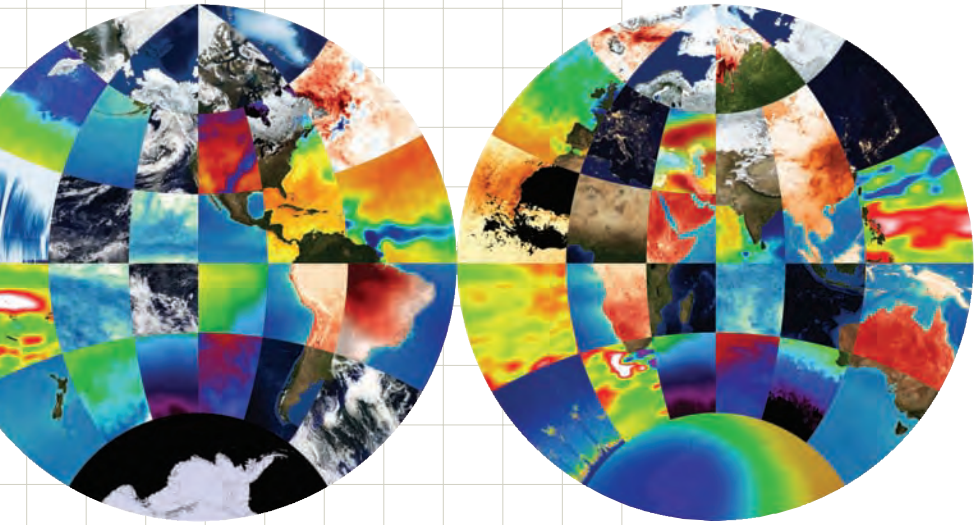
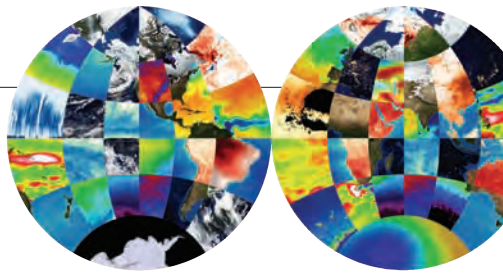
National Aeronautics and
Space Administration

images & data

Educators Guide to NASA Earth Science Images and Data



Educators Guide to NASA EARTH SCIENCE IMAGES & DATA



INTRODUCTION

For more than forty years, NASA satellites have enabled a unique perspective on our planet, collecting long-term global observations of its land surface, biosphere, atmosphere and ocean. These data have proven an invaluable asset for advancing our understanding of Earth as a complex, dynamic system, of the changing climate and its interaction with life, and of how human activities affect the environment.

NASA Earth science research, observations and visualization tools, which allow the international research community to interpret and communicate these complex data, are available for anyone wanting to understand more about our planet. Learners of all ages can view, download and analyze data from the fleet of current and past NASA Earth science missions through a variety of online sources.

Designed primarily for educators, this booklet outlines the different categories of NASA images and data available, with specific sources and detailed descriptions of how sample resources may be used in the classroom or informal education setting. Look for the ***Educator's Toolbelt*** sections for first-hand accounts from fellow educators on how they use specific sources to support their teaching.

The NASA Earth science data and imagery sources listed in this guide are organized in three categories:

INTRODUCTORY ■ NASA science images, animations, and visualizations that do not require special software or tools to be accessed and used. These resources can be used to illustrate a concept, to engage students, to develop an educational exhibit, program or product, to learn about the latest science discoveries, and more.

INTERMEDIATE ■ NASA science images, data and visualization tools designed for use in the classroom, in informal education, and by citizen scientists.

ADVANCED ■ Full NASA science data sets and analysis tools for conducting research and analysis.

If you are looking for data from a specific mission or science topic, go to pages 10–11 for a table listing data and imagery sources for each of the operating NASA Earth science missions.

■ INTRODUCTORY

■ INTERMEDIATE

■ ADVANCED

■ NASA Earth Science Missions:

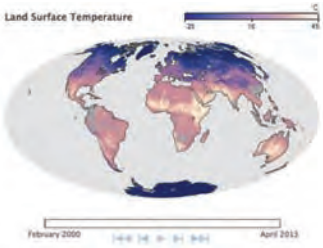
■ Image Credits & Acknowledgements

Earth Observatory

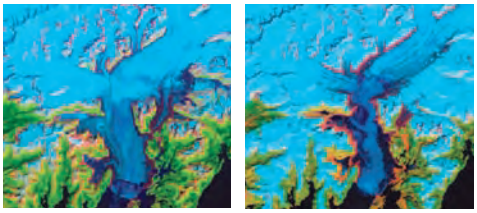
http://earthobservatory.nasa.gov

Explore images, stories and discoveries from NASA Earth science research, including its satellite missions, in-the-field research, and climate models. View global maps of NASA data, check out the Image of the Day, images of current events and special collections, and read feature articles and blogs. Images can be downloaded in multiple formats and resolutions.

Examples of what you will find:



Global Maps • *http://bit.ly/esw13-global* This series of animated global maps depict month-to-month changes in the Earth's climate system in 15 key parameters, including vegetation, snow cover, carbon monoxide, and land surface temperature, as shown above.



World of Change • *http://bit.ly/esw13-change* This series documents how our planet's land, oceans, atmosphere, and sun are changing over time. The Columbia Glacier in Alaska, shown above, has shrunk by half between 1986 and 2011.

Image of the Day • *http://earthobservatory.nasa.gov/IOTD*

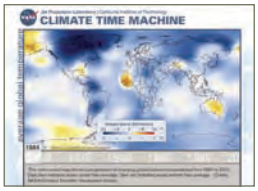
The image of the day and accompanying text showcase the latest in Earth science research. Browse the archive by month and year, or by topic: atmosphere, land, life, water, snow and ice, human presence, or remote sensing.

NASA Global Climate Change

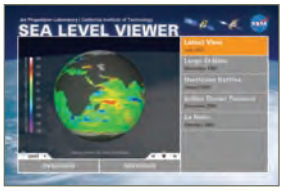
http://climate.nasa.gov

This website features a collection of climate news, visualizations, FAQs, interactives and resources related to the changing climate and NASA's role in studying climate change.

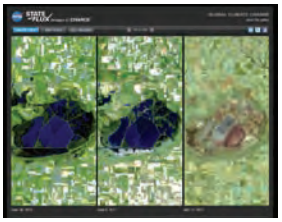
Examples of what you will find:



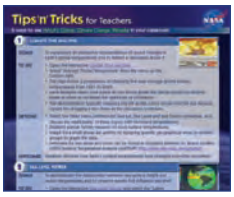
Climate Time Machine • *http://climate.nasa.gov/interactives/climate_time_machine* • This series of visualizations show how some of the key indicators of climate change, such as temperature, sea ice extent and carbon dioxide concentrations, have changed in Earth's recent history.



Sea Level Viewer • *http://climate.nasa.gov/interactives/sea_level_viewer* • Explore the latest global sea level from space, as well as sea level changes during El Niño and La Niña years, Hurricane Katrina, and the 2004 Indian Ocean tsunami.



State of Flux • *http://climate.nasa.gov/state_of_flux* • Every week, this gallery features sets of images of different locations on the planet that show change over time, with periods ranging from centuries to days. The images showcase the effects of climate change, human impact, natural hazards, and more.



Tips and Tricks for Teachers • *http://climate.nasa.gov/education/tips* • Download this 3-page, interactive document for step-by-step instructions on six ways to use NASA's Global Climate Change website in your classroom, aligned with National Science Education Content Standards.

educator's tool belt

I teach a course in waves and tides and another one in satellite remote sensing. I use [the Earth Observatory's] Image of the Day all the time. I have the students start off a class discussing an image of the day, discussing what satellite sensor produced the image, whether it was active or passive, and what we're learning about the Earth, ocean or atmosphere from that image.

Commander Emil Petruncio
Permanent Military Professor,
U.S. Naval Academy

Engage students with the Climate Reel. Play a video from Climate Reel at the beginning of each class period, such as *Remotely Sensing Global Ocean* or *Keeping Up with Carbon.* Ask student groups to make their own videos for climate change or solutions to climate change and share with the class. This and other exercises engage students in a variety of scientific topics through short, fun and interesting videos.

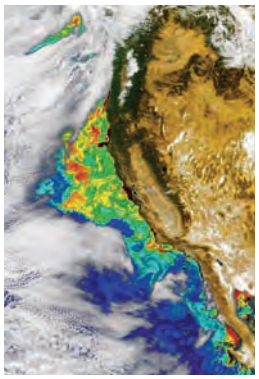
From: **NASA Global Climate Change** *Tips and Tricks for Teachers*

Ocean Color Web

http://oceancolor.gsfc.nasa.gov

This website allows users to download and order global ocean color, sea surface temperature and sea surface salinity data from NASA's ocean monitoring missions.

An example of what you will find:



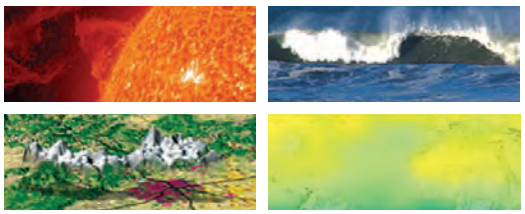
Ocean Color Image Gallery • *http://bit.ly/esw13-oceangallery*
Browse or search by keyword for stunning images of the ocean in the Feature of the Day database. Other features include a downloadable SeaWiFS biosphere animation.

Scientific Visualization Studio

http://svs.gsfc.nasa.gov

Located at the NASA Goddard Space Flight Center, SVS works closely with scientists to create data visualization products that promote a greater understanding of NASA Earth and space science. Thousands of visualizations are available—with new ones added frequently—and include images, animations and short movies on topics as wide-ranging as NASA science. These are wonderful resources to use as an initial engagement piece with students or audiences. Browse the collection by theme, mission, instrument, and more. Visualizations can be downloaded in a variety of formats and resolutions.

An example of what you will find:



Climate Essentials • *http://bit.ly/esw13-essential* • This multimedia gallery brings together the latest and most popular climate-related images, data visualizations and video features. Find multiple resources on key topics, such as the sun, the oceans, the land and the atmosphere (shown above).

NASA Visualization Explorer • *http://svs.gsfc.nasa.gov/nasaviz*

Get the latest multimedia stories about NASA's exploration of the Earth, sun, moon, planets and universe delivered right to your iPad. The NASA Viz app is freely available for download on the App Store.

educator's tool belt

Approaches to using the NASA Viz app in the classroom:

SHORT GROUP ACTIVITY

One middle school teacher has used the NASA Viz Explorer app since 2011 as an engagement tool with his students while taking attendance. Consider using the **3,2,1 strategy.** Working in small groups, ask your students for:

- **3** new things they learned from a given story or image;
- **2** things they found of interest;
- **1** question they have about the subject.

This exercise helps students build skills of summarizing and collaborating, while introducing them to new science-related subjects, in what would otherwise be a period of inactivity.

INTRODUCTORY ACTIVITY

The 3,2,1 strategy can also be used to introduce a new topic related to an ongoing lesson and assess students' prior knowledge and related misconceptions.

GROUP DISCUSSION

Because the resources on the app are up to date and current, it can be used year-round as a discussion-starter. Select an image and consider asking the following questions:

- How would you describe what you are seeing?
- How do you think this data was collected and why?
- After reading the accompanying information, what would you like to learn more about?

Adapted from suggestions by Gary Popiolkowski, science teacher, Chartiers-Houston Middle School, Pa.

SCIENCE STORYTELLING & RESEARCH TOOL

Ask your students to:

- Write the rest of the story.
- Find more information to discuss how a given image might be used by policy makers or local government officials to provide a societal benefit.
- Describe how they would explain this image and its importance to their grandparents or younger children.

Cassie Soeffing, former middle school teacher, Sioux Falls, S.D.

The Gateway to Astronaut Photography of Earth

http://eol.jsc.nasa.gov

This database hosts the best and most complete online collection of astronaut photographs of the Earth, from the Mercury missions in the early 1960s to daily transmissions from the International Space Station (ISS). Find information about the location and other supporting data for over 1.6 million photographs.

Sally Ride EarthKAM

https://earthkam.ucsd.edu

Sally Ride EarthKAM (Earth Knowledge Acquired by Middle school students) is a NASA educational outreach program enabling students, teachers, and the public to learn about Earth from the unique perspective of space.

During Sally Ride EarthKAM missions, middle school students around the world request images of specific locations on Earth. A searchable archive of Sally Ride EarthKAM images and accompanying learning guides and activities are available to engage students in Earth and space science, geography, social studies, mathematics, communications, and art.

Earth as Art

http://bit.ly/esw13-art

This iPad app features stunning images of Earth from the Terra, Landsat 5, Landsat 7, EO-1, and Aqua satellites, as well as time-lapse images of locations undergoing significant change. Find images organized by geographic region in the interactive directory, including several from the US Geological Survey Landsat image gallery, and many new images. It is freely available for download on the App Store.

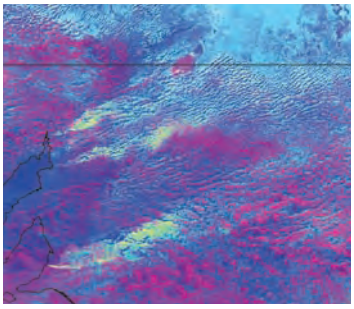
Examples of what you will find:

Visible Earth

http://visibleearth.nasa.gov

This website provides a searchable directory of NASA Earth science images, animations and data visualizations. Most resources are available digitally at multiple resolutions, with captions and metadata. Users can search the database using full text and advanced searches by topic, keyword, sensor, location, parameter and dates.

An example of what you will find:



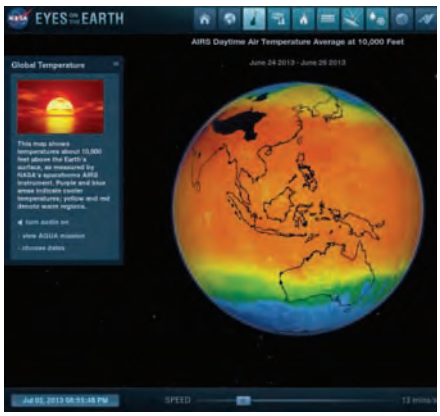
Pollution Tracks in Australia

- This false-color image over Australia, produced using NOAA Advanced Very High Resolution Radiometer (AVHRR) data, shows where pollution from human industry reduced clouds' particle sizes.

Eyes on the Earth 3D

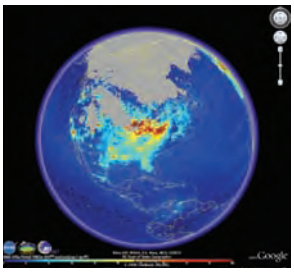
http://eyes.jpl.nasa.gov/earth

Fly in real time alongside current Earth-observing missions, which constantly monitor our planet's vital signs—such as sea level height, carbon dioxide concentrations in our atmosphere, global temperatures, and extent of sea ice in the Arctic.



Earth Exploration Toolbook (EET)

http://serc.carleton.edu/eet



Developed by teams of scientists and educators, EET is a collection of online Earth system science activities. Each activity, or chapter, introduces one or more scientific data sets and analysis tools that enable users to explore some aspect of the Earth system. The target audience for individual chapters varies, ranging from middle school to college level instruction.

Within the context of a case study, each chapter guides users through a step-by-step process in which they access data and use analysis tools to explore real issues and questions in Earth system science. Topics using NASA data tools include *Analyzing the Antarctic Ozone Hole; Envisioning Climate Change Using a Global Climate Model;* and *Exploring Air Quality in Aura NO_2 Data.* In the course of completing a chapter, users produce and analyze maps, graphs, images, or other data products. The ultimate goal of each activity is to build users' skills and confidence so they can use data to conduct their own investigations of the Earth system.

Above image: NASA Aura NO_2 data overlaid on Google Earth, from the EET chapter on Exploring Air Quality in Aura NO_2 Data.

SatCam App

http://bit.ly/esw13-satcam

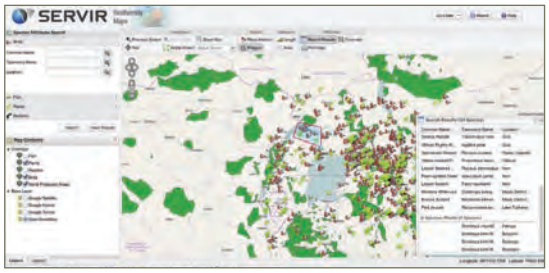
With this free app for iOS devices, users can capture observations of local cloud and surface conditions, coordinated with an overpass of the Terra, Aqua or Suomi NPP satellites. By making a SatCam observation, users help check the quality of the products created from the satellite data. In return, they receive a satellite image captured at their location, anywhere in the world!

The app was developed at the Space Science and Engineering Center, University of Wisconsin-Madison.

SERVIR Interactive Mapper

http://bit.ly/esw13-servir

The Regional Visualization and Monitoring System, SERVIR, is an international collaborative venture aiding decision making by providing Earth observations and predictive models in a variety of areas of social benefit, including biodiversity and weather.



The SERVIR Interactive Mapper allows you not only to access and display SERVIR data and functionality, but also to retrieve the same kinds of information from multiple external sources so you can create new services. Using the online Mapper interface, you can choose specific data sets and information products, display them on a base map, and further manipulate them for analysis.

educator's tool belt

I used Satcam while my students were laying out a 30-meter x 30-meter field sample site for a Watershed Watch *activity. The* GLOBE Land Cover *and* GLOBE Carbon Cycle *activities use the same site setup protocol, which outlines a site that is the same size as a Landsat pixel. We were in the field when both Aqua and Suomi NPP passed over, and we took and submitted our pictures. We used the satellite images to compare our site with regional land cover, and to start a discussion about NDVI (normalized difference vegetation index) and carbon storage, both of which we will use to plot the study. Students were also interested in comparing cloudiness in the satellite images with sky cover in the field.*

Dr. Annette L. Schloss
Earth Systems Research Center, University of New Hampshire

INTERMEDIATE

Landsat Images and Educational Resources

http://landsat.gsfc.nasa.gov/education

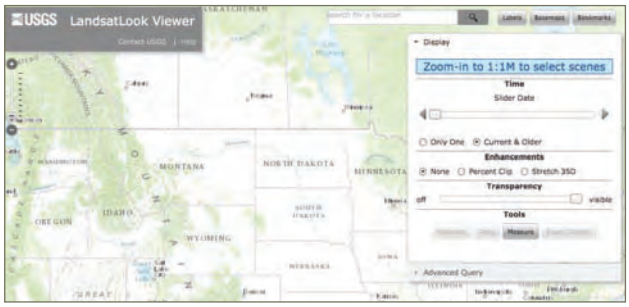
How has your community changed in your students' lifetime? How has it changed in your lifetime? Landsat education activities allow you to explore land use and land change spanning more than four decades. Since 1972, Landsat satellites have been collecting specialized digital images of Earth's land and coastal regions. Scientists use Landsat data to study forests, food production, water and land use, ecosystems, geology, and more. Landsat is a joint mission between NASA and the US Geological Survey.

This NASA website provides access to images, tools and tutorials to help teachers and students learn how to access data and create and interpret images. The activity *Quantifying Change in the Land Over Time* will show you how to measure change in your community.

Examples of what you will find:

Greek Fire Scars

On the Peloponnesus Peninsula in southwestern Greece, severe wildfires burned large tracts of land late in the summer of 2007. Before and after images like the ones shown above, taken by Landsat 7, are used to create maps for disaster response.



Visit the USGS Landsat home page • *http://landsat.usgs.gov* • to find useful educational resources, such as EarthNOW!, which allows users to view live and recently received images of North America from Landsat 7; and Landsat Look (shown above) • *http://landsatlook.usgs.gov* • featuring topographic maps and a slider depicting changes through time.

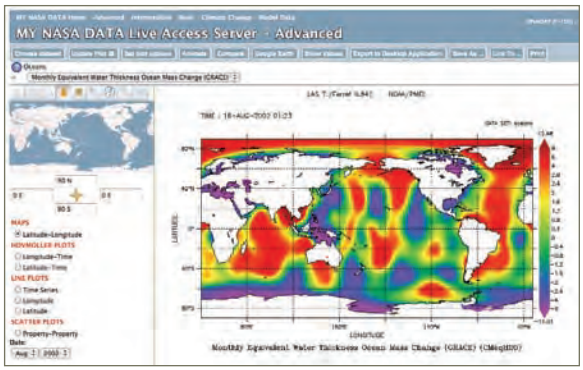
MY NASA DATA

http://mynasadata.larc.nasa.gov

Students of all ages can investigate micro sets of NASA Earth science satellite data, including atmosphere, biosphere, cryosphere, ocean, and land surface. Data are available along with lesson plans, computer tools, and an Earth science glossary. Citizen science project ideas are also available.

Examples of what you will find:

Featured MY NASA DATA Lessons for Educators • *https://mynasadata.larc.nasa.gov/educators* • The website offers over 120 standards-based lesson plans to help educators bring real NASA science into their classroom, including *Comparing Temperature and Solar Radiation for Common Latitudes,* featured above. In this lesson for grade 7, students use NASA satellite data to examine the solar radiation received at same-latitude locations compared to the surface temperature of each location.



Live Access Server • *https://mynasadata.larc.nasa.gov/live-access-server* • The MY NASA DATA Live Access Server (LAS) allows you to create your own micro sets of data for your class or your interests. The LAS contains over 200 parameters in atmospheric and Earth science from several different NASA sources, including satellite instruments, satellites and research programs.

INTERMEDIATE

NASA Earth Observations (NEO)

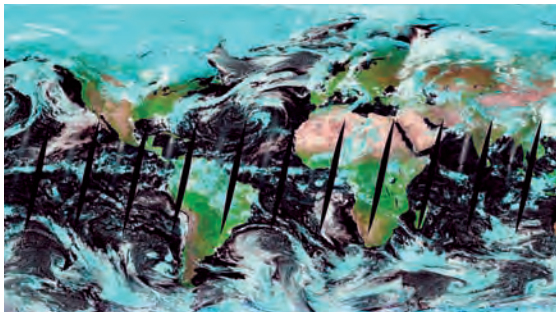
http://neo.sci.gsfc.nasa.gov

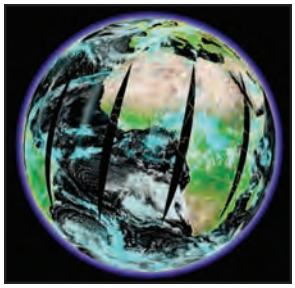
NEO provides a repository of global data imagery highlighting NASA research in climate and environmental change, making that imagery easily accessible. It was developed to help museums, science centers, and other informal education institutions access imagery of NASA's global data sets. Images are available in several formats (jpeg, png, GeoTIFF, and Google Earth), including those supported by Science On a Sphere and other global kiosk displays. Includes access by Web Mapping Service so that kiosks and other applications can update automatically.

An example of what you will find:

False Color

This image was taken with the MODIS sensor onboard NASA's Terra satellite on April 22, 2013 (Earth Day).





The above image can also be viewed in Google Earth or Science on a Sphere.

INTERMEDIATE

educator's tool belt

In the summers of 2011 and 2012, Katherine Soriano, Earth science teacher programs developer at the Liberty Science Center in New Jersey, led the NASA Real Time Data Summer Institute, a NASA-funded teacher development course that encouraged teachers to use real-time and near real-time data sources in their teaching. Here are two firsthand accounts from teachers that participated in the course and developed lessons using NEO.

One of the lessons I developed is focused on climate, and it culminated with a design-a-continent project. Students first use NEO to acquire temperature and precipitation data from real world cities before they develop and place their cities on their own continent. Once they identify what the climate would be like in their cities, students are asked to consider the potential impacts of climate change.

As a result of this lesson, students were able to relate the seven factors that control climate to real-time data. They also had a better understanding of latitude, solar insolation, albedo, and how heat, temperature and thermal energy are integral to understanding climate.

My students loved designing a continent, and to many, it was their favorite project of the trimester.

Teri Cosentino
Middle School Science Teacher
Gill St. Bernard's School, Gladstone, N.J.

I run the Lang Science Program, a 7-year student program at the American Museum of Natural History (AMNH) in New York that allows students to learn a lot of the science studied by scientists at the museum. I used NEO during the summer and fall of this academic year with a mix of 8–12th grade students taking one of the research courses in the program.

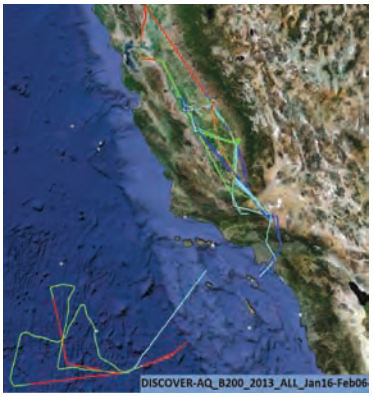
My students learned a lot about remote sensing, especially how researchers use various techniques here at AMNH, some of which are taken by the same satellites that contribute to NEO. In the course, we concentrated on NEO data as well as techniques for taking and processing images, the satellites that contribute to NEO sets, numerical data, and more. They also learned to use the NEO site, how to select, download, animate, and analyze their data sets, and how to set up images and animations for spherical projection. Each group made an iMovie about their selected sets and questions, incorporating the animations, which were presented to their parents and other students on the final day.

Brian Levine
Youth Programs Manager and
Astrophysics Educator, AMNH

Airborne Campaigns

DISCOVER-AQ

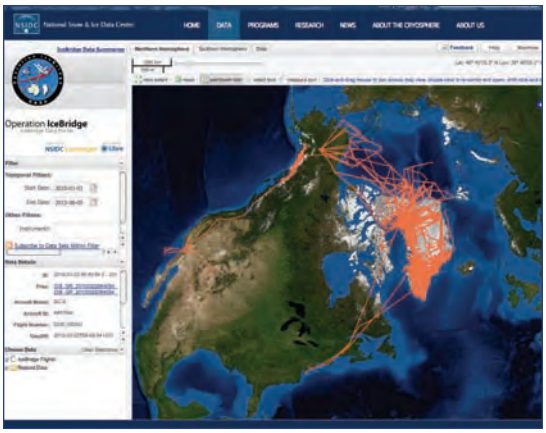
http://bit.ly/esw13-discoveraq



This website allows users to download data from the DISCOVER-AQ mission, which seeks to improve the interpretation of satellite observations to diagnose near-surface conditions relating to air quality through an integrated data set of airborne and surface observations. Data and flight track images are available for download from the 2011 and 2013 campaigns, with more added as they become available.

IceBridge Data Portal

http://nsidc.org/icebridge/portal



Hosted by the National Snow & Ice Data Center, this portal lets you visualize and interact with data from NASA's Operation IceBridge mission, an airborne campaign to image Earth's polar ice in unprecedented detail in order to better understand the connection between the polar regions and the global climate system. Researchers can also download a variety of data products by instrument.

EOSDIS—Earth Data Website

http://earthdata.nasa.gov

The Earth Observing System Data and Information System (EOSDIS) is comprised of twelve distributed active archive centers (DAACS) that manage, process and distribute thousands of Earth system science data products and associated services to a diverse end-user community. Each DAAC focuses on a specific Earth system science discipline. Almost all EOSDIS data holdings are free, held online and accessed via ftp.

Examples of what you will find:

Land-Atmosphere Near Real-Time Capability for EOS (LANCE) • *http://earthdata.nasa.gov/data/near-real-time-data* • Available in less than three hours from observation, Near Real-Time (NRT) products from the MODIS, OMI, AIRS and MLS instruments are offered by LANCE. LANCE supports application users interested in monitoring and analyzing a wide variety of natural and man-made phenomena.

State of the Ocean (SOTO) • *http://podaac-tools.jpl.nasa.gov/soto* • SOTO is a web interface that provides interactive viewing of near real-time parameters extracted from ocean science data products archived at the Physical Oceanography Distributed Active Archive Center (PO.DAAC). Near real-time data displayed on a virtual globe features data overlays such as sea surface temperature, ocean currents, and ocean surface wind vectors. Also available are kml overlays for ice extent, hurricane tracks and clouds.

Worldview Alpha • *http://bit.ly/esw13-worldview* • This new tool allows users to interactively browse satellite imagery in near real-time, generally within three hours of observation. Users can select the imagery on the map and compare it to past observations, and can even take and download pictures of the maps created.

educator's tool belt

NASA Earthdata Webinar Series

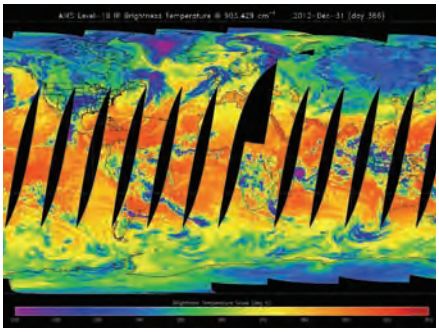
http://bit.ly/esw13-webinar

Participate in the monthly NASA Earthdata webinars to learn more about NASA data sets and how you can discover, access and use these data. A different EOSDIS data product, data discovery or data access tool is featured in each webinar. Webinars are also archived on the website.

ADVANCED

Giovanni

http://disc.sci.gsfc.nasa.gov/giovanni



Giovanni is a web-based application developed by the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data. Giovanni is an acronym for the Geospatial Interactive Online Visualization And aNalysis Infrastructure.

educator's tool belt

As lead of the NASA Applied Remote Sensing Training (ARSET) project for the past five years, I have had the unique opportunity to teach about the practical uses of NASA Earth science. Through hands-on trainings and other capacity-building activities, we educate decision makers in the public and private sectors how to access, analyze and interpret NASA Earth science data, images and models.

Among the NASA tools used by ARSET are Giovanni, Worldview Alpha, and the TRMM Near Real-Time Flood and Landslide Information. For example, ARSET recently offered an advanced online course that showed the use of images from the MODIS instrument on the NASA Terra and Aqua satellites. Learners analyzed stunning images of fires in Utah and Colorado, whose smoke, detected by MODIS, spread across several states (reaching as far as Canada!), causing health problems and lack of visibility.

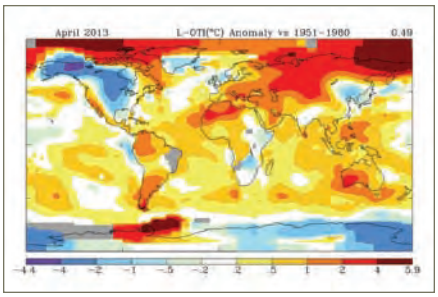
We have also offered several workshops in California, which has some of the highest levels of air pollution in North America. Students in these courses not only learned how to use MODIS images, but also OMI (Ozone Monitoring Instrument on the Aura satellite) images of nitrogen dioxide, a pollutant emitted by cars and industrial activity that can be very harmful to the respiratory system.

Ana I. Prados, Ph.D.
Joint Center for Earth Systems Technology (JCET), University of Maryland

Note: Find the courses, webinars, training materials and other resources at: *http://airquality.gsfc.nasa.gov* • *http://water.gsfc.nasa.gov*

Goddard Institute for Space Studies (GISS)—Data Sets and Images

http://data.giss.nasa.gov



Located at Columbia University, NASA's GISS is a laboratory of NASA's Goddard Spaceflight Center, which carries out interdisciplinary research on global change. This research addresses natural and man-made changes in our environment that occur on various time scales—from one-time forcings such as volcanic explosions, to seasonal and annual effects such as El Niño, and on up to the millennia of ice ages—and that affect the habitability of our planet. This website includes information on how to access data sets and derived material from GISS research projects.

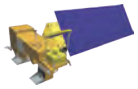
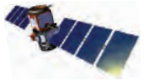
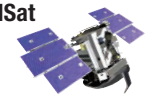
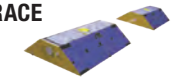
EdGCM

Educational Global Climate Modeling

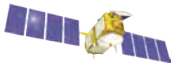
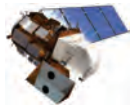
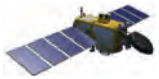
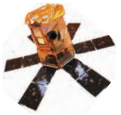
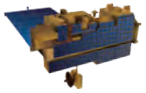
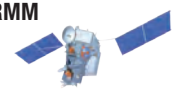
http://edgcm.columbia.edu

EdGCM provides a research-grade Global Climate Model (GCM) with a user-friendly interface that can be run on PCs and Macs, allowing students to explore the subject of climate change in the same way that actual research scientists do. The global climate model at the core of EdGCM was developed by scientists at the Goddard Institute for Space Studies.

ADVANCED

NASA Earth Science Mission	Purpose/Website	■ INTRODUCTORY *Images, animations and visualizations that do not require special software or tools.*	■ INTERMEDIATE *Images, data and visualization tools designed for use in the classroom, in informal education, or by citizen scientists.*	■ ADVANCED *Full science data sets and analysis tools for conducting research.*
ACRIMSAT 	Solar irradiance from the sun to understand connection between the sun's total energy output and global climate change. • ***http://acrim.jpl.nasa.gov***		**ACRIM Data Products** • *www.acrim.com* **Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**EOSDIS** • *http://earthdata.nasa.gov/data*
Aqua 	Earth's water cycle, energy fluxes, aerosols, land vegetation cover, ocean biology, and sea and land ice. • ***http://aqua.nasa.gov***	**Earth Observatory Global Maps** • *http://bit.ly/esw13-global* **Ocean Color Web** • *http://oceancolor.gsfc.nasa.gov* **SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth* **MY NASA DATA** • *http://mynasadata.larc.nasa.gov*	**EOSDIS** • *http://earthdata.nasa.gov/data*
Aquarius 	Understanding the interaction between ocean circulation, the water cycle and climate, by measuring ocean salinity. • ***http://aquarius.nasa.gov***	**Aquarius Gallery** • *http://aquarius.nasa.gov/gallery.cgi* **SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Aquarius Data Tool** • *http://aquarius.jpl.nasa.gov* **Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**PODAAC** • *http://podaac.jpl.nasa.gov*
Aura 	Atmospheric composition, chemistry and dynamics to study the ozone layer, air quality, and how our atmosphere is changing. • ***http://aura.gsfc.nasa.gov***	**SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth* **MY NASA DATA** • *http://mynasadata.larc.nasa.gov*	**EOSDIS** • *http://earthdata.nasa.gov/data* **Giovanni** • *http://disc.sci.gsfc.nasa.gov/giovanni*
CALIPSO 	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations—Effects of aerosols and clouds on climate. • ***http://www-calipso.larc.nasa.gov***	**SVS** • *http://svs.gsfc.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth* **MY NASA DATA** • *http://mynasadata.larc.nasa.gov*	**Giovanni** • *http://disc.sci.gsfc.nasa.gov/giovanni* **LARC Atmospheric Science Data Center** • *https://eosweb.larc.nasa.gov*
CloudSat 	Structure, composition and effects of clouds on a global basis. • ***http://cloudsat.atmos.colostate.edu***	**SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**CloudSat Data Processing Center** • *www.cloudsat.cira.colostate.edu* **Giovanni** • *http://disc.sci.gsfc.nasa.gov/giovanni*
DISCOVER-AQ 	Integrated dataset of airborne and surface observations to improve the interpretation of air quality satellite observations. • ***http://discover-aq.larc.nasa.gov***	**SVS** • *http://svs.gsfc.nasa.gov*	**MY NASA DATA** • *http://mynasadata.larc.nasa.gov*	**DISCOVER-AQ Data** • *http://bit.ly/esw13-discoveraq*
EO-1 	Land-imaging mission to demonstrate instruments and spacecraft systems for Landsat. • ***http://eo1.gsfc.nasa.gov***	**SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth* **USGS Earth Explorer** • *http://earthexplorer.usgs.gov* **USGS GloVis** • *http://glovis.usgs.gov*	
GOES* 	Geostationary satellites for NOAA's U.S. weather monitoring and forecast operations. • ***http://goespoes.gsfc.nasa.gov***	**SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**NOAA Geostationary Satellite Server** • *www.goes.noaa.gov*	
GRACE 	Gravity Recovery and Climate Experiment—can detect changes in mass (such as ground water) by mapping Earth's gravity fields. • ***www.csr.utexas.edu/grace***	**GRACE Gallery** • *www.csr.utexas.edu/grace/gallery* **SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth* **MY NASA DATA** • *http://mynasadata.larc.nasa.gov*	**EOSDIS** • *http://earthdata.nasa.gov/data* **GRACE Tellus** • *http://grace.jpl.nasa.gov*

**Operated by partner agency.*

NASA Earth Science Mission	Purpose/Website	■ INTRODUCTORY *Images, animations and visualizations that do not require special software or tools.*	■ INTERMEDIATE *Images, data and visualization tools designed for use in the classroom, in informal education, or by citizen scientists.*	■ ADVANCED *Full science data sets and analysis tools for conducting research.*
Jason-1 	Continues accurate sea surface height measurements begun by TOPEX/Poseidon; monitors ocean circulation for improved climate prediction and improved understanding of ocean eddies and events such as El Niño and La Niña. • ***http://sealevel.jpl.nasa.gov/missions/jason1***	**Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**Aviso** • *http://www.aviso.oceanobs.com/en* **EOSDIS** • *http://earthdata.nasa.gov/data* **PODAAC** • *http://podaac.jpl.nasa.gov*
Landsat* 	Since 1972, Landsat satellites have collected measurements of Earth's continents and surrounding coastal regions that have enabled people to study forests, food production, water and land use, ecosystems, geology, and more. They have enabled the longest continuous space-based record of Earth's land. Landsat 7 and Landsat 8 are currently in operation. • ***http://landsat.gsfc.nasa.gov***	**Landsat Gallery** • *http://landsat.visibleearth.nasa.gov*	**Landsat Look** • *http://landsatlook.usgs.gov* **Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**Landsat Look** • *http://landsatlook.usgs.gov*
Operation IceBridge 	Airborne campaign to image Earth's polar ice in unprecedented detail to understand connection between polar regions and global climate system. • ***www.nasa.gov/mission_pages/icebridge/index.html***	**SVS** • *http://svs.gsfc.nasa.gov*		**IceBridge Data Portal** • *http://nsidc.org/icebridge/portal*
OSTM/Jason-2* 	Ocean Surface Topography Mission on Jason-2 satellite (OSTM/Jason-2) to extend sea level height data record for science applications, and to support commercial and recreational applications. • ***www.nasa.gov/mission_pages/ostm/main/index.html***	**Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**Aviso** • *http://www.aviso.oceanobs.com/en* **EOSDIS** • *http://earthdata.nasa.gov/data* **PODAAC** • *http://podaac.jpl.nasa.gov*
QuikSCAT 	Sea-surface wind speed and direction under all weather and cloud conditions over Earth's oceans. • ***http://winds.jpl.nasa.gov/missions/quikscat***	**Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**EOSDIS** • *http://earthdata.nasa.gov/data*
SORCE 	X-ray, ultraviolet, visible, near infrared and total solar radiation to address long-term climate change, natural variability and enhanced climate prediction, and atmospheric ozone and UV-B radiation. • ***http://lasp.colorado.edu/sorce/index.htm***	**Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**Giovanni** • *http://disc.sci.gsfc.nasa.gov/giovanni* **LISIRD** • *http://lasp.colorado.edu/lisird*
Suomi NPP* 	Extend key measurements for long-term monitoring of climate trends and global biological productivity. • ***http://jointmission.gsfc.nasa.gov***	**CIMSS Satellite Blog** • *http://cimss.ssec.wisc.edu/goes/blog/archives/category/suomi_npp* **SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth*	**Suomi NPP Science and Data** • *http://npp.gsfc.nasa.gov/science*
Terra 	Global measurements of atmosphere, land and ocean, to improve understanding of Earth's energy and carbon budgets. • ***http://terra.nasa.gov***	**Earth Observatory Global Maps** • *http://bit.ly/esw13-global* **Ocean Color Web** • *http://oceancolor.gsfc.nasa.gov* **SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth* **USGS Earth Explorer** • *http://earthexplorer.usgs.gov* **USGS GloVis** • *http://glovis.usgs.gov* **MY NASA DATA** • *http://mynasadata.larc.nasa.gov*	**EOSDIS** • *http://earthdata.nasa.gov/data*
TRMM 	Tropical Rainfall Measuring Mission: Monitor and study tropical rainfall. • ***http://trmm.gsfc.nasa.gov***	**Earth Observatory Global Maps** • *http://bit.ly/esw13-global* **SVS** • *http://svs.gsfc.nasa.gov* **Visible Earth** • *http://visibleearth.nasa.gov*	**Eyes on the Earth 3D** • *http://eyes.jpl.nasa.gov/earth* **MY NASA DATA** • *http://mynasadata.larc.nasa.gov*	**Giovanni** • *http://disc.sci.gsfc.nasa.gov/giovanni* **TRMM Data Products** • *http://trmm.gsfc.nasa.gov*

**Operated by partner agency.*

IMAGE CREDITS

Introduction: Page 1

Users can find NASA images for locations around the world to teach a variety of subjects.The sample images on this page were collected from NEO, NASA Landsat, Earth Observatory and Visible Earth.

The artwork on the cover features data from over a dozen NASA Earth observation missions. It was created by Ginger Butcher, Aura mission education and public outreach lead, and Jesse Allen, visualization specialist for NASA's Earth Observatory, both with Sigma Space Corporation at NASA's Goddard Space Flight Center.

Page 2

World of Change

Credit: Jesse Allen, Robert Simmon/ NASA Earth Observatory, with Landsat data/US Geological Survey.

Page 3

Ocean Color Image Gallery

Credit: SeaWiFS Project, NASA/Goddard Space Flight Center/ ORBIMAGE.

Page 4

The Gateway to Astronaut Photography of Earth

Credit: Tom Washburn, NASA Astronaut.

Pollution Tracks in Australia

Credit: Daniel Rosenfeld, Hebrew University of Israel.

Page 6

Greek Fire Scars

Credit: US Geological Survey.

Page 7

False Color

Credit: MODIS Rapid Response System, Jacques Descloitres, Jackie Kendall, Jeff Schmaltz, and MODIS Land Science Team.

Page 9

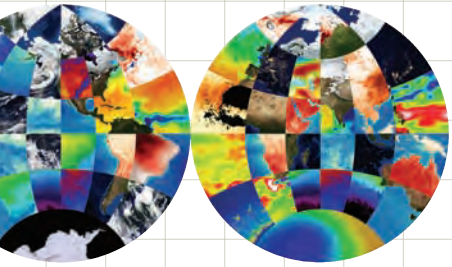
Giovanni

Credit: Infrared temperature brightness on Dec 31, 2012 from Atmospheric InfraRed Sounder (AIRS) Global Image Gallery.

ACKNOWLEDGEMENTS

Laura Delgado López and Theresa Schwerin, Institute for Global Environmental Strategies; Susie Duckworth, Duckworth Design Studio.

SPECIAL THANKS TO: Jeannie Allen, Sigma Space Corporation/NASA Goddard; Katie Bethea, SSAI/NASA Langley; Eric Brown de Colstoun, NASA Goddard; Susan Callery, NASA JPL; Brian Campbell, Sigma Space Corporation/NASA Wallops; Lin Chambers, NASA Langley; Annette deCharon, University of Maine; Trena Ferrell, NASA Goddard; Randal Jackson, NASA JPL; Holli Riebeek, Sigma Space Corporation/NASA Goddard; Jessica Taylor, NASA Langley; Morgan Woroner, Institute for Global Environmental Strategies.



Mapping Our World

NASA Earth science provides unique perspectives that advance our understanding of the planet. From satellites and airborne campaigns to missions on the ground, NASA develops technologies that improve our ability to map the world, transforming how we see the changes taking place in the global Earth system.

For the latest version of this guide, please visit • ***http://climate.nasa.gov/esw2013***

National Aeronautics and Space Administration

www.nasa.gov

NP-2013-06-948-HQ