30000
Heat Index:	86°	Visibility:	6mi
Dew Point:	75°	Wind:	6mph
Humidity:	84%	Direction:	10° (N)
Pressure:	29.85″	Gusts:	NA

(Feb. 16, 2011)

Current Conditions F° | C°

Broken Clouds **82°F**
Feels like: 89°

Wind Chill:	82°	Ceiling:	35000
Heat Index:	89°	Visibility:	6mi
Dew Point:	75°	Wind:	12mph
Humidity:	79%	Direction:	10° (N)
Pressure:	29.83″	Gusts:	NA

(Feb. 17, 2011)

Current Conditions F° | C°

Broken Clouds **81°F**
Feels like: 86°

Wind Chill:	81°	Ceiling:	30000
Heat Index:	86°	Visibility:	6mi
Dew Point:	75°	Wind:	6mph
Humidity:	84%	Direction:	10° (N)
Pressure:	29.85″	Gusts:	NA

(Feb. 18, 2011)

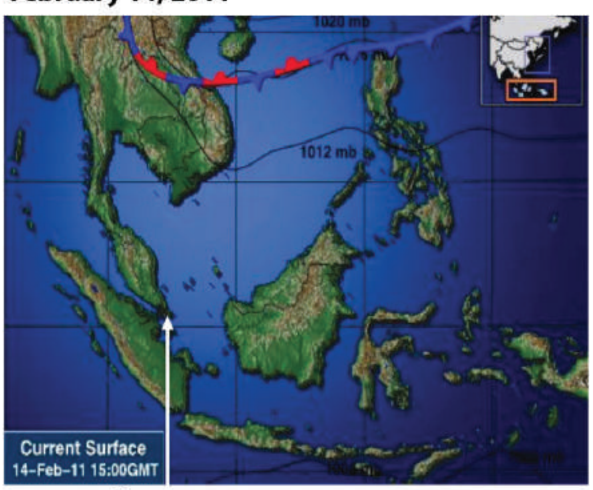
10-Day Forecast °F | °C

View the Detailed Extended Forecast >>

mon	tue	wed	thu	fri	sat	sun	mon	tue	wed
feb 14	feb 15	feb 16	feb 17	feb 18	feb 19	feb 20	feb 21	feb 22	feb 23
M Clear	PM T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms	Sct T-Storms
88° 75°	88° 75°	88° 76°	86° 76°	86° 76°	87° 76°	87° 75°	86° 75°	87° 76°	87° 76°

Singapore Surface Area Map

February 14, 2011



Singapore

Data

Ushuaia, Argentina Weather Data

This data was collected between February14–February 18, 2011

Current Conditions F° | C°

Moderate Rain **50°F**
Feels like: 50°

Wind Chill:	50°	Ceiling:	Unl
Heat Index:	50°	Visibility:	6mi
Dew Point:	41°	Wind:	28mph
Humidity:	71%	Direction:	250° (WSW)
Pressure:	29.03″	Gusts:	NA

(Feb. 14, 2011)

Current Conditions F° | C°

Broken Clouds **50°F**
Feels like: 50°

Wind Chill:	50°	Ceiling:	3900
Heat Index:	50°	Visibility:	6mi
Dew Point:	37°	Wind:	21mph
Humidity:	62%	Direction:	230° (SW)
Pressure:	29.12″	Gusts:	NA

(Feb. 15, 2011)

Current Conditions F° | C°

Broken Clouds **48°F**
Feels like: 44°

Wind Chill:	44°	Ceiling:	4700
Heat Index:	48°	Visibility:	6mi
Dew Point:	28°	Wind:	9mph
Humidity:	46%	Direction:	230° (SW)
Pressure:	29.59″	Gusts:	NA

(Feb. 16, 2011)

Current Conditions F° | C°

Scattered Clouds **55°F**
Feels like: 55°

Wind Chill:	55°	Ceiling:	Unl
Heat Index:	55°	Visibility:	6mi
Dew Point:	36°	Wind:	15mph
Humidity:	47%	Direction:	230° (SW)
Pressure:	29.91″	Gusts:	NA

(Feb. 17, 2011)

Current Conditions F° | C°

Broken Clouds **61°F**
Feels like: 61°

Wind Chill:	61°	Ceiling:	10000
Heat Index:	61°	Visibility:	6mi
Dew Point:	39°	Wind:	17mph
Humidity:	45%	Direction:	320° (NW)
Pressure:	29.71″	Gusts:	NA

(Feb. 18, 2011)

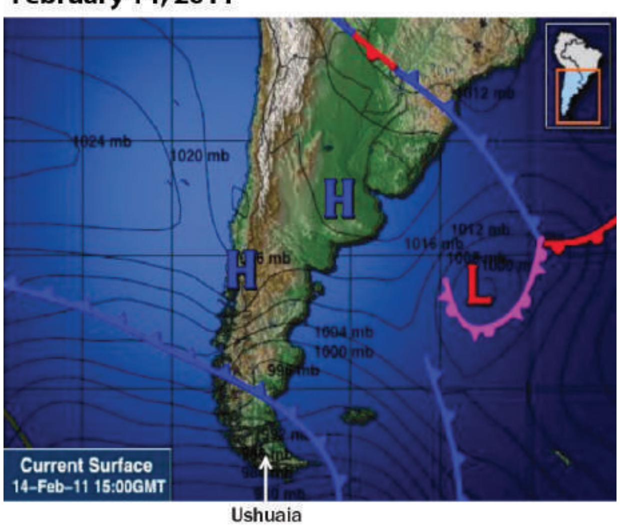
10-Day Forecast °F | °C

View the Detailed Extended Forecast >>

mon	tue	wed	thu	fri	sat	sun	mon	tue	wed
feb 14	feb 15	feb 16	feb 17	feb 18	feb 19	feb 20	feb 21	feb 22	feb 23
Showers	Showers	M Sunny	AM Showers	P Cloudy	M Sunny	P Cloudy	Few Showers	Sct Showers	P Cloudy
52° 42°	54° 41°	50° 42°	56° 43°	59° 45°	63° 45°	65° 45°	51° 43°	51° 44°	52° 46°

Ushuaia Surface Area Map

February 14, 2011



ACTIVITY 1.2 – SETTING UP THE DRIVING QUESTION BOARD (DQB)

Reading 1.2 – What Can Clouds Tell Us about Weather?

Getting Ready

Think about the heat of summer. You and your friends decide that it would be fun to go to the beach tomorrow, so you turn on the television to listen to the weather forecast. The weatherperson says it will be hot and sunny, so you decide to make plans to go to the beach. The next day, you all arrive at the beach, but soon the clouds move in and it begins to rain. Your day at the beach is ruined. What happened to the weather forecast of hot and sunny?

Think about what you know about weather forecasting. How far in advance do you think accurate weather forecasts can be made?

In class, you looked at data about the weather for a specific city. The data provided information on the current conditions, and then it predicted the weather for the next five days. You learned that the conditions that make up the weather are *temperature*, *humidity*, *air pressure*, *wind*, *clouds*, and *precipitation*. If they interact in a particular way, they can produce storms. Scientists look for these patterns of interaction to help them predict the weather.

Most people have listened to a weather forecast that turned out to be wrong. Meteorologists are people who study and forecast the weather. They use technology to study the clouds, winds, and temperature in order to look for patterns to help them forecast the weather. In other IQWST units, you used patterns to help you figure out the answers to questions. In the IQWST IC1 unit, you saw that different gases created different color patterns on the light spectrum. You could use this pattern to tell one gas from another. In the IQWST LS1 unit, you looked for patterns in the data in NetLogo to help identify predator/prey relationships.

In this unit, you will look for patterns in the weather conditions you identified. This will help you figure out how conditions like temperature, humidity, pressure, and wind interact to produce storms. Once you figure out the patterns, you will be able to answer the Driving Question: What Makes the Weather Change?

Can Cloud Patterns Predict Weather?

One pattern that meteorologists use is clouds. Cloud patterns have been used to predict weather for centuries. From the time of the ancient Greeks until today, clouds have been used as signs of the weather to come. Most of the changes in the weather that clouds can predict happen within two or three days. They are useful for predicting day-to-day changes in weather. People have studied clouds over long periods of time and identified three main patterns in clouds that are very good indicators of weather to come. These three main cloud types or patterns are called *cumulus*, *stratus*, and *cirrus*.

The big, white, puffy clouds that are spread across the blue sky in the top picture, promise a dry afternoon. These clouds are called *cumulus* clouds, and this pattern in the clouds indicates that the weather will be fair and dry.

The term *stratus* is used to describe flat, hazy clouds that are low above the earth's surface. They vary in color from dark gray to nearly white. Stratus clouds mean rain or, if it is cold, snow. Stratus clouds do not bring heavy rain and snowstorms the way some other types of clouds do. Stratus clouds usually bring drizzle or very light precipitation. If you are talking about a cloudy day, you are usually talking about a sky filled with stratus clouds that hide the sun. They look like a huge gray blanket that hangs low in the sky.

Have you ever gotten up in the morning and not been able to see across the street because the fog was so thick? What do you think fog is? Would you be surprised to learn that fog is really a cloud? Sometimes stratus clouds are on the ground or very near the ground, and then we call them *fog.*

High, see-through, wispy clouds are called *cirrus* clouds. If there are only a few in the sky, the weather will not change, but when you see a lot of these clouds, it can be a sign that the weather will change tomorrow or the next day. This type of cloud pattern lets meteorologists know that stormy weather is on the way.

The last type of cloud is one that you probably have seen on a stormy day. You may call them *thunderheads*. These are really a special kind of those light, puffy cumulus clouds you saw a few paragraphs ago. If cumulus clouds continue to get bigger, they form a special kind of cloud called *cumulonimbus*.

Even though these clouds may look light and fluffy on the top from a distance, their size and the dark color below indicate a strong storm very soon. When meteorologists see this pattern of cloud in the sky, they know that there will be severe storms with high wind, lots of rain, and probably lightning. If the weather is cold, they will bring heavy snow.

Can Clouds Help with the Weather Forecast Months from Now?

You have been reading about cloud patterns that help meteorologists predict weather in the near future. Scientists who study and forecast the weather a week or more into the future also use technology to study weather conditions, including clouds.

Do You Think the Clouds You See Today Could Help You Predict What Would Happen Six Months from Now? Why?

You are going to read an article about a group of people who do not use any technology but are able to make a very accurate prediction about the weather six months in advance. As you read, pay attention to what these farmers use to predict the weather and how clouds play an important part in their prediction.

Can Stars Help People Predict the Weather?

What if people did not have technology for forecasting the weather? Could they predict storms or major weather events correctly? Some farmers in South America predict the weather six months in advance by looking at the stars. In the predawn early morning, bright, clear stars lead farmers to predict plenty of rain and a successful growing season for their crops. If those stars appear less bright, farmers plant their crops later, because they are expecting less rain, and they expect it to come later in the season. Both the amount and the timing of the rain affect the growing season. Looking to the stars is important to these farmers to help determine when they should plant their crops.

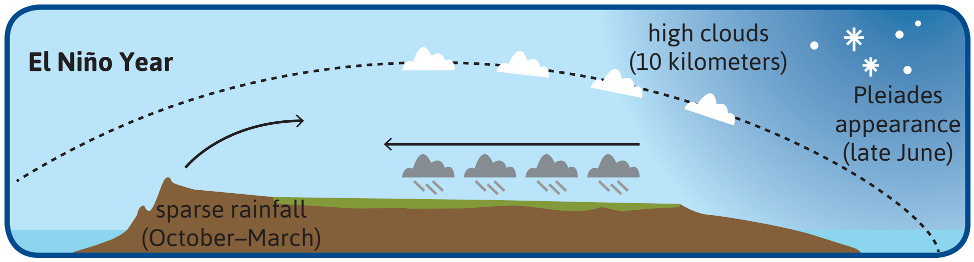
A group of scientists studied what the South American farmers do to see if their ideas make sense scientifically. It may surprise you to learn that farmers who look to the stars have correctly predicted El Niño for hundreds of years, but scientists only have had the technology for predicting El Niño for about 20 years. Watching the stars is a successful way for farmers in the Andes Mountains to forecast the weather.

How Accurate Is This Prediction Technique?

El Niño is a weather pattern that brings heavy rains to South America. It does not occur every year, but because it affects crops and fishing, it is important to be able to predict when it will occur. The farmers did not know they were forecasting what is now called El Niño. They understood what the difference in the stars indicated. Each village has its own specific way of making these observations. Some watched the sky for 10 nights, while others only focused on June 24, which is the Festival of San Juan. In every case, the results are used to plan when they will plant their crops. They do this by looking at the following three things about the constellation, Pleiades:

1. how bright the constellation appears
2. the date when the constellation is first visible in the sky (because sometimes it is too cloudy to see the constellation when it should first be visible in the Southern Hemisphere)
3. the position of the brightest star in the constellation

All three of these things depend on the clarity of the atmosphere. In El Niño years, clouds high in the atmosphere block the constellation. Farmers know that this means there will not be much rain during the growing season. The following diagram indicates where the clouds appear in an El Niño year. They block the Pleiades from clear view. Clouds play a big part in helping these farmers make predictions about the weather.



The scientists who wrote this article wanted to know how accurate the farmers were in their predictions. They decided to review climate data from the Andes Mountains. They reviewed cloud data from the month of June and precipitation data from October through February. They also reviewed data that showed how good the potato harvest was. They discovered that the farmers were right about 65% of the time. That is pretty amazing when you consider the farmers were using what they could see in the sky to predict what would happen with the weather six months later.

Lesson 2

What Makes Air Hot?

ACTIVITY 2.1 – IT IS HEATING UP

What Will We Do?

We will construct a model of how the earth's air is heated.

Procedure

1. With your group, use the following space to construct a model of the way the air above the earth is heated. Use arrows to show the transfer of energy. Your model should include the energy source, what is being heated, and any process that is taking place.

ACTIVITY 2.1 – IT IS HEATING UP

2. The class will meet and discuss the models and arrive at a class consensus model. Copy the class model in the following space.

Making Sense

1. Does the class model make sense to you? YES NO

2. Explain your ideas.

ACTIVITY 2.2 – A LITTLE HEAT FROM ME TO YOU

What Will We Do?

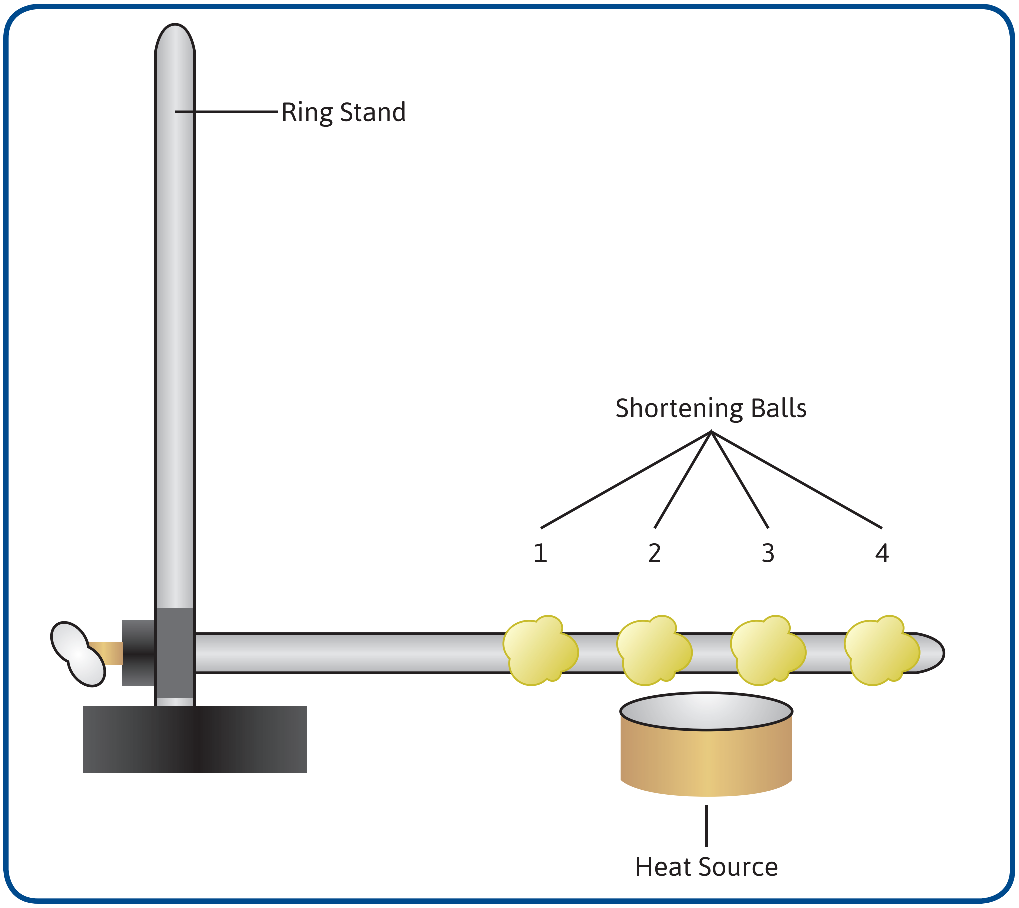
We will determine if thermal energy can be transferred from one object to another.

Safety

- Be careful with the heat source as well as the objects that are heated.
- Follow lab safety procedures for working with heated objects.

Procedure

Your teacher will show you how to set up the apparatus. You will be observing a setup similar to the following illustration.



Prediction

Which shortening ball will fall from the rod first, or will they all fall at the same time? (Circle one)

1 2 3 4 all at the same time

Why do you think that?

1. Record your start time at the top of the data table.

2. Light the heat source. Have one person use a stopwatch to record the time when each object falls from the rod.

3. Record the time on the data table.

4. Calculate the difference in fall time by subtracting the start time from each fall time.

Data

Start Time: ______________________________

Object Number	Fall Time	Time Difference
1		
2		
3		
4		

Making Sense

1. What pattern did you see with the fall time of the objects?

2. Why did the objects fall like that?

3. Did the thermal energy from the heat source transfer directly to the objects?

4. At the beginning of this activity you asked, how, how does thermal energy get into the atmosphere? How would you answer that question after doing this activity? Be sure to include energy transfers.

5. Your class will return to the class model from Activity 2.1 and add or delete elements. Be sure to adjust the copy of the model you have on Activity Sheet 2.1.

Reading 2.2 – Why Does Conduction Matter?

Getting Ready

Have you ever hard-boiled an egg? When you start, the egg is not solid on the inside. When you crack and peel the egg and eat it, the center is cooked and firm. How do you think that happens?

In class today, you heated the end of a metal rod and saw evidence that the heat was transferred from one end to the other. You learned that this is called *conduction*. If you put a metal pan on the stove, even though the heat is under the pan, the metal handle on the pan can become very hot. This is just like the rod from the investigation you did in class. By conduction, the heat is transferred from the bottom of the pan to the end of the handle. In this reading, you will find out how conduction cooks food, like your hard-boiled egg.

Conduction and Your Food

Have you ever thought about how food gets hot? In order for food to cook, it has to come into contact with a hotter object like a pan. Think about what you do to cook hard-boiled eggs. You start with a pan of water and put it on the stove. Turn on the stove and the burner transfers energy to the pan. That is conduction. The thermal energy from the pan is transferred to the water. Because the eggs are in contact with the water, thermal energy is transferred to them by conduction. But what cooks the inside of the egg?

Have you ever helped crack an egg, or watched someone else do it? If so, then you have seen that what is inside the egg is gooey and soupy—an egg white (which is usually clear) and a squishy round yellow yolk in the middle. Why does an egg that was boiled in hot water form into something solid that you can hold in your hand? The reason why eggs transform shape when they are heated (boiled in their shell or even just fried or scrambled in a pan) has to do with what they are made up of—a lot of proteins. Proteins are molecules that make up a large part of most living things, and it is important for us to eat proteins as part of our diet.

When the proteins of a raw, liquid egg come into contact with heat, it causes them to change form. When you increase the temperature of the food, you increase the speed of the molecules in a food. The greater their speed, the more they collide. These collisions between the molecules can lead to changes in molecular structures by creating new molecules. These collisions break apart the protein molecules and create new molecules. These new molecules have different characteristic colors, flavors, and textures from the original molecules. The formation of new molecules is called a *chemical reaction*. A chemical reaction is necessary to break down the proteins that are in the uncooked egg.

Remember what you learned about conduction. It is all about the motion of the molecules inside of objects. As the molecules move faster, the object has more thermal energy. Those fast-moving molecules bump into others and make them move faster. So that is what happens inside the egg. As the molecules in the egg white start to move faster, some of their energy gets transferred to the yolk. As they all move faster, the thermal energy inside of the egg increases and cooks the egg all the way to the yolk.

Do you think that conduction is what heats and cooks other food as well? Describe another example of how conduction cooks food.

Look at the picture of the hand holding an ice cube. The ice cube that this person is holding is melting. Use what you know about conduction to draw a diagram that explains what is happening in this image. If you remembered that the energy moves from where it is warmer to where it is cooler, then your diagram should show the heat being transferred from the hand to the ice cube by conduction. As more thermal energy is transferred from the hand to the ice cube, it melts. So what does all of that have to do with weather? In this lesson, you learned that air at the surface of the earth is heated from below by conduction. The energy is transferred to the air and the thermal energy of the air increases. Temperature measures the thermal energy of an object. You identified temperature as a condition of weather. On the DQB, the class is keeping track of what happens to matter and energy during a storm. In this lesson, you added the idea of conduction as a way that energy is transferred and moved.

Lesson 3

What Happens to the Hot Air?

ACTIVITY 3.1 – HOW DO DIFFERENCES IN TEMPERATURE AFFECT AIR MASSES?

What Will We Do?

We will investigate what happens if cold air and warm air are next to each other.

⚠ Safety

- Wear goggles when handling hot water and hot soil.
- Be sure to clean up any water or soil that spills.
- Be careful when lighting the incense with the match, and make sure the match is no longer burning before throwing it away.
- Dispose of water and soil as directed by your teacher.

Prediction

1. What do you think will happen to the smoke from the incense if you hold it above the glass tube that is over the cold water?

2. What do you think will happen if you put it above the tube that is over the hot soil?

Procedure

There are two trials in this activity. Record the results of each trial in the boxes on the chart. Your teacher will have an example of the setup for you to look at.

Trial 1: Smoke on the Cold Side

1. Assemble the materials for the apparatus according to your teacher's direction. It should look the same as the example that your teacher has set up.

2. Your teacher will give you a dish with hot soil. Be sure to handle the dish carefully.

3. Place the dish of hot soil under the chimney on the left side of the box. The dish of cold water should go under the chimney on the right side. Slide the glass over the front of the box.

4. Use a match to carefully light the incense. Hold the incense with the smoking end at the opening of the chimney above the cold water.

5. Do not move around or bump the table while you are watching the smoke, because it will disturb the air inside the box.

6. Shine the flashlight at the window of the apparatus to help you see the smoke.

7. Draw a picture of what you observe happening in the box labeled Trial 1. Be sure to include the water and soil in your diagram.

Trial 1

Trial 2: Smoke on the Hot Side

1. Have your teacher check to make sure that the soil is still hot enough to do Trial 2. It may be necessary to replace the soil with new hot soil.

2. When the apparatus is set up, hold the incense with the smoking end over the dish of hot soil.

3. Shine the flashlight at the window of the apparatus in order to observe what is happening to the smoke.

4. Draw a picture and write a description of what you observe in the Trial 2 box.

5. After you complete both trials, return all equipment and clean your work area.

6. Complete the Making Sense questions that follow.

Trial 2

Trial 1	Trial 2
Diagram	**Diagram**
Description	**Description**

Making Sense

1. Based on what you saw in this activity, what do you think is happening to the matter and energy in this experiment?

2. What do you still need to be able to explain?

ACTIVITY 3.2 – WHAT HAPPENS WHEN AIR IS HEATED OR COOLED?

What Will We Do?

We will create a model of what happens to air when it is heated and cooled.

Prediction

This is a picture of the equipment you will use to do this activity. First, you will heat the bottle by putting it in a dish of very hot water. Then, you will cool it by filling the bowl with ice.

Predict what you think will happen to each of the parts when they are heated and cooled.

- When heated, the bottle will ______________________________
- When cooled, the bottle will ______________________________
- When heated, the balloon will ______________________________
- When cooled, the balloon will ______________________________

Procedure

1. Gather the materials necessary to perform the activity. Your teacher will specify these.
2. Follow the steps and be sure to fill in the chart as you go along.
    - Place the balloon over the neck of the bottle, making sure there is a good seal and that no air can escape.
    - Weigh the bottle and the balloon. Record the weight.
    - In the chart, describe what the balloon and bottle look like before you begin.
    - Stand the bottle in the container and have your teacher add the hot water. Let the bottle sit in the hot water for two minutes. On the chart, record any changes in the balloon or bottle.
    - Remove the bottle from the hot water and immediately place it in the ice water bath for two minutes. Record any changes on the chart.
    - Remove the bottle from the ice-water bath. Allow the bottle to return to room temperature. While you wait for the bottle to return to room temperature, clean your work area and return everything except the scale/balance.

- Weigh the bottle and balloon again and record the data. Be sure to describe what the room temperature bottle and balloon look like.

Data

Weight of Balloon and Bottle

At room temperature before heating and cooling: ______________________

At room temperature after heating and cooling: ______________________

Change in weight: ______________________

	At Room Temperature (Before)	After Heating	After Cooling	At Room Temperature (After)
Description of Bottle				
Description of Balloon				

3. Return to your prediction at the beginning of the activity. Compare your prediction to what actually happened. Record your comparison.

4. Create a model to show what happened to the matter (air) and the energy in the activity you just completed. Your model should include what happened to the matter and energy when the bottle was heated and then when it was cooled.

   - location of heat source
   - label for how air is heated
   - the arrangement of molecules in the bottle and the balloon
   - arrows to show the movement of molecules

Making Sense

Compare what you just saw with the balloon and bottle to what you observed in the first experiment with the smoke in the box.

ACTIVITY 3.3 – WHY HEAT RISES

What Will We Do?

Develop a consensus model of why hot air rises.

Procedure

1. Use your description of what happened in Activity 3.1 and your diagram from Activity 3.2 to start your model. Be sure to include the following items in your model:

    - location of heat source
    - label for how air is heated
    - location of hotter and cooler air masses
    - the arrangement of molecules in each air mass
    - small arrows showing the movement of molecules in each air mass
    - large arrows showing how each mass of material moves

2. Add anything that you have learned about density to your model that will help explain why heat rises.

3. After you have drawn your model, write a description of what is happening in your model. Be sure to include what is happening to both the matter and the energy.

Group Model of Why Heat Rises

Group Model

"Use your model to explain why warmer air rises.

Use this space to record the consensus model of why hot air rises.

Consensus Model

Reading 3.3 – Why Learn about Convection?

Getting Ready

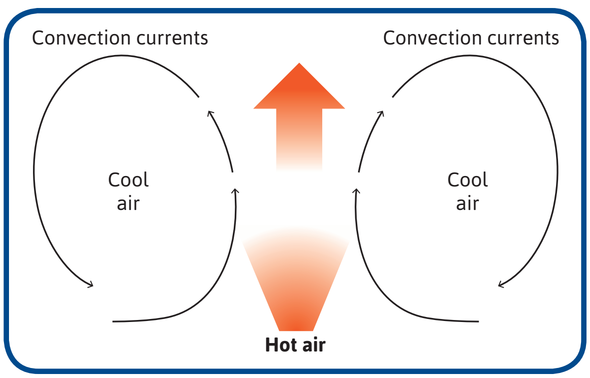
Have you ever sat by a fire and roasted marshmallows? If you hold the marshmallows above the fire or coals and slowly turn the stick, they will cook and become golden brown. Sometimes if you are not careful, they can burn or even catch fire. How do you think that can happen if they are not in the flames but are above the fire?

Have you ever watched a fire burn and seen the sparks from the fire rise and swirl above the fire? The sparks are following the movement of air away from the fire. What do you think is causing the air to rise? In class, you learned that convection is a process that moves both energy and matter.

How Does Convection Toast the Marshmallow?

In Lesson 2, you learned that air is heated from below, so the fire heats the air above it. When a fire burns, both matter and energy are being moved. As it heats, the space between the molecules in the air increases. This makes the air less dense, and it rises. As it moves upward, it carries the extra energy with it. As the hotter air rises, cooler air moves in to take its place. This air is then heated and rises. When it moves farther from the fire, it cools, becomes denser, and sinks.

This diagram is a model of convection taking place around a fire. Notice how the air above the fire is being heated and rising. The red arrow shows the air above the fire heating and rising, carrying more thermal energy. The cooler air near the fire is pulled in. It is then heated and rises. This is what causes the sparks to swirl above the flame. They are caught in the air that has been heated by the fire and is rising. As long as the fire continues to burn, this convection current will continue to move the air and energy.



What does that have to do with roasting marshmallows? You know that if you put your marshmallow directly in the fire it will burn, but there is enough thermal energy in the air above the fire to heat your marshmallow until it turns a golden brown like the one in the image. Even if only hot coals are left, they continue to heat the air above them by conduction. The air carries enough thermal energy to roast the marshmallows.

Where Else Does Convection Occur?

Have you ever helped bake cookies? If there are two trays of cookies baking at the same time, you often need to switch the trays around, because the one on the top rack bakes faster than the one on the bottom. Most ovens, gas or electric, have their heat source on the bottom of the oven.

If the heat source is on the bottom, why would the cookies on the top shelf bake more quickly?

If your answer included convection, you are right. The air in the oven is heated by the heat source on the bottom and rises. Because the oven is closed, there is no place for the hotter air to go, and it is trapped on the top of the oven. Even though some of the air cools and sinks, because of the trays of cookies, there is more hot air on the top of the oven than on the bottom, so the food at the top cooks faster. This natural convection occurs in all ovens because of temperature differences and the placement of the heat source.

If there is convection in a regular oven, what is a "convection oven"? You may even have a convection oven in your kitchen. Does it look any different from the regular oven? Why is it called a *convection oven*?

The difference between the two types of ovens is that in a convection oven, air is moved throughout the oven with the help of a fan. In natural convection, the movement is caused by a difference in temperature. Because the air in a convection oven is constantly moving, it does not get trapped at the top and food cooks more evenly. This moving air transfers thermal energy more quickly than if the air was still. The term *convection oven* may be a shortened version of *forced convection oven*, which is a more accurate description of what is occurring.

Making Sense

If you hold your finger next to the flame on a candle like the one in the picture, you can feel heat, but you will not get burned; however, if you hold your finger above the candle, you will. Use what you know about the movement of matter and energy to help to explain why this happens.

Lesson 4

Where Does the Energy Come from in a Storm?

ACTIVITY 4.1 – CONSTRUCTING A BAROMETER

What Will We Do?

We will collect data to determine if air exerts pressure on the earth's surface.

Prediction

1. Draw a diagram of the barometer that is set up in your classroom.

2. Predict what you think will happen to the water level in the tube (and why) if the air pressure (a) goes up or (b) goes down.

Procedure

Every day for 10 days, record the following data:

- readings from your class barometer
- air pressure reported in the weather report
- a brief description of the weather on each day

Data

Date	Class Barometer	Air Pressure (Weather Report)	Weather Description

Making Sense

1. How did the data from the class barometer compare to the air pressure shown in the weather report?

2. Was there a change in the weather when the air pressure changed? Describe what happened.

3. Using what you know about air pressure, explain what happened with the class barometer and why.

ACTIVITY 4.2 – TEMPERATURE DIFFERENCE AND MOVEMENT OF AIR MASSES

ACTIVITY 4.3 – IS A STORM CLOUD DIFFERENT FROM OTHER CLOUDS?

What Will We Do?

We will determine how storm clouds are different from other clouds and revise the storm model.

Procedure

1. You will look at a video of storm clouds that are forming. Your teacher will show you the video two times. The first time, you should watch and observe what is happening. Before you watch the video the second time, read the following questions and then look for the answers as you watch the video. Record your answers after the video is finished.

    a. What happens to the size and shape of the cloud?

    b. Are all parts of the cloud behaving in the same way? Explain your answer.

    c. What happens to the top of the cloud?

    d. Was there anything else you noticed about the cloud?

Making Sense

1. List any questions you have about what was happening in the storm cloud. After the class discussion, return to these questions to see if you can answer them.

2. Record any answers to the questions that you learned from the class discussion.

3. When your class has finished revising the storm model, create a final model in the following space.

LESSON 5

What Can Weather Maps Tell Us?

ACTIVITY 5.1 – WHAT CAN WEATHER MAPS TELL US?

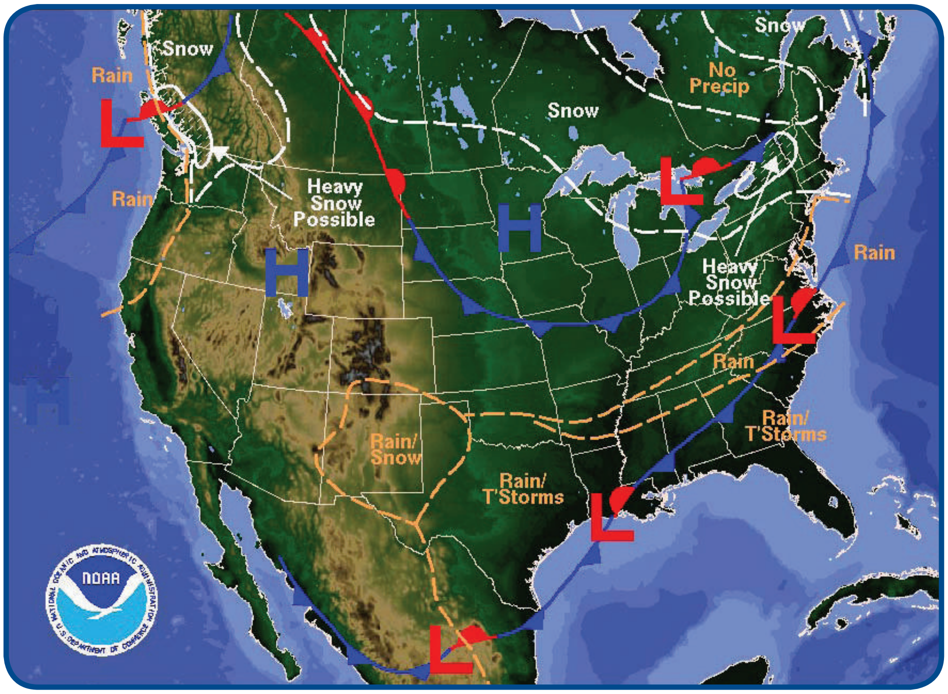
What Will We Do?

We will interpret representations on a weather map.

Procedure

1. The following is a surface area map like the one your teachers showed you. Look at the map with your group and answer Question 1a. After the class discussion, answer Question 1b.

Surface Area Map



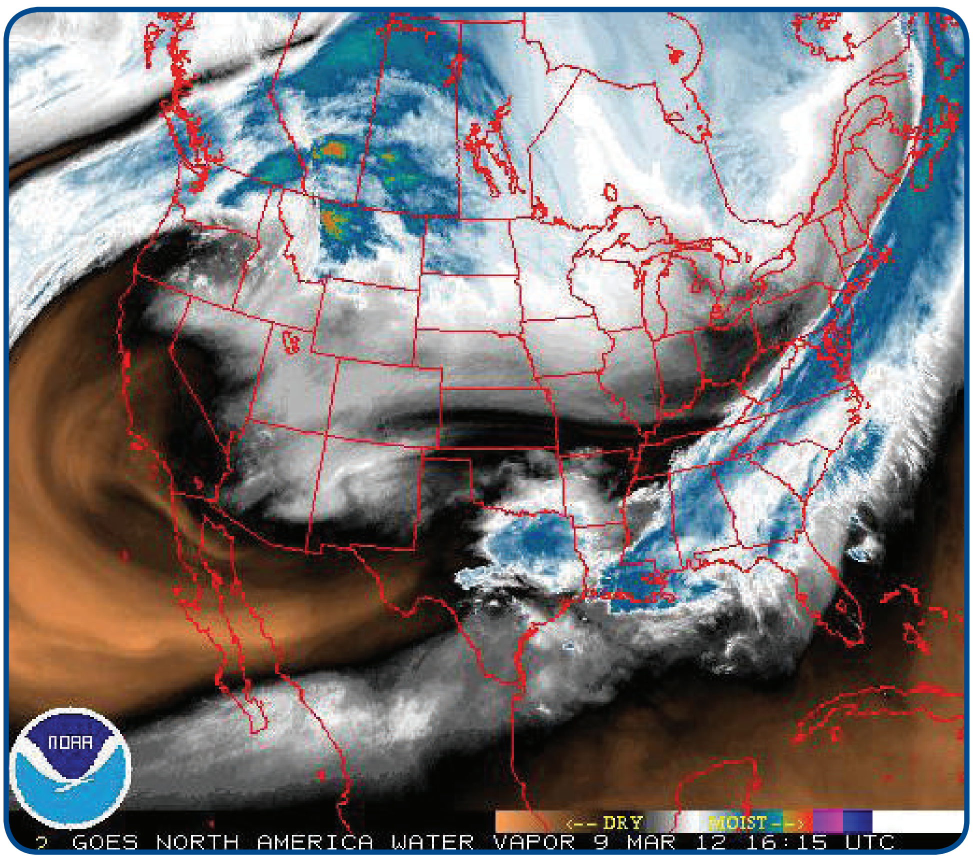
Weather Forecast for Fri. Mar 09, 2012, issued 3:17 AM EST
DOC/NOAA/NWS/NCEP/Hydrometeorological Prediction Center
Prepared by McReynolds Base on HPC, SPC, and NHC forecasts

a. What do you notice on the map? List everything you can think of.

b. What questions do you have about the map? What did you learn about this map from the discussion in class?

2. Study the following map with your group and then answer the questions. You will come back to Question 2c after the class discussion.

Cloud Cover (3/9/12)



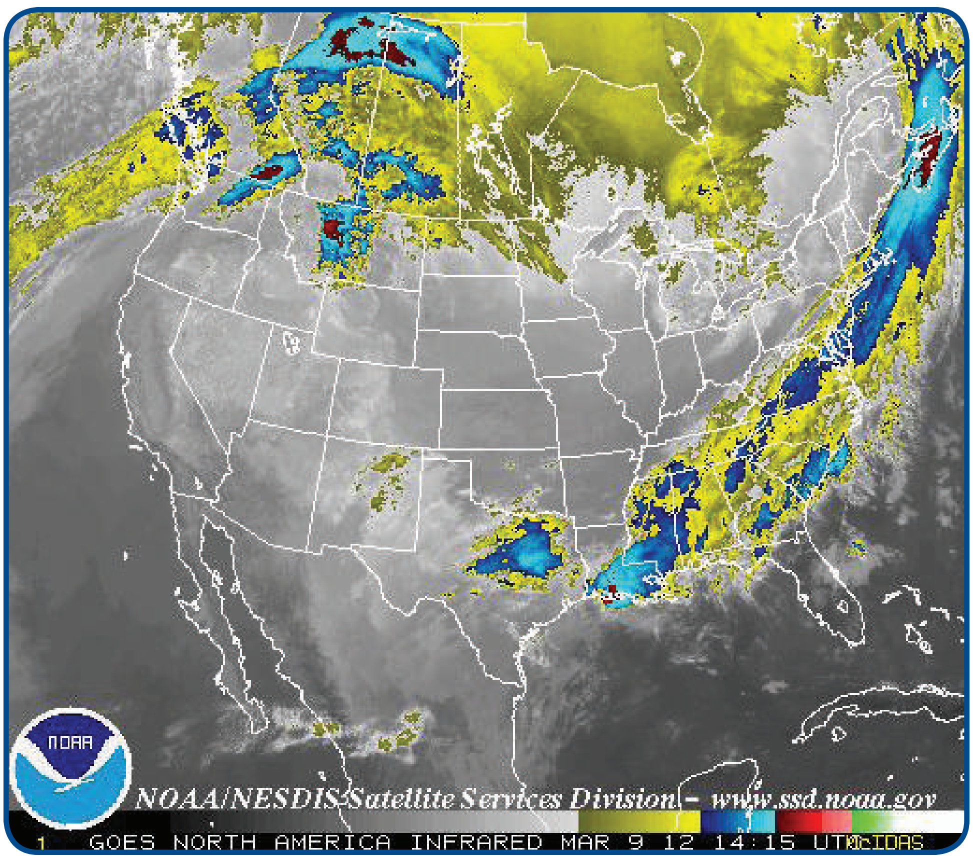
a. Where are clouds in this picture? Where do you think there is precipitation?

b. What did you learn during the discussion?

c. What questions do you still have?

3. Study the following map with your group and then answer the questions. You will come back to Question 3c after the class discussion.

Precipitation (3/9/12)



a. Where is the precipitation on this map?

b. Look back at the map of the clouds in Question 2. What do you notice about the location of the clouds and precipitation?

c. What did you learn from the class discussion?

d. What questions do you still have about the map?

ACTIVITY 5.2 – CREATING AN ISOBAR MAP

What Will We Do?

We will create a map that represents air pressure data.

Procedure

Part 1

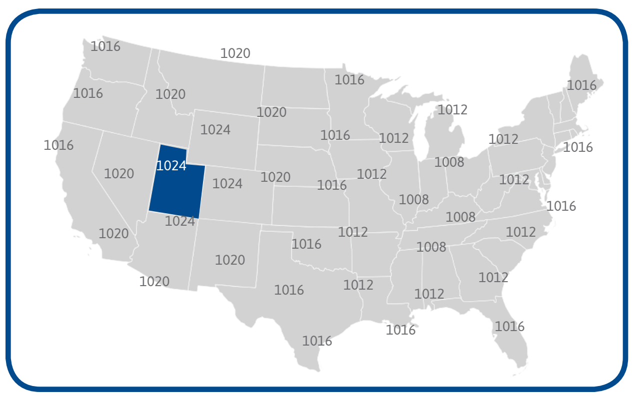
1. In class, you learned that millibars (mb) are a measurement of air pressure. The following map shows pressure readings for different locations in the U.S. These readings are shown in millibars.

2. Use the following map and complete Steps 3 through 5.

3. Use a pencil to lightly draw lines connecting identical values of air pressure. Begin by finding the 1024mb reading that is highlighted in blue. Draw a line to the next 1024 value to the northeast. Without lifting your pencil, draw a line to the next 1024 value located to the south. Then connect that line to the one located to the southwest. Finally, return to the value highlighted in blue. You have now created an isobar that represents 1024mb of pressure. Everywhere along that line, the pressure is 1024mb.
   Remember: Isobars are smooth lines with few, if any, bumps in them.

4. Repeat this procedure with the next isobar value. This is 1020mb. Be sure that your isobars do not cross each other.

5. Continue with the remaining values until you have each of the remaining values connected with an isobar.



Part 2

Isobars can be used to identify *highs* and *lows*.
In a high, the pressure is greater than the surrounding area. In a low, the pressure is lower than the surrounding area. Using the same map from Part 1, complete Steps 1 through 4.

1. Label the center of the high-pressure area with a large blue H.

2. Label the center of the low-pressure area with a large red L.

3. You have learned that low-pressure areas usually have precipitation because as the warmer, less dense air rises, the water vapor condenses, forms clouds, and causes precipitation. On your map, shade in green the areas where you would expect to see rain or snow.

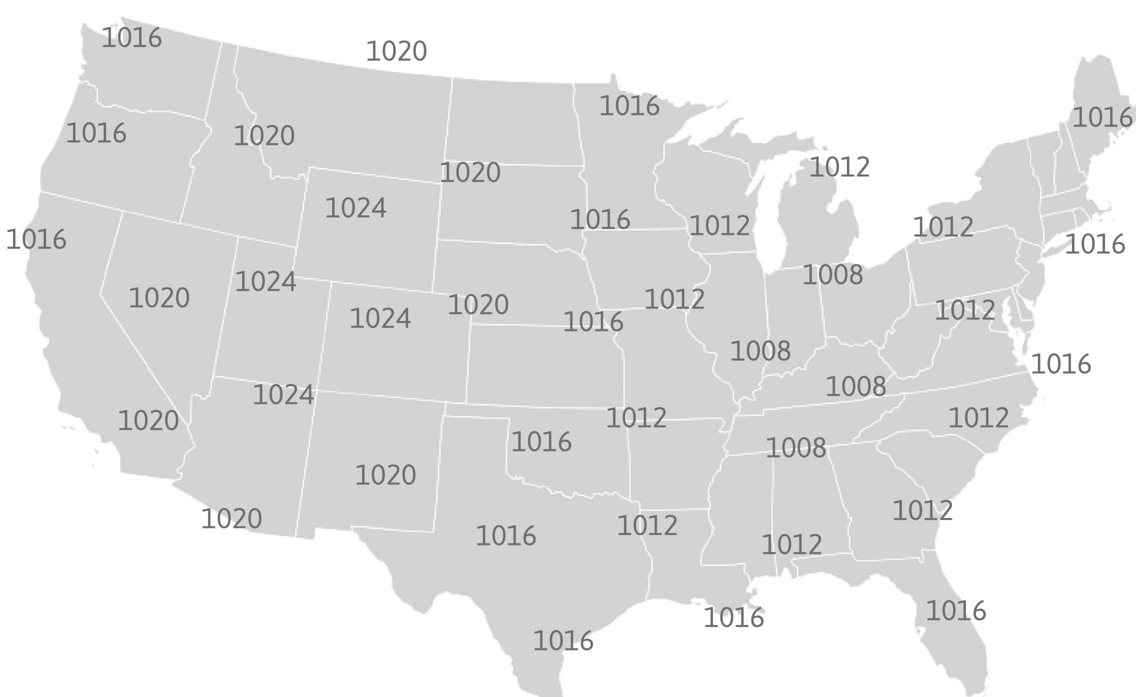
4. High-pressure areas are usually clear and dry because the cooler, denser air sinks and has less moisture in it. On your map, shade in yellow the areas where you would expect to see clear skies.

Making Sense

1. Look at the low-pressure area on your map. What is the pressure reading at the center of the low?

2. What is the pressure reading on the next isobar?

3. What do you think is happening to the pressure between those two isobars?



Reading 5.1 – How Do Scientists Get the Data?

Getting Ready

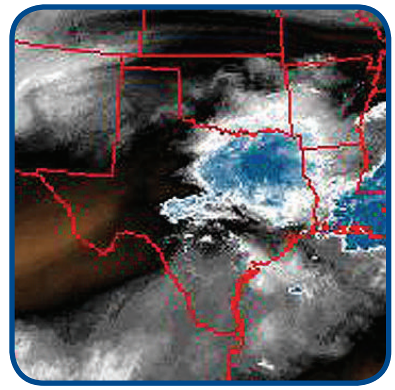
Here is a satellite image of a hurricane near Florida. In this picture, you can see Florida and the island of Cuba. You have probably seen pictures like this in the newspaper or on the news.

In class today, you looked at images of clouds over the United States. Clouds can help scientists tell where it is raining. You learned in Lesson 4 that clouds are necessary for precipitation, so it would be important for people who predict the weather to know where the clouds are and where they are moving. The weatherperson on television refers to these as *satellite images*. Have you ever wondered how they get these images? In this reading, you will learn how these images are taken. You will also learn about how they get the images of rain or snow that you see.

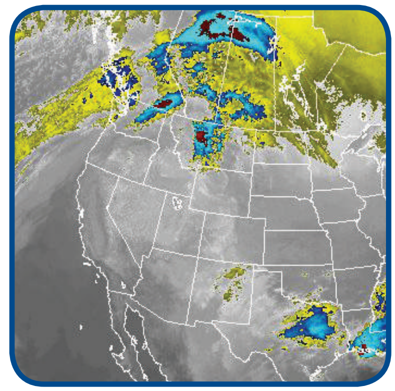
What Is a Satellite?

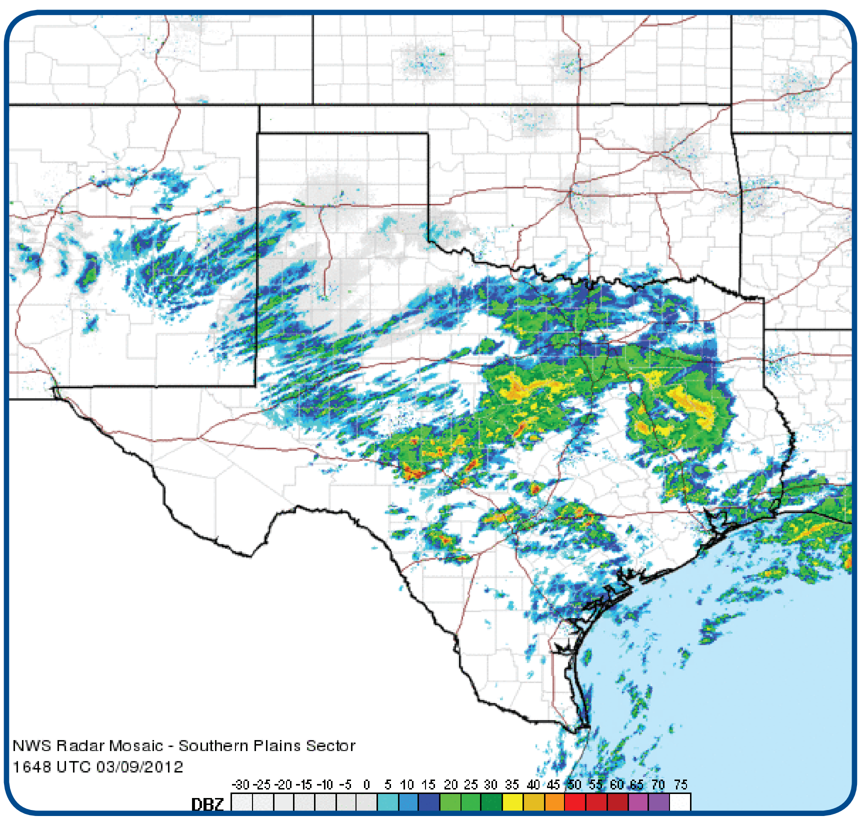
A satellite is an object that moves around another object. Sometimes these are natural satellites, like the moon that orbits Earth. Sometimes satellites are man-made. Man-made satellites have many purposes. For example, they can be used for telecommunication, such as televisions and cell phones. Some cars have global positioning systems (GPS) that use satellite information in order to get directions or tell drivers exactly where their car is on a map. In the following paragraph, you will learn how satellites are used to gather information about the weather. How do you think weather satellites gather information about the weather?

A *weather satellite* is a type of satellite that is used to monitor the weather and climate of Earth. The image that these satellites take is in the infrared band of light. In the IQWST PS1 unit, you learned that the light you see is called *visible light*, and light that you cannot see is called *infrared light*. Weather satellites are programmed to see infrared light and show the relative warmth of objects. Colder objects appear brighter, and warmer objects appear darker. The advantage to taking infrared images is that scientists can take them day or night, because objects like land and clouds never stop giving off infrared light. Look at the picture of the eastern part of the U.S. taken by a weather satellite.



When you looked at the satellite images in class, you learned that the outline of the states was added to help make the picture easier to understand. Scientists have added the outline here to help see where the clouds are located. The areas on the map that appear darker are warmer and give off more infrared light. The lighter areas are cooler and give off less infrared light. The light clouds in this picture are higher and cooler. The very dark places on the map have no clouds. The darker clouds are lower and warmer. Looking at the next map with images that go from white to grey to darker grey to black, it is hard to tell what is going on in some places. This image is from the same time and place as the other map, but color has been added to it for ease of reading.





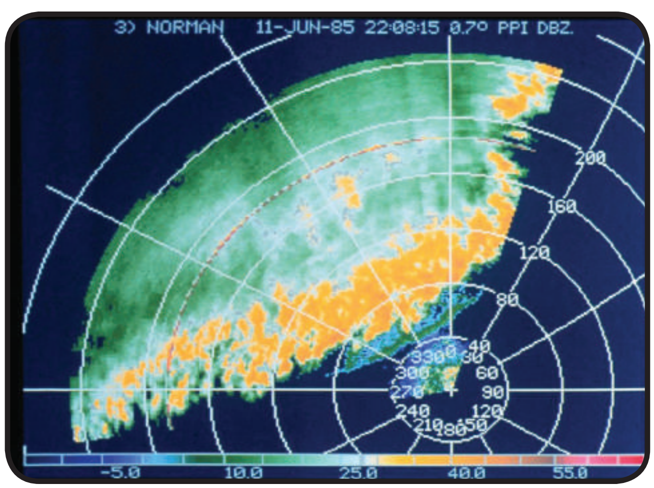
Why Do You Think Color Is Added to the Map?

Scientists often color maps to make it easier for people who are not scientists to interpret. This is called *false color* because it is not in the original image. Adding the color makes the image easier to understand. In the second image of the clouds, some clouds appeared yellow, green, blue, orange, and red. In class, you learned that the dark blue showed the highest and coldest clouds. The orange and red are the warmest and lowest.

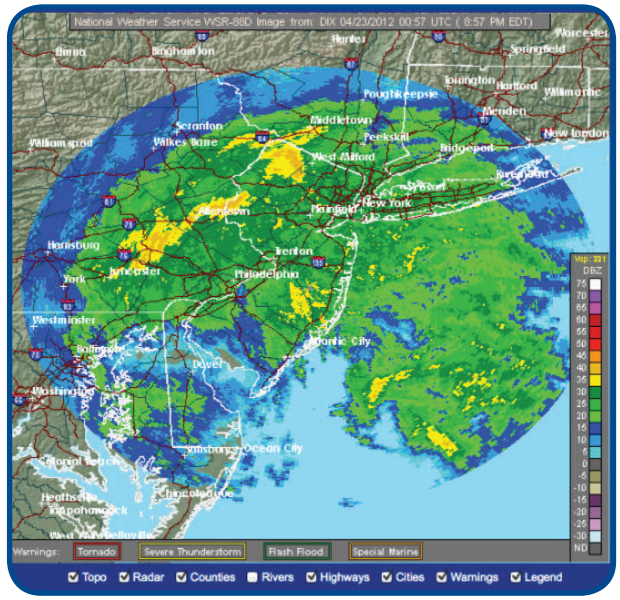
How Do They Determine Where the Rain Is?

When giving the weather report on television, the weatherperson usually shows a radar picture of where is the rain. How does radar know where the rain is? Weather radar works just like the radar that the police use to tell how fast a car is going. The radar that the police use sends out a flash of light that cannot be seen called *radio waves*. The radar gun also has a detector in it for this type of light. The light from the radar gun travels to the target car and bounces off back to the detector in the radar gun.

However, weather radar sends out a signal that bounces off drops of water instead of a car. Have you ever noticed lines on the radar image that form a circle just like on this picture? The radar light source and detector are on a tower that rotates 360°. While it scans, the detector will detect any light that comes back to the tower if it is reflected or scattered off of airborne particles. From light signals that do bounce back to the tower, weatherpersons can tell how far away the precipitation is, the direction it is moving, how fast it is moving, and whether it is rain or snow. This helps the weatherperson forecast the weather for your area.



Draw a diagram that shows how a weather radar tower can see where the water is in the atmosphere. When you see the weather radar on television, they add color to make it easier to read, just like in the satellite images. Look at the following picture of a radar image of a storm in New York. What can you tell about the precipitation in the storm from this radar image?



What Can You Tell about the Precipitation in the Storm from This Radar Image?

If you said that it was raining, you would be right. Did you also say that the rain was heavier in some places? When you are watching the weather, the weatherperson interprets the pictures for you. On the side of this image, there is a key to help you figure out the colors. The green indicates rain, but how dark the green is tells you how intense the storm is. The next time you are watching the weather on television, think about what you learned in this reading about satellite and radar images. See if you agree with the weatherperson's interpretation of the images. Maybe you can forecast the weather better than the weatherperson can.

Lesson 6

Does the Storm Model Fit Data from a Storm?

ACTIVITY 6.1 – CAN WE IDENTIFY PATTERNS IN DATA?

What Will We Do?

We will find patterns in data from an actual storm.

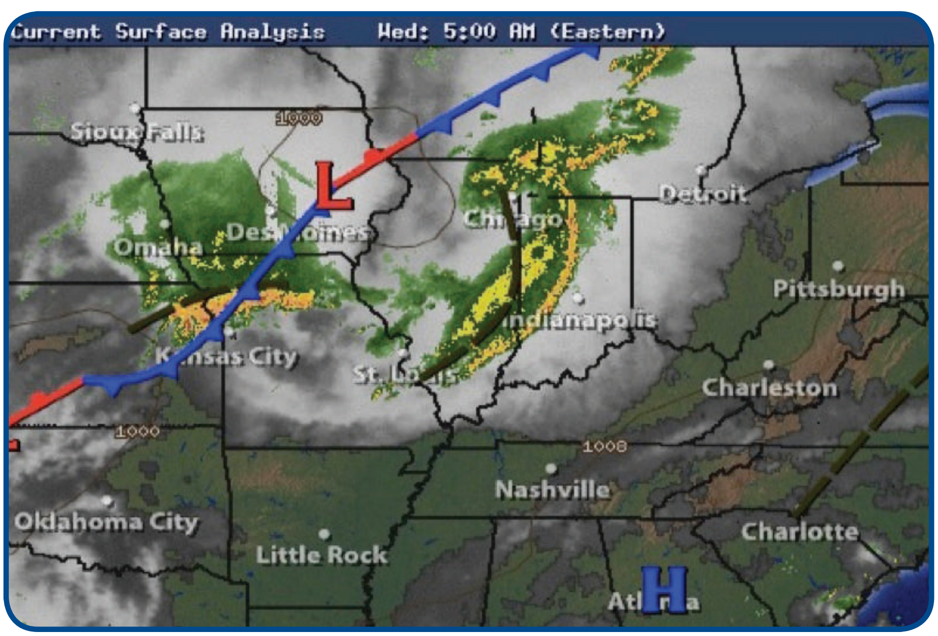
Procedure

1. Begin by answering the questions about the surface area map.

2. With your group, use the data on the pages after the map to complete the chart. Be sure to record any changes that occur or patterns that you observe in the data.

3. Your teacher will have you draw vertical lines on each graph to show the time periods in the chart. Those lines will help you to find patterns and compare them.

Midwest Regional Surface Map



June 2, 2010

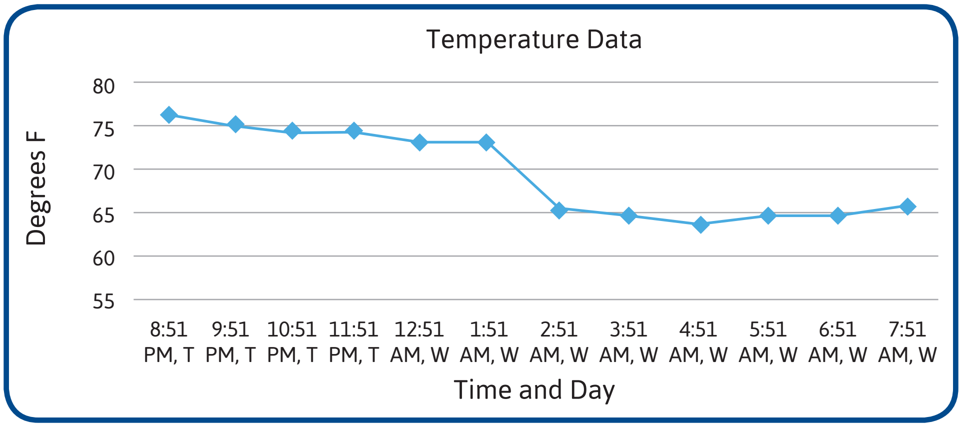
Weather Conditions (at Midway Airport) Chicago, IL	Before the Storm	During the Storm	After the Storm
Temperature			
Air Pressure			
Humidity			
Precipitation			

Using what you learned about the information on surface maps in the last activity, answer the following questions:

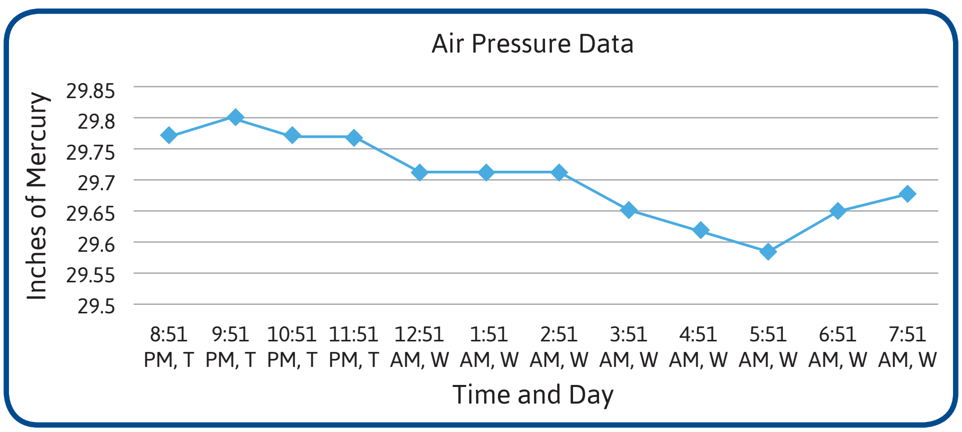
1. Where are the storms on the map?

2. Are high-pressure and low-pressure areas shown on the map? How can you tell?

Temperature Data
Midway Airport (Chicago, IL)
June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM



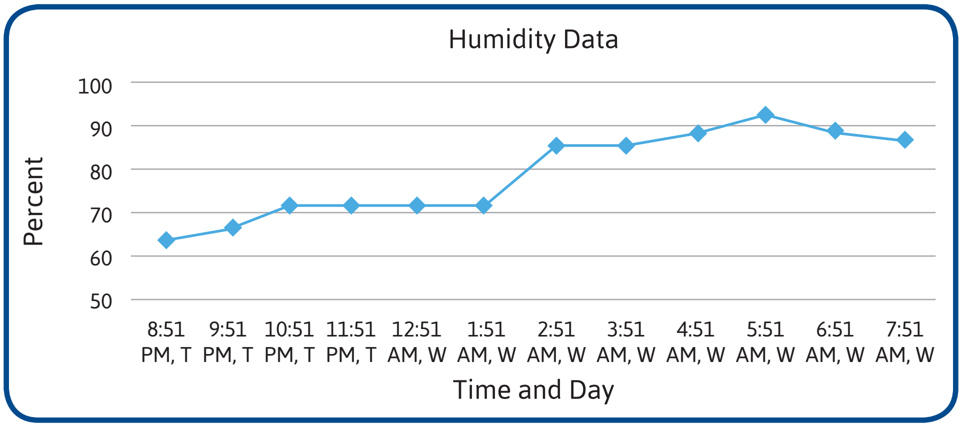
Air Pressure Data
Midway Airport (Chicago, IL)
June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM



Humidity Data

Midway Airport (Chicago, IL)

June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM



Precipitation Data

Midway Airport (Chicago, IL)

June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM

Time	Rainfall in Inches
8:51 PM	N/A
9:51 PM	N/A
10:51 PM	N/A
12:51 AM	N/A
1:19 AM	N/A
1:51 AM	0.00 (amount too small to measure)
2:51 AM	1.27
3:51 AM	0.61
4:51 AM	0.40
5:51 AM	0.08
6:51 AM	0.09
7:16 AM	N/A
7:51 AM	N/A

Making Sense

Did any of the patterns in the data surprise you, given your model? Pick one variable that you found surprising or interesting, and explain what you thought and why.

ACTIVITY 6.2 – CAN THE STORM MODEL EXPLAIN THE DATA?

What Will We Do?

We will use the class storm model to explain the data from an actual storm.

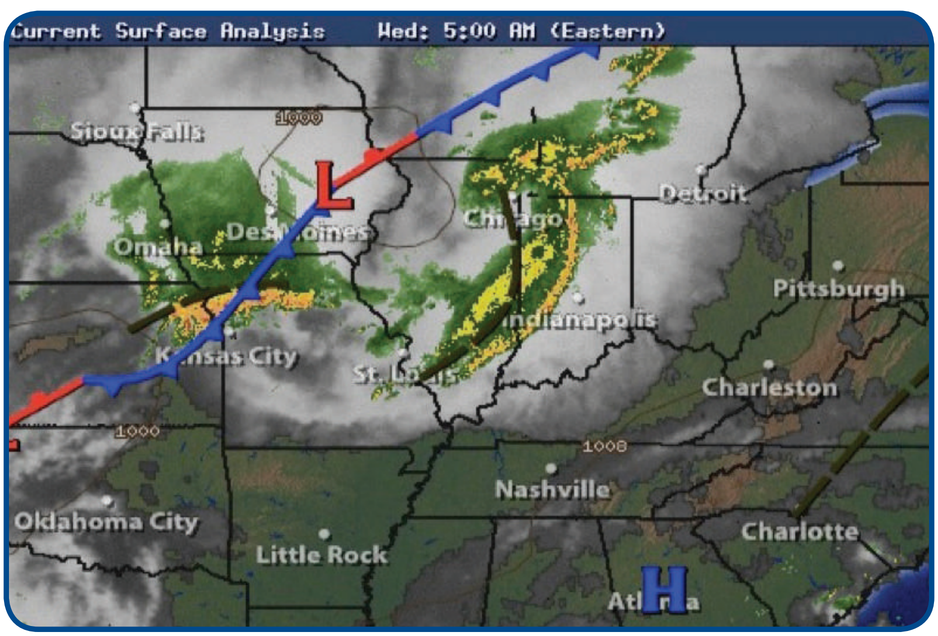
Procedure

1. Your teacher will assign your group one set of data to try to explain using the storm model your class created. You will be assigned temperature, air pressure, precipitation, or humidity. Refer to the model you created in Lesson 4 to answer the questions your group has been assigned.

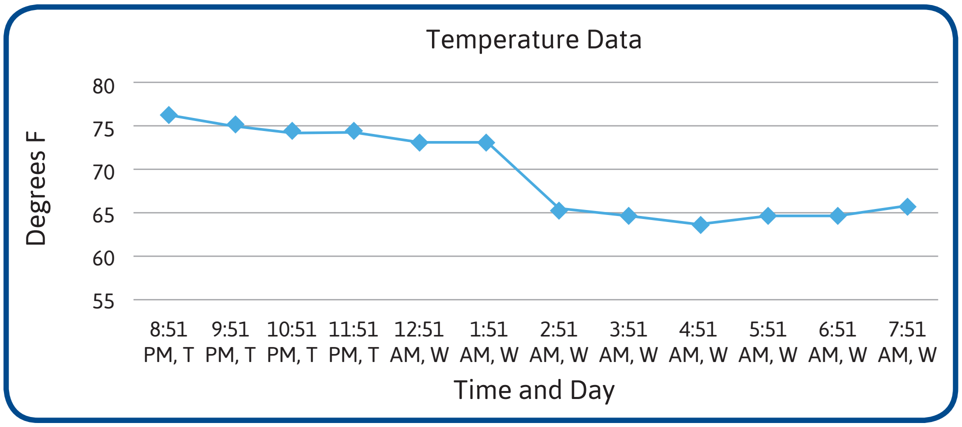
2. Jigsaw with a member from each of the other groups. Discuss what they found out about their data and record it on your activity sheet.

3. Your group now needs to write an explanation that will answer the following question: Why did the storm happen? Use your model, the data from Activity 6.1, and information from the following map. Be sure to explain what is happening to the matter and energy before, during, and after the storm.

Midwest Regional Surface Map
June 2, 2010, at 5:00 AM



Midway Airport (Chicago, IL)
June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM

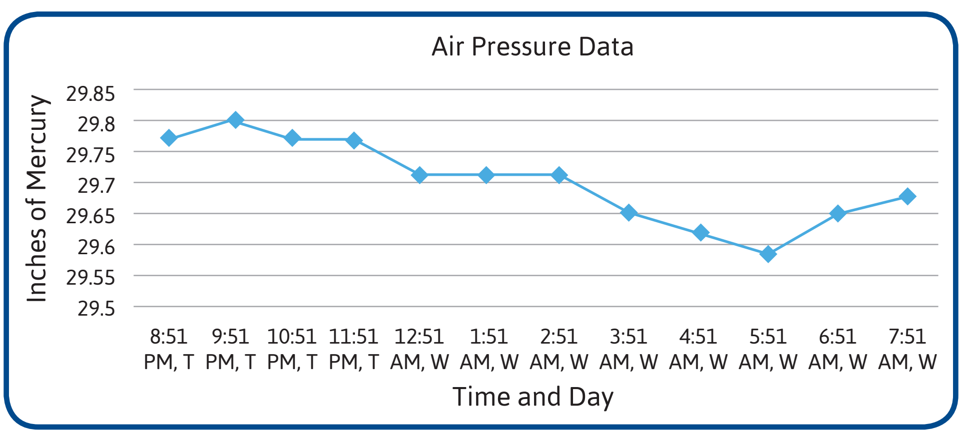


1. What can our model explain about the data?

2. Is there anything that the model cannot explain about the data?

Air Pressure Data

Midway Airport (Chicago, IL)
June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM



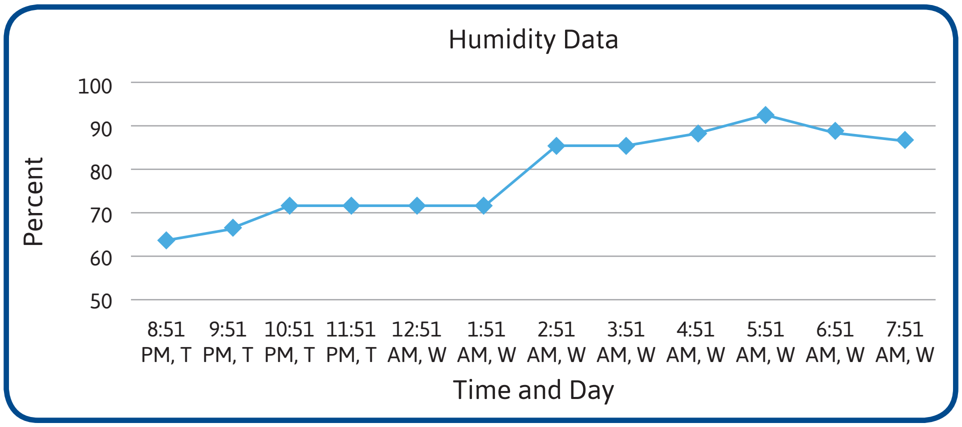
1. What can our model explain about the data?

2. Is there anything that the model cannot explain about the data?

Humidity Data

Midway Airport (Chicago, IL)

June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM



1. What can our model explain about the data?

2. Is there anything that the model cannot explain about the data?

Precipitation Data

Midway Airport (Chicago, IL)

June 1, 2010, at 8:51 PM through June 2, 2010, at 7:51 AM

Time	Rainfall in Inches
8:51 PM	N/A
9:51 PM	N/A
10:51 PM	N/A
12:51 AM	N/A
1:19 AM	N/A
1:51 AM	0.00 (amount too small to measure)
2:51 AM	1.27
3:51 AM	0.61
4:51 AM	0.40
5:51 AM	0.08
6:51 AM	0.09
7:16 AM	N/A
7:51 AM	N/A

1. What can our model explain about the data?

2. Is there anything that the model cannot explain about the data?

Using the Model to Explain the Storm

Write an explanation to answer the question, why did the storm happen? (Be sure to support your use of the model with data. Remember, you need to explain what happens to the matter and the energy.)

Reading 6.2 – Is It Going to Snow or Rain or . . . ?

Getting Ready

What is the weather like today where you live? Is it clear and sunny? Maybe it is cloudy. Or is it a stormy day? What conditions or clues do you use to decide if it is a stormy day?

In class, you have been developing a model of a storm. When you think of a storm, do you picture rain or some other form of precipitation? You may live some place where it only rains during a storm, but precipitation can occur in several forms. It can be rain, snow, sleet, or hail. Just as in Lesson 1, where you learned that clouds come in many different types, storms can bring different kinds of precipitation.

What about Rain?

Have you ever played outside in the rain? Has your baseball game or soccer game ever been played in the rain? Or maybe it has been rained out. Almost everyone has been caught in the rain at some time.

Rain is the most common type of precipitation on Earth. The class storm model showed that rain happens when the water vapor in the atmosphere condenses and forms drops of liquid water. These drops of water fall all the way to the surface of the earth. If the temperature all the way to the earth's surface is above freezing, then it is raining. Rain can come in the form of showers or drizzle, or it can be a thunderstorm with heavy rain and thunder and lightning. In the first reading, you learned that cumulus (or cumulonimbus) clouds produce precipitation. Most types of precipitation are produced by some type of cumulus cloud.

If cumulus clouds produce precipitation, why doesn't it rain all the time? Think about the other conditions that you identified as part of a storm in your model. What other condition(s) are important in determining if it will rain or snow? Explain why.

Rain or Snow?

Snow actually occurs almost every time it rains, but it often melts before it reaches the earth's surface because of the temperature of the air around it. In class, you learned that clouds are formed when the water evaporates into the air and the water vapor condenses into liquid around something like dust or other particles in the air. Sometimes if the temperature of the cloud is cold enough, the condensing water turns directly into ice without ever becoming liquid. This happens when the vapor condenses around an ice crystal. This creates snow.

As snow falls to the ground, it often melts on the warm surface of the earth. However, if the surface is cold enough, it begins to pile up. If there was a lot of water vapor in the air, then there will be more snow. That means that if you live where it snows, you may end up shoveling a lot of snow. Just like when it rains, snow is produced in cumulus clouds. The temperatures in the cloud and on the earth's surface determines whether it rains or snows.

What about Other Forms of Precipitation?

If you live where the weather can get cold, maybe you have gone outside on a cold morning and found the door to the car frozen shut, or you have slipped on the icy sidewalk. Maybe you have even found a frozen scene like the one in this picture. This ice glaze was actually formed by freezing rain. Freezing rain occurs when the earth and objects on the surface, such as roads, tree limbs, and power cables, are at temperatures below 0°C (32°F). The precipitation that was falling started out as snow. Before it reached the ground, it passed through a warmer layer of air. This melted the snowflakes, so they were drops of liquid water. Why did it not fall as rain?

Think about what you learned in Lesson 2 about how air above the surface is heated. What do you think happened to those raindrops just before they hit the surface? Why?

You learned that air at the surface is heated from below. Right above the surface, there is a very cold layer of air because the surface and everything on it is very cold. This cold layer of air makes the liquid water supercooled and ready to freeze up. Because the water molecules are close to the surface, they do not have time to freeze. When they hit the freezing surfaces on Earth, they freeze. This results in a thin layer of ice.

What about Snow in the Summer?

Sometimes during a severe rainstorm during the summer, there will be ice pellets, called *hail*, that hit the earth. These pellets can be small or sometimes as big as baseballs. Hail is formed like snow, but in a severe thunderstorm, the snowflakes and raindrops can be pushed back up into the colder air so that they refreeze around other snowflakes. This process of melting and refreezing can cause the water to form large chunks of ice. When they get so heavy that they cannot be lifted by the wind, they fall to the earth. Sometimes these ice chunks can be very large. When hail falls during a thunderstorm in the summer, it can make the ground look like it has been snowing. Large, baseball-sized hail can also cause a lot of damage.

You have been reading about different kinds of storms. They are different because they bring different kinds of precipitation, depending on the temperature. Do you think that the model of a storm that you developed in class can explain all of the different kinds of storms you read about? Why?

Lesson 7

Why Does Temperature Vary in Different Locations?

ACTIVITY 7.1 – HOW CAN WE COMPARE CITIES ON EARTH?

What Will We Do?

We will use latitude and longitude to plot city locations and compare the temperatures of the cities based on location.

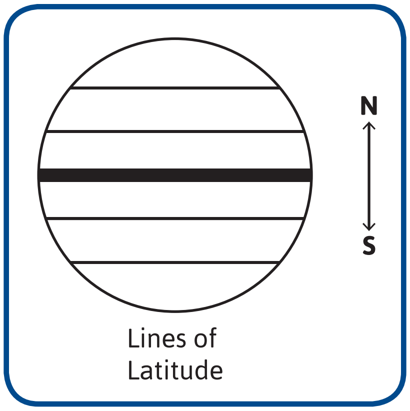
Procedure

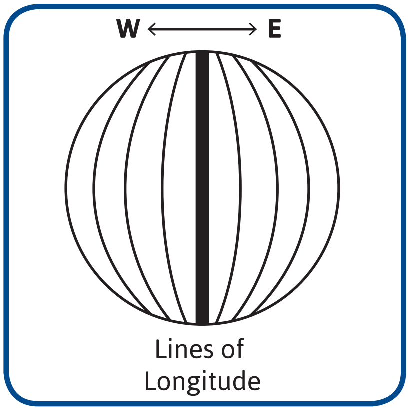
Review the following information about latitude and longitude.

Part 1: Background on Reading Maps

Maps and globes help us understand the location, distances, and relative sizes of places on the planet. Places on a map or globe are described by imaginary lines on Earth's surface. These imaginary lines are called *latitude* and *longitude*.

- Latitude lines are shown as the horizontal lines that run east to west. On a globe, they look something like the rungs of a ladder.
- The equator is the line of latitude that divides the earth into Northern and Southern Hemispheres, or halves. The numbers used to describe latitude are the number of degrees (°) from the equator. Latitudes with °N are north of the equator, and those with °S are south of the equator.
- Longitude is shown by the vertical lines going north to south. They are curved. On a globe, they look like orange segments.
- The prime meridian is the line of longitude that divides the planet into Eastern and Western Hemispheres. The numbers used to describe longitude are the number of degrees from the prime meridian. Longitudes with °E are east of the prime meridian, and those with °W are west of the prime meridian.



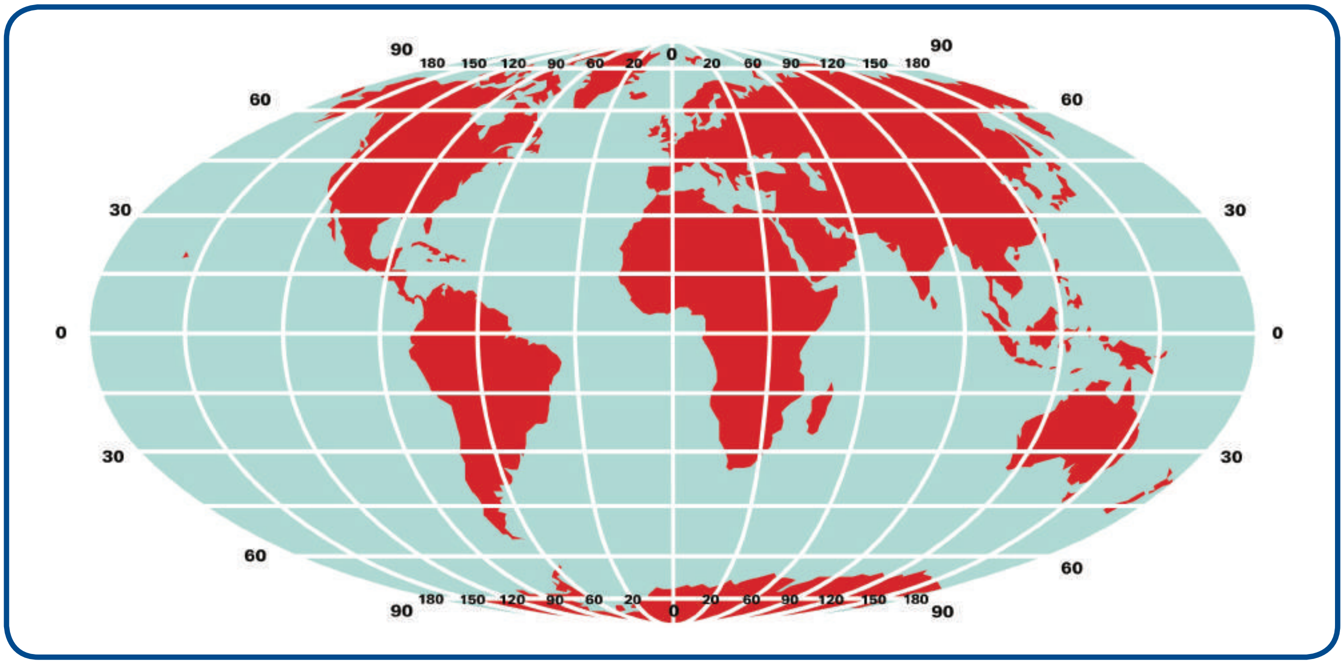


The numbering of the lines of latitude and longitude are the same on a globe as on a map. If you can find the location of a city on a map, you would be able to find it on the globe as well using the same latitude and longitude.

Part 2: Comparing Data from Different Cities

1. Using the data from the chart that follows, plot the location of each group's city on the map. Use small black circles to show city locations.

City	Latitude/Longitude
Atlanta, Georgia	33°N 84°W
Belem, Brazil	1°S 48°W
Buenos Aires, Argentina	35°S 58°W
Oslo, Norway	59°N 10°E
Singapore, Singapore	1°N 103°E
Ushuaia, Argentina	54°S 68°W



2. Plot the location of your group's city on the map in your classroom.

3. Using the chart at the end of the activity sheet, calculate the average yearly temperature for each of the class cities. When you finish, answer the Making Sense questions.

Making Sense

1. Are there any patterns in the temperatures of the cities? Describe them.

2. Make a claim about the relationship between location and temperature.

City Latitude/ Longitude	Average Daily Temperature by Month (˚F)												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Atlanta, Georgia 33˚N 84˚W	43	46	53	62	70	77	79	79	73	63	53	45	
Singapore, Singapore 1˚N 103˚E	81	82	83	83	83	84	83	83	82	82	81	80	
Oslo, Norway 59˚N 10˚E	26	26	33	41	54	60	64	61	53	44	34	27	
Buenos Aires, Argentina 35˚S 58˚W	75	73	69	62	56	51	50	53	56	61	66	72	
Belem, Brazil 1˚S 48˚W	81	80	80	81	82	82	82	82	82	82	82	82	
Ushuaia, Argentina 54˚S 68˚W	49	49	46	40	36	32	32	34	38	43	45	47	

ACTIVITY 7.2 – DO THE NUMBER OF DAYLIGHT HOURS VARY IN DIFFERENT LOCATIONS ON EARTH?

What Will We Do?

We will investigate the effect of daylight hours on temperature.

Prediction

Do you think the number of daylight hours could have an influence on the temperature difference that you noticed at different latitudes? Why?

Procedure

1. Examine the data on the chart at the end of this activity sheet. It shows the average hours of daylight by month for each of the class cities.

2. Find the average number of daylight hours in a year for your city. Record your answer in the last column on the chart at the end of the activity sheet.

3. Jigsaw groups so that there is one member from each of the cities in the new group. Record each group's answer about the hours of daylight on the table.

Making Sense

1. Did you notice any patterns in the total hours of daylight for the year? Describe.

2. Did you notice any patterns in the daylight hours each month? If so what are they?

3. Look back at the average temperatures from Activity 7.1. Do you see any connection between the hours of daylight and the temperature for each city? Describe the pattern.

4. Can you make a claim about the affect of the number of hours of daylight and how it influences temperature? Write your claim here:

5. Look at the prediction you made at the beginning of this activity.

   a. Do the data in this activity support your prediction? Explain.

   b. What questions do you still have?

City Latitude/ Longitude	**Average Hours of Daylight by Month**													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Total	Aver-age
Atlanta, Georgia 33°N 84°W	10.1	10.9	11.8	12.9	13.7	14.2	14.0	13.2	12.2	11.2	10.3	9.8	144	
Singapore, Singapore 1°N 103°E	11.9	12.0	12.0	12.0	12.0	12.1	12.1	12.0	12.0	12.0	12.0	12.0	144.1	
Oslo, Norway 59°N 10°E	6.5	9.0	11.5	14.3	16.8	18.3	17.6	15.3	12.6	9.9	7.3	5.7	144.8	
Buenos Aires, Argentina 35°S 58°W	14.0	13.2	12.2	11.7	10.2	9.7	9.9	10.7	11.7	12.8	13.8	14.3	144.2	
Belem, Brazil 1°S 48°W	12.1	12.0	12.0	12.0	12.0	11.9	11.9	12.0	12.0	12.0	12.0	12.1	143.9	
Ushuaia, Argentina 54°S 68°W	16.3	14.4	12.2	10.1	8.2	7.0	7.6	9.3	11.5	13.6	15.8	17.0	142	

ACTIVITY 7.3 – DOES THE EARTH'S SHAPE AFFECT TEMPERATURE?

What Will We Do?

We will determine if the shape of the earth affects temperature at different locations.

Prediction

Using what you know about the earth's shape and how it is heated, why do you think that temperature varies based on latitude?

Procedure

1. If your teacher has already set up your model, check the setup before you begin. Be sure that the light source is approximately five feet from the lantern. It should be directly opposite the equator on your model.

2. Your teacher will show you how to use the light sensor. Remember the following:

   - Make sure that the side of the sensor that shows the reading is facing the hole at the top of the lantern.
   - Rest the tip of the sensor on the top of the cork inside the lantern. This will help make sure that you hold the sensor in the right position.
   - Be sure to have your teacher check your setup and how you are reading the sensor before you begin to complete the data table.

3. Take the first reading at the equator on your lantern. This is 0° on the data table.

Data

Latitude (°N)	Incoming Light (Lux)
0°	
10°	
20°	
30°	
40°	
50°	
60°	
70°	
80°	

1. Was there a pattern in the intensity of incoming light and the latitude of the pins on your model? If you saw a pattern, describe it.

2. Using what you know about light, draw a diagram of how light rays from the sun hit the earth. Be sure to include

   - Earth and sun.
   - light rays from the sun.
   - a label showing where the light was most intense in your data.
   - a label showing where the light was least intense in your data.

3. Do you have any ideas that could explain this relationship? What questions do you still have?

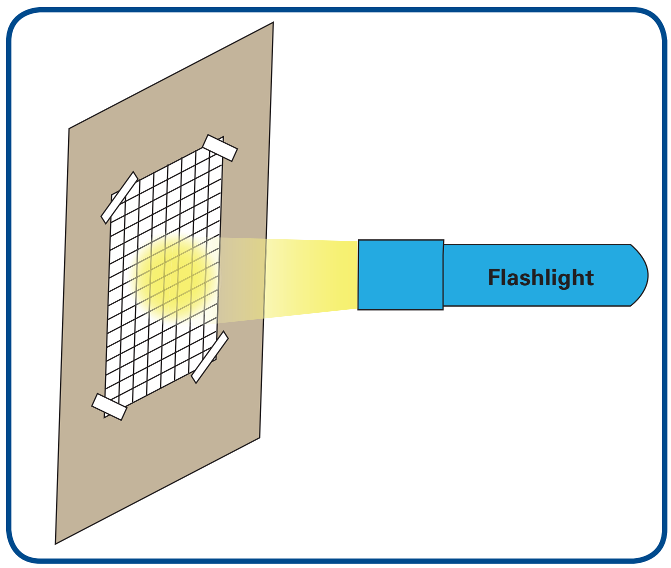
ACTIVITY 7.4 – DOES THE ANGLE THAT LIGHT HITS THE EARTH AFFECT INTENSITY?

What Will We Do?

We will investigate the effect of angle on light intensity.

Procedure

1. Using masking tape, attach a piece of graph paper to the cardboard.
2. On your desk or lab table, make a stack of books that will be two feet away from the cardboard.
   Place your flashlight on the books so that it is parallel to the floor. One person in the group should place their hand on the flashlight so that it does not move during the investigation.
3. Hold the cardboard with the graph paper so that it is perpendicular to the floor. The beam of the flashlight should be in the center of the paper.
4. Trace the outline of the flashlight beam on the graph paper.
5. Keep the cardboard the same distance from the flashlight and tilt the board away from and then toward the light. Describe what happens to the light on the board.



6. Tilt the board away from the light at a large angle (about half the distance to the table, moving away from the light). Using a different color pen or pencil, draw an outline of the beam on the graph paper.
7. Try a larger angle (moving away from the light and closer to the table). Use a third color and draw an outline of the beam on the graph paper.
8. Take your graph paper and count the number of squares that are inside of the first outline you drew.

Record your data in the table. Then, count the squares inside of each of the other outlines.

Data

Angle of Board	Number of Squares Covered by Light
#1 (at the equator)	
#2 (halfway to North Pole)	
#3 (near North Pole)	

Making Sense

1. Did the number of squares covered by the light change? Describe the pattern.

2. Why would you get different readings when the light source remained the same?

3. How does the number of squares explain the temperature data?

ACTIVITY 7.5 – CAN WE EXPLAIN THE PATTERN IN THE DATA?

What Will We Do?

We will construct an explanation about why temperature varies at different latitudes.

Procedure

In this lesson, you have looked at data about the temperature and latitude of six cities. You also plotted their location on a map. You did two investigations about the intensity of light in different locations. In this activity, you will construct an explanation and diagram that answers the question, why is the temperature different at different latitudes?

Draw a model that shows the pattern that connects temperature, latitude, and intensity of light. Below the diagram, explain what your diagram shows.

Homework 7.5 – Do the Data Match the Explanation?

In class today, you constructed an explanation to answer the question, why is the temperature different at different latitudes? For homework tonight, you are to use the explanation you created in class about the difference in temperature at different latitudes to explain the following visualization of the Average Surface Temperature for January (1959–1997). Then, write down any questions you still have.

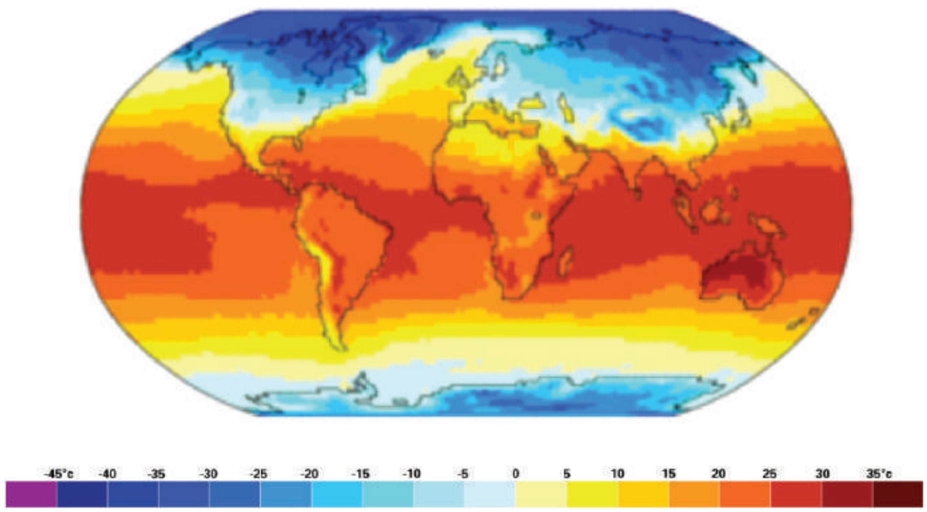


Figure 2: Mean January air temperature for the Earth's surface, 1959-1997. (Source of Original Modified ImageL Climate Lab Section of the Enviromental Change Research Group, Department of Geography, University of Oregon - Global Climate Animations).

To help you interpret the visualization, you need to understand what the colors represent. Each color indicates the average temperature for that location. The data has been averaged over 30 years. The color scale goes from red (the hottest) to yellow to light blue and then to dark blue (the coldest).

1. How does what you learned in class explain this visualization?

2. Write down any questions you have about temperature and latitude.

Lesson 8

What Else Is Affecting Temperature?

ACTIVITY 8.1 – DOES THE CITY DATA MATCH THE VISUALIZATIONS?

What Will We Do?

We will compare city data to identify patterns in the city temperature data and compare them to the visualizations.

Procedure

1. You will need the city temperature data from Activity Sheet 7.1. Plot the monthly temperature for each city on the graph.

2. Label the *x*-axis (horizontal axis) with the months of the year. Label the *y*-axis (vertical axis) with temperature. Each line on the vertical axis should represent 10°F.

3. Use a different color pencil for each of the cities. Be sure to fill in the key below the graph to show what colors you are using.

4. Begin with Oslo and plot a point for each of the average monthly temperatures. When all 12 months are plotted, connect the points so that you have a line graph of the temperature for Oslo.

5. Repeat Step 3 for each of the five remaining cities.

6. When your graph is complete, answer the questions under the Making Sense section.

Data

Making Sense

1. Describe any patterns you see in the graph.

2. Does the latitude of the cities explain the patterns? Why?

3. Can the shape of Earth explain the patterns in the data? Why?

4. List any ideas that you have that might explain the patterns you observed in the data.

ACTIVITY 8.2 – HOW DOES THE EARTH MOVE?

What Will We Do?

We will investigate Earth's movements to answer the question about temperature variation at different latitudes.

Procedure

Part 1

1. Follow these steps to create your Earth model.
   Important: The dots you mark on the model should form a straight line from the North Pole to the South Pole.

   - Draw a black line around the middle of the Styrofoam ball to represent the equator.
   - Place an X on the top of the ball to mark the North Pole. On the opposite side of the ball, make a dot to represent the South Pole. It is important that you can tell which mark is the North Pole and which is the South Pole.
   - Approximately halfway between the equator and the North Pole, make a green dot.
   - Between the green dot and the North Pole, place a blue dot. This dot should be slightly closer to the North Pole than the green dot.
   - Halfway between the equator and the South Pole, place another green dot.
   - Between the green dot and the South Pole, place a blue dot.
   - Place two yellow dots just above and just below the equator.

2. The green, blue, and yellow dots each represent one of the six case study cities. Using the map in your classroom, or the map from Activity 7.1 where you marked the location of these cities, fill in the chart.

Dots North of the Equator	City
Blue	
Green	
Yellow	
Dots South of the Equator	**City**
Blue	
Green	
Yellow	

Making Sense

Part 1

In class, you modeled Earth spinning on its axis (rotation). Use what you learned to answer the following questions:

1. In the model, did all parts of the earth receive the same number of hours of daylight in a day?

2. Does your answer from Question 1 agree with the data about hours of daylight from Activity 7.2? Support your answer with evidence.

3. Does the rotation of Earth on its axis, creating day and night, answer the two questions the class still has? Be specific about what it can and cannot answer.

    a. What causes the temperature differences that create seasons?

    b. Why are seasons the opposite in the Northern and Southern Hemispheres?

Part 2

Prediction

1. Draw what you think Earth's orbit looks like. Be sure to include the sun, Earth, and a line showing the shape of the orbit.

2. Explain why you drew the shape of Earth's orbit the way you did.

Making Sense

1. Does the shape of the earth's orbit answer the two questions the class still has? Be specific about what it can and cannot answer.

    a. What causes the temperature differences that create seasons?

    b. Why are seasons the opposite in the Northern and Southern Hemispheres?

2. Return to the Prediction section where you drew Earth's orbit. Redraw your model and explain what you changed and why. If you did not change anything, explain how your model answers both questions.

New Model of Earth's Orbit

Reading 8.2 – Day and Night

Getting Ready

Have you ever wondered how you would keep track of time if all of the clocks in the world disappeared? Long, long ago, our ancestors were faced with a problem just like that. Clocks had not been invented, and they needed a way to tell time so that everyone could understand it.

Every day you can see the sun as it seems to rise from the eastern horizon, move across the sky, and set in the west. Once the sun has set, the night follows. This difference between the dark nights and the daylight was probably the first way ancient people began to tell time, but how could they tell the difference between early morning, noon, and late afternoon in an accurate way? You tell time by looking at your watch or checking the time on your phone. Ancient people looked at shadows.

Think about what you know about how shadows are created. How could ancient people have used shadows to tell the time? If you remembered that the length of a shadow changes over the course of a day, you would be right. During the day, people saw that the shadow cast by a tree, a rock, or even their own body was long in the early morning and grew shorter and shorter until it disappeared when the sun was overhead in the middle of the day. As the afternoon went on, they noticed that the shadow got longer again—only on the other side of the object.

Using Shadows to Tell Time

After a while, people were able to tell how much of the day was over by looking at the shadows. The first clock was probably invented by a person who put a stick into the ground and made marks in the dirt to show where the stick's shadow was every hour.

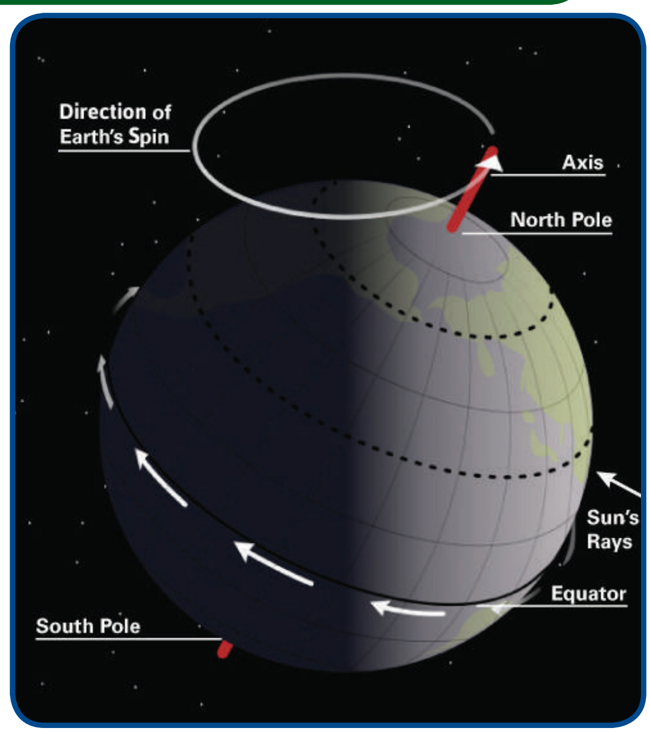
Look at the picture. What time of day do you think it is based on the length of the shadow and why?

Because the shadow cast by the stick is very long, it is either early in the morning or late in the afternoon. Shadows are the longest at sunrise and sunset. People judged the time of day by the length and position of the stick's shadow. After a while, people divided the daylight into 12 hours and designed sundials like the one pictured. These sundials had the hours marked on them. By watching where the shadow fell, people would use the numbers to name what time of day it was.

Why Do Sundials Work?

Just like us, ancient people saw that the sun seems to move across the sky, starting in the east in the morning, moving toward the south in the afternoon, and then toward the west at the end of the day. Long ago, people believed many strange things about how the sun traveled across the sky. For example, the ancient Greeks believed that the sun rode across the sky in a chariot that was pulled by four white horses and driven by one of their gods, called *Heleius*. They believed that Earth was the center of the universe and the stars and other planets moved around it. They used the movement of the sun in the sky as evidence for their belief.

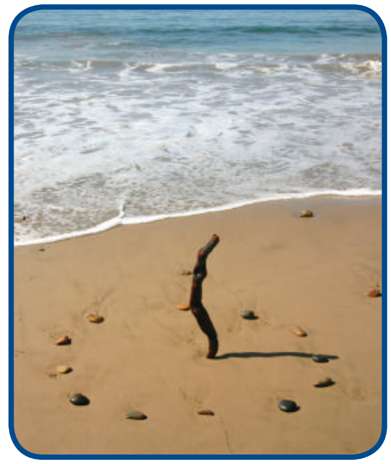
Is the sun actually moving across the sky? Explain your answer.



In class, you used a ball and a pencil to make a model of Earth to show day and night. It showed you that the sun is not really moving at all. It only seems to move because Earth is spinning around. You see the sun during the day because you are on the part of the earth facing the sun. You do not see it at night because Earth has rotated so that you are on the side away from the sun.

Imagine that you are sitting on a chair that can spin and a friend is standing next to you holding a candle. You first see the candle out of the corner of one eye. If you spin slowly in the chair, you can see the candle move from the side until it is right in front of you. Then, it seems to move to the other side until it disappears. It is now behind you. If you did not know you were spinning, you might think the candle was moving around you in a circle. This is the same thing that happens with the earth and the sun. Instead of the chair spinning, it is Earth that spins. People are on the surface of the Earth as it points them in the direction of the sun and then away from it. This same thing happens every single day. You experience sunrise and sunset because Earth is spinning on its axis. Actually, the terms *sunrise* and *sunset* are misleading, since the sun does not actually move around Earth; it just appears to do so.

In your model in class, you used a pencil to represent Earth's axis. Remember that Earth's axis is an imaginary line that runs from the North Pole to the South Pole through the middle of the earth. Earth completes one full turn around its axis once every day. That means it takes 24 hours for Earth to do a complete turn. This spinning is why people experience day and night. One half of Earth faces the sun and is lit by the sun. At the same time, the other half faces away from the sun. The sun's rays are blocked, so it is dark (or night time) on that side of Earth. As Earth spins on its axis, different parts turn to face the sun. This is what causes people to experience day and night.



Back to the Sundial

How does the spinning Earth help you understand the sundial? A sundial relies on the fact that as Earth rotates, the sun seems to travel across the sky. Any object standing in the sun blocks the sun's rays and creates a shadow. Shadows change position and length depending on the time of day. That means that the different times of day can be marked around a stationary object and, during daylight, an estimate of the actual time can be made.

Think about the question you were asked at the beginning of this reading. What would you do if all of the clocks in the world disappeared? Do you think that you could still tell time?

Look at the homemade sundial. What time does the sundial show? How do you know?

If you want to try making your own sundial and see how well it works, search the Internet for some simple instructions.

ACTIVITY 8.3 – DOES A TILTED EARTH EXPLAIN THE SEASONS?

What Will We Do?

We will investigate whether Earth's tilt could create temperature differences causing seasons.

Procedure

1. In class, you created a model of a tilted Earth and its path (orbit) around the sun that created seasons. Draw a picture that shows the following:

    - Earth's orbit around the sun. Be sure to label the sun in your diagram.
    - The position of Earth in all four seasons—summer, fall, winter, and spring in the Northern Hemisphere. (You will need to draw four Earths on your diagram and label them with the seasons.) Then, label the equator and the North and South Poles on each Earth. Next to each of the four Earths, indicate which season is represented.

2. Answer the following questions to explain your diagram.

    a. Look at Earth in your model that has the Northern Hemisphere in winter. Explain why you positioned Earth that way to make it winter.

    b. Now look at the earth that is in the summer position for the Northern Hemisphere. Why did you position it in this way?

    c. Does the way you have the earth positioned in your diagram show that the seasons are opposite in the Northern and Southern Hemispheres? How?

Making Sense

1. List all of the evidence you have from Lessons 7 and 8 and connect it to the scientific principles you have developed. In the column in the middle, tell how the evidence supports the principle.

Big Idea (Scientific Principle)	How Evidence Supports the Principle	Evidence

Reading 8.3 – Seasons of the Year

Getting Ready

All parts of the earth experience seasons. In some places, the differences between one season and the next are large. It may be 90°F in the summer, but in the winter the temperature may only reach 5°F. Each season is different in some ways from the other seasons, no matter where you are. This reading is about what causes the changes in seasons.

Before you read, think about what the different seasons are like where you live. Describe how summer and winter are different. Remember, the differences do not have to be just about temperature. Think about the other conditions you learned about in Lesson 1.

What Did Ancient People Know about Seasons?

More than 3,000 years ago, people in England built Stonehenge, which is a giant monument made of stone. Somehow these ancient people managed to move and stack these gigantic stones. Some were over 25 feet high and weighed as much as 26 tons! Nobody really knows why people built Stonehenge, but one of the reasons might have been to mark the longest day of the year.

In the last reading, you learned about sundials and how ancient people told the time of day. People noticed not only that there was day and night, but they also saw patterns in the year. At certain times of the year, days were longer than at other times. The stones in Stonehenge were placed so that they line up with the sunrise on the longest day of the year. Every year on this one day, the sunrise appears on the horizon, directly aligned with one giant stone. It makes sense that the people who built Stonehenge created it as a way to mark the longest day as the beginning of each year. They could then count the number of days between these annual occurrences and determine the length of the year. It is obvious that the ancient people in England already knew about seasons. They knew that the hottest time of year, summer, was when the days were the longest. They saw that when the days got shorter, the temperature got colder. They called this time of year with colder temperatures and shorter days, *winter*. Stonehenge was a kind of calendar that helped them keep track of the passing of the year and the seasons.

Why do you think it was important for people to be able to tell how long it would be before the seasons changed? If they were in the middle of summer, why would they want to know how many days it would be before winter?

What Are Seasons?

What do you think of when you hear the word *seasons*? Depending on where you live, it may mean different things. Much of the world experiences four seasons: summer, fall, winter, and spring. Each of these brings changes in temperature and precipitation, as well as changes to the living things in the area. In some places, fall brings cooler temperature and changing color in leaves. By winter, the trees have lost their leaves. In spring, the leaves begin to grow again. Here are photographs of the four seasons in one location.

In some places, the seasons do not look like these pictures. Some places only have two seasons that they call *wet* and *dry*. Other places have two seasons that they call *summer* and *winter,* but in winter they never get snow, only rain. All places on Earth experience seasons.

Describe the seasons where you live. How many seasons do you have? Does it get cold in winter and snow?

Why Does Earth Have Different Seasons?

Many people think that the seasons are a result of the earth getting closer or farther from the sun as it travels in its orbit around the sun. It makes sense to think that when Earth is closer to the sun, it is warmer, and it would be summer. When it is winter, Earth should be farther away because it is cooler, but that is not true.

ACTIVITY 8.4 – WHY IS THE TEMPERATURE NOT THE SAME EVERYWHERE?