



Objective

This activity familiarizes students with remote sensing data using imagery from Google Earth, the High Resolution Imaging Science Experiment (HiRISE) for Mars, and Light Detection and Ranging (LiDAR) data. The goal is to use landscape imagery to understand and interpret the effect of geologic processes on a landscape and to relate the processes to past climatic conditions.

Materials

- Computer with internet access
- Paper and pen or pencil

The Critical Zone

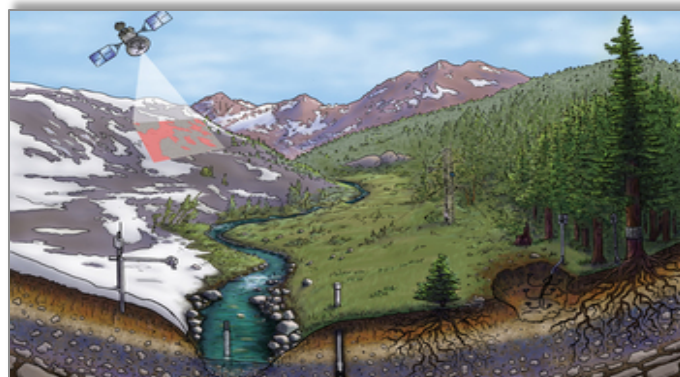
The Critical Zone (CZ) is defined as the zone at Earth's land surface extending from the top of the vegetation canopy through soil to subsurface depths at which fresh groundwater freely circulates. This is the zone where most terrestrial life, including humanity, resides. Critical Zone Observatories (CZO) provide important platforms for studying the processes occurring in the Critical Zone (see criticalzone.org). The goal of the CZOs is to build a network to advance interdisciplinary studies of Earth surface processes, in part to enable a predictive capability for recognizing potential variations in CZ processes in response to ongoing human-induced land-use and climate change. Nine CZOs work on cross-site activities to enhance the broader impact of work at individual CZOs and to advance the CZO network. One cross-site activity is remote sensing using LiDAR. An earlier-developed CZO LiDAR classroom activity is available at <http://criticalzone.org/national/education-outreach/k-12-education-1national>.



Remote Sensing

Remote sensing refers to gathering information on an object or area from a distance usually by aircraft or satellite. Remote sensors collect data by detecting energy reflected from Earth. Sensors can be active or passive. Passive instruments detect energy being naturally emitted by the object or reflected from another source, the most common being sunlight. Active instruments emit their own energy to an object and then detect the reflection. For more examples of active and passive methods visit: <http://earthobservatory.nasa.gov/Features/RemoteSensing/>.

Satellites and aerial photography, like those provided from Google Earth and HiRISE, can be either active or passive methods depending on the source of energy. LiDAR is an example of an active method using a laser to transmit light pulses to an object and then record the time it takes for the light to be reflected back to the instrument. LiDAR data can reveal micro-topography that is difficult for a field scientist to recognize and is not represented well on topographic maps. For more information visit <http://ocean.service.noaa.gov/facts/lidar.html>.



Climate & Landscapes

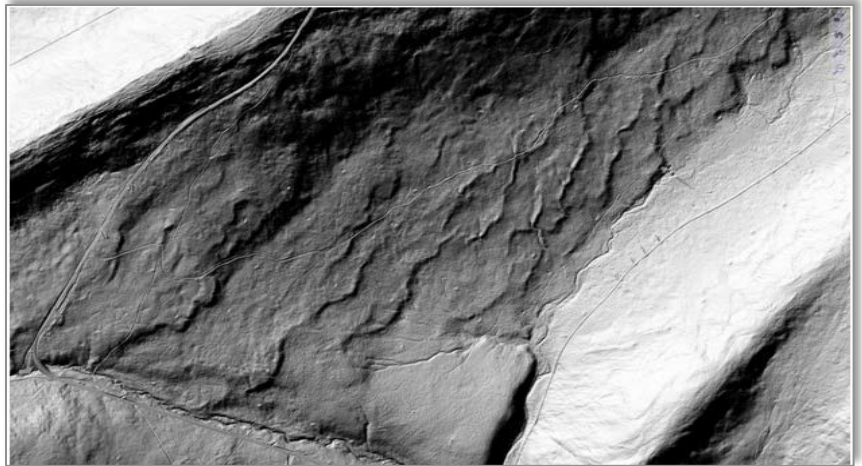
Much of Earth history can be characterized as having had climate conditions that were much colder, and warmer, than what we experience today. Climate affects the types of geologic processes that occur within and on Earth's surface, and the effects of these processes shape landscapes. Geologic processes can be destructive (e.g. erosion), constructive (e.g. deposition) or in some cases both (e.g. volcanic eruptions). Geoscientists study geologic processes occurring in different modern environments and use this information to better understand landscape evolution.

The landscape of interest in this activity is located in central Pennsylvania within the Valley and Ridge Physiographic Province of the Appalachian Mountains where long, narrow mountain ridges of shale capped by sandstone are separated by valleys of carbonate rock. This region has a temperate humid climate that is characterized by four seasons, moderate yearly temperatures and precipitation (rain and snow), and mixed deciduous/evergreen forests. What types of geologic processes could occur in this climate? And what processes may have occurred during more extreme climates of the past?

Classroom Activity: Geomorphology & Paleoclimates

1. Use Google Maps to find Pine Grove Mills, Pennsylvania. Follow State Route 26 south from Pine Grove Mills to the intersection with Harry's Valley Road. Your study area lies to the northeast (right on Google Maps) between this intersection and Beaver Pond. Study and make notes about the topography and landscape here.

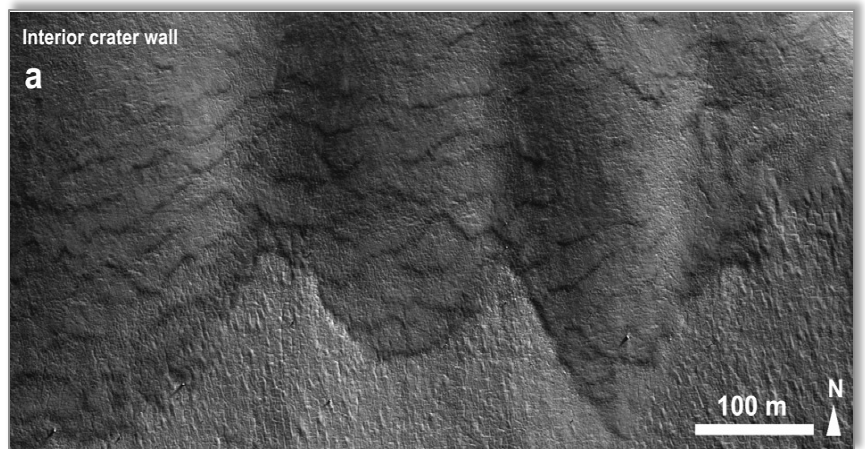
2. View the photo to the right, a LiDAR image of your study area, noting that the image is about two miles long by one mile wide. Do you see anything unusual in the landscape, anything that you did not recognize on the Google Maps imagery?



3. View the photos below, taken from the Chugach (left) and Talkeetna Mountains (right) in Alaska. Do you see anything in these photos that helps you better understand the landscape in your Pennsylvania study area?



4. Go to the Pennsylvania Bureau of Topographic and Geological survey web site and download Pennsylvania and the Ice Age (<http://www.dcnr.state.pa.us/topogeo/field/glacial/index.htm>). Focus on the centerfold map entitled "Glacial Deposits of Pennsylvania." Was the study area once covered by glaciers?
5. Read the section in the downloaded report entitled "Periglacial Phenomena" on page 25 of the report. Can this information help you understand the study area? Consider the relationship between Alaska today and Pennsylvania in the past. How might the photos from Alaska be relevant to considering present-day Pennsylvania?
6. Now view the image below of a crater wall from Mars taken by HiRISE. Compare this landscape to the LiDAR image of Pennsylvania and the photographs from Alaska. From the information you have gathered, what could you reason about the climate on Mars?



Teacher's Notes: 2) Image shows sinuous lobe-like features on the hillslope. 3) Left: Lobe features seen at top and mid-slope in the background, note person at bottom left for scale. Right: Close-up of lobe directly behind people, note succession of more or less parallel lobes on the hill slope in the background. 4) Study area located in Centre County was never covered by glacial ice. 5) Pennsylvania once had a periglacial climate, similar to present-day Alaska; a colder climate caused permafrost conditions and solifluction to occur during summer. 6) Mars has extremely cold temperatures at or below freezing, but can warm to ~70°F

(20°C) at its equator during summer months; freezing and thawing leads to the development of solifluction lobes (<http://quest.nasa.gov/aero/planetary/mars.html>).