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Solar System Poster
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Cerro Tololo Inter-American Observatory in Chile is operated by the National Optical Astronomy Observatory. This image is composed of 316 individual 15 second exposures taken with a Canon 60D and a Sigma 10mm fisheye lens at f/2.8 and ISO6400. The star trails trace the motion of the night sky over 79 minutes. The stars move around the south celestial pole in very small circles in the upper right of the image. The celestial equator can be seen in the lower left of the image. Photo by Robert Sparks. To see more of Robert's work, go to <http://www.flickr.com/photos/halfastro/>

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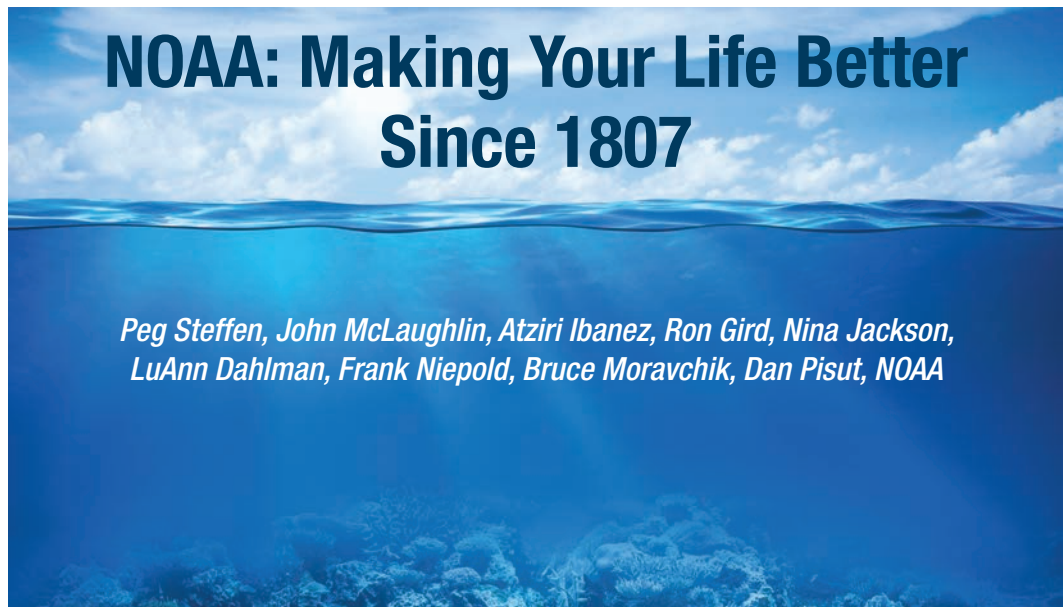


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NOAA: Making Your Life Better Since 1807

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Abstract

NOAA's mission touches the life of every American every day from weather forecasts to tide predictions and space weather. NOAA's education community works cooperatively to translate the agency's scientific work into useful classroom activities, data visualizations, and science investigations. Formal and informal educators have many opportunities to join learning communities and research expeditions with scientists to better understand the processes of science and to share that knowledge with students. New web sites and search tools are providing educators with engaging ways to help their students understand earth systems and to prepare them to face the challenges of the future. Join the growing number of earth science teachers who use NOAA resources in their teaching.

Serving Educators

The National Oceanic and Atmospheric Administration (NOAA) has roots dating back to Thomas Jefferson in 1807¹. It offers a wide range of programs, resources and opportunities to assist teachers in their efforts to increase their students' scientific understanding. The foundation for NOAA's educational content is based on the agency's scientific work. Often referred to as NOAA sciences, the core of this work is the investigation of patterns, features, and interactions of Earth's oceans, coasts, Great Lakes, weather, and climate. NOAA's education efforts strive to bridge gaps in support for teaching the scientific concepts of interactive Earth systems, the integration of 21st century investigative technologies, and ocean and climate literacy principles to address the future workforce needs of the agency and the Nation. A community of educators within NOAA offers a myriad of learning resources and opportunities for classrooms teachers, informal educators and students at any level of science interest and expertise.

Earth science resources with educators in mind

Resources for educators are distributed across many websites and program offices within NOAA as well as on NOAA partner websites. The site (<http://www.education.noaa.gov/>) offers resource collections specially selected by educators and reviewed by scientists. Materials selected for the site are organized by themes, topical collections, and content type, and are aligned with common teaching topics and expressed needs of educators. Linked resources are organized into collections which provide the user with a toolkit of materials and activities suitable for integration into a variety of

educational settings. Collections are not grade specific but resources are labeled for grade appropriateness where applicable. The site contains multimedia, lessons, activities, real work data and profiles of scientists and resources managers including academic preparation requirements, employment pathways, and lifestyle information related to selected careers. Each Collection contains 15-25 resources vetted by the NOAA education team to support teaching in both formal and informal settings.

NOAA has a large and expanding collection of data and visualizations for educators to incorporate into their science education curricula. For educators new to using data, consider starting with the NOAA Data in the Classroom Project², (www.dataintheclassroom.noaa.gov) a curriculum for grades 5-12 designed to help teachers and students use real scientific data to explore dynamic Earth processes and understand the impact of environmental events on a regional or global scale. The modules combine a system for accessing data with structured lesson plans that model the use of online data in the classroom. Authentic research questions and scaled data interactions provide a stepped entry into accessing and using real-time data. Entry and adoption levels are teacher-driven. The levels of adaptation through invention are more student-directed and open up opportunities to design lessons featuring student driven inquiry. Modules developed to date include:

- El Niño
- Sea level
- Water Quality
- Ocean Acidification
- Coral Bleaching (coming end of 2014)

Developed by the NOAA Satellite and Information Service “**NOAA View**,” an on-line educational tool, gives educators and the public interactive access to NOAA environmental data, enabling unique views of the world’s oceans, land, atmosphere, cryosphere and climate. (See Figure 1) The data imagery portal brings together more than 60 different sets of data, some even as far back as 1880, with new data sets being added regularly. Content is updated on a daily, weekly, monthly, or annual basis as data observations and collections permit. It provides a single point for experiencing NOAA data, including environmental information captured by satellites, inserted into scientific models and other data analyses. Users can browse, animate, and download high-resolution imagery from the NOAA Visualization Lab and Google Earth formatted files, making it an ideal tool for putting NOAA data into the hands of students in classrooms around the world. Examples of data contents include: wind speed, coral bleaching, ice cover, vegetation, precipitation, and views of the Earth at night. (See Figure 2) NOAA View lets users manipulate the display to change views of the world, data inputs, and periods of time to observe the Earth. NOAA View is compatible with all major internet browsers, as well as Apple and Android mobile devices. To use NOAA View, visit: <http://www.nnvl.noaa.gov/view>

Climate.gov offers an extensive collection of climate information and resources for educators and their students, the latest reports on global, national, and regional climate assessments, popular-style articles, compelling data visualizations, and clear explanatory videos describing concepts in climate. The Global Climate Dashboard invites users to explore a range of interactive graphs showing data that illustrate climate change and variability. Be sure to click on the Maps and Data section for a mapping interface with global to local climate data from the past and present. (See Figure 3)



Figure 1. NOAA View Banner

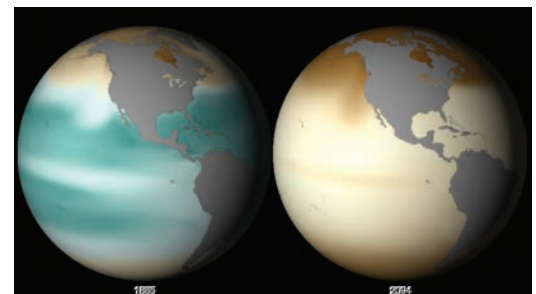


Figure 2. The two globes illustrate the changes in ocean acidification that are expected as the ocean continually absorbs carbon dioxide from the atmosphere. This climate model shows the change in ocean aragonite saturation from 1885 to what is expected in 2094. Most of the ocean in the image on the right is uninhabitable by organisms using calcium carbonate, such as corals, pteropods, and oysters. (NOAA)

Figure 3. Climate.gov includes resources for educators, a search engine using the vetted CLEAN collection of lessons and multimedia, and links to professional development opportunities. (NOAA)

High-quality learning activities, visualizations, videos, and short demonstrations and experiments that address climate and energy literacy are found in the “Teaching Climate” section of climate.gov. Each resource undergoes a rigorous review by multiple practicing educators and climate and energy scientists. Resources are annotated with reviewers’ comments and aligned with: a) the AAAS Project 2061 Benchmarks for Science Literacy; b) the National Science Education Standards (soon to be replaced with the Next Generation Science Standards) and c) the North American Association for Environmental Education (NAAEE) Excellence in Environmental Education Guidelines for Learning. Teaching Climate and Energy Science pages are designed to help the user understand the big ideas of climate and energy.

Experiential learning opportunities for educators

Looking for a personal research experience? Check out **Educator Opportunities** on <http://www.education.noaa.gov/> to find training, workshops, online and self-directed learning, experiential learning, and events at conferences. For example, join workshops at the Dauphin Island Sea Lab, the Georgia Aquarium, Flower Garden Banks National Marine Sanctuary, and Ocean Explorer Workshops held around the country. If online learning is your style, NOAA provides webinars and comprehensive courses provided by partners. For example, DataStreme Ocean, Atmosphere, and Earth’s Climate System courses each offer a 13-week distance learning course with real-time data, activities, and online investigations. Course materials are free to selected participants and 3 graduate credits are awarded upon completion.

Science educators frequently have opportunities to steer interested students toward experiences that might encourage STEM career paths. www.education.noaa.gov is *the* one-stop shopping site for scholarships, internships, fellowships, and special opportunities for students in high school and college.

Get your feet wet with **Teacher at Sea (TAS)** which provides K-12 educators an opportunity to experience an interdisciplinary research experience to increase their level of environmental literacy and provide a clearer insight into our ocean planet. In 2013, thirty-five teachers from every grade level sailed on NOAA research cruises working side-by-side with NOAA scientists at sea as part of the research team. “I received instant respect from the scientists and ship crew. They gave me the opportunity to participate right away and to be part of the team. The scientists, were very open to answering questions and took time to explain the value of the research and why they do what they do,” Louise Todd, 2013 Teacher at Sea. Educators have been part of biological and physical fisheries surveys, physical oceanography studies, and hydrographic cruises to scan the coastal sea floor to locate submerged obstructions, and hazards to navigation. <http://teacheratsea.noaa.gov/>

“We have the opportunity to re-invent the world.” That was a final thought from one participant at the end of a **Teacher on the Estuary (TOTE)** workshop last summer (2013). Teachers experience a 4-day field and research-based summer workshop designed for middle and high school science teachers. The workshop aims to improve teacher and student understanding of the environment using local examples, and to provide resources and experience to support the incorporation of climate change, ecosystem services, systems thinking, service learning, estuary and watershed topics into classroom teaching. The course is also designed to promote stewardship of watersheds

and estuaries. Following the summer workshop, teachers implement a stewardship project with students throughout the school year, using a \$200 mini-grant through TOTE. Teachers also commit to attending a half-day fall follow up session to report on their stewardship project progress. <http://estuaries.noaa.gov/Teachers/Default.aspx?ID=170>

“What I’ve been learning through the Climate Stewards program is giving me such a rich background of knowledge to use as a teacher. It’s a phenomenal resource/opportunity.” wrote Susan Pike, a NOAA Climate Steward. (See Figure 4) One of NOAA’s newest programs, **NOAA Climate**

Stewards, (<http://oceanservice.noaa.gov/education/climate-stewards/>) provides professional development opportunities and supports a collaborative online learning community to educators from K-12 schools colleges, and informal institutions. Educators benefit from an active online learning community that offers collaborative space, web seminars, conference symposia, workshops, and virtual conferences. Teachers report that they are able to understand the science behind climate concepts and to connect it to their classes in a useable way. “I am becoming a local expert and NOAA Climate Stewards is my resource. It adds credibility and I appreciate that and use it wisely...I am amazed at how much information is out there and how easy it is to find what I need... it is such an awesome benefit for a busy teacher.” Justine Lines, NOAA Climate Steward.

Funding for stewardship projects and travel stipends for conferences support the design and implementation of environmentally friendly action plans to reduce the “carbon footprint” in their own communities. Projects completed by Climate Stewards have included:

- Studying climate change and sharing mitigation activities with a sister school in South Africa.
- Studying climate change’s impacts on local watershed ecosystem health through direct investigation and historical data discovery.
- Conducting a school-wide audit of electricity usage, and working to amend teacher and student behaviors as well as school-wide lighting hardware.
- Conducting a tree carbon sequestration (CS) audit along a local stream, and planting trees to supplement CS capacity.
- Studying carbon sources and sinks in relation to climate change via the production of biochar and its use in creating a school vegetable garden.

Evaluations of the Climate Stewards project indicate that educator practices have been changed as a result of being in the project. Kottie Christie-Blick wrote, “Climate Stewards now permeates my teaching far beyond lessons about climate. In EVERY subject, my students know that I’m going to ask them, “What’s your evidence?”

“After over 20 years in Education, my work with NOAA is what keeps me excited. It’s what keeps me learning and what keeps my teaching fresh and inspiring. There is always something new to experience, to learn about or to participate in...It has taken my teaching in directions I never dreamed of. What a gift.” Jacob Tanenbaum, NOAA Climate Steward.



Figure 4. Ms. Kottie Christie-Blick, a NOAA Climate Steward, and her 5th grade students celebrate the Earth after studying about climate change and working to mitigate global warming. (NOAA)

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¹ NOAA Legacy. Derived from http://www.history.noaa.gov/legacy/agency_history.html

² Steffen, P, Ibanez, A., NOAA Data in the Classroom, TES, Volume XXVIII, Issue 4, Winter 2013, pp32-36.

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Dan Pisut fuses his background in environmental research and secondary education to create scientific visualizations that simplify complex topics and are impactful to the viewer. As a writer, producer, and director, Dan oversees the idea conceptualization and execution of visualizations in consultation with scientific experts. His visualizations are routinely incorporated into classrooms, museum exhibits, primetime news coverage, and award-winning documentaries around the world (www.nnvl.noaa.gov). Dan can be reached at dan.pisut@noaa.gov

Nina Jackson is a former research meteorologist with 35 years of experience in satellites and satellite remote sensing. In her present position as the education coordinator for NOAA's Satellite and Information Service, (<http://www.nesdis.noaa.gov/education.html>), she works to provide education and outreach opportunities and materials that promote NOAA sciences and environmental literacy (<http://www.goes-r.gov/education/overview.html>). Nina can be reached at Nina.Jackson@noaa.gov.

Bruce Moravchik has worked with students, educators, and scientists for over 20 years to advance environmental and climate literacy as a high school teacher and through the development of online products and professional development programs. Among his key responsibilities as an education specialist with NOAA's National Ocean Service (<http://oceanservice.noaa.gov/education>), he is the coordinator of NOAA's Climate Stewards Education Project (<http://oceanservice.noaa.gov/education/climate-stewards/>). Bruce Moravchik can be reached at Bruce.Moravchik@noaa.gov

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