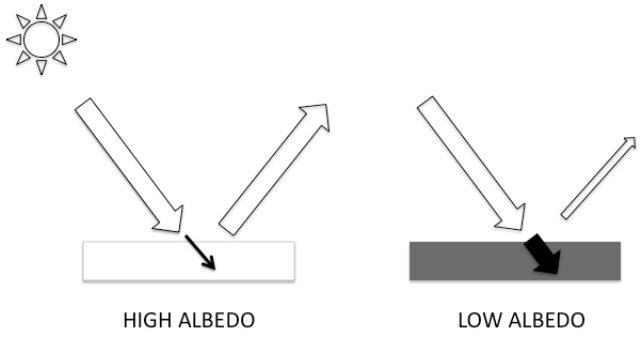
Name: Date:

# Introduction to Albedo and Feedback Loops

## What is Albedo?




Wearing dark colored clothing on a summer day makes individuals feel much warmer than if they were wearing light colored clothing. This is because of a property called albedo. **Albedo** is the fraction of incoming solar radiation (sunlight) that is reflected back into space. Because it is expressed as a fraction, albedo values do not have units. Objects that are very dark in color *absorb* most of the incoming radiation (causing them to heat up) and have a low albedo, while objects that are very light in color *reflect* most of the incoming radiation and have a higher albedo.

Albedo values range from 0 for a perfectly black surface to 1 for a perfectly white surface. The Earth has an average albedo of 0.30, which means that out of all the solar energy that reaches Earth, about 30% is reflected back into space and 70% is absorbed (http://mynasadata.larc.nasa.gov). Different surfaces on Earth have different albedos depending on the nature of the surface.

***1.*** *Below is a table of average albedo values for different locations on Earth. Based on your knowledge of albedo, try to match the surface on the right with the correct albedo value in the table.*

**Table 1. Local Albedo**

| Surface | Average Albedo |
|---|---|
| Perfectly White Surface | 1 |
| | 0.95 |
| | 0.40 |
| | 0.30 |
| | 0.26 |
| | 0.10 |
| | 0.04 |
| Perfectly Black Surface | 0 |

*Source: SG Philander. 2008. Encyclopedia of Global Warming and Climate Change: Vol 1. SAGE Publications, Inc. pp.24.*

a. New Asphalt
b. New Snow
c. Grass
d. Coniferous Forest
e. Sea Ice
f. Desert Sand

## How is Albedo Measured?

Albedo can be measured on the ground at small scales with hand-held light meters or albedometers. These instruments simultaneously measure how much solar radiation is hitting a surface and how much of that radiation is reflected. This data can be then be used to calculate the albedo. They give very accurate albedo measurements for a specific area, but they are not practical for large areas or for taking many measurements over a long time span. For this reason, many scientists use albedo data collected by satellites. Satellites measure albedo frequently (often every few days) and for the entire globe, which makes it easy to compare different locations, or study how the albedo of an area changes over time.

## Albedo and Climate Change

Albedo can have a large influence on the Earth's climate. The more energy that is reflected back into space, instead of absorbed, the less warming there is likely to be. Humans can impact albedo through changes in land use. Changing what is on the surface of the Earth through deforestation, urbanization, agriculture, etc. will change the albedo of that location, and therefore either increase or decrease the potential for warming.

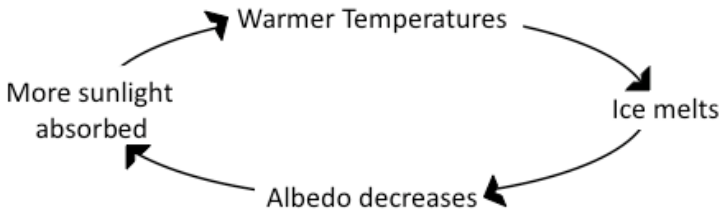
***2.*** *If a deciduous forest is cut down to build a parking lot, what will happen to the albedo of that location? What influence would that have on climate?*

## Feedback Loops

A **feedback loop** is when the result of an event influences the occurrence of that same event in the future. For example, imagine rolling a snowball down a hill. Each time the snowball rolls, it gets bigger, allowing it to pick up even more snow the next roll, thereby getting even bigger, so it can pick up even more snow, and on and on. This is an example of a **positive feedback.** Positive feedbacks are destabilizing, and can often be destructive to ecosystems.

The opposite of a positive feedback is a **negative feedback**. Negative feedbacks are not negative in the sense that they are 'bad,' but that they generally resist change, and keep a system stable. For example, when you get hot, your body temperature rises, so you start to sweat, which cools you off, thereby decreasing and stabilizing your body temperature.

Feedback loops play an important role in the interaction between albedo and climate. Rising temperatures can cause snow and ice to melt, exposing the surfaces below (ocean water, bare soil, etc), which generally have lower albedos. The lower albedo will increase solar absorption in that location, raising the temperature more, which would cause further snow and ice melt, and so on.




***3.*** *Does the ice melt and warmer temperatures example illustrate a positive or negative feedback loop? Describe the impact this would have on changes in climate.*

4. *Identify another example of a feedback loop (climate related or not)? Explain if the example you provide is a positive or negative feedback loop.*