# LESSON 8: CYCLES IN THE OCEAN

## INTRODUCTION

Scientific drawing can often help students understand science ideas in ways that examining a figure does not. In this lesson, students will have an opportunity to develop a scientific drawing as a model to explain the ocean cycles that affect global climate.

## LESSON SUMMARY

In this lesson, students use a directed drawing to develop a model of how water moves around the world. Students read a scientific reading that describes one major ocean current system and how it may be slowing down. They consider what the impacts would be if this system were to slow significantly or stop moving water.

## OBJECTIVES

- Students will use scientific drawing to understand how water moves in the ocean and the impacts of that movement.
- Students will explain how changes to a major ocean current would impact the Earth.

## ESTIMATED TIME

60 minutes. If you wish to complete this lesson over multiple days, divide the lesson to do steps 1 through 7 on day 1 and the remainder of the lesson on day 2.

## STANDARDS ADDRESSED

**Science (NGSS):** 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

## OCEAN LITERACY PRINCIPLES

3 The ocean is a major influence on weather and climate.

**Geography**: Standard 7 The physical processes that shape the patterns of Earth's surface.

Standard 15 How physical systems affect human systems.

Standard 18 How to apply geography to interpret the present and plan for the future.

**English Language Arts (CCSS):** W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

## FOCUS QUESTION

What impact would there be on plants and animals if a major ocean current slowed down or stopped?

## MATERIALS

- Paper, one or two pieces of light blue (preferred) or white paper for each student
- Colored pencils, one set per student (see Preparation)
- Chart paper
- Markers
- Scientific Drawing: Ocean Currents master, one copy to use for facilitation
- Rulers, a few for the class
- Ocean Conveyor Belt master, one copy to display
- Science News, one copy per student

## PREPARATION

In this activity, it will be difficult for students to share sets of colored pencils because the scientific drawing will ask them to use certain colors for some parts of the drawing. It will save time if each student has a set of colored pencils, so students do not have to wait on each other to finish with a color.

Lesson 4 "Ocean Currents" is also about thermohaline circulation. Consider previewing the activities and resources in that lesson to determine if you would like to use any of them in conjunction with this lesson.

## FACILITATION

**Step 1**. Share with students that sometimes people think that if you like science, you cannot like things like art or music or that you must grow up and be a doctor or a scientist. But that is not true! In this activity, they are going to have an opportunity to learn science while exploring an area that combines science and the arts. This activity focuses on scientific illustration to learn about some processes that happen in the ocean.

**Step 2**. Distribute one piece of light blue or white paper and a set of colored pencils to each student. Place chart paper in a landscape orientation in a place where everyone can see it. Ask students to turn their paper in a landscape orientation.

**Step 3**. Tell students that they are going to have a chance to do a scientific drawing to show how large ocean currents work to affect the whole planet. Share that you will take them through the scientific drawing step-by-step because they will be learning and illustrating at the same time.

**Step 4**. Use the Scientific Drawing: Ocean Currents master to guide students through the drawing. The left column describes a possible narrative for the steps. The right column has an example of what the drawing might look like. As you go through each step, students should add to their own drawings on the blue or white paper. At the same time, complete a drawing of your own on the chart paper. In some cases, such as step 1 of drawing the horizontal line, you might do the drawing first. In other cases, such as drawing arrows, you might wish to have students come to consensus on where/how to draw on the chart paper or you might have a student come up to draw at that point.

**Step 5**. Share with students that the type of current that they have illustrated is an example of thermohaline circulation. This is a process which drives large masses of water throughout the ocean on a current known as "The Great Ocean Conveyor Belt." Display the Ocean Conveyor Belt master and have them compare what they drew to the image of the thermohaline circulation process. Students should recognize that there are places where warm water is rising and cool water is sinking as it traverses the globe.

**Step 6**. Once students have completed their initial drawing, have them work in pairs or small groups to share the "story" of their drawing with a partner or small group. Ask each student to use the scientific drawing to explain how ocean currents move water around the world and why they function the way they do. After each student explains the process, have the small group share any feedback that could make the drawing clearer or more accurate.

If students are not used to offering feedback to one another, you may need to give examples and non-examples of constructive feedback to help them. Sentence stems may help guide students in giving feedback.

**Step 7**. Give students a few minutes to make any revisions to their drawings based on the feedback they received. Share that the drawing they have is a model of how water and heat move around the world, and there are different kinds of currents and water "conveyor belts" around the globe so they are going to have a chance to learn more about a real system in the ocean.

**Step 8**. Distribute copies of the handout, Science News, to students. Ask them to read the brief article. Support them by suggesting a reading strategy if your students would benefit from using one.

**Step 9**. Ask students to summarize the article. This could be in small groups or as a class. Then ask them to use their models to show why the Earth getting warmer would keep the current from flowing.

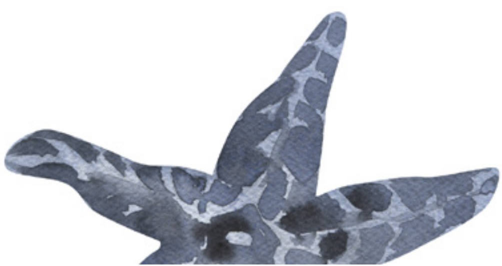
If you would like additional information about thermohaline circulation to help you lead the discussion, two resources that may be useful are

- The Global Conveyor Belt, a clickable animation with descriptions of the stages of water movement (https://oceanservice.noaa.gov/education/tutorial_currents/05conveyor2.html) and
- What is a Current, a video which presents the thermohaline circulation process in its third section (https://oceanservice.noaa.gov/facts/current.html).

**Step 10**. Ask students to develop an explanation to answer the question, "What impact would the AMOC slowing or stopping have on plants and animals?" (Atlantic Meridional Overturning Circulation, or AMOC for short) Encourage students to think about the different points in the article, such as salt, temperature, nutrients, and other substances, such as waste. Each student can pick one area, but across the class encourage different focuses for the explanations.

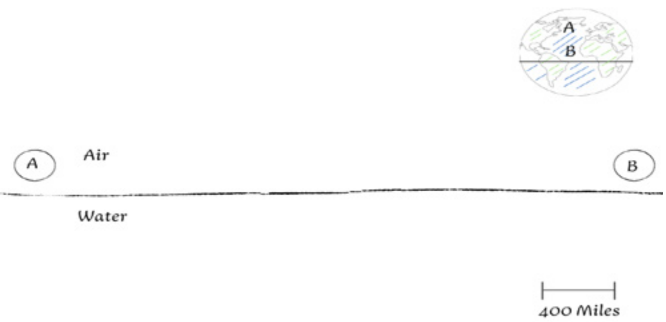
If students have done claim-evidence-reasoning before, ask them to use the format they have used. If they have not created explanations previously, offer more guidance to help them with the process. The following points may support them in developing their explanations.

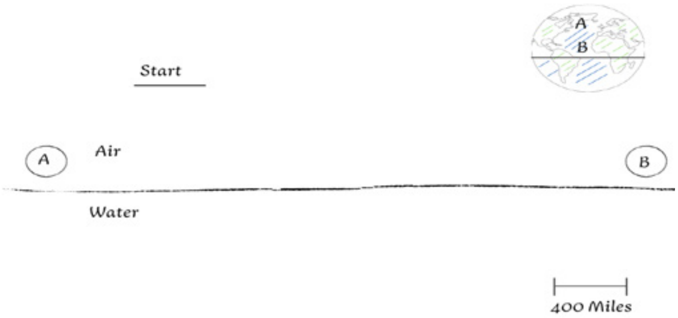
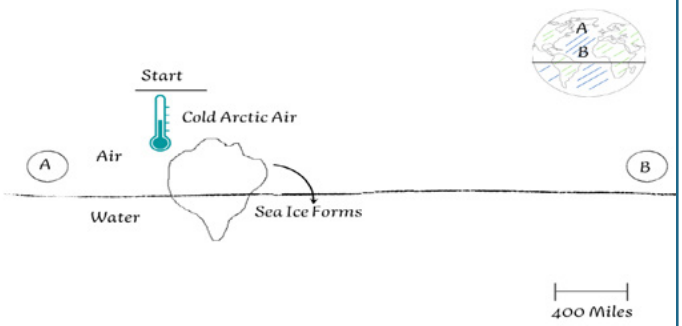
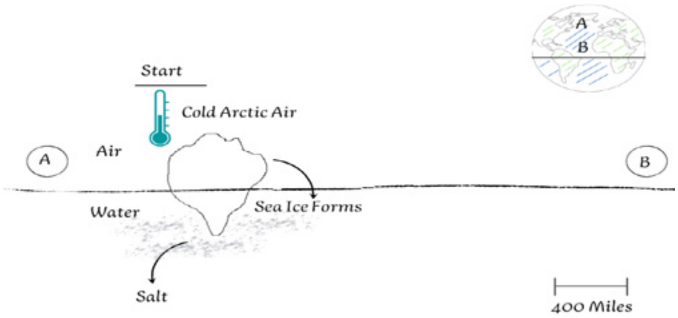
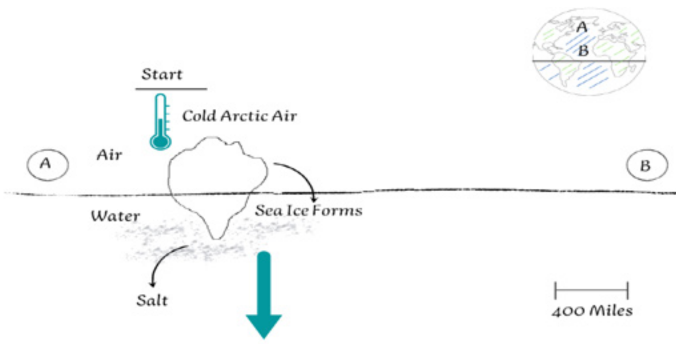
- A claim is an answer to a question. It should be specific, such as, "If the AMOC stopped flowing, the Earth would be too cold in some places for plants and animals to live and too warm in other places," rather than a general statement such as, "If the AMOC switched to weak circulation it would affect plants and animals."
- Explanations use evidence. Students should be able to point to specific points on their drawings that would be different. Describing what they see on the drawings that would be different represents evidence.
- Reasoning links the evidence to science ideas. Students should be able to explain the impacts each piece of evidence would have on the Earth.

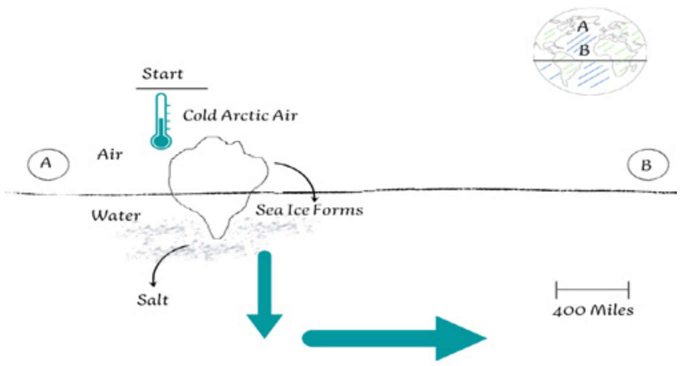
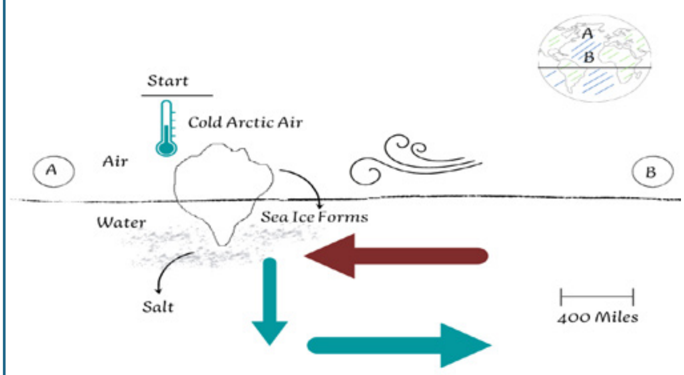
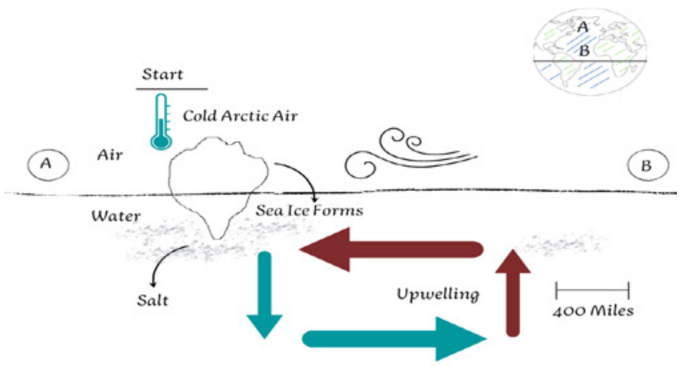
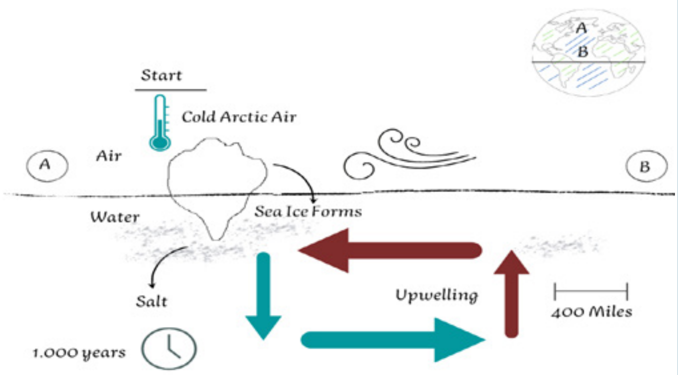


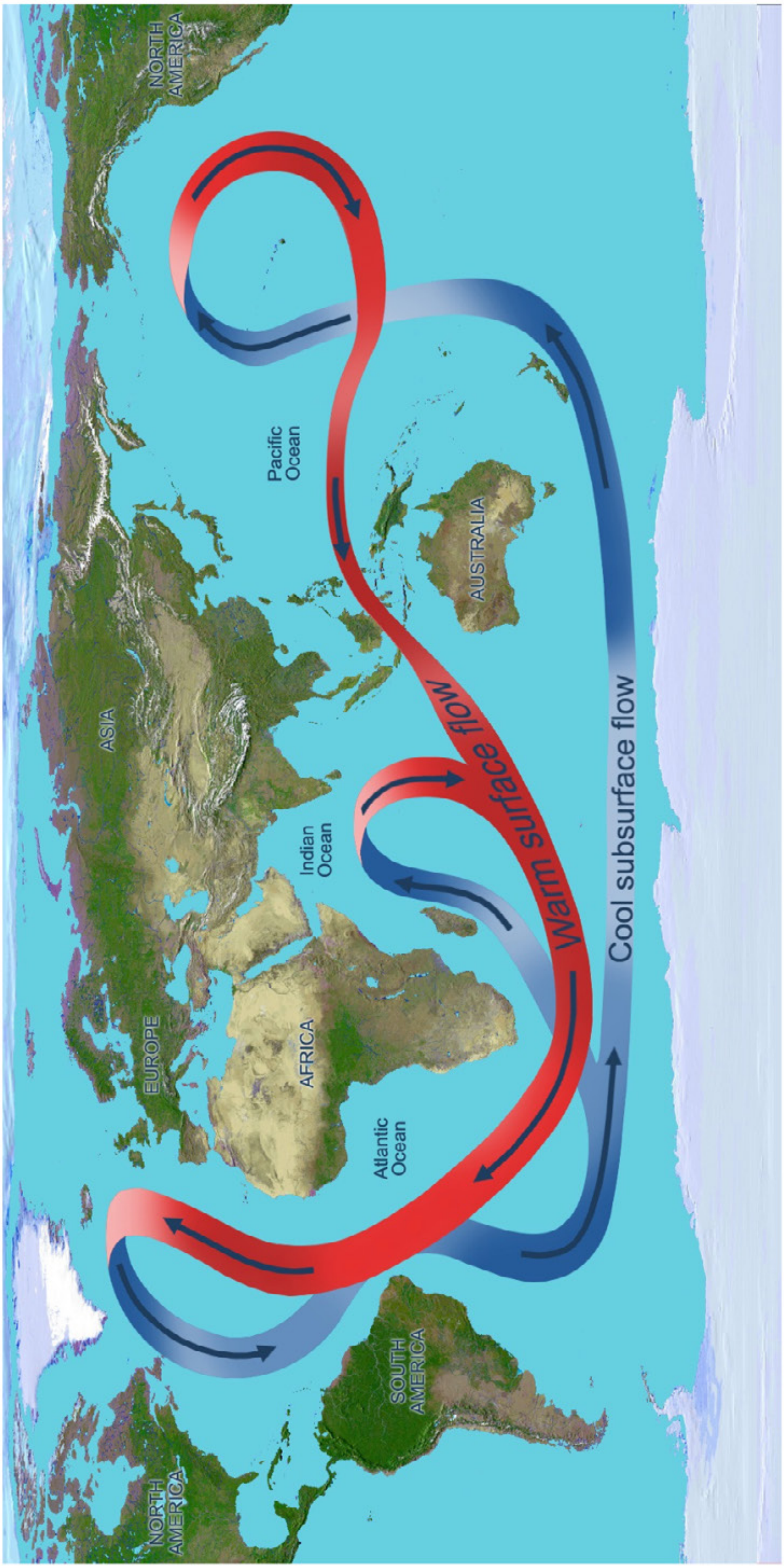
## EXTENSION

NOAA has many resources about the impacts of climate change. Preview the information and resources at Climate Change Impacts (https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts). Decide if you would like students to use any of the lessons, videos, or other resources to further explore how climate may change and affect global currents.

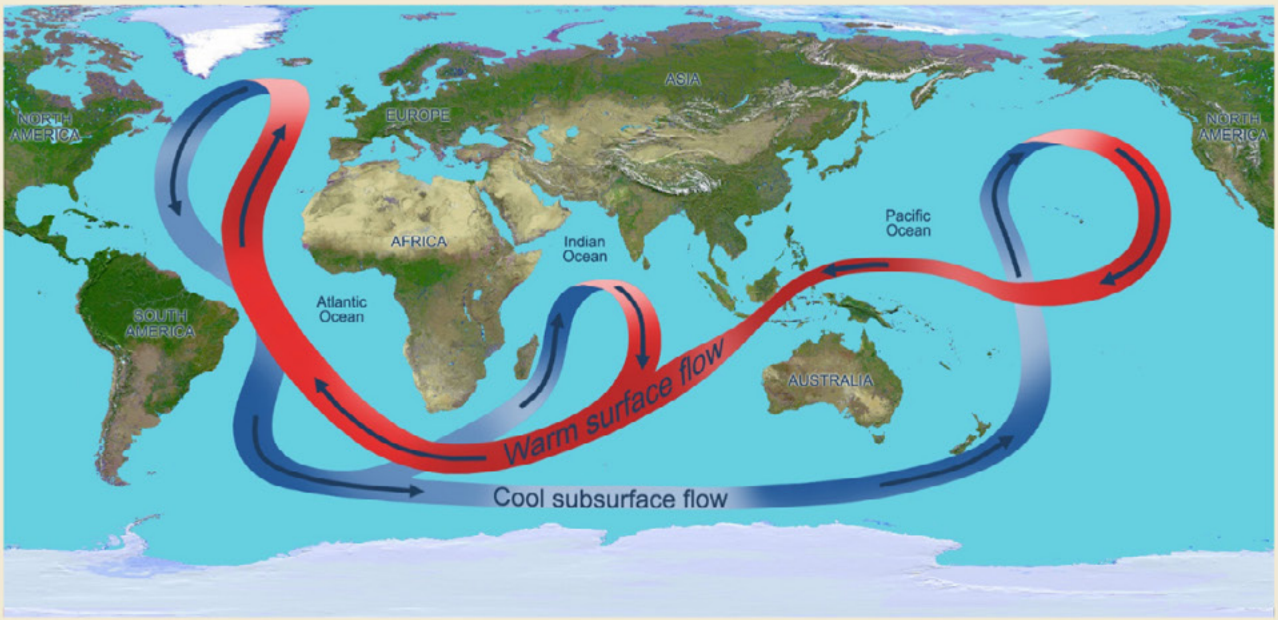
| Possible Narrative | Example of Drawing |
|---|---|
| With your page landscape (the long side going from left to right), draw a horizontal line near the center of the page. This represents where the ocean meets the atmosphere. The line does not have to be perfect, because the ocean does not have a straight, flat surface. Do not draw waves or ripples, though because we are looking at a side view across thousands of miles. Above the line, write a label that says "air" and below the line write a label that says "water." |   |
| Next, we need to orient people to where we are on Earth and what they are looking at. Often, when we are looking at a representation of thousands of miles along the Earth's surface, we are looking at something like a globe or a world map. In this case, so far we just have the air and the water. Let's make sure we are helping people know what they are looking at. I am going to have you draw a rough sketch of the Earth in the upper right corner.<br><br>• It should start with a circle that is about 1 ½ inches in diameter.<br>• Draw a line across the middle to (equator).<br>• Draw a rough outline of North and South America—it does not need to be perfect, but just show land that crosses the equator and spans from north to south.<br>• Sketch in a few lines of blue in the ocean and a few lines of green on the land.<br>• Now put an A in the ocean near the north part of the land and a B near the equator.<br>• On the main part of your picture, put an A at the far left near the line and a B at the far right near the line.<br><br>What does this tell us about the orientation of our picture compared to the globe? We should also add something to show the scale of this drawing. It is around 4,500 miles from the equator to the Arctic Circle so we will use that as a guide. If we say that A is close to the Arctic Circle and B is at the equator, and your paper is 11 inches from side to side, that means 1 inch is about 400 miles or so. Draw a line that is about 1 inch and label it as 400 miles. |   |

| Possible Narrative | Example of Drawing |
|---|---|
| Today, we are going to be creating a model for the "global conveyor belt" currents in the ocean. These are the currents that move water around the globe. Our description of the conveyor belt is going to start near our "A" label. Make a symbol or write the word "start" to show where our description will begin. |  |
| In the arctic, it is very cold. That starts to chill the water near the surface and sea ice starts to form. I am going to draw a thermometer that is blue to show how cold the air is and label it, "cold arctic air." Then I am going to draw some sea ice in the water and label it with, "sea ice forms." |  |
| When the sea ice forms, it is only the water that freezes. It leaves behind the salt, which stays in the water around the ice. Let's draw some salt in the water here to show that there is extra salt. Remember we are doing scientific drawing to help explain this concept, so we will need to label it as, "salt." |  |
| Now we have sea ice surrounded by water that has extra salt in it. That water is heavier because it does have more salt. It is also very cold from being near the surface with the cold air.<br><br>Have you ever heard the idea that hot air rises, like with a hot air balloon? The same idea applies to liquids where warm liquids rise, and cold liquids fall. Now this water is not only colder than the water below it, but it is also heavier. What do you think will happen? (The water will start to sink toward the bottom of the ocean.) Let's draw a big blue arrow to show that this water is sinking toward the bottom. |  |

| Possible Narrative | Example of Drawing |
| --- | --- |
| As the water sinks, it pushes the water that was already on the ocean floor to the side. The water becomes warmer and less salty because it mixes with other water. But, the water on the floor begins moving out of the way. Draw a blue arrow along the ocean floor to show that this water is still cooler and is moving toward B. Which direction is that on our globe up here in the corner? (to the south) |  |
| At the same time, new water must replace the water that sank toward the bottom. This water is helped by winds on the surface. It is mostly coming from the south, so it is warmer. Let's draw some winds on the surface as well as a red arrow to show that warmer water is moving into the arctic area. |  |
| Now we have water moving near the bottom of the ocean toward warmer areas of the Earth, near the equator. We also have water moving from those warmer areas toward the arctic. As the water warms up, it is going to begin to rise toward the surface and complete this cycle. Let's draw a red arrow to show warmer water rising toward the surface. This is called upwelling so let's label it with that word. We want to remind ourselves that the water is not as salty here, so add something to show that the water is salty, but not as much as it is near A where we have the sea ice forming. |  |
| This type of current moves water and heat around the world. Let's add that to the drawing. The other thing we will want to add to give people a sense of how this works is to add time. Scientists say that if you followed one particle of water around through a current like this, it would take 1000 years to make it all the way through the cycle. It moves a lot of water, but it is not moving really fast. Let's put something on our scientific drawing to show that it is roughly 1000 years to go through the whole cycle. |  |


NORTH AMERICA
Pacific Ocean
ASIA
AUSTRALIA
Warm surface flow
Cool subsurface flow
Indian Ocean
EUROPE
AFRICA
Atlantic Ocean
SOUTH AMERICA
NORTH AMERICA

# SCIENCE NEWS




- An illustration of the AMOC and its place within large-scale global ocean circulation

## THE AMOC

The "Atlantic Meridional Overturning Circulation," or AMOC for short, is a system of ocean currents. It runs from the northern part of the Atlantic Ocean around South America, Australia, and Africa.

The AMOC moves a lot of water! Salt moves with it and mixes with other water that is less salty. This helps to keep parts of the ocean from becoming too salty for living things. The AMOC also carries heat. Areas around the equator get a lot of direct sunlight, so there is a lot of heat there. The AMOC helps to distribute the heat to other parts of the globe. This makes the poles warmer as the heat moves toward them. It also makes the area around the equator cooler because heat does not build up.

Parts of the AMOC can move nutrients and other substances around in the ocean so they do not build up. The water carries nutrients to living things in different areas. Other substances, such as waste, become more spread out and do not build up in one area.

Like a gyre, the AMOC depends on the cooling that happens at the surface of the water in the North Atlantic. If the climate of the Earth changes and temperatures become warmer, the surface water will not cool. Sea ice will not form. Scientists think that this could slow down the AMOC making it much weaker. Some scientists think that in the future, the AMOC might stop circulating.