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| Microsoft Education and BBC Learning bring you *Oceans*-inspired, inquiry-based STEM lessons that challenge students to build sensors, create in 3D, analyze data, and experience mixed reality. Using affordable, hands-on, standards-aligned STEM activities, students discover ocean phenomena.  This lesson engages students in the question: How does thermal energy influence deep ocean currents?  **Related lesson** [Build an electrical conductivity sensor to measure ocean conductivity](https://aka.ms/STEM-oceans-currents-build/en)  **Download all lesson materials**  [Understand ocean currents](https://aka.ms/stem-oceans-currents-understand-assets/en) |



How are currents formed?

**Understand ocean currents**

*Click on images to navigate to activity*

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| Research ocean temperature and salinity vocabulary |  | *Experiment with thermal energy and molecule movement* |
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| Analyze ocean current strength in Excel |  | *Examine ocean current temperatures in Excel* |
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| *Model ocean currents in 3D* |  | *Create a video reflection* |

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| **Standards**  **NGSS**  **Performance Expectation**  [*MS-PS1-4*](https://www.nextgenscience.org/pe/ms-ps1-4-matter-and-its-interactions)*: Develop a model that predicts and describes changes in particle motion, temperature, and state of the pure substance when thermal energy is added or removed.*  *MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation*  *of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climate.*  **Science and Engineering Practices: Developing and Using Models**  [*MS-ESS2-1*](https://www.nextgenscience.org/pe/ms-ess2-1-earths-systems)*,* [*MS-ESS2-6*](https://www.nextgenscience.org/pe/ms-ess2-6-earths-systems)*: Develop and use*  *a model to describe phenomena. Modeling In 6-8 grade levels builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.*  **Disciplinary Core Ideas: ESS2.C: The Role of Water in Earth’s Surface Processes**  [*MS-ESS2-4*](https://www.nextgenscience.org/pe/ms-ess2-4-earths-systems)*: Global movements of water and Its changes in form are propelled by sunlight and gravity.*  [*MS-ESS2-6*](https://www.nextgenscience.org/pe/ms-ess2-6-earths-systems)*: Variations In density due to variations In temperature and salinity drive*  *a global pattern of Interconnected ocean currents.*  **Crosscutting Concepts: Systems and System Models**  [*MS-ESS2-6*](https://www.nextgenscience.org/pe/ms-ess2-6-earths-systems)*: Models can be used to represent systems and their interactions-such as inputs, processes and outputs-and energy, matter, and information flows within systems.*  **ISTE**  [*3c*](https://www.iste.org/standards/for-students)*: Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.*  [*3d*](https://www.iste.org/standards/for-students)*: Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.*  [*7d*](https://www.iste.org/standards/for-students)*: Students explore local and global Issues and use collaborative technologies to work with others to Investigate solutions.* |

# Lesson overview

**How are ocean currents formed?**  
**Understand ocean currents**

Target grades: 6-8 (ages 10-14)

Duration: 50 minutes (One 50-minute class period)

Please note that lesson activities will require adult supervision.

**Background**

In this lesson, you and your students will be exploring the phenomenon of deep ocean currents. Students will use models to investigate the influence of temperature on ocean current overturning. Students will consider the potential impacts of global climate change and the slowing of ocean currents in the North Atlantic.

**Student introduction**

Students take on the role of physical oceanographers researching an explanation for the phenomenon of ocean circulation slowing in the North Atlantic. Students study conditions that influence overturning strength of the North Atlantic also known as the Atlantic Meridional Overturning Circulation (AMOC) currents. The slowing of the AMOC raises uncertainty about the impact of global climate change on fragile marine ecosystems and rising sea levels. Experiences from lesson activities help students understand how global ocean currents occur so they can investigate current global conditions and provide evidence for an explanation for why currents are slowing down.

**Scientific phenomenon**

Data related to global ocean circulation shows deep ocean currents are slowing down.

**Lesson question**

How does thermal energy influence deep ocean currents?

**Learning target(s)**

Students can use a model to describe how deep ocean currents occur on Earth.

Students can use evidence from observations of a physical model and global ocean data to construct an explanation for why deep ocean currents are slowing down.

**Lesson core**

Students use a model to compare water molecule movement when thermal energy is added or removed.

Students use a model to make observations of water molecule movement in an environment with uneven heating and cooling.

Students use 3D modeling to describe global ocean currents.

**Related lessons**

This lesson is related to [Build an electrical conductivity sensor to measure ocean conductivity](https://aka.ms/STEM-oceans-currents-build/en) and can be used on its own or in sequence.

**Recommended preparation**

These activities can be grouped together or can stand alone—depending on educational needs and objectives. Items that may require your attention:

**1** | For footage of wondrous *Oceans*, view the [BBC Earth & OceanX Film *Oceans: Our Blue Planet* trailer.](https://www.microsoft.com/en-us/education/oceans)

**2** | Acquire [materials](https://aka.ms/oceans-currents-materials/en) for activities with a build or an experiment.

**3** | Familiarize yourself with instructions and tech requirements before teaching to mitigate unforeseen challenges.

**4** | Download the free [Data Streamer add-in](https://aka.ms/data-streamer) for Excel to support real-time data streaming.

**5 |** Confirm students have access to all links. Download [PowerPoint resources](https://aka.ms/stem-oceans-currents-understand-assets/en).

**6** | Confirm that each student computer has all required software:   
 • [Office 365](https://www.microsoft.com/en-us/education/products/office/default.aspx) • Microsoft Excel 2016 (desktop version) with Office 365 subscription  
 • Microsoft PowerPoint 2016 (desktop version) with Office 365 subscription  
 • Windows 10 Fall Creators Update

**Lesson assets**

Download individual elements of the lesson as you go through the science and engineering notebook or download all [assets for understand ocean currents.](https://aka.ms/STEM-oceans-currents-understand-assets/en)

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| **FIELD NOTES:**  *As you complete this lesson, use*  *the margin to keep note of any interesting finds or insights* |

# Welcome young scientists and engineers!

**You have been invited to participate in an important exploration project!**

A global environmental research group has just acquired data that reveals deep ocean currents are slowing down, particularly in the North Atlantic. Scientists hypothesize that this is due to global warming and rises in atmospheric and oceanic temperatures. The decrease in ocean circulation could have wide-reaching impacts on sea levels and fish populations and adversely affect the global climate. You and your team of physical oceanographers have been asked to contribute to this investigation and provide an understanding of this global phenomenon as the first steps in preventing future human activities from contributing to slowing currents.   
The question that you plan to explore: how does thermal energy influence deep ocean currents?

**Relevance to science, technology, and the world**

If you visit two cities at the same latitude in the North Atlantic in the winter, for example James Bay, Canada and London, England, you will experience cooler temperatures in James Bay and enjoy more temperate weather in London. Why? Warm surface currents from the tropics bring warmer waters to London but their path is diverted away from James Bay.

Historical ocean data shows that currents, particularly in the North Atlantic, are slowing down. What does this mean for ocean life such as fish and sharks? What does this mean for animals who migrate north to south such as Humpback whales? Collecting data with modern technological instruments will help us model and understand human impact on these natural processes and find ways to maintain Earth's fragile ecological balance.

Find out more!\*

[Slow-Motion Ocean: Atlantic’s Circulation Is Weakest in 1,600 Years](https://www.scientificamerican.com/article/slow-motion-ocean-atlantics-circulation-is-weakest-in-1-600-years/)

[Atlantic current strength declines](https://www.nature.com/news/atlantic-current-strength-declines-1.15209)

[Schematic of the Atlantic Meridional Overturning Circulation (AMOC)](https://www.youtube.com/watch?time_continue=34&v=UT2Xy6dZXpQ)

[Arctic Change: Global – Ocean Overturning](http://www.pmel.noaa.gov/arctic-zone/detect/global-ocean.shtml)

**Your mission**

Develop an understanding of currents and how they are influenced by temperature changes. Use your findings to come up with an evidence-based explanation for the slowing down of deep ocean currents.

Your contribution has the potential to positively impact today's world, monitor changes in climate, and maintain or restore the health of our fragile ecosystems.

**Good luck!**

*\*Microsoft Education provides contextual links for informational purposes only; they do not imply support or affiliation with the authors or source of publication.*

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| **LESSON:**  **Understand ocean currents**  **DATE:**  **TEAM/NAME:**  **FIELD NOTES:**  *As you complete this lesson, use*  *the margin to keep note of any interesting finds or insights.*    *Temperature and ocean currents PowerPoint* |

# Science and Engineering Notebook

**Use your science and engineering notebook to record ideas and findings. Add drawings, photos, and video to your descriptions.**

**Prior knowledge**

Complete questions 1- 3 individually, then discuss with your team and share responses with the class.

**1** | What forms of energy interact with the Earth's oceans?

**2** | How might these energy forms get transferred throughout the Earth's oceans?

**3** | How would you describe the energy of water at the equator compared to water at the polar regions?  Provide evidence for your response.

**Vocabulary**

Research vocabulary terms listed below using the [Temperature and ocean currents PowerPoint](http://aka.ms/STEM-oceans-currents-understand-TempPPT/en) and write a definition for each in your own words. Add sketches and drawings to help clarify your answers. This will give you some background information specific words related to ocean exploration.

Density | Salinity | Energy | Thermal energy | Warm current | Cold current Gyre | Overturning strength | Thermohaline | Surface circulation | AMOC

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| *Thermal energy and molecule movement experiment*  *Thermal energy and molecule movement*    *Ocean currents workbook* |

**Thermal energy and molecular movement**

Use the directions in the [Thermal energy and molecule movement](http://aka.ms/STEM-oceans-currents-understand-DiffusionInstructions/en) experiment document. Answer the following questions based on your observations:

**Food coloring in hot water**

**1** | What happened when you dripped food coloring in a beaker of hot water? Provide an explanation. Be sure to describe/diagram the movement of the molecules in your explanation.

**Food coloring in cold water**

**2** | What happened when you dripped food coloring in a beaker of cold water? Provide an explanation. Be sure to describe/diagram the movement of the molecules in your explanation.

Use the directions in the [Uneven heating and cooling in water](http://aka.ms/STEM-oceans-currents-understand-TempInstructions/en) experiment document. Answer the following questions based on your observations:

**3** | What happened when you dripped food coloring (or Potassium Permanganate crystals) in the tub with a beaker with hot water and a beaker with cold water at opposite ends? Include a description/diagram of molecule movement in your explanation.

**Why are ocean currents in the North Atlantic Ocean slowing down?**

Study the **Current strength** sheet in the [Ocean currents](https://aka.ms/STEM-oceans-currents-understand-bigdata) workbook. This workbook utilizes real-world data to show how the Atlantic Meridional Overturning Circulation (AMOC), a system of currents in the Atlantic Ocean that is part of the great ocean "conveyor belt," has changed over time. Use the worksheet and the data collected in the [Thermal energy and molecular movement](http://aka.ms/STEM-oceans-currents-understand-DiffusionInstructions/en) experiments to answer these questions:

**1** | What is the AMOC and how has it been changing?

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| *Ocean currents Excel*  *Temperature*    *Ocean currents Excel polar ice meltingPolar ice melting* |

**2** | Describe what you think causes deep ocean currents. Refer to [Thermal energy and molecular movement](http://aka.ms/STEM-oceans-currents-understand-DiffusionInstructions/en) experiments.

**3** | What factors do you believe are causing ocean currents to slow down in the North Atlantic?

**Global ocean currents**

Use the **Temperature sheet** in the [Ocean currents](https://aka.ms/STEM-oceans-currents-understand-bigdata) Excel workbook to answer these questions:

**1** | Select "0-50m" and scroll over the map. What do you notice about temperatures when you move from the equator northward or southward? How do temperatures at the other two depth ranges change as you move north or south from the equator?

**2** | While focusing on the North Atlantic Ocean, select different depth ranges to compare temperatures at different depths near the equator and the poles. What patterns do you notice about temperature at different depths?

Use the **Polar ice melting sheet** in the [Ocean currents](https://aka.ms/stem-oceans-currents-understand-bigdata) Excel workbook to answer this question:

**3** | How might ice melting influence global currents? Support your idea with evidence from the worksheet. Use a diagram/model in your response.

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| *Exploring oceans in 3D*    *Drawing currents on a 3D model*    *How to create a video reflection* |

**Summary of how temperature impacts ocean currents**

Use the [Temperature and ocean currents PowerPoint](http://aka.ms/STEM-oceans-currents-understand-TempPPT/en) and [Drawing currents on a 3D model](http://aka.ms/STEM-oceans-currents-understand-Paint3DCurrents/en) instructions to study global ocean currents and how temperature impacts the formation of currents.

**1** | Study how temperature impacts water density and deep ocean current formation.

**2** | View the animation of ocean currents using the [Exploring ocean currents in 3D](http://aka.ms/STEM-oceans-currents-understand-MRVInstructions/en) instructions and consider the cluster of warm and cold ocean currents on the globe.

**3** | Draw the flow of current in the specified ocean using the [Drawing currents on a 3D model](http://aka.ms/STEM-oceans-currents-understand-Paint3DCurrents/en) instructions.

**Reflection**

Use the [How to create a video reflection](https://aka.ms/STEM-oceans-VideoInstructions) tutorial to discover how to use Microsoft Photos to reflect on your learning. [See an example](https://www.youtube.com/watch?v=vBBcBAUhHTI&feature=youtu.be) of how to combine photos and videos. These questions guide you in creating a reflection:

**1** | Why do global ocean currents occur on earth? (Provide evidence from this lesson to support your answer.)

**2** | Based on observations and evidence from this lesson, what are factors that could be responsible for the slowing down of global ocean currents?

**3** | What other questions do you have about ocean currents and their influence on climate and Earth’s ecosystems?