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Seashore Science: How Melting Polar Ice Affects Ocean Levels

An environmental exercise from Science Buddies

By Science Buddies | Thursday, January 10, 2013 | 5 comments

Key concepts

Water

Ice

Oceans

Sea levels

Climate change

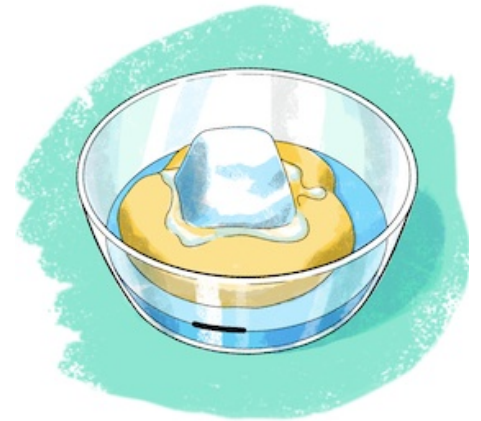
Introduction

Have you ever noticed that if you leave an ice cube out on the kitchen counter and come back to check on it in a while, you find a puddle? The same thing happens to ice in nature—if the temperature gets warm enough, ice melts. In this activity you'll explore what happens to the sea levels when ice at the North or South poles melts. Does melting ice at either or both caps contribute to a rise in the world's oceans? It's an especially important question for the millions of people who live along the coasts of the world.

Background

If you've ever been to a beach, you may have noticed that the ocean waves come farther up at certain times of the day than at others—this is due to daily tides, caused mainly by the gravitational pull mostly from the moon (along with some assist from the sun). Tides are a normal daily rise and fall of the ocean surface.

Scientists are concerned, though, about a different kind of rise in the ocean surface—one not due to the moon's tug, but due to changes in Earth's climate. Many areas of the globe have been getting warmer for decades. This warming is thought to be caused mainly by things that people do, such as burn gasoline to drive cars, coal to make electricity, oil or natural gas to heat homes or forests to make room for growing crops. All this burning creates gases that trap heat from the sun. As more gases are created, more heat is trapped in Earth's atmosphere, and the average temperature of Earth's air and oceans increases. One concern with the warming of Earth's global climate is that as the average temperature increases, greater amounts of northern and southern polar ice will melt, which could make the sea level rise. Both poles are slightly different, however; the region around the North Pole—the Arctic—is simply a large sheet of ice covering ocean underneath, whereas the South Pole—the Antarctic—is actually a continent covered by ice that also extends part of the way into the surrounding water.



RISING SEAS: Learn how ice melting at the poles will affect shores all over the globe.

Image: George Resteck

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Materials

- Measuring cup
- Permanent marker
- Two clear plastic containers, approximately two and a quarter cups in size, such as take-out containers that are slightly larger than a pint (*Note:* Smaller or larger containers can be used if they are both the same size, but you'll need to scale up or down the amount of clay you add to the containers. Also, you will be marking the clear plastic containers with a permanent marker, so make sure they are containers you won't mind marking.)
- Play-Doh or modeling clay
- Butter knife
- Tap water
- Ice cubes

Preparation

- If you're using containers that are not two and one quarter cups in size, scale up or scale down the amount of clay you use in the next step.
- Put one cup of Play-Doh or modeling clay into one of the clear plastic containers. This container will be a model of the South Pole, with the mound representing the continent of Antarctica. Use a butter knife to scrape around the sides of the measuring cup, if necessary.
- Leave some space between the sides of the clay and the wall of the container all around, so that you can add water later.
- Make the top of the clay flat and level.

Procedure

- Take the second, empty clear plastic container and fill it about one third to half full of tap water. The water represents the ocean.
- Add two ice cubes to the container and immediately mark the water level on the side of the container with a permanent marker. This container is a model of the North Pole, where the ice cubes represent the floating northern polar ice cap. *What do you think will happen as the ice cubes melt?*
- Take the first plastic container, which has the Play-Doh or modeling clay inside of it, and add around one quarter cup of water around the sides of the clay, so that the water level comes up about one third to half of the way up the clay. The water represents the ocean.
- Place two ice cubes on top of the clay, lightly pressing them down into the clay. Immediately mark the water level on the side of the container with the permanent marker. The ice cubes represent the southern polar ice sheet in this model of the South Pole. *What do you think will happen as the ice cubes melt?*
- Allow the ice in your models to melt in a place where they won't be disturbed. Keep an eye on the ice cubes in the South Pole model to make sure they stay balanced on the clay, and that all the water from these melted ice cubes is able to drain off of the clay.
- Once the ice has completely melted, check the water level in each container again. *Has the water level risen in any of the containers? If it has, why do you think this is, and what do you think the implications are for changes in sea level in the real world?*
- **Extra:** Repeat this activity two more times. *Do you get the same results each time?*
- **Extra:** Using the remaining clay, create a different South Pole ice model in which two ice cubes are placed on the clay continent to represent the ice sheet and one ice cube is placed in the water to represent floating ice shelves surrounding and attached to the continent of Antarctica. *What do the results of doing this new activity tell you?*

Observations and results

After the ice cubes melted, did the water level in the North Pole model remain unchanged, whereas the water level in the South Pole model increase?

The ice on the North Pole is in the form of a floating polar ice cap, whereas the ice on the South Pole is mainly in the form of an ice sheet on top of the continent of Antarctica. As floating ice melts into the water, the ice's solid volume is displaced as it becomes liquid by the same amount, so the water level in the North Pole model should not increase much as the ice cubes melt. However, when an ice sheet on a landmass (such as in Antarctica or Greenland) melts and flows into the "ocean," this does cause an increase in the water level. This is

what you should have observed in the South Pole model, with an increase of around one centimeter (0.4 inch), depending on the shape of the clay landmass and ice cubes. It's estimated that if all of the ice on the poles melted, sea levels would increase by at least 60 meters (200 feet), due to the ice covering the South Pole (as well as that on and around Greenland) melting, although the ice on Antarctica is not considered to be in danger of melting as soon as the Arctic ice cap.

Many people around the world enjoy living by the ocean, but even a small rise in sea levels will cause flooding of areas that are at a low elevation and close to the water. In 2007 a study reported that around 634 million people (about one in 10 people in the world) live in locations that are less than nine meters (30 feet) above sea level and are consequently at more immediate risk from rising seas.

Cleanup

Let the wet Play-Doh or modeling clay dry off a little bit before resealing it in its storage container.

More to explore

Study: 634 Million People at Risk from Rising Seas, from Nell Greenfieldboyce at National Public Radio

Climate and Global Change, from Windows to the Universe

Regarding global warming..., from the University of California, Santa Barbara, ScienceLine

Polar Puzzle: Will Ice Melting at the North or South Poles Cause Sea Levels to Rise?, from Science Buddies

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