GOES-R and GEO-XO

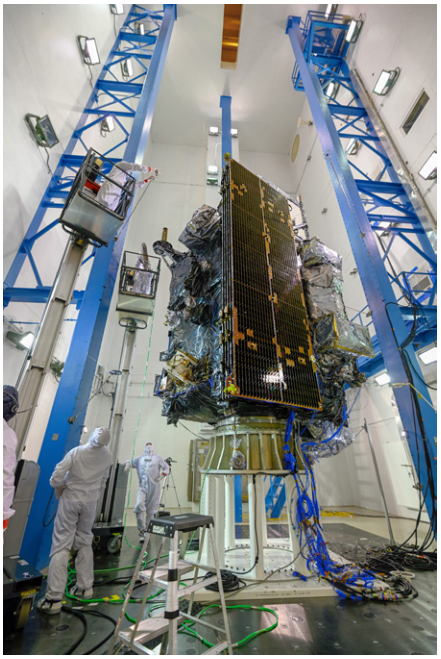
QUARTERLY NEWSLETTER ■ JANUARY–MARCH 2021 ■ ISSUE 33

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

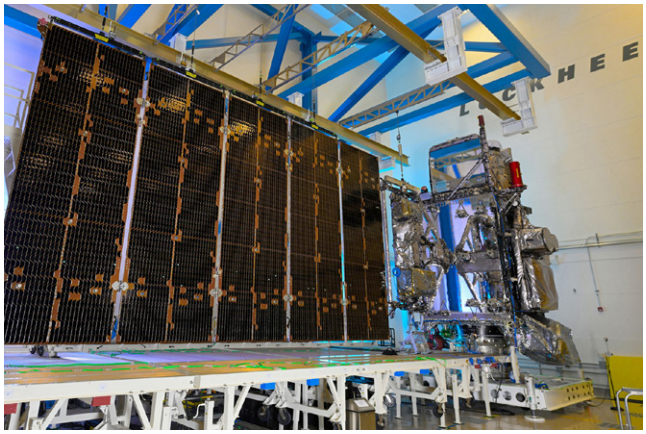
It's launch year, and I can definitely feel our pace and energy increasing! It's hard to say what is more remarkable: that in 2021 we are still dealing with the pandemic, or that the pandemic has barely affected our progress. Thank you all, again, for handling the inconveniences, concerns, and stresses of the past year. Please continue to take measures to stay healthy – the wellbeing of our team is my highest priority. Despite the challenges, the GOES-R/GEO-XO team continues to shine and perform critical work for our nation. GOES-T completed environmental testing and is on track to launch in December. We are moving forward with the GEO-XO Program. We awarded two Phase A Study contracts for the imager and are planning for the Mission Concept Review in June, which will affirm the need for the mission. GOES-16 and GOES-17 provided critical data for recent severe weather, fire, and dust storm events. Our program continues to do a remarkable job of advancing the mission.

PROGRAM HIGHLIGHTS

GOES-T completed several critical tests and mission preparations for its planned launch in December 2021. In February, GOES-T completed vibration, acoustic, and shock testing. Vibration testing mimicked the stresses it will experience during launch to ensure the spacecraft doesn't have structural weaknesses. GOES-T then endured extremely high sound pressure of 138.4 decibels from high-intensity horns during acoustic testing. This testing simulated the noises GOES-T will experience when it is launched. Finally, shock testing ensured the spacecraft can withstand the shocks encountered during separation from the launch vehicle and deployment of the satellite's solar panels. In March, the GOES-T/United Launch Alliance/ Launch services team completed electrical testing and successful deployment of the satellite's solar array. These tests ensure that the spacecraft and all of its instruments can endure the launch and maintain functionality in orbit.



GOES-T acoustic testing. Credit: Lockheed Martin



GOES-T solar array deployment. Credit: Lockheed Martin

DID YOU KNOW? Dust from Mexico was found in Colorado snowfall during the record-breaking storm in March. GOES-16 tracked the dust that gusty winds from a low-pressure system carried nearly 800 miles.

The testing was conducted at the Lockheed Martin facility in Littleton, Colorado, where the spacecraft was built.

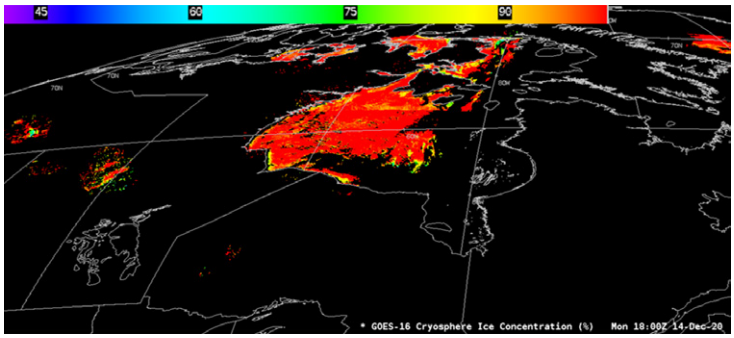
While the satellite was undergoing testing to prepare it for the physical conditions of launch and space, the GOES-T mission operations team conducted critical activities to test communications between the satellite and ground system and rehearse launch procedures. On Jan. 26, 2021, the Mission Operations Team successfully performed GOES-T end-to-end 3a (ETE-3a) testing on the new Goddard Magnetometer (GMAG) instrument that will fly on GOES-T. ETE-3a verified the GMAG interfaces. ETE tests serve as a validation of the compatibility of flight and ground hardware, software, and communications interfaces in a mission operations context.

The first GOES-T mission rehearsal was held Feb. 8-12, 2021. The team made significant use of the new Remote Access for Development system to minimize travel and staffing at the NOAA Satellite Operations Facility during the rehearsal. Mission rehearsals use a satellite simulator and the ground system to train operations personnel as well as test the readiness of operational products and the ground system. These simulations help test different parts of launch, like orbit raising, post-launch separation events, solar array deployment, and propulsion system readiness. They simulate both nominal and contingency operations.

GOES-U development, testing, and integration continue. The Advanced Baseline Imager (ABI) completed its delta Pre-Environmental Review on Jan. 19, 2021. The review determined the reworked ABI, which uses a new radiator to mitigate the GOES-17 cooling system issues, was ready to proceed with environmental testing. The sensor unit completed vibration testing and was installed in the thermal vacuum chamber in late March. The Geostationary Lightning Mapper (GLM) completed environmental testing and, after a successful Pre-Shipment Review on March 3, was delivered to Lockheed Martin in Littleton, Colorado. GLM will reside in storage until it is needed for integration with the spacecraft.

The GOES-U GLM arrives at Lockheed Martin. Credit: Lockheed Martin

Several GOES-16 and GOES-17 products completed Peer Stakeholder-Product Validation Reviews (PS-PVRs) this quarter. The GOES-16 and GOES-17 ABI National Weather Service (NWS) Operational Algorithm Team cryosphere ice concentration and extent and ice age and thickness data products were declared provisionally mature on Jan. 20, 2021. Once a product reaches provisional maturity status, the product is ready for operational use but is not yet fully validated. Now that these products are provisionally validated, the data can be distributed from the Product Distribution and Access (PDA) and Comprehensive Large Array-data Stewardship System (CLASS) to the broader user community. **The GOES-17 ABI fire/hot spot data product completed a delta provisional PS-PVR on Feb. 18, 2021.** The product was provisionally validated in July 2020. This review checked the performance of the product during the GOES-17 ABI "hot periods" due to the loop heat pipe cooling system issue. The review verified that the loop heat pipe changes that were implemented do not negatively affect product performance. **The GOES-17 GLM and GOES-16 and GOES-17 Magnetometer data products reached full validation maturity in February.** These data products are now fully validated and operational.



GOES-16 ice concentration product. Credit: NOAA

The GOES-17 ABI saturation prediction reference tools have been updated for 2021. This includes daily maximum temperatures, hour-by-hour band saturation, interpretations and examples of "marginal" and "unusable" hours, and details on the cooling timeline. See the GOES-17 ABI Performance webpage for additional information.

The GOES-R ground system executed the first GOES-T data operations exercise (DOE) from March 22 – April 7, 2021. The exercise utilized the new virtualized servers in the NOAA Satellite Operations Facility (NSOF) Product Processing Zone (PPZ) to run the L2+ science data processing and distribution applications in a shadow mode alongside the current operational/production environment.

GEO-XO

The GEO-XO program is working with NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) to refine the scope, cost phasing, constellation options, and schedule to meet new program budget parameters. While we are refining program details, we have reverted back to the original program name, "Geostationary and Extended Orbits (GEO-XO)."

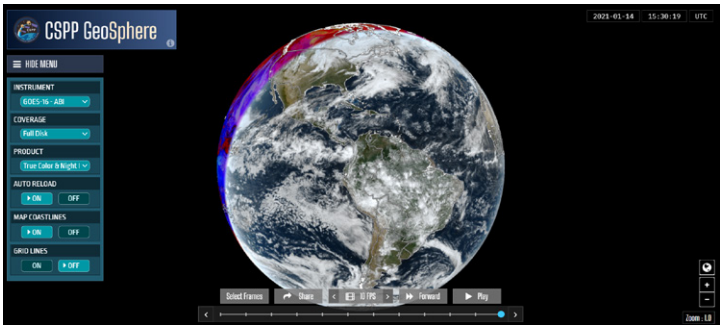
The GEO-XO team is working toward a Mission Concept Review (MCR), currently planned for June 2021. The MCR will evaluate the proposed objectives and the ability of the mission concept to meet the stated objectives. The MCR will affirm the need for the mission.

NASA posted Requests for Information (RFIs) for two possible GEO-XO instruments this quarter. On Jan. 14, 2021, NASA released the GEO-XO Lightning Detector Focal Plane Array (FPA) RFI to survey industry on its capabilities to produce a high-speed FPA with digital outputs in a single active Complementary Metal Oxide Semiconductor (CMOS) Integrated Circuit (IC) device. The FPA is intended to be considered for applications such as lightning detection in a spaceflight environment from geostationary orbit. On Feb. 3, NASA released the GEO-XO Sounder (GXS) RFI to solicit responses from vendors interested in bidding on a definition-phase study of a geostationary sounder instrument. The sounder will be an infrared and day/night band imaging instrument that is planned to fly on the GEO-XO series of satellites. The GEO-XO team is reviewing responses to the sounder RFI and held an industry day with respondents. The team plans to release the GXS Phase A Study Request for Proposal in April.

On March 31, 2021, NASA awarded GEO-XO Imager (GXI) Phase A Study contracts to L3Harris Technologies, Inc., and Raytheon Company. These definition-phase study and design development contracts are part of GEO-XO instrument formulation activities. Each company will conduct a one-year study to develop an infrared and visible imaging instrument concept and mature necessary technology. These studies will help define the imager's potential performance, risks, costs, and development schedule.

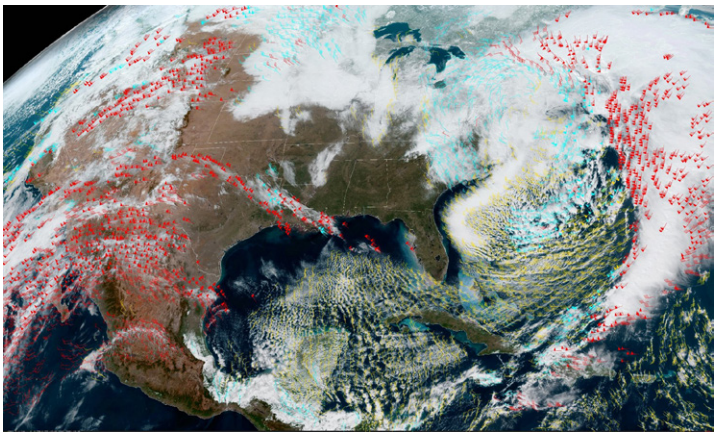
IMAGERY AND SCIENCE APPLICATIONS

The University of Wisconsin/Space Science and Engineering Center (SSEC) unveiled the GeoSphere cloud-based GOES-R imagery service at the American Meteorological Society (AMS) annual meeting in January 2021. The GeoSphere website allows quick access to GOES imagery via cloud-friendly, flexible, and configurable software. GeoSphere uses the Community Satellite Processing Package (CSPP) Geo software and its CSPP Geo GOES-R Rebroadcast (GRB) package. The GeoSphere website provides users an interactive map to investigate various imagery products and animate through a series of user-chosen time steps. The GOES-R Program funds CSPP-Geo.



CSPP GeoSphere interface. Credit: SSEC

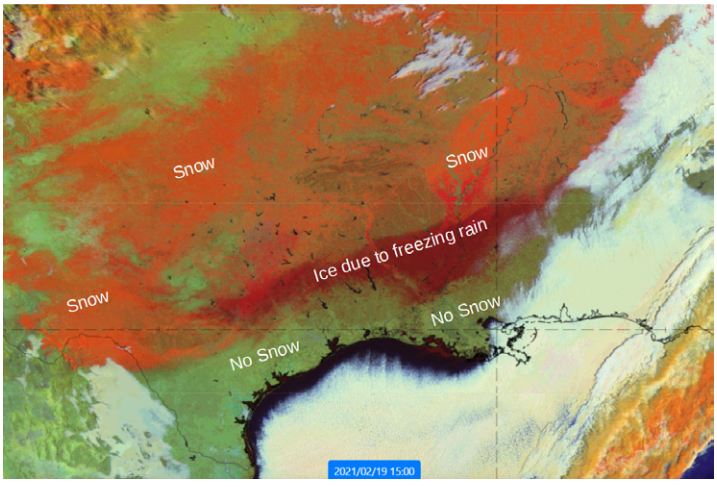
GOES-16 (GOES East) monitored the powerful nor'easter that brought heavy snowfall, blizzard conditions, strong gusty winds, storm surge, and coastal flooding to much of the Northeastern U.S. from Feb. 1-3, 2021. Areas in New York, New Jersey, Pennsylvania, and Massachusetts received more than two feet of snow, with Nazareth, Pennsylvania recording 36.1 inches. Below is an image of GOES-16 winds data plotted over GeoColor imagery of the nor'easter on Feb. 3. Additional imagery of the storm can be found on the CIMSS Satellite Blog.



GOES-16 winds over the continental U.S. on Feb, 2. 2021. Credit: NOAA

On Feb. 26, 2021, the American Geophysical Union publication *Eos* published an article "Advances in Satellite Data for Wildfire Smoke Forecasting," highlighting new capabilities from GOES-16 and GOES-17 for wildfire smoke forecasting. The fire detection data are poised to help solve issues with regional smoke modeling systems, especially for large and explosive wildfire events that may require rapid responses to protect public health. These data, through their combined higher spatial and temporal resolution, offer unprecedented views of both smoke plume development and fire progression. The latest research using GOES-16 and -17 data indicates we will be better positioned to forecast harmful air quality from wildfire smoke in upcoming fire seasons.

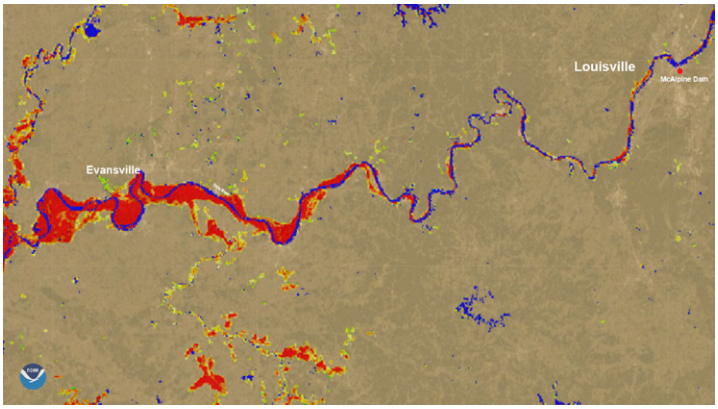
A blog post from the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) on Feb. 26, 2021, "Arctic Blast Turns US White," details the winter weather that impacted the Southern U.S. and highlights satellite tools for differentiating snow cover from ice cover. A band of ice from freezing rain over Texas was obvious in satellite red-green-blue (RGB) imagery on Feb. 19. GOES-16 day snow RGB imagery shows the far southern extent of snow cover across northern Mexico, Texas, Louisiana, and Mississippi. The most interesting feature in this snow RGB image is a dark red band from southern Texas across northern Louisiana to Mississippi that highlights an area where ice accumulated due to freezing rain. A March 4 Satellite Liaison Blog post, "VIIRS and ABI Capture Ice vs. Snow and Melting Snow," highlights satellite imagery of the snowmelt that occurred Feb. 28 – March 2, 2021.



GOES-16 day snow RGB imagery distinguishes snow and ice from freezing rain. Credit: NOAA/EUMETSAT

On March 4, 2021, forecasters at the NWS in Amarillo, Texas, used GOES-16 imagery to alert partners of a newly-developed wildfire in the Oklahoma Panhandle. Forecasters used one-minute shortwave infrared imagery to detect the fire hot spot. Due to periodic cloud cover across the scene, the one-minute imagery helped to detect the hotspot (with confidence) roughly nine minutes ahead of what was possible in the continental U.S. five-minute imagery. The one-minute imagery helped to capture the "in-between" moments that the five-minute imagery missed. The utilization of the hot spot notification tool with the GOES-16 mesoscale imagery allowed forecasters to relay information to core partners about the location of the wildfire and current conditions quickly and easily.

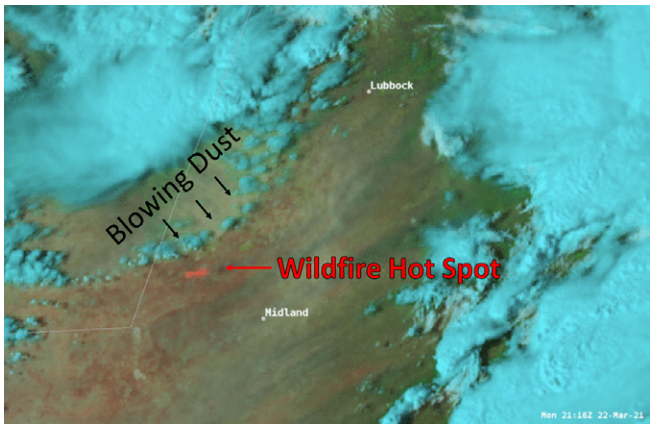
On March 6, 2021, data from the GOES-16 ABI and the VIIRS instruments aboard NOAA-20 and Suomi-NPP were used to map flooding from the Ohio River. Heavy rain pelted the Ohio River Valley, leading to swollen rivers and flooding. The Ohio River's water, mixed with mud and debris, rose out of its banks and into homes and businesses. In Louisville, Kentucky, dozens of streets were closed and a large portion of River Road was impassable. Significant flooding also occurred in Evansville, Indiana.



ABI/VIIRS flood map of the Ohio River on March 6, 2021, shows significant flooding in red and orange. Credit: NOAA

On March 22, 2021, GOES-16 imagery was critical for tracking the progression of a haboob and associated wind shift as it approached a wildfire in Texas. On that day, strong southwesterly winds wrapped around a low-pressure system led to widespread blowing dust. This region of blowing dust, or haboob, reduced visibility considerably. One-minute GOES-16 imagery that was available over the region to monitor wildfire hot spots also provided a unique view of the blowing dust plume. NWS forecasters in Midland, Texas, used GOES-16 imagery to time the outflow boundary and associated wind shift and

IMAGERY AND SCIENCE APPLICATIONS (CONTINUED)

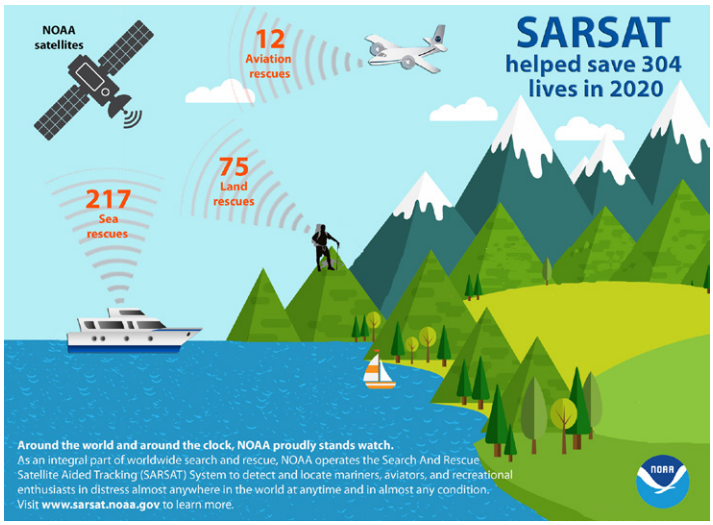


GOES-16 natural color fire imagery captured the outflow boundary and associated lofted dust approaching the wildfire hotspot. Credit: NOAA

alerted local partners. As a result, fire crews were moved off the southern periphery of the fire before the wind shift and dramatic drop in visibility, potentially saving lives and equipment.

EDUCATION AND OUTREACH

NOAA's satellite fleet played a pivotal role in rescuing 304 people from potentially life-threatening situations throughout the United States and its surrounding waters in 2020. NOAA's geostationary and polar-orbiting satellites are part of the global Search and Rescue Satellite Aided Tracking system, or COSPAS-SARSAT, which uses a network of U.S. and international spacecraft to detect and locate distress signals sent from emergency beacons from aircraft, boats, and handheld Personal Locator Beacons (PLBs) anywhere in the world.



Of the 304 lives saved in 2020, 217 people were rescued at sea, 12 were rescued from aviation incidents and 75 were rescued from incidents on land. Credit: NOAA

2020 will be remembered as a time of unprecedented challenges and changes. These circumstances inspired us to push our boundaries and try new things so that we could provide the nation with the most accurate and timely environmental observations with critical expertise. Learn more about our 2020 accomplishments and how NOAA satellites help protect life and property.

The GOES-R Program, in partnership with the Joint Polar Satellite System (JPSS) Program, NESDIS, NASA Goddard, and the Cooperative Institute for Research in the Atmosphere (CIRA), debuted a new video series on Feb. 25, 2021. "This Week in Weather" highlights a significant weather event or environmental hazard each week with NOAA satellite imagery, music, and an explanation of the science behind the imagery and event. Each video has an accompanying article with additional information. Events highlighted this quarter included Saharan dust, fires, lake-effect clouds, a record-breaking snowstorm, and tornadic storms in the Southern U.S.

This Week in Weather: Superior Flow of Clouds. Credit: NOAA/NASA

Just like we experience weather on Earth, there's weather in space. The Sun may look very constant and quiet from Earth, but it's constantly spewing out a stream of particles called the solar wind. Space weather is activity on the Sun that can affect Earth and interact with our technology. Part of NOAA's mission is to monitor space weather and provide timely, accurate warnings to help our nation prepare for and minimize the extent of economic loss and human hardship. A new video, "5 Things: Space

EDUCATION AND OUTREACH (CONTINUED)

Weather, Explained," highlights NOAA's space weather mission, including observations from GOES-16 and GOES-17. On March 2, 2021, NOAA Satellites hosted a space weather social media Q&A to spark meaningful conversation and interaction between the online community and NOAA space weather experts.

On March 1, 2021, NOAA SciJinks published a new article, "The Most Extreme Weather in America." North America is home to several different climate types. That means the continent is also home to a variety of extreme weather events. Although we experience the effects of extreme weather here on Earth's surface, weather satellites can collect some pretty wild pictures and information about extreme weather from above. Meteorologists use this important information to warn us about extreme weather heading our way. The article highlights a few of the most extreme weather events captured over the past few decades by GOES satellites.

During Black History Month, NOAA Satellites sat down with Kevin Fryar, chief of staff at GOES-R, to talk about his formative experiences as an African American in the sciences, along with advice for budding meteorologists of color. A veteran of the U.S. Air Force with over twenty years of experience as a weather decision support specialist, Fryar has also served at both NWS and NESDIS in a variety of roles. Most recently, he has been instrumental in the development of the new GEO-XO satellite system, advising on key issues related to disaster preparedness and management. During his interview, Fryar gave an overview of GOES-R's newest initiative as well as some practical advice on how his military and on-the-job experience made all of the difference in his career.

GOES-R chief of staff Kevin Fryar. Credit: NOAA

CONFERENCES AND EVENTS

The 101st AMS Annual Meeting was held virtually Jan. 10-15, 2021. The theme of the meeting was "Strengthening engagement with communities through our science and service." NOAA discussed its plans in a special session "NOAA Satellite Mission in 2030 and Beyond" and a panel discussion, "What Follows GOES-R: Planning the GEO-XO Satellite Series." Additional presentations throughout the week highlighted future geostationary satellite plans and the status and science applications of the GOES-R Series.

The American Meteorological Society (AMS) short course, "GOES-R/JPSS Hands-On Training to Process, Display, and Analyze Satellite Data Products" took place virtually on March 17 and 18, 2021. The short course was attended by 49 people, including undergraduate and graduate students, forecasters, instructors, and professors from the U.S., Canada, Central America, and the Caribbean. The course focused on exercises that allowed participants to access, process, and display GOES-R and JPSS data and products.

Satellite subject matter experts instructed participants on how to use satellite data products to analyze specific environmental scenarios such as severe convection, tropical storms, flooding, fire weather, air quality, and more. View agenda and short course presentations.

MEET THE TEAM

In this issue, meet Andy Heidinger, NESDIS Geostationary Earth Observations (GEO) senior scientist. In this new position within NESDIS, Andy is the senior scientist for all GEO activities and is currently focused on supporting the GEO-XO program. Previously, Andy led the GOES-R and JPSS cloud algorithm teams at the NESDIS Center for Satellite Applications and Research (STAR).

We welcomed Andy to the team in October 2020. In this new role, he looks forward to helping formulate the GEO-XO Program and working with the program and NESDIS to bring the mission to fruition. "The public will rely on the future GEO-XO system to provide critical information to weather models, forecasters, and decision-makers," said Andy. "This information requires scientific analysis to translate raw observations into data for a wide range of users. My job is to help ensure the science is sound and appropriate for the mission," he continued.

Andy is an internationally recognized expert in the areas of cloud remote sensing, satellite calibration, radiative transfer, and climate research, and his work has contributed to the development and improvement of satellite sensors and data acquisition and processing systems, leading to better data products for end-users. When Andy arrived in 1998, NESDIS had no operational cloud products from its polar imager and limited cloud products from its GEO imager. He was instrumental in bringing a full suite of cloud products to NESDIS operations.

Andy has a bachelor's degree in mechanical engineering from Purdue University and a master's degree and doctorate in atmospheric science from Colorado State University. He and his wife have three children who are starting and finishing college as well as a dog who likes to bark during video meetings. Andy likes to golf and learned during the pandemic that he needs to brush up on his comics, superhero, and video game trivia. His goal for 2021 is to learn how to back up a pop-up camper.

UPCOMING EVENTS

GOES-T Mission Rehearsal #2
April 26-20, 2021

GEO-XO Atmospheric Composition Town Hall
April 29, 2021

GOES-T End-to-End Test 3b
May 7-9, 2021

GEO-XO Mission Concept Review
June 7-9, 2021

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