

Tuesday, December 13

10:00 – 11:30 ***Images of a Changing Planet: Using Remote Sensing Data and Images to Investigate Land Surface Changes*** – Dr. John Bailey (Google Geo Education), Dr. Ed Robeck (American Geosciences Institute, Center for Geoscience and Society), Peder Nelson (Oregon State University), Aida Awad (Einstein Distinguished Educator Fellow, Department of Energy), and Dr. Susan Sullivan (University of Colorado).

Team Bios for Images of a Changing Planet: Using Remote Sensing Data and Images to Investigate Land Surface Changes



Aida Awad is an Einstein Distinguished Educator Fellow at the U.S. Department of Energy (DOE) Office of Science. She is certified to teach Geology, Earth Science, Chemistry, Physics, Political Science, Social Science, and World History. Aida was the Science Department Chair at Maine East High School in IL for thirteen years, after teaching Earth Science, Geology, Chemistry and Physics at Maine West High School for nine years. Aida served as an adjunct instructor at Oakton Community College, teaching dual credit Physical Geology courses, and as an adjunct instructor at Aurora University, teaching courses in educational technology integration. She is the Secretary/Treasurer of the National Association of Geoscience Teachers (NAGT), as well as a Past President of the organization. She was a co-convenor of the Summit on the Implementation of the Next Generation Science Standards (NGSS) in the Earth and Space Sciences. Aida received her Bachelor of Science degree in Geological Science from the University of Illinois Chicago, and her Master's degree in Earth and Environmental Sciences from the University of Illinois Chicago. She is a Google for Education Certified Trainer and a Hapara Certified Educator. Aida was recently named as a Fellow of the Geological Society of America.



Dr. John Bailey is a former volcanologist turned Googler. He holds a MPhys in Physics from the University of Kent at Canterbury, along with a MS and PhD in Volcanology & Remote Sensing, from the University of Hawaii. After working a postdoc at the Alaska Volcano Observatory, he then became faculty at the University of Alaska Fairbanks. Finally, after almost two decades in academia, John decided he needed a new challenge and accepted an offer to join the Google Earth Outreach team as Program Manager for Geo Education. John has a passion for travel and exploring new places and landscapes for himself. To date he has visited over fifty countries and every continent. He aims to teach knowledge, understanding, and stewardship of the planet we live on through the use of Google's Geo tools and other innovative technologies.



Peder Nelson is an Instructor in the Geography Program at Oregon State University teaching cartography, geographic information systems, and remote sensing. He uses these tools to research and teach dynamic landscape processes. As a Senior Faculty Research Assistant at Oregon State University, Peder contributes to land cover and land use change research using remote sensing. He has developed an automated visualization and analysis tool for mapping changes in glacier extent using annual 1984 to 2014 satellite imagery. He also contributed significantly to research projects that mapped and analyzed forest and land cover changes using Landsat satellite imagery across the United States, eastern Europe, Russia, Mongolia, and Kazakhstan. He holds a Master of Science degree in Biology-Environmental Education from Southern Oregon University.



Dr. Ed Robeck is Director of Education and Outreach at the American Geosciences Institute (AGI), supporting geoscience education throughout the U.S. and internationally. Ed has worked professionally as an educator at several levels, including as a middle school science teacher and an online teacher professional development facilitator. He has also worked in commercial publishing as a writer, designer, editor, and software developer. He holds a PhD from the University of British Columbia where he studied the socio-cultural context of science education and contributed to the Trends in Mathematics and Science Study (TIMSS). In 2008 Ed became a Fulbright scholar, working with teachers in Malaysia to implement technology-based instructional practices. Prior to joining AGI in 2014, Ed was a science teacher educator at Salisbury University in Maryland for 14 years.



Dr. Susan Sullivan is Director of the Education and Outreach Group at the Cooperative Institute for Research in Environmental Sciences (CIRES), a NOAA joint institute at the University of Colorado Boulder. At CIRES, Susan has focused on climate and environmental science education and professional development for teachers for more than twenty years. She is a past president of the National Association of Geoscience Teachers (NAGT) and a co-convenor of the Summit on the Implementation of the Next Generation Science Standards (NGSS) in the Earth and Space Sciences. In order to support NGSS implementation, Susan coordinates a webinar series for support of NGSS Earth and Space Science as part of her activities with the NGSS-ESS Working Group, and is currently working with the Denver Public Schools to implement NGSS climate science units in the context of resiliency planning. She holds a PhD in atmospheric chemistry from the University of Colorado, Boulder.

Images of a Changing Planet: Using Remote Sensing Data and Images to Investigate Land Surface Changes

Aida Awad, John Bailey, Peder Nelson, Ed Robeck, Susan Sullivan

Participants in this session will need both a **laptop** and **mobile** device in order to fully partake in all activities offered. It is requested that participants download and install the following applications prior to attending the workshop.

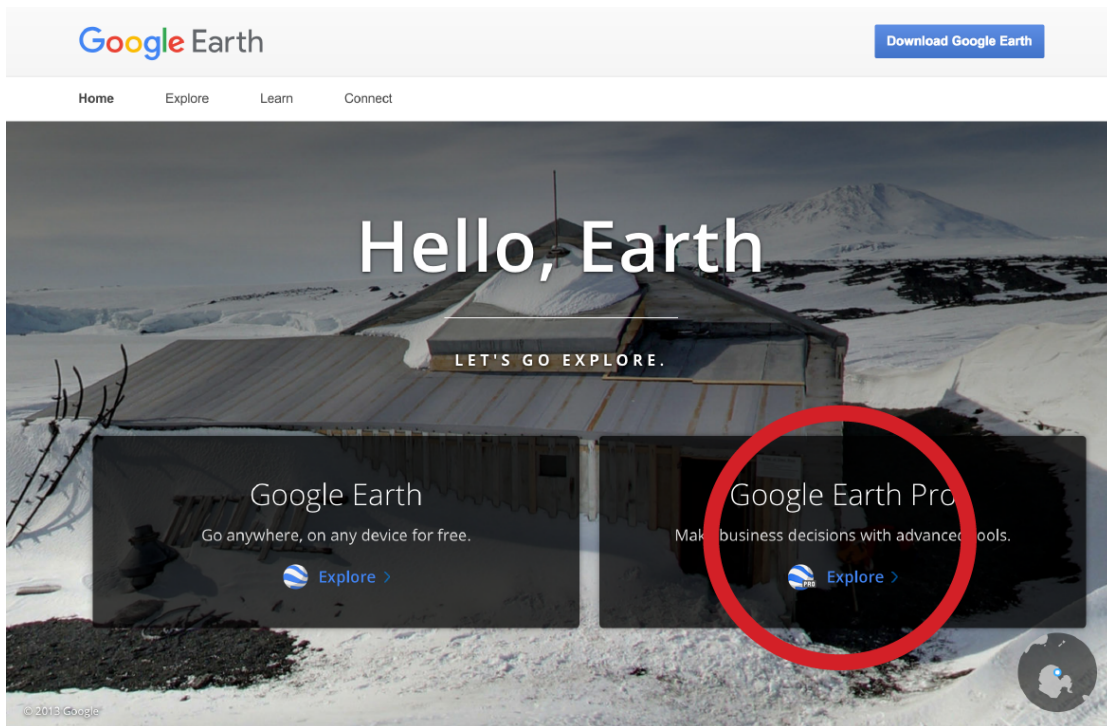
LAPTOP

Google Earth Pro



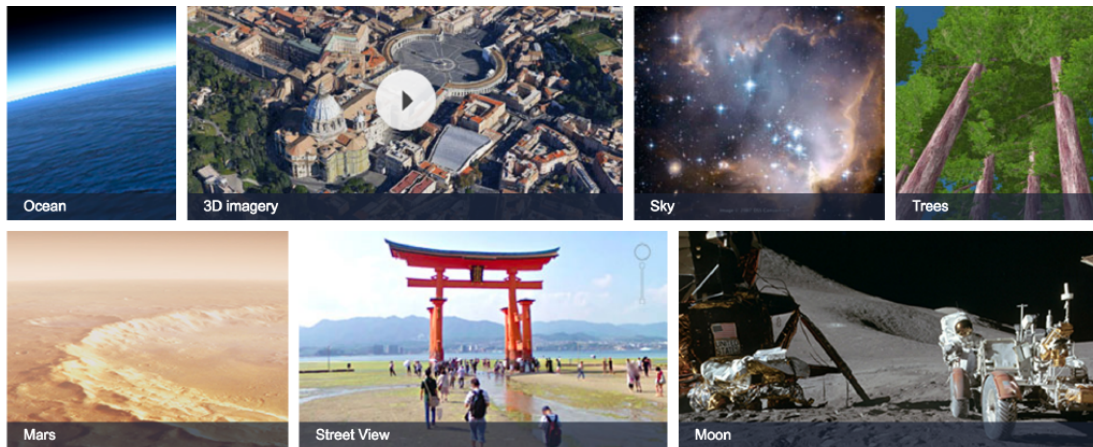
Please note that there are several versions of Google Earth. For this GIFT workshop we will be using Google Earth Pro. To install the correct version follow the instructions below.

- (1) Go to earth.google.com
- (2) At the landing page, click on “Explore” within the Google Earth Pro box (see red circle).



Google Earth Landing Page. Note: Background image changes with each visit

(3) Click on “Download Google Earth Pro” (see red circle). You may need to scroll down to see the blue download button.



Google Earth

Explore the world with Google Earth.

- Explore rich geographical content
- Zoom from outer space to street level
- Search for business locations
- Visualize your GPS tracks and share with others
- Fly around cities (or the entire world) in 3D
- Go back in time with historical imagery
- Dive beneath the surface of the ocean

[Download Google Earth](#)

Google Earth Pro | now free!

Get all the tools in addition to all the easy-to-use features and imagery of Google Earth.

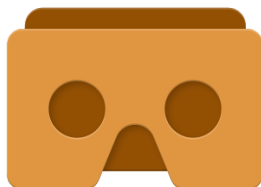
- Compute distances and areas using measurement tools
- Use Movie Maker to produce media collateral
- Print high-resolution images for presentations and reports
- Import large vector image files to quickly map GIS data
- Map addresses with the Spreadsheet Importer

[Download Google Earth Pro](#)

(4) You will be prompted to agree to the terms and conditions, and allow the program to make changes to your computer. If a license key is requested use any email address and “GEPfree” as the password.

MOBILE

Google Cardboard



Search for “Google Cardboard” in the App Store (iPhone) or Google Play (Android). The app will be identified by the icon like the image on the left.

Google Street View



Search for “Google Street View” in the App Store (iPhone) or Google Play (Android). The app will be identified by the icon shown on the left.

Light Meter Apps

You will also find a **light meter app** useful to have on a smartphone, tablet, or iPad. There are several free apps that will work in the App Store (iOS) or Google Play (Android). You only need a numerical light reading, no other features will be used. Two that we recommend are:

Lux Camera (iPhone or iPad)



Lux Meter (Android)



Images of a Changing Planet: Using Remote Sensing Data and Images to Investigate Land Surface Changes

Aida Awad, Einstein Distinguished Educator Fellow, NAGT Past President

John Bailey, Program Manager - Google Geo Education

Peder Nelson, Oregon State University

Ed Robeck, American Geosciences Inst., Director Center for Geoscience & Society

Susan Sullivan, Coop. Inst. for Research in Enviro. Sciences, NAGT Past President





Introduction

Susan Sullivan & Aida Awad



Ed



Susan



John



Aida



Peder

Using storylines to bundle PEs, CCCs, & practices

- Remote sensing data provide opportunities to explore land cover and land use changes. Tools like **Google Earth, Street View and Expeditions** are tools we can use to explore the Earth, make measurements, and predictions based on observations.
- Using the tools and approaches teachers can design learning opportunities for their students that help them focus on the following **NGSS big storylines, science and engineering practices**, and crosscutting concepts.
- Qualitative and quantitative data may be collected and analyzed leading to the **development of models explaining how processes change Earth's surface over time** and spatial scales, and create feedbacks that impact other systems.

NGSS: DCIs, CCCs & Practices

- Metacognition encouraged!
- Using the matrix to document your thinking

Crosscutting Concepts	Science & Engineering Practices	Disciplinary Core Ideas
Patterns	Asking questions	ESS2: Earth's Systems
Cause and effect	Developing/using models	Change over time
Scale, proportion, and quantity	Planning/carrying out investigations	Earth materials & systems Roles of water in surface processes Weather and climate
Systems and system models	Analyzing/interpreting data	ESS3: Earth and human activity
Energy and matter	Using math and computational thinking	Human interactions with Earth Human impacts on Earth systems
Structure and function	Constructing explanations	Climate change
Stability and change	Engaging in argument from evidence	Natural hazards
	Obtaining, evaluating, communicating information	

Workshop Agenda

- Introductions to us & workshop
- Simulating satellite-based remote sensing using smart devices
- Investigating land surface cover through satellite imagery
- Enhancing investigations with Google Street View and Expeditions
- Wrap-up



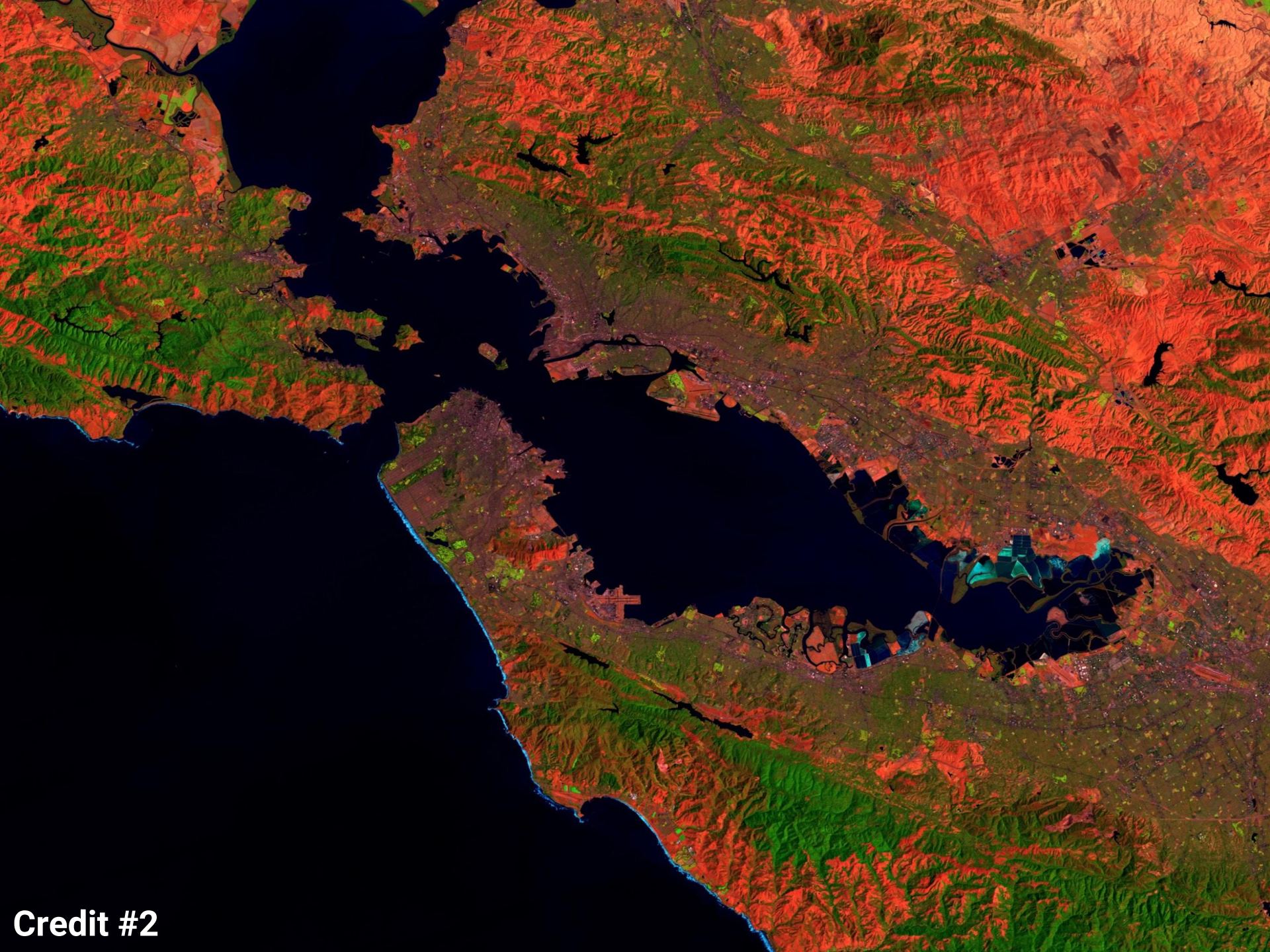
Simulating Remote Sensing

Ed Robeck

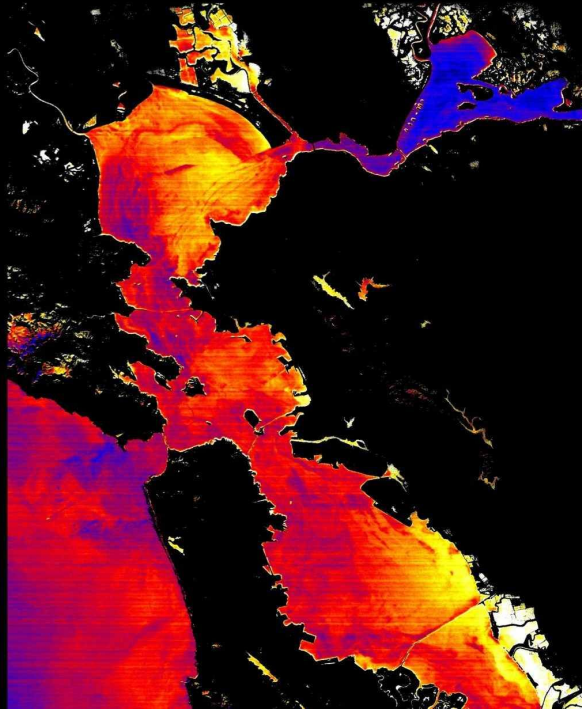
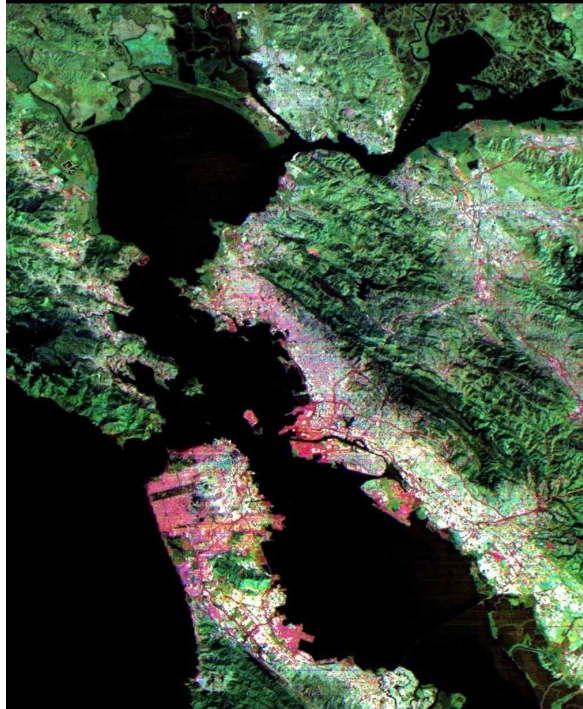
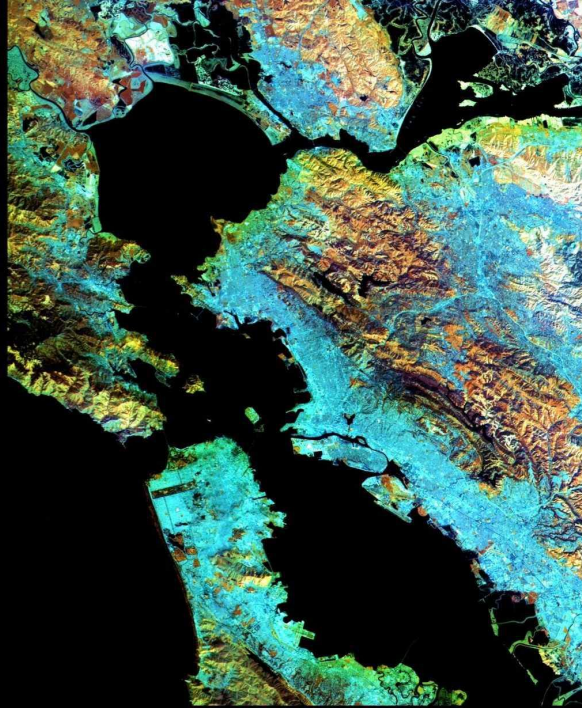




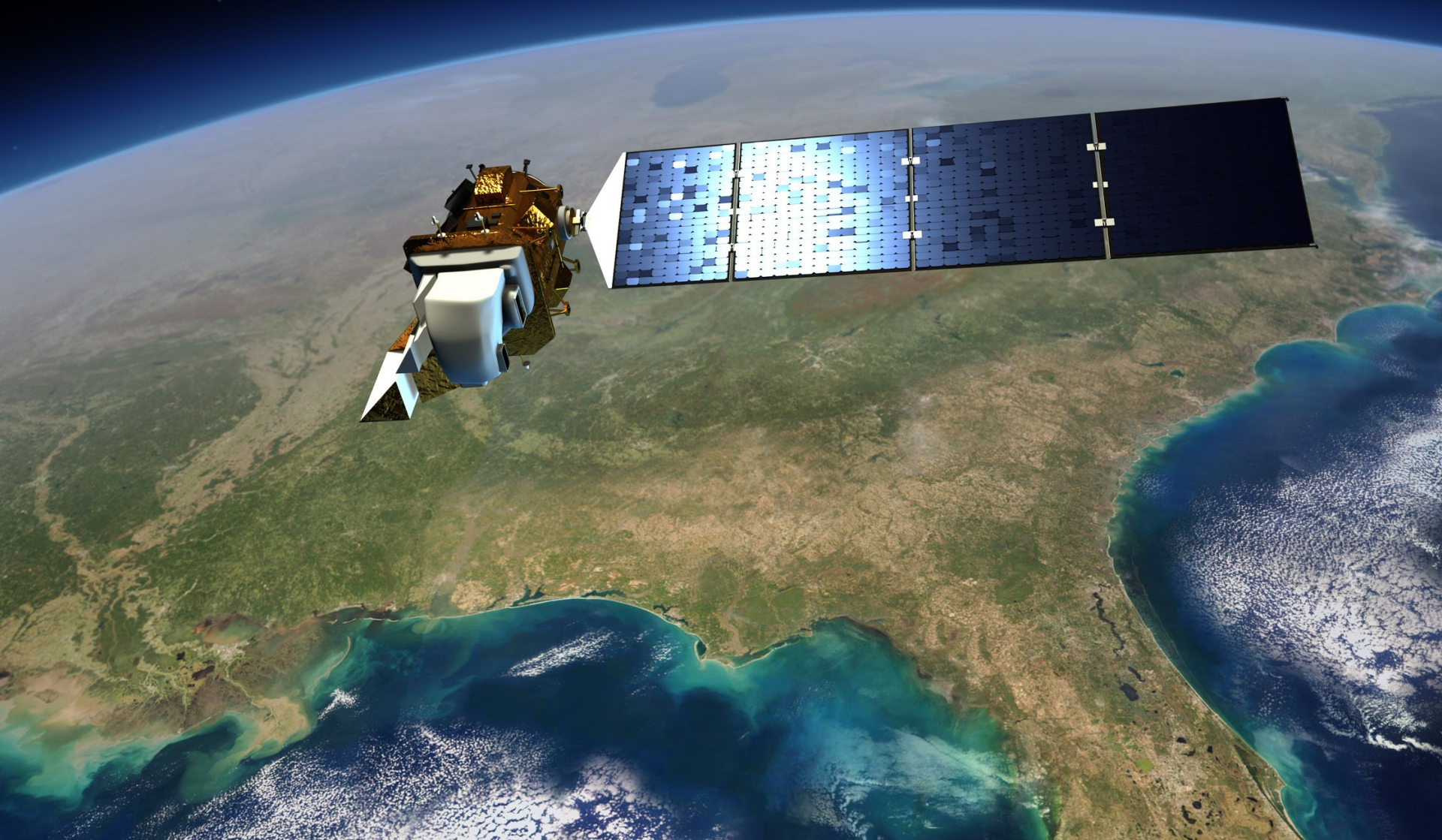
Credit #1



Credit #2

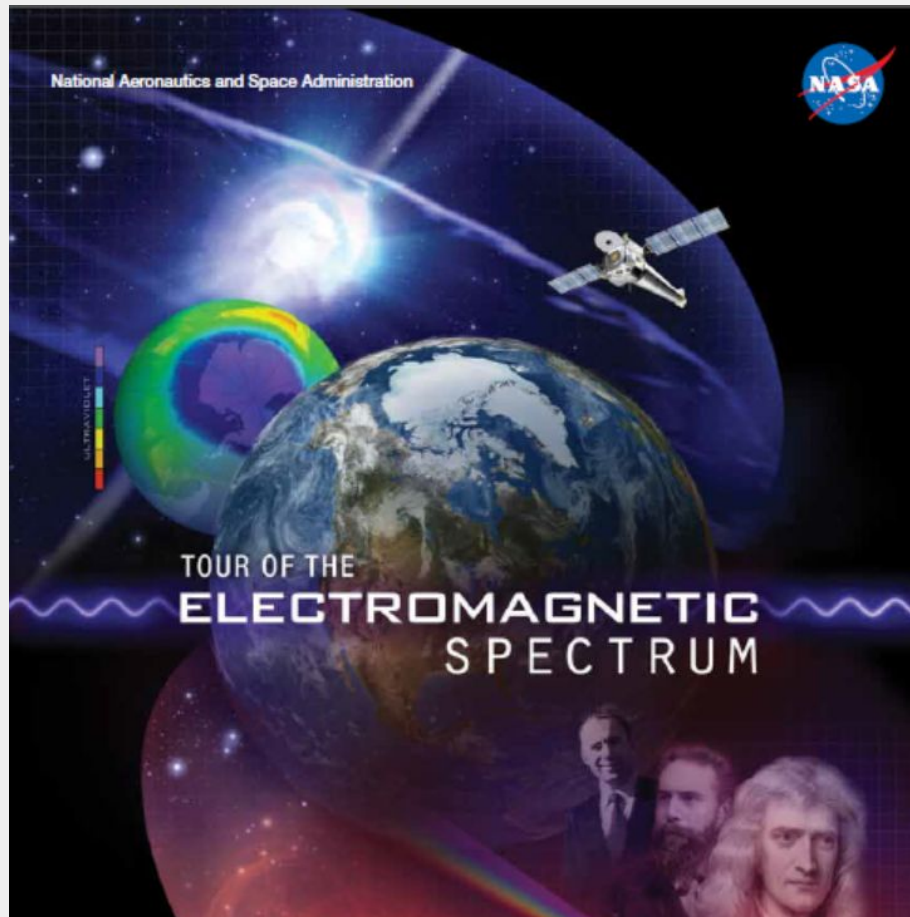


Credit #4



Satellite-based Remote Sensing

Simulating Satellite-based Remote Sensing



<https://science.nasa.gov/ems>

Activity: Exploring Remote Sensing

ACTIVITY

EXPLORING REMOTE SENSING

This lesson simulates the process of remote sensing using surface materials of different colors to represent different ground coverings on Earth. Light meters are used as an analog for satellite instruments to record data from surfaces representing the different ground coverings. The lesson will help students understand the role of satellites in remote sensing. Instructors can introduce the concept of albedo, which is the percentage of the Sun's radiation that reflects from different surfaces on Earth. Albedo is an important component of Earth's radiation budget (see pp. 26–27).

LEVEL: Grades 5–9

CONNECTIONS TO THE NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Idea PS4.B: Electromagnetic Radiation. When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.

MATERIALS

- Paper or fabric of different colors (about 6–10) to simulate ground coverings on Earth, including at least one each of a light-tone/white surface, a dark-tone/black surface, and a medium-tone/gray surface. Any patterns should be small and even across the surface, such as a calico print with small flowers.

A MASSIVE WINTER STORM SYSTEM dropped 20 to 30 inches (50 to 70 centimeters) of snow from Tennessee and Georgia to Massachusetts from January 22 to 24, 2016. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite captured a broad view of the eastern United States at 1:30 p.m. EST on January 24, 2016. Image from <http://earthobservatory.nasa.gov/ACTD/view.php?id=87285>



- Light meters (or an iOS/Android device with a lux meter app).
- Meter sticks.
- Copies of this booklet printed for students, loaded onto a mobile device, or projected in the classroom. A PDF is available at <http://science.nasa.gov/ems>.
- Access to an outdoor area with several types of ground cover (e.g., asphalt, grass, bare dirt) (optional).

SET UP

- Place the surface materials in locations around the room. (If outdoors, identify a space that has several types of ground cover.)
- Divide the students into groups and provide each group with a light meter and a meter stick.

ENGAGE

Show students the satellite image of the eastern United States after a snowstorm. Ask them what they observe on the image (e.g., cloud cover, coastlines) and record their answers. Ask what can be inferred (e.g., lack of clouds over an area suggests a sunny sky there) or what they aren't sure of regarding what the image shows (e.g., whether white-colored areas are clouds or snow). Have students record their answers. Invite students to select one or two satellite images from this booklet and ask the same questions. Ask students to share their answers and discuss what kinds of information we get from these remotely sensed images.

EXPLORE

Demonstrate to students how to use the light meter with the meter stick as a guide for height. Have students design a method for collecting, analyzing, and communicating their data. Have them determine the parameters to include in their science journal entries (e.g., headings, data, methods, predictions, conclusions). They can include predictions on the reflectance of various materials and compare those to measurements.

EXPLAIN

Ask students to communicate group results. Did they notice any patterns? How did the values differ between surfaces? What happened to the light as it interacted with different surfaces? Can they explain any differences in the light measurements? How did they decide on the height at which they held the light meter to make measurements? This process will help make student thinking discernible so both they and the teacher can assess understanding.

Discuss how these measurements are like those of passive remote sensing instruments on satellites (e.g., the light meter collects light that reflects off the surface while some light is absorbed—see pp. 12–13). Discuss how light meters are unlike satellite instruments. For example, light meters used in this activity measure light in the entire visible range of the electromagnetic spectrum (see pp. 2–3), while most satellites collect data at specific regions—sometimes called bands—of the visible spectrum as well as parts of the spectrum beyond visible light (see the back cover).

EVALUATE

A simple rubric could be created from the steps above. Did students collect and record all the parameters that would influence their data (e.g., light source, height of measurement)? Did they recognize patterns? Did they collect enough data?

Gaining insight into students' thinking is a good way to scaffold student learning and monitor their progress. Have each student draw and label a diagram (visual model) of how satellites and/or the light meters detect electromagnetic energy. Encourage students to include on their diagrams features such as the radiation source, the interaction between the radiation and the surface (i.e., whether the radiation is reflected, absorbed, or scattered), and the detector (e.g., the light meter or a satellite instrument). Have students share their diagrams with others in order to refine their thinking.

EXTEND

The measurements in this activity correspond to the amount of visible light being reflected from the surface and detected by the meter. The percentage of how much of the Sun's radiation (light) that hits a surface is reflected without being absorbed is called albedo. Albedo is an important component of Earth's radiation budget (see pp. 26–27). Snow, for example, has a high albedo, meaning that it reflects a lot of the radiation that strikes it.

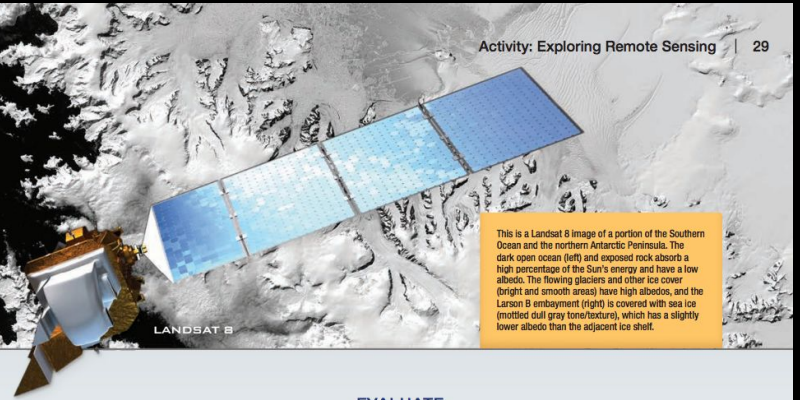
Observe the sea ice image on the top of page 13. In their science journals, ask students which has a higher albedo: ice or open ocean? (Ice.) As sea ice melts, what happens to the albedo of the Arctic? Will it increase or decrease? (Decrease.) What happens when the Sun's energy is absorbed by a surface? (It heats up.) What happens as sea ice melts? (The newly exposed water reflects less and absorbs more of the Sun's energy. This causes the water to warm and melt more ice.) This phenomenon is called the ice-albedo feedback effect. As the surface ice and the sea ice melt, the overall surface albedo lowers, causing more energy to be absorbed and continuing in a cycle, thus creating a positive feedback loop.

ADDITIONAL RESOURCES

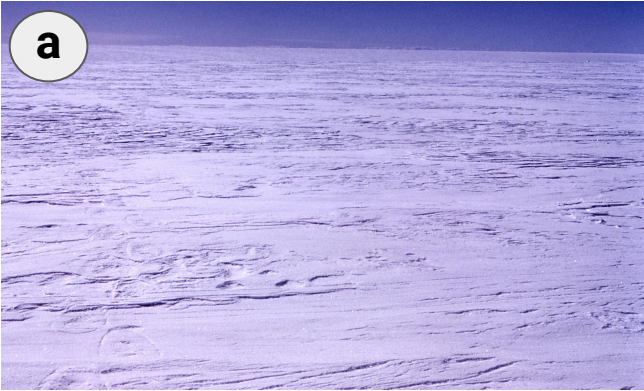
"Ice Albedo: Bright White Reflects Light" is a short animation (~30 seconds) that illustrates the albedo concept: <http://go.usa.gov/cShKA>

"Daisy World" is a short video (~4 minutes) that demonstrates the albedo feedback loop using black and white daisies: <http://go.usa.gov/cShKm>

This is a Landsat 8 image of a portion of the Southern Ocean and the northern Antarctic Peninsula. The dark open ocean (left) and exposed rock absorb a high percentage of the Sun's energy and have a low albedo. The flowing glaciers and other ice cover (bright and smooth areas) have high albedos, and the Larsen B embayment (right) is covered with sea ice (mottled dull gray tone/texture), which has a slightly lower albedo than the adjacent ice shelf.



Sequence these images by predicted reading (1=low, 6=high)



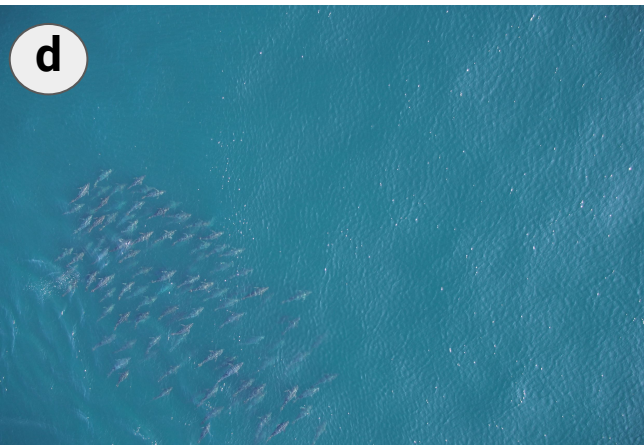
Glacier
Yellowstone Photo Collection



Volcanic Landscape
NASA Earth Observatory



Mangrove Forest
SOFIA



Open Ocean
Northeast Fisheries Science Center



Desert Rivers
Earth Science World Image Bank
(image h4vfel: (c) Bruce Molnia)



Trees and Eroded Soil
Land Cover Assessment

An aerial grayscale satellite image of a rural landscape. The image shows a patchwork of agricultural fields, some of which are rectangular and others irregular. A prominent feature is a large, dark, textured area that appears to be a forest or a dense thicket of trees, located in the upper right and lower right portions of the frame. The overall scene is a typical agricultural landscape with varying shades of gray representing different land uses and vegetation.

Visualizing Remote Sensing Imagery Using Google Earth

Peder Nelson

Motivations

- What is the need for Earth observing satellites?
- What do they show us?
- What could your classroom contribute to the science of long term ecological monitoring?
- How can you use technology to teach NGSS using remote sensing and virtual reality?

We will highlight how to use satellite imagery and virtual reality field trips in support of NGSS

HS-PS4-3 Waves and their Applications in Technologies for Information Transfer

Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

MS-ESS3-3 Earth and Human Activity

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

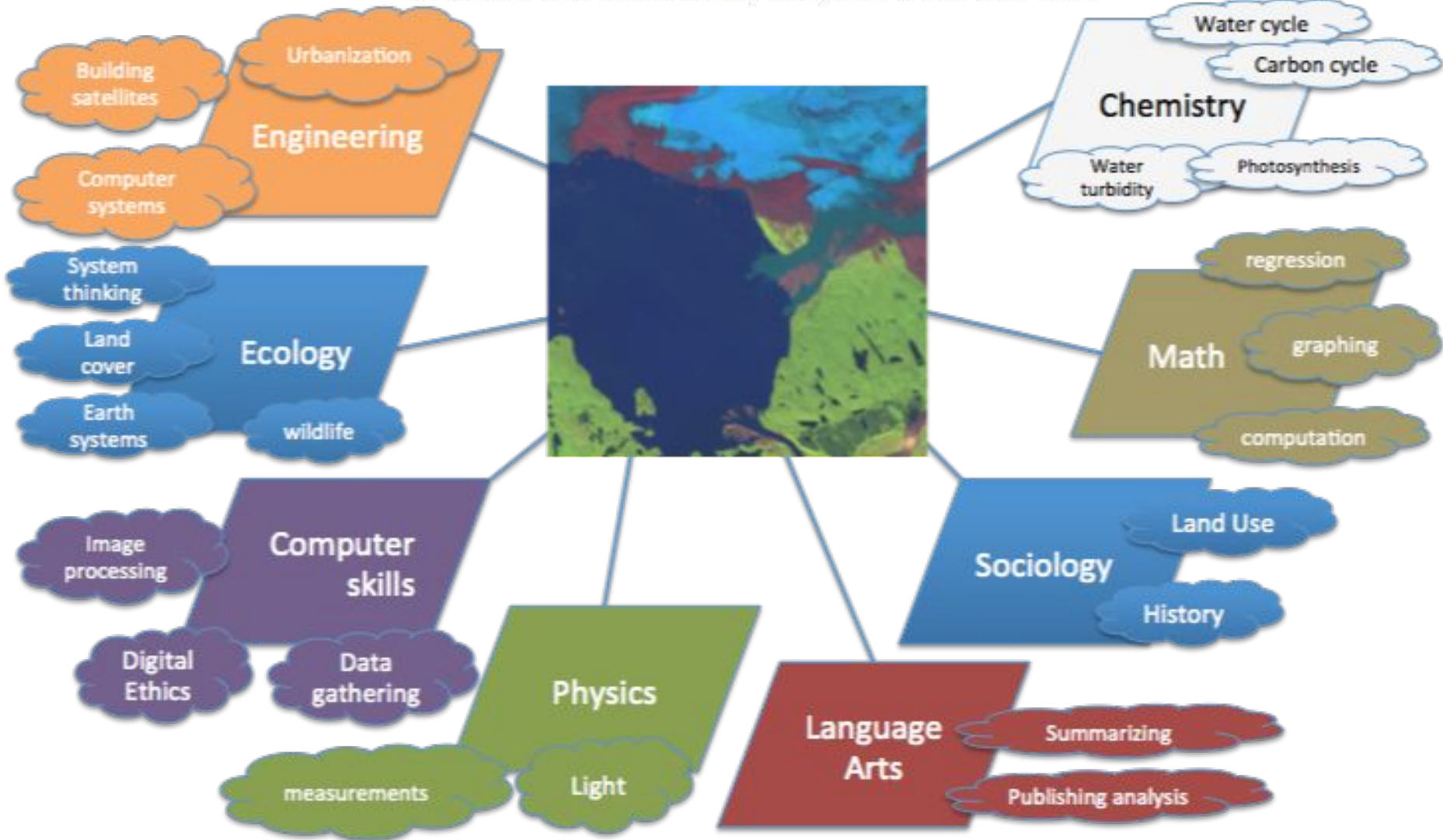
HS-ESS3-6 Earth and Human Activity

Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

MS-ESS3-5 Earth and Human Activity

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Students can learn many subjects from this data





Washington

Oregon

V Search

Search

ex: 15213

Get Directions History

Places

Layers Earth Gallery >>

- Primary Database
- Voyager New!
- Borders and Labels
- Places
- Photos
 - Panoramio
 - 360 Cities
- Roads
- 3D Buildings
- Ocean
- Weather
- Gallery
- Global Awareness
- More
- Terrain



- Visualize satellite images
- View data
- Create data
- Make measurements
- Tell a story

© 2016 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
US Dept of State Geographer

Google Earth

eye alt 4989.77 mi

Tour Guide

▼ Search Search

ex: NYC

[Get Directions](#) [History](#)

► Places

▼ Layers [Earth Gallery >>](#)

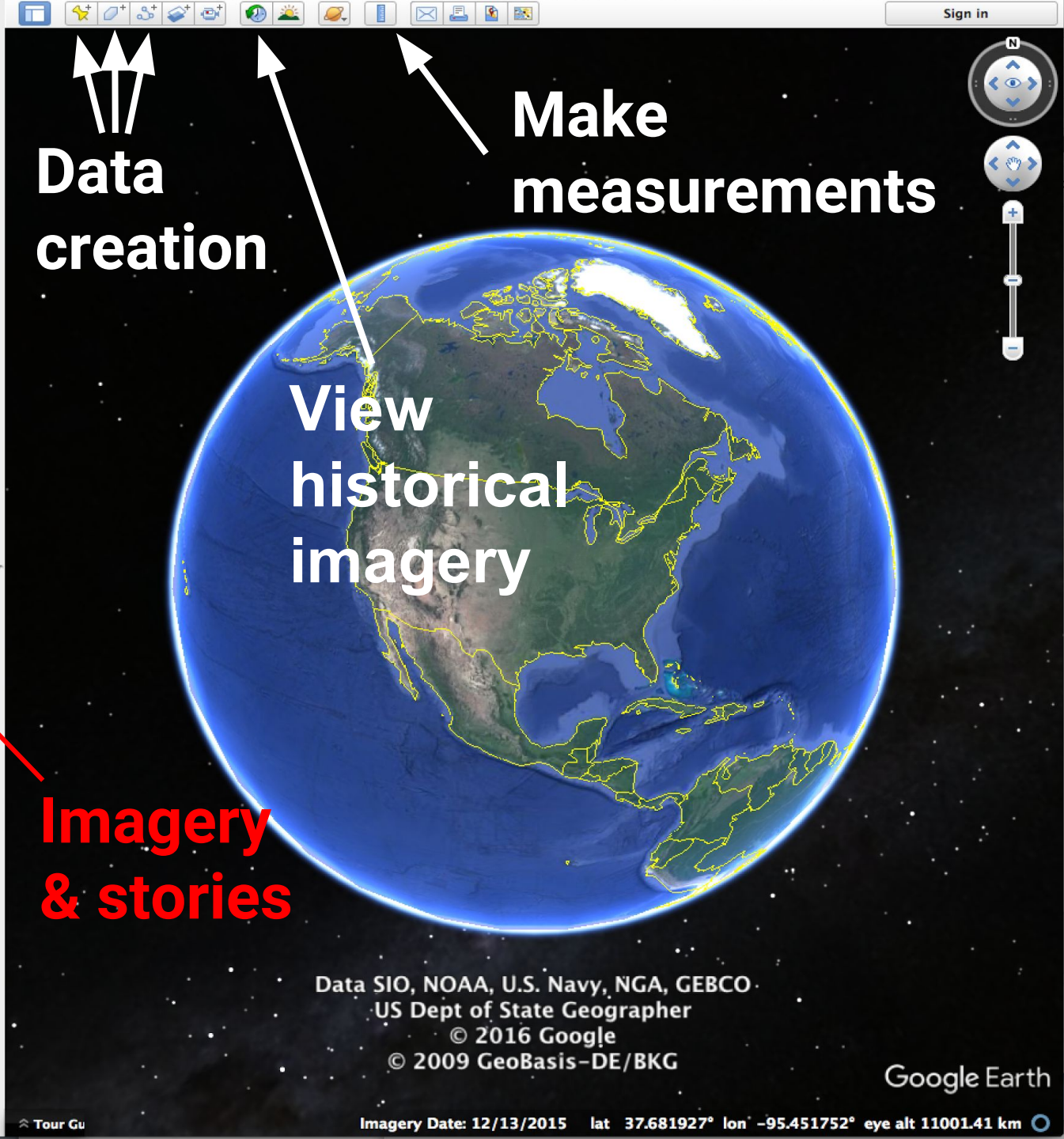
- Primary Database
 - Voyager
 - Borders and Labels
 - Places
 - Photos
 - Roads
 - 3D Buildings
 - Ocean
 - Weather
 - Gallery
 - Global Awareness
 - Appalachian Mountaintop Removal
 - ARKive: Endangered Species
 - Earthwatch Expeditions
 - Fair Trade Certified
 - Global Heritage Fund
 - Greenpeace
 - Jane Goodall's Gombe Chimpanzee Blog
 - The Earth from Above with GoodPlanet
 - The Elders: Every Human Has Rights
 - UNDP: Millennium Development Goals Monitor
 - UNEP: Atlas of Our Changing Environment**
 - Unicef: Water and Sanitation
 - USHMM: World is Witness
 - USHMM: Crisis in Darfur
 - WaterAid
 - WWF Conservation Projects
 - More

Data creation

Make measurements

View historical imagery

Imagery & stories



Data SIO, NOAA, U.S. Navy, NGA, GEBCO ·
US Dept of State Geographer
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Google Earth

Use Google Earth to study and document land cover and land use changes



NLCD National Land Cover Dataset

- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only

- Data Unit: type
- 11-Open Water
 - 12-Perennial Ice/Snow
 - 21-Low Intensity Residential
 - 22-High Intensity Residential
 - 23-Commercial/Industrial/Transportation
 - 31-Bare Rock/Sand/Clay
 - 32-Quarries/Strip Mines/Gravel Pits
 - 33-Transitional
 - 41-Deciduous Forest
 - 42-Evergreen Forest
 - 43-Mixed Forest
 - 51-Shrubland
 - 61-Orchards/Vineyards/Other
 - 71-Grassland/Herbaceous
 - 81-Pasture/Hay
 - 82-Row Crops
 - 83-Small Grains
 - 84-Fallow
 - 85-Urban/Recreational Grasses
 - 91-Woody Wetlands
 - 92-Emergent Herbaceous Wetland

Landcover questions

We will use this form to help us identify and keep track of the labels for these plot points.

Complete label classification definitions can be found at the following website - http://www.mrlc.gov/nlcd11_leg.php

What is the label for 45.00565, -92.8564



- Developed - area with a mixture of constructed materials and vegetation.
- Forest - area dominated by trees
- Grass - generally greater than 80% of total vegetation
- Open Water - areas of open water, generally with less than 25% cover of vegetation or soil



bit.ly/landcoverqus

Search south cascade glacier Search

ex: 15213 Get Directions History

South Cascade Glacier

Places

Layers Earth Gallery

- Primary Database
- Voyager New!
- Borders and Labels
- Places
- Photos
- Panoramio
- 360 Cities
- Roads
- 3D Buildings
- Ocean
- Weather
- Gallery
- Global Awareness
- More
- Terrain



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White Rock Lakes

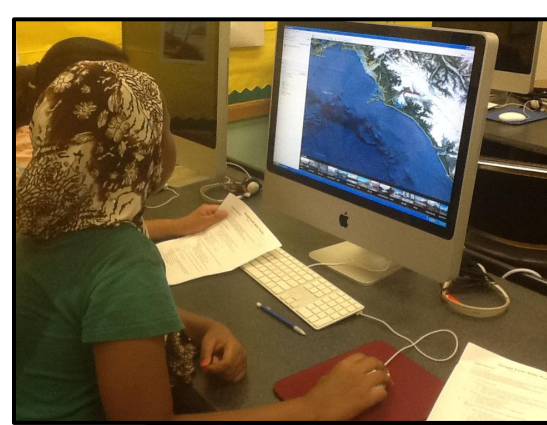
Le Conte Lake

South Cascade Lake

South Cascade Glacier

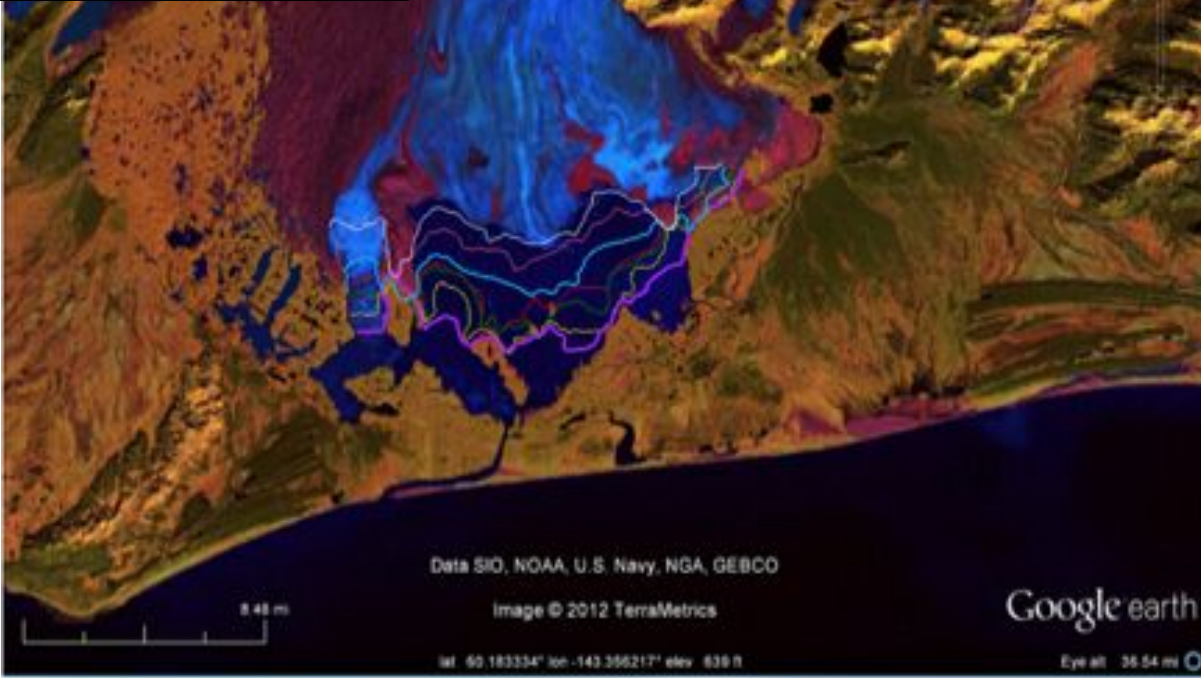
Drag to enter Street View

Google Earth



← Create points, lines, polygons to track changes

Credit #7



Use tools to measure length, area →

predict, measure, summarize

Examples of adding more context to the satellite images

Performance Task:

Graph SWE using SNOTEL sites

SWEet! Oregon's Snowpack and Water Supply



Where do YOU get your water? What are the characteristics of Oregon's snowpack and how have they changed over time? In this activity we will be looking at current and past snow data and the affects it can have on our local economy.

SNOTEL-
The Natural Resources Conservation Service (NRCS) operates and maintains an automated system (SNOWpack TELEmetry or **SNOTEL**) designed to collect snowpack and related climatic data in the Western United States and Alaska and to develop accurate and reliable water supply forecasts. For over 30 years **SNOTEL** sites in Oregon and the west have collected data on snow depth and **SWE** (snow water equivalent). We will use yearly SWE data to look for changes and to relate our snowpack to Oregon's Economy.

A. Using the data in the table, graph the SWE for your site over time (1980-2012).

B. Analyze your results:
1-What trend do you see on the graph?

2-Compare your graph with another group and discuss your observations.

3-After your discussions what do you think the possible effects will be of less snow in Oregon? Who/What could be effected? How might they be effected?

4-What questions do you still have? List 1+.

Water Year	Maximum Yearly SWE (measured in inches)		
	Summit Lake 5610 ft.	Hogg Pass 4790 ft.	Santiam Jct. 3740 ft.
1980		30.1	10.1
1981		17.8	4.3
1982	56.3	61.8	37.1
1983	50.5	31.3	17.8
1984	63.5	46.6	18.3
1985	48.1	48.8	32.7
1986	42.8	39.4	18.5
1987	37.8	38.8	18.5
1988	33.9	37.4	15
1989	58	56	29.6
1990	30.1	31.5	18.7
1991	35	31.5	10.4
1992	26	19.8	4.7
1993	59.8	48.1	25.3
1994	25.1	29.2	12.8
1995	44.8	42.6	18.8
1996	39.4	48.8	14.1
1997	49.8	52.1	21.7
1998	39.4	37.2	13.2
1999	69.7	68.5	37.2
2000	40.7	45.5	20.7
2001	27.1	24	8.5
2002	48.6	54	26.2
2003	35.4	27	7.2
2004	49.6	32.5	17.8
2005	29.5	10.6	4.1
2006	53.1	40.2	19.7
2007	42	22.4	12.7
2008	55.3	50.3	38.4
2009	43.9	29.9	21.1
2010	42.1	25	5.4
2011	54.5	31	24.7
2012	43	33.2	20.1

Credit #8, #9

Performance Task:

Glacier mass balance graphing

The Big Melt? Glaciers and Mass Balance



Are glaciers really melting? As our climate changes there appear to be changes to the glaciers around the world. In this activity we will be looking at past and current glacial data from North America and discussing the possible implications for the future.

Glacial Mass Balance

For over 50 years scientists from around the world have studied changes in glaciers. This long period of observation and data provide us with the opportunity to look at glaciers more closely. A **glacier** is a large, slow moving body of ice that over the years has accumulated ice from snowfall. On glaciers around the world the amount of snow and ice that is added to a glacier, snow and ice **inputs**, and the amount of snow and ice that melts and runs off as water, the **outputs**, are measured. Using this data we can determine the yearly **net mass balance**, or the net increase or decrease, of the glacier. This can tell us whether the glacier is shrinking or growing year by year.

A. Using the data to the right, calculate the **net mass balance** of the glacier for each year by **ADDING** the Summer water outputs to the Winter snow inputs (1980-2011).

B. Graphing: Create a line graph of the mass balance for your glacier over time.

C. Analyze your results:
1-Look at your graph. Explain what the data says is happening to this glacier over time. What evidence do you have to support this answer?

2-Create a figure map showing the location of the glacier. On this map, use points, lines, or polygons to show this change over time.

Credit #10

South Cascade Glacier, Washington
(measurements are in meters water equivalent)

Balance Year	Winter Snow Inputs	Summer Water Outputs	Net Mass Balance (+/-)
1980	1.83	-2.85	
1981	2.28	-3.12	
1982	3.11	-3.03	
1983	1.91	-2.68	
1984	2.38	-2.26	
1985	2.18	-3.38	
1986	2.45	-3.06	
1987	2.04	-4.10	
1988	2.44	-3.78	
1989	2.43	-3.34	
1990	2.60	-2.71	
1991	3.54	-3.47	
1992	1.91	-3.92	
1993	1.98	-3.21	
1994	2.39	-3.99	
1995	2.86	-3.55	
1996	2.94	-2.84	
1997	3.71	-3.08	
1998	2.76	-4.62	
1999	3.59	-2.57	
2000	3.32	-2.94	
2001	1.90	-3.47	
2002	4.02	-3.47	
2003	2.66	-4.76	
2004	2.08	-3.73	
2005	1.97	-4.42	
2006	2.61	-4.19	
2007	3.41	-3.61	
2008	3.22	-3.51	
2009	3.12	-4.98	
2010	2.54	-3.35	
2011	3.81	-2.60	

Contribute ground observations for long term ecological research



An aerial, grayscale photograph of a city grid, showing a dense pattern of streets and buildings. The image is used as a background for the title text.

Enhancing Investigations with Google Street View & Expeditions

John Bailey

Street View



- Launched in 75+ countries
- Driven over 7 million miles
- 1000s of Special Collects







Tengboche Monastery

See inside - Feb 2013





Street View Trolley

When a group of art-loving Googlers wanted to take Street View technology to museums around the world, we needed to develop a system that could easily fit through museum doorways and navigate around sculptures. We worked to fit all of the equipment on an even smaller frame: a push-cart lovingly dubbed the Trolley. The Trolley has captured hundreds of complex interior locations all over the world, including over 40,000+ pieces of art in 200 museums across 40 countries as part of the Google Art Project.













Heron Island



Pause

turtles' nests determines the gender of turtle hatchlings—warmer for females and cooler for males.



School of Fish

Look at how many fish are traveling in this school!



Living Dinosaurs

Turtles are often called the ancient mariners of the sea. They've been swimming our oceans for over 150 million years, first appearing in the age of the dinosaurs.



Nesting

All turtles make incredibly long migrations from their feeding grounds to their breeding grounds. Male turtles never leave the ocean. Instead female turtles will return to the beach where they were born to lay their eggs in the sand.

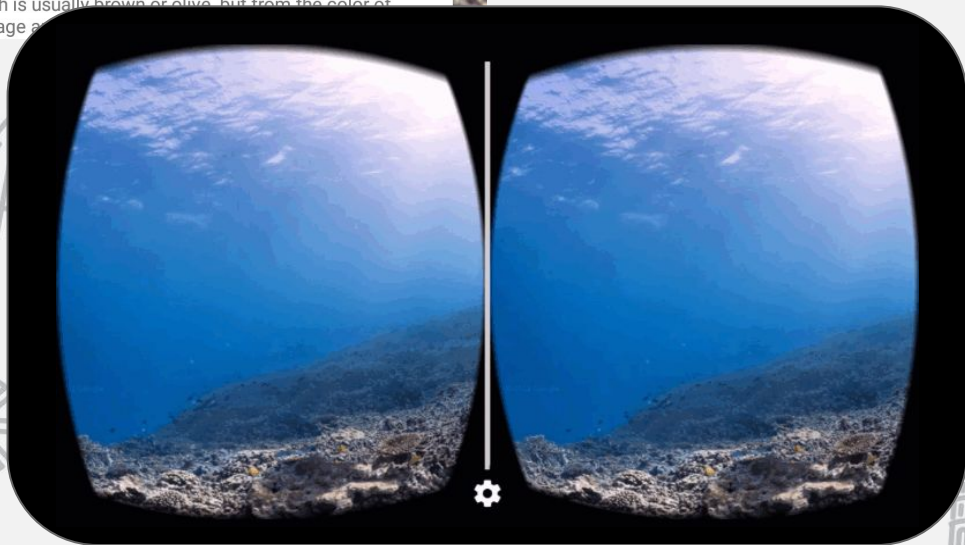


Green Turtle

Green turtles like these are the most abundant of all the Great Barrier Reef's turtle species. Their name comes not from their shell, which is usually brown or olive, but from the color of their cartilage.

Explorer (Student View)

Guide (Teacher View)





EXPEDITIONS INCUBATOR KEY DESIGN CONSIDERATIONS

EXPLORE HAWAII'S BEAUTY & HERITAGE



Google Expeditions



www.moonshotincubator.com/expedition

S

Street View

sheep



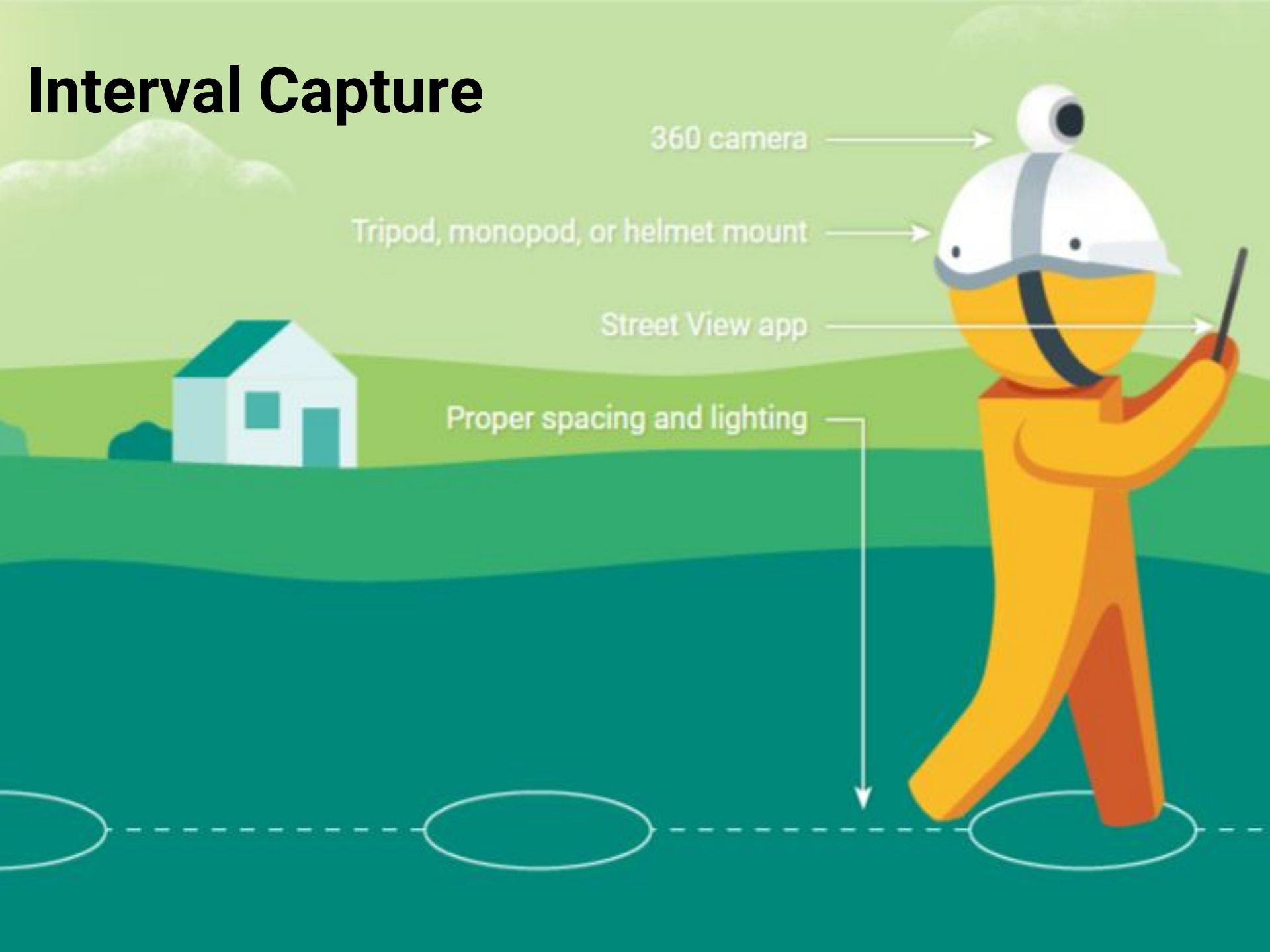


**Ricoh
Theta-S**



**Samsung
Gear 360**

Interval Capture



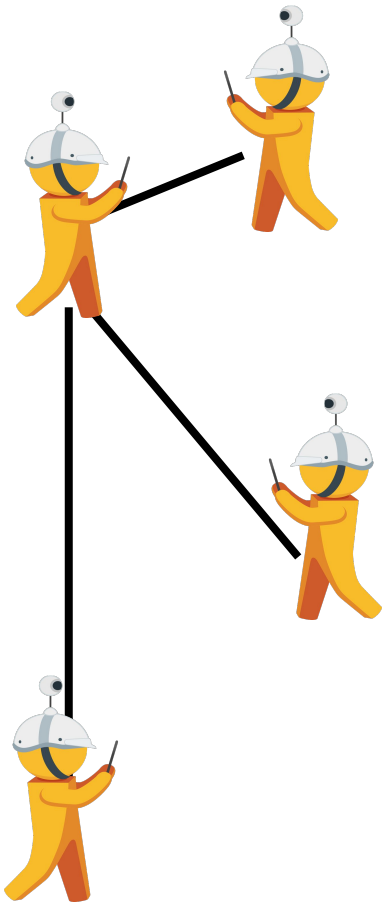
360 camera

Tripod, monopod, or helmet mount

Street View app

Proper spacing and lighting

Inter-connecting



← Connect 360 photos

7:53

```
graph TD; 1 --- 3; 3 --- 6; 1 --- 2; 3 --- 2; 6 --- 2; 2 --- 7; 2 --- 5; 7 --- 5; 5 --- 8; 8 --- 4;
```

Google

©2016 Google

W NW N NE E

A 360-degree panoramic view of the interior of a space station. The view shows various pieces of equipment, cables, and structural elements. A circular overlay with the number 3 is centered on the view. The view is divided into sections labeled W, NW, N, NE, and E.

Blurring



TOOLS OF THE TRADE

Choose the camera and accessories that best suit your needs — or [apply to borrow](#) a Street View camera.



RICOH THETA S

- Exceptional quality
- A new 360 photo every 8 seconds
- 1.25 hours of continuous use
- \$350

[See example image](#)
[Learn more and order](#)



SAMSUNG GEAR 360

- Swappable batteries and memory
- A new 360 photo every 8 seconds
- 2 hours of use per battery
- \$350

[See example image](#)
[Learn more](#)



GOOGLE TREKKER

- The same camera Google uses
- Captures constantly
- Lasts all day
- Available for loan

[See example image](#)
[Borrow a Trekker](#)

google.com/streetview/publish



Wrap Up

Aida Awad & Susan Sullivan

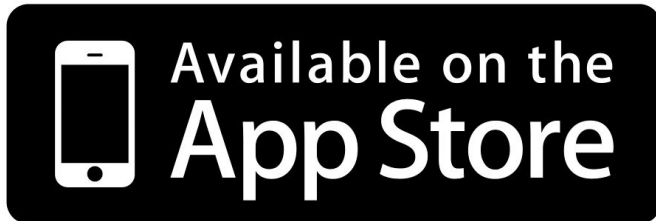
Small group processing:

- Which CCCs, practices, DCIs did we address throughout the course of the activities?
- At your table, how did your perceptions of what we addressed differ?



Downloads

Download the **Lux** Apps



iOS - Lux Camera

By Tu Anh Do

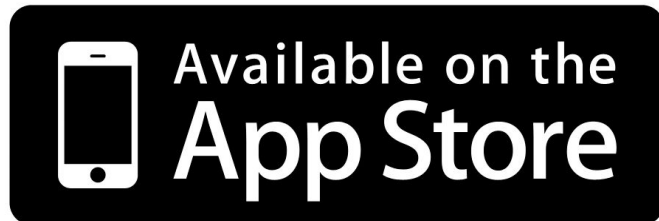


Android - Lux Meter

By KHTSXR



Download the **Street View** App



An aerial topographic map of a mountainous region, overlaid with a teal color filter. The terrain is characterized by a complex network of ridges and valleys, with a prominent river system winding through the landscape. The word "Resources" is centered in the image in a white, bold, sans-serif font.

Resources

Image & Data Credits

- #1 https://commons.wikimedia.org/wiki/File:SF_Bay_area_USGS.jpg
- #2 <https://svs.gsfc.nasa.gov/vis/a000000/a000800/a000876/index.html>
- #3 <http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA02605>
- #4 https://www.nasa.gov/sites/default/files/578319main_20110809-ldcm-lrg.jpeg
- #5
 - (a) <https://www.nps.gov/features/yell/slidefile/geology/glacial/Outside%20Yellowstone%20Park/Page.htm>
 - (b) <http://earthobservatory.nasa.gov/IOTD/view.php?id=43859&eocn=image&eoci=moreiotd>
 - (c) http://sofia.usgs.gov/projects/gcc_impacts/photogallery.html
 - (d) <http://nefsc.noaa.gov/rcb/photogallery/pelagic.html>
 - (e) [http://www.earthscienceworld.org/images/search/results.html?Category=\\$Category&Continent=\\$Continent&ImageID=h4vfe](http://www.earthscienceworld.org/images/search/results.html?Category=$Category&Continent=$Continent&ImageID=h4vfe)
 - (f) <http://lca.usgs.gov/lca/theme5task7/results.php>
- #6 http://www.mrlc.gov/nlcd11_leg.php
- #7 <http://onrep.forestry.oregonstate.edu/authentic-science-activities>
- #8 <http://www.wcc.nrcs.usda.gov/snotel/earth/>
- #9 <http://www.nohrsc.noaa.gov/earth/>
- #10 <http://onrep.forestry.oregonstate.edu/authentic-science-activities>

Resources: Google Earth Education

Google Expeditions

Homepage: <https://www.google.com/expeditions/>

Google Help Pages: <https://support.google.com/edu/expeditions>

How to [create a kit](#) and [run Expeditions tours](#)

Google Street View

Street View Galleries: <https://www.google.com/streetview/>





Learn about Street View: <https://www.google.com/streetview/publish/>

Other Presentation Links:

Sheep View: <http://visitfaroeislands.com/sheepview360/>

Expeditions in Hawaii: <http://www.moonshotincubator.com/expeditions/>

Resources: AGI Education

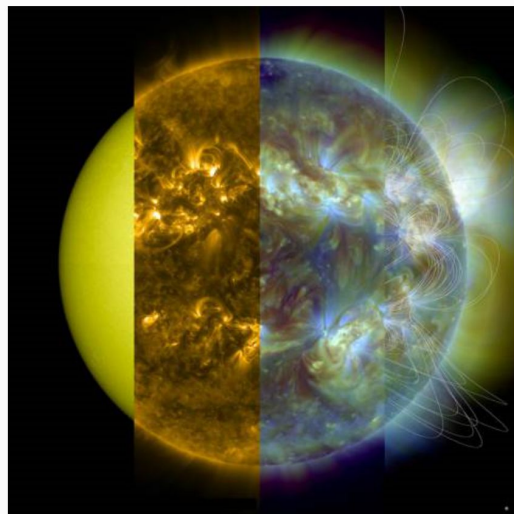
	<p><u>Earth Science Week</u> Discover the resources offered through this international event, organized by AGI each October to promote better understanding and appreciation of Earth science and encourage stewardship of the planet. http://www.earthsciweek.org/classroom-activities</p>
	<p><u>Big Ideas in Earth Science</u> <u>Big Ideas videos</u> bring to life the "big ideas" of Earth science—the nine core concepts that everyone should know. Teachers can use the videos in many ways. http://www.earthsciweek.org/big-ideas</p>
	<p><u>AGI's Center for Geoscience and Society</u> <u>Education Resource Network</u> – The geoscience education resources on this site come from a variety of providers. The site provides visitors with the widest possible collection of curricula, classroom activities, teacher professional development opportunities, science education standards, virtual field trips, teaching ancillaries, and much more. http://www.americangeosciences.org/center-for-geo/ern</p> <p><u>Critical Issues Program</u> The Critical Issues Program provides a portal to decision-relevant, impartial, expert information from across the geosciences. http://www.americangeosciences.org/critical-issues/</p>
	<p><u>Earth Science World Image Bank</u> The Image Bank now has over 6,000 images available to search, making it one of the largest sources of Earth Science imagery available on the web. http://www.earthscienceworld.org/images/index.html</p>

Resources: CIRES



- Climate Literacy and Energy Awareness Network
- Solar Dynamics Observatory Module
- Discover Air Quality Module
- Arctic Climate Connections

A screenshot of the DISCOVER-AQ website. The header reads "DISCOVER-AQ: Know Your Air Quality". Below the header is a video player titled "DISCOVER-AQ Overview" showing a 3D visualization of a rural landscape with a red heliostat tower and solar collectors. To the right of the video are navigation links for "Workshop", "Curriculum", and "Links". The "Links" section includes a list of resources such as "NASA DISCOVER-AQ Mission", "NCAR FRAPPÉ Field Campaign", "UCAR Air Quality Teaching Box", "OzoneAware", "CO Air Pollution Control Division", "AirWaterGas", and "GO3 Project".



Information

Space science, earth science, sun-earth interactions
6-8

Resources

- SDO Intro Resou
- 1 Sun Features
- 2 EMS Magnetisr
- 3 Sun Earth
- 4 Solar Exhibit
- 5 Appendices

Project

Solar Dynamics Observatory
- EVE

A screenshot of the CLEAN website. The header features the word "CLEAN" in large green letters, followed by four small globe icons showing different climate data visualizations. Below the header is the text "CLIMATE LITERACY & ENERGY AWARENESS NETWORK". The main content area has a background of wind turbines and contains the text "Collection of Climate and Energy Educational Resources". It describes a collection of 650+ free, ready-to-use resources rigorously reviewed by educators and scientists, suitable for secondary through higher education classrooms. An orange button labeled "Explore the Collection >" is visible. To the right, there is a "Featured Resources from" section with a small image of a person in a lab coat and a caption about ice cores.

Resources: Oregon State University

Land cover change & science:

<http://Geotrendr.oregonstate.edu>

<http://ltweb.ceoas.oregonstate.edu/mapping/>

GLOBE Observer: <http://observer.globe.gov>

<http://www.globe.gov/web/peder.nelson>

SnoTel data: <http://www.wcc.nrcs.usda.gov/snotel/earth/>

National Snow and Ice Data Center:

https://nsidc.org/data/google_earth/

Earthquake hazards:

<http://earthquake.usgs.gov/learn/kml.php>

USGS Stream Flow (viewing in Google Earth):

<http://waterwatch.usgs.gov/?m=real&r=us&w=real%2Ckml>

Explore Mt St Helens:

<http://volcano.oregonstate.edu/volcanoes-lesson-5>

Kennedy Geospatial Lab

Understanding landscape dynamics through computational and statistical analysis



Source of NASA produced data for viewing in Google Earth (land cover, biomass, etc)

<http://webmap.ornl.gov/wcsdown/>

Resources: NAGT



Quick Links

- Membership & Support
- Journal of Geoscience Education
- Teaching Resources
- IGES Field Training
- Field Camp Scholarships
- NAGT Workshops

The National Association of Geoscience Teachers works to foster improvement in the teaching of the Earth sciences at all levels of formal and informal instruction, to emphasize the cultural significance of the Earth sciences and to disseminate knowledge in this field to the general public.

[JOIN NOW »](#)

Promoting Excellence in Geoscience Education

About NAGT
Learn about our mission and sponsored events, or get involved.

Professional Development
NAGT offers a variety of workshops, meeting sessions, and more.

Teaching Resources
Explore teaching activities, the rock and mineral exchange, and more.

Publications
NAGT's publications include the *Journal of Geoscience Education* and *In the Trenches*.

Educational Advocacy
NAGT works to improve science education and influence public policy.

nagt.org/index.html

Recent News
Spring News - Issues #11

- InTeGrate Fall 2016 Webinar Series Continues
- Apply Now to Join the InTeGrate 2017 Faculty Mentoring Network Spring 2017



Teach the Earth the SERC portal for Geoscience Educators

Search the Portal ▶

Thousands of pages of activities, workshops, course descriptions and more. The work of hundreds of geoscience educators and over a dozen projects. Also, [search our supporting catalog](#): geoscience resources in print and from across the web.



Explore Topics and Themes

[Finding Visuals](#), [Classroom Activities](#)

[Undergraduate Introductory Geoscience](#)
[Year Colleges](#), and [K-12 Classroom](#)

[Strengthening Your Teaching](#)
[Research on Teaching and Learning](#) | [Design Thinking](#) | [Teaching in the Field](#) | [Teaching with](#)

InTeGrate
Interdisciplinary Teaching about Earth for a Sustainable Future

For Faculty and Instructors
Undergraduate Teaching for a Sustainable Future

For Program Directors and Administrators
Laying the Foundation for Tomorrow's Sustainability Workforce

InTeGrate Developed Modules and Courses

[Explore the Materials »](#)

InTeGrate Community Collections

- [Contributed Teaching Activities »](#)
- [Course Descriptions »](#)
- [Program Profiles »](#)
- [Community Voices: Essays »](#)

NGSS webinar series:



The screenshot shows the NAGT website header with the NAGT logo and the Center for Geoscience & Society logo. The main content area is titled "Implementing the Next Generation Science Standards" and includes a paragraph about the American Geosciences Institute's collaboration with the National Association of Geoscience Teachers. A sidebar on the left lists various NAGT activities, and a "Related Links" box is visible on the right.

NAGT
About NAGT
Membership
Professional Development
Workshops
GER Community Planning
(Re)Designing your Earth-related Course for Improved Student Learning
Shaping the Future of Geoscience Education Research
Supporting Broader Educational Impacts Webinar
Implementing the NGSS

Implementing the Next Generation Science Standards

The American Geosciences Institute's [Center for Geoscience and Society](#) and the National Association of Geoscience Teachers are collaborating with other organizations and member societies to support implementation of the Earth and space science Next Generation Science Standards. The Earth and Space Science (ESS) community will need to work together to help states, school systems, and teachers implement the [Next Generation Science Standards](#) and, more broadly, the principles in the [Framework for K-12 Science Education](#). Activities to further this aim include webinars, sessions at professional meetings, Town Hall discussions, workshops, [email discussions](#), and collection of resources.

Webinars
Teaching for Sustainability with NGSS
January 12, 2017
1:00 PM Pacific | 2:00 PM Mountain | 3:00 PM Central | 4:00 PM Eastern
Registration Deadline: January 10, 2017

2015 NGSS Summit
[Implementation of the NGSS at the State Level](#)
The purpose of the summit was to identify and/or devise ways in which key players in the Earth and Space Sciences (ESS) community could work together to help states and school districts implement the Next

Related Links
[NAGT's role in the development of NGSS](#)

- January 12, 2017 - 4 p.m. ET / 1 p.m. PT
 - Teaching for Sustainability with NGSS
- Archived videos/slides of previous webinars:
 - http://nagt.org/nagt/profdev/workshops/ngss_summit/index.html