NO PREP

Thermohaline Circulation and the Global Conveyor Belt

MORE LESSONS LESS PLANNING · MLLP · FREE TODAY · FREE TOMORROW · FREE FOREVER

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Thermohaline Circulation and the Global Conveyor Belt

The Driving Forces of Deep Ocean Circulation

Name: **Period:** **Date:**

Thermohaline Circulation and the Global Conveyor Belt

The Driving Forces of Deep Ocean Circulation

The ocean is always in motion. While surface currents are shaped by winds and Earth's rotation, the deep ocean follows a different rhythm. Thermohaline circulation, named for temperature ("thermo") and salinity ("haline"), is the great engine of deep-sea movement. It forms the backbone of the global conveyor belt, a planetary system that links the oceans into a single, interconnected circulation network. At its heart, thermohaline circulation is powered by density differences. Cold water is denser than warm water, and salty water is denser than fresh water. When seawater becomes both cold and salty, as it does near the poles, it sinks to great depths and begins a slow journey across the world's ocean basins. This deep flow may take centuries to complete its cycle, but it shapes climate, nutrient distribution, and the health of ecosystems worldwide.

Sinking Waters and the Conveyor Belt

The process begins most dramatically in the North Atlantic Ocean. During winter, cold winds cool the surface and sea ice formation increases salinity, making the water dense enough to sink. This creates a current of deep water that moves southward, hugging the seafloor. A similar process occurs in the Southern Ocean around Antarctica. As these waters travel, they gradually rise back to the surface through upwelling, completing the conveyor belt. This circulation redistributes heat, helping keep regions like Western Europe warmer than other places at the same latitude. It also moves nutrients from the deep sea into surface waters, fueling plankton growth that supports the marine food web. Disruptions to this system can be serious. If freshwater from melting ice dilutes the North Atlantic, the sinking process may slow. This could weaken the conveyor belt and change rainfall, storm tracks, and global climate patterns.

Heat, Nutrients, and Life in the Ocean

The global conveyor belt is not only a climate stabilizer—it is also a lifeline for marine ecosystems. Nutrients that sink with decaying matter in one region can resurface thousands of miles away, feeding plankton blooms and fisheries. Upwelling zones, such as those off the coast of Peru, are some of the most productive ecosystems on Earth precisely because they tap into this nutrient conveyor. In addition, circulation helps regulate the balance of carbon dioxide in the atmosphere. The deep ocean is a massive carbon reservoir, and the conveyor belt determines how fast that carbon is cycled back to the surface. By controlling both nutrient supply and carbon storage, thermohaline circulation links the deep sea to human societies, whether through food security, weather stability, or climate regulation.

Key Information: Key Concepts Table

Process	Driver	Impact on Earth Systems
Thermohaline Circulation	Temperature + salinity density	Moves water between surface and deep ocean
Global Conveyor Belt	Interconnected currents	Redistributes heat worldwide
Upwelling	Rising of deep waters	Brings nutrients that fuel ecosystems
Ice Formation	Leaves behind salty brine	Increases density, drives sinking currents
Freshwater Input	Dilutes salinity	Can weaken or shut down circulation

Case Study: The Younger Dryas Cooling Event

Around 12,000 years ago, Earth was warming after the last Ice Age. Then, suddenly, temperatures in the Northern Hemisphere plummeted back to near-glacial conditions for about 1,200 years. This puzzling period is known as the Younger Dryas. Evidence suggests that a massive outburst of freshwater from melting ice sheets poured into the North Atlantic, reducing salinity. With less salt, the surface waters were not dense enough to sink, and thermohaline circulation stalled. Without the conveyor belt moving heat northward, Europe and North America entered a deep freeze. This case is a powerful reminder that the conveyor belt is not unbreakable. A relatively short-term change in freshwater balance created centuries of disruption to climate and ecosystems. Today, scientists worry about a repeat scenario, as modern ice sheets in Greenland and Antarctica melt at accelerating rates. Understanding the past helps us prepare for possible future climate surprises.

1. How did melting ice sheets contribute to the Younger Dryas cooling?

2. Why do scientists today compare Greenland's melting to this event?

Multiple Choice

1. What causes seawater to become dense enough to sink in the North Atlantic?

a) Cooling and increased salinity from ice formation

b) Nutrient depletion and plankton growth

c) Strong winds and tidal forces

d) Seafloor spreading and volcanic hydrothermal activity

2. What role does upwelling play in the conveyor belt?

a) It blocks thermohaline circulation

b) It increases salinity at the poles

c) It traps nutrients in deep water, limiting surface circulation

d) It brings deep nutrients to the surface, supporting ecosystems

3. Why was the Younger Dryas significant to climate science?

a) It showed that volcanic eruptions control major climate cycles

b) It caused the permanent end of Ice Age conditions

c) It proved that circulation disruptions can rapidly cool regions

d) It demonstrated the conveyor belt's steady ability to stabilize heat

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Thermohaline Circulation	A) Temporary cooling 12,000 years ago
2. ___ Global Conveyor Belt	B) Fueled by cold, salty water sinking
3. ___ Younger Dryas	C) Leaves behind salty brine, increasing density
4. ___ Upwelling	D) Redistributes heat across oceans
5. ___ Ice Formation	E) Brings nutrients to the surface

Fill-in-the-Blank

1. The combination of temperature and salinity that drives circulation is called _____.

2. The deep ocean is a major storage area for atmospheric _____.

3. The _____ Conveyor Belt links all of Earth's oceans together.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain how melting ice sheets could disrupt the thermohaline circulation.

2. Why is the global conveyor belt important for maintaining marine ecosystems?

3. How does circulation connect the deep ocean to climate regulation on land?