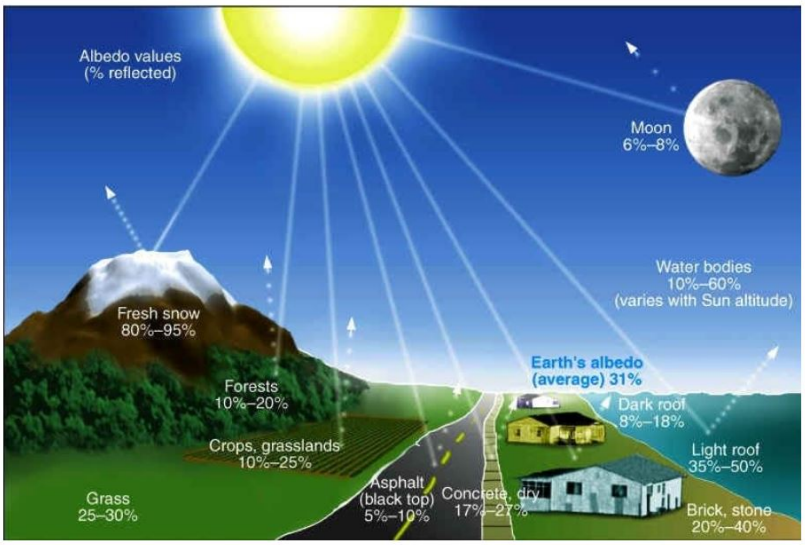
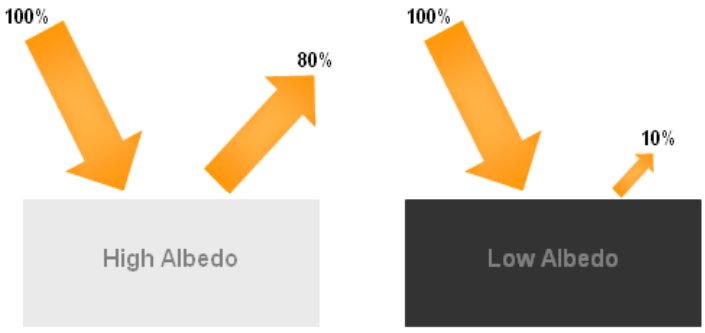
SURFACE TEMPERATURE FACT SHEET

Energy from the sun in the form of visible radiation (light) warms the earth. Some of the energy is reflected back into space while some of the energy is absorbed.

Different land uses have varying abilities to reflect the sun's energy, absorb it, and emit the energy as heat. All materials can absorb radiant energy or reflect the energy back into space. The absorbed radiation warms objects, which subsequently re-radiate energy (infrared) back out into space (known as emissivity). The hotter the earth's surface, the more energy is radiated out.



Albedo of various landscapes. Image via University of Arizona.



A light colored object has high albedo reflecting most of the light that hits it. A dark object absorbs more light (energy) (Image source: NC State University)

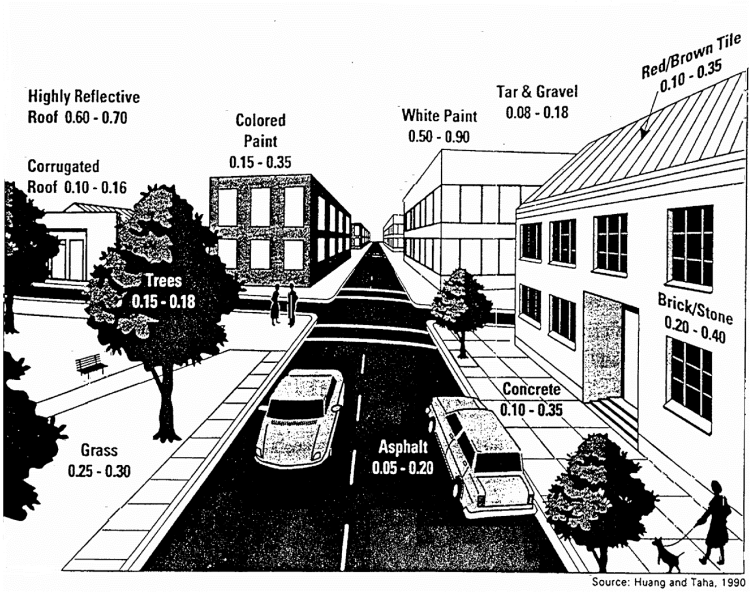
Surface temperatures vary depending on local factors, such as

- Cloud cover
- Climate
- Weather (ex. wind and rain)
- Shade (from buildings or trees)
- Type of material (ex. steel, concrete, vegetation)
- Albedo of the surface

The albedo of an object is a measure of how strongly it reflects light from radiant sources such as the sun. A surface's albedo is the percentage of incoming light that is reflected rather than absorbed. In general, lighter colored objects tend to have a higher albedo, while darker colored objects absorb more of the sun's energy.

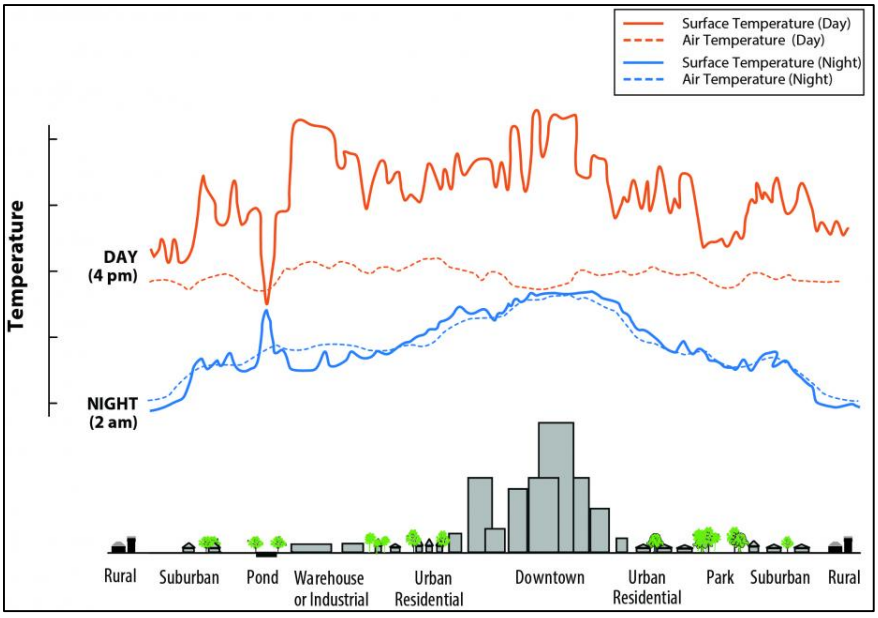
Below are examples of objects and their albedo ratings. Numbers closer to 1 are considered to have a higher albedo, while numbers closer to 0 have a lower albedo. A high albedo means that material has a more reflective surface and can reflect much of the sun's energy away. While the ocean has a low albedo (~0.06), snow has a high albedo (~0.9). It is thought that the earth's overall average albedo is around 0.3 (30%).

Surface	Typical Albedo
Conifer Forest (summer)	0.09-0.15
Deciduous Trees	0.15-0.18
Fresh Asphalt	0.04
Black Brick	0.08
Worn Asphalt	0.12
Bare Soil	0.17
Green grass	0.25
Red brick	0.36
Desert Sand	0.40
Ocean Ice	0.5-0.7
New Concrete	0.55
White brick	0.72
Fresh Snow	0.80-0.90



If a location (or the entire earth) receives more energy from the sun than it sends back to space, that location gets warmer. If a location reflects more of the sun's energy than it absorbs, the locale gets colder. Changing the surface albedo changes the energy transfer (i.e., temperature). An example of this albedo effect is the snow-temperature feedback. If a snow-covered parking lot warms and the snow melts, the albedo decreases, more sunlight is absorbed, and the temperature of the asphalt tends to increase.

This is how heat islands form in and around urban centers. More energy is absorbed in areas with higher impervious surfaces having low albedo. Combined with tall buildings (reducing wind) and less vegetation (less transpiration and shade), the urban area becomes warmer than rural locations.



Temperature differences of Surface and Atmospheric Urban Heat Islands compared to rural locations. Image Credit: USEPA 2008

Terms to Know

>Albedo: *a measure of how much light that hits a surface is reflected without being absorbed. A white object with high albedo, reflects most light that hits it and a dark object of low albedo absorbs most of the light that hits it.*

>Emissivity*: the measure of an object's ability to emit infrared energy. Emitted energy indicates the temperature of the object. Emissivity can have a value from 0 (shiny mirror) to 1.0 (blackbody).*

Various surface temperatures can be measured using an inexpensive handheld infra-red thermometer. When investigating surfaces in a location, consider measuring similar surfaces in direct sunlight compared to those in the shade, as well as during different periods of cloud cover.

Learn more about measuring surface temperatures at The Globe Program (www.globe.gov)

Information provided in this fact sheet from:

- U.S. Environmental Protection Agency. 2008. Reducing urban heat islands: Compendium of strategies. Draft. https://www.epa.gov/heat-islands/heat-island-compendium.
- Landscape albedo image credit: https://www.mprnews.org/story/2018/02/07/snowblind-fresh-snow-covers-bright-albedo. Cited source: University of Arizona (Accessed August 2020)
- Albedo image credit: http://www.bitsofscience.org/urban-heat-island-rooftop-albedo-geoengineering-3966/ . Cited source source: Huang and Taha, 1990 (Accessed August 2020)
- Sample albedo values https://en.wikipedia.org/wiki/Albedo (Accessed August 2020)
- Albedo graphics and definition: NCStateUniversity: Climate Education K-12 http://climate.ncsu.edu/edu/Albedo (accessed August 2020)
- U.S. EPA, Learn about Urban Heat Islands, https://www.epa.gov/heatislands/learn-about-heat-islands (Accessed August 2020)
- The Globe Program, Atmospheric Protocols https://www.globe.gov/do-globe/globe-teachers-guide/atmosphere