

# Measuring Albedo with the LEGO® Light Sensor

## Background

Albedo is a very important piece of the climate puzzle. Albedo is the measurement of how much radiation the Earth and its atmosphere reflects. As you may know, white and light-colored surfaces reflect light (and heat!) and black and dark surfaces absorb light and heat.

Clouds control the amount of heat and light energy that reach the surface of the Earth. When the sun shines, light can be reflected by low, thick stratocumulus clouds, or absorbed toward the Earth through other clouds (or a clear sky). Scientists believe that the high, thin Cirrus clouds that absorb the sun, trap infrared radiation, contributing to the greenhouse effect.

Add light and dark surfaces below the clouds, and the puzzle becomes quite complex.

Can you think of some light colored surfaces on the Earth? What about dark ones? If there are a lot of light-colored surfaces, how do you think they might impact climate? What if we replace those light surfaces with darker ones?

In this activity, you will use your Robot Set (LEGO® MINDSTORMS Edu NXT or RCX) to measure the amount of light reflected by various surfaces. The LEGO light sensor works by emitting a light and then measuring how much of that light is reflected back to the sensor. Although this isn't an exact model of how albedo works, it will give you a good idea of how different things reflect and absorb light energy.

## Materials

LEGO light sensor

LEGO MINDSTORMS Edu NXT or RCX

LEGO bricks

Plain white paper from a copier or printer

Black construction paper

Crushed ice

Wax paper, baking parchment, and/or vellum (all are translucent papers)

Cookie sheet or other baking pan (to hold the ice)

Soil

Access to grass, soil, and other surfaces (concrete, asphalt, roofing shingles, a small body of water, fabric, etc)

## Method

Build a stand, similar to a microscope stand, that can hold a light sensor above the surface of a table. The exact distance doesn't matter and may vary depending on which set (NXT or RCX) you are using, but it should remain the same for each surface you are testing. Since this is an experiment, you will want to be able to adjust only one variable at a time.

Using either a simple program that you write or the View function on your NXT (or RCX), measure the amount of light reflected by each surface and record your results below. To simulate clouds, hold a piece of wax paper (or other translucent paper) between the light sensor and each of your surfaces. What happens when you move the paper closer to the light sensor? Closer to the surface?

**Your measurements**

Surface	Light reflected	With wax paper
White paper		
Black paper		
Crushed ice		
Snow (if available)		
Soil		
Grass		
Asphalt		
Concrete		
Roofing shingles		

**Results and Discussion Topics**

How were the measurements different between darker surfaces and lighter ones? How did the numbers change when you simulated cloud cover using translucent paper?

If there are low, thick clouds and lots of snow in the Arctic, how do you think it will impact the climate? If it's summer and some ice has melted and then there's a long period with high, thin clouds, what do you think will happen to the rest of the ice? If forests migrate over time northward into areas that are not tundra, how would albedo in that area change? What kinds of conditions do you think will keep the Arctic cold (and frozen!)?

How do you think dust in the atmosphere and volcanic eruptions will affect albedo?

### **Further investigation**

What other surfaces could you test?

What things would you consider in designing a city?

To learn more about albedo, you can visit:

<http://www.eoearth.org/article/Albedo>

<http://en.wikipedia.org/wiki/Albedo>

[http://en.wikipedia.org/wiki/Cloud\\_albedo](http://en.wikipedia.org/wiki/Cloud_albedo)

<http://www.arcticice.org/albedo.htm>

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