National Aeronautics and Space Administration

the earth observer

The Earth Observer. January - February 2016. Volume 28, Issue 1.

Editor's Corner

Steve Platnick
EOS Senior Project Scientist

I am happy to report that the Jason-3 satellite successfully launched on January 17, 2016 at 10:42 AM Pacific Standard Time from Vandenberg Air Force Base in California onboard a Space-X Falcon 9 rocket. Minutes after Jason-3 separated from the rocket's second stage, the spacecraft unfolded its twin sets of solar arrays and ground controllers successfully acquired the spacecraft's signal. All indications are that the satellite is in good health.

Jason-3 will extend the multidecadal time-series of sea surface height measurements began by TOPEX/Poseidon [1992–2005] and continued with the Jason-1 [2001–2013] and OSTM/Jason-2 [2008–present] missions. Knowledge of ocean surface topography provides scientists with crucial information about ocean currents, interannual phenomena (e.g., El Niño Southern Oscillation), global and regional changes in sea level, and their climate implications for a warming world.

Jason-3 will have a period of overlap with the ongoing Jason-2 mission. Such measurement overlap is highly desirable to help ensure the continuity of long-term satellite records of climate variables. Jason-3 entered orbit

continued on page 2

A SpaceX Falcon 9 rocket carrying the U.S.-European Jason-3 satellite launches from Vandenberg Air Force Base Space Launch Complex 4 East on January 17, 2016. Jason-3, an international mission with NASA participation, will continue a 23-year record of monitoring global sea level rise. **Image credit:** NASA/Bill Ingalls

In This Issue

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

about 25 km (16 mi) below Jason-2. Over the next month, the new spacecraft will gradually raise itself into the same 1336-km (830-mi) orbit and position itself to follow somewhere between 1 and 10 minutes behind Jason-2's ground track. The two spacecraft will then fly in formation, making nearly simultaneous measurements, for about six months to allow scientists to precisely calibrate Jason-3's instruments.

The primary instrument on Jason-3 is a radar altimeter—essentially an identical copy of the instrument that flew on Jason-2—that will measure sea-level variations over the global ocean with very high accuracy. Scientists and operational agencies (e.g., NOAA, European weather agencies, marine operators) will use the data for a variety of scientific research topics and operational oceanography applications that benefit society.

Both TOPEX/Poseidon and Jason-1 were cooperative missions between NASA and CNES. Additional partners in the Jason-2 mission included NOAA and EUMETSAT. Jason-3 continues the international cooperation, with NOAA and EUMETSAT leading the efforts, along with partners NASA and CNES. More information about Jason-3 can be found at *sealevel.jpl.nasa.gov/missions/jason3*.

In other news, January 10, 2016, marked the one-year anniversary of the launch of the Cloud–Aerosol Transport System (CATS) that flies on the International Space Station. (February 12 marked the one-year anniversary for science operation.) Data users, especially those seeking to use CATS data to improve aerosol modeling forecasts (e.g., Air Force, GMAO, NRL) are beginning to ingest and interpret the CATS profile data. The volume of CATS data now collected are sufficient to allow researchers to begin statistical studies of cloud and aerosol coverage.

The CATS team has implemented a new feature on their webpage (*cats.gsfc.nasa.gov*), called *Image of the Week*. The aim is to show some interesting image or science result each week. Level 1 data products are available from the ASDC DAAC (follow links on the CATS web page), and the team has a goal of releasing Level-2 data products by March 1.

On December 23, 2015, the CLARREO Team received notification of an FY16 appropriation to begin the CLARREO Pathfinder project. The CLARREO Team includes scientists from LaRC, GSFC, JPL, seven universities, and other government partners (e.g., NIST). The objective of the CLARREO

Pathfinder project is to demonstrate essential measurement technologies of the CLARREO mission[1] via the International Space Station. The CLARREO Team has begun to refine high-level project plans and budget profiles for the CLARREO Pathfinder mission with NASA Headquarters and the Earth Systematic Missions Program Office. A CLARREO Pathfinder project execution team has been identified and is currently in formation.

In our last issue, we reported that November 21, 2015, marked the fifteenth anniversary of the launch of the Earth Observing-1 (EO-1) mission, which began as a sensor and spacecraft bus technology testbed in support of NASA's New Millennium Program, but evolved into much more. Following the 2015 Earth Science Senior Review, it was decided that in October 2016, EO-1 will end its run after nearly 16 years. While the decision is bittersweet, the entire EO-1 team should be immensely proud of their accomplishments. EO-1's hardware was innovative—the Advanced Land Imager (ALI) multispectral instrument was the prototype for Landsat 8's Operational Land Imager (OLI) instrument, and Hyperion was the first civilian hyperspectral instrument in orbit. Lessons learned from the instruments onboard EO-1 are being incorporated into the planning for and design of the proposed Hyperspectral Infrared Imager (HyspIRI) mission, which includes a scanning visible-to-shortwave infrared imaging spectrometer. Turn to page 23 to read a summary of the most recent HyspIRI Science and Applications Workshop.

Over the years, EO-1 moved far beyond its initial testbed status, taking on additional tasks and duties—all the while performing beyond design expectations. The satellite is a leader in acquiring quick-response disaster imagery around the globe. It was used to test the concept of *SensorWebs*, where independent sensors can trigger satellite image acquisitions. Hyperion and ALI have taken images all over the world, amassing a library of over 165,000 images, including time-series over many calibration sites. Turn to page 4 to read more about the remarkable EO-1 mission.

Since it launched in 2003, NASA's SORCE mission has advanced our understanding of the total and spectral solar irradiance while maintaining continuity of solar climate data records from space that were initiated in the late 1970s. In an effort to continue this crucial long-term time series without interruption, the 2015 Earth Science Senior Review approved the extension of the SORCE mission to 2018 to allow overlap with the NASA Total and Spectral Solar Irradiance Sensor (TSIS-1) that is scheduled for deployment on the International Space Station in late 2017. SORCE instruments now make routine measurements in a daytime-only operations mode in order to compensate for reduced battery capacity. SORCE continues to function well and has far exceeded its planned mission. However, in the event the venerable mission must end prior to the launch of TSIS-1, there is a "backup" to insure continuity in the total solar irradiance (TSI) calibration scale between SORCE and TSIS. The Joint Polar Satellite System (JPSS) TSI Calibration Transfer Experiment (TCTE) was launched onboard the U.S. Air Force Space Test Program Satellite-3 (STPSat-3) in 2013. TCTE has been extended to 2017 in order to overlap with TSIS. On page 29 of this issue we report on the November 2015 Sun-Climate Symposium on multi-decadal variations in the Sun and Earth during the space era. Over 80 scientists and students from around the world gathered in Savannah, GA to discuss a broad range of topics related to solar variability and climate change. Observations from SORCE were highlighted in many of the presentations.

For more than 10 years, the Science Program Support Office (SPSO) at GSFC has organized and supported the NASA exhibit at the American Geophysical Union (AGU) Fall Meeting. For the last few years, the SPSO has also organized and hosted a one-day Annual Communication Meeting the weekend before the start of AGU. Even in an era of near instantaneous communication via the Internet and social media, there is still value in face-to-face contact. The annual communication meeting provides such an opportunity for the NASA outreach community, which includes management, public engagement personnel, and the like from several NASA centers. On page 20 of this issue, we provide a glimpse of what took place at the Annual Communication Meeting along with details about recent NASA exhibits at AGU, GEO-XII, and COP-21. ■

[1] The National Research Councils's *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (2007), a.k.a., the "2007 Earth Science Decadal Survey", identified CLARREO as a *Tier 1* (highest priority) mission. The report can be found at *nap.edu/catalog/11820/earth-science-and-applications-from-space-national-imperatives-for-the.*

Note: List of undefined acronyms from the *Editor's Corner* and the *Table of Contents* can be found on **page 41**.

EO-1: 15 Years After the Start of Its "One-Year Mission"

David R. Landis, NASA's Goddard Space Flight Center, david.r.landis@nasa.gov
Elizabeth M. Middleton, NASA's Goddard Space Flight Center, elizabeth.m.middleton@nasa.gov
Stephen G. Ungar, NASA's Goddard Space Flight Center, stephen.g.ungar@nasa.gov
Stuart W. Frye, NASA's Goddard Space Flight Center, stuart.frye@nasa.gov
Daniel J. Mandl, NASA's Goddard Space Flight Center, daniel.j.mandl@nasa.gov
K. Fred Huemmrich, University of Maryland, Baltimore County/Joint Center for Earth Systems Technology UMBC/JCET, karl.f.huemmrich@nasa.gov
Petya K. Campbell, UMBC/JCET, petya.k.campbell@nasa.gov
Mitchell K. Hobish, Sciential Consulting, LLC, mkh@sciential.com

Introduction

Originally planned as a "one-year mission," NASA's Earth Observing-1 (EO-1) satellite celebrated the fifteenth anniversary of its launch on November 21, 2015. EO-1 was originally a technology testbed satellite, built quickly and inexpensively. EO-1 is finally heading for the end of its mission, which is projected for October 2016. While the platform and its instruments are operating well, fuel reserves have been exhausted and the satellite has lost its orbital maintenance ability. The impressive milestone of reaching its 15-year anniversary, coupled with the impending end of the mission, provides an excellent time to review EO-1's origins and goals, its expanded mission, and the utility of the data acquired so far. For more specific details on EO-1, visit *eo1.gsfc.nasa.gov*.

EO-1's Beginnings—NASA's New Millennium Program

The story of EO-1 begins with the Land Remote Sensing Policy Act of 1992, which required NASA to continue collecting Landsat data through the use of two technologies: *multispectral imaging* for "traditional" Landsat end-users, and *hyperspectral imaging* for Landsat's research data users (with a requirement for backward compatibility with older Landsat images). The differences in these types of sensors are shown in **Figure 1**, which compares the spectral coverage of multi- and hyperspectral imagers in the visible through shortwave infrared wavelengths.

In 1995 NASA recognized that more-complex space missions would require increasing levels of technology development. Rather than attempt to implement cutting-edge technologies in the new missions themselves, NASA's Office of Space Science and the

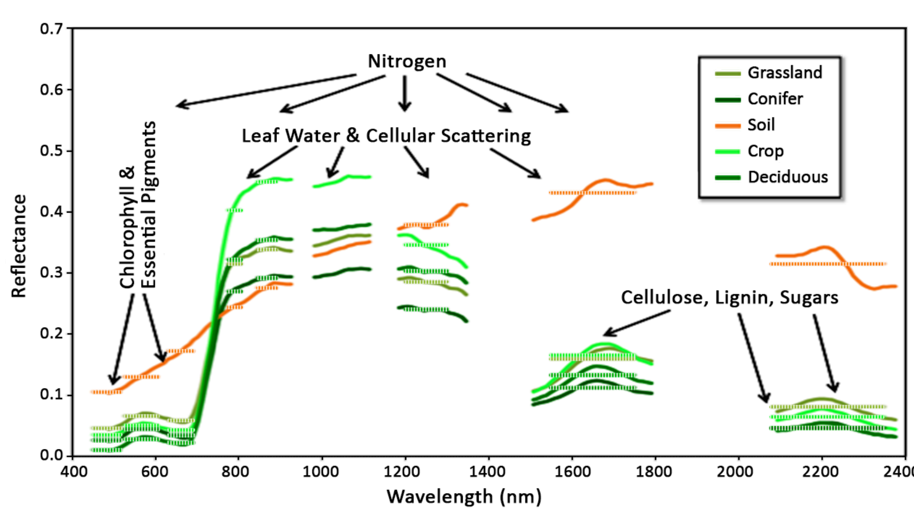

Figure 1. The horizontal lines indicate the spectral coverage of EO-1's multispectral Advanced Land Imager (ALI) instrument, which samples selected regions of the electromagnetic spectrum like Landsat 7 and 8. The smooth curves show the spectral coverage of the imaging spectrometer Hyperion, which acquires images over the visible-to-shortwave-infrared spectrum (0.4-2.5 μm). The gaps are due to atmospheric absorption. The arrows indicate the sections of the spectra where the listed biological features can be detected. **Image credit:** K. Fred Huemmrich