UCAR CENTER FOR SCIENCE EDUCATION

LEARNING SEQUENCE 3

LESSON 12 How do storms move around the world?

LESSON 13 Why is it hotter at the equator than other places on Earth?

LESSON 14 How and why does air move in the tropics?

LESSON 15 When air and storms move, why do they curve?

BSCS SCIENCE LEARNING

NASA

THE GLOBE PROGRAM

Name Period Date

LESSON 12

How do storms move around the world?

STEP 1: How do storms move across North America?

Watch the video of storms moving across North America and draw arrows on the map below to record the patterns of storms you observe.

Draw arrows to indicate the direction that each storm moves through this region.

STEP 2: Why is this pattern important?

Explain below why it would it be helpful to understand the patterns of storm movement.

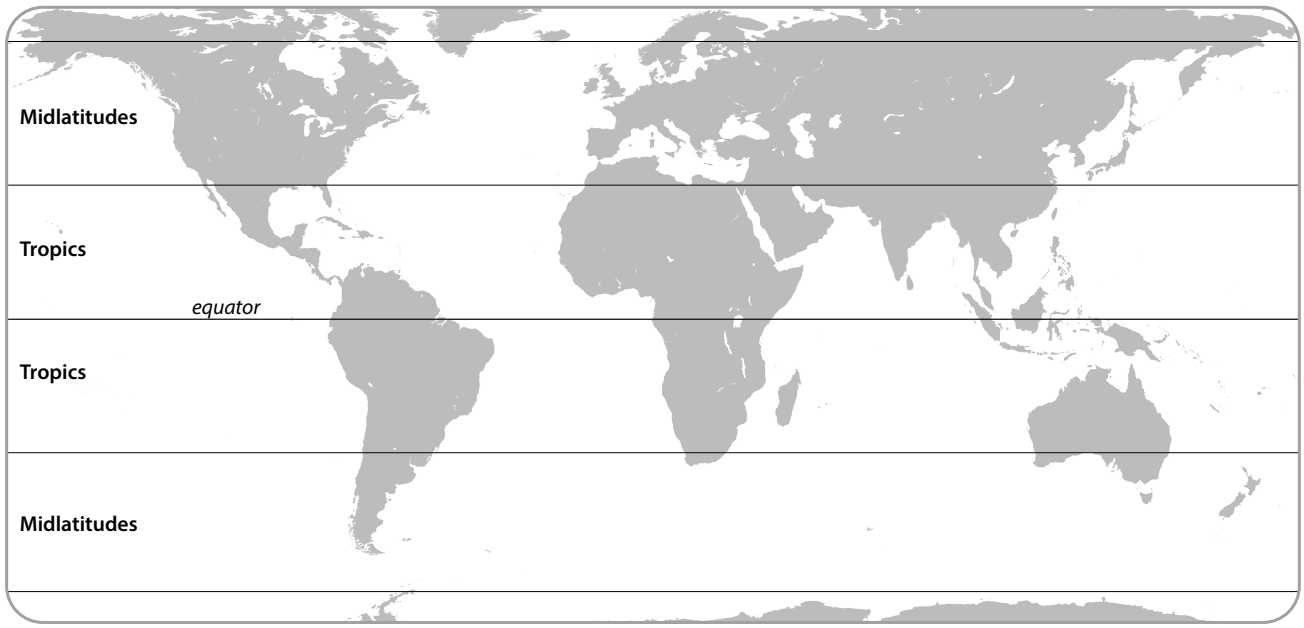
LESSON 12

How do storms move around the world?

STEP 3: Observe precipitation movement around the world.

Watch a video of storms as they move around the world. How do storms move near the equator? In the tropics? In the midlatitudes?

Draw arrows on and write on the map below to record your observations of moving storms from the video.



STEP 4: Discuss your observations.

Discuss the following questions with your peers and record your answers below. Be ready to share your ideas in a whole class discussion.

1. What patterns did you notice about how precipitation moves around the world?

2. What questions do you have about these patterns?

LESSON 12

How do storms move around the world?

STEP 5: Form an initial explanation.

What do you think could be causing these patterns of global storm movement? Draw on your knowledge from Learning Sequences 1 and 2 to answer the questions below.

1. What do you know about what causes rain?

2. What do you know about what causes air to move?

3. How could the same processes affect the whole world?

Name Period Date

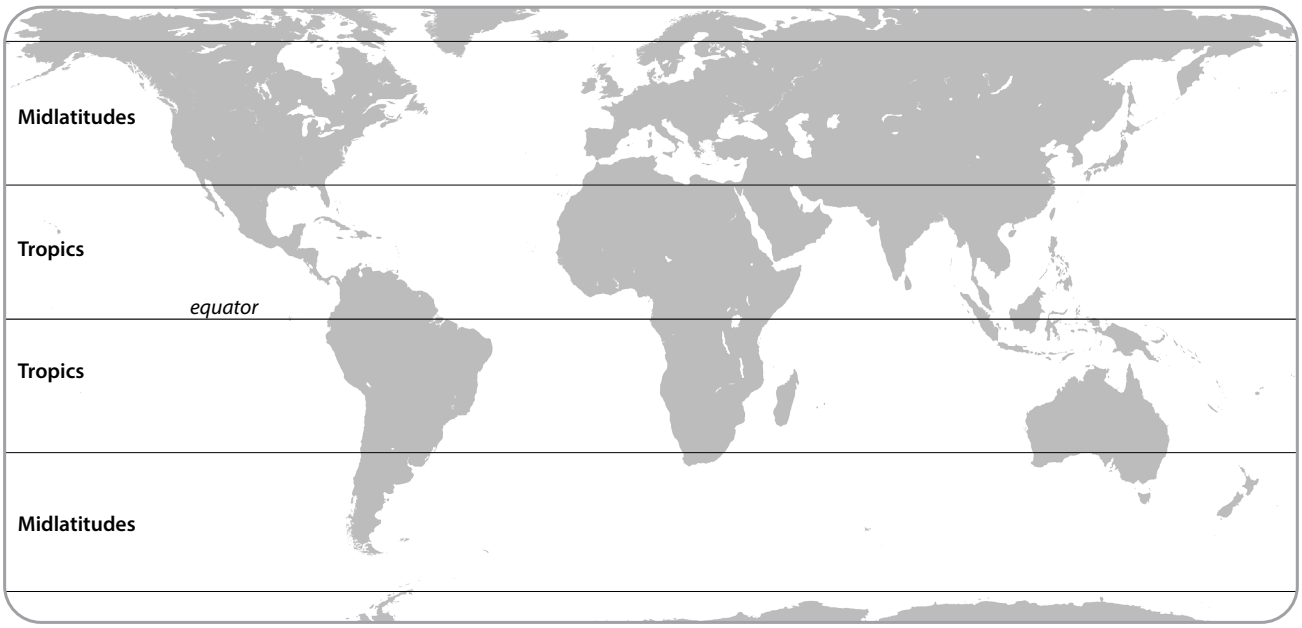
LESSON 13

Why is it hotter at the equator than other places on Earth?

STEP 1: Observe patterns in average annual temperatures.
Look closely at the World Average Temperatures slide.

1. Where are temperatures cooler?
2. Where are they warmer?
3. What patterns do you notice?

Draw and write your answers to the questions above on the map below.



Record your ideas about why it's hotter at the equator than other places on Earth.

LESSON 13

Why is it hotter at the equator than other places on Earth?

STEP 2: Observe energy angles.

Work in groups of three to investigate what happens to light when it shines on graph paper at different angles. Be prepared to share your ideas.

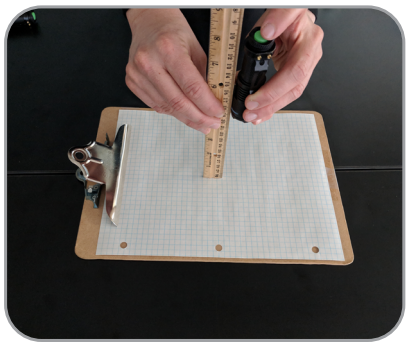
Materials: A clipboard or flat surface, flashlight, ruler, one sheet of graph paper, pencil

What does the flashlight represent in this investigation?

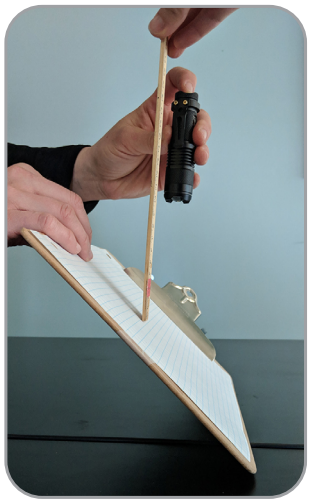
What does the clipboard represent in this investigation?

INSTRUCTIONS:

1. Decide who will hold the flashlight and ruler, who will hold the clipboard, and who will record.
2. Put a piece of graph paper on your clipboard and lay it flat on the table.
3. To investigate what happens to light that shines at different angles onto a surface, follow these steps:
   a. Turn on the flashlight and hold it directly above the clipboard.
   b. Adjust the distance between the flashlight and the clipboard so that the light shines entirely on the graph paper, with lots of space around the edges. Use your ruler to measure the distance.
   Note: This distance will vary depending on how bright your flashlight is, but try about 4-5 cm and move closer or further away as needed.
   c. The recorder will trace the edges of the light pattern onto the graph paper. Be sure that the flashlight is pointed straight down when you take this measurement!
   d. Label this image "straight on."
   e. Next, tip the clipboard so that the light shines on graph paper at an angle, as shown in the picture at the right. Remember to hold the flashlight the same distance from the clipboard as you did when taking the "straight on" measurement (Use your ruler!). Again, be sure that the flashlight is pointing straight down towards the table like it was when you made the "straight on" measurement.
   f. The recorder should trace the new pattern of light on the graph paper.
   g. Label the new image "tilted."
   h. Now, tip the clipboard at different angles and observe what happens to the light. You do not need to record these images. Just notice what happens to the light when you have less of a slant (less of an angle) versus more of a slant (a greater angle).



STRAIGHT ON



TILTED

DISCUSS WITH YOUR GROUP:

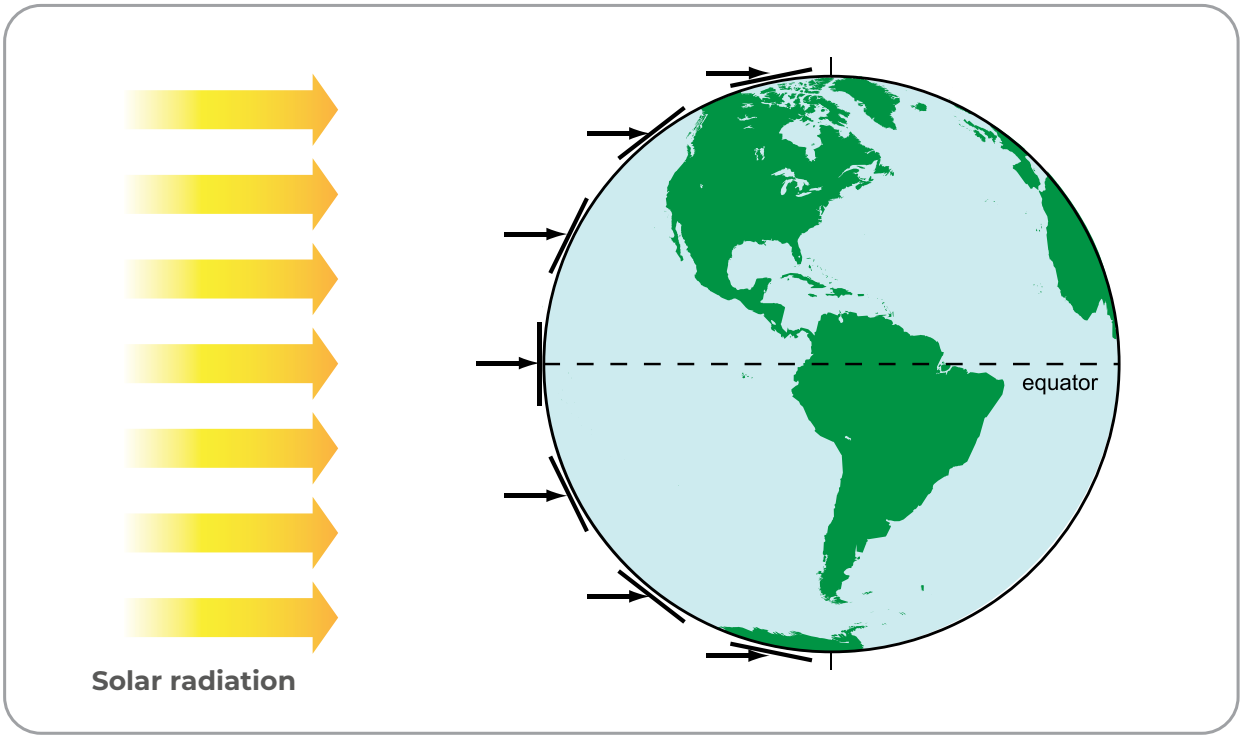
- Describe how the pattern of light changes when the clipboard changes from flat to angled.
- Do you observe any difference in the brightness of the light?
- Think about the amount of light energy from the flashlight that reaches any particular square on the graph paper. How does this change when you change the angle of the clipboard?

LESSON 13

Why is it hotter at the equator than other places on Earth?

STEP 3: Think about the Sun's incoming energy.
Use the image below to think about where solar radiation (sunlight) is more direct and where it is more spread out on Earth's surface. Then answer the questions below.

THE SUN'S INCOMING ENERGY - ANGLE RELATED TO LATITUDE



1. Which area receives more concentrated sunlight? What is your evidence?

2. Which area receives less concentrated sunlight? What is your evidence?

3. How does the concentration of sunlight affect temperatures? Which areas are hotter? Which areas are colder?

LESSON 13

Why is it hotter at the equator than other places on Earth?

STEP 4: Analyze temperature and latitude.

Your teacher will provide you with graphs of daily maximum temperature. Students at schools in Finland, Vermont (US), Arizona (US), Saudi Arabia, and Sri Lanka collected these data. Work with your group to match the graphs with the location where you think that data was collected. Use the clues below to help you decide how graphs and locations match:

CLUE 1: Seasonal differences are stronger at higher latitude (further from the equator). At or near the equator there is usually no seasonal difference in temperature.

CLUE 2: Temperatures are warmer at low latitude (close to the equator) than at high latitude (far from the equator).

	GRAPH (letter)	LOWEST MAXIMUM TEMPERATURE	HIGHEST MAXIMUM TEMPERATURE	DIFFERENCE IN TEMPERATURE (highest minus lowest)
Finland				
This is why I think Finland matches this graph:				
Vermont, US				
This is why I think Vermont matches this graph:				
Arizona, US				
This is why I think Arizona matches this graph:				
Saudi Arabia				
This is why I think Saudi Arabia matches this graph:				
Sri Lanka				
This is why I think Sri Lanka matches this graph:				

Name Period Date

LESSON 14

How and why does air move in the tropics?

STEP 1: Develop a model.

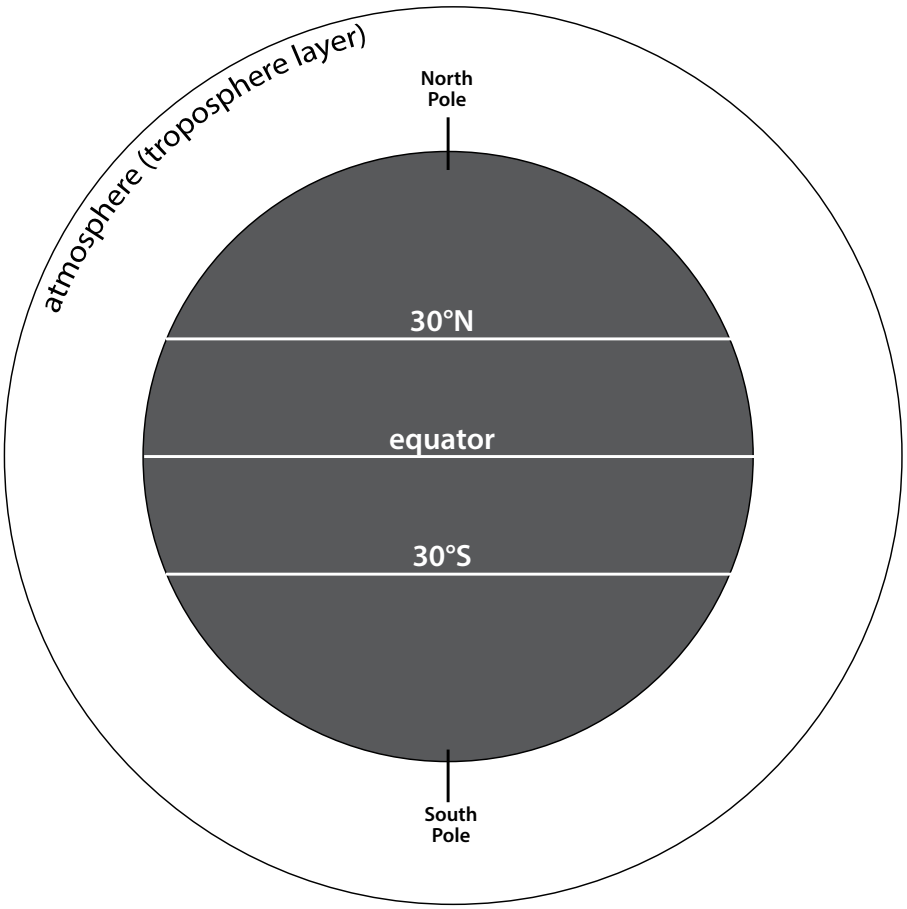
How do you think air is moving in the tropics between 30°N and 30°S? Why? Record your initial ideas on the image below.

Temperature differences cause air to move around the world.

- In some places, warm temperatures cause air to rise from the Earth's surface to higher in the atmosphere.
- In other places, cooler temperatures cause air to sink from higher in the atmosphere to the Earth's surface.

Translate those ideas to the illustration of Earth's atmosphere below. In the illustration, the atmosphere is exaggerated.

1. **Draw arrows in the troposphere layer of the atmosphere** to indicate where air is rising. Remember that warm air rises.
2. Air can't rise forever. **Draw arrows** to indicate where you think the rising air goes when it gets to the top of the troposphere.
3. At 30°N and 30°S latitude, air is cooler than it is at the equator. **Draw arrows** in the atmosphere to indicate what happens to the cooler air.



How and why does air move in the tropics?

STEP 2: Investigate air movement across Earth's surface.

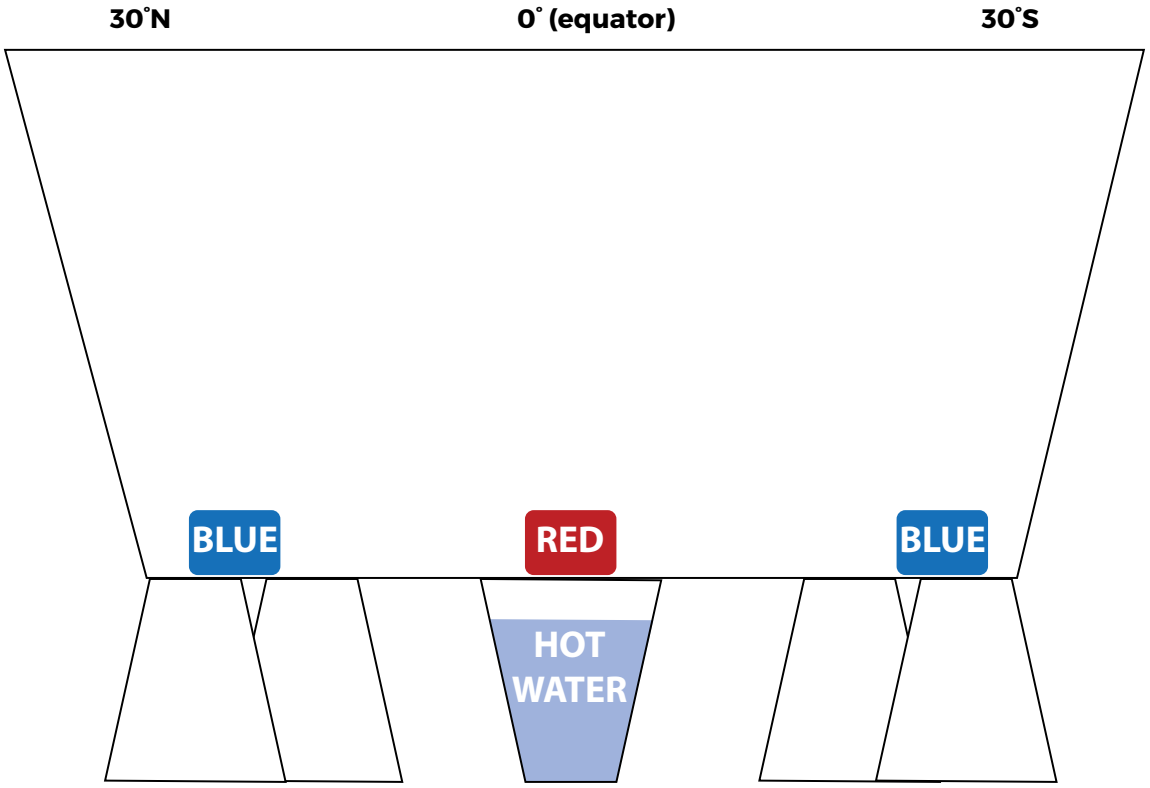
With a partner, write a statement that connects the water tank demonstration to the real world and explains why they are alike. The first part of the model is completed for you as an example.

PART OF THE MODEL		PART OF THE REAL WORLD		WHY ARE THEY ALIKE?
The water in the tank	*is like*	the Earth's atmosphere	*because*	the water in the clear plastic tub represents the air surrounding the Earth. Air and water are both fluids, so they behave similarly.
Red food coloring	*is like*		*because*	
Blue food coloring	*is like*		*because*	
The cup of boiling hot water	*is like*		*because*	
The bottom of the clear plastic water tub	*is like*		*because*	

How and why does air move in the tropics?

STEP 3: Record observations of the water movement.

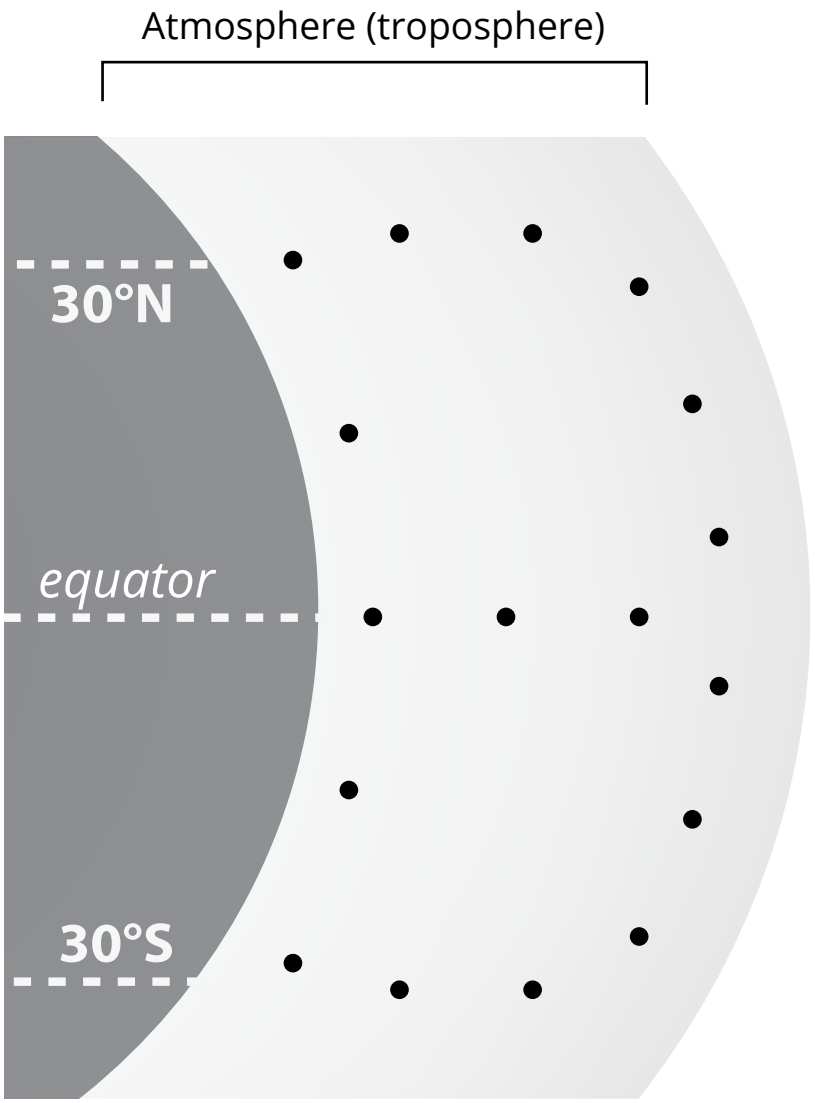
Draw how the water moves through the tank.



RECORD YOUR OBSERVATIONS *I notice...*	RECORD IDEAS FOR WHY *I think...*	RECORD YOUR QUESTIONS *I wonder...*

How and why does air move in the tropics?

STEP 4: Describe how and why air moves in the tropics.
Focus on how air is moving in the tropics (between 30°N and 30°S of the equator). Draw arrows to connect the dots and show how air is moving in the atmosphere, just as the water moved in the water tank model.



Write a caption to describe air movement in the model above.

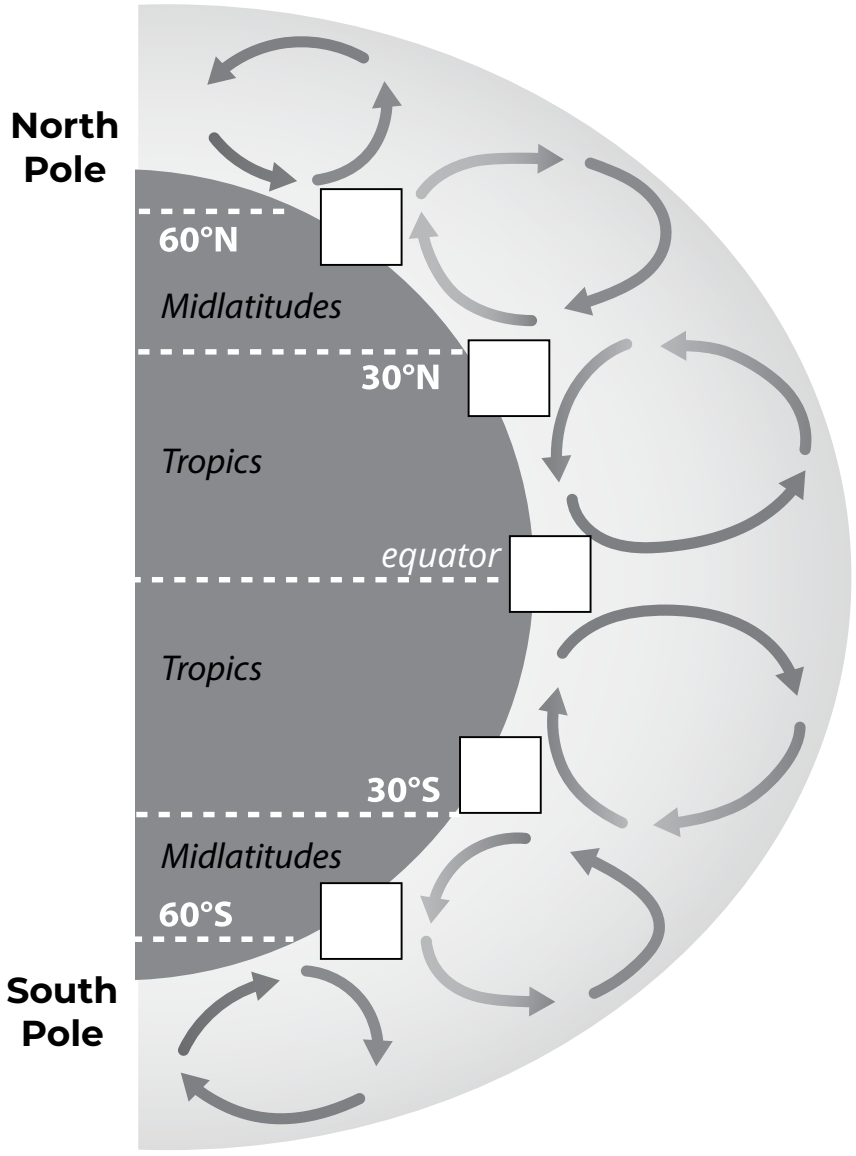
How and why does air move in the tropics?

STEP 5: Create a model to describe air pressure and clouds at different latitudes.
Review the following diagram of how air moves around the world.

L **Put an "L"** in the white boxes where there would be low pressure.

H **Put an "H"** in the white boxes where there would be high pressure.

Draw in clouds at locations of low pressure, where they are likely to form.



Name Period Date

LESSON 15 When air and storms move, why do they curve?

STEP 1: Compare storm movement with your model.

Watch the *Global Rainfall and Snowfall* video from Lesson 12 again, this time focusing your observations on the movement of storms in the tropics. Below, compare the movement you see in the video to how you might predict storms to move based on your model about air movement in the tropics (from the end of Lesson 14).

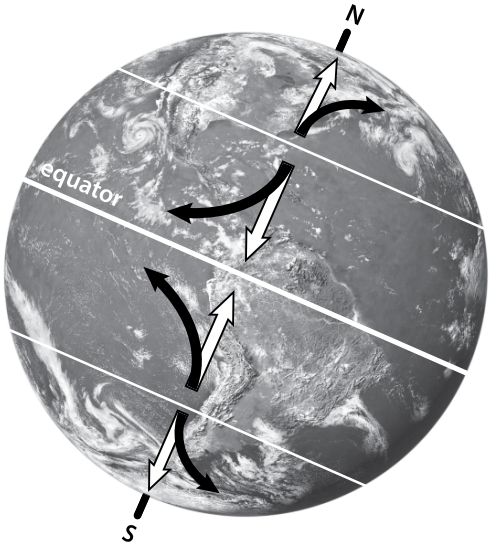
1. What kind of movement did you observe in the video that isn't explained by your model?

LESSON 15

When air and storms move, why do they curve?

STEP 2: Learn about the Coriolis effect.

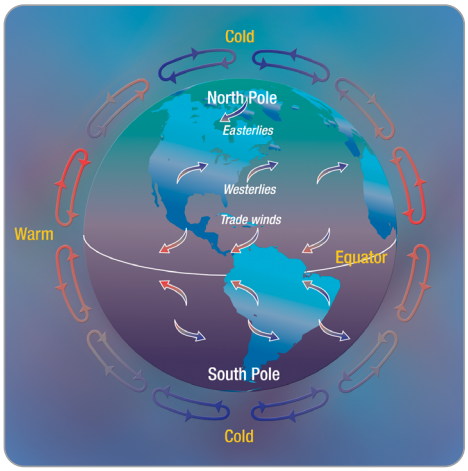
Because Earth is spinning, air does not travel in a straight line above the surface (like the white arrows on the picture to the right). Instead, air has a curved path (like the black arrows). Air north of the equator turns to the right as it moves. Air south of the equator turns to the left as it moves. This is called the **Coriolis effect.**



STOP AND DO

Make a model of the Coriolis effect.

1. Make a model of the Earth.
   - **Inflate** the balloon.
   - **Draw** an equator around the widest point.
   - **Draw** lines around the balloon where 30˚N latitude and 30˚S latitude lines would be.
2. Simulate how air in the tropics would move if the Earth didn't spin.
   - *Student 1:* **hold the balloon** in front of you so that the equator and latitude lines are parallel to the floor.
   - *Student 2:* **draw an arrow** starting at 30˚N latitude going toward the equator.
3. Simulate how air moves with Earth's spin.
   - *Student 1:* **slowly rotate** the balloon counterclockwise to model the Earth spinning on its axis. (Look at the balloon from above to determine which direction is counterclockwise.)
   - *Student 2:* **draw another arrow**, starting from the same point as before and trying to get to the equator.



Why does air move in different directions in the tropics and in the midlatitudes?

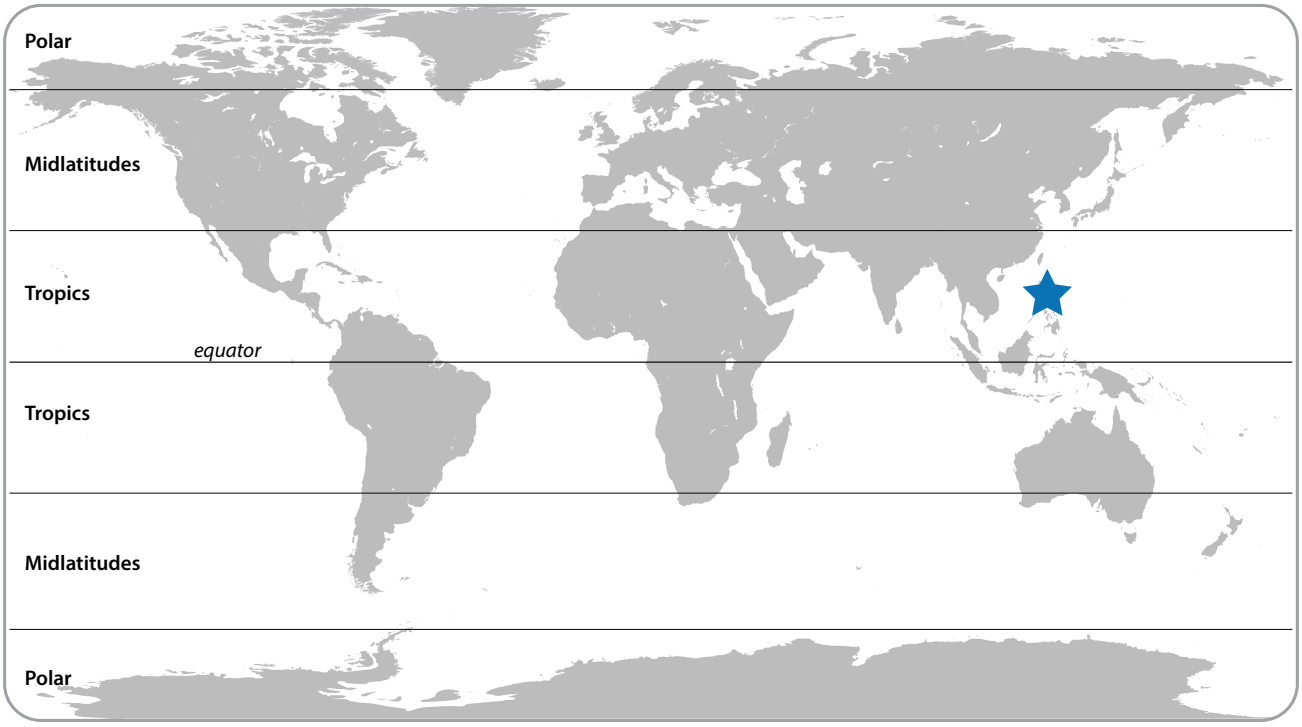
Earth is always on the move. Earth rotates, or spins, making one full turn every 24 hours. If Earth did not spin, air would rise at the equator and sink at the poles. But because Earth spins, there are three areas of convection north of the equator and three south of the equator. Convection causes winds to move across Earth's surface toward the equator in the tropics, away from the equator in the mid-latitudes, and toward the equator around each pole. These winds are called **prevailing winds**. Prevailing winds curve because of the Coriolis effect. Winds in the midlatitudes curve, moving west to east. Winds in the tropics generally move from east to west.

When air and storms move, why do they curve?

STEP 3: Record an explanation.

Use the model of air movement in the tropics you developed and what you learned about the Coriolis effect to explain the direction that storms will likely move through the Philippines (indicated with a star below) and where you live.

- **Draw an arrow** on the map to indicate the direction that storms in the Philippines (starred location) usually travel.
- **Draw a different symbol** on the map that shows where you live. Then, **draw an arrow** to indicate the direction that storms usually travel where you live.



1. Explain why you think storms move through the Philippines in a particular direction.

2. Explain why you think storms will come from a particular direction where you live.