LESSON 4: OCEAN CURRENTS

INTRODUCTION

There is a clear connection between ocean currents and climate. Ocean currents help to move heat, support rainforests on land, and make life possible for animals across the globe. Without ocean currents large parts of Earth would be unlivable. Humans are already seeing the impact of climate change on life in the sea.

LESSON SUMMARY

This lesson helps students explore the role of the ocean in climate. They do this through an investigation to show how hot and cold temperatures help to move water around the world. Students examine temperature and precipitation data from two cities and use their understanding of water movement to explain why these cities have differences between their temperatures and rainfall.

OBJECTIVES

- Students will use a demonstration as a model to explain how water moves in the ocean.
- Students will analyze data about rainfall and temperatures in two cities in the world.
- Students will describe how water movement and proximity to the ocean affect the climate in a location.

ESTIMATED TIME

60 minutes. If you would like to divide this lesson among multiple days, good break points are between steps 4 and 5 or between steps 7 and 8.

STANDARDS ADDRESSED

Science (NGSS): 3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.

OCEAN LITERACY PRINCIPLES

1a The ocean is the defining physical feature on our planet Earth.

1c Throughout the ocean there is one interconnected circulation system.

FOCUS QUESTION

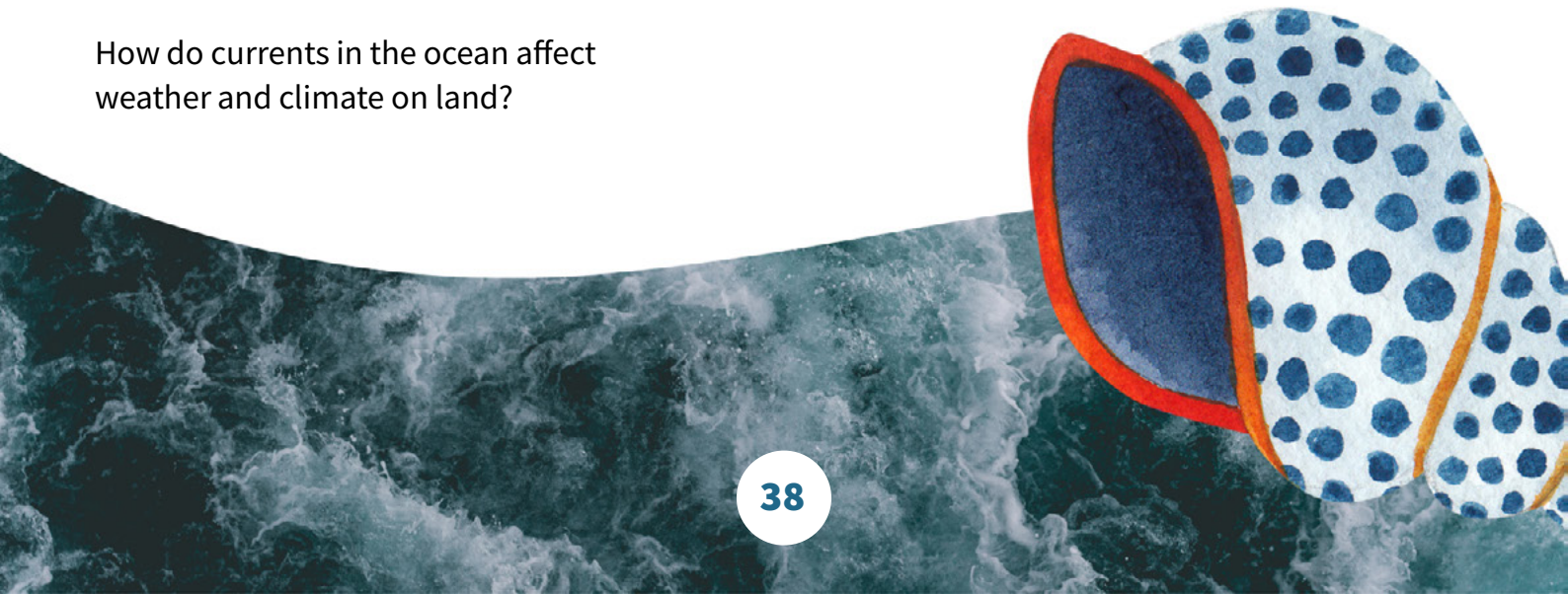
How do currents in the ocean affect weather and climate on land?

MATERIALS

- Ice water
- Hot water, heated in an electric kettle, on a hot plate, or from a coffee machine
- Clear or transparent container (glass or heat resistant). A deeper container will help students observe the results more easily; however, a dish such as an 8” x 8” baking dish will work if that is what is available.
- Two distinct colors of food coloring, such as red and blue
- World Map master, one for display
- Milwaukee and Hobart Climate Data, one per student
- Oceans and Climate, one per student

PREPARATION

- Read Lesson 2 in this guide. Consider if completing that lesson with your students might help support their learning in this lesson.



- Practice the demonstration, as described in step 3 below, to ensure that your set up works well. Adding hot water to the dish then slowly adding ice cold water to one side is one effective set up, though other variations such as adding ice to one side and letting it sit for several minutes may also work well.
- Decide how many times you want to repeat the demonstration to ensure that all students can easily make observations. Ensure you have enough materials prepared to repeat the experience a few times.

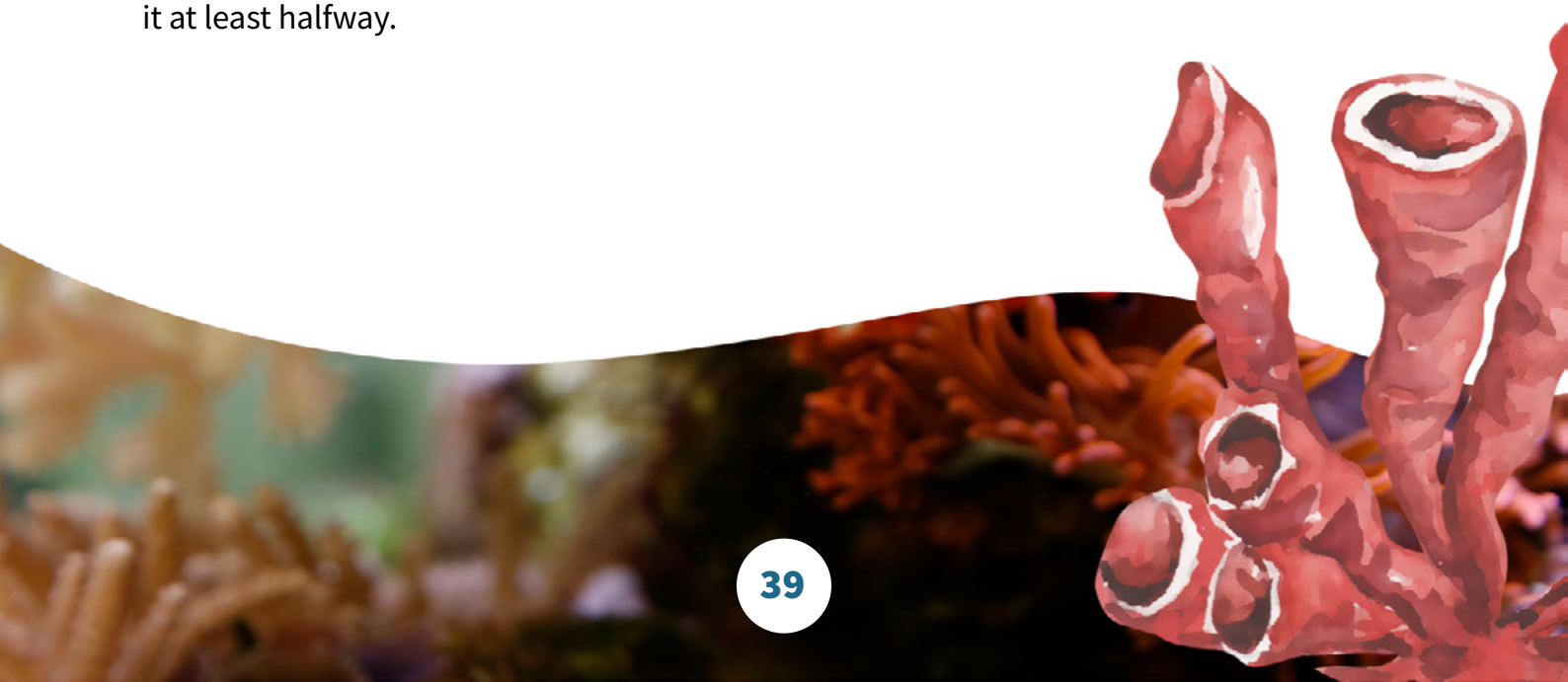
FACILITATION

Step 1. Share with students that the ocean is very large. We cannot simply stand on a beach and see how the water moves. Today they are going to have a chance to explore how one kind of current in the ocean moves water.

Step 2. Set up the demonstration in a way that students can see what happens in the dish from the side. To set it up, complete the following steps.

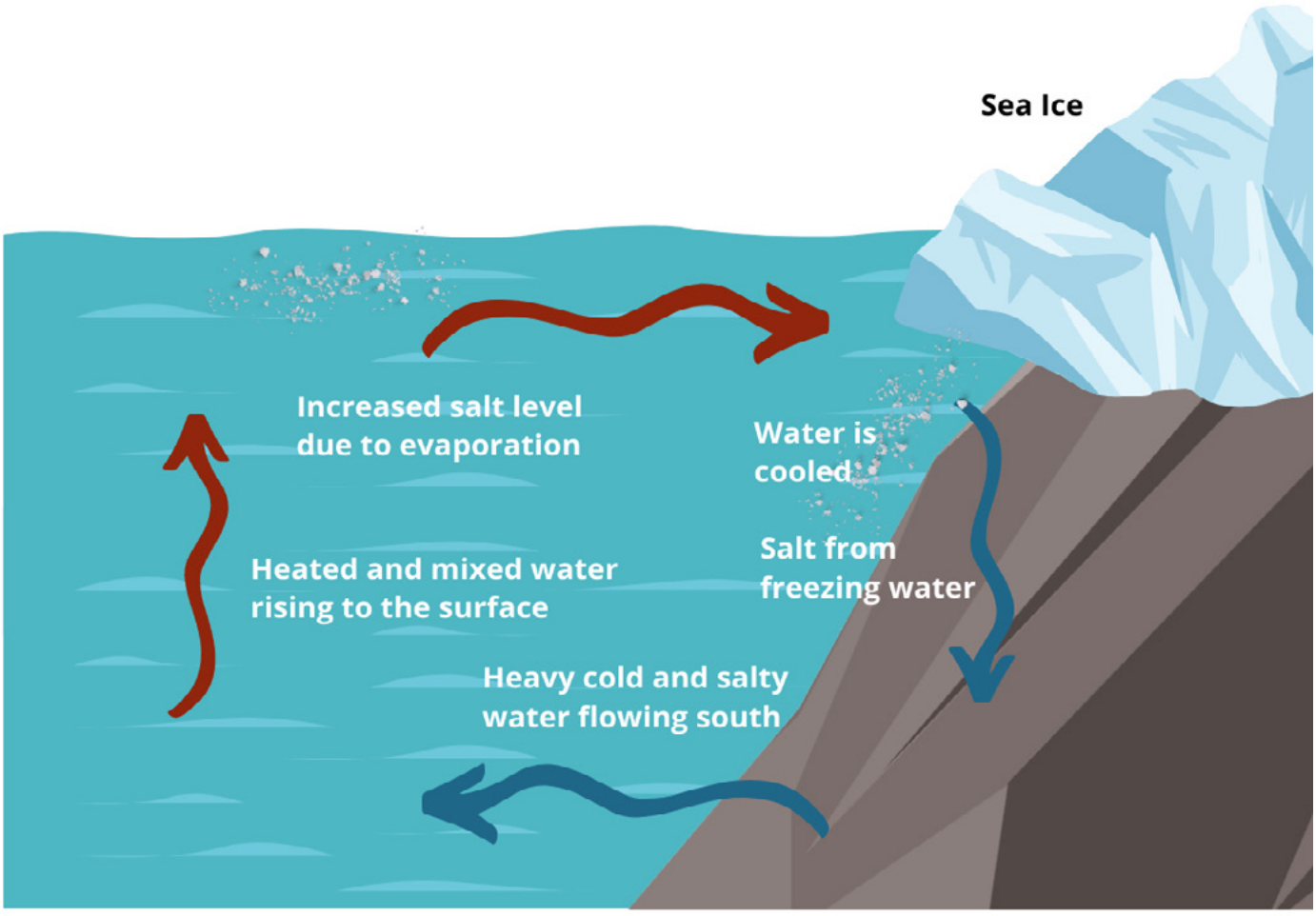
- Place the transparent container on a flat surface. Add hot water to the dish to fill it at least halfway.
- Add ice or ice water to one side of the dish. Do this very carefully to minimize mixing the hot and cold water. If you are adding ice water, try adding it very slowly along one side of the dish so that it does not disturb the water on the other side of the dish.
- With students watching carefully, add 3 drops of red food coloring (or another color) to the hot side of the dish, about an inch from the side. Add 3 drops of blue food coloring (or another color) to the cold side of the dish, about an inch from the side. Ask students to observe what happens over the next 3 minutes. You may wish to point out key observations, listed below, if students do not seem to be noticing them.

Observations: Students should be able to see that the food coloring on the cold side sinks to the bottom and then begins traveling toward the hot side of the dish, along the bottom. The food coloring on the hot side will disperse more quickly but should generally move toward the cold side of the dish.



Step 3. Ask students about why they think the colors moved the way they did. They do not have to develop a complete understanding but should know that the heat and water from the warm side moves to the cold side. As it cools off, it sinks and pushes water that is already on the cool side out of the way, toward the warm side. That water warms up, rises to the top part of the water in the dish, and the process creates a current. Draw a representation on the board as you discuss these ideas

Step 4. Explain that there are other kinds of currents in the world, including some that move by wind, tides, and the way the Earth rotates. Share with students that large currents depend on both heat and salt, but for now they are going to focus on heat. To relate this to ocean currents, show students the World Map master and ask where temperatures are warm and where they are cold. Students are likely to know that it is hot near the Equator and cold at the north and south poles. Ask them to connect what they saw in the demonstration to the water on Earth.

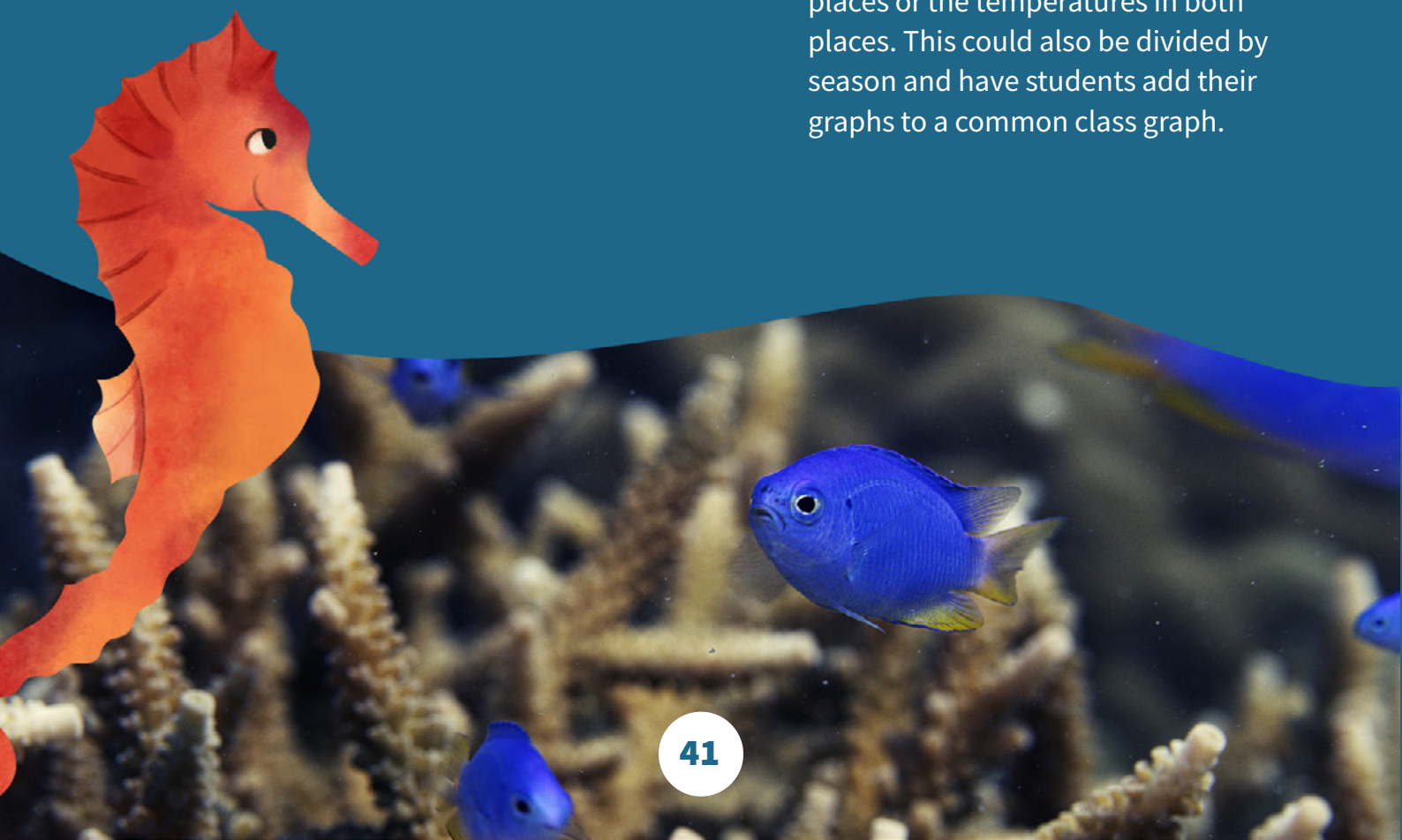


Step 5. Point out the two cities that are shown on the World Map master—Milwaukee, WI and Hobart, Australia. Share with students that Hobart, the capital of Tasmania, is at 43 degrees latitude south. Tell them that in the United States, the city of Milwaukee, Wisconsin is at 43 degrees latitude north, so they are the same distance from the equator. Ask students the following questions and accept all ideas at this point.

- How would you describe where each city is and what is around it?
- Do you think that the temperatures in Hobart and Milwaukee are the same or different? Why?
- Do you think the amount of rainfall in Hobart and Milwaukee is the same or different? Why?

Step 6. Share with students that they are going to have a chance to learn more about temperatures and rainfall in the two cities. Distribute the handout, Milwaukee and Hobart Climate Data, to students. Ask them to graph the data using a strategy appropriate for your students. The following are suggestions for how you might have students analyze the data.

- As a class, create a bar graph to show the average temperatures in each location and another to show the average rainfall in each location. If your students are not comfortable graphing on their own, this is the best option.
- Have pairs of students graph 1 of the 4 sets of data (rainfall in Milwaukee, rainfall in Hobart, precipitation in Milwaukee, precipitation in Hobart), then compare the two rainfall graphs and the two temperature graphs.
- Have small groups of students create two bar graphs on one set of axes to compare either the rainfall in both places or the temperatures in both places. This could also be divided by season and have students add their graphs to a common class graph.



Step 7. Lead a class discussion to compare the rainfall and temperatures in both cities. Students should see that in Hobart, both temperatures and precipitation are more even through the year, creating a mild climate. Milwaukee has a more distinct variation in temperature and amount of rainfall across the year. Ask students if they have any ideas of why that might be but accept all answers at this point.

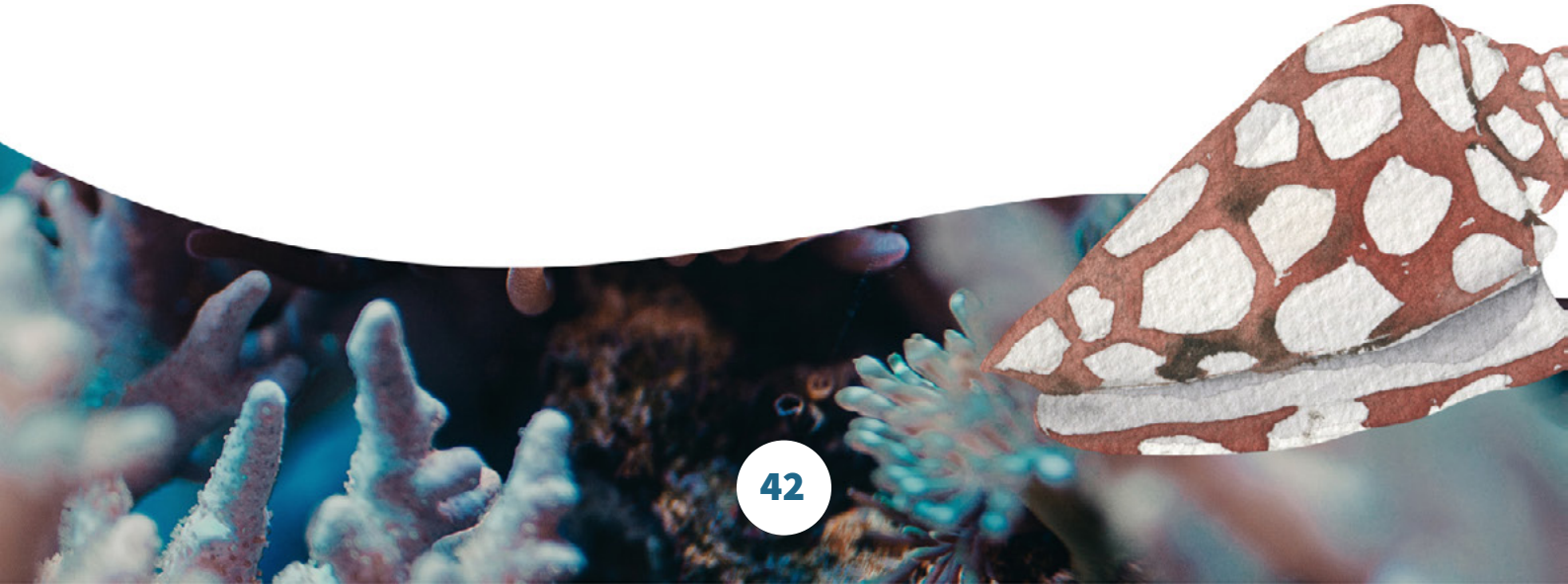
Step 8. Tell students that they are going to have a chance to create a comic to learn more about why the two places might be different. Distribute the Ocean and Climate handout and different-colored pens or pencils. Show students that there are five boxes that will make up the comic and each has a description, with the fifth box being a summary of the other boxes together. Tell them that their task is to draw pictures for each box to show what the words are describing. They can discuss their ideas in their small groups to make sure everyone understands but emphasize that each student should draw pictures on the comic individually. Tell students that the goal is to be able to explain how the ocean affects climate, particularly when they think of Milwaukee and Hobart.

Step 9. Lead a class discussion to talk about their comics. Make sure they link box 4 of the comic to the demonstration.

Have them discuss how the story in the comic relates to temperature and rainfall in Milwaukee and Hobart. As part of the discussion, share the Ocean Currents animation from Science on a Sphere (https://sos.noaa.gov/catalog/datasets/ocean-circulation-labeled-currents/). You may wish to point out:

- that the animation distinguishes between warm surface waters (red arrows) and deep, cold waters (blue arrows),
- gyres, which are the currents that are affected by heat and salt like the demonstration,
- other types of currents, such as the equatorial currents,
- that currents move water long distances around the world, and
- that Hobart is on an island south of Australia with a warm current running near it while Milwaukee is far inland and is less affected by ocean currents.

After the discussion, encourage them to explain why Milwaukee has more variable weather than Hobart, using their comic as a reference. They should relate it to both warm currents and to evaporation of water leading to storms.



Step 10. Remind students of the demonstration. Ask, what would happen if the two sides of the dish had water that was a similar temperature? How would that affect the story in their comics? If they struggle to reason through what would happen, consider repeating the investigation with one temperature of water while still using two colors of food coloring at opposite ends. Students should see that the food coloring disperses the same way on both ends and does not travel toward the other side of the dish.

Step 11. Ask students to use the discussion from the previous step with their comics to explain how Hobart would be different if the water at the poles became too warm for sea ice to form.

Milwaukee, Wisconsin, USA 43° North	Average High Temperature (°F)	Rainfall (inches)	Hobart, Tasmania, Australia 43 ° South	Average High Temperature (°F)	Rainfall (inches)
January	31	1.79	**January**	69	2
February	34	1.69	**February**	68	1.9
March	44	2.20	**March**	65	1.9
April	55	3.86	**April**	60	2
May	67	3.54	**May**	55	1.9
June	77	4.38	**June**	51	1.9
July	82	3.40	**July**	50	2.2
August	80	3.65	**August**	52	2.5
September	74	3.16	**September**	55	2.4
October	61	2.78	**October**	59	2.4
November	48	2.24	**November**	62	2.6
December	36	1.88	**December**	66	2.6

EXTENSION

Divide students and have half the class learn about the plants and animals that live in Tasmania while the other half learns about plants and animals that live in the Milwaukee area. Have them choose one plant or and learn more about its life, including what might happen to the plant or animal if the climate in its home area changed. Have students share what they learned with the class so that they hear about plants and animals in both areas, then hold a class discussion about what would happen to living things if the climate changes where they live.

Lesson 4 NOAA Reference

- Science on a Sphere Ocean Circulation (https://sos.noaa.gov/catalog/datasets/ocean-circulation-labeled-currents/)


Milwaukee,
Wisconsin
EQUATOR
Hobart,
Tasmania

1

The ocean absorbs energy from the sun, especially near the equator. This makes the ocean warmer, and it stores the heat.

2

The extra heat and humidity cause rainstorms. These storms move long distances because of winds. The rain often falls on land.

3

When the water heats up some of it will evaporate into the air. This warms up the air. It also makes it more humid, or moist.

4

Heat also moves with ocean currents. Some currents are part of cycles that start with sea ice in the poles. Other currents move because of wind, tides, or the way Earth rotates.

5

Summary: Heat and water move around Earth both in the ocean and in the air.