STEM

Polar Connections

Measuring Albedo with Digital Cameras *Rev. 8/3/21010*

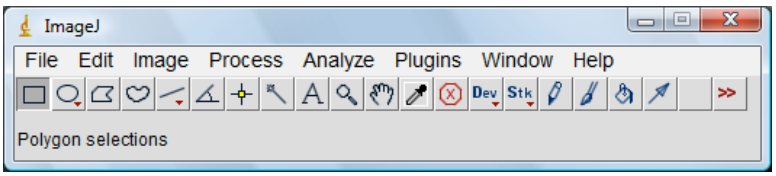
Why are Polar Regions more affected by global warming than other parts of the globe? One reason is that as sea ice melts and more open water appears, more energy is absorbed, and warming accelerates. This is a form of positive feedback and it makes the polar climate change faster than the climate in temperate areas. A similar effect occurs as snow melts exposing vegetation or soil.

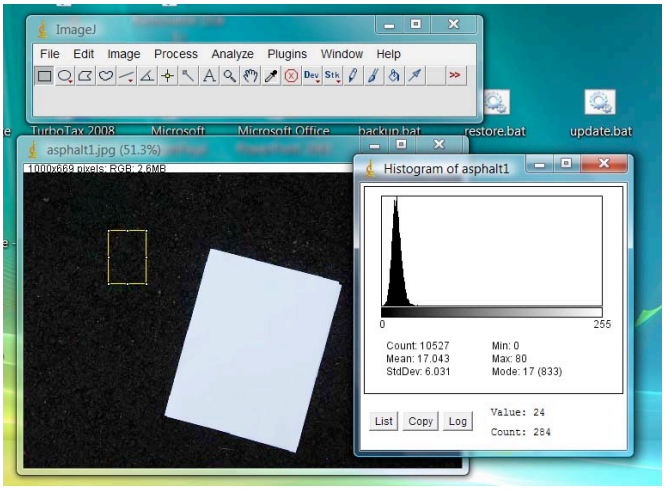
Technically, this effect is referred to as a change in the *albedo* – the fraction of the incident sunlight that is reflected back to space. It is much higher for snow and ice than for water. Fresh snow can have an albedo as high as 0.95. This is why skiers wear dark glasses. Ice and old snow typically have albedos from 0.2 to 0.45. However, liquid water has an albedo of only 0.03 for light incident at right angles to the water, and the albedo remains small until light comes in almost at a grazing angle.

You can easily observe effects of changes in the albedo. For example, if you clear the snow from a patch of dark colored driveway, the adjoining snow melts more quickly than the snow further away. The driveway absorbs more solar energy and heats the nearby snow, speeding up the melting process.

This experiment will use a digital camera and image analysis software to determine the relative albedos of various surfaces. We will use a sheet of Xerox paper as a standard. Measurements with a light meter indicate that the albedo of the Xerox paper is about 0.60.

1. Take a series of photographs of various surfaces indoors or outdoors ***with one or more sheets of Xerox paper included in each*** for comparison. Make sure the surfaces have uniform artificial or natural lighting. The Xerox paper area should be about half the total.
2. Transfer the photos to your computer.
3. If your computer does not already have ImageJ installed, download this image analysis program from http://rsb.info.nih.gov/ij/. It is available for Mac, 32 and 64 bit Windows XP and Vista, and additional platforms.
4. Click on the ImageJ desktop icon. You will see an ImageJ window which includes a menu bar, a tool bar, and a status bar (next page). The messages in the status bar will change and may not look like what is shown here.





5. Click on **File** and then **Open**. Navigate to your image folder, and click on one of the images.
6. Click on the Rectangle tool on the far left of the menu bar. Then click (left button on a PC) and drag the mouse to draw a small rectangle in the area to be measured. On the menu bar, click on **Analyze** and then **Histogram**. The Mean brightness **B(s)** in the histogram is 17.043 units.
7. Close the histogram. Click on a spot on the Xerox paper, again drag to form a rectangle, and again use **Analyze** and **Histogram**. Note the Mean brightness **B(x)**. *If the Xerox brightness is at or close to the maximum value, 255, it is overexposed and the relative intensities are distorted. Take a new photo with the paper occupying a larger part of the area.*
8. Calculate the albedo assuming that the Xerox paper has an albedo of 0.6.
9. Repeat for additional images as time permits, measuring the Xerox and sample brightness.

ImageJ Albedo Analysis Data Sheet

Photo #	Surface Description (color, material, etc.)	Brightness Surface B(s)	Brightness Paper B(x)	Albedo 0.6 B(s)/B(x)