Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

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SEA ICE AND GLOBAL WARMING

Lesson plan for grades K-3
By: Laura Sanders, Environmental Science Institute, March 2011
Length of lesson: two 30-minute class periods

SOURCES AND RESOURCES:

- Atmospheric Radiation Measurement Climate Research Facility Education and Outreach http://education.arm.gov/
- National Aeronautics and Space Administration Research News (January 2011) http://www.giss.nasa.gov/research/news/20110112/
- NASA Global Temperature Anomalies years 1880-2000 (Image credit: NASA/Earth Observatory/Robert Simmon) http://www.giss.nasa.gov/research/news/20110112/509796main_GISS_annual_temperature_anomalies.pdf
- Teachers' Guide to High Quality Education Materials on Climate Change and Global Warming. http://hdgc.epp.cmu.edu/teachersguide/teachersguide.htm#topten
- All About Sea Ice http://nsidc.org/seaice/intro.html
- Icebergs and Glaciers – Lessons and Activities by Jessica Fries-Gaither http://beyondpenguins.nsdl.org/issue/column.php?date=August2009&departmentid=literacy&columnid=literacy!lessons
- Antarctica Live - http://uncw.edu/tc/antarctica/questions2_8.htm
- Discovery Education: Elements of Chemistry http://www.discoveryeducation.com/teachers/free-lesson-plans/elements-of-chemistry-solids-liquids-and-gases.cfm

SAMPLES OF POTENTIAL TEKS ADDRESSED THROUGH THIS LESSON:

§112.11. Science, Kindergarten, Beginning with School Year 2010-2011. 2A, 2C, 2D, 2E, 3B, 4A, 5B, 9B
§112.12. Science, Grade 1, Beginning with School Year 2010-2011. 2A, 2C, 2D, 2E, 3B, 4A, 4B, 5B, 7B, 10A
§112.13. Science, Grade 2, Beginning with School Year 2010-2011. 2A, 2C, 2D, 2E, 3B, 4A, 4B, 5B, 7B, 8C, 9C
§112.14. Science, Grade 3, Beginning with School Year 2010-2011. 2B, 2C, 2D, 3C, 4A, 5C, 9A, 9C, 10A

PERFORMANCE OBJECTIVES:

In this activity, students will investigate the effect of melting ice on sea level due to global warming and analyze data from a class experiment. By the end of this investigation, students will be able to:

- Compare icebergs to glaciers and describe the similarities and differences.
- Analyze water level data.
- Predict whether icebergs melting will affect global sea level.

POTENTIAL VOCABULARY:

- **Calving -** The breaking off a piece of ice from a glacier, which often lands in the sea and becomes a floating iceberg.
- **Glacier -** A large body of ice that moves slowly over the land, changing its surface.
- **Iceberg -** A large ice mass floating in the sea.
- **Global warming -** The slow increase in Earth's temperature; the release of large amounts of gases that trap the sun's heat, resulting in change in climate.

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- **Rising sea level -** An occurrence that could take place as a result of the rising temperatures on Earth and the melting of glaciers; less ice means that more heat is absorbed, causing the water levels in the sea to rise.

BACKGROUND INFORMATION AND CONCEPTS:

WHAT ARE GLACIERS AND ICEBERGS?

When sea ice forms, pure water crystallizes out of the sea and leaves salt behind. Therefore, the ice that forms on the sea is made primarily of fresh water, and floats because it is less dense than the water it is in. During winter when lots of sea ice forms, it causes an increase in the salt concentration of the seawater below the ice. That increased salinity further influences ocean currents as the cold, saline water sinks more readily.

Glaciers are formed on land by snowfall that builds up over time, as long as snowfall exceeds snowmelt each year. Therefore, it has to be in a consistently cold region for a glacier to form, such as high in the mountains or in high latitudes or Polar Regions. The glacier ice is constantly forming and flowing downward, too slow to be visible, but leaving clear signs of its movements such as rock debris scoured from the edges of valleys or lots of crevasses where the glacier breaks apart when moving over steep terrain. Glaciers slowly flow downward toward the sea and into the ocean, remaining frozen because the water temperature is so close to freezing.

Icebergs are parts of glaciers that break off (called "calving") into the sea, especially in the warmest parts of summer. These bergs have a variety of shapes sculpted by the waves and occur in a variety of sizes, and may take many years to break up and finally melt into the cold waters.

Tabular ice bergs break off from ice shelves. These shelves form on the sea, are flat and layered from annual snowfalls, and may be over a hundred feet thick. The weather is so cold and dry that snow layers remain intact and are compressed by the weight of each accumulating layer. The intermediate stage between snow and glacial ice is called "firn." It is formed under the pressure of overlying snow by the process of compaction, recrystallization, localized melting, and the crushing of individual snowflakes. This takes about one year. Further compaction of firn at a depth of 45 to 60 meters (150 to 200 feet) results in glacial ice.

The amount of pack ice that forms each year is highly variable. In especially cold winters, enough ice forms on the sea around Antarctica to essentially double the size of the continent. In warmer years it is much less. Usually, most of the ice will break up in the summer, but there are many regions with permanent ice shelves and fast ice (ice attached to land). Some of these shelves, however, have started to break up for the first time in recorded history, probably due to global warming. The average winter temperature in the Antarctic Peninsula has increased by 4-5 °C over the past 20 years and this is impacting the amount of sea ice that now forms each winter.

WHAT IS GLOBAL WARMING?

The rise in average temperature of the Earth is referred to by scientists as global warming. Earth's average temperature mostly stays the same from year to year, and current average global temperature is about 57°F (14°C). If there is a rise in this average temperature, then we have global warming.

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A new analysis from the Goddard Institute for Space Studies shows that 2010 tied with 2005 as the warmest year on record, and was part of the warmest decade on record. The analysis found 2010 approximately 1.13°F warmer than the average global surface temperature from 1951-1980. The temperature trend, including data from 2010, shows the climate has warmed by approximately 0.36°F per decade since the late 1970s.

HOW DOES GLOBAL WARMING AFFECT SEA LEVELS?

Global warming has already caused a rise in sea levels and they are projected to rise much more. In fact, average sea level around the world has already risen 4 to 8 inches in the past 100 years due to global warming and is expected to rise another 4 to 35 inches (with a best guess of around 19 inches) by 2100. The primary reason for this rise is that water expands as it warms. Another reason is land-based glaciers melt and the resulting water runs to the sea, increasing the sea level. Thousands of small islands are threatened by the projected sea-level rise for the 21st century, as are low-lying coastal areas such as southern Florida.

The melting of land-based glaciers is also of greater concern to scientists than the melting of sea-based icebergs because while heat from the sun is reflected equally by ice on the land and on the water, ice on land tends to hold onto heat longer than the ice does in water. As a result, the loss of ice on land is more significant because sunlight that previously had been reflected by the ice is now absorbed. As the planet absorbs more heat, the temperature rises, causing more melting and more heat. The end result is a warmer planet with greater potential for rising sea levels.

As global warming heats up the upper layers of the ocean, the ice which floats in the water near the Arctic and Antarctica will melt more rapidly. Arctic sea ice acts like a blanket that insulates the atmosphere from the ocean's heat. Take away that blanket, and the heat can escape into the atmosphere, increasing local surface temperatures.

Icebergs floating on the water create a different situation. Because much of the iceberg (90%) is underwater, the sea level doesn't rise significantly as it melts. But if the temperatures increased enough to cause significant melting of icebergs, glaciers on land would melt, resulting in higher sea levels.

MATERIALS:

Per teacher: globe
Per student: Student recording sheet and/or science notebook
Per group of 3-6 students (if not done as a class demonstration):

- Large clear container (such as a beaker or clear bucket)
- Water (enough to fill the container ¾ full)
- Ice cube (add to the water in the container to make container full)
- Measuring tape (with centimeters)

TEACHER PREPARATION:

Gather materials and fill the containers with water before the class begins. Decide if you feel the model of ice in water would be better with salt in the water or not for the conceptions of your class. Students may need to

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fill in student response sheets as directed by the teacher dependent upon student needs. A worksheet can be modeled under a document camera, or be enlarged to poster size if being done as a class activity.

ENGAGEMENT:

Overview: Through discussion, establish definitions for sea ice and global warming. Point out the white land masses on the globe that represent glaciers on the North and South Poles.

- Ask: What is global warming? How would global warming affect our lives where we live?
- What is floating ice? Where might you find floating ice? [Melting icebergs near the Arctic and Antarctica].
- How does ice affect people and animals at the poles?
- What do you think happens when floating ice melts into the sea/ocean? Will this affect the level of sea water?

Watch video: Understanding: Animals and Ice from TLC http://www.youtube.com/watch?v=96299IbLXZI

EXPLORATION:

Overview: People are concerned that as global warming heats up the upper layers of the ocean, it will cause the melting of the icebergs that float in the water near the Arctic and Antarctica, which will cause a rise in sea level. Students will have the opportunity to test this idea.

- Measure and record the initial water level.
- Place ice cubes in the containers of water. Measure and record the water level (it should be at or near the top edge of the container).
- Throughout the day, observe and record the water level (twice) as the ice melts.
- Measure the water level after all the ice has melted (can be the next day if needed).

EXPLAIN:

- Does the water level rise when the ice melts? Did it overflow the container?
- Do you think melting icebergs will make the sea level rise? Why or why not?

ELABORATION:

- Study the Polar Regions, including their climate, habitats, animals, flora and fauna, scientific explorations, etc. Write a report about an animal which depends on polar ice for their habitat (polar bears, walruses, etc.).
- Make a map of the globe highlighting the areas with icebergs and melting ice.

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Sea Ice and Global Warming
Student Record Sheet

Name: _____ Date: _____

Words to know:

Calving Glacier Iceberg Global Warming Rising sea level

Research Question: What do you think happens when floating ice melts into the sea? Will this affect the global sea level?

Hypothesis:

Materials:

- Large clear container (such as a beaker or clear bucket)
- Water (enough to fill the container ¾ full)
- Ice cube (add to the water in the container to make container full)
- Measuring tape (with centimeters)

Data: Water level over time

Time	0 minutes *Ice enters container.*	__ minutes *Ice melting.*	__ minutes *Ice melting.*	__ minutes *Ice has melted.*
Level of water (centimeters)				

Conclusion:

Based on what I observed during the investigation, I conclude…