Polar STEAM
Education. Art. Science.

Icy Archives Instructors Guide

Key points:

Ice Cores & Atmospheric Data:

- Ice cores provide a record of Earth's air composition, temperature, and snow accumulation over time.
- Dust, ash, soot, and other chemicals within these layers reflect seasonal fluctuations, allowing scientists to distinguish annual cycles.
- Scientists need to know the time associated with different depths of an ice core to confidently interpret the data.

Scientific Techniques:

- **ECM (Electrical Conductivity Measurements)**: Detects changes in acidity, helping scientists identify significant environmental events. Video: Running an EMC at National Ice Core Facility
- **Other Chemical Markers (Black Carbon, Sulfur, Sodium)**: Provide further evidence of atmospheric changes and seasonal patterns.

Opening Activity:

Students listen to the sounds melting ice makes. This may be through using a microphone, recorder and headphones to listen to melting physical ice submerged in a bucket of water or it may be using the provided video/audio recording.
Students are prompted to brainstorm ideas of why the ice is making these noises.
Questions to explore with students before, during and after activity/video:

- What is happening to the ice?
- What is the cause of all the different sounds/noises? or Why does the ice make noise as it melts?

Author's Note: Students might wonder if ice in their home freezer would sound the same. I wondered the same thing but haven't tested it myself but based on the following, my guess is that it would not sound the same. Ice core ice is different from ice cubes in your freezer which froze rapidly and captured the air immediately surrounding them. Regular ice cubes trap air representing current atmospheric composition, while ice cores capture air from past climates.

Activity Overview (60 minutes):

1. **Introduction to Ice Cores (5-10 minutes):**
   - Briefly introduce what ice cores are and how they are used to study past climate conditions. Show them an image of an ice core and estimate as a class how much time they think is held in that particular sample.
   - This would be a good place to introduce the term "chronology". Ask students what they think it means. Guide them through discussion to understanding that when it comes to ice cores, chronology defines the relationship between depth and time. They may have heard the word "dendrochronology" and connect to how scientists use tree rings to understand how old the tree is/was as well as what climate conditions were at different periods of time.
     - **Supporting background materials**. Students could be given the opportunity to explore a few of these options on their own or information could be provided verbally by teacher
       - (Video, 2:31) Studying Ancient Ice {NICL} | Science Nation - shows ice core storage and multiple techniques for gathering data.
       - (Text) Ice Cores Tell the Story of Climate
       - (Video, 3:32) Colorado Has a Giant Freezer Filled with Polar Ice - Richard Nunn talks about Ice Cores
   - Pose the questions to students: "What environmental factors or conditions could create a repeating signal in an ice core and how can scientists use this to identify individual years in ice cores?"
   - Introduce the different types of data students will analyze: ECM (Electrical Conductivity Measurements), Black Carbon, Sodium, and Sulfate. Don't provide students any background yet about these types of data.

2. **Initial Group Work (15 minutes):**
   - Divide students into 4 groups, each focusing on one of the following topics (or 8 groups with 2 groups per data type for a class around 30 students). Each group will need their specific graph as noted below:
     Group 1: ECM (Graph 5)
     Group 2: Black Carbon (Graph 4)
     Group 3: Sodium (Graph 3)
     Group 4: Sulfate Graph 2)
   - Ask groups to have initial discussions about how they would go about trying to break their sample down into layers by individual years. Allow them enough time to think, process and come up with their own ideas as a group. Check in on their conversations. They may need a nudge to not focus on every little peak but rather to direct their attention to trends in larger peaks. Provide each group with a **signal parameter background reading sheet** - either entire sheet or section specific to their topic (see downloadable files). Students read and discuss how they think trends in their specific data type measurements might vary seasonally (ie: is there a peak in the winter and a trough in the summer?).

- Using the provided graphs, students will estimate where annual layers appear by drawing lines on the graphs.

3. **Mixed Group Sharing (20 minutes):**
- Reorganize students into new mixed groups (one representative from each original group) and provide each group with a copy of Graph 1. If the graph is laminated, then they will also need finepoint wet/dry erase markers.
- Each student shares their findings and background information with their new group. Individuals can draw lines as they present (ie: the student that shares about Black Carbon repeating patterns can draw the lines as they present. Once all group members have presented, then the graph will be marked up for all 4 signal parameters.)
- Groups compare their estimates for annual layer patterns and discuss any similarities or differences.

4. **Class Discussion (10 minutes):**
- Give students a copy of the graph with marked layers (Graph 6)
- Groups compare their estimates with the actual data. Students discuss similarities and differences between their estimates and the actual data. What similarities and differences do they notice across data types? Students may notice that while the signals sometimes peak at different times, they may show the same measurement between peaks.
- Ask students to annotate the group graph with their discoveries.

Reflection (15 minutes):

- **Group Reflection:** Each group will summarize their findings and reflect on what they learned about how ice cores provide insight into past climate conditions.
- **Optional Assessment:** Teacher will assess understanding through group discussions and compare estimates to actual data. Each student will wrap up the activity by using their group graph and ideas discussed as a team to create an annotated torn paper ice core art piece representing 1-2 take-aways from the lesson.