A Note from Pam Sullivan, GOES-R System Program Director:

The GOES-R Program ended 2019 on a high note. GOES-16 and GOES-17 continue operational service, providing critical weather data for the nation. Our team continues to make great progress building GOES-T and U and upgrading our ground system. The Geostationary and Extended Orbits (GEO-XO) program is officially underway, authorized to move into the conceptual phase of the mission. The team looks forward to presenting our work and connecting with colleagues at the upcoming 100th American Meteorological Society Meeting in Boston. Here's to a productive and successful 2020 for the GOES-R and GEO-XO Programs!

PROGRAM HIGHLIGHTS

On November 18-21, the ground segment project successfully completed the delta System Definition Review (dSDR)/System Requirements Review (dSRR) for the IBM server replacement and other architecture changes being made to the system. The dSDR examined the proposed changes to the system architecture and design and assessed the flow down to all functional elements of the system. The dSRR confirmed technical requirements are understood and correctly allocated to design elements. This review was a gate review for material procurement. The review board acknowledged that the project and the Harris team did an outstanding job preparing for review and much of the material was at Critical Design Review level.


GOES-R ground segment personnel celebrate a successful dSDR/dSRR. Credit: Harris

DID YOU KNOW?

NASA Ames Research Center has a new website that documents GOES-R Geostationary Lightning Mapper (GLM) bolide detections. Approximately two GLM bolide events per day are being discovered. In addition to mapping lightning, GLM is able to pick up the signals of meteors in Earth's atmosphere when they are brighter than the full moon. Meteors that bright are called "bolides" and they are caused mainly by the impact of small asteroids.

On December 9, GOES-16 space weather data from the Solar Ultraviolet Imager (SUVI), Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS), Space Environment In-Situ Suite (SEISS), and Magnetometer (MAG) became operationally available from NOAA's Space Weather Prediction Center (SWPC). GOES-16, which offers a number of improvements to space weather data, is now the primary satellite for geostationary space weather observations.
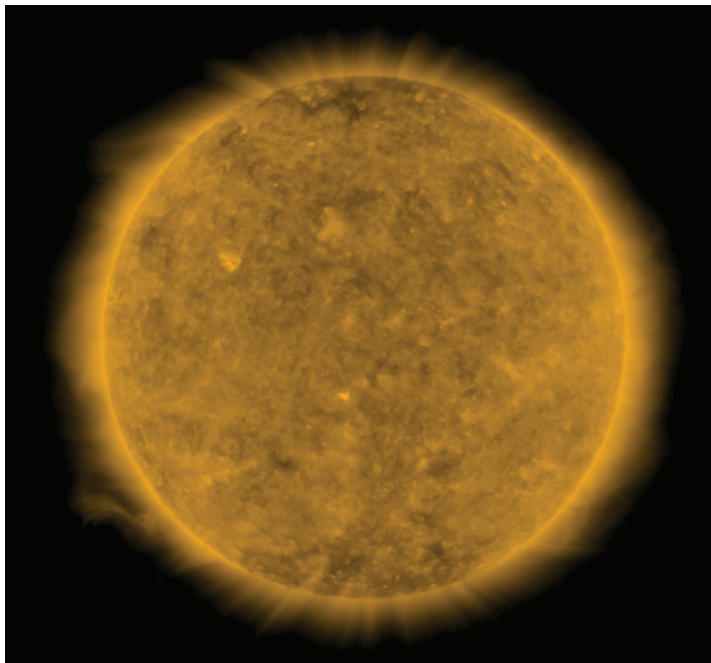
GOES-16 SUVI image from December 10. Credit: NOAA SWPC

A two-phase test was conducted in October to investigate whether modifying the GOES-17 Advanced Baseline Imager (ABI) scan pattern during periods of high thermal loading would decrease the number of saturated images due to the loop heat pipe (LHP) anomaly. Preliminary results from scan pattern tests indicate that scanning only one full disk every 30 minutes drops LHP temperature by 7 Kelvin, resulting in about two extra hours of unsaturated water vapor imagery. L3Harris is running thermal models to project these results to other possible scanning strategies. Results were provided to the National Weather Service (NWS), which is assessing whether any of these scanning mode alternatives are desirable. Additional cooling timeline tests will be conducted before a final decision is made.

The GOES-T and GOES-U satellites will fly NASA Goddard Magnetometer (GMAG) instruments, instead of the Macintyre Electronic Design Associates Magnetometers that fly on GOES-16 and GOES-17. The change is being implemented to improve instrument

performance. Two GMAGs are currently in long-term stability testing at the NASA Goddard magnetic test site.

A new GOES-R 3D model was completed in December. The interactive model allows users to rotate the spacecraft, zoom in and out, and explore the components of the satellite. The mobile version has an augmented reality capability that allows users to superimpose the satellite on the scene in their device's camera.

A GOES-R satellite "visited" the GOES-R Program Office at NASA Goddard Space Flight Center via augmented reality. Credit: GOES-R Program

On December 18, NOAA officials announced plans to power off the GOES-15 satellite and place it into orbital storage by January 31, 2020. Since late 2018, GOES-15 has operated in tandem with GOES-17, as a precaution, while engineers worked on technical issues with the ABI LHPs. NOAA also announced GOES-14, which has been providing supplemental space weather instrument operations, will be powered off and placed in storage by January 31. GOES-16, in the GOES East position, is sending more advanced space weather data to NOAA's SWPC. Additionally, GOES-17 is

PROGRAM HIGHLIGHTS (CONTINUED)

providing products in a developmental system for space weather. GOES-15 and GOES-14 can be called back into service if either GOES-17 or GOES-16 experience issues.

In December, NASA selected United Launch Services LLC (ULS) to provide launch services for GOES-T, the third satellite in the GOES-R Series. GOES-T is currently targeted to launch in December 2021 on an Atlas V 541 rocket from Launch Complex 41 at Cape Canaveral Air Force Station in Florida. NASA's Launch Services Program at Kennedy Space Center in Florida will manage the ULS launch service.

GEO-XO

Planning for next-generation NOAA satellite systems is underway. In the geostationary domain, NOAA is preparing for the Geostationary and Extended Orbits (GEO-XO) program, so named because it is envisioned to employ sensors and spacecraft in geostationary orbit and also in Sun-Earth Lagrange Point orbits as successors to the Deep Space Climate Observatory (DSCOVR) and Space Weather Follow-On (SWFO) missions. GEO-XO may also include new orbits, instruments, and space architecture. The GEO-XO operational phase is planned for the 2030-2050 timeframe.

On October 3, NESDIS released a pair of Broad Agency Announcements (BAAs) to engage the commercial sector in developing new concepts for instruments, spacecraft, business models and mission elements for NOAA's future space-based observation architecture beyond the JPSS and GOES-R systems. Interested parties gathered more information at Industry Day events October 17-18. The GEO-XO BAA sought white papers that will lead to funded concept studies of instrument and architecture concepts for remote sensing capabilities in geostationary and extended orbits. The GEO integrated program team reviewed the BAA responses and provided recommendations to the management review team on which studies to fund.

On December 18, the GEO-XO pre-formulation team presented the GEO-XO program for Milestone Zero (M0) for approval. The presentation highlighted the necessity of the GEO-XO program to maintain continuity of critical terrestrial and space weather data collected currently by the GOES-R system and in the future by the Space Weather Follow On mission. The team presented a thorough plan for the GEO-XO program definition activities, including a road map of major activities and decisions, governance structure, planned partnerships, and plans for user engagement. The NESDIS Assistant Administrator, as the Milestone Decision Authority, approved the GEO-XO M0 and its entrance to the conceptual phase (Milestone 1). This phase is planned to last approximately one year and culminate in a Mission Concept Review and Milestone 1 key decision point in late 2020.

SCIENCE APPLICATIONS

With the advent of the GOES-R Series, forecasters now have an overwhelming amount of information to sift through. To help meteorologists quickly discern the information they need to issue timely forecasts and warnings, scientists are working on new ways to combine information from multiple ABI channels to enhance features of interest. The result is a variety of red-green-blue or "RGB" composite imagery. The stunning, colorful imagery you see from GOES-16 and GOES-17 isn't just beautiful to look at, it also provides critical information to forecasters for situational awareness and nowcasting rapidly changing weather.
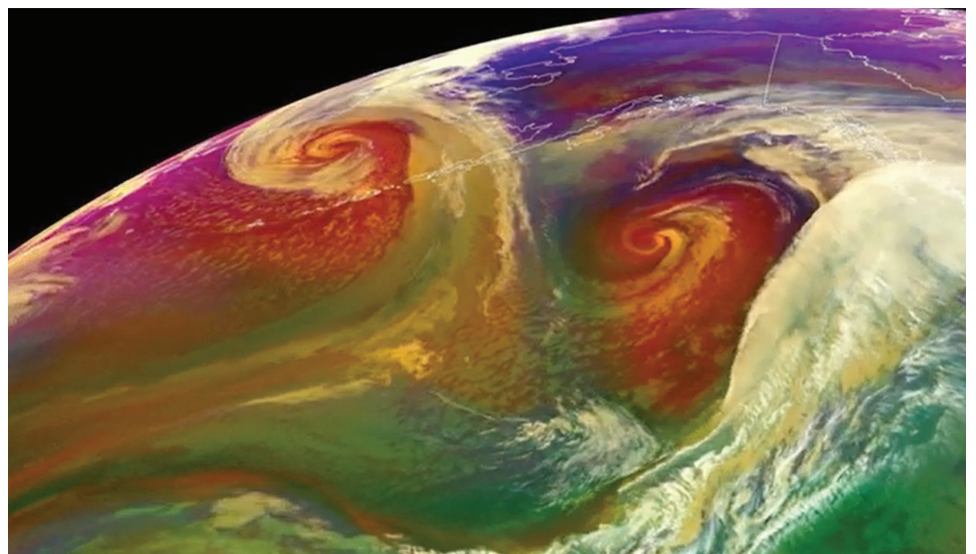
This GOES-17 air mass RGB imagery shows a hurricane-force low (the remnants of Super Typhoon Hagibis) over the Bering Sea and a storm-force low over the Gulf of Alaska. This type of imagery combines water vapor and infrared imagery from the ABI and is used to monitor the evolution of cyclones and jet streaks. Credit: NOAA/CIRA

The GOES-R Series Geostationary Lightning Mapper (GLM) is the first instrument of its kind in geostationary orbit. It detects total lightning (in-cloud and cloud-to-ground) activity and reveals the spatial extent and distance lightning flashes travel. Rapid increases in total lightning activity often precede severe and tornadic thunderstorms and can be an indication that a hurricane is strengthening. This new infographic explains how GLM data is critical not only for a number of public safety applications but also for understanding and predicting long-term changes in climate.


Wind is a fundamental variable of weather. The heating of Earth's surface and atmosphere by the sun drives winds that move heat and moisture from one place to another. Variations in large-scale wind circulation patterns are responsible for the daily weather we experience. Satellite wind estimates help forecasters understand current weather conditions and contribute important information to global weather prediction models. Satellites like GOES-16 and GOES-17 provide more and better estimates of winds for improved forecasting tools and a better understanding of severe weather.
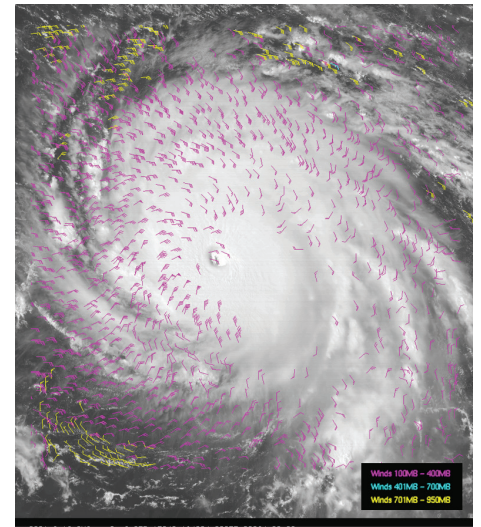
GOES-16 winds generated over Hurricane Irma on September 6, 2017, overlaid on GOES-16 visible imagery. Credit: NOAA

A new machine-learning algorithm uses SUVI data to find solar flares and other events in vast streams of solar images and help NOAA forecasters issue timely space weather alerts. This technique, developed by scientists at the National Centers for Environmental Information (NCEI) and the Cooperative Institute for Research in Environmental Sciences (CIRES), searches massive amounts of satellite data to pick out features significant for space weather. Changing conditions on the sun and in space can affect various technologies on Earth, blocking radio communications, damaging power grids, and diminishing navigation system accuracy. SUVI data is being used to generate solar thematic maps that will serve as the basis for a variety of new space weather products from NOAA's SWPC. In the thematic maps, different colors correspond to different themes: yellow corresponds to active regions while dark blue shows quiet solar regions.
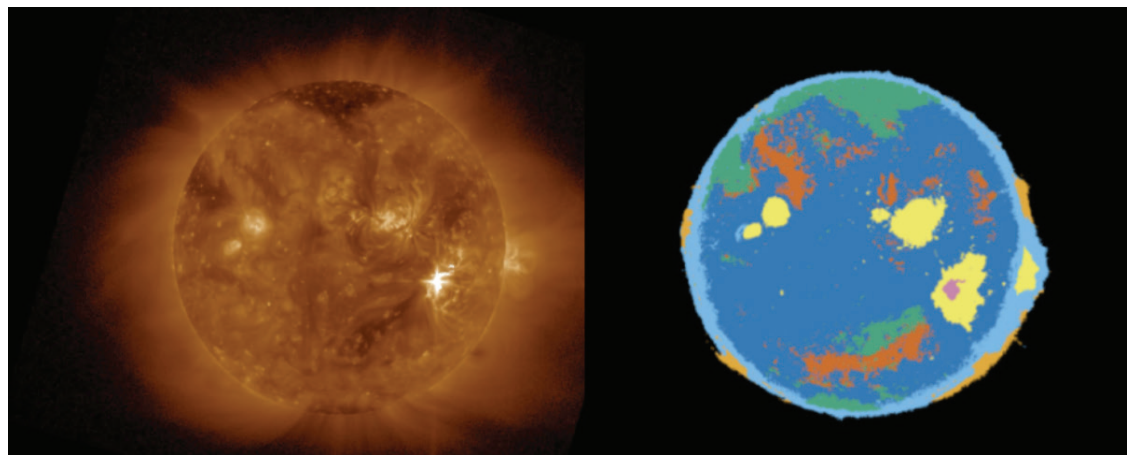

The SUVI thematic map (right) produced by the new algorithm tracks changes in the sun (left) over time. Credit: Dan Seaton and J. Marcus Hughes, NCEI/CIRES/CU Boulder

DATA AND IMAGERY

GOES-16 captured two large storm systems over the United States on October 11. To the west, a powerful cold front pushed eastward into the Plains and the Midwest. This moved into a much warmer, more humid air mass to the east, causing a massive line of fast-moving thunderstorms to form along the sharp temperature gradient. Off the East Coast, a former nor'easter centered southeast of New England became Subtropical Storm Melissa. It brought rain and some wind to coastal areas of Massachusetts.
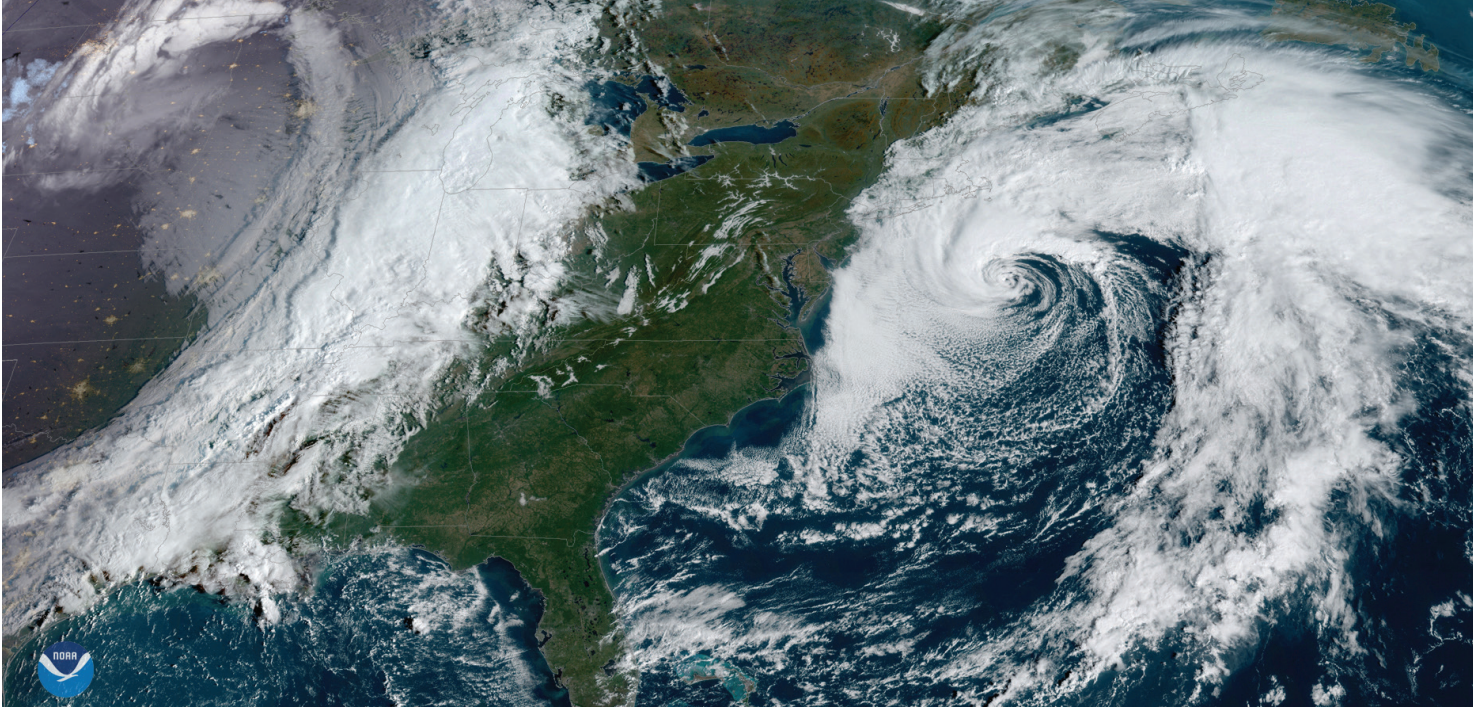
GOES-16 captured two large storm systems over North America on October 11. Credit NOAA

**A fast-moving wildfire, driven by strong winds, ignited on October 23 in Sonoma County California.** At 9:21:01 p.m. PDT, the GOES-17 mesoscale sector positioned over California first detected heat in ABI bands 5, 6, and 7, indicating a potential fire. The fire intensified rapidly and the GOES-R fire detection and
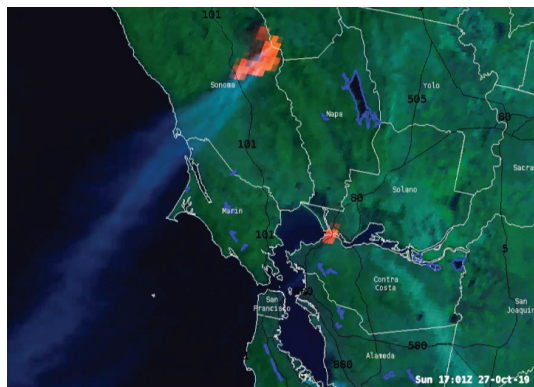
GOES-17 hot spot, smoke, and burn scar RGB imagery of the Kincade Fire on October 27. Credit: NOAA/Satellite Liaison Blog

characterization product picked up the fire. Initial reports from the California Department of Forestry and Fire Protection put the ignition time at 9:26 PDT. GOES-17 captured hot spot, smoke, and burn scar RGB imagery of the Kincade Fire on October 27. This type of imagery allows forecasters to see a fire's hot spots, smoke, and burn scar in one image. Hot spots (active wildfire) appear as red, the smoke plume as faded blue or cyan, clouds a bright cyan, and burned area as locally dark. Highly vegetated areas appear as bright green and bodies of water very dark. The active large fire is readily apparent, with the associated burn scar extending north of the ongoing fire. The smoke plume extends well to the southwest of the fire.

On November 11, the planet Mercury passed directly between the sun and Earth and the GOES-16 SUVI tracked the transit. The event lasted for approximately five and a half hours, from 7:35 a.m. to 1:04 p.m. EST. During the transit, Mercury appeared as a tiny blck dot moving across the sun. Transits of Mercury only happen about 13 times per century – the next transit will be in 2032 and the next opportunity to catch a Mercury transit in the U.S. will be in 2049.
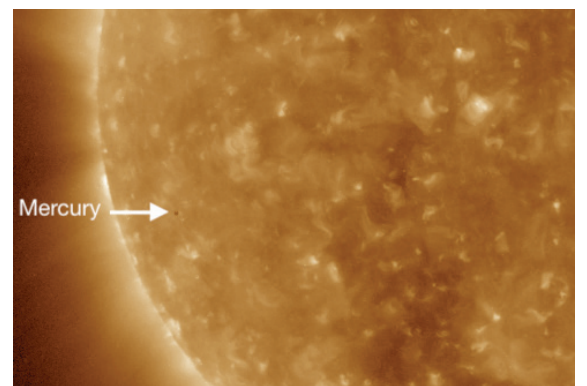

GOES-16 SUVI image of the Mercury transit at 8:00 a.m. EST on November 11, near the beginning of the transit. Credit: NOAA

GOES-17 monitored a mid-latitude cyclone swirling in the Gulf of Alaska on November 12. These tend to form within the Aleutian Low, which is a semi-permanent breeding ground for some of the strongest storms on Earth. Located near the Aleutian Islands of Alaska, the Aleutian Low helps encourage storm development due to a combination of considerable temperature differences, a strong Coriolis force, and a high latitude location. This storm system steadily crept northward, bringing rain to the southwestern region of Alaska, across the Gulf Coast, as well as into the southeast.
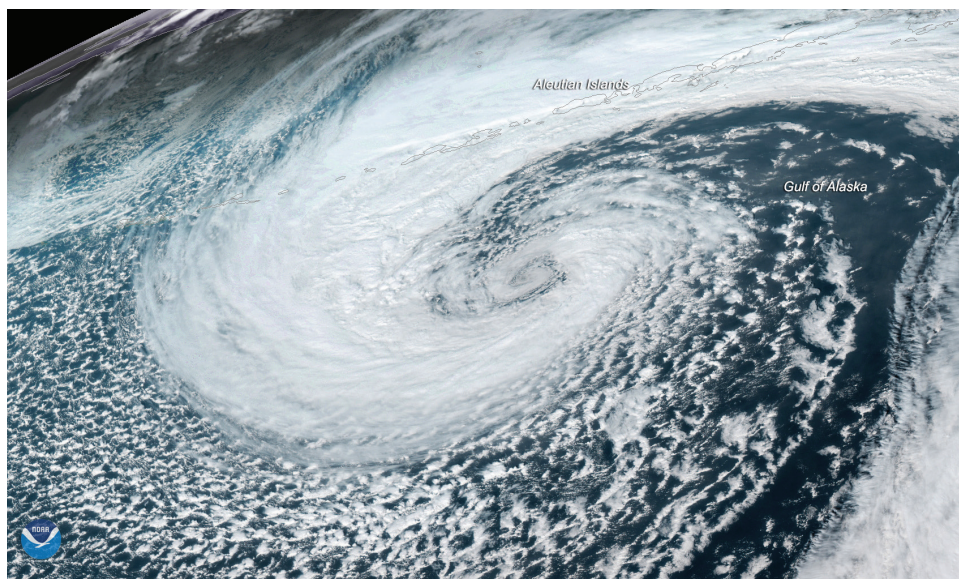
GOES-17 imagery of the mid-latitude cyclone in the Gulf of Alaska on November 12. Credit: NOAA

CONFERENCES AND EVENTS

A RELAMPAGO (Remote sensing of Electrification, Lightning, And Mesoscale/microscale Processes with Adaptive Ground Observations, translates to lightning flash in Spanish and Portuguese)/CACTI (Clouds, Aerosols, and Complex Terrain Interactions) Data Analysis Workshop was held in Buenos Aires, Argentina, November 19-22. This meeting brought researchers and students together to highlight available data, analyze data quality, present first research results, and forge research collaborations. The RELAMPAGO campaign is a high-impact weather project endorsed by the World Meteorological Organization (WMO) World Weather Research Program with international participation of scientists supported in the U.S. by NOAA, NASA, the Department of Energy, and the National Science Foundation. The RELAMPAGO campaign began in June 2018 and extended through April 2019. During the campaign, GOES-16 data collection supported the experiment research objectives and also provided additional post-launch data validation. Special GOES-16 mesoscale domain requests collected more than 470 hours of one-minute imagery over a 30-day period. As part of the workshop, a short course "Using GOES 16 to nowcast convection over South America" was conducted on November 22. This course provided information about the ABI and GLM sensors as well as multiple tools and products for analyzing and nowcasting storms in South America.

United States Ambassador to Argentina Edward C. Prado (left) and RELAMPAGO co-leads Professor Paola Salio, University of Buenos Aires (center) and Professor Steve Nesbitt, University of Illinois (right) during a reception at Bosch Palace, the ambassador's residence. Credit: U.S. Embassy, Republic of Argentina

The American Geophysical Union (AGU) Annual Fall Meeting was held December 9-13 in San Francisco. There were several GOES-R presentations in two sessions on remote sensing of land, ocean, and atmosphere from the new generation of geostationary satellites. These sessions highlighted new data sets, algorithms, and computational platforms that utilize data from the latest generation of geostationary satellites. The GOES-R program also supported the NOAA exhibit at the conference with handout materials and live presentations at the booth.
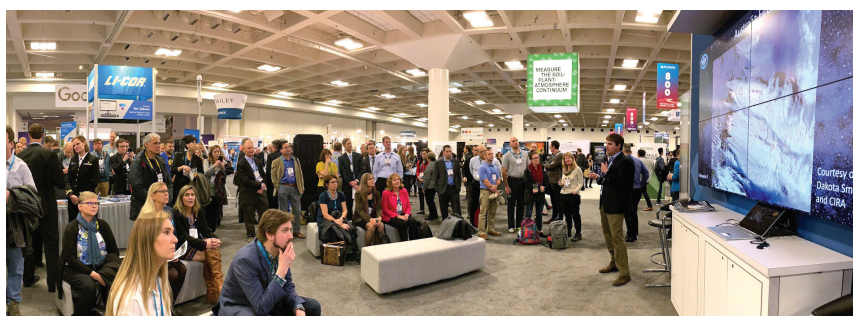
GOES-R senior scientific advisor Dan Lindsey shows off GOES-R capabilities to visitors of the NOAA booth at the AGU conference. Credit: NOAA

ACCOLADES AND AWARDS

2019 Administrator's Award recipients, including GOES-R's Kathryn Mozer (now with NOAA's Office of Oceanic and Atmospheric Research) and Elizabeth Kline, who were honored for innovation and collaborative problem-solving to establish NWS' operational readiness for new weather-satellite data products. Credit: NOAA

Several GOES-R team members were recipients of the NOAA Administrator's Award in November. Pam Sullivan and Dan Lindsey were part of a team recognized for the extraordinary effort to recover the capability of the GOES-17 ABI for our nation's weather forecasting needs. A team including Matthew Seybold, Kathryn Mozer, and Elizabeth Kline was recognized for innovation and collaborative problem solving to establish the National Weather Service's operational readiness for new weather satellite data products. The NOAA Administrator's Award recognizes employees who have demonstrated exceptional leadership, skill, and ingenuity in their significant, unique, and original contributions to NOAA, the Department of Commerce, and the Federal Government. Recipients were honored at a ceremony on November 21.

Matt Ikemeier received the NESDIS Outstanding Information Technology and Engineering Employee of the Year award in December. Matt was recognized for developing effective operational efficiency tools for the GOES-R product generation and distribution systems.

MEET THE TEAM

In this issue, meet Audrey Hogg, NOAA Contracting Officer for the GOES-R Series ground segment contract with Harris Corporation. Audrey, an acquisition professional with more than nine years of federal contracting experience and 20+ years of private sector experience in multiple disciplines, joined the program in November.

Prior to joining NOAA, she served as a member of the U.S. Navy's Strategic Systems Program high-level contracts team for the nation's multibillion-dollar submarine-launched Trident II D5 fleet ballistic missile program.

To achieve agency goals while saving the government money, Audrey stresses the importance of effective communication and innovative problem-solving skills. These qualities help her exceed established milestones and complete all assignments ahead of schedule and within or below budget. Audrey has received several awards during her career, including a monetary award from the Department of the Navy for her distinguished accomplishments as a part of Fiscal Year 2020 TRIDENT II Tri-Party Negotiation Team.

Audrey holds a Bachelor of Science degree in computer science from California State University, and a master's degree in telecommunications management from Golden Gate University. She is also one of a few elite graduates of the Naval Acquisition Associates Program and a Certified Federal Contract Manager (CFCM) by the National Contract Management Association (NCMA). Outside of work, Audrey enjoys travel, church missions, and reading. She is originally from the same home country as the fastest man in the world and the most recent Miss Universe. "Yes, man, Irie"!

UPCOMING EVENTS

American Meteorological Society 100th Annual Meeting
January 12-16, 2020
Boston, MA

GOES-R/JPSS Proving Ground/Risk Reduction Summit
February 24-28, 2020
College Park, MD

36th Space Symposium
March 30 – April 2, 2020
Colorado Springs, CO

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