



Name _____

Class _____

Arctic Climate Connections Activity 3 Exploring Arctic Climate Data

Part A. Understanding Albedo

Note that albedo can be expressed either as a ratio or as a percentage. While reading about albedo, you are likely to find values expressed either way, for example, 30% or 0.30.

A surface that reflects most of the radiation it receives has *high albedo*.

1. Give an example of a surface that has high albedo.

2. Explain your reasoning. Why do you think this surface has high albedo?

A surface that absorbs most of the radiation it receives has *low albedo*.

3. Give an example of a surface that has low albedo.

4. Why do you think this is true?

5. On the graph of incoming short-wave radiation, why is the value zero in November – February?

Calculate some practice albedo values. Use the graphs of incoming shortwave radiation and outgoing shortwave radiation to calculate albedo.



The mathematical definition of albedo is the ratio of incoming to outgoing shortwave radiation.
$$\text{incoming shortwave radiation (w/m}^2\text{)} \div \text{outgoing shortwave radiation (w/m}^2\text{)} = \text{albedo (unitless)}$$

On May 1	On July 1
Incoming (downward) =	Incoming (downward) =
Outgoing (upward) =	Outgoing (upward) =
Albedo =	Albedo =

6. Confirm your calculated answers with the data on the albedo graph. **Do they agree?**

Compare your calculated albedo values with known averages for the following surfaces:

Asphalt 0.05 - 0.10

Forest 0.05 - 0.20

Tundra 0.18 - 0.25

Open ocean 0.06

Sea ice 0.50 - 0.70

Snow 0.40 - 0.95 (Fresh snow is up to .95 reflective, meaning it reflects back 95% of the incoming sunlight. Very dirty snow is in the 0.4 range. Recent work in Greenland found ice with albedo as low as 0.3.)

Earth and atmosphere average 0.30

7. Explain your two values with respect to these average values. **Do they make sense?**



Part B. Analysis of Albedo, Snow Depth and Temperature

Next, work with three datasets from the Eureka weather station.

- Temperature
- Snow depth
- Albedo

8. Of these three graphs, where do you see a strong *correlation*? In other words, find a point where the data on one graph seems to be similar, or strongly related to data on another graph.

Follow the instructions in the student guide to create graphs in Excel that plot.

Looking at snow depth vs. albedo:

9. What are some reasons that albedo could vary while there is snow covering the ground?

10. Can you come up with an explanation for the sharp increase in albedo on May 12?

Looking at snow depth, temperature, and albedo:

11. What causes the initial drop in snow depth?

12. On what date does the snow depth begin to rapidly decrease?



13. What happens to the temperature around that same time?
14. What other effects can you see in the data that are closely linked with melting?
15. How does that, in turn, affect snow depth?

Concept sketch and essay

Graphics are powerful tools for explaining complex concepts. How would you summarize albedo graphically? Sketch, label, and describe what albedo is. Identify the key features you decide to include. Explain the processes that happen. Indicate how the features and processes are related. Use clear, complete sentences and leaders.

Then, write a short essay (2 - 4 paragraphs) that leads the reader through the concept of albedo and the related processes and features you used in your concept sketch. Use complete sentences and proper writing mechanics.

Part C: Think Globally

Let's think about how the concept of albedo is related to global climate on a larger scale. Examine the paired images below that show changes in snow and ice cover over time.

Okpilak Glacier, Alaska



June 1907

Image credit:
Leffingwell, Ernest. 1907. Okpilak Glacier: From the Glacier Photograph Collection. Boulder, Colorado USA: National Snow and Ice Data Center/World Data Center for Glaciology. Digital media.



August 2004

Image credit:
Nolan, Matt. 2004. Okpilak Glacier: From the Glacier Photograph Collection. Boulder, Colorado USA: National Snow and Ice Data Center/World Data Center for Glaciology. Digital media.

How has the albedo of this area changed over time? In turn, how does that affect further melting? What are the implications for global climate change?