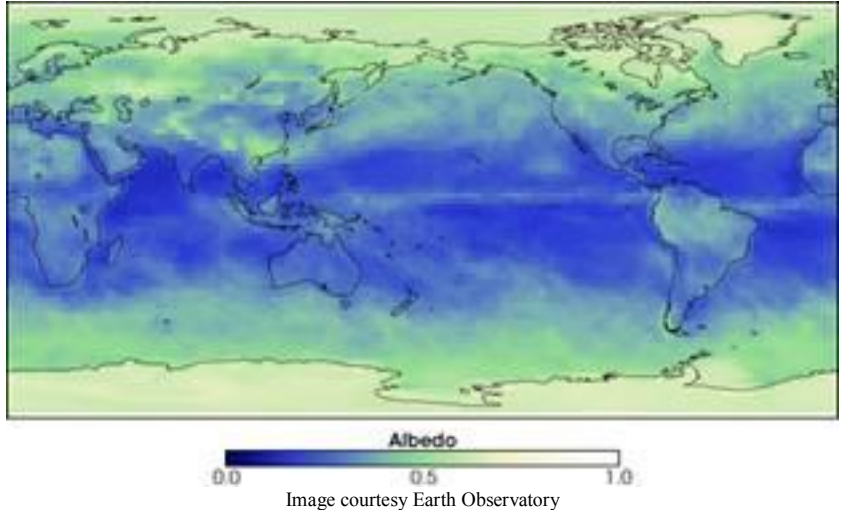


Variables Affecting Earth's Albedo

Purpose: To have students investigate one of the variables that affect the Earth's albedo

Grade Level: 6-12

Estimated Time for Completing Activity: 2-3 class periods



Learning Outcomes:

- collect data on Earth's albedo from two surface types at the same latitude
- graph the differences in the data for the two locations over a period of two years
- use the data to calculate how much difference there is in Earth's albedo between the two locations
- suggest reasons for the differences

Prerequisite

- Geographic knowledge and understanding of latitude and longitude
- Familiarity with the concepts of Earth's energy budget
- Knowledge of Earth's climate zones, climatographs of temperature and precipitation
- Some experience with Excel

Tools

- MY NASA DATA website
- Google Earth or maps or atlas where latitudes and longitudes can be determined within 1 degree
- Excel or other spreadsheet

National Standards:

- **Geography:** Places and Regions
- **Geography:** The World in Spatial Terms
- **Math:** Data Analysis and Probability
- **Science Content:** A Science as Inquiry
- **Science Content:** D Earth and Space Science
- **Science Content:** E Science and Technology

Virginia Standards of Learning:

- **ES.1c:** The student will plan and conduct investigations in which scales, diagrams, maps, charts, graphs, tables, and profiles are constructed and interpreted.
- **ES.2a:** The student will demonstrate scientific reasoning and logic by analyzing how science explains and predicts the interactions and dynamics of complex Earth systems.
- **ES.3d:** The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery. Key concepts include location by latitude and longitude and topographic profiles.
- **ES.13d:** The student will investigate and understand that energy transfer between the sun and the Earth and its atmosphere drives weather and climate on Earth. Key concepts include weather phenomena and the factors that affect climate including radiation and convection.
- **LS.1:** The student will plan and conduct investigations in which c) data are organized into tables showing repeated trials and means; h) continuous line graphs are constructed, interpreted, and used to make predictions; and i) interpretations from a set of data are evaluated and defended.
- **Sci6.3:** The student will investigate and understand the role of solar energy in driving most natural processes within the atmosphere, the hydrosphere, and on the Earth's surface.
-

Vocabulary:

- [albedo](#)
- [CERES](#)
- [radiation](#)
- [reflectivity](#)

Lesson Links:

- [Earth's Radiation Budget](#)
- [Live Access Server](#)
- [Key for Surface Scene Types-Biome Types](#)
- [Time Coverage for the Live Access Server](#)
- [CERES Website](#)
- [Importing Data into Excel](#)
- [Earth's albedo animation](#)
- [Biome Types and Descriptions](#)
- [Seasonal changes in Earth's albedo](#)
- [Albedo in Decline sample image](#)
- [Albedo Animation](#)
- [Explanation of Albedo](#)
- [Biome Types and Descriptions](#)
- [Earths Albedo in Decline](#)

- [Seasonal Changes in Earths Surface Albedo](#)

Background:

Earth's albedo is the fraction of incoming radiation (sunlight) that is reflected into space. The Earth has an average albedo, which describes how much sunlight is reflected on average for the whole planet and the whole year. That value is about 0.3. The Earth also has a local albedo, which determines how much of the Sun's light is reflected from a particular place at a particular time. The local albedo depends on the particular local surface, which can change seasonally as vegetation changes. It also depends on more rapidly changing things such as snow and clouds.

For reference, the values of albedo range from 0 to 1, where a value of 0.0 absorbs all radiation that strikes its surface and a value of 1.0 represents a body that reflects 100% of the radiation that strikes its surface.

Fresh snow has an albedo ranging from 0.75 to 0.90.

Dry dark soil has an albedo of approximately 0.13.

Procedure:

Part I. Select locations to compare.

1. Go to the lesson links above and click on the 'Live Access Server' link.
2. You should automatically be prompted with data parameter choices, if not click on 'Choose Dataset' in the top left of the screen and select Atmosphere, Surface Cover, and then Surface Scene Type (CERES SARB)
3. On the left side of the screen under 'Line Plots' select 'Longitude'
4. In the Compass Rose boxes under the navigation map, enter 1 S and press the enter key, then enter in 5 W and 55 E in their corresponding locations. Be sure to click on the radio button next to 'Update Plot' at the top of the screen to view your new plot.
5. You should now see your updated plot. Be sure to print or save the plot for comparison later in the lesson.
6. Referring to the Scene Type key in the Links above, begin picking out the surface scene types for the Longitude line you have selected. You may want to zoom in on the navigation map in the upper left of the screen to see what features the line crosses.
7. NOTE: the date for this data set is fixed at February 1, 2006. This data set does not change that much over time, allowing you to make a comparison with the albedo data and still be able to draw accurate conclusions from the two sets.

Part II. Obtain local albedo data.

1. Go to the lesson links above and click on the 'Live Access Server' link.
2. You should automatically be prompted with data parameter choices, if not click on 'Choose Dataset' in the top left of the screen and select Atmospheric Radiation, Top of Atmosphere (TOA) All Sky, and then Monthly TOA All-sky Albedo (ERBSSCAN)
3. On the left side of the screen under 'Line Plots' select: Longitude
4. In the Compass Rose boxes under the navigation map, enter 1 S and press the enter key, then enter in 5 W and 55 E in their corresponding locations.
5. Change the date to Feb, 1998. Be sure to click on the radio button next to 'Update Plot' at the top of

the screen to view your new plot.

6. You should now see your updated plot. Be sure to print or save the plot for comparison later in the lesson.

Part III. Compare

Looking at the data for your two plots, begin to determine what relationship exists between surface scene type and albedo.

Questions:

1. What is the relationship between surface scene type and albedo? (Surface Scene Type Variable can be used interchangeably with biomes. A link can be found in the links section that covers biomes in greater detail.)
2. Were there any features along the line that helped you make the comparison? Explain.
3. When comparing your surface scene line plot to the surface scene type key in the links section, were there any discrepancies in what you think should be in those locations? Explain!

Extensions:

1. Ice has a high reflectivity. Choose a location over water that may or may not freeze during the winter, depending on the severity of the winter. Obtain the local albedo data for that location. Looking at the values in the winter, try to determine whether the water froze or not. Obtain the surface temperature data to see whether it agrees with your determination.
2. Repeat this activity using the Monthly TOA Clear-sky Albedo, which includes only the surface characteristics, not the effects of clouds on the reflection of sunlight. What can you learn about the surface type? About the importance of clouds?
3. Find out what you can on the CERES satellite and the Earth Observing System (EOS). What other satellites have been part of EOS? What instruments did each have on board, and what properties did they measure? When were they put into service, and how long were they operational? What was the importance of their measurements?

Lesson plan contributed by Carl F. Katsu, Fairfield, PA

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NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION



Teacher
Feedback



Responsible NASA Official: [Dr. Lin Chambers](#)

Page Curator: [Daniel H. Oostra](#) | Questions? Comments? [Contact Us](#)

Teacher's Notes

Teachers Notes: Variables Affecting Earth's Albedo

- 1) To create a free PDF of this lesson, see the [Convert this Lesson into a PDF link](#) and choose from a list of online hosts.
- 2) Depending on the capabilities of your students, you may want to focus this lesson more narrowly to look at a single location.
- 3) Instructions for obtaining [surface temperature](#) information
 - Click on DATA ACCESS
 - Click on Live Access Server (Advanced Edition)
 - Click on [Atmosphere](#) then Atmospheric [Temperature](#)
 - Click on Monthly Near-Surface Temperature ([ISCCP](#))
- 4) Because much of the information presented is cross-categorical, many aspects of this lesson could be used as a social studies or a geography lesson.
- 5) If used in a middle school setting explanations and examples prior to doing the lesson may be needed.
- 6) Due to the wide variety of locations that students can choose, a wide variety of answers should be acceptable.
- 7) Instructions on obtaining surface temperature information
Click on DATA ACCESS, Live Access Server (Advanced Edition), Atmosphere, Atmospheric Temperature, Monthly Near Surface Temperature (ISCCP)
- 8) As much of this information is cross categorical, many aspects of this lesson can be used as a social studies or a geography lesson

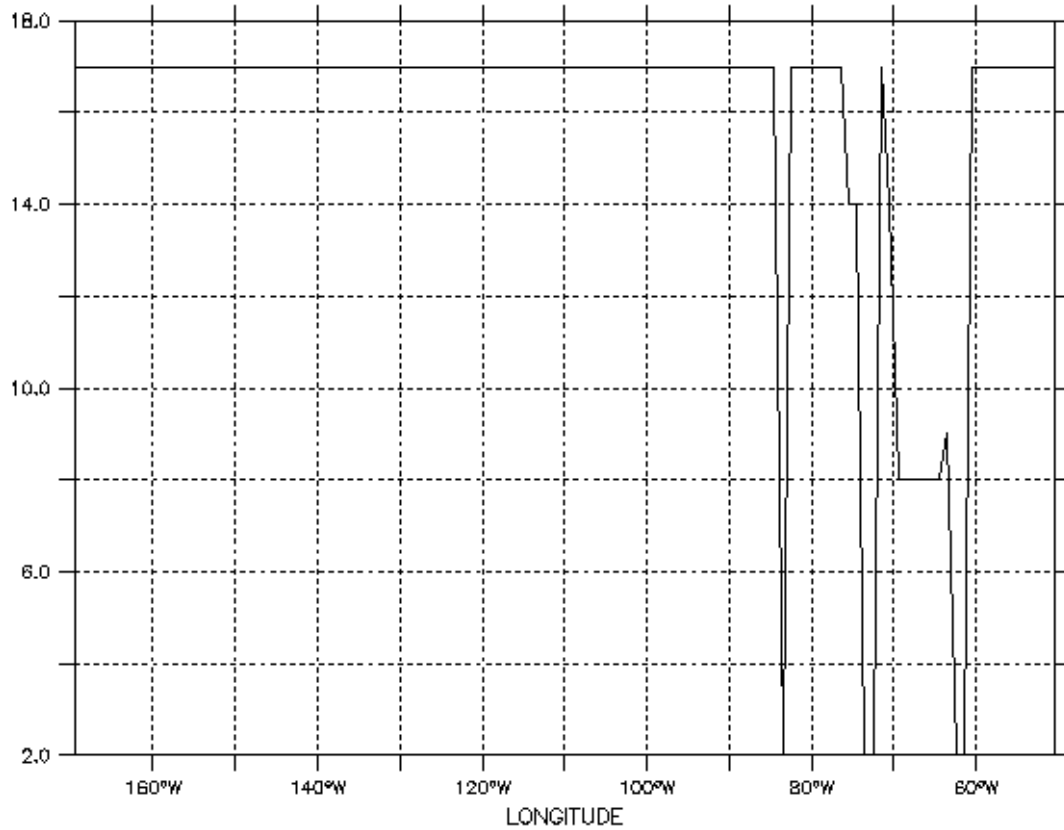
Lesson 37: Variables Affecting Earth's Albedo

Examples:
North America

LAS 7.+ / Ferret 6.1 NOAA / PMEL

LATITUDE : 9.5N
TIME : 01-FEB-2006 00:00

DATA SET: IGHPa_2006.1deg.nc



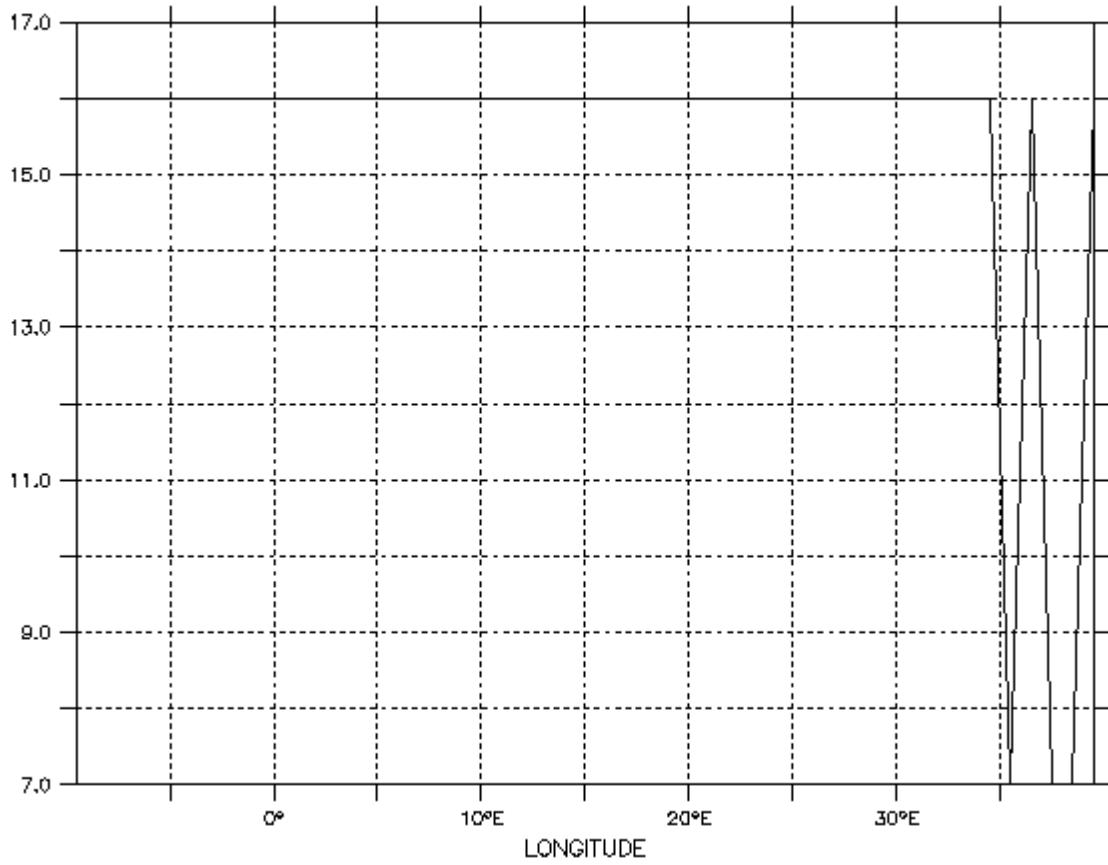
Surface Scene Type (CERES/SARB) (dimensionless)

Europe:

LAS 7.+ / Ferret 6.1 NOAA/PMEL

LATITUDE : 29.5N
TIME : 01-FEB-2006 00:00

DATA SET: IGHPa_2006.1deg.nc



Surface Scene Type (CERES/SARB) (dimensionless)

North America Text File:

VARIABLE : EBAF Albedo
FILENAME : CERES_EBAF_TOA_Terra_Edition1A_200003-
200510_AALB.nc
FILEPATH : /usr/local/fer_data/data/
BAD FLAG : -9999.000
SUBSET : 24 points (TIME)
LONGITUDE: 110.5W(-110.5)
LATITUDE : 42.5N

coordinates 110.5W

16-NOV-2003 00	0.5758
16-DEC-2003 00	0.5822
16-JAN-2004 00	0.5852
16-FEB-2004 00	0.5734
16-MAR-2004 00	0.4103
16-APR-2004 00	0.3704
16-MAY-2004 00	0.3323
16-JUN-2004 00	0.2946
16-JUL-2004 00	0.2687
16-AUG-2004 00	0.2887
16-SEP-2004 00	0.3252
16-OCT-2004 00	0.3997
16-NOV-2004 00	0.4078
16-DEC-2004 00	0.4986
16-JAN-2005 00	0.5689
16-FEB-2005 00	0.5412
16-MAR-2005 00	0.4566
16-APR-2005 00	0.3821
16-MAY-2005 00	0.3383
16-JUN-2005 00	0.2959
16-JUL-2005 00	0.2097
16-AUG-2005 00	0.2636
16-SEP-2005 00	0.2872
16-OCT-2005 00	0.3291

Europe Text File:

VARIABLE : EBAF Albedo
FILENAME : CERES_EBAF_TOA_Terra_Edition1A_200003-
200510_AALB.nc
FILEPATH : /usr/local/fer_data/data/
BAD FLAG : -9999.000
SUBSET : 24 points (TIME)
LONGITUDE: 10.5W(-10.5)
LATITUDE : 29.5N

coordinates 10.5W

16-NOV-2003 00	0.1988
16-DEC-2003 00	0.2446
16-JAN-2004 00	0.2356
16-FEB-2004 00	0.2097
16-MAR-2004 00	0.2034
16-APR-2004 00	0.2309
16-MAY-2004 00	0.2133
16-JUN-2004 00	0.3212
16-JUL-2004 00	0.251
16-AUG-2004 00	0.2457
16-SEP-2004 00	0.2757
16-OCT-2004 00	0.2667
16-NOV-2004 00	0.2328
16-DEC-2004 00	0.2504
16-JAN-2005 00	0.2158
16-FEB-2005 00	0.2341
16-MAR-2005 00	0.2106
16-APR-2005 00	0.2414
16-MAY-2005 00	0.2434
16-JUN-2005 00	0.2842
16-JUL-2005 00	0.2464
16-AUG-2005 00	0.3
16-SEP-2005 00	0.1938
16-OCT-2005 00	0.2512