POLAR TREC

TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

Ice From the Ocean vs Ice From the Sky – Can You Tell the Difference?

Ice that forms in the polar oceans is an important driver behind the global climate. This ice is physically different from frozen precipitation in a number of different ways. In this brief inquiry activity, students make qualitative observations about two types of ice cubes and deduce ice composition based on their observations. This activity may serve as an introduction to a variety or chemical/physical/environmental science concepts.

Objectives

Students will be able to:

- Understand the physical differences between sea ice and freshwater ice.
- Discuss the formation of each type of ice and what leads to these differences.

Lesson Preparation

- For a class of 30 students, working in pairs, assemble the materials listed.
- Prepare the day before by preparing a saltwater solution with the proportion of 3.5 grams of salt per 100mL of water. Fill two of the four ice cube trays with saltwater solution. Fill the remaining two trays with freshwater. Place all trays in the freezer.

Procedure

Details

Lesson
ArcticAntarctic
Less than 1 period
Download, Share, and Remix
All Ages

Materials

4 CLEAN standard ice cube trays
graduated cylinder or measuring cup
1lb table salt
1/10 gram balance
15 droppers of food coloring (color does not matter)
paper towels
freezer

Standards

- At the beginning of the activity, - without telling students which is which - issue one “sea” ice cube, one “sky” ice cube, and some paper towels to each student pair. Ask them to handle each cube, comparing and contrasting appearance, hardness, weight, temperature (by feel), texture, smell, and lastly, taste (but only if ice cube trays were clean). Have them record their observations down.
- Issue each student pair a dropper of food coloring. Reminding them that food coloring stains skin and clothing, ask them to carefully drip one or two drops on each ice cube and note the differences they see.

Extension

This inquiry is appropriate for all grade levels and is intended to be a suitable introduction to any number of chemical, physical, and environmental science lessons. Some examples:

- Chemistry/Physics – solutes like NaCl depress the freezing point of fluids so the two types of ice cubes should register two different temperatures when measured with precise thermometers. Additionally, “sea” ice has greater porosity because solutes stay in solution as solute-free ice forms around them. This creates microscopic “brine channels” which cause the sea ice to be weaker than freshwater ice when the two are compressed. The freezing process also leaves a small amount of liquid brine in the bottoms of these ice cube trays. The increased concentration of NaCl can be measured with a refractometer or other spectroscope.
- Environmental/Earth Science – Thermohaline circulation (the global ocean conveyor) is partially driven by salty water in the polar seas sinking to the ocean floor and pulling warmer surface waters towards the poles. This is demonstrated by way of the brine that finds its way to the bottom of the ice cube tray.

Resources

NGSS

This lesson is specifically designed to target Next Generation Science Standards in Earth and Physical Sciences. Earth Science standards addressed relate to water and its effect on Earth surface conditions. Physical Science standards addressed include investigation of properties of matter, specifically changes of phase and mixtures.

HS-ESS2-5 Earth's Systems

Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

5-PS1-4 Matter and Its Interactions

Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

5-PS1-3 Matter and Its Interactions

Make observations and measurements to identify materials based on their properties.

2-PS1-4 Matter and Its Interactions

Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Lesson Materials attached

Assessment

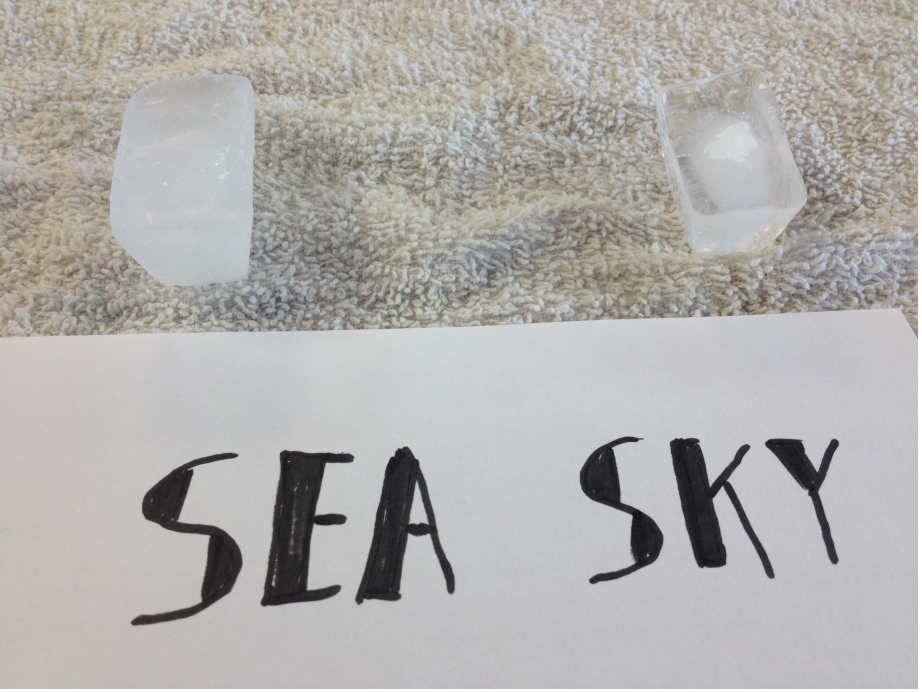
Students are assessed on their deductive reasoning skills via verbal questioning and written assessment. See Lesson Materials.

Author/Credits

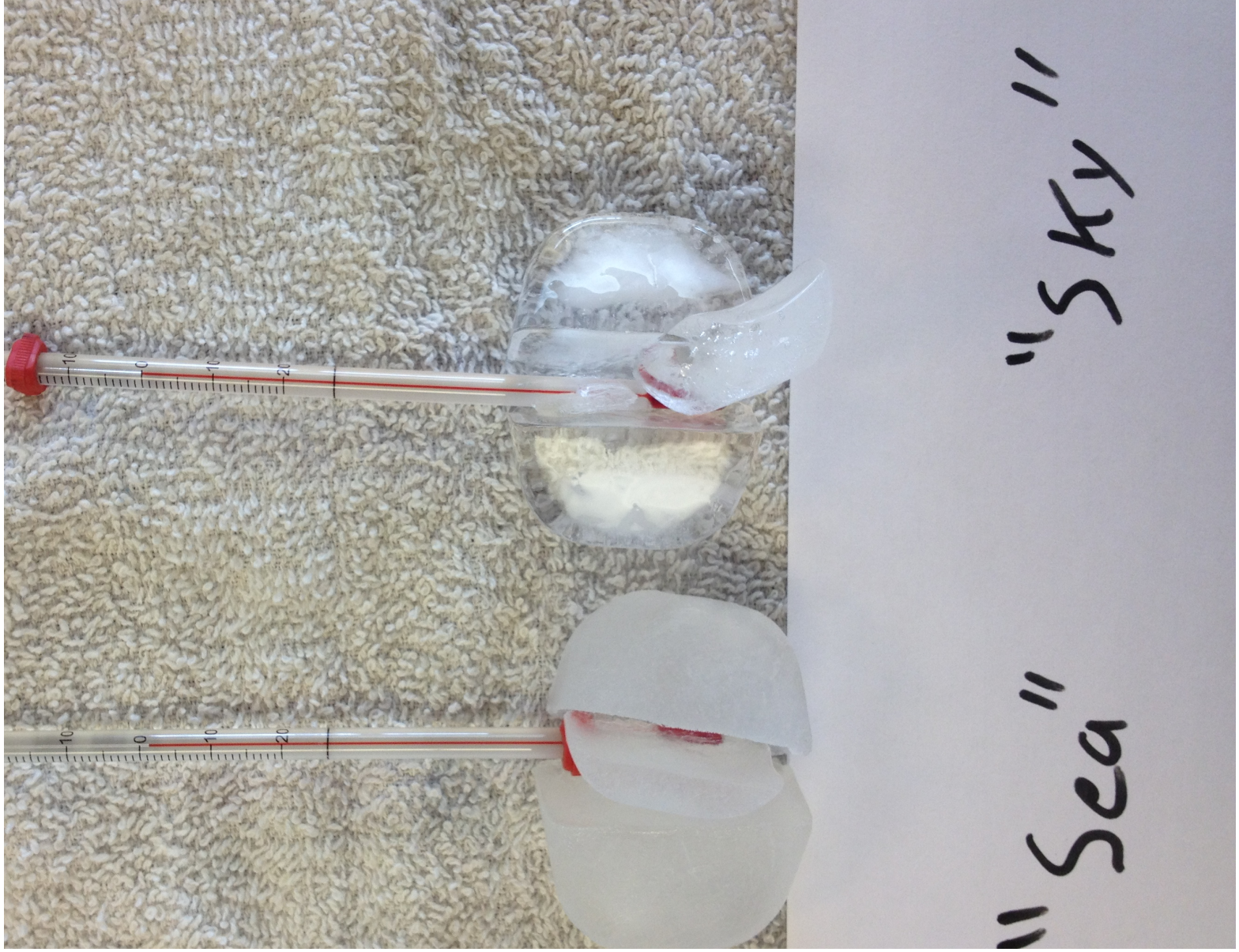
Created by Timothy Dwyer from experiences and photographs taken during the Polar Gigantism in Antarctica 2016 expedition.

This person is standing on floating sea ice, next to a glacier formed from precipitation.

Materials: Ice cube trays, tap water, liquid measuring device, salt (mix 3.5g per 100mL), balance, food coloring, paper towels, freezer



After students record observations of ice, drip a single drop of food coloring to illustrate “sea” ice porosity



Possible extension using thermometers
("sea" ice is ~2°C colder)

Possible extension: What causes these “brinicles?”

Ice From the Ocean vs Ice From the Sky – can you tell the difference?
Name_____

Carefully observe the two ice cubes. Record your observations below:

Ice cube #1

Ice cube # 2

Some guiding questions:
1) Describe the effect that high concentration of dissolved salt has on the freezing point of water.

2) What happens to the salt in the seawater as the liquid water forms solid ice?

3) Based on your observations, what would happen if you collected the water from the melted "sea" ice and refroze it.

POSSIBLE ANSWERS to Some guiding questions:
Describe the effect that high concentration of dissolved salt has on the freezing point of water.
ANSWER: Dissolved solutes often lower the freezing point of water, so sea water in McMurdo Sound should freeze at <0°C/32°F.

What happens to the salt in the seawater as the liquid water forms solid ice?
ANSWER: Dissolved solutes are excluded from the ice and are concentrated into nearby non-freezing water, increasing the salinity and further lowering the freezing point. Teacher's NOTE: In actuality, the super-cooled liquid ("brine") is forced into tiny canals within the crystal matrix of the ice.

Based on your observations, what would happen if you collected the water from the melted "sea" ice and refroze it.
ANSWER: In theory, much of the brine solution would have leaked out of the ice cube via brine channels forming during the initial freezing process. Therefore, salt concentration should be much lower the second time around and the new ice cube should have properties similar to those of the freshwater ice.