Annual Year-End Report 2021

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A Message From The Director

Welcome to the 2021 STAR annual report. I'm excited to share the many accomplishments that we achieved this past year.

I begin by thanking STAR's former Acting Director Joe Pica, Acting Resources Division Chief Jolene McGill, and Budget and Acquisition Branch Chief Shanita Logan for getting us past our first challenge. With STAR facing an uncertain
FY 2021 budget, they successfully conveyed the urgent need for congressional funding to the NESDIS Office of the Chief Financial Officer.

In May, when I took over as acting director, their efforts, along with support from Chief of Staff Ian Zelo and the STAR leadership team, helped me to secure congressional funding for STAR operational services and avoid delays that would have impacted our work. The comprehensive and rigorous approval process made us stronger, provided us with additional insight into our operations, and established a solid foundation for the future.

This year, we also debuted a new video about our work, improved our internal communications to keep our team better connected and informed, and enjoyed a successful year regarding the number of publications and awards that recognized the work of our outstanding staff. We feature some of that work in the pages to come.

Having survived and thrived in another year of COVID and our telework environment, we remain focused on our mission to use innovative science to transform what satellites observe into meaningful information for the public and policymakers. We also remain committed to our vision, which is to achieve an informed, sustainable, and equitable society through Earth observations.

This past year demonstrated our resiliency as an organization and as individuals, as well as underscored the talent and tenacity we bring to every project with our NESDIS and NOAA partners.

With everything we do, we strive for excellence, creativity, and integrity. We work to exceed expectations, improve mission outcomes through innovation, and earn the trust of our partners and the public we serve.

I hope you enjoy the stories of What Works in STAR.

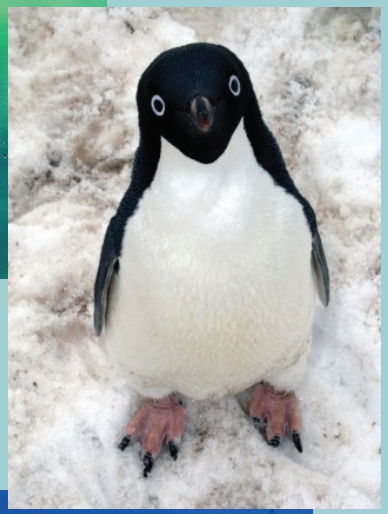
CoastWatch brings an “all-in-one” approach to satellite data resources

Are you researching pack ice to learn about the winter migration of the Antarctic’s Adelie penguins? Are you tracking harmful algae blooms? Are you a fisher who wants to avoid catching protected sea turtles? Are you studying ocean conditions that might impact critical ecosystems in the Papahānaumokuāke National Monument in the Pacific Ocean? Do you need to know about ice conditions for navigating the Great Lakes?

All that information can be found through NOAA CoastWatch, which exists to help people access and use satellite data for their ocean and coastal applications.

The CoastWatch Data Portal is one of the tools used by scientists across NOAA’s Line Offices, other governmental agencies, businesses, academic researchers, nonprofits, international partners, and the public. The Portal provides novice observers and veteran researchers alike with a wealth of NESDIS and non-NOAA satellite data about ocean, coastal, and inland waters, which they can view, evaluate, interrogate, and download.

Want to look for the sea surface temperature for a particular day in the Chesapeake Bay? You can do that. Or, you can access annual averages for over 10 years.



Since the value of the information depends on the user’s ability to search for, access, understand, and analyze data, CoastWatch scientists continually add products to the Portal, as well as user-friendly guides, tutorials and “how-to” videos on topics such as how users can download information through data access protocol services. In 2021, new products were added to serve Harmful Algal Bloom managers at NOS/NCCOS, new tools were offered for better viewing of normalized radar cross-section data from Synthetic Aperture Radars, and new short “how-to” video clips were produced. When users hit a roadblock, they reach out to the CoastWatch Helpdesk for fast, personalized hands-on assistance.

For the past two years,CoastWatch staff have adapted to the new virtual environment by redesigning training materials for online delivery. Lectures, tutorials, and hands-on computer work help participants gain skills on how to include satellite data in their research using software of their choice. In 2021, staff organized two week-long virtual classes, during which 60 participants received hands-on help to complete their projects and leave with workflows for their specific applications. One class was organized specifically to help the Office of National Marine Sanctuaries develop climate indicators and condition reports. This year, Coastwatch also organized several workshops including a training day for the Second International Operational Satellite Oceanography Symposium and a scientific workshop at the AGU Fall Meeting, familiarizing over 300 participants with CoastWatch data offerings and services. Additional classes and workshops are planned for 2022.

The ultimate goal is to help diverse ocean and coastal stakeholders make better decisions and reach better outcomes for a wide range of natural resource and blue economy issues by leveraging the value of satellite observations.

Veronica Lance, STAR, NOAA CoastWatch Program Manager

Estimating 3-D hurricane winds by using satellite data to improve forecasts

With a hurricane barreling toward your town or city, wouldn't you want the most accurate information about how the storm's winds might impact you? Yes, you would.

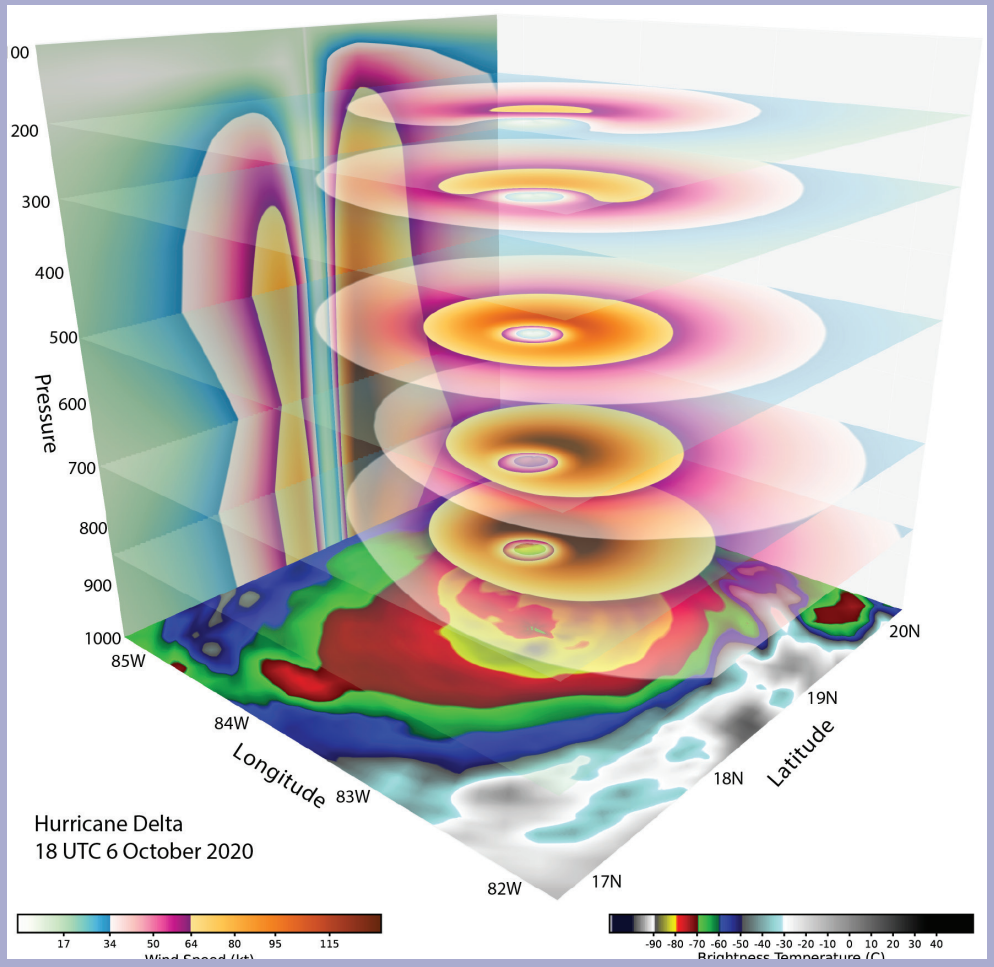
This past year, STAR and Cooperative Institute scientists developed a new way to look at data coming from space, specifically NOAA's Geostationary Operational Environmental Satellite (GOES), to better estimate the three-dimensional movement of wind around hurricanes here on Earth. A new algorithm transforms raw and always-available data, such as infrared imagery, storm motion, and storm intensity, into information that forecasters and models can use to better anticipate a storm's destructive potential.

Unlike typical satellite-based wind observations, this method can generate wind speed and wind direction estimates at multiple levels within the hurricane and over a large area - similar to what reconnaissance aircraft observe. It also reduces initial wind errors in models, which can make subsequent forecasts more accurate.

Our scientists are evaluating this approach in state-of-the-art models to ensure it performs as expected in real-life applications. If the experimental runs are successful, forecasters will have a tool to make timelier and more accurate forecasts, which will help communities to get a jump on preparation, to create evacuation plans, and to assess just how hard the storm will hit.

The team believes with more refinement and effort, this analysis tool will become increasingly impactful, and possibly a routine procedure for all hurricanes.

John A. Knaff (STAR), Christopher J. Slocum (STAR), Alex G. Libardoni (Cooperative Institute for Research in the Atmosphere – CIRA, Colorado State University), Milija Zupanski (Cooperative Institute for Research in the Atmosphere – CIRA, Colorado State University)



A three-dimensional depiction of the estimates of wind magnitude for Hurricane Delta (2020)

New NOAA SST products make diving into data a whole lot easier

Sea surface temperature (SST) is a key component of climate change monitoring, weather forecasting (including hurricane tracking), and atmospheric modeling, as well as ecosystem assessment and military and defense operations.

Following an enduring maxim, “less is more,” scientists in STAR’s Satellite Oceanography & Climatology Division launched a new suite of mission-agnostic SST products in 2021. Users now have more streamlined access to data with improved quality, greater global coverage, and richer information content.

The newly designed L3S-LEO-AM/PM suite takes SST data gathered by the NESDIS VIIRS and AVHRR sensors, flown onboard the U.S. afternoon Joint Polar Satellite System (JPSS) and European mid-morning Metop First Generation (Metop-FG) low earth orbiting satellites, and fuses that information together. This enhances the depth and breadth of data, which solves data access and usability issues that our users experienced in the past.

The first global SST product of its kind, NESDIS scientists are using the new suite and it is already archived in NASA PO.DAAC and NOAA NCEI. Meanwhile, the National Oceanic Service is exploring using this new data resource for its West Coast Ocean Forecast System (WCOFS), and the National Marine Fisheries Services (NMWFS) is eyeing the suite for fisheries assessment.

The mission-agnostic L3S-LEO SST products will continue into the future, phasing in new JPSS and Metop-Second Generation launches, and phasing out the retired platforms (such as the recently decommissioned Metop-A launched in 2006, first in Metop-FG series).

Irina Gladkova (NOAA), Olafur Jonasson (NOAA), and Alexander Ignatov (NOAA/STAR)

Sentinel-6 Michael Freilich Satellite

STAR scientists fix critical error in Sentinel-6 Michael Freilich wave heights

In November 2020, the Sentinel-6 Michael Freilich satellite launched as part of a U.S.-European partnership to continue a decades-long effort to track sea level rise on a global scale. Prior to the launch and throughout this year, the STAR Jason/Sentinel-6 Project team, along with colleagues at NASA and in Europe, calibrated and validated instruments aboard the spacecraft to ensure accurate and effective operations.

When we send a 2,628-pound spacecraft 830 miles into space, we want the instruments to work. So far, all systems are a go.
This new technology improves upon instruments in previous missions. The new High-Rate altimeter (Poseiden-4) will collect the most accurate and precise data yet on how oceans are rising and warming because of climate change. With the Advanced Microwave Radiometer (AMR-C) onboard, NOAA can now see smaller, more complicated ocean features, such as coastline changes.

Additional benefits of this technology include better hurricane intensity forecasting, greater guidance for oil spill and marine debris response, and more accurate extreme wave warnings. Seafarers and offshore workers can thank the STAR team for that last feature. In reviewing Sentinel-6's data output, the team discovered the vertical motion of the waves caused high waves to be measured lower than they actually were. The STAR team created the critical fix, and this new algorithm will be included in future Sentinel-6 products.

Eric Leuliette (STAR-Jason Program and Project Scientist), Alejandro Egido (Global Science and Technology, Inc., Jason Measurement System Engineer), Christopher Buchhaupt (CISESS), Amanda Plagge (GST, Inc.), Walter H.F. Smith (STAR)
The Sentinel-6 Michael Freilich is a partnership of NOAA, the European Commission, the European Space Agency, the European Organisation for the Exploitation of Meteorological Satellites, NASA, and France's National Centre for Space Studies.

A new look at lake and sea ice from space with GOES-R

Many of the Earth's inhabitants probably don't give that much thought to the planet's cryosphere. For scientists, however, tracking all of Earth's ice and snow cover – from Alaska's permafrost to Antarctica's ice sheets – is of vital importance.

Climatologists, weather forecasters, biologists, oceanographers, and other scientists all keep their eyes on the cryosphere to observe variations in snow cover, ice thickness, ice concentration, and ice motion - changes that may indicate global warming, marine hazards, potential threats of natural disasters such as flooding and landslides, and impacts to ecosystems.

Earlier this year, STAR scientists successfully added cryosphere measurement capabilities to the GOES-R satellite series Advanced Baseline Imager. Specifically, this allows the geostationary spacecraft GOES-16 and GOES-17 to provide more frequent and precise sampling of ice concentration, thickness, motion, and surface temperature, particularly in the Great Lakes.

These products will provide institutions such as the National Ice Center, the National Centers for Environmental Prediction, and the National Weather Service with more tools for observing and forecasting ice conditions. These tools also meet STAR's goal of providing users with the information that they need to ensure safe marine navigation and improved local and regional weather forecasts.

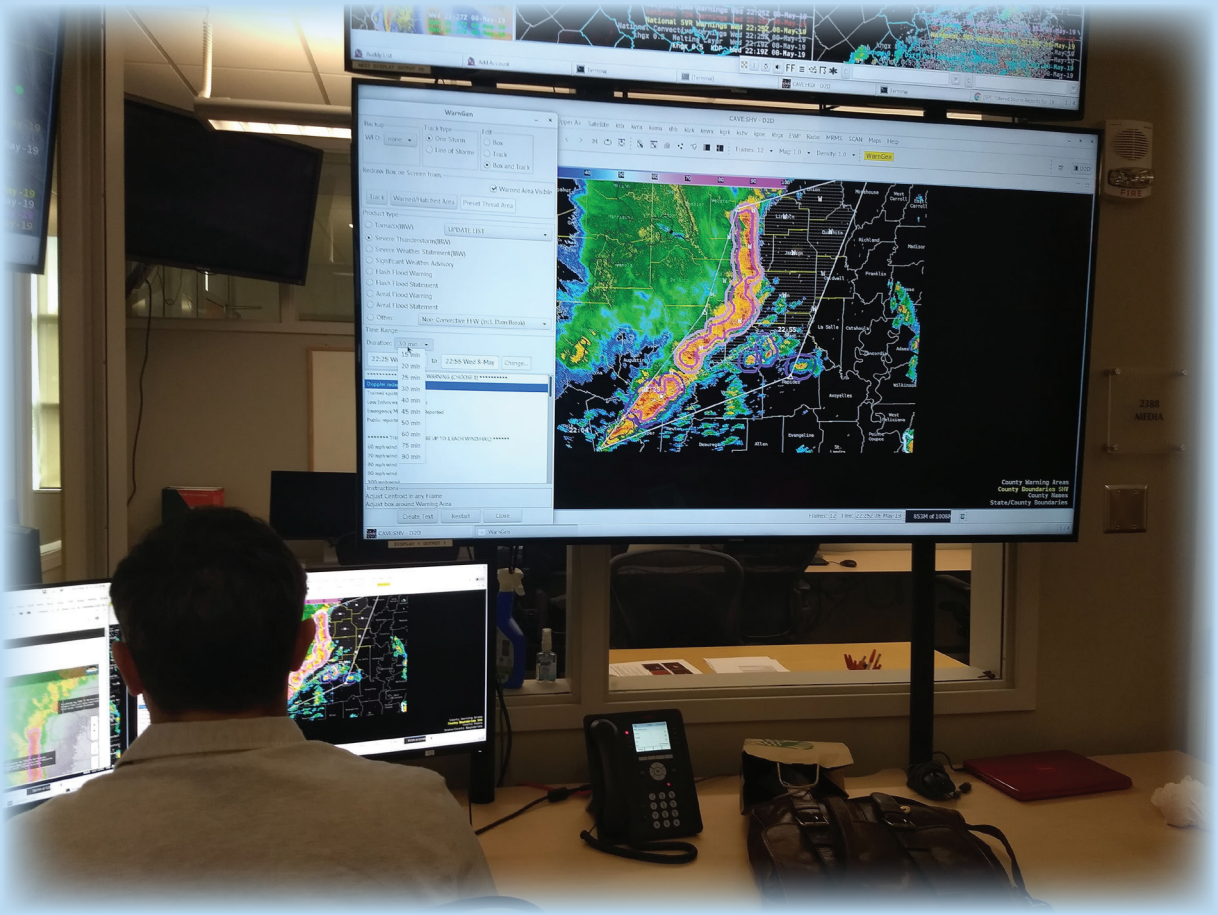
Jeff Key (STAR), Yinghui Liu (STAR), Xuanji Wang (Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison), Aaron Letterly (CIMSS), and Richard Dworak (CIMSS)

Artificial intelligence tool improves severe weather warnings

Not every thunderstorm produces tornadoes, but plenty of storms do. Forecasters who get it right make a crucial difference in the lives of people who live, work, and travel in the path of severe storms.

When severe weather comes knocking, quick decisions must be made. For National Weather Service forecasters, the information deluge from weather-observing satellites, like NOAA's Geostationary Operational Environmental Satellites (GOES), is sometimes too much. Analyzing and combining that data with other information, such as radar, lightning activity, and forecasting models, can be a significant challenge for forecasters who must issue timely and accurate warnings.

This is where STAR's Probability of Severe (Weather), or ProbSevere, tool comes in. This suite of machine learning applications quickly and continuously analyzes multiple data sources to help forecasters focus on critical data and alert the public and emergency managers to severe weather – not just tornadoes, but strong thunderstorms, high winds, and large hail, too.



First developed in 2012, STAR scientists transitioned the tool to NOAA operations in October 2020.

This effort is part of an ongoing initiative to get the most out of the data STAR gathers every day. By using artificial intelligence and machine-assisted learning, we are helping our users gain more comprehensive insights and lead time for severe weather forecasts.

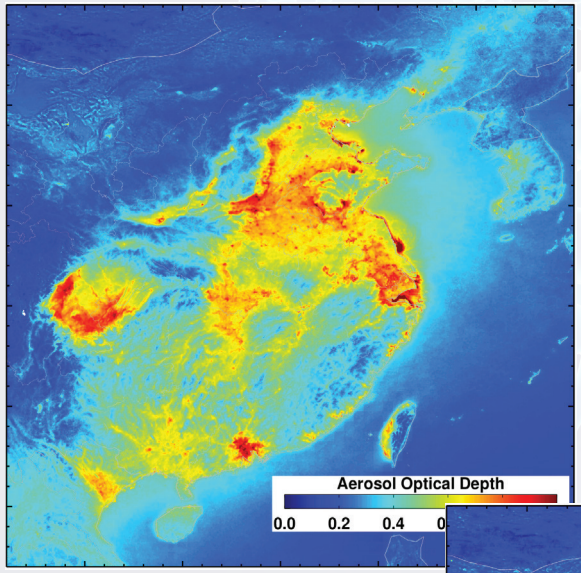
Mike Pavolonis (STAR), John Cintineo (University of Wisconsin Cooperative Institute for Meteorological Satellite Studies – UW-CIMSS), and Justin Sieglaff (UW-CIMSS)

Impact of COVID-19 lockdown measures on global air quality

In early 2020, as COVID-19 lockdowns spread and the global economy slowed, our air became cleaner. With fewer fossil fuels burning, nitrogen oxide emissions fell, which led to improvements in global air quality.

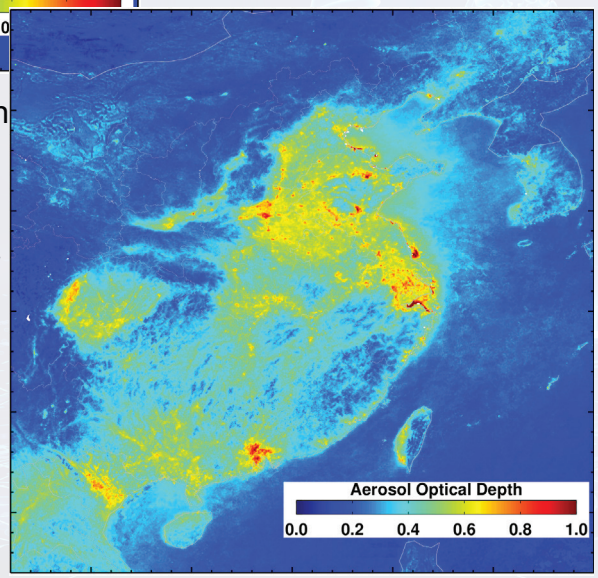
Scientists in our Satellite Meteorology & Climatology Division used this event to study the effect of lockdowns on particulate pollution (which is caused by traffic emissions, among other sources), by using NOAA satellite aerosol optical depth (AOD) data. NOAA satellite data are used to monitor and forecast daily air quality, and can also track particulate pollution over time.

This work is significant for several reasons. First, it validated that a drastic drop in industrial production and vehicle emissions had a rapid effect on improving air quality in major U.S. cities, Europe, and across China. In China, where pollution levels are four times larger than in the United States, it was found that lockdown measures improved air quality by 50 percent in major urban areas. For this work, a new uniform dataset was developed by reprocessing the entire Suomi National Polar-orbiting Partnership satellite Visible Infrared Imaging Radiometer Suite AOD data from 2012 to the present – remarkably – in only six months by employing the Amazon Web Services Cloud service.



Top left: SNPP VIIRS AOD Climatology for March (2012-2019 China).

Bottom right: SNPP VIIRS AOD for March 2020 showing lower values due to COVID-19 pandemic related lockdown measures (China).



Moving forward, this extensive historical climatological record may help policymakers better assess pollution reduction strategies over time, such as expanded telework options. Meanwhile, researchers can more accurately place a singular event, such as a pandemic, into a broader historical context.

Shobha Kondragunta (STAR), Zigang Wei (IMSG), Hongqing Liu (IMSG), Istvan Laszlo (STAR), Hai Zhang (IMSG), Bin Zhang (UMD/CISESS), and Changyong Cao (STAR)

A post-millennium climate data record for tracking trends

Whether it's researchers creating climate models or tracking trends in atmospheric warming, or policymakers and political leaders discussing climate change mitigation and adaptation strategies, they all now have a tool for better assessing climate change.

After STAR researchers took a fresh look at satellite observations of atmospheric temperatures, they created a new climate data record from the start of the current century to the present day. Their work addressed a phenomenon that has occurred since the beginning of this century. Atmospheric warming indicators from satellite observations have paced slower than the rate projected by climate models based on increased greenhouse gases. Why the discrepancy?

The team's review of microwave sounder observations from several NASA, NOAA, and EUMETSAT satellites accounts for (and reconciles) differences in climate trend comparisons because of distinct and multiple satellite data collections and potential glitches in data sensing caused by orbital changes and instrument errors. This new data gives scientists and forecasters greater confidence in tracking global warming trends, as it significantly improves upon the previous climate record's accuracy.

Moving forward, this dataset has the potential to create a more accurate picture of global climate change and long-term trends, assist U.S. federal agencies and institutions to verify climate model simulations, and help forecasters better predict extreme events, such as flooding, drought, and heavy precipitation.

Cheng-Zhi Zou (STAR), Hui Xu (ESSIC/CISESS, University of Maryland, College Park), Dr. Xianjun Hao (Environmental Science and Technology Center, College of Science, George Mason University, Fairfax, VA), Qiang Fu (Department of Atmospheric Sciences, University of Washington, Seattle). *Funding: Dr. Mitch Goldberg and Dr. Satya Kalluri, both of JPSS/PGRR Program*

S-NPP satellite rescue effort ends with success

Earlier this year, when a piece of equipment failed on the Suomi National Polar-orbiting Partnership satellite, S-NPP, it was far from ideal. But there was a silver lining. The same team that solved a similar technological snag two years ago was back on the case, and that made all the difference.

It all started on May 21, when radiation damaged the long-wave infrared signal in the Cross-track Infrared Sounder, or CrIS. S-NPP had a similar failure in 2019 that affected a different signal processor. And, as in 2019, critical data on atmospheric conditions once again could not be delivered to global forecasters and researchers hundreds of miles below.

When NOAA and its partners couldn't revive the equipment, the CrIS team got to work. They faced several issues. The long-wave infrared sensor was part of the satellite's backup system, or Side B, which was activated after the first signal was damaged. Switching back to Side A was an option, but would there be additional problems if they switched back? How long would it take to assess the new system and ensure it was accurately collecting data?

By working round-the-clock, conducting extensive testing and assessment, and relying on past experience – all while working remotely – the CrIS team got their answers. On July 12, the Mission Operations Team made the switch to Side A, and by July 22, in a dramatic turnaround, the equipment and the data were operational.

Changyong Cao (STAR) and Flavio Iturbide-Sanchez (STAR). Members of the CrIS team: Alisa Young (STAR), Bruce Thomas (OSPO), Chris Sisko (OSPO), James McNitt (OSPO), Awdhesh Sharma (OSPO), Lihang Zhou (JPSS), and Satya Kalluri (JPSS).

Two data sources are better than one in drought surveillance

It's been said that two heads are better than one. Does the saying hold true for two remote sensing instruments?

This year, scientists from NOAA NESDIS Center for Satellite Applications and Research (STAR), NASA, and USDA discovered that by teaming evapotranspiration (ET) observations from the Advanced Baseline Imager (ABI) on NOAA GOES satellites with data collected by the Advanced Microwave Scanning Radiometers on the Japanese GCOM-W satellite (AMSR2) they had themselves a better product.

And here's why …

Evapotranspiration is evaporation, or water in soil that's released as vapor into the atmosphere. ET also is transpiration – water vapor released from plants via the holes on their leaves. Among its many roles, evapotranspiration indicates water contents of soil and plants, and thus whether an area will experience drought.

One way to assess evapotranspiration is through the Geostationary satellite Evapotranspiration and Drought (GET-D) tool that is based on thermal infrared observations of land surface temperatures (LST). For years, researchers, weather forecasters, water resource managers, farmers, and numerical weather prediction modelers have relied on the GOES thermal infrared observations. However, the thermal infrared sensing gets sidelined on cloudy days. The microwave radiometer on GCOM-W doesn't.

The team's work has led to the first effort to integrate data from GOES ABI and AMSR2 observations to create this all-weather ET data collection. This resource provides more comprehensive data that covers a broader area more consistently and accurately.

Li Fang (UMD-CISESS/NESDIS-STAR), Xiwu Zhan (NESDIS-STAR), Satya Kalluri (NESDIS-JPSS), Christopher R. Hain (NASA-MSFC) and Martha C. Anderson (USDA-ARS)

New tool tracks water quality and maps suspended particle concentration throughout the world

For more than 50 years, earth observation satellites have been vital tools in gathering data that researchers need to analyze trends, monitor conditions, and make long-term climate predictions. However, until recently, researchers who were looking for satellite data on water quality faced challenges.

How do you determine water quality? An important indicator is the level of the organic and inorganic material present, known as suspended particulate matter. Safe drinking water has a particular SPM concentration.

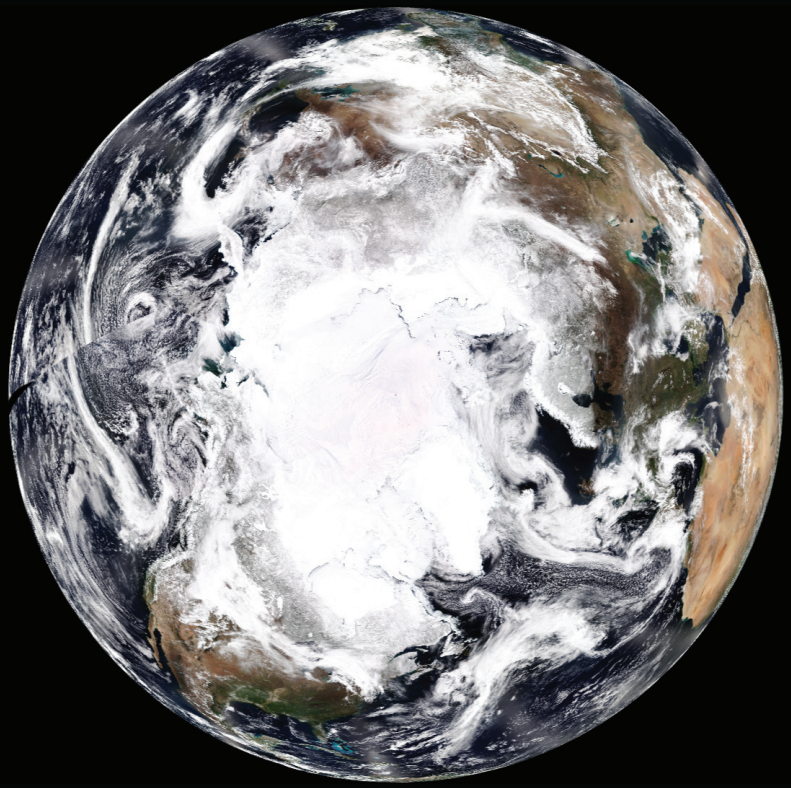
During the past two decades, we have had formulas and algorithms to determine SPM concentration levels, but have not yet successfully applied one to global satellite data. A consistent and easily replicable algorithm for assessing SPM through satellite ocean color imagery remained elusive – until scientists from STAR's Ocean Color Team created it.

Developed from data captured from the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (SNPP) and NOAA-20 satellites, the near-infrared, red, green, and blue (NIR-RGB) SPM algorithm can successfully predict SPM concentrations across open ocean, coastal, and inland waters. It can handle SPM of variable sizes, shapes, densities, and fluctuations. And it can be applied across a range of satellite sensors.

The algorithm is already at work and is producing global SPM products for coastal and inland communities across the United States (see accompanying SPM image over the U.S. east coast). Additional details are found here (https://doi.org/10.1029/2021JC017303).

Menghua Wang (STAR), Jianwei Wei, Lide Jiang, Karlis Mikelsons, and the Ocean Color Team

STAR's products: Are we getting our partners what they need?



Every year, the National Oceanic and Atmospheric Administration, NOAA, invests billions of dollars in environmental satellites to provide scientists, meteorologists, forecasters, and policymakers with information they need to study climate change, predict severe weather, track air quality, and help the public to better understand and protect the environment.

STAR is an important partner in this effort. Whether testing instruments before launch, developing technology for data collection, monitoring products in space, or providing additional assistance, STAR scientists help fellow researchers do their work.

But how do we know what our partners need? This past year, we shifted toward a more collaborative and creative starting point. What do our users need rather than what do we think they need? In 2021, STAR conducted successful sessions with the Ocean Prediction Center (OPC) and the Atlantic Oceanographic & Meteorological Laboratory (AOML). We plan to connect with additional partners across NOAA.

This new approach brings together agency leadership, STAR scientists, and our partners in a process that helps everyone to better understand the challenges that our users face, as well as the outcome or goal they are trying to achieve. Developing innovative products and services that more closely align with their needs not only helps us to help them, but also allows us to better prioritize and allocate resources.

Katherine Hawley, STAR User Engagement

STAR BY THE NUMBERS

358 Contractors on board

STAR TEAM

Federal Employers on board **74**

40

ALGORITHM SYSTEMS SENT TO STAR USERS

27 Science Teams

3 LOCATIONS

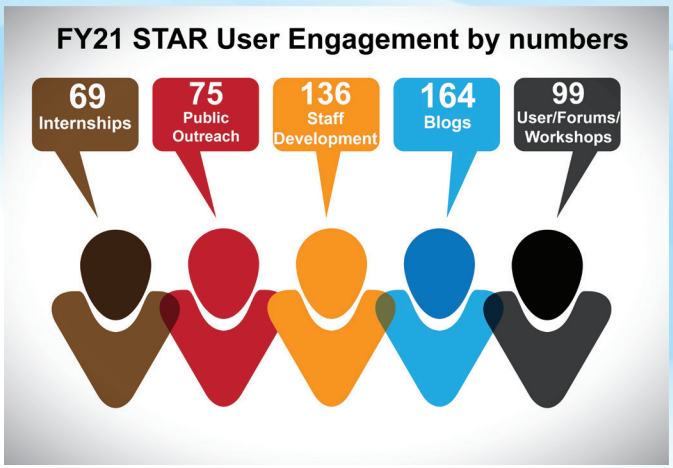
1400 Science Products

STAR GRANT TEAMS

Grants

126 Financial Awards

231 Project Funded



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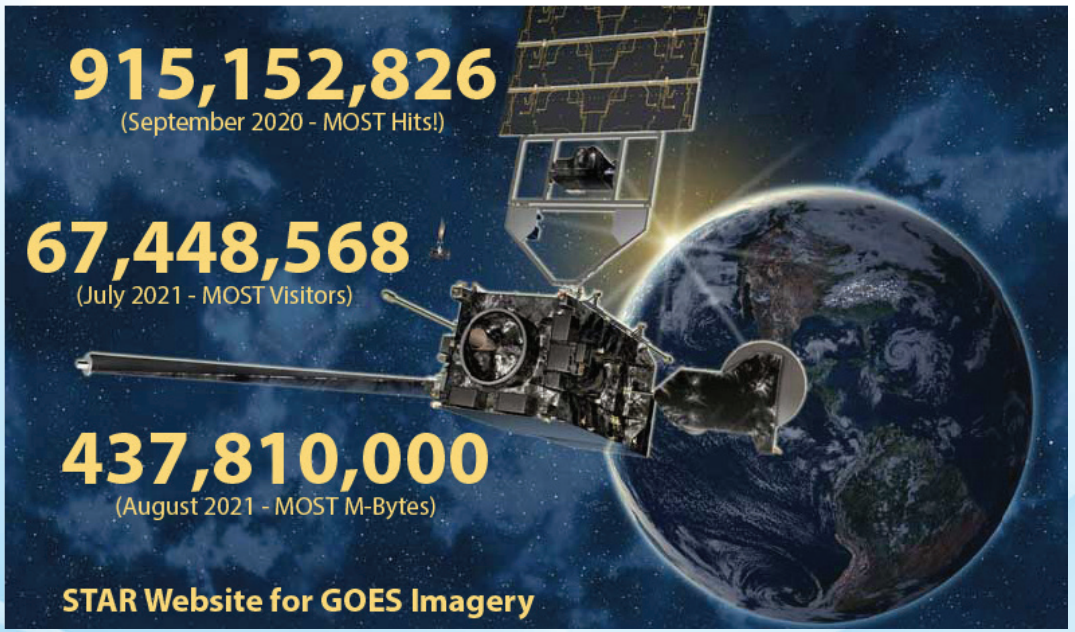
New improved hurricane products developed

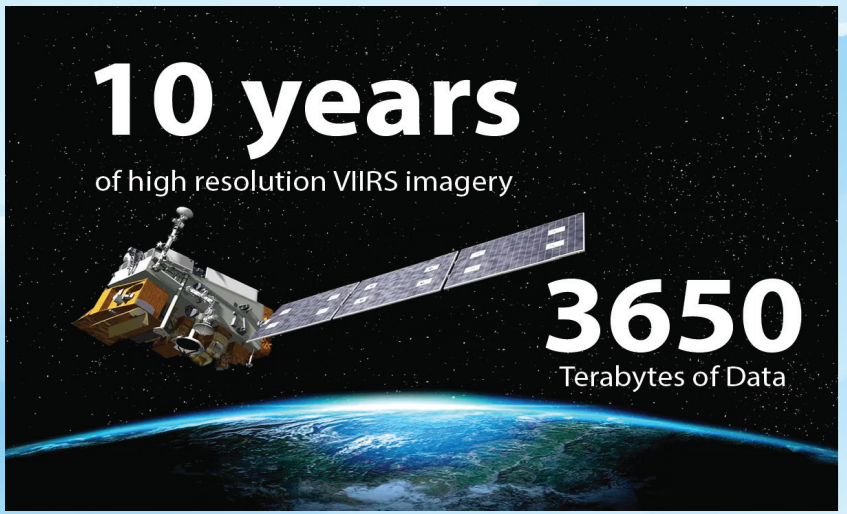
STAR BY THE NUMBERS



Coral Reef Watch (CRW)

25
years of service

25,000
recorded observations
of coral bleaching



STAR brings the power of satellite remote sensing science to all NOAA missions.

Awards

NESDIS Collaboration Award

Marilyn Yuen Murphy

Scott Lindstrom

The Silver Sherman Award

Ericka Rosier

Organizational Development Achievement Award

Shobha Kondragunta

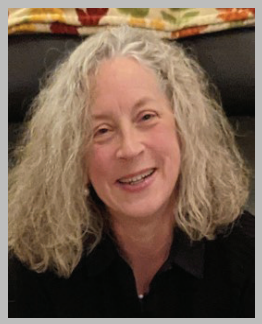
NESDIS Vision and Creativity Award

Kevin Garrett

Narges Shahroudi

Katherine Lukens

Stacy Bunin



Lori Brown

Sid Boukabara

Employee/Team Member of the Month

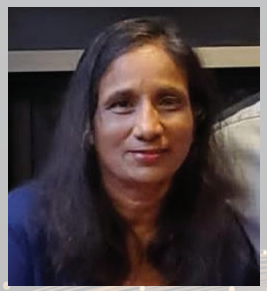
Alisa Young

Stacy Bunin

Distinguished Career Award

Jeff Key

Administrator's Award



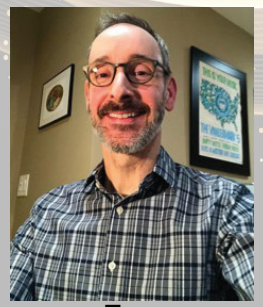
Shobha Kondragunta

Bronze Scientific Or Engineering Achievement Award

Paul Chang

Shobha Kondragunta

Derek Manzello



Tom King

Walter Wolf

Matt Jochum

Samuel J. Heyman Service to America Medals

C. Mark Eakin, Ph.D. (Ret.)
2021 Finalist