POLAR TREC
Learning Resources

Details

Completion Time: Less than a week

Permission: Download, Share, and Remix

Permafrost Thaw Depth and Ground Cover

Overview

Students are presented with an actual series of tundra photos, which they use to develop a hypothesis for which sort of ground cover will have the most/least permafrost depth. Then they are given a set of actual data and use this to test their hypothesis

Objectives

Students will:

- understand what permafrost is and how it develops.
- practice creating and testing a hypothesis.
- learn about field measurement techniques in the Arctic.

Lesson Preparation

Email Misty Nikula (mnikula@whatcomday.org) for a pdf file (4 MB) of the transect photos and print them out. I suggest no more than one transect (20 pictures) for lower level students, though upper levels could handle 2 transects depending on time available

Procedure

(See Resources section for background information)

Launch:

- Tell students about thaw depth or active layer and how it might affect and be affected by climate change.
- Introduce the idea that scientists are curious about whether the characteristics of the terrain around a transect location, such as standing water, grass cover, etc., affect the thaw depth at that location.
- Explain that the pictures are showing the ground cover around each transect marker from the BEO study site.
- Show them the transect pictures and have them spend a bit of time looking over the pictures, making notes of their observations. They may want to begin identifying, sorting and categorizing them by com-

Materials

- Transect pictures - one set per group (I suggest no more than one transect (20 pictures) for lower level students, though upper levels could handle 2 or 3 transects depending on time available)
- Active Layer Data for BEO site, July 21, 2004 (attached)
- Student Journals

mon traits such as standing water, mud, grass cover, etc.

Explore:
- Bring the group back together and have the students share their observations of the transect pictures.
- After sharing their observations, make a list of the characteristics that they think might affect the thaw depth at a particular location.
- Each group should make a hypothesis concerning which types of transect locations will have the greatest thaw depth.
- Have students sort their pictures into their selected categories and record a list of transect markers that belong to each category.
- After they have completed their sorting and recording, give the students a copy of the actual thaw depth measurements that were taken for these locations on the day that the pictures were taken (attached).
- Have them decide how to analyze the data (averaging all three, use one, etc) and record their processed data.

Summarize:
- The students will compare their data to their categories and their hypothesis, deciding if their hypothesis was supported or unsupported.

Extension
N/A

Resources
Background for Teacher:

The thaw depth, or active layer, of the tundra is affected by and has a positive feedback with global warming and the carbon cycle. Each year, during the summer, part of the tundra permafrost melts and becomes the layer that animals, plants, insects and other organisms can use effectively. Beneath this thawed layer is the continually frozen and inaccessible permafrost. Within the permafrost are "locked" nutrients of undecomposed dead plant and animal matter – materials that are literally frozen in time.

The depth to which the permafrost melts each year is important for scientists to understand for two main reasons:

1. Increasing thaw depth is an indication that the earth is warming.
2. As the thaw depth increases, more material previously locked in the permafrost can decompose. This will allow more carbon dioxide to be released into the atmosphere. This gas contributes to greenhouse warming and this warming, in turn, increases the thaw depth, creating a positive feedback loop.

Learning Resources

Scientists measure the thaw depth at various locations throughout the Arctic. Typically, a measurement grid is laid out, marked with stakes and measurements are taken at equally spaced locations within a study area. These measurement lines are called transects.

At the sites on which this activity is based, the San Diego State University Global Change Research Group's eddy covariance tower located at the Barrow Environmental Observatory, there are three transects that radiate out from the tower at due North (0 degrees) and 60 degrees to either side (60 degrees and 300 degrees). Each transect line has 20 markers spaced 10 meters apart.

To measure thaw depth, a steel rod with calibrated markings is pushed into the earth near the transect marker until it can go no further because it has hit the permafrost. Then, while holding the rod as close to the ground as possible, the rod is pulled out and the reading taken in centimeters. Three readings are taken at every transect marker and averaged. During the summer months (once the snow has melted), readings were taken once a week.

There is a good description and animation of the active layer thawing and freezing cycle at the Arctic National Wildlife Refuge website:

* http://arctic.fws.gov/activel.htm

More information about Barrow, the Global Research Group and these studies can be found through the TREC website at:

* http://www.arcus.org/TREC/phpbb/portal_barrow.php

Assessment
Have the students share their classification system, hypothesis, data and conclusion with the class.

Credits
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Learning Resources

National Science Education Standards (NSES):

Content Standards, Grades 5-8
Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard B: Physical Science
a. Properties and changes of properties in matter

Content Standard D: Earth and Space Science
a. Structure of the earth system

Content Standard E: Science and Technology
b. Understandings about science and technology

Content Standard G: History and Nature of Science
a. Science as a human endeavor

Content Standards, Grades 9-12
Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard B: Physical Science
b. Structure and properties of matter

Content Standard D: Earth and Space Science
a. Energy in the earth system

Content Standard F: Science In Personal and Social Perspectives
f. Science and technology in local, national, and global challenges

Content Standard G: History and Nature of Science
a. Science as a human endeavor

Other Standards:
N/A

BEO, 06/21/04(Julian day: 174)

Distance (m)	Point	300			0			60		
10	1	12.8	12.3	18.2	8.5	10.3	9	8.5	3.2	8.2
20	2	7.2	9.8	10	13.3	12.8	14.1	4.2	4.5	5
30	3	19.8	13.2	18.7	7.1	9	9.2	10.2	11.1	10.3
40	4	8	3.2	5	10	10	11.2	5	4.3	3.9
50	5	7.3	8	5.1	13.9	12.2	12.3	9	10	10.2
60	6	5	6	5.5	12.8	11	15.5	4	5	4.8
70	7	10.3	10	10	7.6	8	11.4	0.5	1	1
80	8	11.8	12	11.3	8.6	8.2	10.9	7.3	7.3	10.2
90	9	9.3	10	9.1	8.5	9	10.1	8	10.1	7.9
100	10	10.7	10.2	8	10.3	8.8	10.4	5.3	1	3.3
110	11	3	3.2	6	13.1	14.2	13.6	8.5	8.9	10.2
120	12	4.5	4	3	13.2	10.4	14.7	10.9	11.8	13
130	13	5	4	5.9	6.3	8.7	5.5	15	15	11.6
140	14	13.7	14.9	14	8.2	8.2	8.5	17.5	14.8	13.9
150	15	17.2	17.8	20.3	6.6	7.7	8.2	10.3	12.9	13.2
160	16	6	5.8	10.2	8.9	9.7	10.6	6.3	7.6	6.4
170	17	1	7.3	3.2	15	12.2	14.6	11.8	11.2	10.7
180	18	8.8	10	10.2	6.5	9.6	10.2	6.1	11.5	9.2
190	19	9.8	10	6.8	10.1	12.2	11	14	14.6	14.3
200	20	9.1	10.3	10.5	10.9	13.2	13.3	10	9.7	8.2
									Average:	**9.5**