

Activity Title: Causes and Effects of Melting Ice

Learning Objectives

Ocean Literacy Principles

#1 -- The Earth has one big ocean with many features

- c. Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation
- d. Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools

#2 -- The ocean and life in the ocean shape the features of Earth

- b. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land

#6 -- The ocean and humans are inextricably interconnected

- e. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
- f. Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).

National Science Education Standards: NS. 5-12.1, NS 9-12.2, NS. 9-12.4, 5-12.6

Supplies and Materials

(per group)

For Teacher Prep:

- One sandwich-sized plastic bag that seals
- One plastic cup and spoon group
- Ice Cube Tray
- Food coloring: recommended blue or green

For Groups:

- Two clear, plastic shoebox sized containers (approximately 25.5 cm x 15 cm x 17.5 cm)
- Masking tape

- 1 multi colored package of modeling clay
- Access to warm water (tap water is fine)
- Pitcher
- 2 Heat lamps with bulb
- Salt (approximately ¼ cup)
- One refractometer or Hydrometer
- Permanent marker
- Ruler
- Measuring scale or balance

Background

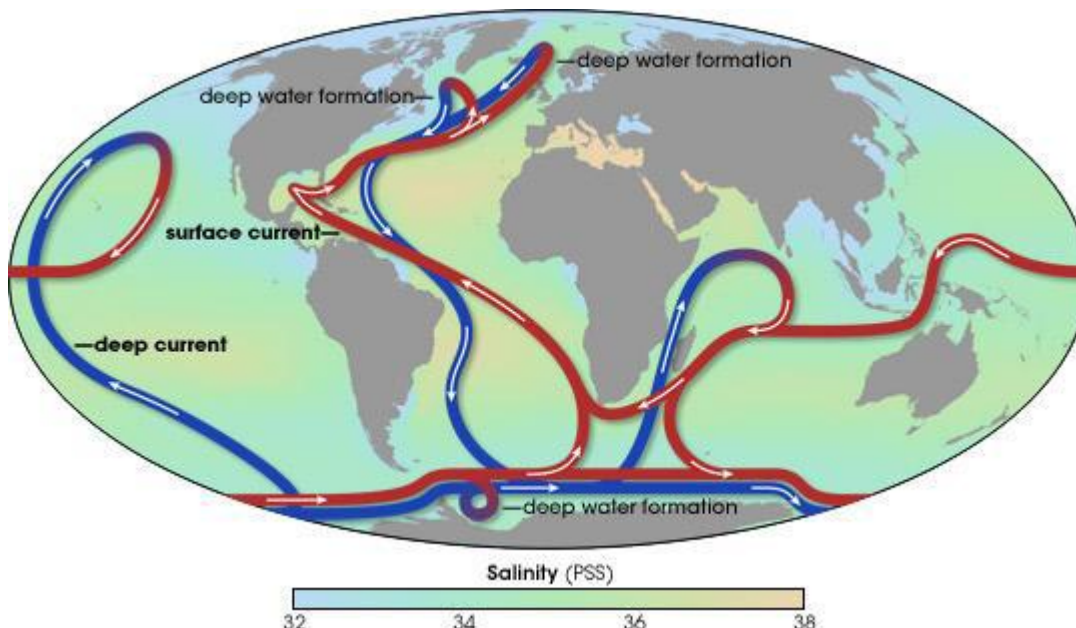
Ocean Currents and the Effects of Melting Land Ice

The world's oceans exhibit two types of currents, or movement of water, by wind and/or density: **surface currents**, which are wind-driven, and **subsurface currents** or **deep water currents**, which are density-driven. Density is the ratio of mass to a unit volume denoted as grams per cubic centimeter. In order to better understand density-driven currents, remember that colder substances, like the cold ocean water located at the higher latitudes, are denser than warmer substances, like the warm oceanic water adjacent to the equator. Additionally, salt water in the ocean is denser than freshwater. In measuring salinity, or the total concentration of dissolved salts, in a solution, one can use a refractometer or a hydrometer and the measurement is expressed as parts per thousand (ppt).

In the ocean, the salinity and temperature variations create a great conveyor belt of density driven currents. This density driven circulation is also known as **thermohaline** circulation (Figure 1).

Thermohaline circulation is responsible for the formation and perpetuation of the North Atlantic Deep Water current (NADW), which originates in the north near Greenland, sinks due to its moderately salty and cold nature, and flows along the bottom of the Atlantic Ocean. The NADW and other ocean currents play a key role in our global climate as the conveyor belt should the temperature or salinity of the ocean change, then the speed and function of the thermohaline circulation will be impacted.

Figure 1. Thermohaline Circulation (Source: <http://www.ncdc.noaa.gov/paleo/abrupt/story2.html>)



Sea Level Rise

Two major environmental factors can lead to accelerated sea level rise: (1) the oceans temperatures increasing due to absorbing heat from the atmosphere, and (2) the melting of glaciers and the Greenland and Antarctic ice sheets. The effects of sea level rise would vary for each geographical location based on several factors including tidal range, land elevation, and topography (the shape and features of the land). One of the major concerns linked with a global warming scenario of 1.5-4.5°C over the next 100 years is the potential for sea level (the level of the ocean surface midway between high and low tide) to increase by an average of 65 cm (approximately 6 cm per decade) (IPCC Third Report 2001) which would inundate many coastal communities.

Duration

30 minutes – 2 hours

Audience

Grades 5-Adult

Procedure

Preparation :

1. Fill each ice cube tray with water, then add 2 drops of food coloring per cube. Freeze one ice cube tray per group.
2. Partially fill each plastic sandwich bag with water, add 5 drops of food coloring, seal securely, and lay bag flat in freezer, ensuring no leaks. Freeze one plastic bag per group.
1. Have groups:
2. Collect necessary materials and supplies.
3. Fill pitcher with 1 Liter of warm tap water.
4. Using the scale, measure out 35 grams of salt per 1 Liter of water. This should create a 35 part per thousand (ppt) saline solution that will represent the ocean's average salinity.
5. Use the hydrometer or refractometer to measure the salinity of the water to make sure it is at 35 ppt. If the salinity is not 35 ppt, add more salt or water so that it does measure 35 ppt.
6. Pour the 1 Liter of newly created sea water into Bin #1 (Figure 2).
7. In Bin #2 (Figure 3), shape modeling clay into a cylindrical shaped stand with a flat top. To make sure that this "land mass" will extend above the water line, examine the water height in Bin #1 and make the clay land mass taller than the water level.
8. Repeat Steps 4-6.
9. Pour the 1 liter of newly created sea water into Bin #2 making sure not to cover the top of the land mass.

Melting Sea Ice: (Figure 2)

10. In Bin #1, place all fourteen colored ice cubes into your plastic container. Using masking tape and a marker, mark the new water level (sea level) as Pre-Melt Sea Level (**PMSL1**) on your plastic container **as soon as the ice cubes are added**.
11. Allow the ice cubes to melt completely and DO NOT MIX.

12. Re-measure the sea level and label it as New Sea Level 1 (**NSL1**) on your plastic container.

NOTE: Observe the layer of colored water in the container after the ice melts. Is the color on the top or bottom of your container? Why?

13. Gently use the hydrometer or refractometer to measure salinity and compare to first measurement.

Melting Land Ice: (Figure 3)

14. In Bin #2, mark the water level as Pre-Melt Sea Level 2 (**PMSL2**)

15. Unwrap the sheet of colored ice from the plastic bag. This ice sheet is representative of glacial ice or land ice.

16. Place the ice sheet on your clay land mass; be sure that it is not making contact with your ocean water.

17. Place the heat lamp over your plastic container.

18. Allow the land ice to melt completely and DO NOT MIX.

19. Re-measure the sea level and label the new sea level in Bin #2 as **NSL2** on your container

Note: Observe the color layers of the water. How has the level or water color changed?

20. Use the hydrometer or refractometer to measure salinity and compare to the first measurement.

Figure 2. Bin #1 Setup:

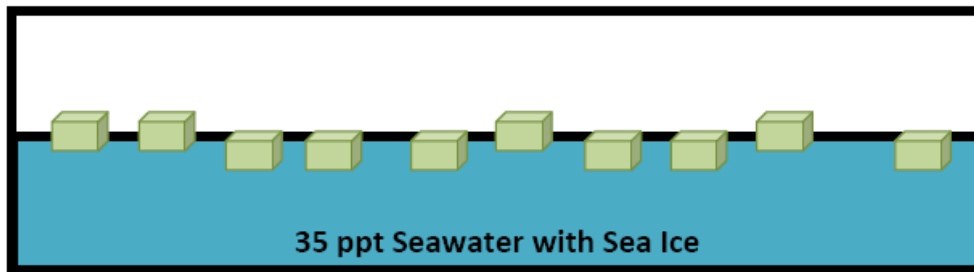


Figure 3. Bin #2 Setup:



Assessment

Inquiry questions that can be asked during or after the activity:

1. Which do you think has a greater impact on sea level rise, melting glaciers or melting sea ice?

Why?

2. Are glaciers made of freshwater or saltwater? How does this impact the ocean when the glaciers melt?

Additional Resources

- <http://www.cosee-se.org/ForEducators/EducatorResources/GlobalandSoutheastClimateChange/>
- <http://epa.gov/climatechange/>
- http://www.nasa.gov/centers/goddard/earthandsun/climate_change.html
- <http://www.ipcc.ch/>

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