Ice Bucket Exercise:
Prep-time: 2 days
Activity time: 1 hour

Observation: The processes of ice formation in the polar oceans have an important impact on global circulation. As sea water freezes and forms ice crystals, it rejects the salt, creating very salty water adjacent to ice crystal formation. This salty water is more dense than the surrounding sea water, which then sinks to the bottom of the ocean, taking with it the atmospheric signature of the surface ocean. This sinking is the start of thermohaline circulation, which provides oxygen to organisms in the deep sea. Few students will have the opportunity to observe, measure or interact with the naturally freezing sea-water environments that occur in the polar oceans.

Theory: Students that have the opportunity to interact with frozen seawater, even at a small scale will be able to envision the formation of cold brine water, and the process that drives the beginning of global thermohaline circulation.

Set-up and Materials:

1. 7-gallon bucket with 5-6 gallons seawater (~32 PSU)
2. Electric or manual hand drill and ½ inch bits
3. Meter stick or (dowel rod marked along its length)
4. 12” immersion alcohol thermometer
5. Refractometer
6. Plastic serological pipettes and bulbs
7. Rubber bands
8. Note-pads
9. Safety goggles

Fill 7-gallon bucket with 5-6 gallons seawater (~32 PSU). Pre-chill in a large refrigerator. Place 7-gallon bucket in a freezer (-20 C or -80 C) for 48-72 hours prior to class exercise. You will need one frozen bucket for every two students. Ice will form on top, and unfrozen brine will be at the bottom.

Activity: Students will break into pairs, each pair having their own ice-bucket, meter stick, thermometer, refractometer, transfer pipette, rubber bands and note pads. Pairs can share drills.

1. Student pairs carefully drill hole in frozen ice while wearing safety goggles.
2. Students fasten thermometer and serological pipette via rubber band to meterstick. Both the bulb of the thermometer and opening of the pipette should be flush with the end of the meter stick.
3. Starting at the surface, students incrementally lower the thermometer 2-3 cm at a time.
4. At each depth stop, students should wait for 30 seconds for thermometer to equilibrate.
5. At each depth stop, students should evacuate the air out of the pipette (before submerging pipette), and fill it with water from that depth.
6. Remove the meter stick after sampling at each stop, record temperature, and take a refractometer measurement using water in pipette to estimate salinity.
7. Repeat sampling procedure to the bottom of the bucket, recording both temperature and salinity at each depth.

Outcomes: Students observe that temperature decreases with depth, while salinity increases with depth. The water at the bottom of the bucket should be very salty, while the ice itself should be fresh. The average salinity of an evenly spaced depth profile should reflect the starting seawater salinity. These data can provide a useful way to introduce students to graphing.