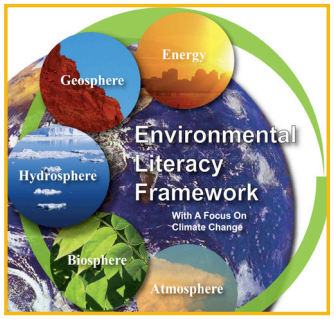
How Does Melting Ice Affect Sea Level?



Focus Questions:

If floating ice (ice shelves and sea ice) melts, will sea levels around the world rise?

If land-based ice (glaciers and ice sheets) melts, will sea levels **rise?**

Preview

Arctic Ice Loss

The area covered by sea ice in the Arctic Ocean has been shrinking. For many decades, more sea ice has melted away during summers than has reformed during winters. Projections show that the ocean around the North Pole could be ice-free during summers as early as the year 2030! How might the melting of this sea ice — an area larger than the country of India — affect the rest of the world?

The ice sheet on Greenland is also shrinking. Over the past 30 years, the total area of the Greenland ice sheet affected by summer melting has grown. What effect might the melting of Greenland's ice sheet have on the rest of the world?

Antarctic Ice Loss

Antarctica has ice sheets on land, floating ice shelves, and sea ice surrounding it. How would the melting of these three different kinds of ice affect the rest of the world?

Time

1 hour

Materials

- Transparent plastic food container, about 8" x 6" x 2" (2)
- Plastic food container, about 4" x 4" (2)
- Aquarium gravel (2 cups)
- Overhead transparency marker
- Measuring cup
- Labels (2)
- Colored markers
- Large sheet of construction paper or poster board

Vocabulary (Terms)

Ice sheet
Ice shelf
Sea ice

Activity 3C-How Does Melting Ice Affect Sea Level?

Prepare

Activity Steps:

Make two identical pieces of ice.

1. Put water into one of your small plastic containers so it is approximately ½ inch deep.

2. Pour the water into a measuring cup so you know exactly how much you have

3. Pour that same volume of water into each of the two small plastic containers and put them in the freezer.

Make two models of land and sea

1. Put a label on the outside of each of the two rectangular containers.

2. Write "Ice on Land" on one container and "Ice in Water" on the other.

3. Pour 1 cup of gravel into each container. Tilt and shake each container gently so the gravel is piled in one end to form the "land."

4. Gently pour 1½ cups of water into each container. Make sure that the water doesn't cover the surface of the gravel.

5. In the Ice on Land container, place one of the pieces of ice on top of the gravel. No part of the ice should be in the water.

(Continue with activity steps on next page.)

6. In the Ice in Water container, put the piece of ice in the water, so no part of it is supported by the gravel.

7. On the outside of each container, mark the water level, using an overhead-transparency marker.

8. Have a discussion with your team members: What do the different parts of the model represent in the real world?

In the model, what is the significance of the water level?

Wait for the ice to melt

1. Put both containers in a place where they won't be disturbed while the ice melts. If it's necessary to leave them for more than a few hours, put lids on the containers to keep water from evaporating.

2. After both pieces of ice have melted, check and mark the water levels again.

Ponder...

Imagine a flat beach area with roads, houses, and shops just beyond the sand. Now imagine how rising sea levels would affect your mental picture. Describe what might happen in your scene year after year as sea levels rise and water covers more of the land.

Go back to the Preview section of this activity. Based on your results, answer the questions about sea ice, Greenland's ice sheet, and the three types of ice in Antarctica.

What about a beach resort?

On the "land" area of your model, use small objects to represent buildings, roads, and parking lots right along your "beach." What might happen to your resort as the ice melts in each model?

Practice

Got the Big Idea?

When ice that is floating in the ocean melts, sea level does not change. This applies to all floating ice, including sea ice and ice shelves. When ice that is on land melts and runs into the sea, additional water is being added to the ocean, so sea level rises.

Get ready to present

Think of an introductory comment or question you can use to explain what the two models show.

As the ice will likely melt during the Flexhibit, you may want to make a chart with drawings or photographs showing how the two models look before and after the ice melts. Emphasize the observed change in water levels so you can draw a connection to changes in sea level. Another option would be to prepare an extra set of the models so that Flexhibit attendees can see what they look like before and after melting.

Present

When you set up your station, be sure that visitors will be able to see the difference in water levels for the container with ice on land. Be ready to explain that the water level represents sea level for the whole world.

For visitors who are interested and engaged with the concept, you might share some of the estimates (below) of the amount of sea-level rise that would result from the melting of ice in different places.

Ice Sheet	Estimated Sea-Level Rise
Greenland	7 meters
West Antarctica	7 meters
East Antarctica	70 meters

Activity 3C-How Does Melting Ice Affect Sea Level?

Background Information for the Teacher

Ice Shelves are floating extensions of land glaciers that move toward the coasts under the weight of accumulating snow and ice in the interior of the continent. Approximately 44% percent of the coast of Antarctica has an ice shelf. As the ice shelf advances over the ocean, pieces break off forming icebergs. Advance and retreat of ice shelves is a natural cycle, however in 2002 the Larsen B Ice Shelf in the Antarctic Peninsula indicated that the glacier flow was accelerating. For more on the story go to this website.

http://earthobservatory.nasa.gov/Features/WorldOfChange/larsenb.php

The two largest ice shelves in Antarctica are the Ross Ice Shelf (487,000 sq mi/148,437.6 m, 2600 ft/792.48 m thick) and the Ronne Ice Shelf (430,000 sq miles/131,064 m, 3000 ft/914.4 m thick). The Ross Ice Shelf moves toward the ocean at a rate of approximately 3000 ft/914.4 m per year.

When glaciers move onto the oceans they add volume and increase sea level. However, once floating on the water, melting or break up of the shelf does not increase sea level rise.

Sea ice forms when ocean water freezes forming a thick solid sheet of ice that extends away from the shore.During the Arctic winter, 9.32 million sq m/15 million sq km cover the Arctic Ocean region which shrinks to 4.34 million sq m/7 million sq km in summer. For Antarctica, the sea ice extent ranges from 11.8 million sq m/19 million sq km in the winter to 2.17 sq m/3.5 million sq km in the summer. These large ice shelves work to control the heat exchange between the polar oceans and the atmosphere, limit the access of the water underneath to receive sunlight and increases the albedo of the oceans. The sea ice reflects solar radiation which helps keep the planet cool. Many scientists are concerned about shrinking ice because of its effect on climate as water absorbs solar radiation and adds to the Earth's heat budget. Pack ice are large rafts (floes) of ice which extend away from the shore. About 90% of the frozen ocean is pack ice. The other 10% is called fast ice and is attached to the land. Both these sea ice formations support a wide array of life from diatoms to seal and whales.

Fluctuations in floating ice (pack ice, fast ice, ice shelves and the North Pole ice cap) does not affect sea level. For more information on sea ice formation go to the website:
http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice_south.php

Glaciers are large amounts of land ice that build up with the accumulation of snow falling over thousands to millions of years. Under the weight of the ice and the influence of gravity, glaciers move toward the coast. As the glaciers move over the surface of the land, they carve landscapes, erode and break up rocks, and carry away the resulting sediments. As the Earth's climate changes over geologic time, glaciers advance and retreat. In the last few decades most of the world's glaciers are retreating.
During cooler times in the Earth's history, glaciers covered large parts of continents and the sea level was lower than it is now. As the glaciers retreated and the ice melted, sea levels rose. When glaciers melt, water is returned to the oceans and sea levels rise.

For more information on glaciers, go to the website: http://climate.noaa.gov/warmingworld/glaciers.html

Arrigo, K. 1998. Antarctic Sea Ice Biological Processes, Interantionc, ad variability, Antarctic Research Series, Vol 73, p 23-43

Activity 3C-How Does Melting Ice Affect Sea Level?

How Does Melting Ice Effect Sea Levels		
Students learn the difference in contribution to sea level rise by comparing the melting of floating ice and land ice.		
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EARTH Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Oceans have a major effect on climate, because water in the oceans holds a large amount of heat. The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past.	2B Changes in ocean circulation caused by tectonic movements or large influxes of fresh water from melting polar ice can lead to significant and even abrupt changes in climate, both locally and on global scales. 4 A. Climate is determined by the long-term pattern of temperature and precipitation averages and extremes at a location. Climate descriptions can refer to areas that are local, regional, or global in extent. Climate can be described for different time intervals, such as decades, years, seasons, months, or specific dates of the year. 4 D. Scientific observations indicate that global climate has changed in the past, is changing now, and will change in the future. The magnitude and direction of this change is not the same at all locations on Earth. 7 A. Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea level to rise. Seawater is beginning to move onto low-lying land and to contaminate coastal fresh water sources and beginning to submerge coastal facilities and barrier islands.	

Glossary

How Does Melting Ice Affect Sea Level?	Glacier	A large persistent body of ice that accumulates over time
How Does Melting Ice Affect Sea Level?	Ice sheet	A large glacier or system of glaciers covering a significant part of a land mass
How Does Melting Ice Affect Sea Level?	Ice Shelf	A floating sheet of ice permanently attached to a landmass.