GEOS 3XXO - Spring 2012

Ice and Climate - Lab 1: Snow

Erin Pettit

University of Alaska Fairbanks

1 Brief Description

This activity is intended to get students engaged and thinking about the role that snow plays in our climate system. It is a hands-on inquiry-based activity that students with no background knowledge can do. The students dig shallow snow pits on campus make observations of texture and color, sketch any layered or other patterned structure, measure the density, and view and sketch crystals in a microscope.

2 Context

1. This activity is intended for the first day of a semester long course called Ice in the Climate System. This is a 3rd year undergraduate course required for geophysics students, but the activity would work for any upper level undergraduate science major (or lower level undergraduate with slight modifications).
2. As an introductory activity, they do not need any skills or concepts before the activity, just an initial curiosity.
3. It is intended for the first day of the lab class (3 hours maximum), but could be used at the beginning of a short unit on snow or climate also. The main part of the activity should take 2.5 hours (30 minutes each for 4 parts, plus another 30 minutes for oral syntheses from each group)

3 Goals

1. Content and Concepts
   (a) snow crystal growth in atmosphere,
   (b) Snow pack structure,
   (c) metamorphism (equilibrium and temperature gradient),
   (d) snow albedo and the snow albedo feedback,
   (e) techniques for making field observations

2. Higher Order Concepts

   (a) recognizing the difference between observations and inference,

   (b) framing a scientific question,

   (c) formulating a hypothesis,

   (d) designing a method for measuring density.

3. Other Skills Goals

   (a) working in groups

   (b) synthesizing results toward making an oral presentation

4 Description

The students will come into this activity with no or very little knowledge of snow. They will divide into groups, each group receiving the first list of questions (on Rite-in-Rain paper). The questions help guide them through their inquiry and are divided into groups: A) initial observations, B) measurement and detailed observations, and C) inferences and hypotheses. They dig a snow pit to the ground (typically < 2ft).

Part A, they study the layered structure, the texture of different layers, the color (presence of sediment?), initially using basic sketching. Then they decide what aspects are worth measuring in further detail (such as thickness of layers, hardness of layer, density of layers, size of crystals) and come up with a plan.

Part B, they are allowed to begin making their measurements and they are given guiding questions, such as what are the errors in these measurements? How many measurements is sufficient to describe the characteristic you are describing?

Part C is primarily brainstorming ideas and hypotheses among their group, and they can return inside if they choose. They are asked consider the role that snow plays on the landscape. How does the snow affect the ground underneath it? Would that role be different at the coldest part of winter than during the spring melt? Does snow affect the air above it? How might snow play a role in the large climate system?

Part D - Oral Synthesis: after completing Part C, each group is given a different overarching question, they must use what they have learned and their ideas to give a 4-5 minute oral synthesis to the class.

This activity is meant to give them new insights into a common geologic material and to recognize the linkages between the atmosphere above the ground and the geology and ecosystem below.

5 Evaluation

The activity involves the students answering 3 series of questions, some of which have more explicit answers than others, which are more open ended. The open ended question are explicit in that they identify the number/type of ideas they should right down. The final task is to synthesize what they learned into a 4-5 minute oral synthesis (given guidelines for the synthesis).

6 Assignment: What is given to students

1. Divide students into teams of 4.
2. Make sure students have proper footwear and clothing for being outside for 1-2 hours in temperatures - many students don't know how to dress for standing in cold weather, take the time to prep them the class before.
3. Give students shovel and Part A question and instructions.
4. When they have completed Part A (they have 30 minutes maximum for Part A), look at their answers and provide guiding questions if the answers are not complete. When their answers are complete, then given them Part B (again for 30 minutes maximum).
5. When their answers to Part B are sufficiently complete, give them Part C (again 30 minute maximum).
6. When Part C is complete, give them Part D (Part D is different for each group). They have 30 minutes to complete Part D. Then each group has 5 minutes to present to the rest of the class.
7. List of suggested equipment for each group:
   (a) shovel, ideally with flat cutting edge
   (b) tape measure in cm
   (c) ruler with mm marks, or laminated card with mm size squares
   (d) plastic or metal spatula such as for spackling a wall
   (e) field microscope or hand lens
   (f) snow density cutter
   (g) scale (resolution of 1g is best, but depends on size of snow density cutter, could be shared among nearby groups)

Overarching Questions (one for each group)

1. What does a snow crystal look like under the microscope? Are they all the same? What might cause the differences you see in the crystals?
2. What are the physical characteristics of this snow pack? How might they change when you change atmospheric conditions (make it warmer? cause it to rain?)
3. What happens to snow after it falls on the top of the snowpack during a cold period (below $-10^{\circ}\,\mathrm{C}$)?
4. What happens to snow after it falls on the ground during a relatively warm period (near $0^{\circ}\,\mathrm{C}$)
5. Does the snow affect the atmosphere above it?
6. How does the snow affect the ground underneath? Is the effect of the snow different at different times of the year?

7 Instructor's Notes

8 Solution Set

9 Supporting Materials