Ice Buoy Field Check & Adjustment

Even scientific instruments need a little help!

Fresh Eyes on Ice
LESSON PLAN

Grade level: 4 to 12

Subjects: Science, math

Target skill: Observation, Measurement, Data interpretation

Duration: 90 minutes

Setting: Classroom or afterschool club

ENDURING UNDERSTANDING:

- Automated scientific instruments can help us collect data when we are unable to be making observations, but the instruments must be calibrated using our in-person field measurements.

ESSENTIAL QUESTION:

- How does our ice buoy measurement of ice thickness compare to our own field measurements?

Fresh Eyes on Ice

Next Generation Science Standards Themes:

- *Practices*- analyzing and interpreting data, constructing explanations, communicating information
- *Cross-cutting concepts*- energy & matter, patterns, cause & effect, stability & change
- *Disciplinary core ideas*- PS3 Energy; ETS1 Engineering design

Alaska Science Standards Alignments:

- Engineering, Technology and applications of Science - ETS1-3 compare data from two different approaches to a real world problem and determine simialrities and differences
- Physical Sciences-PS3-1 transfer of energy (thermal energy)

Common Core Math Standards:

- *Standard Domain*- operations and algebraic thinking, represent and interpret data
- *Mathematical Practices* - make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others

Culturally-Responsive Curriculum tandards:

A5. provides opportunities for students to study all subjects starting from a base in the local knowledge system

E1-3. situates local knowledge and actions in a global context

Climate Literacy Principles:

5A The behavior of an environmental system can be understood and predicted through careful, systematic study.

3C Observations, experiments, and theory are used to construct and refine models that represent the climate system and make predictions.

7E Climate change will influence the distribution of plants &

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MATERIALS:

- Measuring tape from the Fresh Eyes on Ice field kit
- Rubber band
- Air-Snow-Ice Buoy diagram drawn on the whiteboard or large chart paper
- Graphs of your local ice buoy data. Data is visualized on the Fresh Eyes on Ice website (http://fresheyesonice.org/realtime-data/)
- Ice auger, shovel, snow probe and notebook from Fresh Eyes on Ice field kit
- Blank Air-Snow-Ice Buoy calibration plot

Students from Bethel Regional High in Bethel, Alaska Alaska monitor snow and ice thickness in the field as a part of the Fresh Eyes on Ice Project.

LESSON OVERVIEW:

In this lesson, students learn about how and why we calibrate scientific instruments. They are introduced to one of the many reasons why their field observations they make are important to the science in the Fresh Eyes on Ice program of the University of Alaska Fairbanks.

First, they look closely at graphs of the data that is being collected by the Fresh Eyes on Ice air-snow-ice buoy at their site and determine the thicknesses of the ice that the instrument has recorded through the winter. They then go out to the field site to dust snow off of the buoy and make accurate field measurements of the ice thickness around the buoy. Back in the classroom, the students compare the buoy measurements to the field measurements and determine how the buoy should be calibrated.

TEACHER BACKGROUND

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Why Check and Adjust ("calibrate") Fancy Science Equipment like the Air-Snow-Ice Buoy?

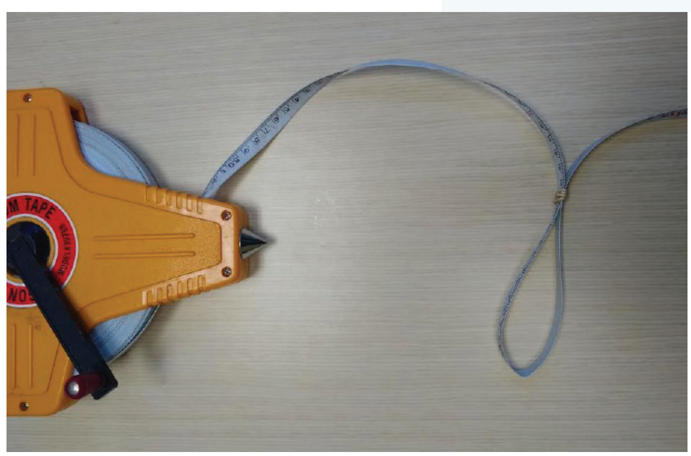
Many times scientists want to measure something over large areas or more frequently than is possible with on-the-ground field visits. You, your students and the community member on your Fresh Eyes on Ice team make measurements every month or so, but more measurements are always better, and you can't be out there all the time! To make broader or more frequent measurements, scientists use methods like remotely sensed measurements from satellites or data collected by an automated sensor put out into field sites. These methods on can be less accurate (off one way or another) or less precise (not as exact) than what can be measured in the field.

Each of the Fresh Eyes on Ice communities has a Air-Snow-Ice Buoy that was installed by UAF scientists during their first visit to your community in the fall. Twice a day, these expensive instruments are helping to get data on the air temperature, snow depth and ice thickness when you can't be outside with your students, or in locations that might not be ideal for you to get to frequently. They transmit the data to satellites, which then transmit and record the data into a database. We get to see the nearly real-time measurements right on the Fresh Eyes on Ice website!

However, these buoys are newly designed instruments. Their precision is plus or minus 10 cm, but their accuracy is not yet known. We've placed many of these buoys at the same locations where your monthly measurements are made so that they can be calibrated with your help. We hope this lesson can help reinforce how important their field measurements and observations are in ice science, and that they learn a little bit about calibration in the process.

ADVANCED PREPARATION:

1. Take your measuring tape and put a rubber band around a folded section of the tape.
2. Assess ice safety near your air-snow-ice buoy field site using the Fresh Eyes on Ice safety protocol.



Example loop on measuring tape for the "Engage" section of the lesson to get youth thinking about what calibration means.

ACTIVITY PROCEDURE:

Engage

1. Take your measuring tape from your Fresh Eyes on Ice field kit. Prior to the lesson, gather a bit of the tape together (20 cm or so) and put a rubber band around it to make an obvious loop. Ask a student to stand up. Start measuring the student with tape. Read the height of the student and record it on

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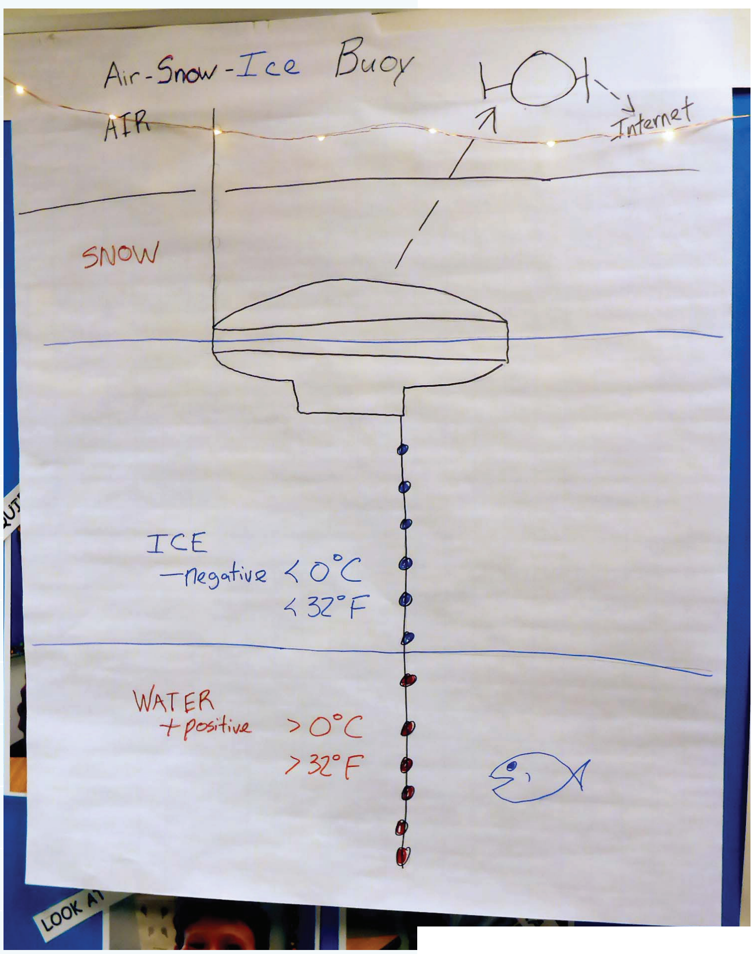
the whiteboard. It should be a number higher than the actual height of the student due to the loop in the tape.

2. Discuss with the students. What was wrong with the measurement? Is the student really that height? No! The measurement wasn't accurate. Our measuring tape is off by a little.
3. Measure another student's height with the same measuring tape with the loop secured in it. Read that student's height. Hmmm? How could we figure out the accurate heights of the students? Have students brainstorm ways to get the true heights. Students may think of getting a wooden measuring stick, or undoing the rubber band on the tape, etc.
4. Remeasure the heights of the two students using a method that they think of during the discussion.
5. How could we figure out how much the original measurements were off by? Discuss with students. We can figure out the difference between the first measurement and the accurate measurement. We could still use the kinked up tape, but we now know the measurement is off by the difference. This is called "calibration." Today, we will be doing the same thing for our Fresh Eyes on Ice air-snow-ice buoys!



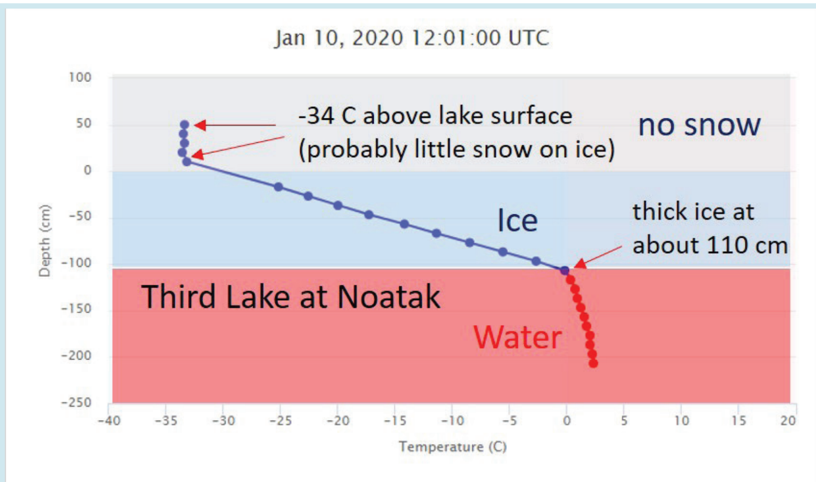
Example air-snow-ice buoy diagram.

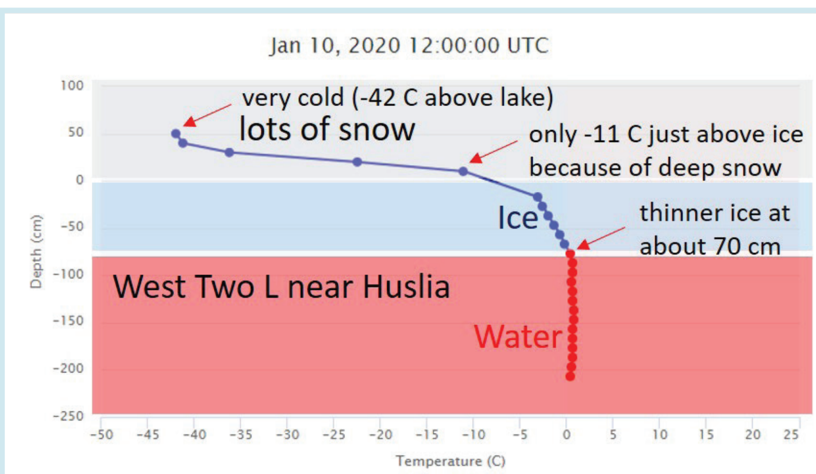
Explain

6. Draw a diagram like the one on below showing what Air-Snow-Ice Buoy looks like frozen in ice if you could see it from the side. Explain that each of the dots is a temperature sensor called a thermistor. If the sensor is reading a temperature that is below freezing (0 °C or 32 °F) what do you think that tells us? That the water is frozen! Color these sensors blue, which will help in the next step of the lesson interpreting the real-time data plots. If the temperature is reading above the freezing point, it tells us that the water is liquid. Color these sensor dots red. Fish can still be living under the ice where the sensors are detecting warmer than freezing temperatures. There are also sensors above the ice. We can use these to infer something about the snow depth. If there is a big change in temperature from the top of the air sensors to the bottom, what do you think that tells us about the snow depth? It is probably deep snow. If there is no change in air temperature above the ice what do you think that tells us? There is probably very little snow on top of the ice. The buoy sends data twice per day to a satellite, and that satellite transmits the data back to us and we can see it in a very short amount of time on the internet on the Fresh Eyes on Ice website!

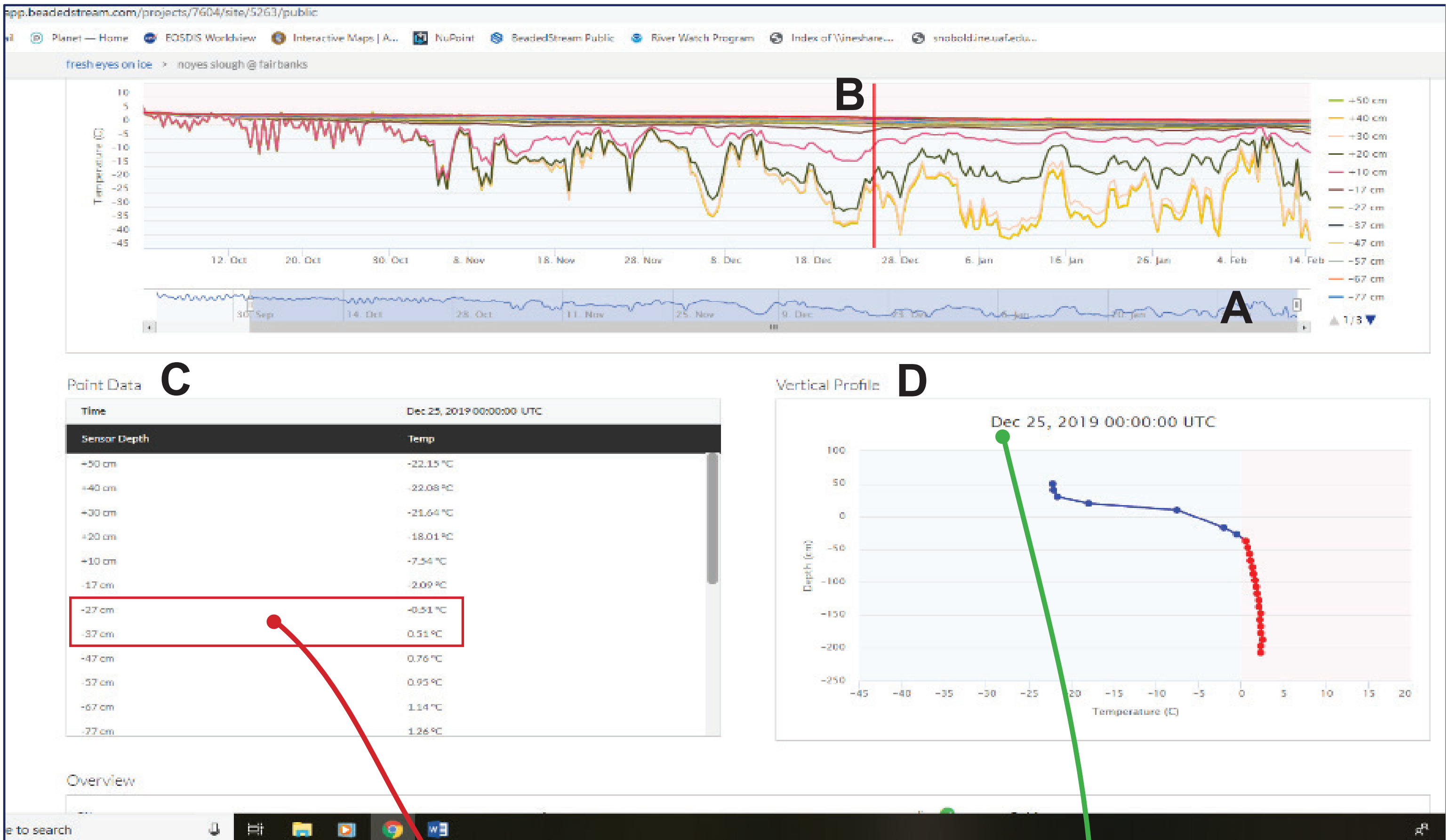
Notes

7. Show students how we can determine the thickness of the ice based on temperature using these buoys. The graphs below are examples from Third Lake in Noatak and West Two Lake near Huslia on the same date that can be retrieved from the Fresh Eyes on Ice website (http://fresheyesonice.org/realtime-data/). Red dots are above freezing (water) and blue are below freezing (ice and snow). Where red and blue meet should be the bottom of the ice. The large change in temperature (long slope) at Noatak tells us the air temperature is very cold and ice is growing fast. The shorter slope in West Two Lake ice is because the ice is insulated by snow and is growing slower.





Example air-snow-ice buoy plots for Jan 10, 2020 on Third Lake at Noatak (top) and West Two Lake near Huslia (bottom). Plots for each buoy are avialable on the real-time data link on the Fresh Eyes on Ice website. These graphs are shaded to show the depths of the unfrozen water (red), the ice (blue) and the air and snow (gray) more clearly.



Explore (indoors)

8. Visit the Fresh Eyes on Ice website (http://fresheyesonice.org/realtime-data/) and click on the link to "data plots" to see the data from your local buoy. As shown in this diagram, increase the viewing window at bottom of long upper plot (A) to see the entire freeze period (Oct to present). Moving the mouse over the Temperature/Time plot (B) and clicking on a date will change the date in both the "Point Data" (C) and "Vertical Profile" (D) below. You can determine the ice thickness for any date by looking at the point data
9. On a chart paper graph like the photo above, draw 3 to 6 points on the graph over the ice growth period to show what the buoy "tells us" the ice thickness is. In the example above, the dot on the graph for the Christmas point was found by mousing over December 25th, and looking at the point data. The thermistor at -27 cm was below freezing and -37 cm was above, so we estimated ice thickness was half way in between at 32 cm thick.
10. Does this seem right? Could the actual ice thickness be higher or lower? Is there any reason we might want to make sure the measurement was accurate, just like in our earlier experience with the tape measure? What things

could happen to make the measurements off one way or another?

11. Today, we'll be going outside to check the accuracy of the buoy and make measurements to calibrate our buoy measurements. Ask your students to make a guess if the buoy is reading thicker, thinner, or the same thickness as what the field measurement will be and explain why they think so.

Explore (outdoors)

12. Head outside to your study site on the lake, river or slough. Locate the buoy by looking for the flag sticking out of the snow and measure the depth of snow next to it and take lots of pictures. After this, clear all the snow from around the buoy so that you can see its top. If snow ice formed it may be buried in the ice. Take pictures of this also as its helps us understand why the buoy might not be accurate. Disturbing the snow around the buoy will affect measurements during the rest of winter, but will help us calibrate buoys for future winters.
13. Carefully drill 2-3 holes around the edge of the buoy, measure the ice thickness, and record these data. If the buoy is buried in snow ice, take care not to drill into the buoy's hull. The average of these ice thickness is the accurate ice thickness and we'll use this to correct (calibrate) the plot made in class. We can also use our field snow depth measurements to correct what the buoy "tells us" snow depth is using the same method.
14. Make sure all measurements are recorded in your field notebook and return to class to warm up and talk about what you learned.

Find the buoy and measure snow depth.

Clear the snow away from the buoy.

Drill 2 or 3 holes around the buoy and measure ice thickness.

Explain (back indoors)

15. Back in your classroom, subtract the actual ice thickness from what the buoy "tells us" for today's date. This is our buoy correction, or "calibration." In the case of Noyes Slough, ice was 5 cm thicker than what we decided the buoy was telling us. Part of this was because of snow ice that formed on top of the buoy.

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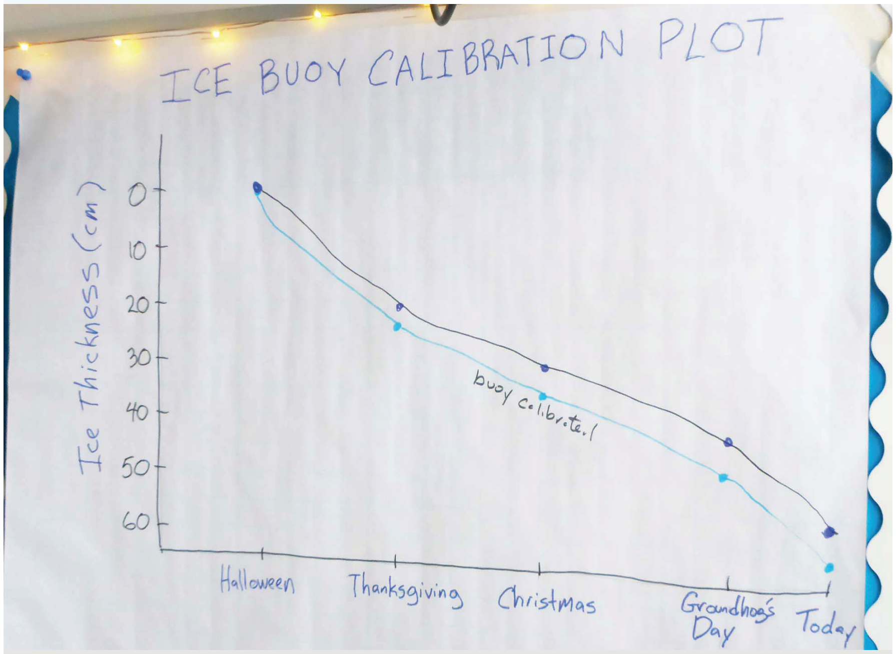

Add the calibrated ice thickness values to the graph.

What are other reason's that the buoy's measurement might not be quite right?

16. Add the accurate field measurement from today to the graph as pictured to the left. Use this correction value to imagine what the actual ice thickness was for the other dates. Discuss with the class if they think the buoy has been consistently off by the same amount for the whole winter. For example, in the Anne Wien School case, do they think that the buoy started reading 5 cm off all at once from a bad weather event? Do you think it gradually got further off as the snow ice formed? How could we gather evidence one way or another? Discuss what experiment, data or evidence you could gather to determine what happened.

Extend

17. Send your data and pictures to the Fresh Eyes on Ice team at UAF (fresheyesonice@gmail.com) so we can improve how well these buoys measure ice thickness for next year. Data from this activity can also be recorded on your online data entry form if you buoy is at your regular ice monitoring site (http://fresheyesonice.org/community-engagement/).

18. *Optional:* Post about your buoy calibration exercise on social media. Compare your calibration data to the calibration data of the other community ice monitoring teams in different communities across Alaska. Were all the buoys off by the same amount? Were the factors that affected the buoy accuracy the same in every community?

Evaluate

19. To evaluate student learning use the following science journal reflection prompts:
    - *What was the actual ice measurement and how far off was it from what the buoy reported?*
    - *Why do you think that the buoy measurements and our measurements today were not exactly the same?*
    - *Do you think the buoys in the other Fresh Eyes on Ice communities are off by the same amount as ours? Why or why not?*

ACKNOWLEDGMENTS

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