Google Earth as a tool for Earth Science classrooms: Lessons and Labs

FERMANN, Eric, Earth Science, Eastchester High School, 2 Stewart Place, Eastchester, NY 10709; efermann@eastchester.k12.ny.us
KLUGE, Steve, Earth Science, Fox Lane High School, Box 390, Route 172, Bedford, NY 10506; skluge@bedford.k12.ny.us

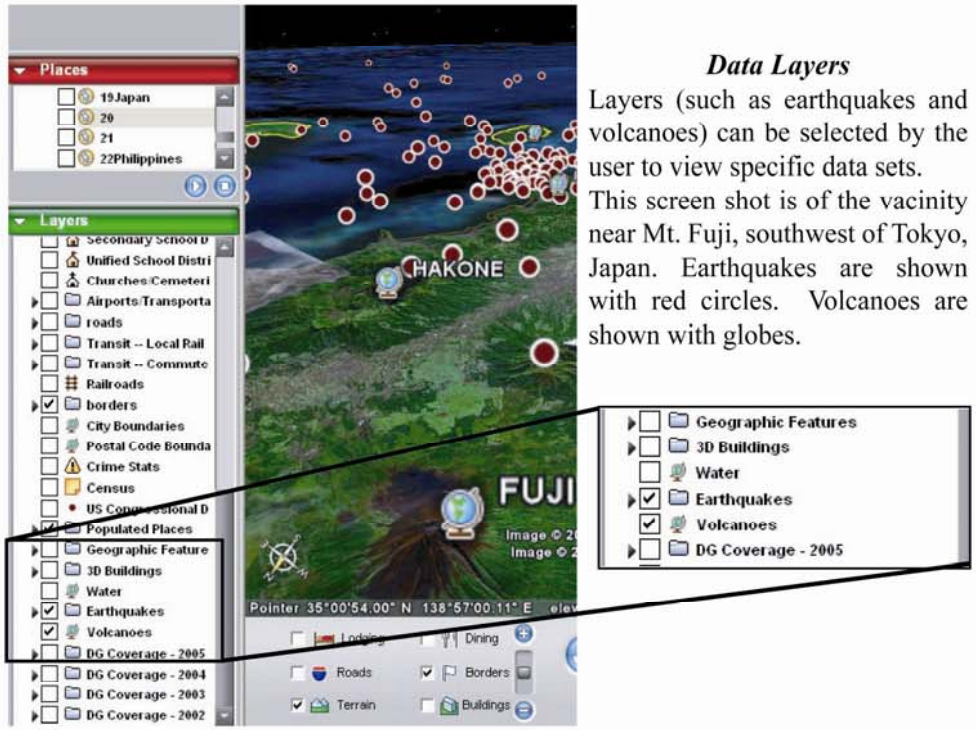
Abstract

The increased availability of detailed satellite imagery creates a unique opportunity for Earth Science students to study landforms and landscapes, enabling them to literally broaden their horizons by including not only individual geologic features, but also boundaries and transition zones between regions dominated by different geologic processes. Since its release in the summer of 2005, GoogleEarth has provided an uncomplicated means of combining satellite imagery with geological and geographic information in dramatic fashion. While satellite visualization tends to grab the student's attention, it remains necessary to integrate these techniques into lessons that include inquiry-based learning activities. The authors have collaborated by beginning to create topical earth science lessons and laboratory activities using the free GoogleEarth software to enhance the conceptual understanding of topics ranging from plate tectonics, volcanoes, glacial geology, erosion and deposition in river systems, and meteorite impacts. These new exercises allow educators to keep up with advances in technology and supply students with the modern tools necessary to understand the fundamentals of geological processes.

Links to further information can be found on the web at
http://www.eastchester.k12.ny.us/schools/hs/teachers/fermann/gsa.htm
and from a link off of
http://www.bedford.k12.ny.us/flhs/science/geohome.html

Once students get past the novelty of finding their homes or schools (Eastchester High School above and Fox Lane High School below), they quickly begin to see the true uses of Google Earth.

Exceptionally useful features of Google Earth for Earth Science classrooms



Data Layers

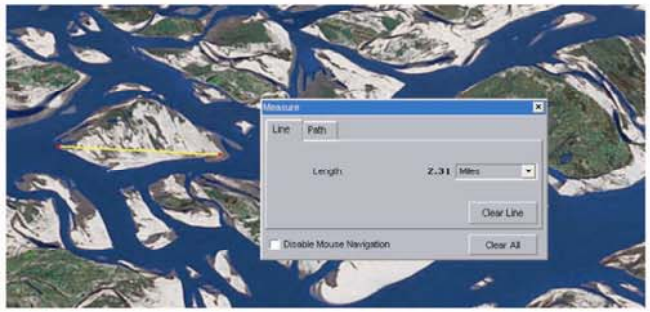
Layers (such as earthquakes and volcanoes) can be selected by the user to view specific data sets. This screen shot is of the vacinity near Mt. Fuji, southwest of Tokyo, Japan. Earthquakes are shown with red circles. Volcanoes are shown with globes.

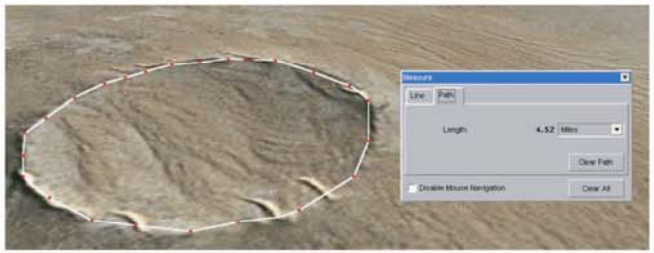
Topography and Flying Tours

Landscape features become true-to-life when seen in a 3-Dimensional view. A flying tour through or around a particular location adds a new sense of reality by bringing the landscape to life. Tours can be large scale, as if flying in a helicopter around a volcano, or small scale, as if viewed from an airplane or the Shuttle, or even farther out in space. Scales can be combined in a single tour, too: zoomed out to fly around the world to various locations and zoomed in on specific features for detailed exploration.The linear volcanic Cascade Range and the Cascadian Margin to the west are clearly visible when viewed from 450 miles up. A smooth zoom to an elevation of 35K feet allows exploration of the details of Crater Lake, in southern Oregon.

Measure Tool

The measure tool allows the user to calculate straight line distances or to measure the distance along a non-linear path. Below left is the linear measurement of a sandbar (2.31 miles in length) in the Bramaputra River in northern Bangladesh. Below right is the non-linear circumference measurement of the Roter Kamm impact crater in southern Namibia (4.52 miles in circumference).





Location and Elevation

Data are given for the cursor location. This location is in the Wasach Range, near Salt Lake City.

Applications for Classroom Use

There are at least three unique ways we have utilized the Google Earth program in our classrooms:

A. As a demonstration tool for introduction of students to new concepts, materials, and places,
B. As a supplement to previously established lab activities,
C. As part of a stand-alone, technology-driven, activity.

A. Demonstration Tool: The Pacific Rim Tour

As an introduction to the dynamic nature of earth's crust, a tour of the Pacific Rim, commonly known as 'The Ring of Fire', was developed. Students were first shown a series of images displaying earthquake and volcanic activity from several locations around the Pacific Ocean. Following the series of images, students 'flew' along a tour around the Pacific Rim that included stops along the west coasts of South America and North America, the Aleutian Archipelago, Japan, and the Philippines. By activating the volcano and earthquake layers of Google Earth, students were able to see how the location of these processes were closely related and connected with tectonic forces.

B. Supplemental Material to Established Lab Materials: The CT River Profile

The gradient of the Connecticut River from its source (Third Lake) to its mouth (Long Island Sound) forms almost an ideal stream profile which is interrupted by several nick points created by waterfalls and dams. To supplement an established lab in which students create a river profile of the CT River, students were brought along a tour with built-in stops at many of the significant nick-points. Along the tour, the landscape morphology clearly changes from lowlands near LI Sound up through the border between VT and NH which is characterized by higher mountains.

C1. Stand-Alone Activity: Meteorite Impacts

By combining the interactive Earth Impact Effects Program website (*http://www.lpl.arizona.edu/impacteffects/*) and a Google Earth file made from available impact crater data (*http://www.unb.ca/passc/ImpactDatabase/*), students were able to examine the nature and potential consequences of meteorite impacts on Earth. After plotting the relationship between meteorite and crater size, students were able to measure the diameter of particular impact structures included in the Google Earth file, estimate the size of the responsible meteorite, and infer the damage that would have resulted to regional and global environments during the formation of craters such as Baranger Crater in Arizona (below right).

C2. Stand-Alone Activity: Topographic Map Overlay

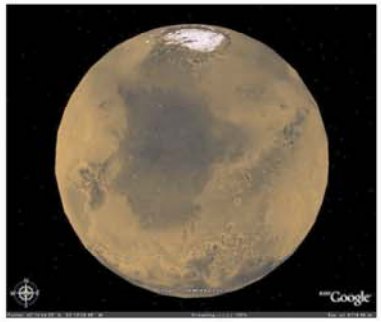
By accessing the image overlay feature of Google Earth, any image including a topographic map, can be draped across the surface of the Earth. By using the image overlay feature with the topographic map of Kaaterskill Clove in the Catskill Mountains (above left), students are able to manipulate the image and the opacity of the overlay to gain a clearer understanding of how topographic contours relate to the actual topography of a landscape region. Geologic information can be stored along with the image overlay to allow students to further their understanding of how the geology of a region can influence its physical features.

More Useful Features of Google Earth

As the usefulness of Google Earth becomes more and more apparent, additional data layers are becoming publicly available. Many recent layers can be found at *http://bbs.keyhole.com/ubb/categories.php/*. This free service is nicely organized and contains numerous layers which can be downloaded, installed, and manipulated for use in the Earth Science classroom.

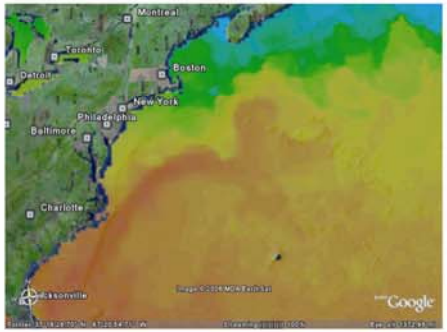
Planets

Data layers developed from NASA/JPL photographs provide an opportunity for students to view solar system objects such as the Moon (left) and Mars (right) in new ways. By rotating the images, even the polar regions of Mars can be explored. The current limitation for planetary exploration is the lack of topographic data for objects in the solar system.



Cloud Cover and Atmospheric Circulation

Current cloud cover layers can be activated to observe a variety of weather characteristics, including inferred rotational patters around high and low pressure systems which can be identified from internet sources (such as *www.weather.com*) The image below shows the characteristic counterclockwise rotation around a low pressure system off the coast of the pacific northwest.



Sea Surface Temperatures

Current sea surface temperatures can be displayed by accessing the dynamic data layer developed by NOAA. Ocean circulation can be inferred by comparing various locations such as the Gulf Stream, which is a warm water current flowing north along the east coast of North America.

Real-Time Progression of the Sun

The effect of Earth's axial tilt on seasonality can be observed by looking at the north and south poles. The two images below were created at 2:00 PM (EST) March 5, 2006. The Polar Regions can be compared to provide the evidence necessary to understand how Earth's tilt is responsible for Earth's seasonality. For example, in the late winter, the North Pole (left) lies more in shadow than Antarctica (right), creating a shorter duration of northern insolation, resulting in cooler seasonal temperatures. Images such as these can be compared throughout the year.

Summary

- The free Google Earth program provides a unique opportunity and perspective for students to visualize the world, especially for locations that students are unlikely to visit.
- The ability to easily manipulate the program to yield content specific information makes the application useful to all Earth Science classrooms.
- Applications of Google Earth for NY State classrooms will continue as activities focused on the many NYS landscape regions are developed.
- The information and activities displayed here, as well as future work, will be available on the websites of both Eastchester and Fox Lane High Schools.

Student Comments About Google Earth

"...it is visual and, learning visually helps me get a better understanding of the world." - T.R.R, 9th grade

"It's better than looking at a plain old map." G.T., 9th grade

"I like Google Earth so much I downloaded it at home". - G.B., 9th grade

"I think that Google Earth is great. Now, when my teacher tells me about something on the Earth, I can actually see it." R.A., 9th grade