

Family Fun

Climate Change and the Global Conveyor Belt

Enduring Understanding: Human actions either negatively or positively impact Earth's processes and climate system.

Materials

- "The Global Conveyor Belt and Climate Change" worksheets
- Computers with Internet access or other research materials (optional)

Setup:

1. Print "The Global Conveyor Belt and Climate Change" worksheets.

Program outline:

Why is the global conveyor belt important?

- Read the text about the global conveyor belt and answer the questions on the worksheet.
- Alternatively, you may select another text or video that discusses thermohaline circulation and climate change.
- Have students work individually or work on it together.

Debrief

- After your student reads the text and answers the questions, bring the group together.
- Review thermohaline circulation and the physical and chemical properties of water that cause it to happen.
 - Thermohaline circulation is the movement of water caused by differences in temperature (thermo-) and salinity (-haline).
 - Variations in these characteristics of water cause variations in that water's density.
 - Water that is more saline, or saltier, is denser than less saline water. Because of this, saltier water sinks.
 - Generally, colder water is denser than warmer water, and generally colder water will sink below warmer water. However, below approximately 4°C, water begins to expand again, making it less dense than warmer water. This is why ice floats in liquid water.
- The unique characteristics of water are responsible for thermohaline circulation, which moves water throughout the world's oceans, also known as the global conveyor belt.



Program outline continued:

- The global conveyor belt is integral to Earth's climate and may be disrupted by climate change.

What can we do to help?

- Everyone has the ability to both contribute to climate change by producing greenhouse gas emissions and to combat climate change by reducing greenhouse gas emissions. We make choices every day that can either contribute to or mitigate the problem.
- The idea of the carbon footprint is a useful tool to help people make smart choices for the climate.
 - It shows how much of an impact a given activity, product, or way of life has in contributing to climate change.
- As a follow-up activity, have your family investigate ways they can shrink their carbon footprint. Have them focus on a specific activity they take part in or product they consume and answer the following questions:
 - What is the carbon footprint of the specific activity or product?
 - How does this activity produce greenhouse gases—both directly and indirectly?
 - Is there a way to shrink the carbon footprint of the activity or product?
 - How can students make a lower-impact choice around this product or activity?
- Examples of products or activities can include the following:
 - Foods they eat
 - Time spent on computers or smart devices
 - Mode of transportation used to get to and from school
 - Clothes they own
- When the students are done with their research and writing their responses, have them share what they found with you.

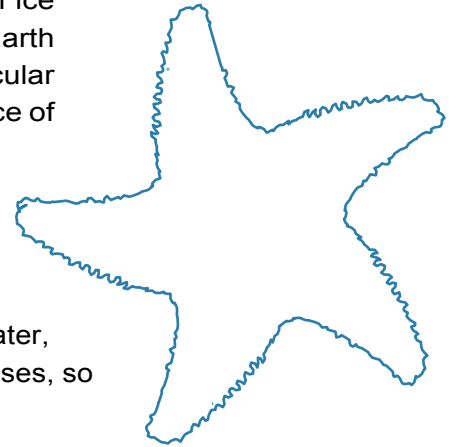


Background information:

Thermohaline Circulation in Earth's Oceans

The density of water varies most notably at or near the temperature at which phase change occurs. As water nears its boiling point of 100°C , its molecules spread farther and farther apart, making it considerably less dense, until it vaporizes into water vapor, which has a very low density. As water approaches its freezing point of 0°C , its molecules move closer and closer together, making it denser. This trend of water becoming increasingly dense continues until approximately 4°C , at which point water is its densest. At temperatures below 4°C , water actually becomes less dense. This is an unusual characteristic of water that is responsible for ice floating in liquid water. It may have played a role in the suitability of Earth for the evolution of life. This characteristic is due to the unusual molecular structure and molecular characteristics of water, including the presence of hydrogen bonds.

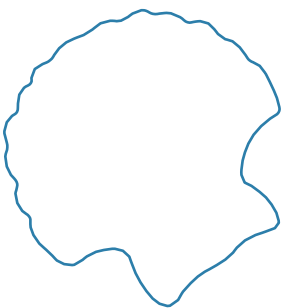
These variations in salinity and density that occur as water undergoes a phase change from solid to liquid, or vice versa, are important drivers in Earth's ocean currents and thus its climate. As ocean water freezes in the polar regions, salt evacuates the freezing water, increasing the salinity of the nearby water. As the water's salinity increases, so does its density. This means that the water sinks.



This sinking of dense, highly saline water at the poles drives thermohaline circulation in the world's oceans. Also known as the global conveyor belt, thermohaline circulation moves vast quantities of water in a slow-moving current that circulates throughout the world's oceans. The circulation happens extremely slowly: any one water molecule may take a thousand years or more to circulate through the conveyor belt. However, the global conveyor belt is important in regulating climate, the carbon cycle, and ocean nutrient cycles throughout the world.

Climate Change and the Global Conveyor Belt

Global climate change caused by human disruptions to Earth's carbon cycle is one of the most pressing social and environmental issues of our time. While climates naturally change over time, the present-day anthropogenic climate change is occurring at an accelerated and perhaps unprecedented rate, which will have—and in some cases already is having—very real implications for humans and other living things.



There are multiple human actions that contribute to the changing climate, but the main cause is the burning of fossil fuels. When people burn fossil fuels—oil, coal, and natural gas—carbon that has been chemically stored in the fuel for millions of years is released into the atmosphere as carbon dioxide, a greenhouse gas. Greenhouse gases trap heat in Earth's atmosphere, making it warm enough for life. However, when there are too many greenhouse gases in the atmosphere, it causes temperatures to rise. This results in increases in the overall temperature of the planet. But higher temperatures are not the only impact expected with climate change. Weather is driven by the way heat moves through the earth system, and adding more heat changes weather patterns, potentially leading to more extreme weather events.

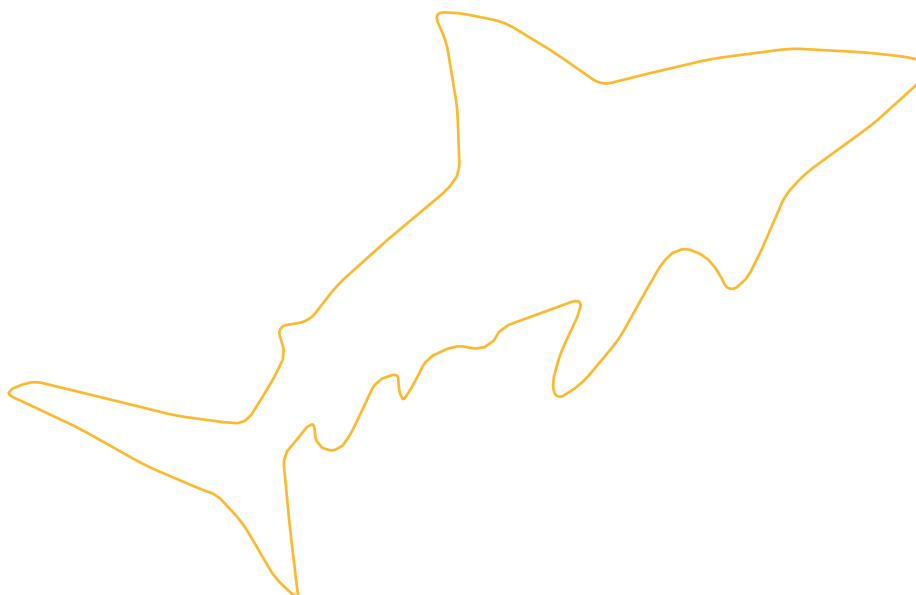
background information continued:

Burning fossil fuels, while the primary cause of climate change, is not the only thing humans do that is raising the temperature. Another major cause is deforestation. When people clear trees—trees that were previously breathing in carbon dioxide and photosynthesizing it into oxygen—the trees are no longer able to uptake carbon dioxide. Any carbon they would have absorbed remains in the atmosphere. Animal agriculture is another major contributor to climate change, accounting for nearly a fifth of all greenhouse gas emissions. Not only does industrialized animal agriculture require the burning of fossil fuels and contribute a major reason for deforestation, but many commonly farmed animals produce methane, a greenhouse gas many times more powerful than carbon dioxide.

One of the many expected impacts of global climate change—and one that has already been observed—is a disruption in the formation of sea ice at Earth's poles. As the patterns of sea-ice formation change, and in some cases cease altogether, the global conveyor belt of water circulating through the ocean may be disrupted, in turn further disrupting global climate and the global climate cycle.

Fortunately, there are steps that people can take, both individually and collectively, to combat climate change by shrinking their carbon footprint. These are just a few actions that can help maintain the equilibrium of Earth's climate and prevent the disruption of the global conveyor belt:

- Make transportation choices that produce fewer greenhouse gases, including walking, biking, taking public transportation, and carpooling.
- Choose to eat foods that have a lower carbon footprint, such as vegetables and fruit, and avoid foods with high carbon footprints, such as meat (particularly beef) and processed foods.
- Shop at farmers' markets and/or choose locally made products that require fewer carbon emissions to ship.
- Reduce consumption by using what you do buy, reusing things you can, and recycling or composting what you can't.



glossary:

Carbon Footprint: Amount of climate change-causing greenhouse gases required to produce a particular product, complete a particular activity, or support the lifestyle of a particular individual or group.

Climate Change: Significant, long-term changes in weather patterns; has happened in the past but is currently happening at an accelerated rate because of human activities; (Current climate change is often referred to as global warming, but climate change is a more accurate description of the phenomenon.)

Density: Amount of matter in a given area; calculated by dividing mass by volume

Global Conveyor Belt: Slow-moving, deep-water, thermohaline currents that circulate through Earth's oceans, influencing climate, the carbon cycle, and nutrient availability

Salinity: Measure of the amount of dissolved salt in water; usually measured in parts per thousand (ppt or ‰)

Sea Ice: Massive floating body of ice in ocean ecosystems; includes icebergs and polar ice sheets

Temperature: Measure of heat within a given object; measured in degrees Celsius, Fahrenheit, or Kelvin

Thermohaline Circulation: Movement of water driven by variations in its temperature and salinity; the global-scale currents of ocean water that form the global conveyor belt.

Name: _____

Date: _____

The Global Conveyor Belt and Climate Change

The oceans are vital to all life on Earth, even to organisms that live far from them. The oceans provide oxygen for us to breathe and food and habitat for many living things. They play a major role in the planet's climate. One of the ways that the oceans help regulate climate is through something called the global conveyor belt, also known as thermohaline circulation.



NOAA Ocean Service Education <http://oceanservice.noaa.gov/education/kits/currents/06conveyor2.html>

The global conveyor belt is a current that moves through and connects all the world's oceans. The current is very slow. It can take a thousand years for any one water molecule to make the whole journey. It is driven by the differences in temperature and salinity in the water of different parts of the ocean. At Earth's poles, dense saltwater sinks. This starts the conveyor belt in motion. The water at the poles is particularly dense for two reasons: One, the poles are the coldest parts of the planet and so have the coldest water, and two, when ocean water freezes to form sea ice, the salt escapes the ice into the surrounding water. As the water moves around the planet on the conveyor belt, it also moves heat around the planet. By moving this heat around Earth, the global conveyor belt helps keep the temperatures and weather on land from changing too

much. It keeps some parts of the world—such as Northern Europe—from getting too cold.

This process has remained relatively unchanged since the last ice age ended 12,000 years ago. But now it may be disrupted by global climate change. When humans burn fossil fuels like coal, oil, and natural gas to power cars, heat homes, and make goods, carbon that was trapped in the fuel for millions of years is transformed into carbon dioxide and other greenhouse gases, which enter the atmosphere. Other human activities like deforestation, raising animals for food, and making cement also release greenhouse gases. Once in the atmosphere, these newly released greenhouse gases trap extra heat on Earth. Carbon dioxide and other greenhouse gases naturally occur in the atmosphere, but human activity is throwing off the balance by adding more than is supposed to be there.

By trapping more heat, Earth is getting warmer overall. However, there is more to the story than things getting warmer. As the planet warms, long-term weather patterns—climates—around the world change. Two places where this is most notable are Earth's poles. These are warming faster than other parts of the planet. The cold polar waters that help drive the global conveyor belt are warming. Also, the sea-ice formation that makes polar water saltier is happening on a smaller scale. If this pattern continues into the future, it could lessen the amount of water sinking at the poles. This would slow or maybe even stop the global conveyor belt.

Fortunately, there are many ways that individuals and communities can reduce climate change impacts on the global conveyor belt and the rest of the planet. By making choices that reduce the amount of

The Global Conveyor Belt and Climate Change continued



greenhouse gases we put into the atmosphere, also known as our carbon footprint, we can maintain a healthy climate and keep the global conveyor belt flowing through the world's oceans.

Using evidence from the text, your previous knowledge, and your own ideas, please answer the following questions.

1. What is the global conveyor belt?

2. How does the global conveyor belt work?

3. Why is the global conveyor belt important?

4. Why is climate change an issue for the global conveyor belt?

5. How do you think a changing climate might impact humans?

The Global Conveyor Belt and Climate Change continued



6. How do you think a changing climate might impact other living things?

7. What are some ways that people—as individuals or as communities—can help slow climate change?
