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Editor's Corner

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Every two years NASA's Earth Science Division conducts a *Senior Review* of the missions in (or entering) extended operations. This past spring 13 missions were reviewed: ACRIMSAT, Aqua, Aura, CALIPSO, CloudSat, EO-1, GRACE, Jason-1, OSTM, QuikSCAT, SORCE, Terra, and TRMM. In March 2013 each team submitted continuation proposals, and budgets for both FY14-15 and FY16-17. The review process involved three panels: a *Science Panel* to review the mission's overall scientific merit and two panels focusing separately on *Technical and Cost* and *National Interests*.

The review panel concluded that all 13 missions have made unique and important contributions to NASA's research objectives, collectively transformed our scientific understanding of the Earth system, and provided data for applications of extremely high relevance. Some funding specifics for the missions follow:

- Terra, Aqua, Aura, ACRIMSAT, CALIPSO, and OSTM/Jason-2 received their baseline (in-guide) request from the recent NASA budget planning exercise for the entire Senior Review period.
- EO-1 received a baseline budget that assumes mission termination at the end of FY15 due to a degrading orbit.
- TRMM received funding for extended operations through FY17; reduced funding beyond FY17 assumes that the data stream has ended due to a degrading orbit.

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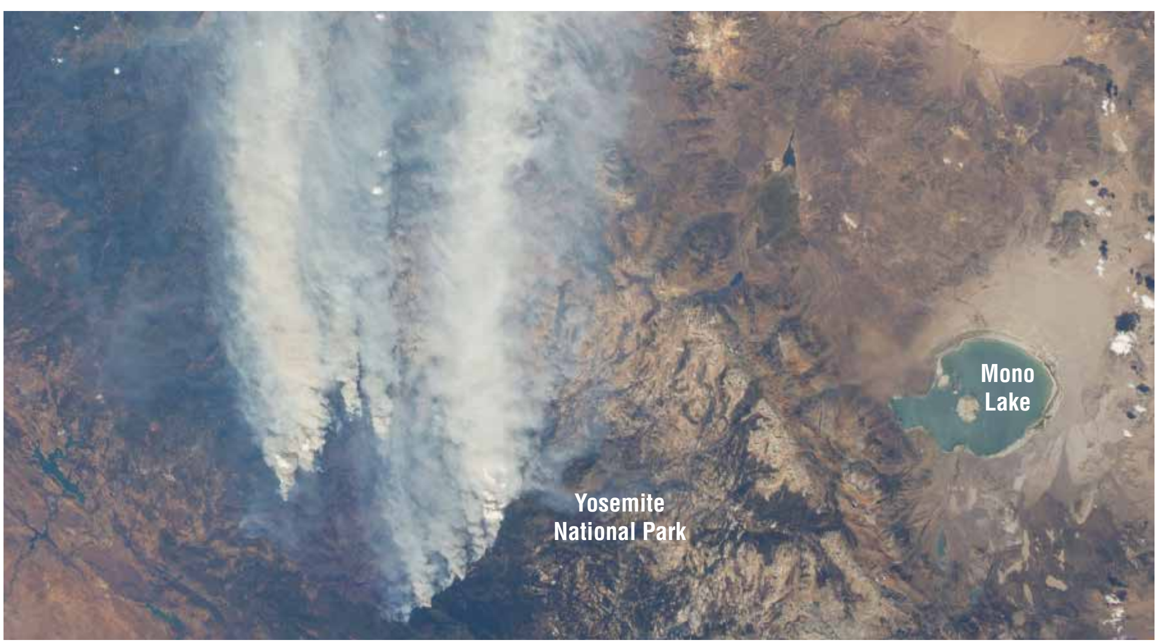

On August 26, 2013, the massive drought-aided Rim fire in and around California's Yosemite National Park was only 15% contained. On that same day, one of the crew members aboard the International Space Station recorded this view of the region. At the time of this writing (September 27), the fire that ignited on August 17 is only 84% contained and continues to smolder. **Image credit:** NASA

In This Issue

Reminder: To view newsletter images in color, visit: *eospso.nasa.gov/earth-observer-archive.*

- CloudSat, GRACE, QuikSCAT, and SORCE have shown evidence of aging issues, so they received baseline funding for extension through FY15, but reduced funding in the out-years, on the assumption that one or more of them will suffer mission-ending failures. Representatives from these missions will be invited to the 2015 Senior Review for further extension if they are still operating.

- Jason-1 had been approved for extension through FY15 when it failed and was decommissioned on July 1, 2013. The Jason team has received FY14 funding for final closeout and processing of the archival dataset.

While mission Education and Public Outreach (EPO) activities were removed from planning budgets per the President's FY14 Budget Request, as of this writing missions are expected to get back most of their EPO support in FY14.

The Senior Review process involves a significant effort for the mission teams and project scientists (in particular for multi-instrument/multicenter missions), panel members, and chairs. On behalf of the broad domestic and international user communities, we thank all those who contributed their time to this process. The full 2013 Senior Review panel report is available at *science.nasa.gov/earth-science/missions/operating*.

Over the next few years, several Earth science investigations will call the International Space Station (ISS) home. While up until now the focus has been primarily on building and maintaining the ISS, the station provides a unique vantage point for a variety of science investigations. NASA and its partners have now turned their attention toward realizing the full science potential of the ISS—including for Earth observations.

In a previous issue we described the Cloud-Aerosol Transport System (CATS[1]), an aerosol and cloud lidar scheduled to launch in mid-2014 for location on the ISS Japanese Experiment Module Exposed Facility (JEM-EF). CATS will continue and expand on the science obtained from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) lidar on CALIPSO.

[1] To learn more about CATS, see "*CATS: A New Earth Science Capability*" in the May-June 2012 issue of *The Earth Observer* [**Volume 24**, **Issue 3**, pp. 4-8].

Also in 2014, the Rapid Scatterometer (RapidScat[2]) will be launched to the ISS and installed on the end of the *Columbus* module. Intended as a "bridge" between the Quick Scatterometer (QuikSCAT) instrument (which failed in late 2009 after a 10-year mission) and future Ocean Vector Wind missions, RapidScat is being assembled from hardware originally used to test parts of QuikSCAT. The ISS RapidScat instrument will provide wind vector measurements that will enhance the existing international scatterometer constellation, and provide unique cross-calibration capabilities to extend the climate data record initiated by QuikSCAT. In addition, because of the precessing ISS orbit, RapidScat will enable the first measurements of diurnal changes in ocean winds.

In early 2015 a third Stratospheric Aerosol and Gas Experiment (SAGE III on ISS) instrument will be deployed to study aerosols, ozone, and other trace gases. The instrument was built in anticipation of being attached to the space station in 2005. While plans were put on hold for several years, SAGE III on ISS now has its chance. This is nearly an exact replica of an instrument that flew on the Russian Meteor-3M satellite from 2001 to 2006; there is still one more SAGE III instrument awaiting a future flight of opportunity. Please turn to page 4 to learn more about the long legacy of SAGE.

Looking beyond, in April NASA approved plans to fly a flight-spare of the Lightning Imaging Sensor (LIS) on the ISS to detect the distribution and variability of total lightning (cloud-to-cloud, intracloud, and cloud-to-ground lightning). The original LIS currently flies on the Tropical Rainfall Measurement Mission (TRMM) satellite. The ISS orbital inclination of 51.6° will extend the measurements from TRMM–LIS farther poleward (to approximately 55°). The lightning measurements from LIS support important NASA Earth science objectives, including increased knowledge of the amount, distribution, and variability of deep convection, and natural sources and sinks of key trace gases (e.g., oxides of nitrogen) on a global scale. ISS–LIS is currently scheduled for an early 2016 launch.

Along similar lines, NASA plans to adapt the Orbiting Carbon Observatory-2 (OCO-2) flight spare instrument for deployment on the ISS JEM-EF as the third OCO mission (ISS-OCO-3) as early as 2017. Both observatories will investigate important questions about the distribution of carbon dioxide. As with RapidScat, the ISS vantage point will offer additional observing capabilities compared with the polar orbiting OCO-2 that will be part of the A-Train constellation.

[2] RapidScat was so-named because it was a quick, creative, and low-cost means to reduce the "data gap" caused by the QuikSCAT failure.

On August 26, NASA's Terra mission completed its five-thousandth day in orbit. For nearly 14 years Terra's five instruments have been collecting data that are helping scientists understand interactions among components of the Earth system. As an example, see page 16 to learn about how images from the Moderate Resolution Imaging Spectroradiometer (MODIS) are being used to track fires in Indonesia. These images provide regional context for a land-use/land-cover change study that uses Landsat images to classify land cover and assess the climate impact (regional and global) of clearing forests and draining peatland to accommodate large-scale oil-palm production in Indonesia.

On page 8 of this issue we report on what is anticipated to be the final data release from the High Resolution Dynamics Limb Sounder (HIRDLS) instrument on Aura; it is worth noting the end of this instrument's successful run. The soft blanketing in the optical cavity shredded at launch, blocking a large portion of the scan mirror and preventing a full range of azimuthal scanning. The HIRDLS team worked tirelessly to separate the atmospheric signal from the contaminant signal due to the blockage, coaxing a great deal of science information out of the crippled instrument. The team succeeded in retrieving all but one of the gas species it was designed to measure—achieving higher vertical resolution profiles than any predecessor instrument. Data are available from January 29, 2005, through March 17, 2008, at which point the chopper ceased functioning. Subsequent efforts to restart the chopper have not been successful. Congratulations to HIRDLS Principal Investigators **John Gille** [National Center for Atmospheric Research] and **Lesley Gray** [University of Oxford] and the entire HIRDLS team on maximizing the science from this sensor. For more information on the *Version 7* release, visit: *www.eos.ucar.edu/hirdls/data/products/HIRDLS-DQD_V7-1.pdf*.

There is also news from *The Earth Observatory*: Its sister-site, NASA Earth Observations (NEO), has been redesigned. NEO is a repository of imagery derived from selected global NASA Earth science data. Over 50 different global datasets and images (daily, weekly, and monthly) are available in a variety of common formats, meeting the needs of museums, science centers, and the popular media. Established in 2005, the site serves about 5-7 million downloaded images per year. To find out more I invite you to visit: *neo.sci.gsfc.nasa.gov*. In addition to the new design, the Aquarius sea-surface salinity dataset is now on NEO. Data are available from August 2011 to the present—in both weekly and monthly composites. Special thanks go to the Aquarius data and outreach teams for their assistance. To view the data, visit: *neo.sci.gsfc.nasa.gov/view.php?datasetId=AQUARIUS_SSS_M*. ■

feature articles

The SAGE Legacy's Next Chapter: SAGE III on the International Space Station

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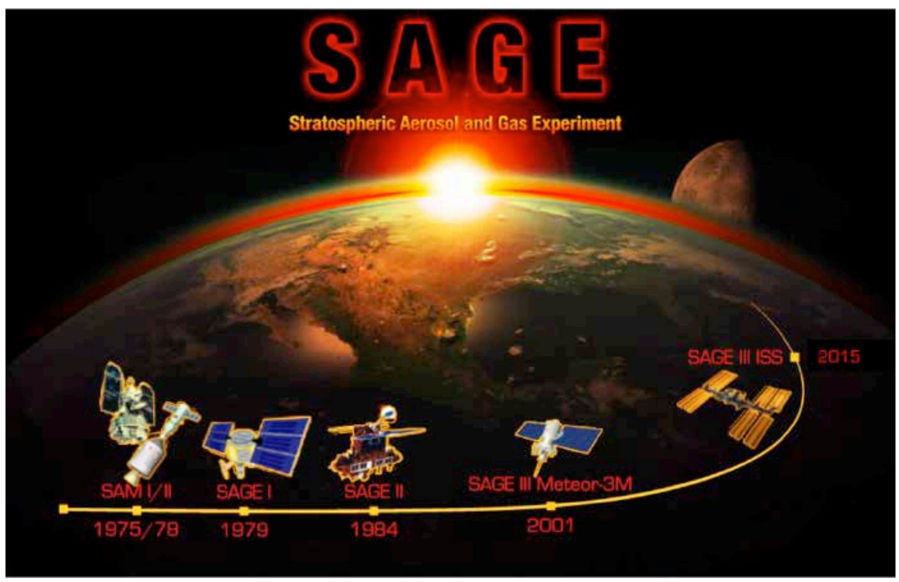
When SAGE III was developed, three identical instruments were built: one launched on the Russian Meteor-3M spacecraft on December 10, 2001; one was built specifically to fly on the International Space Station (ISS); and the other is planned for launch on a future flight of opportunity.

Historic Observations: SAM I and II

Tiny solid or liquid particles suspended in Earth's atmosphere, known as *aerosols*, and atmospheric ozone affect all of Earth's inhabitants. The Stratospheric Aerosol and Gas Experiment (SAGE) family of instruments has long measured stratospheric aerosol and ozone concentrations—see *Observing Ozone Through the Years* on the next page—also enhancing our understanding of the distribution and roles of atmospheric water vapor and other trace gases.

Before the first SAGE mission in 1979, however, there were two Stratospheric Aerosol Measurement (SAM) missions—SAM I and SAM II. Consisting of only a single-channel sunphotometer—used to measure the Sun's intensity—and a camera, SAM I flew on an Apollo spacecraft during the Apollo–Soyuz Test Project in July 1975. The mission proved that the concept of making observations of stratospheric aerosol from space was viable. During the nine-day mission, solar photographs were taken and measurements were recorded by the sunphotometer. A balloonborne aerosol counter and a ground-based laser system later verified those SAM I observations.



A timeline showing the SAGE legacy, beginning with SAM I and continuing to the upcoming SAGE III on ISS mission. **Image credit:** NASA

Success with the SAM I experiment led to the launch of SAM II, which flew on the Nimbus-7 spacecraft from 1978 until 1993, and provided vertical profiles of aerosols over both the Arctic and Antarctic polar regions. Designed to develop a stratospheric aerosol database for the polar regions, data from SAM II allowed scientists to study changes in aerosol concentrations as a function of seasonal and short-term meteorological variations, atmospheric chemistry, cloud microphysics, volcanic activity, and other disruptions. SAM II was a spectrometer that used *solar occultation* as its measurement technique: The instrument pointed toward the Sun as its light source and scanned the limb, or thin profile, of Earth's atmosphere. The SAM experiments demonstrated that solar-occultation measurements by photometer and camera could be used to determine the vertical distribution of stratospheric aerosols. With this now-proven method, scientists and engineers began developing the first SAGE instrument.

Observing Ozone Through the Years

Ozone (O_3) is a highly reactive molecule made up of three atoms of oxygen. It is created and destroyed naturally, a process mediated by sunlight. Although it represents a tiny fraction of the atmosphere (0.02 – 0.1 parts per million (ppm) based on volume), O_3 is vital for life on Earth. O_3 is found mostly in the stratosphere—a layer of the atmosphere between 10 and 31 miles (~16 to 50 km) above the surface. The so-called *ozone layer* acts as Earth's sunscreen, protecting the biosphere from receiving too much of the Sun's ultraviolet (UV) radiation, and is therefore vital for life on Earth—see **Figure 1**.

Without the ozone layer, the Sun's intense UV radiation would sterilize Earth's surface. A decrease in the concentration of O_3 at this level could lead to more-intense UV-B and UV-A radiation exposure at Earth's surface, which could subsequently lead to higher risks of contracting sunburn, more cases of skin cancer, increased incidence of cataracts, and reduced crop yields.

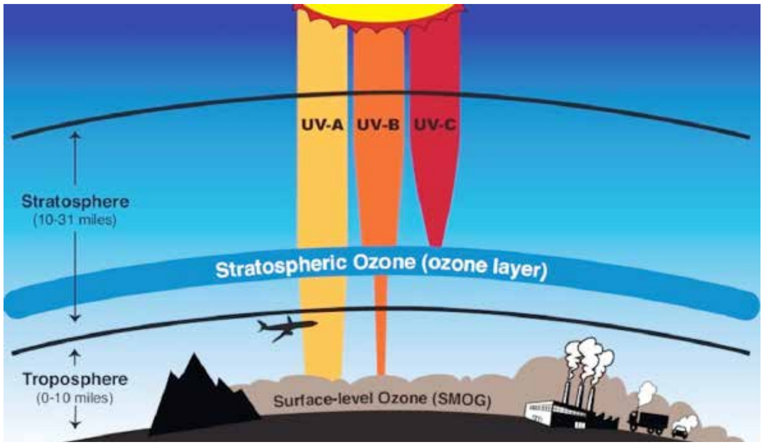


Figure 1. The graphic shows how the stratospheric ozone layer functions as Earth's "sunscreen" and blocks the majority of the Sun's UV radiation (i.e., most UV-B and all UV-C) from reaching the planet's surface. It also shows ozone in the troposphere, which is closer to Earth. Surface-level ozone is called *smog* and is a pollutant. **Image credit**: NASA

Note: While the focus of this article is on SAGE and stratospheric ozone profiling, a history of ozone is not really complete without mentioning the series of Total Ozone Mapping Spectrometer (TOMS) instruments that flew on the Nimbus 7, Russian Meteor-3, Japanese Advanced Earth Observing Satellite (ADEOS), and EarthProbe spacecrafts, and provided continuous measurements from 1978–1994, and again from 1996–2006. More recently, the Atmospheric Infrared Sounder (AIRS) on Aqua (2002) and the Ozone Monitoring Instrument on Aura (2004) have continued these measurements begun by TOMS.

In the early 1980s scientists discovered that when human-made chlorofluorocarbons (CFCs)—used for many years as refrigerants and in aerosol spray cans—break down, they release atomic chlorine (Cl), which greatly accelerates ozone destruction (**Figure 2**). By 1985 ozone levels around the world had continued to drop and scientists discovered thinning of the ozone layer particularly over polar regions in the spring months—and coined the phrase *ozone hole* to describe this phenomenon. This was the impetus for international efforts to further study stratospheric ozone. As a result, scientists and policy makers negotiated the Montreal Protocol. Signed in 1987, the treaty limited the production of CFCs and other ozone-depleting substances.

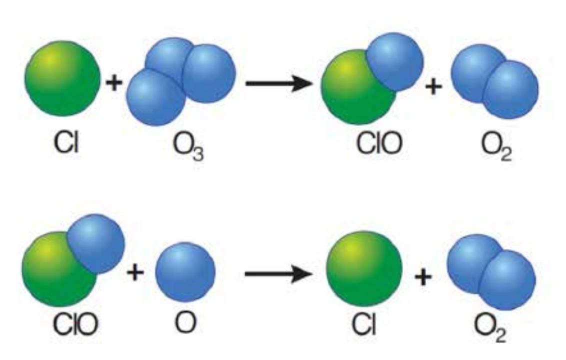


Figure 2. Stratospheric ozone is created and destroyed through reactions with chlorine (Cl), mediated by sunlight. **Image credit:** NASA

The Stratospheric Aerosol and Gas Experiment (SAGE) mission was launched in 1979; in 1990 the U.S. Clean Air Act mandated that NASA continue to monitor ozone. As a result, the SAGE family of instruments observed ozone concentrations, along with water vapor, aerosols, and trace gases, from 1979 to 2006. A second SAGE III instrument—planned for launch in 2015—will continue this legacy of accurate measurements—this time from the International Space Station (ISS). A third and final SAGE III instrument awaits a future flight of opportunity.

Global Aerosol and Ozone Observations: SAGE I and II

The first SAGE mission, SAGE I, was launched February 18, 1979 on the Applications Explorer Mission-B (AEM-B) satellite; it collected valuable data for nearly three years until the satellite's power system failed. Measurements from SAGE I allowed the scientific community to develop a global map of the distribution of aerosols and important trace constituents necessary to understanding global, seasonal, and interannual variability in stratospheric ozone concentrations. Data from SAGE I were used to develop a database of global stratospheric concentrations of ozone, aerosols, and nitrogen dioxide (NO_2). These data are still used to study trends, atmospheric dynamics and transport, and potential climatic effects of these species. In the early 1980s a second-generation instrument was built to continue generation of SAGE's unique datasets.

SAGE II launched on the Earth Radiation Budget Satellite (ERBS) in October 1984; it observed stratospheric ozone from 1984 until 2005. This long-term, stable dataset has proven invaluable in determining trends in ozone distribution and amount. Data from SAGE II, in conjunction with data from SAM II and SAGE I, can be used to estimate long-term constituent trends and identify responses to episodic events such as volcanic eruptions. Major results from SAGE II include the stratospheric impact of the 1991 Mount Pinatubo eruption, identification of a negative global trend in lower-stratospheric ozone levels during the 1980s, and quantitative verification of positive water-vapor feedback in current climate models. Data from SAGE II were integral in confirming human-driven changes to ozone concentrations in the stratosphere, and thus influenced the decisions to negotiate the Montreal Protocol in 1987. Later, observations from SAGE II showed that ozone in the stratosphere stopped decreasing in response to the actions agreed to in the treaty. Building on previous successes, a third-generation instrument was developed to ensure continuous measurements and to generate new data products.

The multidecadal ozone and aerosol datasets from SAGE instruments have undergone intense scrutiny, becoming the international standard for accuracy and stability as a result.

SAGE III Times Three

When SAGE III was developed, three identical instruments were built: one launched on the Russian Meteor-3M spacecraft on December 10, 2001; one was built specifically to fly on the International Space Station (ISS); and the other is planned for a future flight of opportunity. The first two of these will be discussed here.

SAGE III Meteor-3M

Launched in 2001, SAGE III Meteor-3M was a crucial element in NASA's Earth Observing System (EOS). Data from the mission enhanced scientists' understanding of natural and human-derived atmospheric processes. Observations from SAGE III Meteor-3M—that began with data from SAGE I and II—provided the basis for identifying five of the nine critical constituents called out in the U.S. National Plan for Stratospheric Monitoring, including profiles of aerosols, O_3, NO_2, water vapor, and air density (using O_2 as a reporting species).

The multidecadal ozone and aerosol datasets from SAGE instruments have undergone intense scrutiny, becoming the international standard for accuracy and stability as a result—see **Figure 3,** next page. Aerosol data from SAGE are recognized as necessary for understanding ozone trends and predicting climate change. The SAGE ozone product is accurate to better than 1%, and has a vertical resolution of 1 km (~3280 ft) or better.

The SAGE III Meteor-3M mission ended on March 6, 2006, due to a power supply system failure, resulting in loss of communication with the satellite; this left a gap in valuable SAGE data. Two additional copies of SAGE III remained, and as the ISS neared completion in the mid-2000s, plans were developed to fly one of them on that platform.

SAGE III on ISS

Because no active SAGE instrument had been available since 2005, the international scientific community started requesting new (additional) data. The decision to fly a

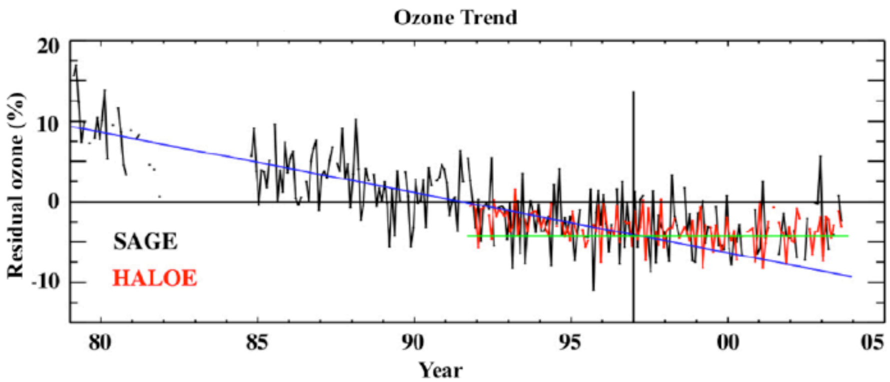


Figure 3. This graph combines data from the first three SAGE instruments, with data from the Halogen Occultation Experiment (HALOE), which flew on the Upper Atmospheric Research Satellite (UARS) and launched from the Space Shuttle *Discovery* in 1991 and operated until 2005. It depicts the decline of ozone with a trend of -7.47% (± 1.04%) per decade between 1979 and 1996. Ozone concentrations stabilized around 19970, ten years after the Montreal Protocol, and have since started to show signs of recovery. **Image credit**: Originally appeared in *The 2006 WMO/UNEP Assessment, Scientific Assessment of Ozone Depletion*.

copy of SAGE III on the ISS came in 2010 with the fiscal year 2011 NASA budget; in 2011 scientists and engineers began preparing SAGE for the ISS. *SAGE III on ISS* will be among the first continuously Earth-observing instruments on the Space Station[1], and among the first NASA Earth-science payloads to be launched on a commercial space vehicle—scheduled to launch on a SpaceX Falcon 9 in early 2015. The instrument, built by Ball Aerospace and Technology Corporation, was refurbished and is being tested at NASA's Langley Research Center (LaRC) in Hampton, VA.

The ISS was designed to allow Earth-observing experiments. Its midinclination orbit allows for a large range in latitude sampling, and it offers scientists and engineers near-continuous communications with payloads. The ISS orbit allows SAGE III to observe ozone during all seasons and globally—including over polar regions. Using the moon as a light source, SAGE III on ISS will detect ozone during the darkness of polar winter. SAGE III on ISS will also measure ozone concentrations deeper into the atmosphere than ever before, reaching into the troposphere—up to where planes fly and down to where people live.

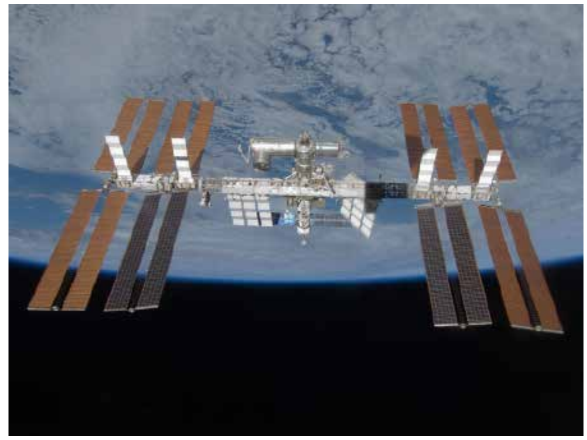
Scientists and engineers have had to come up with innovative solutions to fly SAGE III on the ISS and on the vehicles available to transport it there. To make its measurements, SAGE needs to be oriented facing nadir, or toward Earth. The location where SAGE will be installed does not provide a nadir-facing platform, so the instrument payload (IP) will be mounted to a Nadir Viewing Platform (NVP), an L-shaped bracket designed and built at LaRC. The NVP and IP will be attached to an ExPRESS Pallet Adapter (ExPA), the standard interface used on the ISS. A robotic arm will be used to attach the whole payload to the ISS.

Because no active SAGE instrument had been available since 2006, the international scientific community started requesting new (additional) data. The decision to fly SAGE III on the ISS came in 2010 with the fiscal year 2011 NASA budget; in 2011 scientists and engineers began preparing SAGE for the ISS.

SAGE III on ISS must also adapt to unique ISS physical and chemical environments and busy operations. To avoid contamination from the ISS and visiting vehicles, a special contamination-monitoring package was developed. If contamination near the instrument ever approaches unsafe levels, a clear contamination door on the instrument's sensor assembly will close to protect it, yet still allow measurements to be taken. There is also a disturbance-monitoring package to help identify and reduce noise in the instrument signal. Further, the orientation of the ISS, its attitude, cannot be controlled in the same way that can be done with a smaller, free-flying satellite. As a result, the SAGE III IP includes a Hexapod Pointing System (HPS). The HPS is a combination of a mechanical assembly and electronics unit that can adjust the instrument's pointing direction up to eight angular degrees, using six actuators to account for small directional changes in the ISS. The SAGE III on ISS Project team is working with a number of international partners to prepare the payload; these include NASA's Johnson Space Center, NASA's Marshall Space Flight Center, Ball Aerospace and Technology Corporation, SpaceX, Thales Alenia Space-Italia, and the European Space Agency.

[1] To learn more about the plans for Earth observations from ISS, please see the Editor's Corner in this issue (page 2.)

Scientists and engineers at LaRC work to prepare the SAGE III sensor assembly for launch with the rest of the payload on a SpaceX Falcon 9 in 2015. **Image credit**: LaRC



The ISS provides a unique and beneficial platform for SAGE III. **Image credit**: NASA

Observations from SAGE III on ISS will be validated just as they have been during previous SAGE missions: Data from a number of similar instruments will be used to assess between-sensor biases and precision. Validation plans for SAGE III on ISS include working with ongoing ground-based operations, including the Network for the Detection of Atmospheric Composition Change (*www.ndsc.ncep.noaa.gov*), spaceborne sensors, and balloon-based ozone measurements, including those from the Southern Hemisphere Additional Ozonesondes (SHADOZ) network (*croc.gsfc.nasa.gov/shadoz*).

Conclusion

With SAGE III on ISS scientists expect to track the recovery of stratospheric ozone since ratification of the Montreal Protocol. By the 2020s—in most areas—expectations are that ozone will recover to about half of the amount lost since the pre-1980 levels. SAGE III will also be valuable in assessing the performance of the Ozone Mapping and Profilier Suite (OMPS) flying on the Suomi National Polar-orbiting Partnership (NPP). Data from SAGE III on ISS will help to reinstitute aerosol measurements crucial for more-accurate long-term climate and ozone models. SAGE III will also be valuable in assessing the performance of the Ozone Mapping and Profilier Suite (OMPS) flying on the Suomi National Polar-orbiting Partnership (NPP). Data from the Atmospheric Chemistry Experiment (ACE)—a concurrent satellite mission on the Canadian SCISAT-1—will be combined with data from SAGE III to produce a tropopause dataset. In addition, a new Science Utilization Team, led by researchers at Hampton University in Virginia, will assess SAGE III on ISS data products.

The remaining SAGE III instrument is being kept safe at LaRC for a future flight of opportunity. Once this last copy has been deployed, a new generation of instruments will be needed to continue the long-term record of stratospheric ozone and aerosol concentrations.

To learn more about SAGE, visit: *sage.nasa.gov.* ■

Data Release: Version 007 HIRDLS Atmospheric Products

The High Resolution Dynamic Limb Sounder (HIRDLS) team is pleased to announce the release of its *Version 007* Atmospheric Data Products, which include Level-2 products, Level-3 mapping-coefficient products, and Level-3 gridded products. This likely will be the final version of HIRDLS data.

These data are now publicly available from NASA's Goddard Earth Sciences Data and Information Services Center (GES DISC). The HIRDLS latest improved algorithms (V7.00.00 and V7.05.00) include newly added measurements of water (H_2O), nitrous oxide (N_2O), nitrogen dioxide (NO_2), and chlorine nitrate ($ClONO_2$).

All HIRDLS products, available from January 29, 2005 to March 17, 2008, have a vertical resolution of 1 km (~3280 ft) and are spaced approximately 100 km (~62 mi) apart along the orbit track. Additional information is available at

disc.sci.gsfc.nasa.gov/datareleases/hirdls_v007_data_release.

NASA Reaches Conservation Biology Community

Heather Hanson, NASA's Goddard Space Flight Center, Global Science and Technology, heather.h.hanson@nasa.gov

This year, for the first time ever, NASA participated as an exhibitor at the Society for Conservation Biology's 26th International Congress for Conservation Biology (ICCB), held July 21-25 at the Baltimore Convention Center in Baltimore, MD. The biennial ICCB conference is highly recognized as the most important international meeting for conservation professionals and students. More than 1500 attendees—representing more than 60 countries—had the opportunity to visit the exhibit and talk with scientists who use NASA's Earth-observation data to study biodiversity within the Earth system.

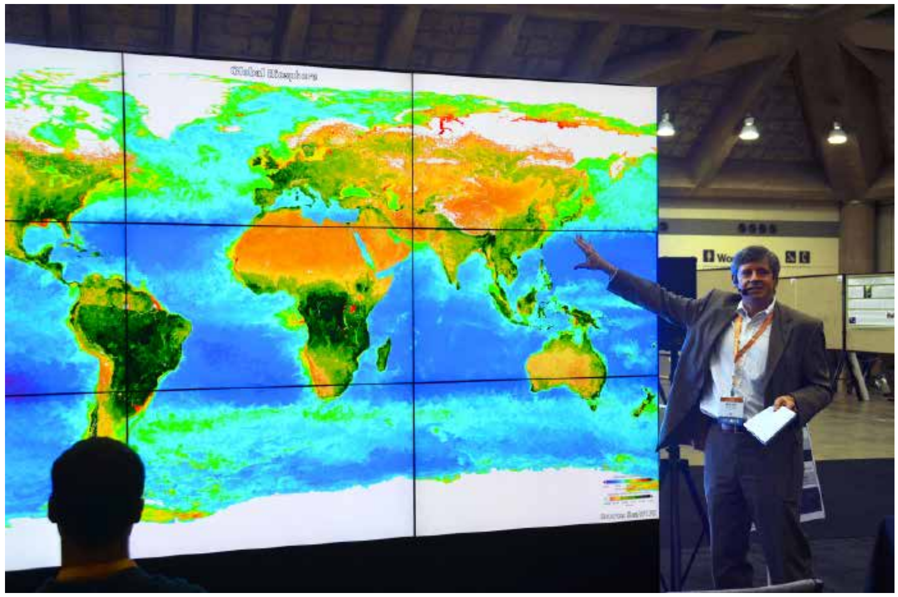
More than 1500 attendees—representing more than 60 countries—had the opportunity to visit the exhibit and talk with scientists who use NASA's Earth-observation data to study biodiversity within the Earth system.

Using NASA's hyperwall as a way to engage conference attendees, **Woody Turner** [NASA Headquarters (HQ)—*Program Scientist for Biological Diversity*] provided an overview of NASA's Earth-observing satellite fleet and described how data from these missions can be used to study biodiversity. Turner showed a number of examples of environmental change in the past decade, including deforestation, human consumption patterns, rising global temperatures, and a decline in Arctic sea ice extent. He described how the vantage point of space provides a unique perspective from which to observe biodiversity and the impacts of environmental change at local, regional, and global scales.

A number of NASA-funded scientists from universities and research institutions also gave dynamic science presentations using the hyperwall—see **Table** below. The presentations highlighted the usefulness of NASA's Earth-observing datasets to study biodiversity and ecosystems. The research topics were well received and generated significant discussion about using remote sensing applications to solve real-world conservation biology issues.

Table. ICCB hyperwall talks and presenters.

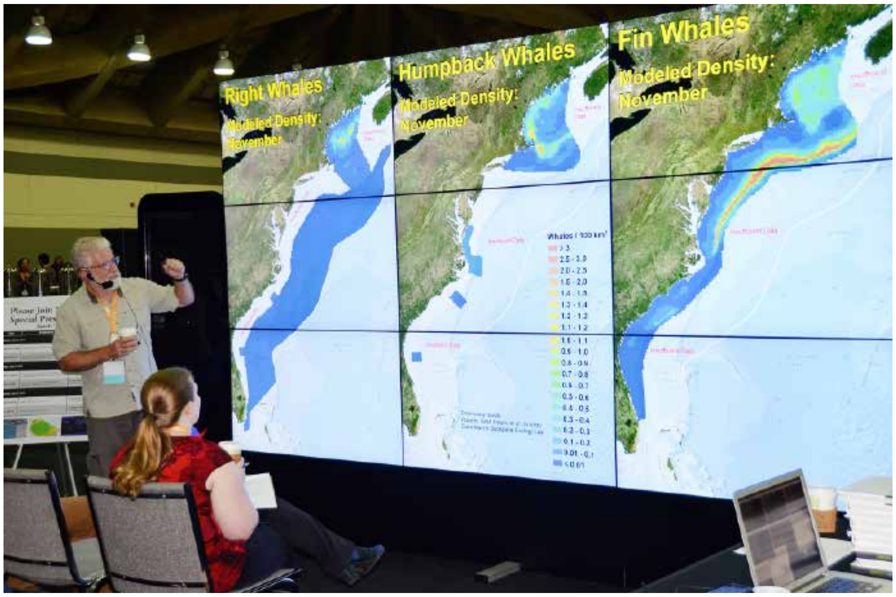
Presenter	Presentation Title
Woody Turner *NASA Headquarters*	Observing the Earth's Climate Conditions
Kristin Laidre *University of Washington*	Impacts of Climate Change on Pack Ice and Associated Arctic Marine Mammals
Pat Halpin *Duke University*	Integrating Ocean Observing Data to Enhance Protected Species Spatial Decision Support Systems
Joe Sexton *University of Maryland, College Park*	Chasing the Green Wave: Wildlife Movement in Response to Vegetation Phenology in the Western U.S.
Scott Goetz *Woods Hole Research Center*	Enabling Conservation from Space
Allison Leidner *NASA Headquarters*	Life on Earth: The View from Space



Woody Turner [NASA HQ] showed global ocean chlorophyll concentrations combined with Normalized Difference Vegetation Index over land, derived from NASA's SeaWiFS mission, to depict the global biosphere. **Image credit:** NASA

ICCB meeting participants enjoyed a series of NASA hyperwall talks during coffee breaks. **Image credit:** NASA

Scott Goetz [Woods Hole Research Center] showed how establishing high biomass corridors between parks and protected areas in the tropics provides the potential not only to mitigate climate change, but also to preserve biodiversity. **Image credit:** NASA



Pat Halpin [Duke University] displayed results that showed how sea surface temperature influenced three types of whale species in the Atlantic. **Image credit:** NASA

Kristin Laidre [University of Washington] described the impacts of climate change on polar bear migration patterns. **Image credit:** NASA

To close the event, **Allison Leidner** [NASA HQ] presented a final hyperwall talk titled *Life on Earth: The View from Space*. Leidner strongly emphasized the usefulness of NASA Earth-observation datasets, stating that satellites provide the temporal and spatial resolution needed to observe environmental change and the interactions between different Earth system components, and how these data enable the development of global models. She noted that within NASA's Applied Sciences Program, the goal of the Ecological Forecasting program is to provide reliable forecasts that allow decision makers access to science-based tools to predict the impacts of environmental change on the ecosystems that support the variety of life on Earth.

Shown here are some images from the event. To view more photos, visit the NASA Earth Observing System Project Science Office *flickr* website at *www.flickr.com/photos/eospso/sets/72157634879362002*. ■

NASA Satellite Data Used to Study the Impact of Oil Palm Expansion Across Indonesian Borneo

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Kimberly M. Carlson, Institute on the Environment, University of Minnesota, kimcarlson@gmail.com
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Alexandra Ponette-González, Department of Geography, University of North Texas, alexandra@unt.edu

The conversion of forest land to plantations represents a significant source of global greenhouse gas emissions, while smoke from fires used to clear land is a major source of air pollution that adversely impacts human health and productivity in Southeast Asia

Introduction

Industrial agricultural plantations are a major source of land-cover change in the tropics. In Indonesia, vast amounts of land are being converted to accommodate large-scale production of palm oil, which is used as a cooking oil, in processed foods, soaps and cosmetics, and as a source of biodiesel fuel—see **Figure 1b-c**. According to the U.S. Department of Agriculture's Foreign Agricultural Service, Indonesia is the world's top producer of palm oil, generating 52% of global production in 2012-2013, while Malaysia ranks second, producing 34%. Within Indonesia, virtually all palm oil production—approximately 96%—occurs on the island of Sumatra and across Kalimantan, the Indonesian part of the island of Borneo—as shown in **Figure 1a**. NASA-funded research has studied the conversion of forests and community-managed agricultural lands to oil palm plantations within Indonesia, a topic of both global and regional importance: The conversion of forest land to plantations represents a significant source of global greenhouse gas emissions, while smoke from fires used to clear land is a major source of air pollution that adversely impacts human health and productivity in Southeast Asia—see *Indonesian Fires Envelop Singapore in Haze* on page 16.

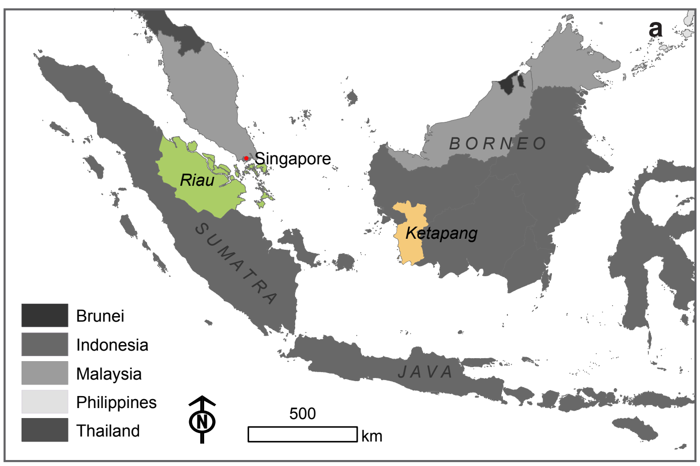


Figure 1. (a) Sumatra and Indonesian Borneo (Kalimantan) are hubs of palm oil production in Indonesia. In Sumatra, production is concentrated within Riau province, just west of Singapore and southern Peninsular Malaysia. Indonesia's West Kalimantan district of Ketapang is also highlighted. (b) Fire is typically used to prepare land for oil palm planting in West Kalimantan, Indonesia. (c) Oil palm fruit. **Image Credit:** (b, c) Yadi Purwanto

Many of the diagrams and figures in this feature article are better represented in color. To view this article and the entire issue in color online, visit: eospso.nasa.gov/earth-observer-archive.

Links and References

NASA Land-Cover Land-Use Change (LCLUC) Project Page: *lcluc.umd.edu/project_details.php?projid=223*
For more information about Carnegie Land Analysis System Lite (CLASlite): *claslite.stanford.edu*
For more information about Dinamica EGO: *csr.ufmg.br/dinamica*
Fire data used in this article available on-line at: *earthdata.nasa.gov/firms*

Mapping Oil Palm Expansion using Landsat Data

Researchers funded through NASA's Land-Cover/Land-Use Change Program have been using Earth-observing data to document the timeline of oil-palm development and the impacts of expanded palm-oil production across Kalimantan. Scientists digitized remotely sensed areas cleared for or planted with oil palm using 35 Landsat 5 Thematic Mapper and Landsat 7 Enhanced Thematic Mapper Plus reflectance images at 30-m (~98-ft) resolution to produce the first comprehensive maps of oil-palm expansion across Kalimantan—see **Figure 2**. Oil palm plantation area expanded from ~350 mi^2 (~900 km^2) in 1990 to ~12,220 mi^2 (~31,600 km^2) by 2010, ultimately occupying 9% of lowlands (under 300-m elevation) outside of protected areas.

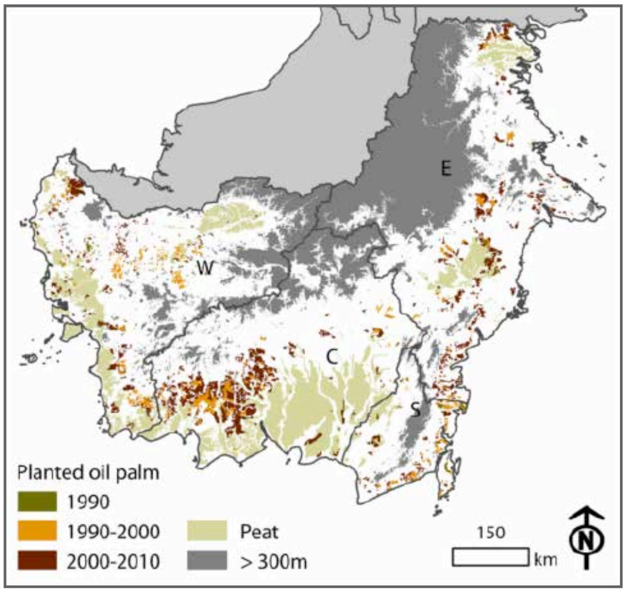


Figure 2. This Landsat-derived map of oil palm plantation expansion across Kalimantan [i.e., Indonesian Borneo, ~208,000 mi^2 (~540,000 km^2)] shows planted oil palm in 2010 distributed among West (W; 28%), Central (C; 40%), South (S; 8%), and East (E; 23%) Kalimantan provinces. Malaysian Borneo and the country of Brunei are light gray. **Image credit:** Modified from Carlson *et al.*, Nature (2012), *dx.doi.org/10.1038/Nclimate1702.*

To assess carbon emissions generated from oil-palm expansion, researchers needed a way to quantify the land-cover sources for oil palm. In a novel application of a cutting-edge classification system—Carnegie Land Analysis System Lite, originally developed for use in the Amazon through NASA-funded research—researchers produced land-cover maps across Kalimantan for the 1990 and 2000 periods using 116 Landsat images obtained between 1988 and 2002.

A typical example of plantation expansion (i.e., converting forest to oil palm), as tracked by the land-cover classifications and digitized oil-palm areas, can be seen in **Figure 3**, next page. The ability to accurately map logged forests, highly heterogeneous agroforests, and rain-fed rice fallows, as well as forest lands (seen at lower left in **Figure 3d**) represents a major advance over previous classification efforts. This region has been subject to extensive logging, and contains extensive agroforest lands that support community livelihoods and represent a substantial carbon store. Thus, accurately capturing such fine-scale land-cover mosaics was essential to reflect the on-the-ground reality.

When land-cover analysis is only done once every ten years or so, nuances of land-cover change can be masked. To track more subtle change, it is necessary to complement large-scale assessments with more focused classifications of smaller regions. For example, within West Kalimantan's coastal district of Ketapang (see **Figure 1a**), the NASA-funded research team used 11 Landsat images to generate a classified time-series that spanned 1989 to 2008. The study region analyzed was limited to the Landsat extent, and covered an area of ~4600 mi^2 (~12000 km^2). Classifications were produced at one-to-seven-year intervals, depending upon the availability of cloud-free imagery. The study region is home to nearly 1090 mi^2 (~2800 km^2) of protected areas, the largest of which is the ~390 mi^2 (~1000 km^2) Gunung Palung National Park (GPNP)—which provides important habitat for the endangered orangutan. While Ketapang spans a diversity of soils and vegetation types, approximately half of

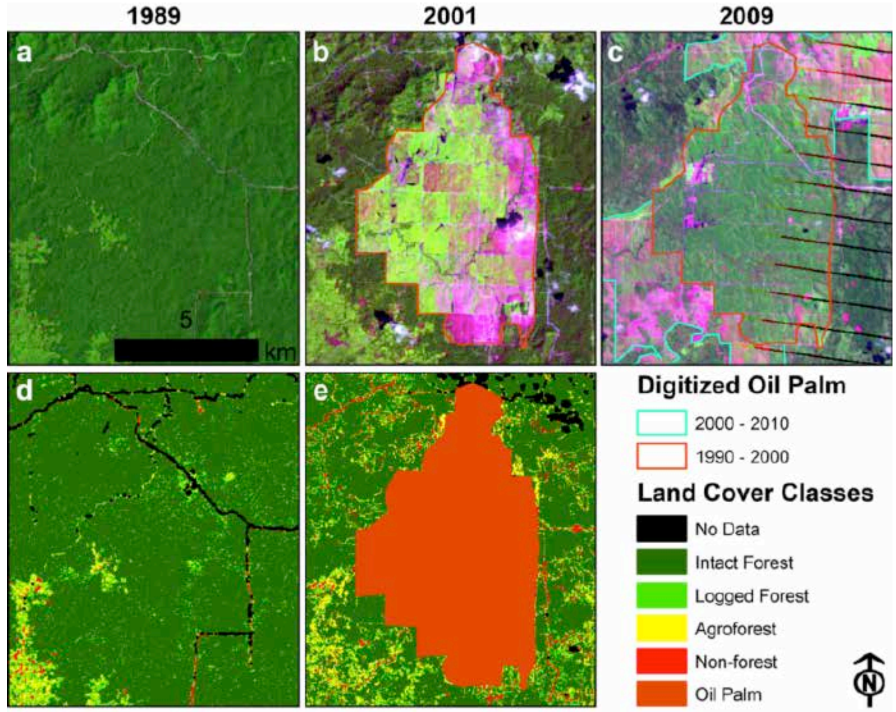


Figure 3. Digitized oil-palm areas overlaying Landsat imagery from (a) February 6, 1989; (b) December 8, 2001; and (c) August 8, 2009, are shown. The corresponding land-cover classifications are shown in (d) and (e). In 1989 (a,d), this area of Central Kalimantan was 88% intact forest, 7% logged forest, 1% agroforest, and <1% nonforest. By 2001 (b, e), 16 mi² (42 km²) had been cleared for oil palm. By 2009 (c), oil palm had expanded to the northeast and southwest of the maturing plantation area. Stripes in the Landsat 7 scan line-corrector-off image (c) from 2009 are locations where no data were obtained. **Image credit:** Modified from Carlson *et al.*, Nature (2012), *dx.doi.org/10.1038/Nclimate1702.*

the focal region is peatland. (Borneo as a whole is 12% peatlands.) Peatlands must be drained by networks of canals to facilitate oil-palm cultivation, a process that results in oxidation of organic matter and generation of carbon dioxide (CO_2) emissions that continue through time post conversion. In addition, peatland burning releases large pulses of CO_2 to the atmosphere.

The Ketapang analysis revealed that as of 2008, ~90% of the ~2,330 mi² (~6,035 km²) covered by plantation leases remained undeveloped. The majority of the lease areas targeted for future development are located on carbon-rich peatlands. Although only 6% of land outside protected areas had been cleared for or planted with oil palm in 2008, oil palm spanned 14% of unprotected land by 2011—see **Figure 4a-b**. From 1994 to 2011, 49% of oil palm development resulted in conversion of lowland forested areas. These areas are classified as "Intact" and "Logged/Sec." forests in **Figure 4b**.

Ketapang's subdecadal expansion dynamics were fed into a spatially explicit model of land-cover change, which included a carbon-bookkeeping component. The model, built on the Dinamica EGO platform, was designed to assess carbon emissions resulting from clearing land for oil-palm plantations, and to project future emission and land-cover change scenarios through 2020. Scenario results reveal that under business-as-usual (BAU) conditions, 2020 forest cover is projected to decline to 24% of the region, while oil palm expands to occupy 41% of unprotected lands (**Figure 4c**); much of this new development would occur on carbon-rich peatland. In comparison, a forest protection scenario that prohibits conversion of intact, secondary, and

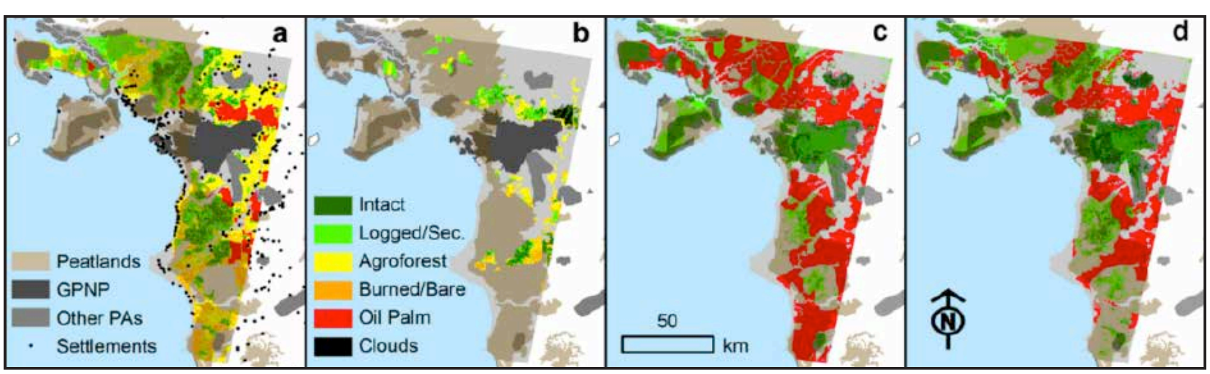


Figure 4. (a) Land cover within Indonesia's West Kalimantan district of Ketapang in 2008, as derived from Landsat data. (b) Land-cover sources for oil palm developed from 1994 to 2011. Future land-cover maps c and d were chosen from 60 model runs per scenario. (c) Business-as-usual scenario, 2020. (d) Forest Protection scenario, 2020. **Image credit:** Carlson *et al.*, PNAS (2012), *dx.doi.org/10.1073/pnas.1200452109.*

logged forests in protected areas and undeveloped oil-palm leases, presents an alternative, yielding 36% greater forest fraction (leaving 32% of the region forested) and 28% lower oil-palm area (~30% of non-protected lands developed with oil palm) in 2020 (**Figure 4d**). Disappointingly, the current moratorium on oil-palm expansion into primary forests and peatlands, enacted by the Government of Indonesia in 2011 and recently extended to 2015, is projected to reduce CO_2 emissions by only 3–4% as compared to BAU emission rates. The model further suggests that uncontrolled fire may undermine the effectiveness of the moratorium.

More than 140 million metric tons of CO_2 were emitted to the atmosphere in 2010 alone, while 2020 CO_2 emissions are projected to exceed ~560 million metric tons. If fires are used to clear land—including peat soils—for oil palm plantations, Kalimantan alone would generate 34% of Indonesia's 2020 land-sourced carbon emissions.

At the Kalimantan-wide level, researchers considered the potential of *reduced emissions from deforestation and forest degradation* (REDD+) credits to compete with oil-palm revenues. They found that REDD+ initiatives could be economically competitive with oil palm only when peatland burning was factored into avoided-emissions estimates. Although REDD+ initiatives may be successful if focused on peatlands, economic tradeoffs are highly dependent on the market price of forest carbon.

Oil Palm Impacts on Global Carbon Cycle

Since 1990, oil-palm plantations have cleared approximately 6180 mi^2 (~16,000 km^2) of Kalimantan's primary and logged forests, potentially accounting for ~60% of Kalimantan's total forest cover loss from 2000 to 2010. Development of oil-palm plantations in Kalimantan is a globally significant source of CO_2 emissions: More than 140 million metric tons of CO_2 were emitted to the atmosphere in 2010 alone, while 2020 CO_2 emissions are projected to exceed ~560 million metric tons—an amount greater than all of Canada's current fossil fuel emissions. If, as is frequently observed, fires are used to clear land—including peat soils—for oil-palm plantations, Kalimantan alone would generate 34% of Indonesia's 2020 land-sourced carbon emissions.

Within Ketapang, fire was implicated as the cause of more than 90% of deforestation between 1989 and 2008. Yet, the sources of fire—whether clearing for industrial agriculture or smallholder upland rice, or wildfires escaping during major droughts—cannot be adequately reconstructed. Despite the dominance of fire, by 2007–2008 oil palm accounted for 27% of total deforestation—and 40% of peatland deforestation. These findings reveal a distinct shift in plantation land sources. While 81% of expansion was concentrated within forests on mineral soils between 1994 and 2001, between 2008 and 2011, 69% of plantation expansion occurred within carbon-rich peatlands. Without strong restrictions on peatland deforestation and development, almost 90% of CO_2 emissions from oil-palm plantations in the Ketapang study area are projected to come from peatlands by 2020.

Leases represent a vast land bank and carbon store, which—if released—could significantly influence the global carbon cycle.

Complementary to the satellite-derived products and key to the modeling efforts were a comprehensive set of Kalimantan oil-palm land-lease records collected in person from local and regional governmental agencies and then digitized. The total allocated leases spanned ~46,000 mi^2 (~120,000 km^2), covering one-third of Kalimantan's lowlands outside protected areas. Yet, 80% of these leases remained unplanted in 2010. When lease areas were analyzed in conjunction with the satellite-derived maps of developed oil-palm and land-cover classifications, the great potential for future forest loss and carbon emissions from Kalimantan became clear: *Leases represent a vast land bank and carbon store, which—if released—could significantly influence the global carbon cycle.*

Conclusion

A fusion of NASA remote-sensing satellite data from Landsat, plantation lease data, and innovative mapping and modeling techniques have enabled a detailed assessment of land-use change and carbon emissions from oil-palm expansion across Kalimantan. Breakthroughs in mapping mosaics of logged forest and agroforests were also achieved. With vast allocated oil palm plantation leases largely undeveloped, modeled future scenarios suggest that a moratorium on oil-palm expansion will do little to curb carbon emissions over the next decade. *Any strategy to reduce carbon emissions from oil palm must focus on protecting peatlands from conversion.* ■

Indonesian Fires Envelop Singapore in Haze

Following days of smoke and haze, for a short time on June 21, 2013, Singapore's Pollutant Standards Index (PSI) hit a record high of 401—a level considered hazardous to human health. Regional schools and outdoor attractions were closed and all residents were advised to stay indoors, crippling productivity. The source of the haze was myriad fires in Riau province, Sumatra—see **Figure 1** of accompanying feature, page 12. Here, oil-palm and pulpwood plantation companies, as well as smallholder farmers, take advantage of the dry season (June to October) to clear land with fire—despite regulations that prohibit plantations from using fire to clear land. Although haze from Indonesian forest fires often affects Southeast Asia during the dry season, the severity of the 2013 haze put significant stress on Indonesia's relations with Malaysia and Singapore, prompting Indonesian President Yudhoyono to apologize publicly for the incident. Indonesia then instituted a suite of measures to extinguish the fires, including cloud seeding and aerial water bombing. The country also pledged to investigate whether illegal burning was to blame. In July, as haze from Indonesian fires again began to engulf Malaysia, Indonesia agreed—after a decade of inaction—to ratify the Association of Southeast Asian Nations (ASEAN) Agreement on Transboundary Haze Pollution that was established in 2002 to reduce pollution from smoke and other fine particles in the atmosphere.

NASA's Earth-observing satellites provide a means to observe fires and their associated smoke plumes, as well to document the land-use sources of these fires (e.g., oil-palm plantations *versus* smallholder lands). The figure below shows examples from the Moderate Resolution Imaging Spectroradiometer (MODIS), on Aqua, and the Operational Land Imager (OLI), on Landsat 8. Maps like these may allow Indonesia and other concerned parties to assess and address the underlying causes of such fires. Moreover, land-cover assessments derived from these NASA satellites provide crucial input for estimates of carbon emissions from fires and other regional land-cover changes.

When Indonesian forest fires make headlines and immediate analysis is required, NASA's Near-Real-Time (NRT) products—available at *earthdata.nasa.gov/data/near-real-time-data*—are invaluable for the policy community and public at large, especially MODIS NRT images, which are posted approximately 2.5 hours after acquisition, and MODIS active fire data, easily downloadable for the preceding 24 hours, 72 hours, and 7 days. In addition, *Worldview* (*earthdata.nasa.gov/labs/worldview*) affords stunning visualization of NRT products and allows easy exploration of daily products across time and space. These datasets allow monitoring and rapid assessment and analysis of mitigation measures, and may motivate Indonesia to enforce existing regulations on burn bans, and to increase transparency of awarded plantation and concession leases.

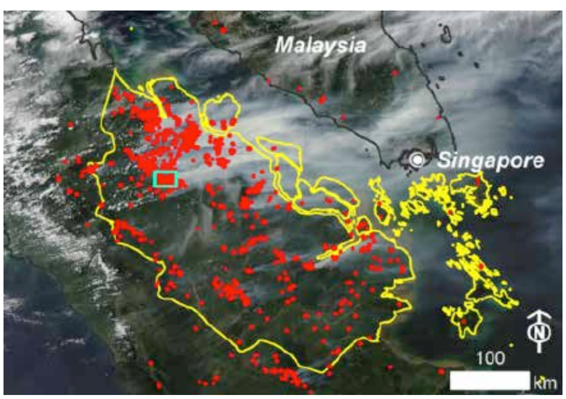
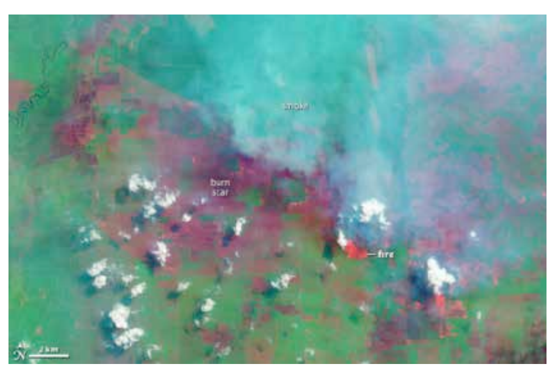


Figure. [*Top*] On June 19, 2013, two days prior to the all-time record high of Singapore's Pollutants Standards Index, MODIS imaged smoke drifting east from Riau province (outlined in white) over Singapore and southern Peninsular Malaysia. Fires suspected to be forest-clearing fires, are shown in red and were detected by MODIS. The green rectangle indicates the extent of the Landsat images that follow. [*Bottom left*] On May 24, 2013, OLI provided a closer look within a region that was to have many fire detections in June. This image reveals a matrix of agricultural lands, including mature plantations (dark green), younger plantations and other crops (light green), and bare/burned areas (red). [*Bottom right*] An OLI image from June 25, 2013, shows smoke and burn scars in the same region—evidence of active fires. Both mature plantation areas and younger plantation/other crop areas burned. **Image credit:** [*Top*] NASA Worldview, [*bottom*] NASA's Earth Observatory



Land, Atmosphere Near-real-time Capability for EOS (LANCE) User Working Group Meeting Summary

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The third Land, Atmosphere Near-real-time Capability for EOS (LANCE) User Working Group (UWG) meeting was held on May 1, 2013, at NASA's Goddard Space Flight Center (GSFC) and via web conferencing. LANCE is the near-real-time (NRT) component of the Earth Observing System Data and Information System (EOSDIS) that provides data and imagery from the Aqua, Terra, and Aura spacecraft to various end users—including the applications user community, scientists, and operational agencies. Summaries of the previous LANCE workshops can be found in previous issues of *The Earth Observer*[1] and at *earthdata.nasa.gov/lance/user-working-group*.

The LANCE UWG is composed of representative LANCE users who help steer LANCE program development. In addition to UWG members, individuals representing NASA Headquarters (HQ), NASA's Earth Science Data and Information System (ESDIS), the LANCE elements, and other data providers attended the meeting. The purpose of the meeting was to review the status of LANCE, assess progress made on previous UWG recommendations, and identify and discuss potential enhancements and upgrades to LANCE.

Chris Justice [University of Maryland, College Park—*UWG Chair*] welcomed everyone to the meeting, stating that in his opinion, based on feedback from the community, LANCE is a great success: It is one of the most important data initiatives that NASA has undertaken for applied science and operational users through the distribution of data products. Justice stressed the need for more outreach—as there are still many potential users who do not know about LANCE and could benefit from this NASA asset.

Martha Maiden [NASA HQ—*Program Executive for Earth Science Data Systems*] provided the programmatic perspective. Maiden said that NASA's administrator wants government data to be useful for the real world, and that LANCE is a good example of this. Looking forward, the UWG needs to understand how it can develop similar capabilities for the next generation of satellites.

[1] The first LANCE Workshop was summarized in the March-April 2010 issue of *The Earth Observer* [**Volume 22, Issue 2**, pp. 18-20]; the second LANCE workshop was summarized in the May–June 2012 issue [**Volume 24, Issue 3**, pp. 19-21]. The summary for the first UWG meeting appears in the March-April 2011 issue of *The Earth Observer* [**Volume 23, Issue 2**, pp. 35-38].

Diane Davies [GSFC/Sigma Space/Trigg-Davies Consulting Ltd., ESDIS] provided an overview of key metrics for LANCE, which is operating well within its three-hour latency requirements, particularly following the last EOS Data and Operations Systems (EDOS) ground updates in March 2011. Data from Terra are usually available with a one-hour latency, while data from Aqua have a one-and-a-half-hour latency.

After these presentations, each of the LANCE elements then provided updates on activities in their respective areas.

Phil Durbin [GSFC/Wyle] said that Aura's Ozone Monitoring Instrument (OMI) is essentially unchanged over the past year, and has maintained nominal performance with the exception of an existing *row anomaly*[2], which has not deteriorated further. OMI NRT updates include new versions of the retrieval algorithms for clouds, ozone, and sulfur dioxide (SO_2); the aerosol algorithm is still to be updated. The agreement between standard and NRT products remains good—i.e., it is within a very small percentage of the standard products.

Feng Ding [GSFC, Goddard Earth Sciences (GES) Data and Information Services Center (DISC)] provided an update on Aqua's Atmospheric Infrared Sounder (AIRS) and Aura's Microwave Limb Sounder (MLS). AIRS *Version 5* and *Version 6* algorithms are running in both systems for Level 1 and 2, respectively. GES DISC is currently working on updating the AIRS science-quality documents, comparing NRT and standard products for Version 6 algorithms; the results are expected to be similar to Version 5. For MLS, NRT temperature and ozone data are of lower quality than standard products. This is because two channels on Aqua's Advanced Microwave Sounding Unit (AMSU) are degrading: Channel 5 is not working well, and channel 6 is starting to degrade.

Karen Horrocks [GSFC/MODIS Adaptive Processing System (MODAPS)] provided an update on the Moderate Resolution Imaging Spectroradiometer (MODIS)—on Terra and Aqua. Over the past year, the value-added MODIS aerosol optical depth product (MxDAODHD) has been added; browse-image processing has been integrated with NRT production; data

[2] The rows on one side of the instrument have an external blockage, which affects about one-third of the pixels.

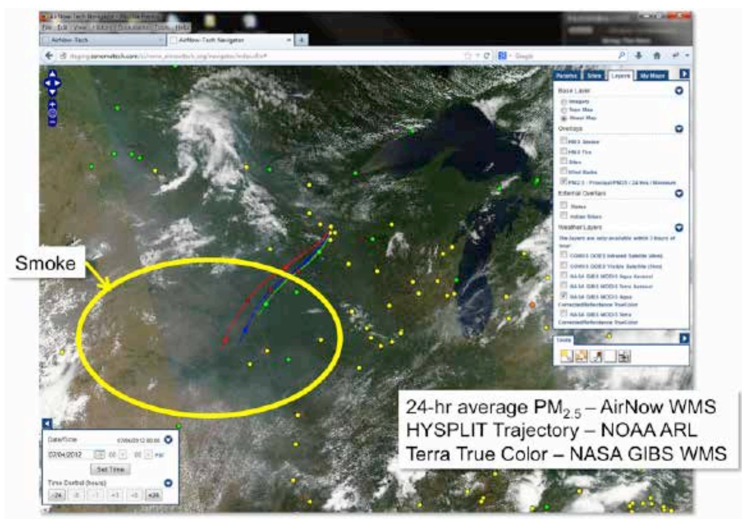
from the Fire Information for Resource Management System (FIRMS) was incorporated into the Earthdata website (*earthdata.nasa.gov*); new datasets were added to the subset tiled data delivered to the flood-watch team (including cloud-top temperature and pressure). The NRT component of MODIS *Collection 6* will be implemented once the science algorithms have been integrated into MODAPS. Products will be added gradually to ensure sufficient hardware and CPU processing capacity to run Collection 5 and Collection 6 in parallel.

Diane Davies summarized key LANCE updates, including the status of previous UWG recommendations. All user feedback is now ticketed, handled, and tracked through the User Support Tool. The website has been redesigned to fit with the rest of the NASA Earthdata site. Based on recommendations from the last UWG, an external data webpage (*tinyurl.com/ngplyfj*) provides links to NRT data from the Physical Oceanography Distributed Active Archive Center (PODAAC), Direct Readout Laboratory, Advanced Microwave Scanning Radiometer-2 (AMSR-2) on the Japanese Shizuku[3] satellite, and Suomi National Polar-orbiting Partnership (NPP). Also, links to science-quality data and explanations of the difference(s) between NRT and science products have been made more prominent. The hazards and disasters page (*tinyurl.com/ntoqzwx*) now includes a page for each key application area that provides a list of products that could potentially be used for monitoring that particular hazard or application, a permalink to Worldview, and a description of a characteristic event from NASA's Earth Observatory (*earthobservatory.nasa.gov*).

[3] This mission is also referred to as Global Change Observation Mission—First Water (GCOM-W1).

Ryan Boller [GSFC, ESDIS] provided an update to the group on two EOSDIS tools: Worldview and Global Imagery Browse Services (GIBS). He reminded the group that the goal of both of these applications is to provide interactive, full-resolution, product-viewing capability for EOSDIS products. LANCE NRT products are being used as a pathfinder for a more-general capability. During the last year, additional NRT products have been added to Worldview and GIBS. Worldview added full-resolution download capability and color bars and legends for the products.

Diane Davies presented two slides—see **Figure**—highlighting the use of GIBS in the U.S. Environmental Protection Agency's (EPA) AirNow-



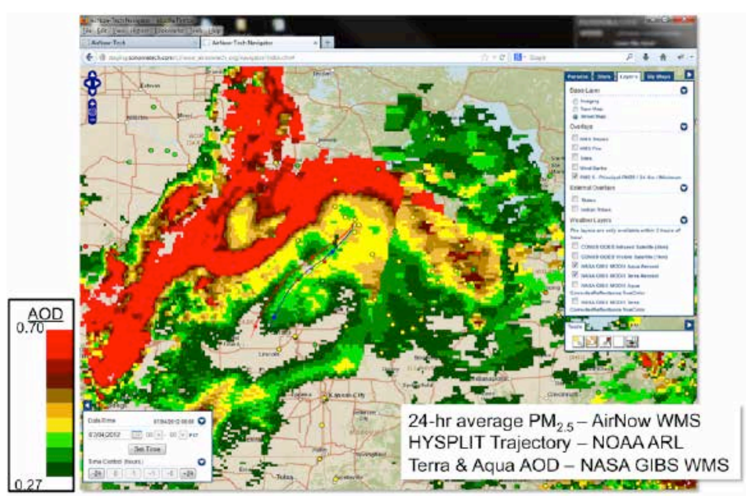


Figure. Screenshots from the EPA AirNow-Tech Navigator, an interactive GIS tool for air-quality forecasters, managers, and analysts. To demonstrate how the system will work in NRT, this example displays spatial plots of air-quality data and satellite data from LANCE's GIBS for July 4, 2012. The introduction of NASA satellite data from GIBS enables air-quality forecasters to evaluate visible smoke (using true-color imagery) and complete a transport analysis using HYSPLIT, a system for computing simple air parcel trajectories. The second image includes an overlay of MODIS Aerosol Optical Depth, to help analyze smoke impacts. **Image credit: Adam Pasch** [Sonoma Technology, Inc.] and **Tim Dye** [STI and EPA].

Tech Navigator application, which will be released in mid-summer 2013. AirNow-Tech Navigator provides air-quality forecasters, managers, and analysts with a spatial analysis tool that displays spatial plots of air-quality data, surface weather conditions, and satellite data. EPA and Sonoma Technologies approached LANCE over a year ago to determine how to ingest LANCE NRT imagery into their online interactive geographic information systems (GIS) tool—as such capability was the number one request received from their users.

George Blaisdell [National Science Foundation (NSF)—*UWG Member*] provided an overview of how NSF uses historical AMSR for EOS (AMSR-E) data in combination with NRT data to determine when to send supply ships to and from McMurdo Station in Antarctica. They need to select a time for passage when open ice-free corridors exist, and satellite imagery is helpful for narrowing this window.

The UWG discussed a number of proposed modifications and potential future updates. As a preface to the discussion **Chris Justice** and **Kevin Murphy** [GSFC, ESDIS] reminded the UWG that their role in considering enhancements is to consider the merits of a proposed product and determine whether there is sufficient demand from the user community to warrant generating the product. Once recommended by the UWG, EOSDIS management and NASA HQ will consider the enhancement request in terms of feasibility and cost.

Diane Davies asked the UWG to approve a NRT eight-day rolling Normalized Difference Vegetation Index (NDVI) product to support the dust modelling, weather forecasting, and agricultural monitoring communities, and a rolling Bidirectional Reflectance Distribution Function (BRDF) surface albedo product to support worldwide air quality and atmospheric modeling communities.

Ed Masouka [GSFC, MODAPS] outlined the large central processing unit (CPU) requirements for producing the NRT rolling BRDF product. Following tests to determine the cost and latency, two options will be considered for the BRDF product: NRT processing and standard processing—with lower latency.

Michael Goodman [NASA's Marshall Space Flight Center] presented an update on AMSR2 and asked the UWG to consider adding AMSR2 products to LANCE to ensure the continuity of a research-quality and self-consistent record of a variety of global datasets from AMSR-E that the climate research community has long relied upon. The approach would be to set up ingest of Level-1 data from the GSFC Precipitation Processing System (PPS), work with the AMSR2 U.S. Science Team to update AMSR-E processing automation for the AMSR2 instrument, and integrate applicable AMSR2 science algorithms into LANCE. The UWG agreed that the proposal should be developed for further consideration.

In addition, the UWG considered potential future enhancements from Terra's Multi-angle Imaging SpectroRadiometer (MISR) and the Tropical Rainfall Measuring Mission's (TRMM) Lightning Imaging Sensor (LIS)—two instruments outside the initial mandate to focus on EOS instruments. **Kevin Murphy** prefaced this discussion by informing the UWG that the two potential enhancements were for information purposes and initial discussion only—i.e., these are possible future products for LANCE.

Pamela Rinsland [NASA's Langley Research Center, Atmospheric Sciences Data Center] presented a potential enhancement from MISR. The original request for a NRT winds product, with a five-hour latency, came from the winds community (currently latency is 10–12 hours). After the discussion, the UWG agreed that LANCE would work with the MISR team to look at process, cost, and latency, and determine whether standard products could meet the five-hour requirement from the winds community.

Michael Goodman offered the possibility of considering NRT lightning products from the LIS as another potential enhancement. The LIS would provide real-time lightning data for data-sparse regions, especially over oceans, and could also support fire-weather assessments in the data-sparse regions of the Western U.S. These data would be used for storm warnings, oceanic aviation safety and international Significant Meteorological (SIGMET) advisories, long-range lightning system validation, and hurricane rapid-intensification evaluations. In addition to the existing LIS on TRMM, there are plans underway to fly the LIS flight spare for TRMM on the International Space Station (ISS). The ISS-LIS was approved in mid-April 2013, with launch in early 2016 aboard a SpaceX launch vehicle. The ISS-LIS will provide real-time lightning data (with latency of one-to-three minutes) using the ISS Low Rate Telemetry channel. It was suggested that a workshop to address this and the other capabilities (Ocean Biology Processing Group, PODAAC, TRMM) be organized to consider the future options for delivery of products in NRT. This workshop should be cohosted by NASA's Applied Science Program and LANCE.

Kevin Murphy asked the UWG to consider a proposal to transition the distribution of data from *ftp* to *https*. The advantages would be that *https* is more secure, and that with *https* it is possible to have a virtual combined data directory structure, using a single sign-in (not currently supported by *ftp*).

Chris Justice led a discussion on Applied Science products. In particular, the group discussed what criteria should be used to determine when products can be considered mature enough to be included in LANCE and how to ensure long-term technical support for algorithms. There is currently a good process for approving products but there is no distinction between science and applied science products. In the past there has been a dependency on science products, leveraging the significant investment and technical expertise provided by science teams; Applied science products do not have the same structure in place. For example, if a product were endorsed from a three-year Applied Sciences project, then who would provide the continued technical support, and technical/applied science oversight once the project was completed? Ideally, when a product is endorsed by LANCE, the endorser should continue to provide some technical support, even if the project were to end. Mechanisms for this exist within the Applied Sciences program, but need to be developed further. The UWG agreed that the process should be reviewed and general guidelines developed for how to handle Applied Science products.

The discussion then moved to Suomi NPP. The LANCE–EOS capability has been developed and is stable. One of the roles for the UWG is identifying the possible evolution of the LANCE system on a one-to-two year timeframe. Suomi NPP instruments have undergone preliminary evaluation and data are being distributed with products in various levels of maturity. Given the dominance of MODIS data downloads in LANCE, there is considerable interest in establishing a LANCE capability for Suomi NPP's Visible Infrared Imaging Radiometer Suite (VIIRS). The Applied Sciences Advisory Group and the Land Group of the NASA VIIRS Science Team have both recommended a LANCE capability for VIIRS for NASA Science and Applied Sciences users. Members of the LANCE UWG have also recommended a VIIRS LANCE capability, but no formal request has been made so far. The UWG agreed that there needs to be an overlap of data from Aqua and Suomi NPP to evaluate and establish product continuity.

Chris Justice added that demand for NRT data from other Suomi NPP instruments may be forthcoming—e.g., from the Ozone Mapping Profiler Suite (OMPS), and Cross-track Infrared Sounder (CrIS) teams—adding that products would have to be evaluated individually to see if they are mature enough. Justice reiterated that LANCE is a very successful initiative and that the UWG has a continuing role in advising on the evolution of LANCE. Follow-up and outreach should continue, as there is a broad need for open source NRT data. A summary of recommendations from the UWG is outlined in the table below. ■

UWG Recommendations	**Description**
Reduced latency	Analyze geographic location of distributed downloaded granules with a view to notifying users that direct broadcast could be used to further reduce latencies.
	Report back on efforts that could further reduce latencies.
NRT workshop	Work with NASA HQ to help facilitate, a NRT workshop (that would include groups such as PODAAC, Ocean Biology Processing Group and PPS) to review NASA NRT architecture, develop best practices, and develop strategy for moving forward.
New/enhanced products	Add a rolling 8-day NDVI product.
	LANCE–MODAPS to report back on cost and latency of a 16-day rolling BRDF product.
	Work with MISR team to investigate possibility of standard products being modified to meet five-hour latency requirement.
	UWG to advocate for useful products from Suomi NPP including Fire, Aerosol, Vegetation Indices and OMPS SO_2 and Aerosol Index. UWG to develop a recommendation to NASA HQ that a Suomi NPP NRT type capability be developed, building on the success of LANCE.
Data access	Investigate level of effort to transition LANCE Elements from *ftp* to *https.*
LANCE website	Add link to CEOS Working Group on Information Systems and Services (WGISS) to provide links to NRT data provided by agencies other than NASA.
Future applications	Work with NASA's Applied Sciences group to discuss how Applied Science-endorsed products might be better supported in LANCE. Feedback from applied scientists should offer guidance on how this could be done. HQ consideration for a LANCE capability from Suomi NPP is needed.

ESIP Federation Meeting Highlights Data Practices

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The latest cohort of partners reinforces the broad community that the ESIP Federation has become. Since 1997, the ESIP Federation has provided a neutral forum where practitioners address timely topics of interest. As a community-led-organization, the ESIP Federation is advancing emerging technologies while making contributions to data management practices both domestically and abroad. The ESIP Federation's standing as a collaboration network has led to its recognition as the go-to place to forge consensus on emerging data-related topics.

—**Karl Benedict** [ESIP, University of New Mexico—*ESIP Federation President*]

Introduction

The Federation of Earth Science Information Partners (ESIP Federation) is a broad-based, distributed community of Earth science data and information technology practitioners that spans government (e.g., NASA, National Oceanic and Atmospheric Administration, Environmental Protection Agency, U.S. Geological Survey, National Science Foundation), academia, and the private sectors (both commercial and nonprofit). Initiated by NASA in 1997, members of the ESIP Federation facilitate data distribution, and provide, products and services to decision makers and researchers in public and private settings. The Foundation for Earth Science provides management services to the ESIP Federation; community members leverage collaboration and coordinate interoperability efforts across institutional, geographic, and domain boundaries. Partners use these independent forums for knowledge exchange and collaboration as an *intellectual commons*—where practitioners work together to solve common challenges. Partnership in the ESIP Federation is voluntary, and open to organizations that work at the intersection of Earth science data and supporting technologies.

The ESIP Federation held its semi-annual meeting at the University of North Carolina (UNC) in Chapel Hill, NC, July 9-12, 2013. Organized around a theme of *Building the Value Chain for Earth Science Data and Information in Disaster Planning, Response, Management, and Awareness*, the objective of the meeting was to advance the work of its data practitioner community. Hosted by Federation member, the Renaissance Computing Institute (RENCI) (*renci.org*), the gathering focused on bringing together communities to improve Earth science data management practices and to coordinate efforts to make data more discoverable, accessible, and useful to many. The fifth annual ESIP Teacher Workshop also took place during the evening of July 9—see *ESIP Federation Teacher Workshop 2013,* on page 22.

A Growing Community

ESIP Federation membership is strictly voluntary and its continued growth reflects the recognition that the ESIP Federation is a dynamic and collaborative forum where data providers (knows as Type 1 members), researchers (Type 2), application developers (Type 3), and sponsors (Type 4) gather to exchange valuable information.

During the meeting at UNC the following organizations joined the Federation:

- Community Modeling and Analysis (CMAS) Center at UNC [Type 3];
- Discinnet Labs [Type 2];
- Geological Survey of Alabama [Type 2];
- NASA/Jet Propulsion Laboratory (JPL), Data Systems and Technology Group [Type 3];
- Knowledge Motifs [Type 3];
- NASA Capacity Building Program [Type 3];
- National Center for Ecological Analysis and Synthesis (NCEAS) [Type 2];
- OPeNDAP [Type 2]; and
- Vightel Corporation [Type 2]

These additions bring the Federation's total membership to 157.

Additional information on the new partners can be found at *bit.ly/18RqIRn.*

Plenary Session

Forging ahead with goals of collaboration and coordination, the plenary on July 10 featured two panel discussions. The first panel provided a platform for representatives of three funded software sustainability planning projects to share their organizations' respec-

ESIP Federation Teacher Workshop 2013

In conjunction with the semi-annual ESIP Federation meeting, the fifth annual ESIP Teacher Workshop took place on Tuesday, July 9 on the UNC, Chapel Hill campus. Although the workshop was scaled back due to limited funding, the experience earned high ratings by the 14 regional teachers who came to learn about climate change and educational resources available from NASA and the National Oceanic and Atmospheric Administration (NOAA). Participating teachers were able to borrow an iPad for the entire 2013-2014 school year from the Cooperative Institute for Meteorological Satellite Studies (CIMSS) iPad Library (*cimss.ssec.wisc.edu/education/cla/iLibrary*).

Educators were also invited to spend the afternoon of Wednesday, July 10 at the North Carolina Museum of Natural Sciences, where several ESIP members presented TED-style (i.e., knowledgeable and inspirational) talks in a large high-resolution theater called the *Daily Planet*. A handful of teachers showed up for this informal educational event where two workshop presenters, **Margaret Mooney** [CIMSS, University of Wisconsin-Madison] and **Preston Lewis** [NASA's Langley Research Center], gave presentations.

ESIP Federation Teacher Workshop presentations on the *Daily Planet*. **Image credit:** Margaret Mooney

ESIP Teacher Workshop participants. **Image credit:** Margaret Mooney

tive visions on the need for more intentional and reusable scientific software development. **Stan Ahalt** [RENCI, UNC], **Peter Fox** [Rensselaer Polytechnic Institute], and **Bryan Heidorn** [University of Arizona] participated in the discussion, putting forward compelling visions for their institutes. The focus on quality, performance, and reusability of scientific software were common themes across the projects and were of great interest to the ESIP Federation community.

In the second panel of the plenary, **Dan Baker** [University of Colorado, Laboratory for Atmospheric and Space Physics], **Todd Vision** [UNC, Dryad], **Michael Tiemann** [Red Hat], and **Stan Ahalt** discussed the ESIP Federation's initiative to promote a *Data Decadal Survey* at the National Academy of Sciences. This initiative is seen as an exciting opportunity for the ESIP Federation to inform the future of scientific data management and practice. Leveraging the strong support that the Federation already provides in these areas, this new effort will enable an authoritative cyclical process to identify both challenges and potential solutions in Earth science data management, access, and use. A Data Decadal Survey will provide additional focus and amplify synergies among disparate Earth science data groups.

ESIP Federation Showcase

Additional meeting activities included an ESIP Federation showcase on the use of data in disaster management, at the North Carolina Museum of

Natural Sciences. Some highlights from the showcase are described below. The complete list is available at the ESIP Commons (*commons.esipfed.org/node/1595*).

Matt Still [Esri] gave a presentation titled *Out-of-the-Box Disaster Response In 15 Minutes: A Case Study* that provided an overview of how Louisiana's Emergency Management Agency transformed what had been a cumbersome, manual, paper-based process for tornado damage assessment into a powerful, smart-device-enabled, digital tool that has greatly improved efficiency in responding to tornadoes.

Lawrence Friedl [NASA Headquarters—*Director of Applied Sciences Program*] gave a presentation on NASA's Earth-observing satellites and how they generate data that are used to support decision making in society.

Videos from the showcase event can be accessed from the ESIP Commons link above.

Breakout Sessions

There were also numerous breakout sessions held throughout the meeting that highlighted the breadth and depth of technical ESIP Federation activities. Topics addressed covered data preservation of physical objects (these identifiers are similar to the concept of Digital Object Identifiers[1] for data), data formats and standards, data discovery, etc. The full list of sessions can be found at *commons.esipfed.org/schedule/Summer%20Meeting%202013*.

Conclusion

The Federation had another very successful meeting. The face-to-face dialogue at these semi-annual meetings is crucial to the ongoing work of the Federation. The Natural History Museum in Raleigh was an ideal location to highlight specific applications related to disaster management and to showcase many of the exciting data tools and technology that Federation partners have developed with the public. The Federation looks forward to its next gathering, planned for January 8-10, 2014, in Washington, DC. Check the ESIP Commons for more details as they become available. We look forward to seeing you there! ■

[1] Similar to the way Digital Object Identifiers (DOIs) are used to classify datasets and International Standard Book Numbers (ISBN) classify books, systems of identifiers have been developed to classify groups of physical objects (e.g., rock samples). *The Earth Observer* reported on how DOIs are being used to categorize data from NASA's Earth Observing System in its September–October 2012 issue [**Volume 24**, **Issue 5**, pp. 10-15].

Data Release: Version 4 SeaWiFS Deep Blue

NASA's Goddard Earth Sciences Data and Information Services Center (GES DISC), in collaboration with **Christina Hsu** [NASA's Goddard Space Flight Center—*Principal Investigator*], is pleased to announce Version 4 of the Long-Term Aerosols over Land and Ocean data products from SeaWiFS (also known as "SeaWiFS Deep Blue") that cover the period September 4, 1997 to December 11, 2010. These data are from the Consistent Long-Term Aerosol Data Records over Land and Ocean from SeaWiFS Project, which is part of the NASA Making Earth Science Data Records for Use in Research Environments (MEaSUREs) Program.

Version 4 data represent significant improvements over the previous version; all users should upgrade as soon as possible. The improved over-land and ocean algorithms are documented in the literature, as noted at the GEO DISC site (see link, below). Improvements from Version 3 to 4 include:

- improved turbid water filter;
- improved aerosol models over regions with highly absorbing aerosols;
- updates to QA-filtering during Level-3 aggregation;
- fixed minor coding error in ocean Look-Up Table (LUT) search; and
- fixed error where very high Aerosol Optical Thickness (AOT) values greater than 3.5 were incorrectly reported as 0.02.

Additional information on and access to these data are available at

disc.sci.gsfc.nasa.gov/datareleases/measures-seawifs-deep-blue-aerosols-version-4-release.

Summary of the 43rd Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team Meeting

Tetsushi Tachikawa, Japan Space Systems, tachikawa-tetsushi@jspacesystems.or.jp

The forty-third meeting of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team was held at Kikai Shinko Kaikan in Tokyo, Japan, June 10-12, 2013. Members of the ASTER Science Team and scientists in ASTER-related projects attended the meeting. In the opening plenary session status reports were provided on the ASTER instrument itself, data processing, and the overall mission; as a result, four issues were raised. These issues and research findings were discussed in the subsequent working group splinter sessions. The meeting concluded with a closing plenary session that included reports from the working groups.

Opening Plenary

H. Tsu [Japan Space Systems (J-spacesystems)—*Japan ASTER Science Team Lead*] and **M. Abrams** [NASA/Jet Propulsion Lab (JPL)—*U.S. ASTER Science Team Lead*] made opening remarks. **H. Tsu** talked about the current tight budget situation. **M. Kato** [J-spacesystems] presented the meeting logistics.

M. Abrams outlined NASA's current status, the 2013 Earth Science Senior Review, budget, and data policy. He reported on the Terra spacecraft's predicted propellant usage and battery status, and went on to discuss several other missions and instruments. The Landsat Data Continuity Mission (LDCM) started operation as Landsat 8 on May 30 when NASA turned over Landsat operational responsibilities to the U.S. Geological Survey (USGS). As with previous Landsat missions, data are available at no cost to all users.

M. Kikuchi [J-spacesystems—*Instrument Team*] reported on the status of the ASTER instrument. He provided an update on instrument lifetime management, radiometric degradation, and a plan of action for the mission's end. Currently, there is no action being taken.

T. Matsunaga [National Institute for Environmental Studies (NIES)] provided an update on the Hyperspectral Imager Suite (HISUI[1]). He described the mission structure, project timeline, instrument development, and activities of the science working groups.

A. Miura [J-spacesystems—*Ground Data System (GDS)*] reported on GDS status. He gave an update on the GDS and operations, and reported on processing and distribution metrics.

D. Meyer [USGS, Land Processes Distributed Active Archive Center (LPDAAC)] provided updates on distribution metrics, plans for long-term data preservation, progress on the new orthorectification product, and on the Terra/Aqua product review at the LPDAAC.

M. Fujita [J-spacesystems—*Science Scheduling Support Group (SSSG)*] presented the SSSG and Operation and Mission Planning (OMP) report. He discussed mission progress, scheduling, and observations.

To close the plenary, **Y. Yamaguchi** [Nagoya University] raised four issues for discussion in the working groups: mission monitoring, radiometric calibration coefficients, preparations for turning off the shortwave infrared (SWIR) instrument, and operational strategies to address budget uncertainty.

Working Group Sessions

Level-1/Geometric/Digital Elevation Model (DEM) Working Group

The first half of the session focused on validation results from ASTER Level-1 (L1) algorithm/software, including a report on new software that can generate L1 products without SWIR data. Overall, there are no major issues or concerns with L1 processing at this time. The second half of the session focused on the ASTER Global Digital Elevation Model (GDEM) project. **H. Fujisada** [Sensor Information Laboratory Corporation (SILC)] reported on the status of the next version of the GDEM. The main updates addressed adding newly observed scenes, removing floating ice effects, and improving river elevation. **A. Iwasaki** [Tokyo University] reported on a new stacking method to remove anomalies in tropical areas using statistical comparisons of elevations from ASTER DEMs with data from the Shuttle Radar Topographic Mission (SRTM). **B. Crippen** [JPL] showed SRTM Version 3, a new release of the SRTM data from JPL that uses GDEM Version 2 to fill SRTM Version 2 and Global Multiresolution Terrain Elevation Data (GMTED) 2010 to fill problem areas.

Radiometric Calibration/Atmospheric Correction (RC/AC) Working Group

B. Eng [JPL] reported on the status of an atmospheric correction (i.e., Level-2 software) update; the

[1] HISUI is composed of both a hyperspectral and multispectral imager, planned as part of the payload of the Japanese Advanced Land Observation Satellite-3 (ALOS-3), slated for launch in 2016.

instrument team reported the results of *onboard calibration*—monitoring the lamp onboard the spacecraft. **F. Sakuma** [J-spacesystems] reported a large gain error, probably caused by an electrical output anomaly from the power supply, **A. Iwasaki** showed differences of up to 2% in odd-even rows in the Band 1 high-gain product, and **H. Yamamoto** [National Institute of Advanced Industrial Science and Technology (AIST)] pointed out a 9% error in Band 2, found by *cross calibration* with the Moderate Resolution Imaging Spectroradiometer (MODIS) on the same satellite. **S. Tsuchida** [AIST] and **H. Tonooka** [Ibaraki University] reported on the results of field *vicarious calibration* exercises. **T. Tachikawa** [J-spacesystems] and **K. Arai** [Saga University] summarized the status of the errors described in this working group session, namely that present radiometric calibration based on *onboard calibration* shows significant errors in degradation coefficient and gain. The working group concluded by recommending additional processing for replacing the degradation coefficient and gain coefficients in the radiometric correction table used for Level-1A processing. **T. Kouyama** [AIST] proposed conducting a second lunar calibration, and reported that a SELENE[2]-derived lunar reflectance model is now available. **M. Kikuchi** announced the termination of onboard calibration due to budget cuts.

Temperature-Emissivity Separation (TES) Working Group

A. Gillespie [University of Washington (UW)] and **S. Kato** [NIES] reported on validation for the emissivity product, explaining that atmospheric correction was necessary to get good emissivity data**. G. Hulley** [JPL] and **H. Tonooka** described ongoing efforts to develop large-scale emissivity datasets. JPL's ASTER Global Emissivity Dataset (GED), will include Africa, the Arabian Peninsula, Australia, China, and Europe, and will be released by the Earth Resources Observation and Science (EROS) Land Processes Digital Active Archive Center (LPDAAC) by the end of June 2013. Tonooka's global mapping of ASTER's thermal infrared (TIR) ortho time-series products is complete—except for Canada and Alaska. **M. Fujita** and **H. Tonooka** discussed the status of nighttime TIR global mapping (TGM). This working group agreed to recommend continuing TGM for the new target areas.

Operations and Mission Planning (OMP) Working Group

The team reviewed all previous action items and addressed two open items regarding the GDEM Science Team Acquisition Request (STAR) and the possibility of implementing a long-term inhibit zone for the Alaskan problem area. **T. Tachikawa** reported that the scheduling simulation generated by removing SWIR data showed a 26% increase in daytime observations without a significant impact on nighttime observations. **H. Inada** [NEC-Toshiba Space—*Instrument Team*] proposed a procedure to stop the onboard SWIR data flow; the Science Team would like to implement this as soon as possible. **M. Fujita** then reviewed the status of Global Mapping 5th Round (GM5) and TGM 5th Round (TGM5). GM5 will continue as-is but, per the recommendation of the TES Working Group, TGM5 will be replaced with TGM6. Fujita also reported on the Underserved Area (UA) STAR and Tachikawa proposed updating the target area for the UA STAR based on GDEM processing. Fujita reported on Global Land Ice Measurements from Space (GLIMS) and the Volcano STAR, both of which are proceeding smoothly. Tachikawa showed that the performance of cloud avoidance by improving a scheduling parameter worked well. **L. Maldonado** [JPL] analyzed the worldwide distribution of the data acquisition requests (DAR). **A. Miura** warned that attention must be paid to the timing of DAR submissions, which could affect scheduling. Maldonado requested that the occurrence of scheduling failures due to GDS operational reduction be monitored.

Ecosystem/Oceanography Working Group

K. Iwao [AIST] and **G. Geller** [JPL] began the session by reviewing action items and STAR status. Two new or updated STARs were submitted, but the total number of submissions has decreased. A series of eight presenta-

[2] SELenological and ENgineering Explorer (SELENE) is a Japanese lunar orbiter, operated by the Japan Aerospace Exploration Agency (JAXA) from 2007 to 2009, that carried instruments for scientific investigation of the Moon.

Table 1. Science presentations from the Ecosystems/Oceanography Working Group.

Topic	Presenter
Observation of Open Burning by Thermal Infrared (TIR) Remote Sensing	**S. Kato** [NIES]
Environmental Implications of a Shrinking Sea: Initial Science Results of the NASA Mineral And Gas Inentifier (MAGI) Airborne Instrument at the Salton Sea, CA	**M. Ramsey** [University of Pittsburgh]
Some Recent ASTER Work Relevant to Ecosystems	**K. Hirose** [J-spacesystems]
JEarth 100 Cities Project	**L. Prashad** [Arizona State University]

Environmental Monitoring of Bolgoda Lake, Sri Lanka, Using ASTER Data	**D.D.G.L. Dahanayaka** [Ibaraki University]
TerraLook/Google Earth Engine Update	**G. Geller** [JPL]
Introduction to Essential Biodiversity Variables and Global Earth Observations Biodiversity Observation Network (GEOBON)	**G. Geller** [JPL]
GEO Work Plan Symposium Review (Earth Datasets)	**K. Iwao** [AIST]

tions describing project and research activities followed the opening remarks—see **Table 1**.

Geology/Spectral Working Group

M. Urai [AIST] and **D. Pieri** [JPL] began the session with a review of outstanding action items. Nine research activity presentations then followed that covered such diverse topics as geology, floods, glaciers, and volcanic activity—see **Table 2**. After the presentations, continuing action items were discussed. Monitoring of GLIMS acquisitions and assessment of the volcano STAR will continue.

STAR Committee

The committee reviewed and approved two new STARs, to monitor eastern Japan's recovery after the 2011 earthquake and urban heat islands. The plan for the GLIMS STAR was confirmed. The maximum number of urgent STARs was set to be around 60 requests per month.

Closing Plenary

The meeting concluded with a closing plenary that summarized the discussions of each working group; specifically, the OMP WG proposed a procedure to stop the SWIR data flow as soon as possible; and the Radiometric Calibration WG recommended adding processing for replacing the radiometric correction table in Level-1A generation.

H. Tsu closed the meeting after announcing that the next (44th) ASTER Science Team meeting would be held in Tokyo the week of March 10, 2014. ■

Table 2. Research presentations from the Geology/Spectral Working Group.

Topic	**Presenter**
Geological Mapping of the Francistown Area in Northeastern Botswana by Surface Temperature and Spectral Emissivity Information Derived from ASTER TIR Data	**T. Yajima** [Japan Oil, Gas and Metals National Corporation]
Rotational Pixel Swapping Method to Detect Circular Features: Extraction of Impact Craters from ASTER Images	**S. Yamamoto** [NIES]
Small-scale Landform Classification and Flood Susceptibility Assessment of the Alluvial Plains in Vietnam Using Remotely Sensed Data	**Y. Yamaguchi** [Nagoya University]
Glaciation in the Gobi Desert	**A. Gillespie** [UW]
Thermophysical Properties of Mantled and Blocky Lava Flows Derived from ASTER TIR Data	**M. Ramsey** [JPL]
New Eruptions in the North Pacific Monitored with the ASTER Urgent Request Protocol Project	**M. Ramsey** [JPL]
Nighttime TIR Geolocation Evaluation Using Volcanic Hotspots	**M. Urai** [AIST]
ASTER Volcano Archive (AVA) Review	**D. Pieri** [JPL]
In Situ Gas Sampling at Turrialba Volcano	**D. Pieri** [JPL]

Around the World in Four Days: NASA Tracks Chelyabinsk Meteor Plume

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EDITORS NOTE: This article is taken from *nasa.gov*. While it has been modified slightly to match the style used in *The Earth Observer*, the intent is to reprint it with its original form largely intact.

Atmospheric physicist **Nick Gorkavyi** [NASA's Goddard Space Flight Center (GSFC)] missed witnessing an event of the century last winter when a meteor exploded over his hometown of Chelyabinsk, Russia. From Greenbelt, MD, however, Gorkavyi and colleagues witnessed a never-before-seen view of the atmospheric aftermath of the explosion.

Shortly after dawn on February 15, 2013, the meteor, or *bolide*, measuring 59 ft (18 m) across and weighing 11,000 metric tons, screamed into Earth's atmosphere at 41,600 mph (18.6 km/sec). Burning from the friction with Earth's thin air, the space rock exploded 14.5 mi (23.3 km) above Chelyabinsk.

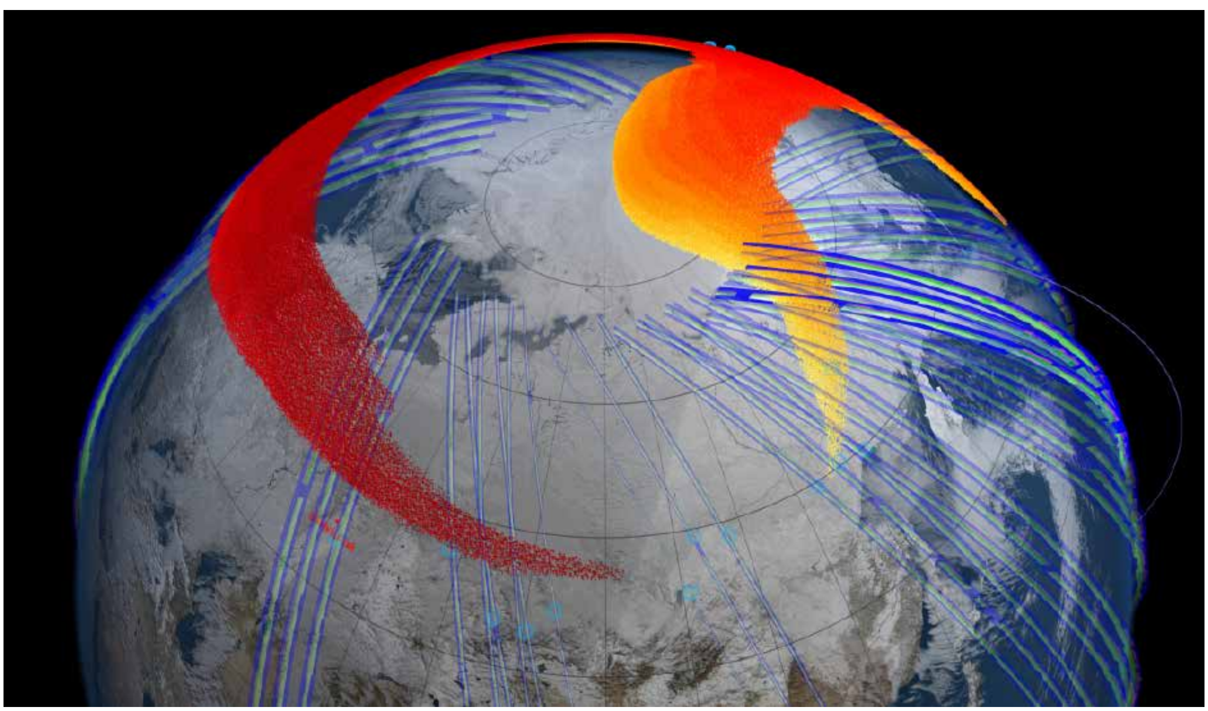
The explosion released more than 30 times the energy from the atom bomb that destroyed Hiroshima. For comparison, the ground-impacting meteor that triggered mass extinctions, including the dinosaurs, measured about 6 mi (10 km) across and released about 1 billion times the energy of the atom bomb.

Some of the surviving pieces of the Chelyabinsk bolide fell to the ground. But the explosion also deposited hundreds of tons of dust up in the stratosphere, allowing a NASA satellite to make unprecedented measurements of how the material formed a thin but cohesive and persistent stratospheric dust belt.

"We wanted to know if our satellite could detect the meteor dust," said Gorkavyi, who led the study, which has been accepted for publication in the journal Geophysical Research Letters. "Indeed, we saw the formation of a new dust belt in Earth's stratosphere, and achieved the first space-based observation of the long-term evolution of a bolide plume."

Gorkavyi and colleagues combined a series of satellite measurements with atmospheric models to simulate how the plume from the bolide explosion evolved as the stratospheric jet stream carried it around the Northern Hemisphere.

About 3.5 hours after the initial explosion, the Ozone Mapping Profiling Suite instrument's Limb Profiler on the NASA-National Oceanic and Atmospheric Administration (NOAA) Suomi National Polar-orbiting Partnership (NPP) satellite detected the plume high in the atmosphere



Model and satellite data show that four days after the bolide explosion, the faster, higher portion of the plume (red) had snaked its way entirely around the Northern Hemisphere and back to Chelyabinsk, Russia. **Image credit:** NASA's Scientific Visualization Studio at an altitude of about 25 mi (40 km), quickly moving east at about 190 mph (more than 300 kph).

The day after the explosion, the satellite detected the plume continuing its eastward flow in the jet and reaching the Aleutian Islands. Larger, heavier particles began to lose altitude and speed, while their smaller, lighter counterparts stayed aloft and retained speed—consistent with wind speed variations at the different altitudes.

By February 19, four days after the explosion, the faster, higher portion of the plume had snaked its way entirely around the Northern Hemisphere and back to Chelyabinsk. But the plume's evolution continued: At least three months later, a detectable belt of bolide dust persisted around the planet.

The scientists' model simulations, based on the initial Suomi NPP observations and knowledge about stratospheric circulation, confirmed the observed evolution of the plume, showing agreement in location and vertical structure.

“Thirty years ago, we could only state that the plume was embedded in the stratospheric jet stream,” said **Paul Newman** [GSFC—*Chief Scientist for Atmospheres*]. “Today, our models allow us to precisely trace [the dust from] the bolide and understand its evolution as it moves around the globe.”

The full implications of the study remain to be seen. Every day, tens of metric tons of small material from space encounters Earth and is suspended high in the atmosphere. Even with the addition of the Chelyabinsk debris, the environment there remains relatively clean. Particles are small and sparse, in contrast to a stratospheric layer just below where abundant natural aerosols from volcanoes and other sources collect.

Still, with satellite technology now capable of more precisely measuring tiny atmospheric particles, scientists can embark on new studies in high-altitude atmospheric physics. How common are previously unobservable bolide events? How might this debris influence stratospheric and mesospheric clouds?

Scientists previously knew that debris from an exploded bolide could make it high into the atmosphere. In 2004, scientists on the ground in Antarctica made a single lidar observation of the plume from a 1000-ton bolide. “But now in the space age, with all of this technology, we can achieve a very different level of understanding of injection and evolution of meteor dust in atmosphere,” Gorkavyi said. “Of course, the Chelyabinsk bolide is much smaller than the ‘dinosaurs killer,’ and this is good: We have the unique opportunity to safely study a potentially very dangerous type of event.”

Come Explore NASA Science at the 2013 Fall AGU Meeting

Please plan to visit the NASA booth (# 325) during the American Geophysical Union's (AGU) forty-sixth annual Fall Meeting! This year's exhibit hall will open on Tuesday, December 9, and will continue through Friday, December 13.

Throughout the week representatives from several different programs and missions are scheduled to give dynamic hyperwall and keynote presentations. Presentations will cover a diverse range of research topics, science disciplines, and programs within NASA's Science Mission Directorate, including Earth Science, Planetary Science, Astrophysics, and Heliophysics.

At the booth there will also be a wide range of other science presentations, demonstrations, printed material, and tutorials on various data tools and services.

A daily agenda will be posted on the Earth Observing System Project Science Office website—*eos.nasa.gov*—in early December.

We hope to see you in San Francisco!

NASA Science presentation using the dynamic hyperwall display during the 2012 AGU Meeting. **Image credit:** NASA

After a Fire, Before a Flood: NASA's Landsat Directs Restoration to At-Risk Areas

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EDITORS NOTE: This article is taken from *nasa.gov*. While it has been modified slightly to match the style used in *The Earth Observer*, the intent is to reprint it with its original form largely intact.

While the 138,000-acre (~558 km^2) Silver Fire still smoldered, forest restoration specialists were on the job. They analyzed maps created using Landsat satellite data to determine where the burn destroyed vegetation and exposed soil—and where to focus emergency restoration efforts.

"The map looked like a big red blob," said **Penny Luehring** [U.S. Forest Service (USFS)], the Burned Area Emergency Response (BAER) and Watershed Improvement Program leader, based in Albuquerque, NM.

Red means high-severity fire, she explained—and the red areas were concentrated in a watershed drainage that fed communities west of Las Cruces, NM—so crews got to work. The BAER teams are designed to go in as soon as the flames die down to help protect reservoirs, watersheds, and infrastructure from post-fire floods and erosion. Landsat satellites, built by NASA and operated by the U.S. Geological Survey (USGS), help direct the crews to those forest areas needing attention.

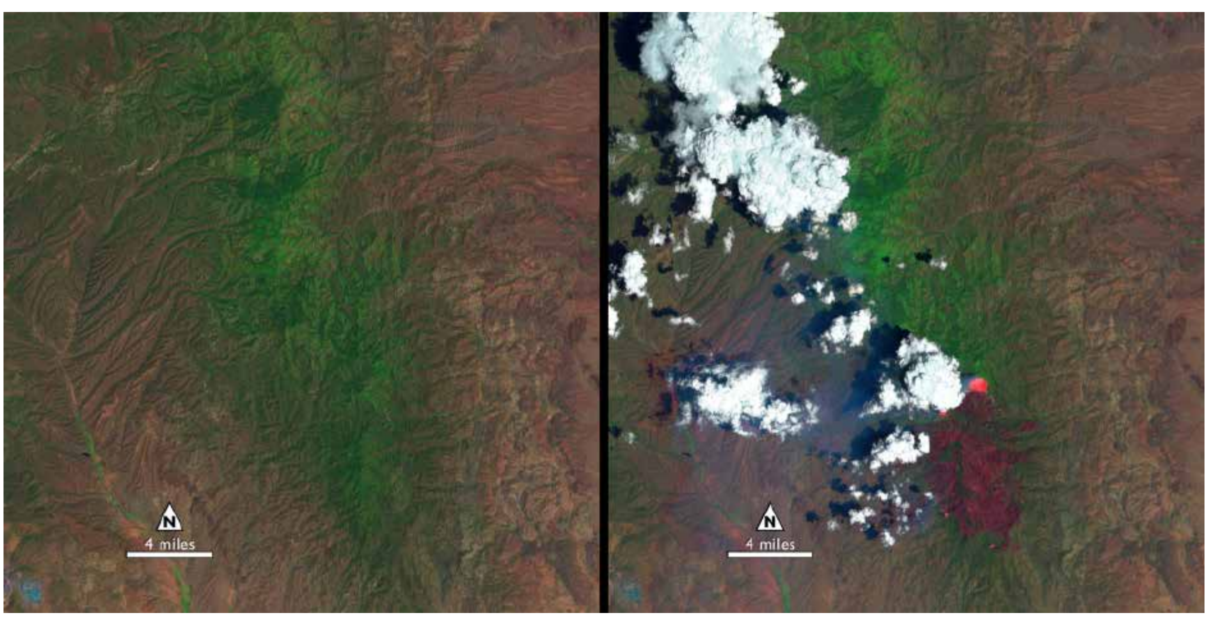
As a wildfire starts to die down, fire managers like Luehring can contact USFS's Remote Sensing Applications Center in Salt Lake City to request maps that identify the high, moderate, and low severity burns. When that call comes in, remote sensing specialist **Carl Albury** [USFS] finds satellite imagery of the burned forest both pre- and post-fire. In Landsat images, he looks at 2 of the 11 spectral bands—the near-infrared band and a short-wave infrared band.

"The near infrared reflects well from healthy vegetation, and the short-wave infrared bands reflect well from exposed ground," Albury said. "By comparing the normalized ratio of the near- and shortwave-infrared bands in the pre-fire image to the post-fire image, we can estimate the burn severity."

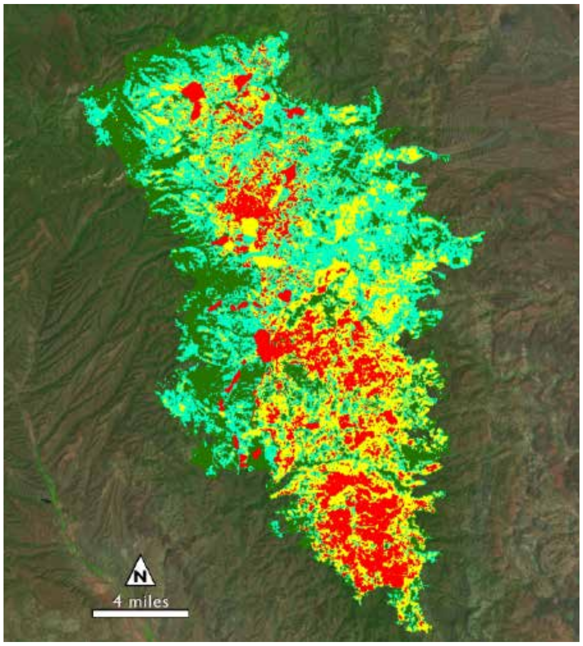
The near-infrared wavelength bounces off of healthy plant cells, and sends back a strong signal to the Landsat detector that isn't present over burned areas, explained **Jeff Masek** [NASA's Goddard Space Flight Center (GSFC)—*Landsat Program Scientist*]. But the shortwave infrared band—added to Landsat satellites starting with Landsat 4—has a distinct spectral signature for burned areas.

"The char will show up very clearly in the shortwave," Masek said.

Albury takes a ratio of the two spectral bands, both before and after a fire. Comparing those ratios, he creates a rough map of fire severity, called the Burned Area



The "before" image [*left*] is a Landsat 8 image acquired May 28, 2013. The "during" image [*right*] was acquired, June 13, 2013, while the New Mexico Silver Fire was still growing. The white puffs with black shadows are clouds. **Image Credit**: NASA/U.S. Geological Survey



The soil burn severity map of the New Mexico Silver Fire shows areas with high (red), medium (yellow) and low (green) severity burns. **Image credit**: USFS, BAER Team

Reflectance Classification (BARC). The BAER teams calibrate or adjust the maps based on on-the-ground observations, and then use them to plan time-sensitive restoration projects. "Without the BARC product the only way for them to assess the fire is on foot or by helicopter," Albury said, noting that doing so is often infeasible for large fires on remote terrain. "It gives them a sense of how much they need to do, and where they need to do it."

While he also employs remote sensing data from other satellites, Landsat is the satellite of choice, Albury said. That's because of the coverage of its spectral bands as well as the free availability of the images—he can sort through to find cloud-free views of that forest at a similar time in the growing season for the pre-fire comparison. And with Landsat 8 online this summer, the new images don't have the gaps present in Landsat 7 imagery. Plus, having two satellites orbiting halves the wait time for post-fire images.

"Now I've got those good, clean, gap-free scenes on a regular basis," Albury said. "That makes an enormous difference for me and for the BAER teams." He's counting on Landsat 8 being closely calibrated to Landsat 7, he said, so he can compare a pre-fire Landsat 8 image with a post-fire Landsat 7 version, or vice versa.

It's one of the reasons why the Landsat team focused on calibrating Landsat 8 so the reflectance data it gathers is measuring land cover and surface properties exactly the same as its predecessors did, Masek said.

"You want to make sure that the same value means the same thing over time and between instruments," Masek said. "Otherwise, you have to treat each image as a separate problem."

Albury estimates he creates maps for about 100 fires each fire season. For some fires, like the Silver Fire, he creates maps even before the fire is contained so that crews can get to work as quickly as possible.

"The whole basis for this is the need for speed," Penny Luehring said. "In the southwest and southern California, there's pretty much anywhere from four to six weeks after fire season before it starts to rain and flood. If we're going to put anything in place that has a chance of holding back water, or controlling or mitigating the effects of water, we have to do it right away." The teams focus on areas at "unacceptable risk," she said, which typically means that post-fire flooding would damage communities, watersheds, and infrastructure. They identify those risky areas with a combination of the Landsat-derived maps, reports from the field, and topographical maps that identify steep slopes and watersheds.

After the Silver Fire, for example, they identified severely burned areas upstream of a community, campgrounds, and forest roads. Crews scattered barley seeds over 11,000 acres, dropped mulch on 800 acres, closed off roads, storm-proofed forest roads, and pumped toilets at risk of flooding.

"It's all hinged on the burn severity map," Luehring said. "It's how you figure out what the watershed response is going to be."

For more information about Landsat, visit: *www.nasa.gov/landsat*.

The 2013 Silver Fire near Kingston, NM, caused ash to wash into streams and creeks. Crews responded quickly to help reduce erosion and runoff, guided in part by maps created from Landsat and other satellite imagery. **Image credit**: USFS, E. Toney

Search On for Climate Clues Across Southern U.S. Skies

Stephen Cole, NASA Headquarters, stephen.e.cole@nasa.gov

EDITORS NOTE: This article is taken from *nasa.gov*. While it has been modified slightly to match the style used in *The Earth Observer*, the intent is to reprint it with its original form largely intact.

NASA research aircraft began flights on August 12 from Houston's Ellington Field to investigate how the combination of summer storms and rising air pollution from wildfires, cities, and other sources can change our climate.

Hoping to improve future predictions of climate change, scientists involved in a NASA study are using the skies over much of the southern United States as a natural laboratory in August and September. They are grappling with one of the tougher factors driving Earth's climate engine: the seasonal push of a complex soup of gases and particles high into the atmosphere when regional weather systems and pollution sources are particularly strong.

The ambitious airborne science campaign, called Studies of Emissions, Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys (SEAC4RS[1]), draws together coordinated observations from NASA satellites, aircraft, and an array of ground sites. More than 250 scientists, engineers, and flight personnel are participating in the mission. **Brian Toon** [University of Colorado, Boulder] is the SEAC4RS lead scientist.

The August 12 flight took two NASA planes and one commercial research aircraft over the Gulf of Mexico coast of Louisiana and into northern Georgia and Alabama. The main target of this flight was sampling air chemistry in the Southeast, which is a mix of natural and human sources. Natural emissions of the carbon compound isoprene from forests in the region can change the chemical balance of the atmosphere and damage the ozone layer if lofted high enough.

NASA's DC-8 flying laboratory and high-altitude ER-2 aircraft sampled the air with dozens of instruments while a Learjet from Stratton Park Engineering Company Inc. measured cloud and aerosol properties. Other targets of the flight were a plume of urban air pollution from Birmingham, AL, and a growing thunderstorm cloud. Convective storms are a key mechanism for lofting pollution and gases high into the atmosphere.

The first SEAC4RS science flight took place on August 6 from the NASA home base at Dryden Aircraft Operations Facility (DAOF) in southern California. The flight sampled the extensive and thick smoke plumes

DC-8 pilot surveys the scene below during the August 12 SEAC4RS flight. **Image credit:** NASA/Lauren Harnett

from forest fires burning in southern Oregon and northern California. The smoke is made up of airborne particles that can absorb incoming and reflected energy from the Sun, alternately warming and cooling the atmosphere. The particles can also change the properties of clouds they flow into, altering their reflective properties.

Scientists using NASA satellite data and climate models project that drier conditions in a warming climate are likely to cause increased forest fire activity across the U.S. in coming decades. Scientists want to take a closer look at what is emitted from large forest fires and how the materials interact.

The second science flight occurred on August 8 as the ER-2 and DC-8 flew from California to Houston, TX, where they will be based for the remainder of the mission. As the planes flew across the U.S. Southwest, they studied the large-scale North American Monsoon weather system, a phenomenon that provides significant rainfall to the region, particularly from July until September, and pumps air high into the atmosphere.

A special target during this transit flight was a plume of dust from the Saharan Desert over Texas and the Gulf of Mexico. The DC-8 sampled the dust by flying through the plume while the ER-2 observed it remotely from above.

Editors note: The final SEAC4RS science flight was flown on September 23 in the transit back to DAOF.

[1] SEAC4RS is sponsored by the Earth Science Division in the Science Mission Directorate at NASA Headquarters. Partial support comes from the U.S. Naval Research Laboratory.

NASA Earth Science in the News

Kathryn Hansen, NASA's Earth Science News Team, kathryn.h.hansen@nasa.gov

How 'Brown Oceans' Fuel Hurricanes, July 17; *LiveScience*. Hurricanes and tropical storms typically gather strength while moving over warm oceans, where the energy released by evaporating water fuels these storms' high winds. These storms usually weaken rapidly as they move over land and are cut off from their fuel source. But researchers are now gaining a better understanding of tropical cyclones that don't conform to the mold and grow stronger over continental land masses, even hundreds of miles from the nearest ocean. Under certain conditions, continents act as "brown oceans" that keep a tropical cyclone from weakening and, in some cases, make the storm even stronger than it was over the ocean. "The land essentially mimics the moisture-rich environment of the ocean, where the storm originated," said NASA-funded researcher **Theresa Andersen** [University of Georgia, Athens], who led the study.

NASA Video: Watch U.S. Heat Up by 2100, July 24; *LiveScience*. Researchers at NASA's Goddard Space Flight Center teamed with scientists at the National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC) in Asheville, NC, to create a new scientific visualization that compares two different climate change scenarios: One in which atmospheric carbon dioxide (CO_2) levels increase from today's level of 400 parts per million (ppm) to 550 ppm, and a second in which CO_2 levels double to 800 ppm. The first scenario would require some kind of mitigation and curtailment of greenhouse gas emissions, while the second would occur if emissions continued to increase. Both scenarios would result in significant temperature changes across the U.S., according to NASA. The conservative scenario of 550 ppm could increase average U.S. temperatures by up to 4.5 °F (about 2 °C) and the more extreme scenario of 800 ppm could heat the country up by about 8 °F (4 °C).

Watch Photosynthesis Light Up Earth From Space, July 28; *Mashable*. We can't see it with the naked human eye, so NASA scientists have figured out how to use satellites to show plants undergoing *photosynthesis*—a process plants go through to convert sunlight into energy. NASA researchers are using satellites in orbit to map photosynthesis across Earth, monitoring plants' health. Healthy plants undergoing active photosynthesis show lots of fluorescence, while stressed plants or those shutting down have low or no fluorescence. These maps can uncover trends in photosynthesis over time. NASA says these records could help farmers detect stressed crops early and help ecologists better understand global vegetation and carbon cycle processes.

NASA Gears Up for "Year of Earth," August 14; *Los Angeles Times*. NASA aims to improve scientists' understanding of climate change on Earth with a trio of missions set to launch in 2014. NASA Administrator **Charles Bolden** toured NASA/Jet Propulsion Laboratory to preview two of the missions—the Soil Moisture Active Passive (SMAP) and RapidScat.

Gorgeous Glimpses of Calamity, August 16; *The New York Times*. In the opinion pages of *The New York Times*, author **Michael Benson** wrote that the "man-made perils to the universe's garden of life are evident from space." The photo essay highlights images such as smoke and haze as seen by NASA's Aqua satellite, melting snow and ice as seen by NASA's Terra satellite, and Hurricane Sandy as seen from the joint NASA/National Oceanic and Atmospheric Administration Suomi National Polar-orbiting Partnership (NPP) spacecraft.

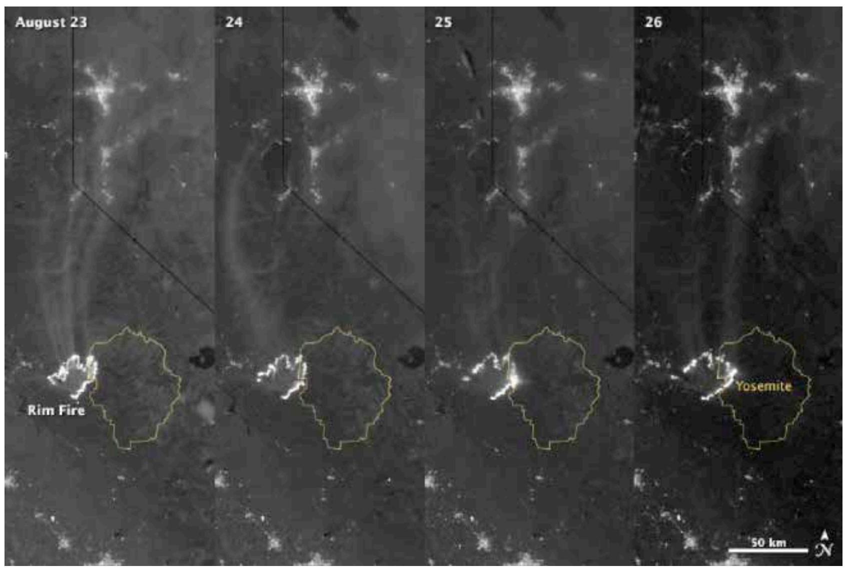
Language Diversity in California Linked to Ecological Diversity, August 20; *Los Angeles Times*. A new study found that migrating tribes first settled along California's lush Pacific coast then moved into progressively drier habitats farther inland, resulting in an array of language groups living alongside one another. **Brian Codding** [University of Utah] and **Terry Jones** [Cal Poly San Luis Obispo] used images of plant growth from NASA's Terra satellite to estimate the abundance of natural resources—a feature known as *environmental productivity*—when migrants first arrived in California. Although the richness of California's habitats has changed, their relative productivity has remained the same.

***NASA Embarks on Air Campaign to Understand Pollution and Climate,** August 21; *Scientific American*. As smoke from the large wildfires in Idaho and Wyoming spread out across the U.S. on August 20, two NASA aircraft flew in to investigate parts of that smoky plume. The two planes, a DC-8, which is a converted passenger plane, and an ER-2, a purpose-built, high-altitude aircraft that can operate between 45,000 and 70,000 feet (between approximately 13 and 21 km), are part of a multiweek NASA campaign called Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys (SEAC4RS) that seeks to better understand how pollution affects climate. In addition to the NASA aircraft, a privately owned Learjet is being used, ground and balloon-based observations are being obtained, and hundreds of personnel are taking part in the investigation, based out of Houston, TX. On Monday, August 26 researcher **Robert Yokelson** [University of Montana], an atmospheric chemist, flew on the DC-8 as it sampled the smoke. Yokelson is trying to learn more about how smoke from wildfires affects Earth's climate. "What we have been doing is to try to fly along that smoke back towards Idaho and Wyoming and try to see how the smoke changes on a multiday scale," he said. That's just one example of the science being undertaken during SEAC4RS.

Shrinking Arctic Ice Will Lead to Ice-Free Summers, August 23; *LiveScience*. In 2012 the ice cap over the Arctic Ocean shrank to its lowest extent ever recorded. Measures of sea ice extent take into account the area of the Arctic Ocean on which ice covers at least 15% of the surface. This year's summer melting season is unlikely to break that record[1], but that does not necessarily herald good news, said glaciologist **Walt Meier** [NASA's Goddard Space Flight Center]. "This is not going to be as extreme a year as last year, but we're still seeing a strong downward trend," Meier told LiveScience. "We're still at levels that are much lower than average." Ten years ago, researchers predicted the Arctic could experience ice-free summers by the end of the century. "Now, it's really looking pretty likely that it could come mid-century at the latest, and perhaps even within the next couple of decades," Meier said. Studies of the Arctic and Antarctic play an important role in global warming prediction. Scientists closely monitor the Earth's poles, because these regions tend to be extremely sensitive to climate changes. "Polar regions tend to heat up faster than the rest of the planet," said **Tom Wagner** [NASA Headquarters—*Cryosphere Program Manager*]. "They're kind of the canary in the coal mine, and these regions are where you expect to see the warming effects take place."

UPDATE: California Rim Fire From Space, August 27; *Slate*. NASA released new images of California's Rim Fire taken from space—see image above. They are from the Suomi NPP satellite, taken with an instrument that detects both visible and infrared light. The four images show the same area over the course of four days, from August 23 to 26. You can see the fire's growth over time, spreading into Yosemite National Park on August 25. It appeared to be weakening a bit to the northeast, but spreading to the southeast. Suomi NPP was designed specifically to observe the Earth's land, ocean, and atmosphere, looking for natural and human-driven changes.

Rainfall in Australia Temporarily Halted Sea Level Rise, August 28; *EarthSky*. A new study suggests that unusual weather events across the Indian and Pacific Ocean may have dropped sea levels in 2010 and 2011—temporarily. According to a new study released by the National Center for Atmospheric Research (NCAR), various atmospheric patterns came together and produced so much rain over Australia in 2010 and 2011 that global ocean levels were temporarily halted from rising. Sea level has been rising since the end of the last Ice Age. It has been rising by at least 1 to 2.5 mm (0.04 to 0.1 in) per year since 1900. It is rising faster now than a century ago, in part due to global warming, which not only causes ice sheets to melt and enter the sea as water, but also drives a thermal expansion of water.



The Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite tracked the growth of California's Rim Fire between August 23 and 26. **Image credit:** NASA's Earth Observatory

However, for an 18-month period from 2010 into 2011, global sea level rise actually dropped 7 mm (~0.3 in). Scientists wanted to know what would make sea level drop suddenly, when it has been rising for centuries. With the help of NASA's Gravity Recovery and Climate Experiment (GRACE) satellites, the Argo global array of 3000 free-drifting floats, and other satellite measurements, researchers at NCAR, NASA/Jet Propulsion Laboratory, and the University of Colorado at Boulder were able to figure out that rainfall in Australia may have been responsible for the drop in sea level.

*See news story in this issue for more details.

Interested in getting your research out to the general public, educators, and the scientific community? Please contact ***Patrick Lynch*** *on NASA's Earth Science News Team at* ***patrick.lynch@nasa.gov*** *and let him know of upcoming journal articles, new satellite images, or conference presentations that you think would be of interest to the readership of* ***The Earth Observer****.* ■

[1] Update: The 2013 Arctic ice extent at minimum was indeed well above the record minimum reached in 2012.

NASA Science Mission Directorate – Science Education and Public Outreach Update

Theresa Schwerin, Institute for Global Environmental Strategies, theresa_schwerin@strategies.org
Morgan Woroner, Institute for Global Environmental Strategies, morgan_woroner@strategies.org

NASA Postdoctoral Fellowships

Deadline—November 1

The NASA Postdoctoral Program offers scientists and engineers unique opportunities to conduct research in space science, Earth science, aeronautics, exploration systems, lunar science, astrobiology, and astrophysics.

Annual stipends start at $53,500—with supplements for specific degree fields and high cost-of-living areas. There is an annual travel budget of $8000, a relocation allowance, and financial supplement for health insurance purchased through the program. Approximately 90 fellowships are awarded annually.

An applicant must be a U.S. citizen, lawful permanent resident, or foreign national eligible for J-1 status as a research scholar to apply. Applicants must have completed a Ph.D. or equivalent degree before beginning the fellowship, but may apply while completing the degree requirements. Fellowships are available to recent or senior-level Ph.D. recipients.

Fellowship positions are offered at several NASA centers. To obtain more information and to apply for this exciting opportunity, visit: *nasa.orau.org/postdoc*.

S'COOL Lesson Plan 20: Fahrenheit vs. Celsius

This newly reviewed lesson plan from the Students' Cloud Observations Online (S'COOL) Project has students working in small groups to build their own meteorological tool. Two key components of the lesson are converting temperature from Fahrenheit units to Celsius and learning the difference between the two systems of measurement. Students will also deliver brief oral reports and learn communication skills. This is a great resource for students in grades 3-5. To access the lesson plan, visit: *scool.larc.nasa.gov/cgi-bin/view_lesson-plan.cgi?id=20*.

GPM Information Lithograph

The Global Precipitation Measurement (GPM) mission lithograph—with a beautiful shot of the satellite on the front cover—provides an overview of the mission and explanation of how it builds on the work of the Tropical Rainfall Measuring Mission (TRMM), portrayed on the back. Also included are details of the Core Observatory satellite and the role of the partner satellites that make up the constellation, a description of the mission's science and applications, and a list of partner agencies. The lithograph can be found online at *nasawavelength.org/resource/nw-000-000-003-538.*

NASA Harriett G. Jenkins Graduate Fellowship Program

Application Deadline: August 9

NASA's Office of Education is accepting applications for fall 2013 as a part of the *NASA Harriett G. Jenkins Graduate Fellowship Program*. Since 2001 this activity has supported 211 students as they obtained masters and doctoral degrees. The graduate fellowship seeks to support the development of the future Science, Technology, Engineering, and Mathematics (STEM) workforce by increasing the number of graduate degrees in the STEM disciplines awarded to underrepresented and underserved individuals. The goal is to address the agency's mission-specific workforce needs and target areas of national need in minority STEM representation. The fellowship awards of up to $45,000 include tuition offset, student stipend, and NASA field center research opportunities. Applicants must be U.S. citizens. For more information, visit: *1.usa.gov/13TCoQ6*.

GLOBE Virtual Student Conference—Upcoming Winners Announcement

Announcement Expected: Mid-August

The GLOBE Virtual Student Conference is an annual online conference in which GLOBE students from around the world submit their research projects in the areas of Atmosphere, Earth as a System/Phenology, Hydrology, Land Cover/Biology, and Soils for review by scientists and feedback from the GLOBE community. These projects are available for viewing at *www.globe.gov/web/scrc/virtual-conference/2013-virtual-student-conference*.

2014 GLOBE Calendar Art Competition

Entries due: September 30

The GLOBE Program is sponsoring an international art competition to encourage students to highlight and document GLOBE communities around the world. Through a variety of media, GLOBE students will show how their local environments are unique, and how participating in GLOBE has helped them appreciate their surroundings. Winning entries will be featured in the 2014 GLOBE calendar. For more information, visit: *www.globe.gov/events/competitions/calendar-art-competitions/art-for-2014-calendar.* ■

EOS Science Calendar

October 15–17, 2013
HyspIRI Science and Applications Workshop, Pasadena, CA.
hyspiri.jpl.nasa.gov/events/2013-hyspiri-science-and-application-workshop

October 15–18, 2013
NASA Sounder Science Team Meeting, Greenbelt, MD.
airs.jpl.nasa.gov/meetings/science-team-greenbelt

October 23–25, 2013
GRACE Science Team Meeting, Austin, TX.
www.csr.utexas.edu/grace/GSTM

October 29–31, 2013
CERES Science Team Meeting, San Diego, CA.
ceres.larc.nasa.gov/ceres_meetings.php

October 29–31, 2013
Landsat Science Team Meeting, Sioux Falls, SD.
landsat.usgs.gov

November 5–7, 2013
SMAP Cal/Val Workshop, Oxnard, CA.
smap.jpl.nasa.gov/science/workshops

January 28–31, 2014
SORCE Science Team Meeting, Key West, FL.
lasp.colorado.edu/home/sorce/news-events/meetings/2014-sorce-science-meeting

Global Change Calendar

October 27–30, 2013
Geological Society of America, Denver, CO.
community.geosociety.org/2013AnnualMeeting/Home

November 11–22, 2013
Conference of Parties (COP)-19, Warsaw, Poland.
www.cop19.org

December 9–13, 2013
American Geophysical Union, San Francisco, CA.
fallmeeting.agu.org/2013

February 2–6, 2014
American Meteorological Society Meeting, Atlanta, GA.
annual.ametsoc.org/2014

April 27–May 2, 2014
European Geosciences Union General Assembly 2014, Vienna, Austria.
annual.ametsoc.org/2014

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Articles, contributions to the meeting calendar, and suggestions are welcomed. Contributions to the calendars should contain location, person to contact, telephone number, and e-mail address. Newsletter content is due on the weekday closest to the 15th of the month preceding the publication—e.g., December 15 for the January–February issue; February 15 for March–April, and so on.

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