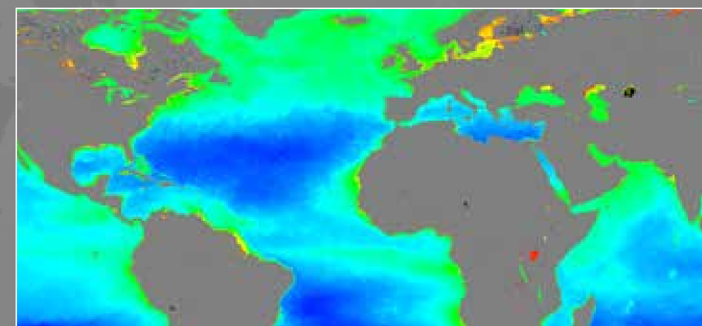
CENTER FOR SATELLITE APPLICATIONS AND RESEARCH (STAR)

STRATEGIC PLAN



2013 - 2018

STAR Overview

Center for Satellite Applications and Research (STAR)

Mission
To research, maintain and transfer to operations new or improved products and services enabling NOAA to offer state-of-the-art capabilities to decision makers and the public

Vision
To advance remote sensing science and technology to better inform the American public and safeguard the environment

Goals

- Promote new sensor and applications research
- Ensure high quality satellite data
- Advance algorithm refinement and technology infusion
- Transition research products into operational use
- Build and sustain partnerships

Science, Service, Stewardship

STAR Provides World Class Satellite Scientific Research and Applications

- To understand and predict changes in climate, weather, oceans, and coasts
- To share that knowledge and information with others
- To conserve and manage coastal and marine ecosystems and resources
- To maximize the impact of NOAA's satellite program for the benefit of society, our communities and Nation's economy

Performance Measures

- Number of peer-reviewed papers published
- Number of calibration / validation corrections or analyses applied to satellite data sets to improve their utility
- Number of data products developed / product reviews completed for NOAA satellite missions
- Number of research products prepared for transition to operational use
- Number of live / recorded training sessions delivered / updated

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In 2012, the Center for Satellite Research and Applications moved to the new NOAA Center for Weather and Climate Prediction building on the campus of the University of Maryland in College Park. (Image credit: University of Maryland)

Letter from the Director

A new era is at hand.

Over the next decade satellite remote sensing will see advances that few could have imagined just a few years ago.

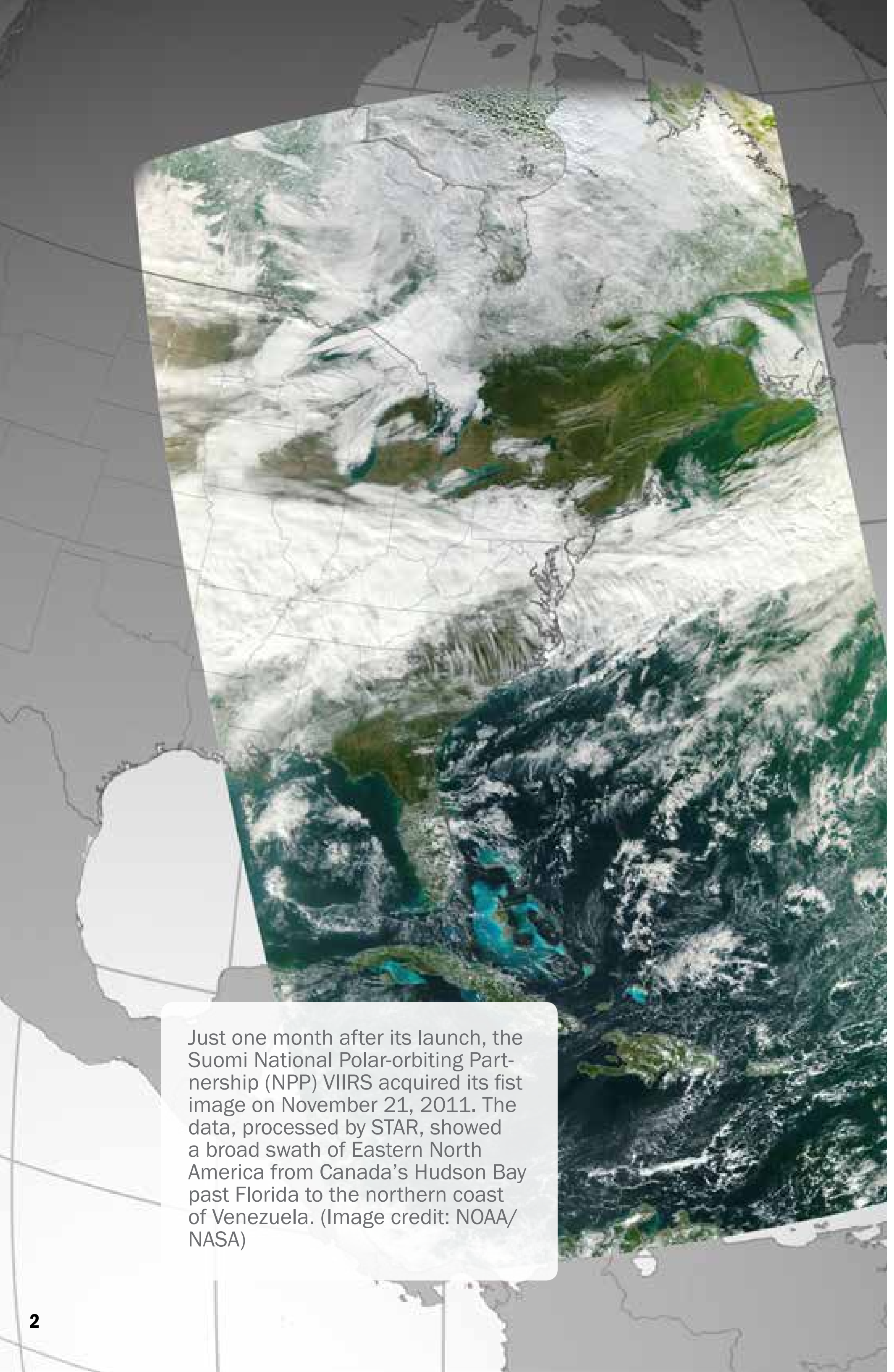
This emerging age of environmental exploration is due to the availability of high-quality satellite data from new advanced satellite sensors. Advances in computing power and collaborative strategic partnerships with U.S. and foreign space agencies will help maximize the return on our investments. In the recent decade, it became clear that the Nation is vulnerable to severe weather outbreaks, hurricanes, flooding, drought, fire, oil spills and other disasters; and there is a recognition that societal well-being and our economy are impacted by weather and environmental events.

As a Nation we especially need to understand how to maximize the benefits of economic growth while managing scarce resources and minimizing the impact of environmental threats to the economy, society, and our communities.

The National Oceanic and Atmospheric Administration (NOAA) and the National Environmental Satellite, Data and, Information Service's (NESDIS)* Center for Satellite Applications and Research (STAR) are maximizing the Nation's return on investment in satellite products, research, and technology. This strategic plan outlines STAR's vision to demonstrate leadership in science by understanding and predicting changes in the weather, oceans, coasts, and climate, while providing stewardship of our precious resources and delivering quality environmental services to benefit our Nation.

Alfred M. Powell, Jr., Ph.D.
Director, NOAA/NESDIS Center for Satellite Applications and Research

*Officially, NESDIS stands for National Environmental Satellite, Data, and Information Service. Informally, NESDIS is also called NOAA Satellite and Information Service.



Just one month after its launch, the Suomi National Polar-orbiting Partnership (NPP) VIIRS acquired its fist image on November 21, 2011. The data, processed by STAR, showed a broad swath of Eastern North America from Canada's Hudson Bay past Florida to the northern coast of Venezuela. (Image credit: NOAA/NASA)

Imagine

Imagine there were no satellites monitoring Earth and its environment. How would things be different? There would be:

- No animations of changing weather conditions on the local news
- Dramatically reduced warning times for severe weather and storms
- Significant reductions in weather forecast accuracy across the country
- Less accurate hurricane forecasts with less time for evacuation in vulnerable areas
- Reduced national drought monitoring capabilities
- Very limited monitoring of ocean conditions for assessing sea level rise, changes to ecosystems or support for marine commerce and transportation
- None of the magnificent satellite images of the Earth

What is the value of satellite data?

NOAA's operational satellites include the U.S. Geostationary Operational Environmental Satellites (GOES East/West), the Polar-orbiting Operational Environmental Satellites (POES), Suomi National Polar-orbiting Partnership (NPP), the European Meteorological Operational Satellite Programme (MetOp) and the Defense Meteorological Satellite Program (DMSP). These environmental satellites help NOAA predict environmental conditions around the globe. The Center for Satellite Applications and Research (STAR) uses the data from these satellites to improve or refine products and services in support of the NOAA mission. The U.S. shares environmental satellite data with its international partners and uses this data to provide a more comprehensive set of satellite observations for monitoring the earth and providing a globally consistent set of observations for use in NOAA's operational forecast models. Over 90 percent of the data used in NOAA's forecast models comes from satellite observations, and these observations provide a unique opportunity to help mitigate environmental impacts on our national economy. Stressing the importance of satellites, the Senate's FY13 appropriation planning language indicated, "The value of NOAA's weather satellite programs cannot be overstated in terms of the data collected that is used to develop daily weather forecasts and provide citizens with ample warning about severe weather."

Environmental satellite measurements span the electromagnetic spectrum from the visible through the infrared, and into the microwave regions. These measurements are combined with other available information to create products and services that various user communities can employ directly. For example, key elements related to the water cycle are critical for facilitating improvements in decisions that help the US agricultural community maximize output, raising our standard of living, and mitigating various environmental impacts. Satellite data, products and services allow global transportation to better understand potential risks to the flow of goods and services, reducing prices, and improving the delivery of essential food and other cargo.

What is NOAA's history in satellite remote sensing?

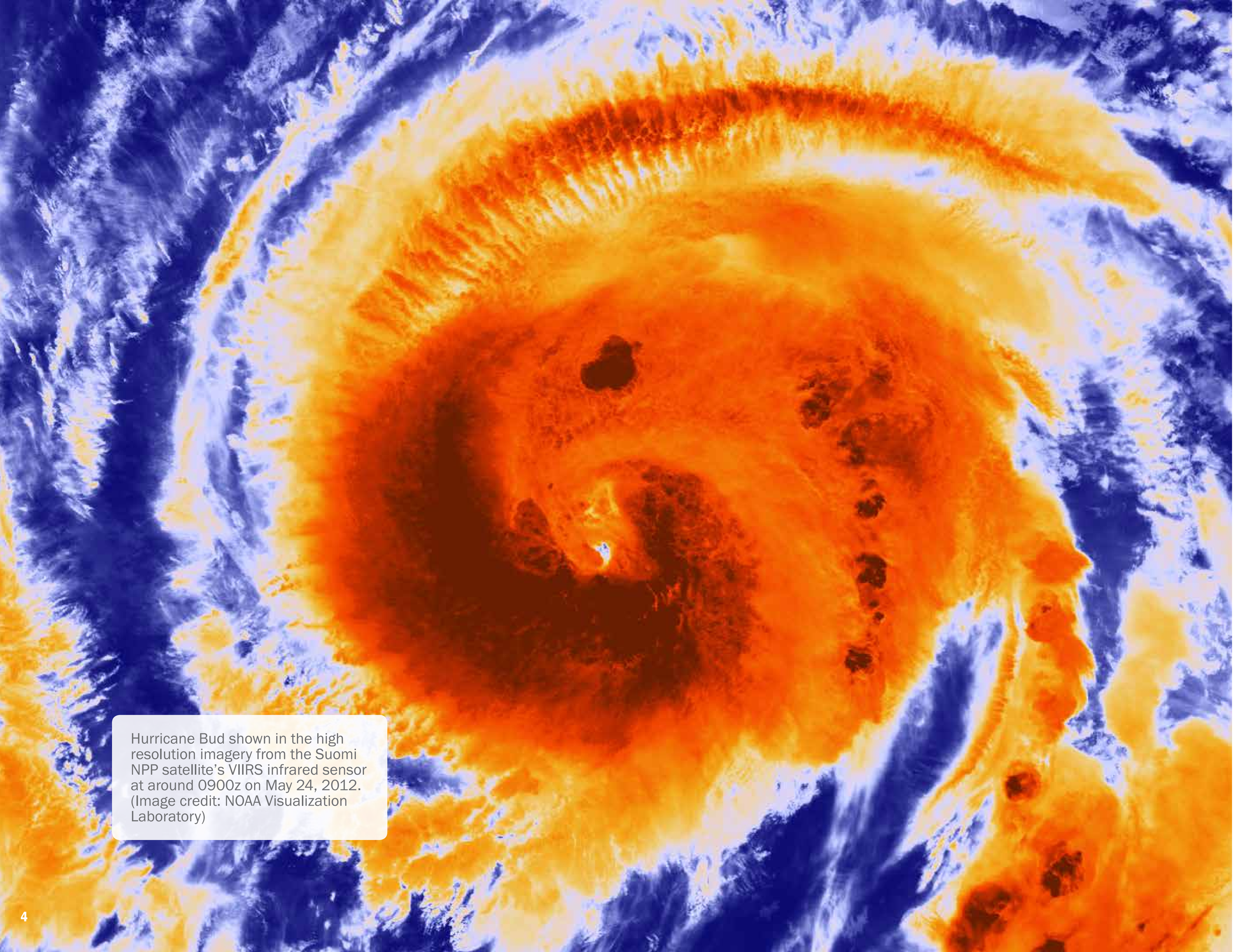
Fifty years ago NOAA launched its first series of weather satellites, creating the demand for new weather and ocean products. Despite the limited capability and coarse resolution of the early satellites, our scientists developed a fundamental understanding of the Earth System. They generated hundreds of new products from these data – many which were never expected nor intended when the satellite and the sensors were designed.

What is NOAA's role in developing future satellite products?

Today, a new era is dawning. With the recent launch of Suomi NPP, the first new satellite in the next generation of weather satellites with advanced sensors, a litany of exciting new capabilities can migrate from research plans to daily use, generating high-quality satellite products to be used and sustained over many years.

These new next generation NOAA missions are only the starting point. Advanced sensor missions flown by partners in other U.S. and international space agencies will provide vast infusions of new data to improve weather forecasting, and ocean monitoring, and greatly improve our fundamental understanding of the Earth System.

This document describes the general strategy STAR will follow to maximize the societal and economic benefits of our Nation's investment in satellite observation systems in a manner consistent with the NOAA strategy for the coming decade.



Hurricane Bud shown in the high resolution imagery from the Suomi NPP satellite's VIIRS infrared sensor at around 0900z on May 24, 2012. (Image credit: NOAA Visualization Laboratory)

STAR'S Mission

STAR plays an important role in ensuring the success of NOAA's mission of science, service, and stewardship. During the next decade STAR will help our Nation:

- Achieve economic growth in a sustainable manner
- Ensure public safety in the face of storms and other extreme weather events
- Improve community resilience to natural disasters
- Support informed management and the preservation of the ocean's natural resources
- Enhance our understanding of the dependence of our Nation's economic success, health and well-being on environmental resources and hazards.

STAR is the NOAA center responsible for improving and advancing satellite-based environmental products. STAR's work ties directly into the NOAA goals of science, service, and stewardship.

Science

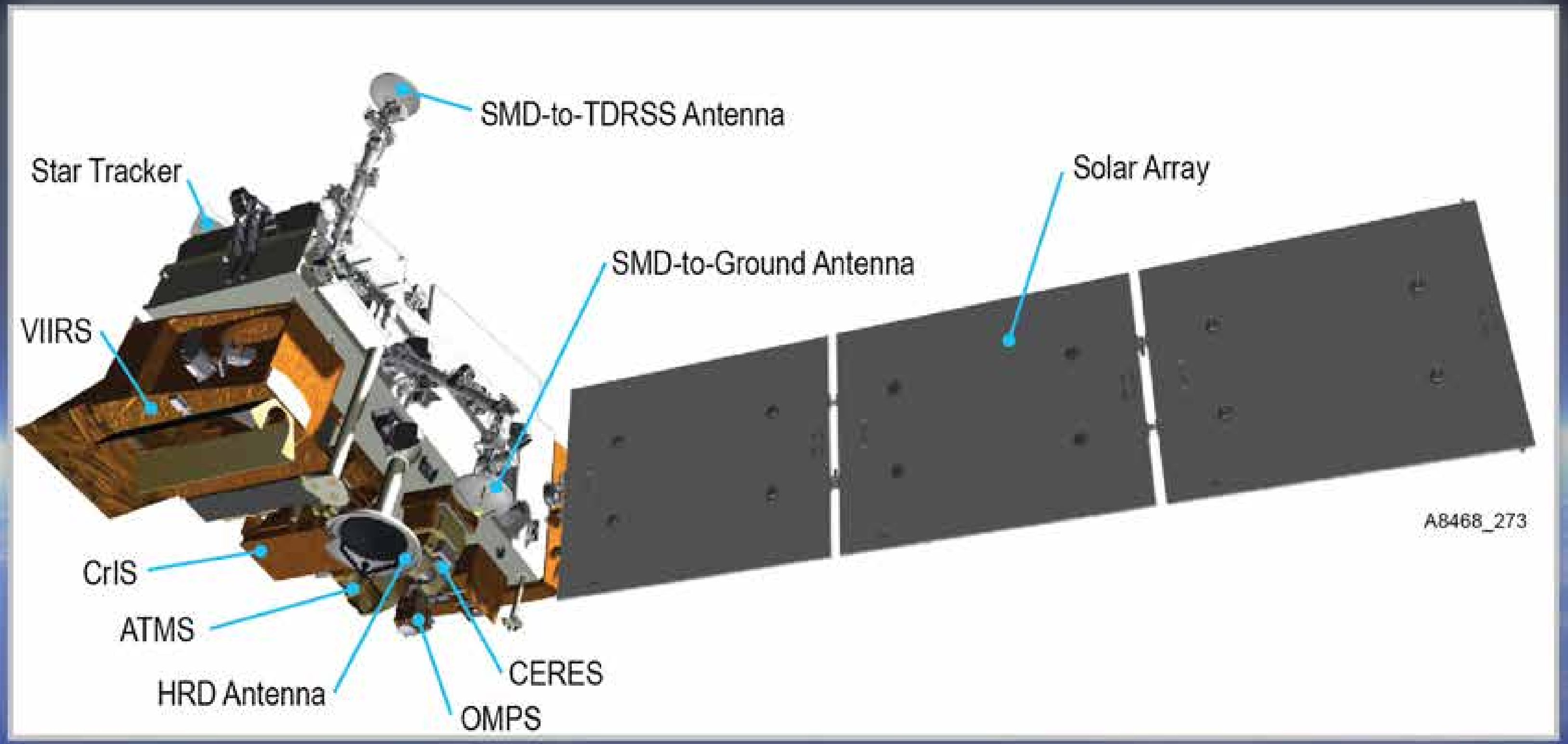
As a scientific research center, STAR contributes to the development of new and innovative satellite-based products. STAR plays a major role in assessing what environmental products can be generated from current and future satellite sensors in response to new and emerging requirements. STAR's unparalleled expertise in satellite calibration and validation enables the generation of consistent and high-quality long-term climate records.

Service

Service is a cornerstone of STAR's work. The highly dynamic and constantly changing nature of environmental conditions can quickly create conditions that result in severe impacts on human populations or the economy. New and experimental STAR products have been rapidly deployed to monitor oil spills and drought, and help predict the path of airborne volcanic ash. The result: improved hazard assessment response and public safety.

Stewardship

Environmental monitoring is essential to maintain and sustain the valuable natural resources and ecosystems on which our economies and communities depend. Humans and environmental resources are highly interdependent. As our society becomes more complex and globalized, it becomes increasingly vulnerable to local hazards. Whether the economic sector is food, energy, or transportation, far-removed hazards can have local consequences due to the web of global supply chains. Accurate and timely environmental observations allow decision makers and managers to be better stewards of scarce resources. This enables sustainable development of our communities and economic growth.



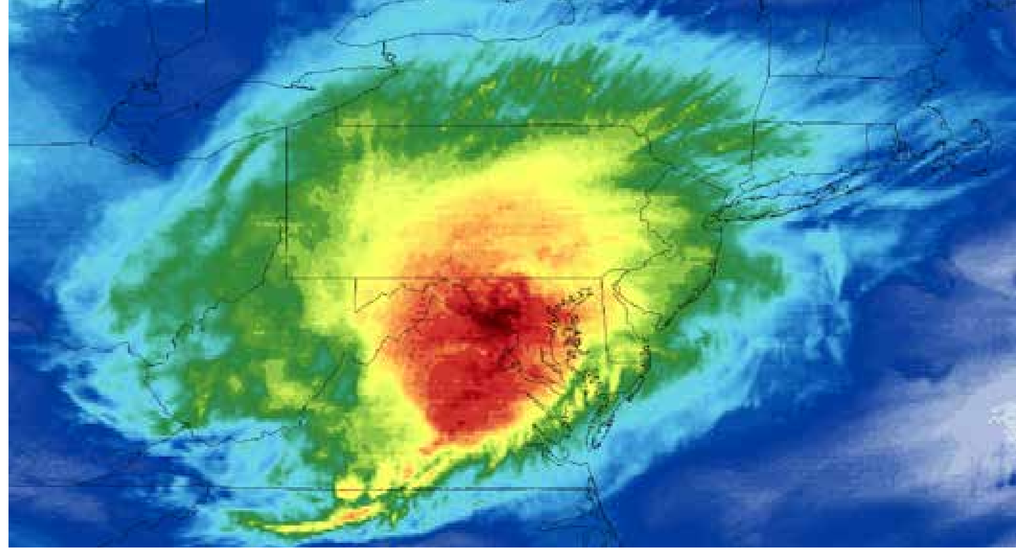
STAR'S Vision

What is STAR's vision?

Over the next decade STAR will help NOAA develop, implement, and collaborate to maximize the benefits of a continued legacy of highly valued polar-orbiting and geostationary satellite constellations: the Initial Joint Polar-orbiting Satellite System (IJPS); the Joint Polar Satellite System (JPSS); and the Geostationary Operational Environmental Satellite Series R (GOES-R).

NOAA's mission of science, service, and stewardship leads to a future where societies and their ecosystems are healthy and resilient in the face of sudden or prolonged environmental change. This resilient paradigm will guide NOAA, STAR, and its partners in a collective effort to reduce the vulnerability of communities and ecological systems in the short-term, while helping society avoid or adapt to long-term environmental, social, and economic changes. To this end, STAR is prepared to support NOAA's four long-term goals:

- Climate Adaptation and Mitigation: Creating an informed society to anticipate and respond to climate and its impacts
- Weather-Ready Nation: Ensuring society is prepared for and responds to weather-related events
- Healthy Oceans, and Marine Fisheries: Marine fisheries, habitats, and biodiversity are healthy and productive ecosystems
- Resilient Coastal Communities and Economies: Coastal and Great Lakes communities are environmentally and economically sustainable.



The June 30, 2013 derecho that caused heavy damage from Ohio to Maryland is shown in this GOES-13 water vapor imagery from 02:30 GMT. (Image credit: NOAA Visualization Laboratory)

To meet NOAA's vision of resilient ecosystems, communities, and economies, STAR will capitalize on data from new satellite platforms and missions, and work through international partnerships to help NOAA support a Global Earth Observation System of Systems (GEOSS) for environmental observations. This system will combine earth observations from NOAA's operational satellites, NASA's environmental research missions, and satellite observations from our international partners. This worldwide program will characterize and monitor environmental changes to maximize societal and economic benefits.

What are the benefits to society and economy?

The Nation will increasingly benefit from the satellite observations through:

- Greater confidence in more accurate weather forecasts
- Improvements in hurricane forecasting and severe weather warnings
- Enhanced monitoring of severe environmental conditions such as oil spills, volcanic ash plumes, and life-threatening fires
- Dramatic improvement in severe weather and hurricane forecast warning times
- Increased ocean monitoring capability to protect and improve the safe operations of the commercial fishing fleet and commercial shipping
- Improved monitoring of harmful algal blooms and ecological forecasting to reduce public health concerns

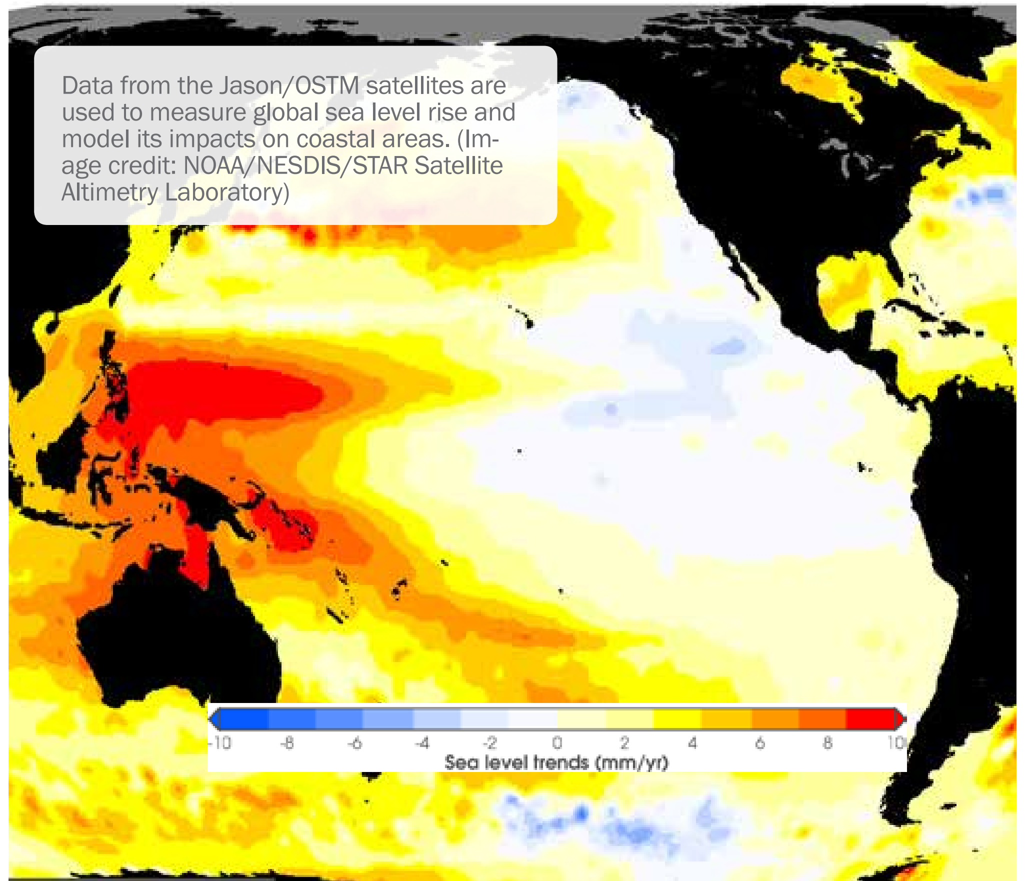
Where will STAR strategically focus its investments?

1. Perform research into new sensors and applications to expand product and service capabilities.
2. Ensure satellite products are consistently of high quality and are available in a timely manner to users.
3. Improve the reliability of satellite research and development processing systems.
4. Ensure the latest technological improvements and advances in scientific knowledge are used in research activities, and the software engineering process.
5. Foster relationships and partnerships to bolster innovation, technology transfer, and provide greater benefit to society.

What benefits will result from collaboration and cooperation?

Scientists will work closely with our Nation's civil and military users to ensure the improved use of satellite data in forecast models to predict global environmental phenomena of societal importance, including daily weather predictions, seasonal outlooks, droughts, sea level rise, and the health of our coastal areas, fisheries, and coral reefs.

To maximize the use of satellite products, STAR scientists will collaborate with NOAA's satellite partners, the Nation's top academic institutions, and the satellite user community with the goal of making even better environmental products for tomorrow, the next decade, and following generations.



Data from the Jason/OSTM satellites are used to measure global sea level rise and model its impacts on coastal areas. (Image credit: NOAA/NESDIS/STAR Satellite Altimetry Laboratory)

STAR's Unique Partnerships and Affiliations

STAR also has a unique set of partners and affiliations which allow it to extend and expand its impact.

National Calibration Center

The NOAA National Calibration Center (NCC) facilitates improved accuracy of NOAA's weather, climate, and ocean models through sharing of technical practices for fine tuning remotely-sensed data from environmental satellites among different programs and agencies. The NCC's mission is to provide common standards and methodology for the user community as well as encourage communication though a centralized Calibration Knowledge Base. This practice provides support to NOAA's satellite programs by enforcing stricter and more widespread quality control on satellite data from GEOSS, which will improve efficiency and reduce costs as the community strives to meet the growing needs for high quality satellite data.

Joint Center Satellite Data Assimilation

A multi-agency research center, co-located with STAR, created to improve the use of satellite data in models for analyzing and predicting the weather, the ocean, the climate or the environment, the Joint Center for Satellite Data Assimilation (JCSDA) is dedicated to developing and improving the ability to exploit satellite data more effectively in the United States. It is a distributed and collaborative effort that facilitates the useful application of millions of satellite observations available daily that are shared across several operational agencies in the United States.

Environmental Visualization Program

The Environmental Visualization Program (EVP) offers enhanced NOAA imagery, and NOAA imagery fused with other environmental data sets or modeled output to promote education and public understanding. It specializes in creating Multi-Dimensional Imagery from both polar orbiting and geostationary satellites, operated by NOAA. NOAA's EVP communicates to the public through its outreach and communications program.

NOAA's CoastWatch Program

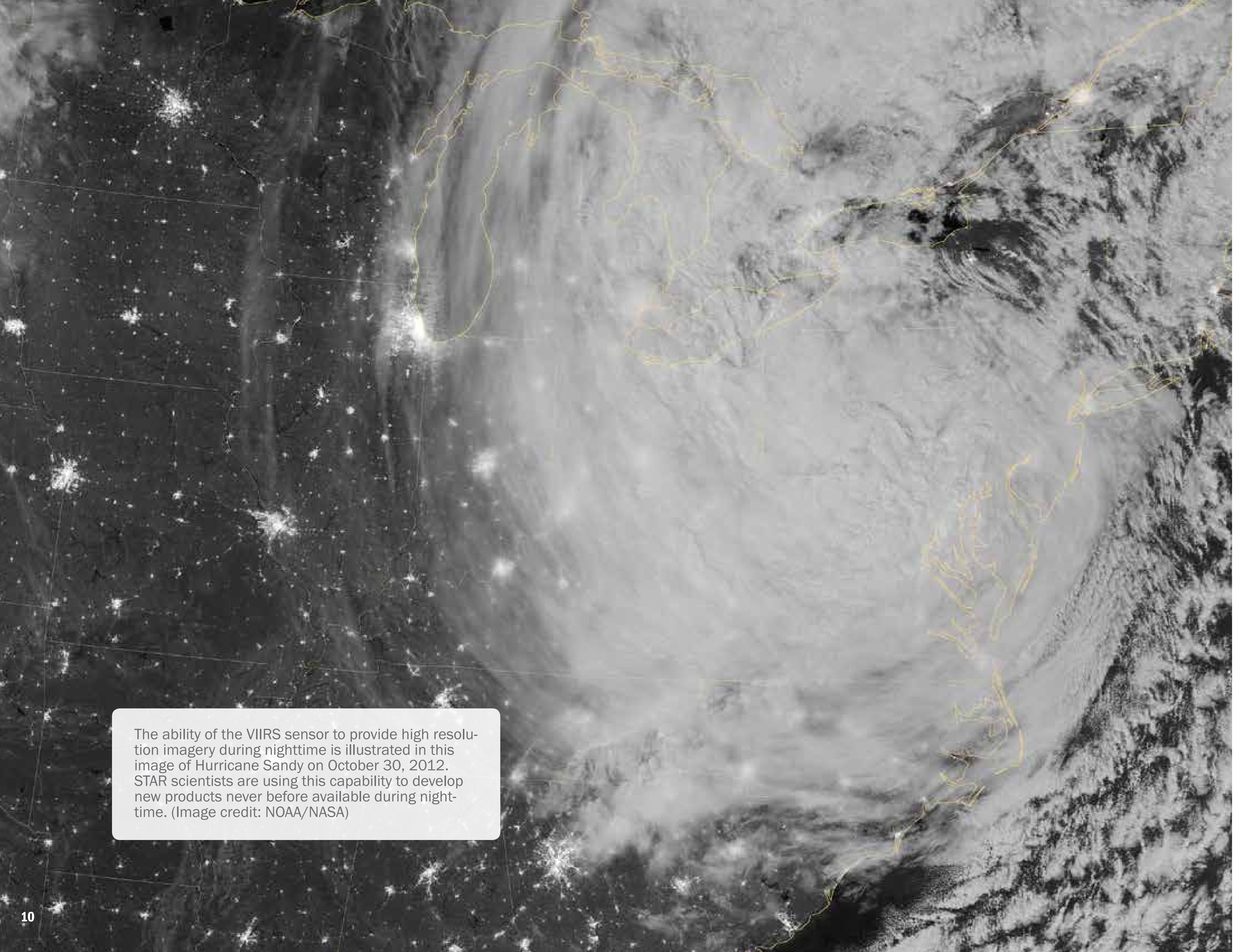
CoastWatch processes oceanographic satellite data, and makes it available to Federal, State, & local marine scientists, coastal resource managers, and the general public.

Coral Reef Watch

NOAA has partnered with other organizations to support sound science and management to preserve, sustain and restore valuable coral reef ecosystems.

Global Space-Based Inter-Calibration System (GSICS) Coordination Center

The primary goal of GSICS is to improve the use of space-based global observations for weather, climate and environmental applications through operational inter-calibration of the space component of the WMO World Weather Watch (WWW) Global Observing System (GOS) and GEOSS.



The ability of the VIIRS sensor to provide high resolution imagery during nighttime is illustrated in this image of Hurricane Sandy on October 30, 2012. STAR scientists are using this capability to develop new products never before available during nighttime. (Image credit: NOAA/NASA)

NOAA's Science & Technology Enterprise

NOAA's vision centers on a holistic understanding of the interdependencies between human health and prosperity, and the intricacies of the Earth system. Achieving this level of understanding presents an overarching, long-term scientific and technical challenge to NOAA: to develop and apply holistic, integrated Earth system approaches to understand the processes that connect changes in the atmosphere, ocean, space, land surface, and cryosphere with ecosystems, organisms, and humans over different temporal or spatial scales.

Objective: A holistic understanding of the Earth system through research

NOAA's long-term goals and objectives hinge on an enhanced understanding of the complex interrelationships that exist across NOAA's climate, weather, ocean, and coastal domains. NOAA needs to advance innovative research that pushes the boundaries of scientific understanding and integrates information across scientific disciplines. This innovative research will enable an improved understanding of the Earth system from global to local scales, and improve the ability to forecast weather, climate, water resources, and ecosystem health.

To achieve this objective, NOAA will expand and maintain reliable and accessible information and develop advanced technologies to better observe, understand, model, and communicate knowledge of complex systems, as well as promote existing and future scientific excellence and collaborations in its scientific workforce.

Objective: Accurate and reliable data from sustained and integrated earth observing systems

NOAA is an environmental information generating organization. Therefore, NOAA's observing system portfolio needs to balance growing demands with continuity concerns and the implementation of emerging technologies. Over the long-term, NOAA must sustain and enhance its many observing systems — and their long-term data sets — and develop and transition new observing technologies into operations, while working in close collaboration with its governmental, international, regional, and academic partners.

To achieve this objective, NOAA will research, develop, deploy, and operate systems to collect remote and in situ observations. NOAA will manage and share data through partnerships and standards. Fundamental to ensuring effective use of the wealth of environmental information collected by observing systems is an increased focus on information management standards and strategies to improve access, interoperability, and usability of NOAA's environmental information resources.

NESDIS Strategic Perspective

STAR's parent organization, the National Environmental Satellite, Data,and Information Service (NESDIS), is responsible for the broader, overall satellite mission which supports the NOAA's science and technology enterprise. STAR's science, research, development, and maintenance roles are major contributors to the success of the NOAA satellite missions.

Mission

NESDIS is dedicated to providing timely access to global environmental data from satellites and other sources to promote, protect, and enhance the Nation's economy, security, environment, and quality of life. To fulfill its responsibilities, NESDIS does the following:

- acquires and manages the Nation's operational environmental satellites,
- operates the NOAA National Data Centers,
- provides data and information services including Earth system monitoring,
- performs official assessments of the environment, and
- conducts related research.

Vision

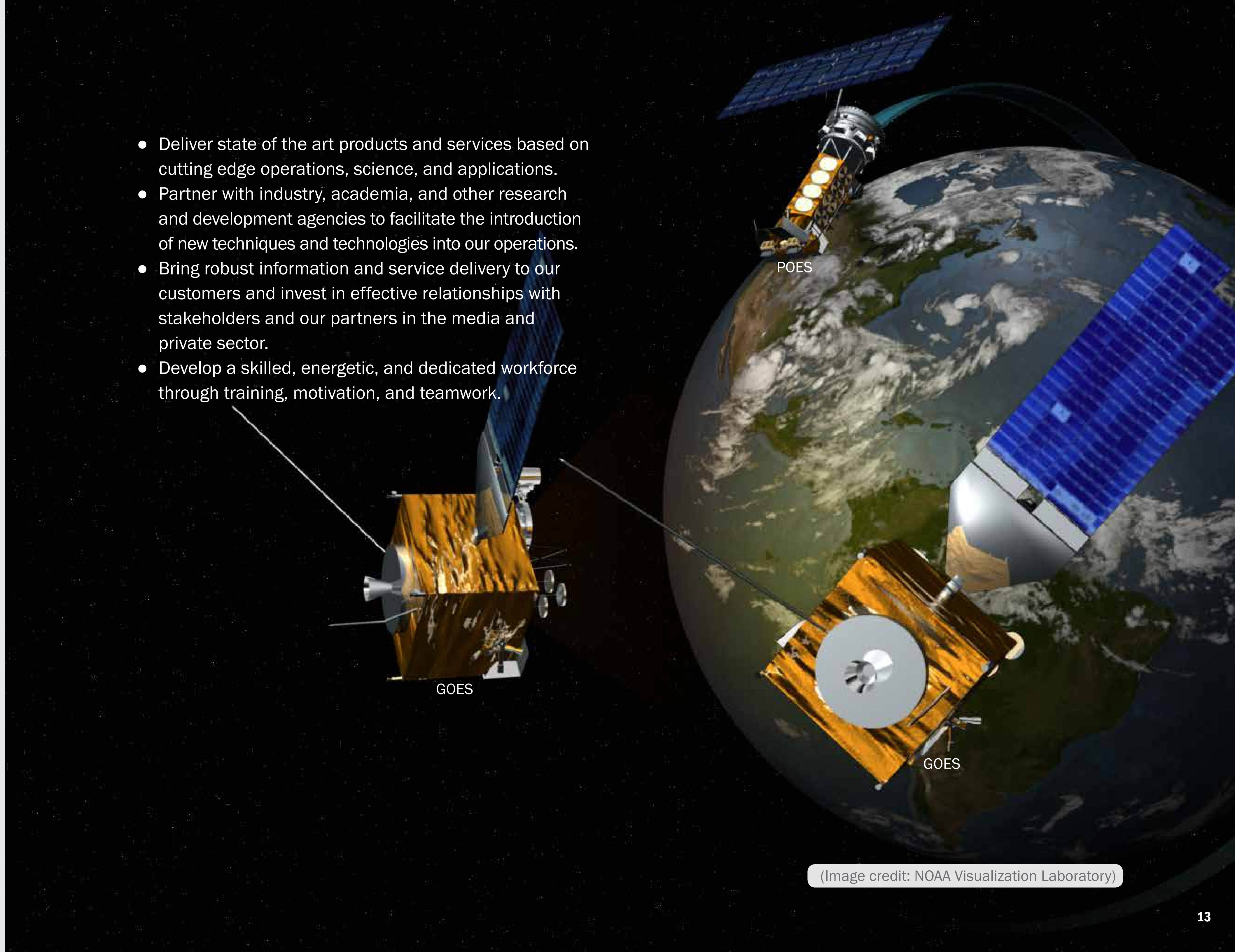
The NESDIS vision is to be the world's most comprehensive source and recognized authority for satellite products, environmental information, and official assessments of the environment in support of societal and economic decisions. To achieve the vision, NESDIS does the following:

- Operate the world's premier environmental satellite system, and the Nation's National Environmental Data Centers, fulfilling customer requirements for quality and timeliness of data.
- Collaborate with other agencies and organizations to describe changes to our climate and the implications of those changes.
- Continue to lead the effort with other agencies and countries in establishing a global observing system to meet the world's information needs for weather, climate, oceans, and disasters.

(Continued on next page)

Top: Employees at the NOAA Satellite Operations Facility (NSOF) review satellite data; Middle: The mission control room at NSOF; Bottom: A rendering of the JPSS-1 spacecraft. (Image credit: (top, middle) NOAA; (bottom) Ball Aerospace)

- Deliver state of the art products and services based on cutting edge operations, science, and applications.
- Partner with industry, academia, and other research and development agencies to facilitate the introduction of new techniques and technologies into our operations.
- Bring robust information and service delivery to our customers and invest in effective relationships with stakeholders and our partners in the media and private sector.
- Develop a skilled, energetic, and dedicated workforce through training, motivation, and teamwork.



(Image credit: NOAA Visualization Laboratory)

Satellite microwave data reveal the dramatic changes in sea ice concentration from September 1979 (left) to September 2012 (right) (Image credit: NOAA Visualization Laboratory)

STAR Goals

Goal 1: Promote New Sensor and Applications Research

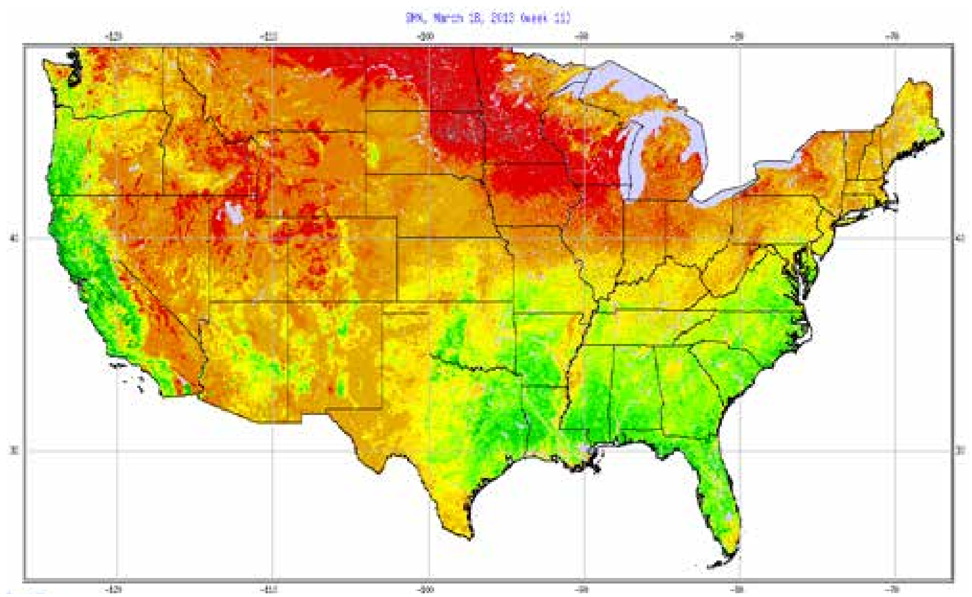
What innovative products has STAR created?

Over the past decade STAR created innovative high-impact and new scientific products from technology on board the current NOAA operational satellites. Examples of these new products include:

- Oil slick monitoring to facilitate evaluation of environmental impacts and clean-up after events such as the Deepwater Horizon oil spill in the Gulf of Mexico
- Monitoring coral reef health to assist evaluating health and sustainability of oceanic ecosystems and valuable fisheries
- Detection and monitoring of burning vegetation to aid local responders and enable effective emergency management
- Monitoring sea ice extent and thickness to evaluate environmental changes in the Arctic and Antarctic and support safe navigation
- Improving sensor calibration and data quality control measures to facilitate better weather forecasts, more accurate climate trends, and more timely ecosystem management planning and decisions.

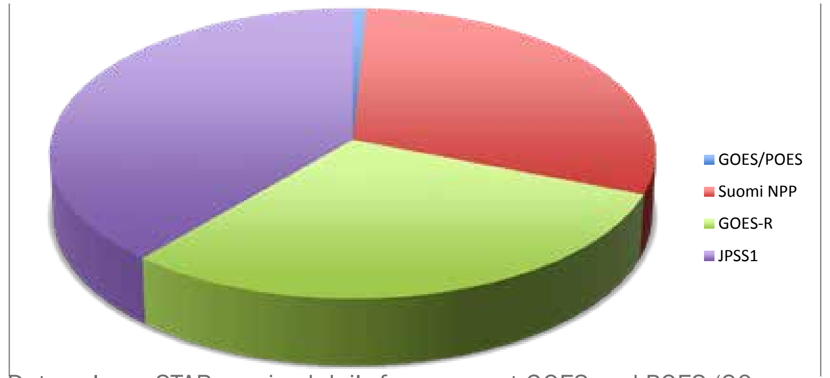
How will satellite products be improved?

The next generation of satellite sensors will improve observation resolution, timeliness, and sensor sensitivity across the electromagnetic energy spectrum. Consequently, NOAA scientists will extract more detail about how the environmental system works. Greater understanding will improve predictions of the weather, and sea level rise.



The graphic, based on a world-wide composite of a 7-day average, shows the "greenness" of the United States. Specialized satellite sensors detect the differences in soil content, moisture and vegetation, and are calibrated before and after the satellite sensor is launched to ensure maximum accuracy. This information can be used to estimate the start and senescence of vegetation, start of the growing season, and phenological phases. (Image credit: STAR)

With increased satellite measurement sensitivity and new capabilities to detect greenhouse gases (carbon dioxide, methane, nitrous oxide) and atmospheric particles (aerosols), NOAA will better understand how atmospheric elements contribute to warming and cooling the atmosphere. Improving our understanding of the Earth System will provide better seasonal to long-term outlooks and trends for use in planning.



Data volume STAR received daily from current GOES and POES (90 Gigabytes), as compared to Suomi NPP (3-4 terabytes) (TB) and will be received from GOES-R (3-4 TB) and JPSS-1 (4-5 TB).

A tremendous increase in the data volume results from dramatically increased satellite observation resolution. Exploiting the huge data volume requires greater storage, additional computer resources to process the observations and extra time to analyze the data.

Suomi NPP is the first next-generation polar-orbiting satellite and was launched in October 2011. Note the dramatic difference in the above chart between data STAR receives from Suomi NPP, and is expected to receive from JPSS-1 and GOES-R, as compared to that of the current GOES/POES satellites. This difference is primarily due to the much higher resolution and improved sensitivity of the very latest instruments flown on Suomi NPP.

Through its Cooperative Institutes and participation in the JCSDA, STAR reaches out and collaborates with satellite acquisition programs and university partners to aggressively expand and enhance access to a collaborative computing environment for more comprehensive scientific computing, utilities, tools, services and data. This will enable scientists at the JCSDA and the Cooperative Institutes, and other external research collaborators, access to critical high performance computing resources to help advance their research.

How can meaningful information be extracted from so much new data?

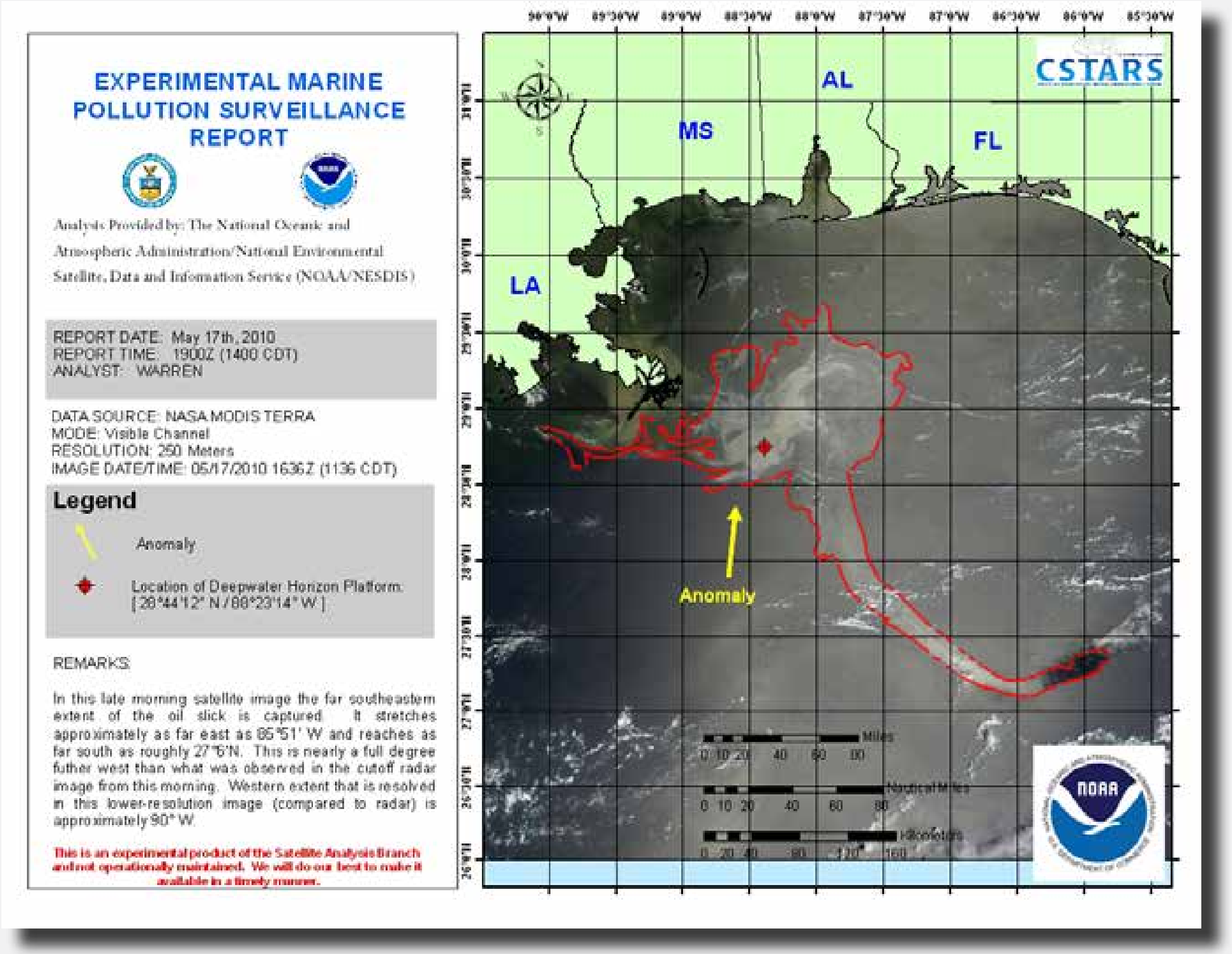
Investment in new scientific research and development systems will create software to remap, blend, calibrate, and generate products from multiple satellite instruments. This will improve NOAA's ability to generate daily satellite products in a consistent format across multiple instruments and systems.

Tools will be developed to produce multi-year climate records from current and past sensors, enabling accurate analysis and monitoring of long-term environmental trends, including sea level rise, deforestation, and trends in Arctic and Antarctic ozone.

Software tools are being developed to quantify the readiness of an application to provide benefits to the public and will indicate when an application should be retired to free resources for higher impact programs. The use of archived data will also allow the comparison of changes between new products and existing products.

The improved capability to extract meaningful information from huge datasets is vital to the continuing incremental steps leading to improved satellite and subsequent forecast products.

SPOTLIGHT



Deep Water Horizon was a watershed event for NOAA. This single spill spread oil over an area 600,000 square miles, and combined with day-to-day changes in currents and wave heights, made detecting surface oils a significant challenge for NOAA's traditional observation capabilities. Luckily STAR scientists had been working on techniques for identifying oil slicks using synthetic aperture radar and high resolution visible channel sensors from both NOAA and non-NOAA satellites. These new techniques proved up to the challenge, and NOAA/NESDIS began issuing real-time surface oil analyses on April 22, 2010, the same day that the Deepwater Horizon oil rig sank.

Gulf Oil Spill - May 17, 2010

This satellite imagery shows most of the main body of the spill as seen in the NASA MODIS Terra imagery. The red outline indicates areas of observed surface oil using STAR's oil analysis techniques. (Image credit: NOAA Satellite Analysis Branch)

Hurricane Katia shown over the north Atlantic Ocean. This image was taken by GOES East at 1545Z on September 6, 2011. The geographic extent, spatial coverage, and vertical resolution of satellite imagery is used to identify impacts on shipping, and other important commerce and transportation. (Image credit: NOAA Visualization Laboratory)

Goal 2: Ensure the Highest Quality Satellite Data

Why focus on satellite data quality?

Weather forecasts using low quality satellite data will be inaccurate at best and in some locations just plain wrong.

Using new and improved satellite products – such as near real-time ocean winds or vegetation characteristics – in NOAA's forecast models leads to increased confidence in the forecasts. Greater public confidence in weather forecasts, in turn, leads to commercial industry integrating weather forecasts more completely into their business models to improve levels of service, reduce costs, and produce overall benefits to the economy.

The National Weather Service (NWS) is the primary user of NOAA satellite products. We also support National Marine Fisheries Service (NMFS) and National Ocean Service (NOS), as key users of STAR products (e.g., ocean color/harmful algal bloom). They expect to receive the best quality environmental measurements to generate accurate and timely weather forecasts for use nationwide by millions of people every day to:

- plan daily activities
- allow business and government to plan for potentially disruptive weather events
- ensure safe and efficient marine operations

Quality control of the satellite data is essential for delivering robust information that decision makers can be confident using. As quality increases, the accuracy of our Nation's forecasts and environmental services improves. STAR helps ensure the highest quality satellite data is generated for use in weather forecasts, ocean predictions, assessing regional impacts, and understanding climate trends.

What is STAR's challenge?

STAR faces a daunting challenge to maintain the data quality to serve all environmental users. STAR's challenge is to meet the ongoing demands for better observation timeliness, improved products, and accurate climate records and trends, to best leverage the capabilities of the newest satellite instruments.

To respond to such demands, STAR collaborates with experts from the World Meteorological Organization (WMO), National Institute for Standards and Technology (NIST), National Aeronautics and Space Administration (NASA), Department of Defense (DoD), and the U.S. Geological Survey (USGS).

Collaboration is mutually beneficial and often leads to the highest quality standards for fused products generated from many sensors, and satellites, thereby improving assessments of the climate record and its trends.

Are there additional benefits to collaboration?

Collaboration draws the best out of the individual and collective effort of many government agencies' scientific, technological and human resources.

NOAA benefits by tapping into and building on successes, such as NIST international reference standards, and NASA expertise with instrumentation. NOAA also benefits by obtaining valuable international weather data through the WMO, partnering with DoD to support international humanitarian assistance, and gaining knowledge of meteorological and climatological interactions with the land surface through collaborative efforts with USGS.

Greenness products from the Suomi NPP are providing more accurate characterizations of land use, drought impacts, and even seasonal changes in vector-borne disease habitats. This VIIRS smoothed NDVI image is taken from March 1, 2013. (Image credit: NOAA Visualization Laboratory)

What is calibration and validation?

Polar-orbiting satellites fly around the Earth at 7 km/sec at an altitude of approximately 500 km. A geostationary satellite flies about 35,000 km above the Earth. How can these satellites reliably detect variations in temperature across the Earth's surface?   The process of calibration and validation ensures that a degree of temperature change, for example, detected by a satellite corresponds to an actual degree of temperature change on the Earth's surface. Since both the instrument and the earth change with time, the measurements must be checked and updated to ensure they remain equivalent through all seasons and through the history of measurements from one satellite and then over the entirety of a data record from multiple satellites over multiple decades.

Why is calibration/validation important?

Calibration and validation requires matching the readings of one satellite with another simultaneously over the same area, and also comparing readings with those from other instruments, including NIST standards, ocean buoys, and ground monitoring stations. The calibration and validation process results in a continual series of tweaks and changes to the equations that process raw sensor data into advanced products, and must occur over the life of the satellite to ensure observation quality.

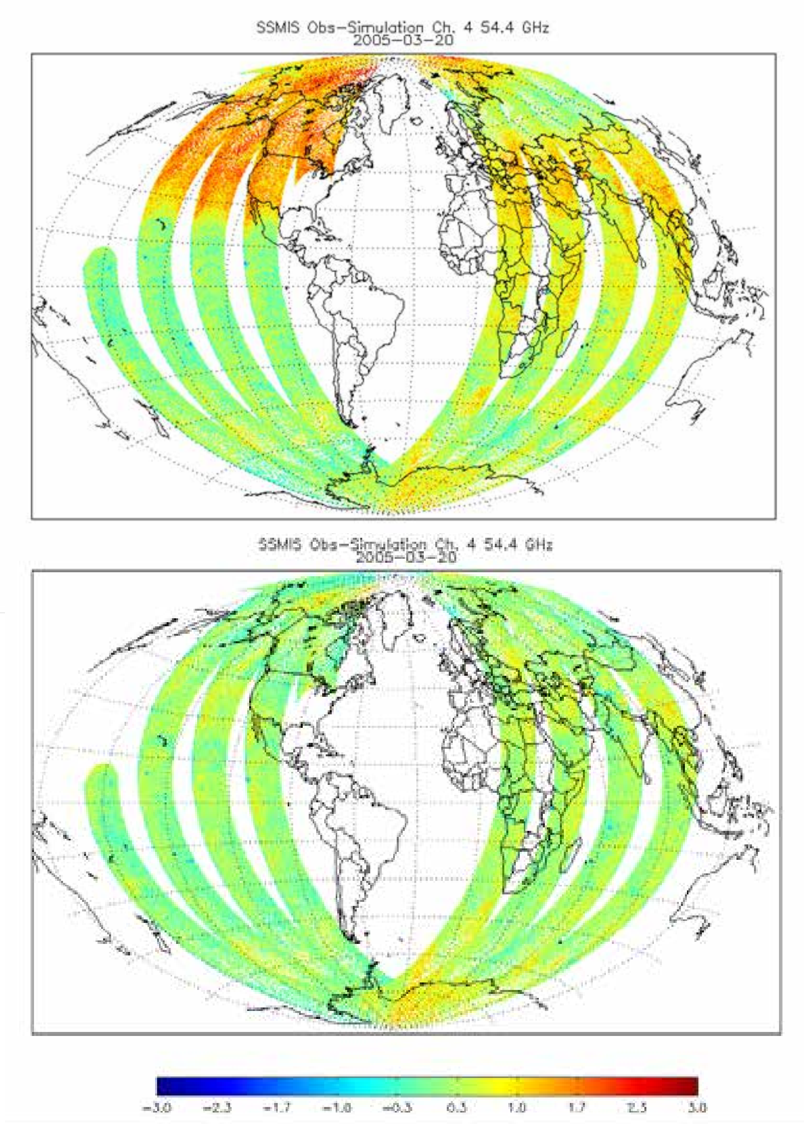
STAR is leading the Nation's efforts in the calibration and validation of satellite data. As new satellites are built, the quality of their measurements before launch, after launch, and during their lifetime will be ensured. Meticulous calibration and validation will also prolong the usable life of our current satellites, will maximize NOAA's return on investment, and ensures that satellite measurements will be aligned with those of preceding and succeeding generations.

What is science maintenance and why is it needed?

In a manner similar to maintenance of an automobile which requires recurring tune-ups, tire rotations, and oil changes, satellite processing systems require frequent tune-ups, usually weekly, through updates to processing systems.

Keeping satellite processing systems running requires retaining knowledgeable staff, producing software to monitor products, quickly diagnosing and fixing possible product performance issues, and generating accurate and up-to-date software documentation.

Continuous improvement of STAR's calibration, validation, and science maintenance processes ensures that only the highest quality satellite data are generated. For example, the Advanced Clear-Sky Processor for Oceans (ACSPO) Sea Surface Temperature (SST) was developed at NESDIS jointly by STAR and Office of Satellite and Product Operations (OSPO), and generates higher spatial resolution and clear-sky radiance, SST, and Aerosol Optical Depth products (see graphic on the next page).



Top: Before NOAA calibration; Bottom: After NOAA calibration. The anomalies were identified as coming from three processes: antenna emission after satellite comes out of the earth eclipse which contaminates the measurements in ascending (large effect) and descending nodes (small effect); solar heating of the warm calibration target; and solar reflection from canister tip, both of which most affect parts of the descending orbits. Correcting unintended instrument contamination is part of the cal/val process to provide accurate data for use in computerized weather forecast models. (Image credit: STAR)

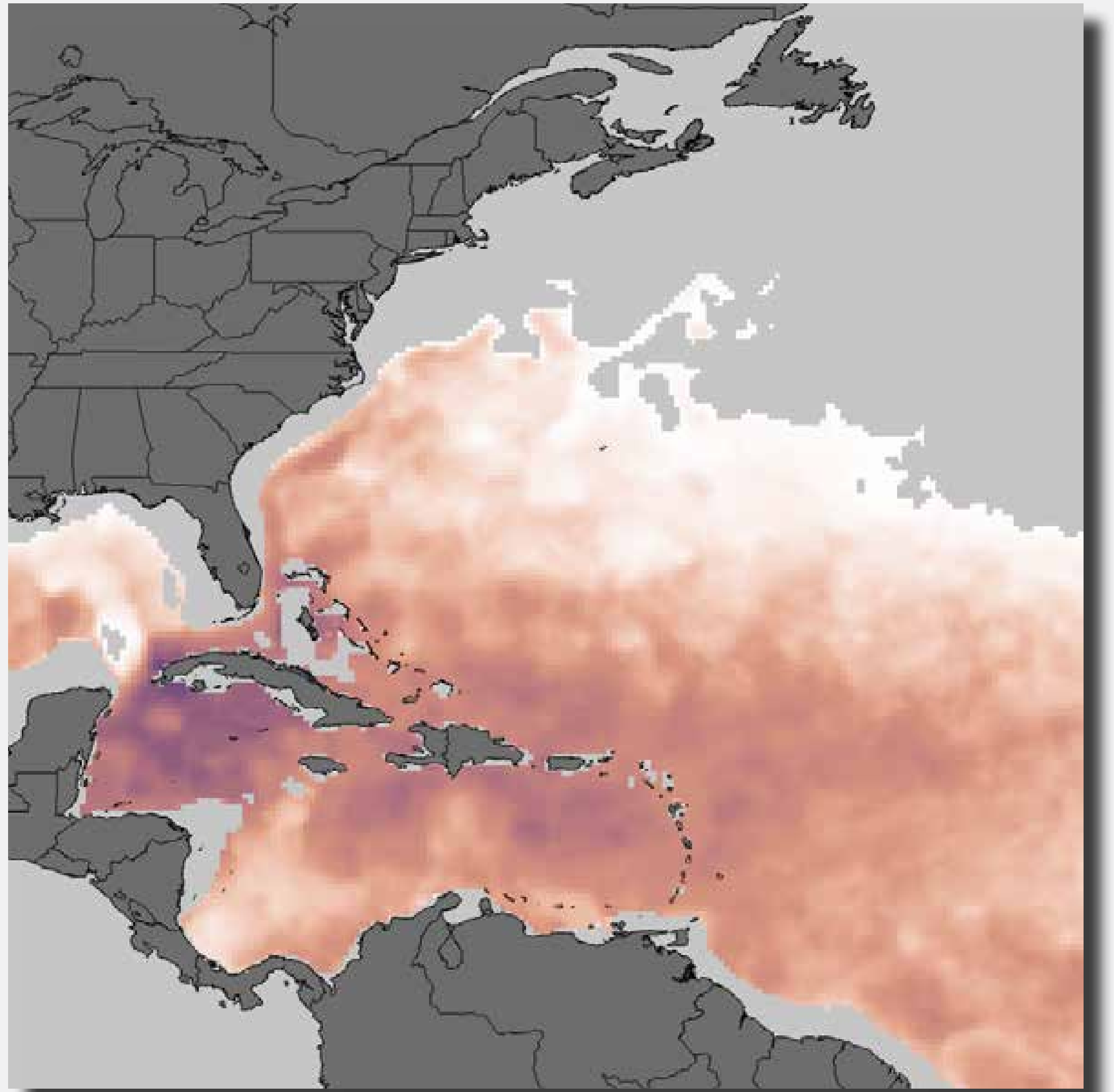
Sea Surface Temperature (SST) product (opposite page):

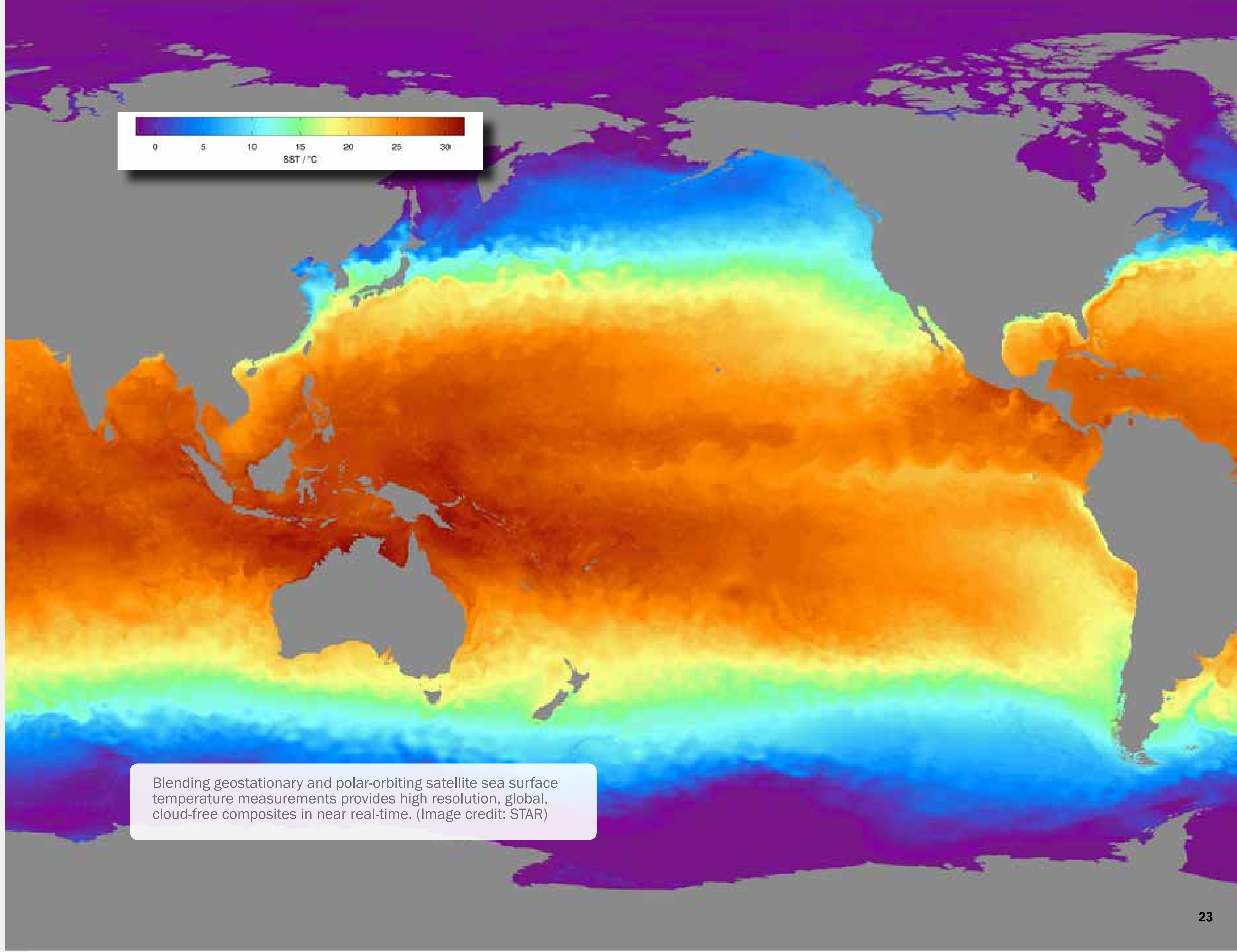
Blending data from several satellite sensors maximizes their strengths while minimizing their limitations. Polar orbiting satellites have high spatial resolution; geostationary satellites have high temporal resolution; satellites with microwave sensors can see through the clouds covering much of the world's oceans. Through careful blending of these data sources, an optimal set of SST with global coverage is produced daily. SSTs are a vital input to weather and hurricane forecast models. Oceans store tremendous amounts of heat that can fuel hurricanes and other storms and satellites measurements, including SST, can be used to assess ocean heat content.

Ocean Heat Content Product (right):

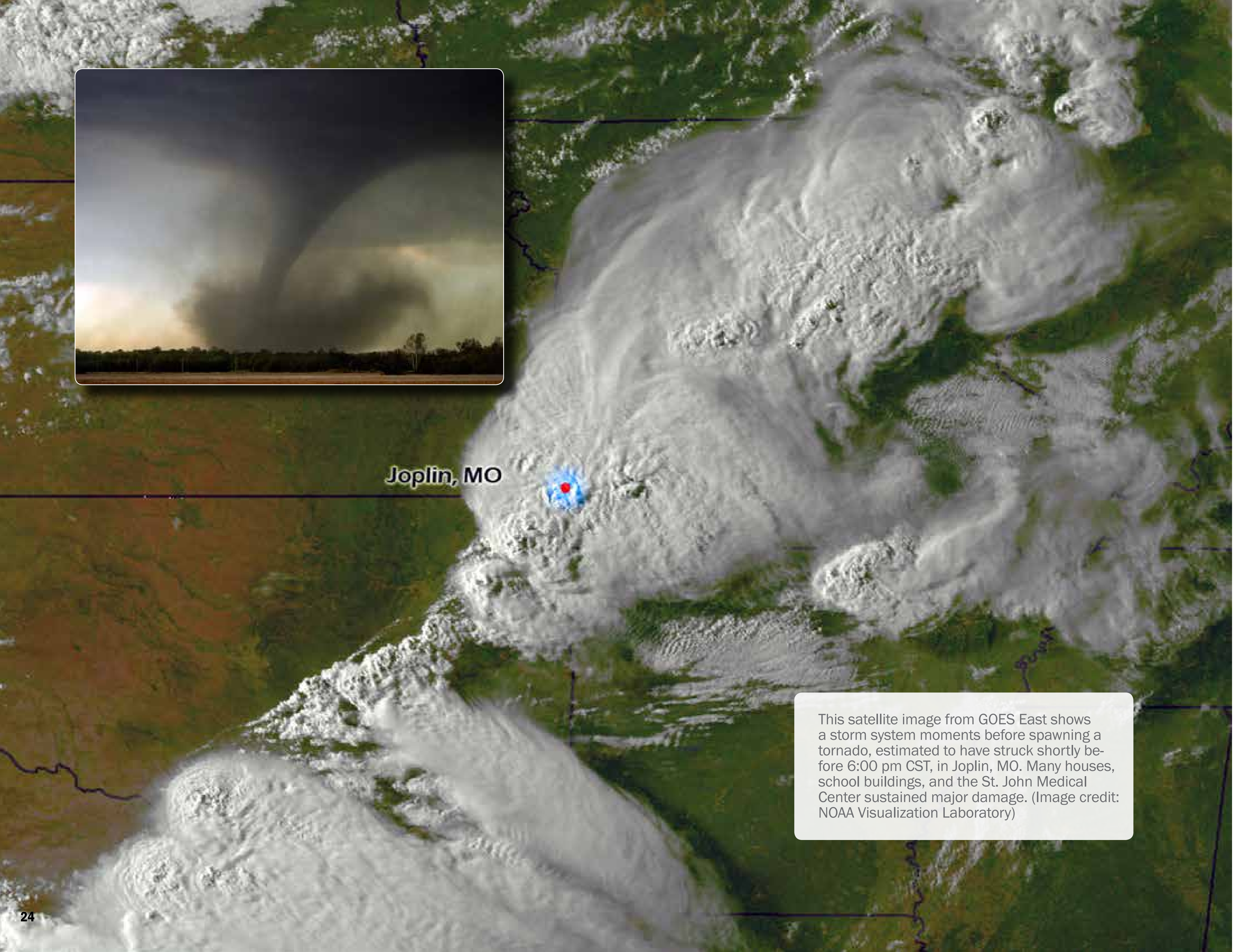
With the addition of satellite altimetry data to understand sea surface heights, it is possible to get an integrated view of the total amount of heat in the ocean. This image shows the depth of waters with temperatures greater than or equal to 26°C. Purplish colors indicate very deep pools of warm water able to fuel hurricanes. In 2005, especially, it was these deep reserves of warm water that allowed for the development of Hurricanes Katrina, Rita, and Wilma in quick succession. (Image credit: NOAA Visualization Laboratory)

SPOTLIGHT





Blending geostationary and polar-orbiting satellite sea surface temperature measurements provides high resolution, global, cloud-free composites in near real-time. (Image credit: STAR)



This satellite image from GOES East shows a storm system moments before spawning a tornado, estimated to have struck shortly before 6:00 pm CST, in Joplin, MO. Many houses, school buildings, and the St. John Medical Center sustained major damage. (Image credit: NOAA Visualization Laboratory)

Goal 3: Advance Algorithm Refinement and Technology Infusion

Why Infuse Proven Systems with new Technology?

Satellite data and other advances have enabled our Nation's weather forecasts to improve dramatically over the last 30 years.

- Today's five-day weather forecasts are as accurate as four-day forecasts were just 10 years ago.
- Hurricane track forecasts have improved 67% since 1985.
- A four-day forecast today is better than a two day forecast was in 1985.
- Advances in the forecast lead time of tornado warnings are expected to increase by over 50 percent

Improved forecast accuracy and timeliness has prevented unnecessary mass evacuations across coastal areas because of the high confidence in storm tracks. This has prevented the loss of millions of dollars in unnecessary evacuations and helped avoid severe impacts to life, property, and local business economies.

Thanks to accurate forecasts with several days lead-time, the Carolinas and Mid-Atlantic States were forewarned and well prepared for the "Snowmaggedon" storm of February 2011 which impacted transportation, the work force, and the economy in many cities. This level of confidence in forecast accuracy did not exist 10 years ago.

Today, energy and public utility officials are using forecasts 5 and 7 days in advance to make decisions about natural gas distribution and the operation of power plants. These decisions were not being made as effectively a decade ago.

It is vital to improve the techniques and technology incrementally over time with the new and emerging environmental data collected by satellites to maintain and improve the accuracy of our forecasts. This will help businesses and communities reduce costs, increase productivity, grow sustainably, and directly share in the benefits of advanced satellite sensors and products.

What is the impact of new technology on weather forecasts? Observing System Simulation Experiments help improve our ability to optimize observation collection and improve NOAA's forecasts. This simulation capability will demonstrate improvement in weather forecast performance using the latest instrument designs while minimizing the constellation of satellites needed to collect the observations.

Why "simulate" satellite data?

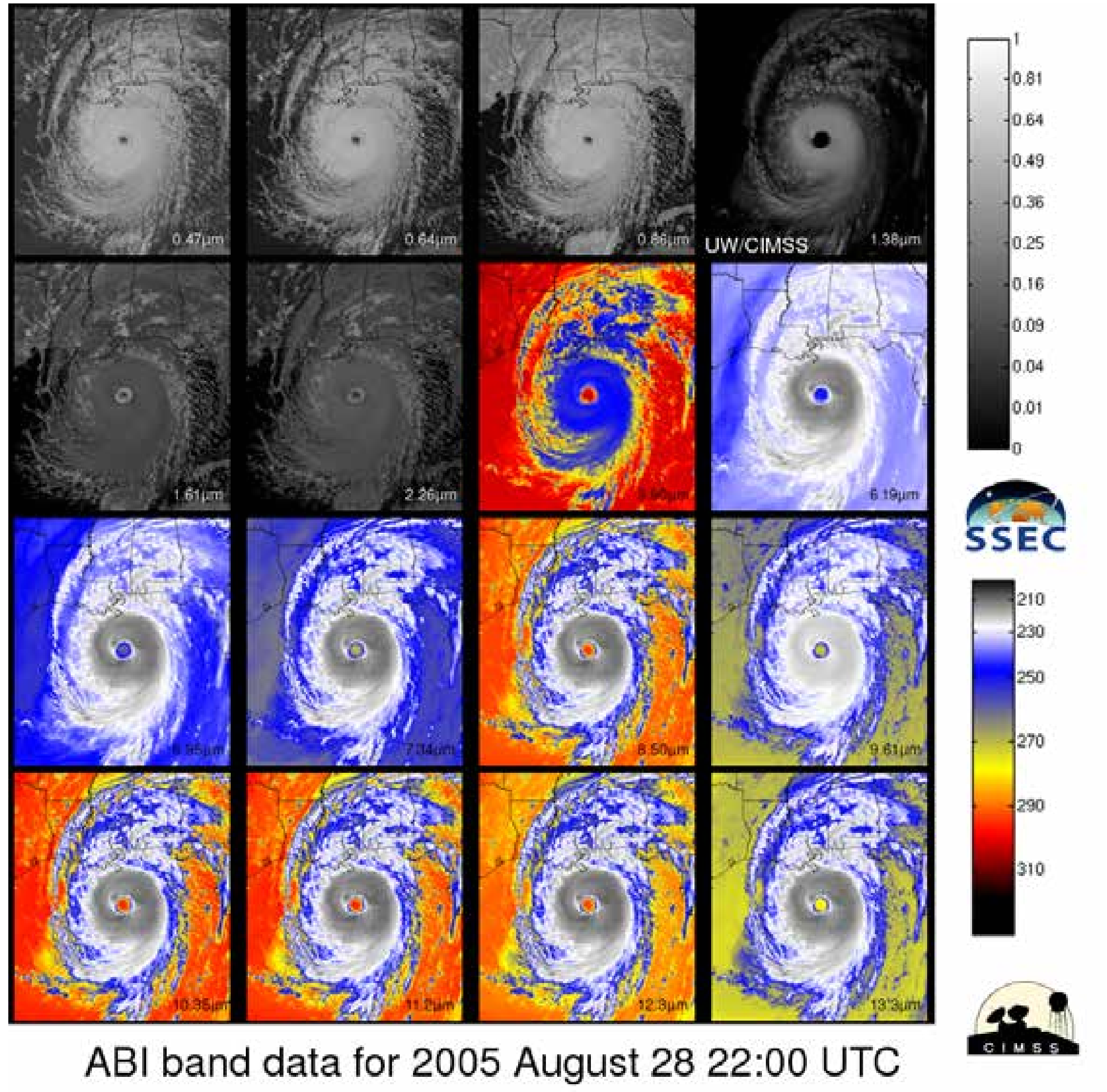
Experimental satellite data are created in simulations because data is not available from future sensors or satellites.

Researchers have developed advanced software systems to generate synthetic data to mimic what will be available from future satellites and sensors. Data from current operational and research satellites can be modified to provide proxy data similar to data expected from planned satellite systems.

Proxy and synthetic data enables testing and refinement of a future or proposed system designed to process data from a new instrument many years before it is launched. This leads to better data quality generated from the system, an optimized satellite constellation, a more reliable and robust satellite processing system, and saves tax dollars.

Increased use of satellite data in weather forecasting systems has greatly assisted in improving:

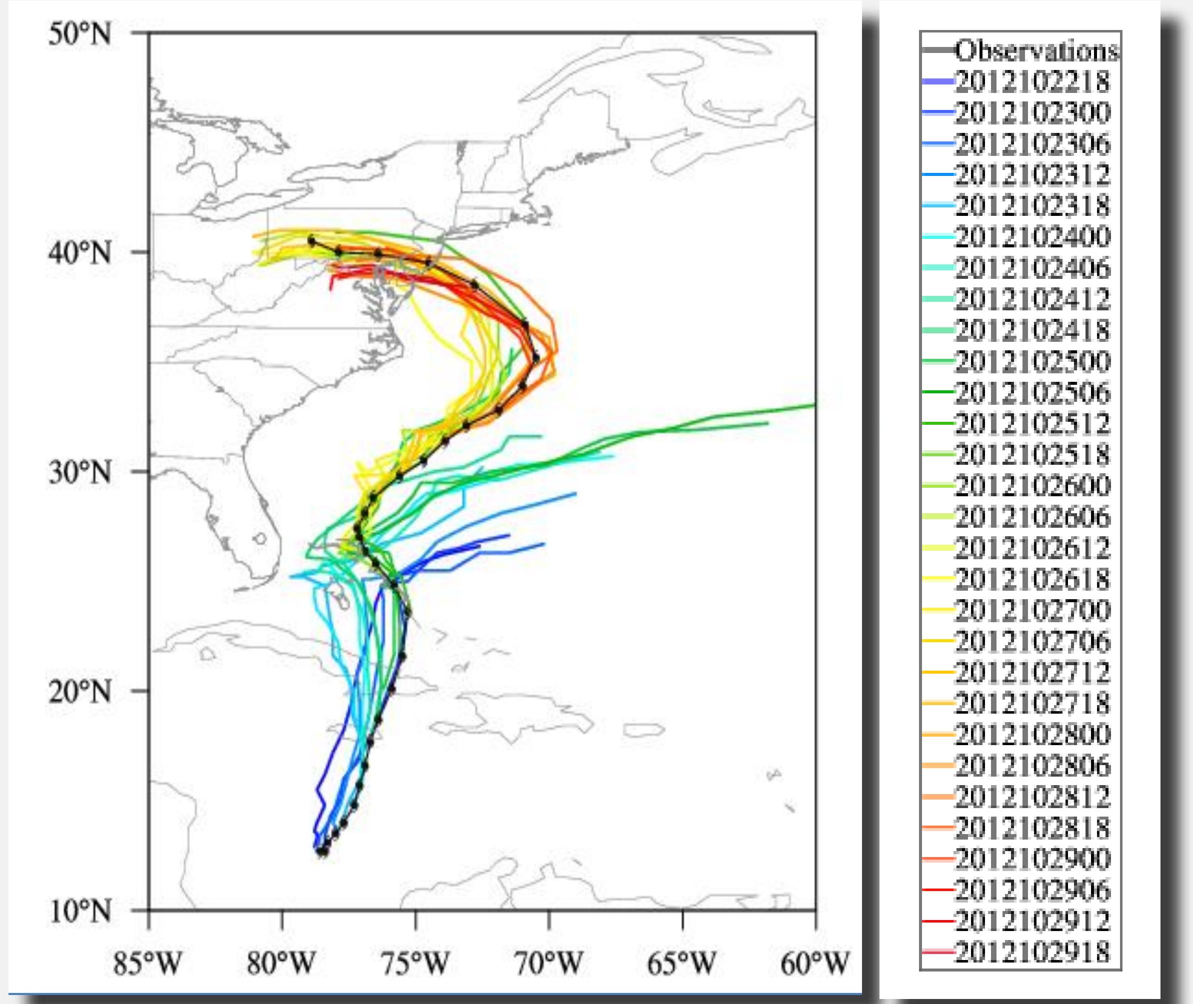
- Forecast lead times and accuracy
- National weather-readiness
- Sustainability of coastal communities
- Public safety



Simulated images of the 16 GOES-R ABI bands for Hurricane Katrina. These images were simulated via a combination of high spatial resolution numerical model runs and advanced 'forward' radiative transfer models. (Image credit: STAR)

SPOTLIGHT

Control Run + ATMS



Impacts of Direct Assimilation of Suomi NPP ATMS Radiances on Hurricane Sandy's Track:

Predicted vs. observed track for Hurricane Sandy during October 22 - 29, 2012. NCEP 2012 hurricane forecast is revised with a high model top and 6-hour forecasts used as background for direct satellite radiance assimilation. Control Run: All conventional ground-based measurements and NOAA operational satellite data. It is clearly demonstrated that assimilation of Suomi NPP microwave radiance data (ATMS) radiance data reduce the forecast errors of Hurricane Sandy's track as seen in the more closely bunched yellow-red tracks versus the early forecast tracks in blue-green. (Image credit: STAR)

The explosive eruption on the April 14, 2010, of the Eyjafjallajökull volcano in Iceland, and the ash cloud it produced caused an unprecedented closure of UK, European and North Atlantic air space to thousands of flights, and billions of dollars of impacts. NOAA/NESDIS/STAR scientists, in collaboration with the Cooperative Institute for Meteorological Studies (CIMSS), are working to develop and transition into operations satellite products aimed at automatically detecting volcanic ash clouds and determining their height and micro-physical properties. (Image credit: Shutterstock.com)

Goal 4: Transition Research Products into Operational Use

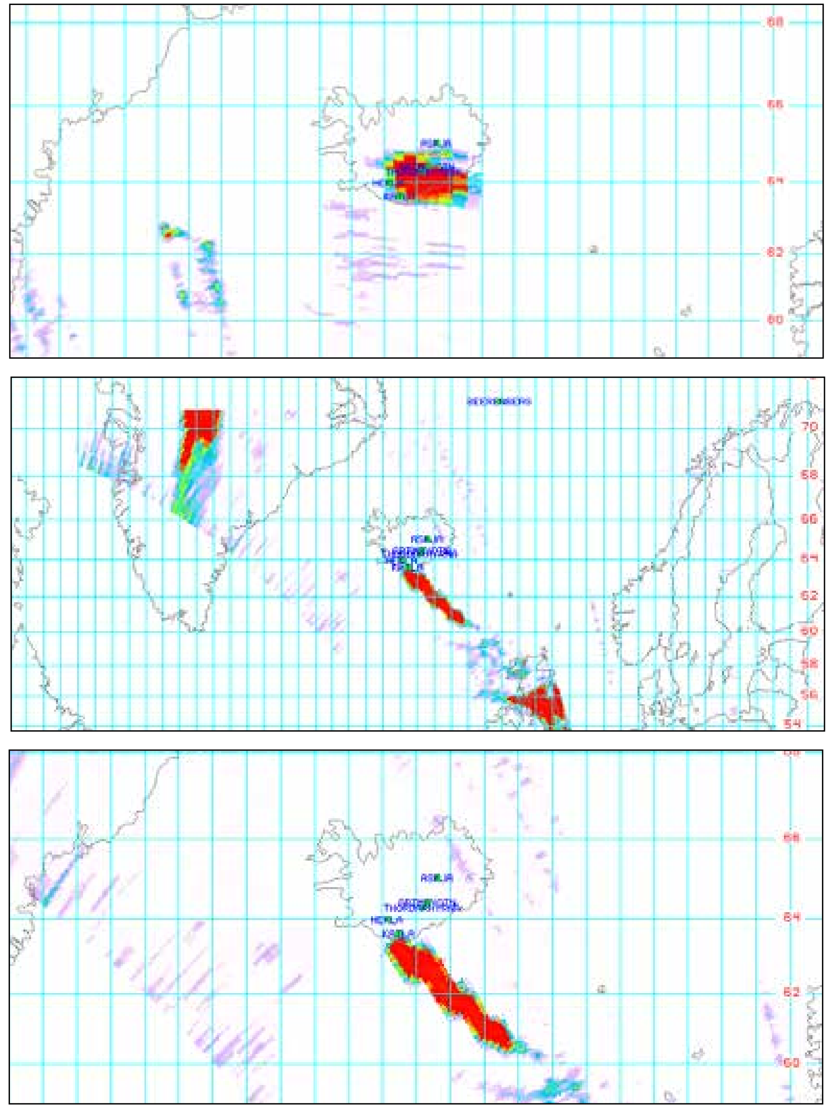
What is the research to operations transition?

When transitioning software from a research setting to an environment where the software must run routinely and dependably multiple times a day, or even more frequently, the software must adhere to the highest quality standards. The research to operations transition includes modifying the research software to adhere to operational standards, system configurations, and rigorous testing of the operational system.

Why is the process of transitioning research software to daily operational use important?

The research to operations transition ensures mature research capabilities will work reliably and produce the highest quality products. STAR developed and implemented a new process to ensure the smooth transition of research applications into daily operational production called the Enterprise Lifecycle (EPL).

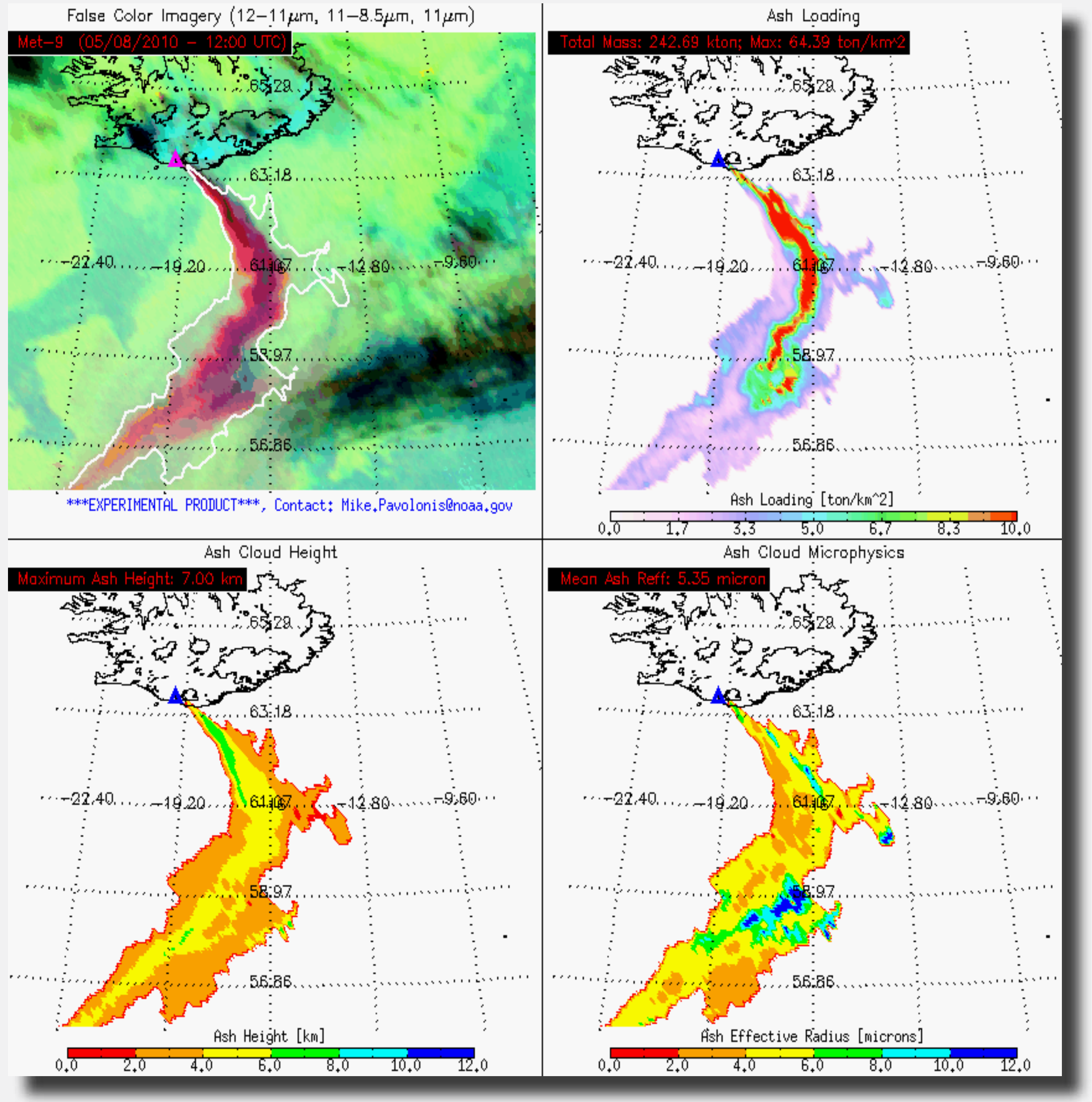
Benefits of standardizing the research to operations transition include lower development and maintenance costs, more robust software, and a faster deployment to an operational setting.

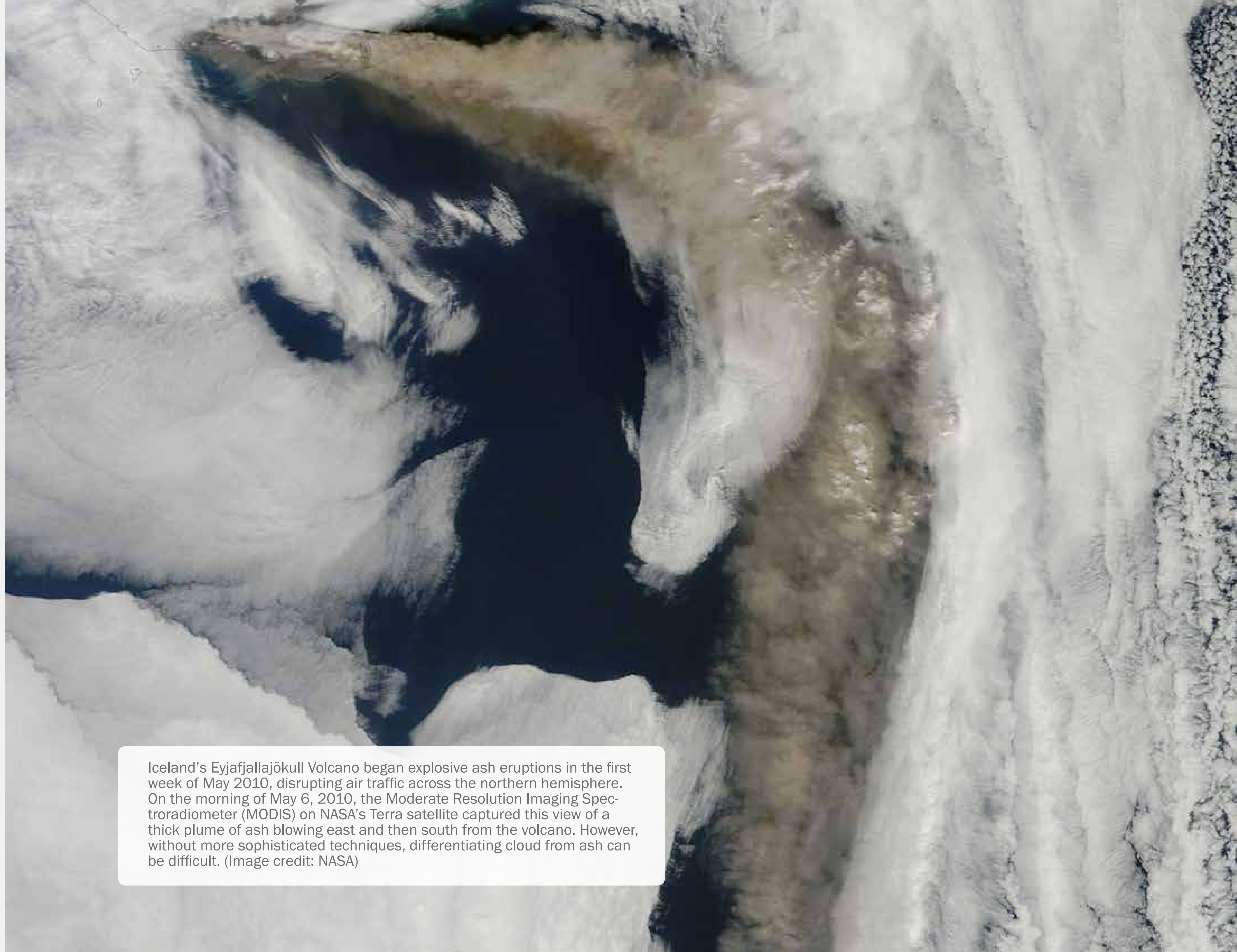


Sulfur dioxide (SO_2) is one of many gases released by volcanoes before and during eruptions. Satellite-based detection of SO_2 can help provide warnings of imminent eruption as well as the extent of hazardous ash plumes. These three images were taken from May 16, 2010 and May 17, 2010 from the OMI instrument on NASA's Aura satellite. (Image credit: STAR)

Volcanic ash product:
Thanks to STAR's research into volcanic ash remote sensing to meet a GOES-R satellite requirement, STAR had a prototype volcanic ash detection and cloud property retrieval algorithm ready to be used to generate volcanic ash products in near-real-time during the 2010 eruption of Eyjafjallajökull. These products were made available to the United Kingdom's Volcanic Ash Advisory Center in April 2010 at the request of the UK Meteorological Office and were subsequently used in the hazard assessment process. This product depicted the areal extent of the ash cloud using satellite imagery (upper left), the thickness and concentration of the ash cloud (upper right), the height of the ash cloud (lower left), and size or effective radius of the particles in the ash cloud (lower right). (Image credit: STAR)

SPOTLIGHT





Iceland's Eyjafjallajökull Volcano began explosive ash eruptions in the first week of May 2010, disrupting air traffic across the northern hemisphere. On the morning of May 6, 2010, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite captured this view of a thick plume of ash blowing east and then south from the volcano. However, without more sophisticated techniques, differentiating cloud from ash can be difficult. (Image credit: NASA)

Image of the Earth from the Suomi NPP Visible Imager Radiometer Suite (VIIRS). This image shows snow cover over the Rocky Mountains and Western USA, and a frontal weather system over the Northwest USA extending southwest over the Eastern Pacific Ocean. (Image credit: NOAA/NASA)

Goal 5: Build and Sustain Partnerships

Why focus on building and sustaining partnerships?

The goal of strategic partnerships and outreach is to increase collaboration, foster innovation, train users, and increase understanding of new products and other capabilities as providers of world class scientific research services. Partnerships allow STAR to modify and expand on the collaborations with other satellite organizations, universities, businesses for the benefit of the Nation. Collaboration helps foster innovation and brings new capabilities to the forefront more quickly. Outreach and education are a core value and helps the public, business community, and economic sectors recognize the value of new NOAA capabilities, while educating potential users about the new techniques.

Academic relationships are important to NOAA for scientific innovation, educating the next generation of scientists and developing the skills of NOAA's future workforce.

NOAA's university-based partners, Cooperative Institutes, are aligned with NOAA research offices to support a broad program of scientific research. Interaction with faculty and graduate research in areas relevant to NOAA help sustain a robust and innovative exchange of ideas providing the foundation for the next series of product improvements. STAR aims to create a more engaged community of Cooperative Institutes and other universities focused on developing innovative satellite information products using common collaborative data systems, common standards and processes, and integrated computing infrastructure.

MetOp-B was launched on September 17, 2012, from Baikonur in Kazakhstan. The Soyuz rocket lifted off at 18:28 CEST, carrying a suite of sophisticated instruments. MetOp-B will ensure the continuity of the weather and atmospheric monitoring service.(Image Credit: EUMETSAT)

STAR and its Partnerships:
In order to provide forecasters and decision-makers with better low cloud products, STAR is working with national and international partners leveraging the Visible Infrared Imaging Radiometer Suite (VIIRS), a 22-channel visible/infrared sensor that combines many of the best aspects of the NOAA Advanced Very High Resolution Radiometer (AVHRR), the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS), and the National Aeronautics and Space Administration (NASA) MODerate-resolution Imaging Spectroradiometer (MODIS) sensors. VIIRS has nearly all the capabilities of MODIS, but offers a wider swath width (3000 km vs. 2330 km) and much higher spatial resolution at swath edge. In addition to use of VIIRS, STAR is taking advantage of a collaboration with EUMETSAT and their work to inter-calibrate the visible bands in order to better identify clouds using the Spinning Enhanced Visible and Infrared Imager (SEVIRI) aboard Meteosat-8, - 9 and -10 satellites with MODIS-Aqua.

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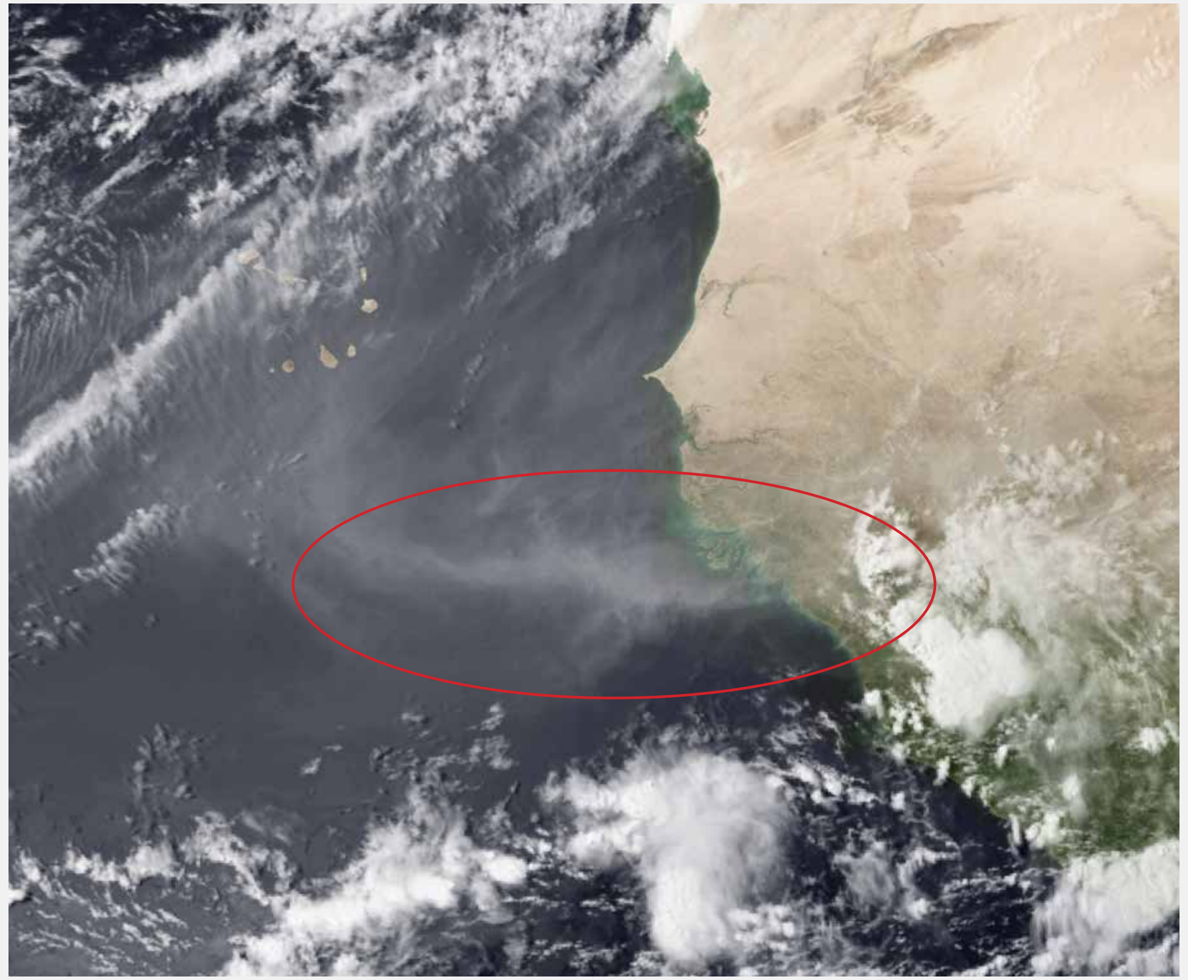


In this image from the Meteosat-9 geostationary satellite, which provides coverage over Western Europe, Africa, and the Eastern Atlantic, dust plumes blow off of the African coast. (Image credit: NOAA Visualization Laboratory)

Strategy, Execution and Evaluation

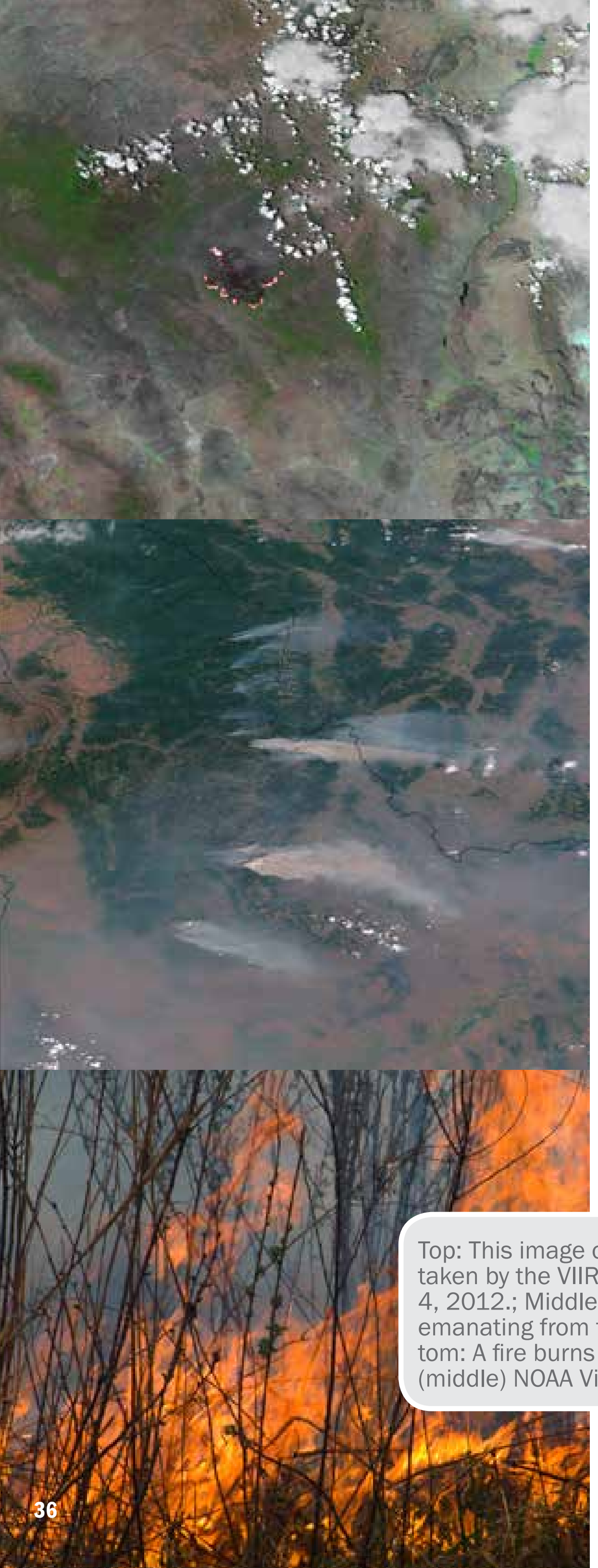
This Strategic Plan sets a vision for the future for STAR, and identifies 5 goals and why the associated outputs related to the goal's outputs are important. STAR's goals are aligned with the Department of Commerce (DOC) and the NOAA strategic goals over the next five years.

STAR will systematically monitor and evaluate its performance toward the outcome-oriented goals and objectives in this plan. Evaluating performance will allow STAR to improve continually as an organization, and help NOAA deliver new and enhanced capabilities promoting science, service, and stewardship.

To ensure these five major goals provide the maximum impact for NOAA and our users, STAR has aligned each of these goals with a specific performance measure:

- Promote new sensor and applications research
  - Number of peer-reviewed papers published
- Ensure the highest quality satellite data
  - Number of calibration / validation corrections or analyses applied to satellite data sets to improve their utility
- Advance algorithm refinement and technology infusion
  - Number of data products developed / product reviews completed for NOAA satellite missions
- Transition research products into operational use
  - Number of research products prepared for transition to operational use
- Build and sustain partnerships
  - Number of live / recorded training sessions delivered / updated

STAR has a long-standing commitment to evaluate and report performance in objective and meaningful terms. The measures of success expressed in this Strategic Plan also signal STAR's intent to expand upon traditional performance evaluation.



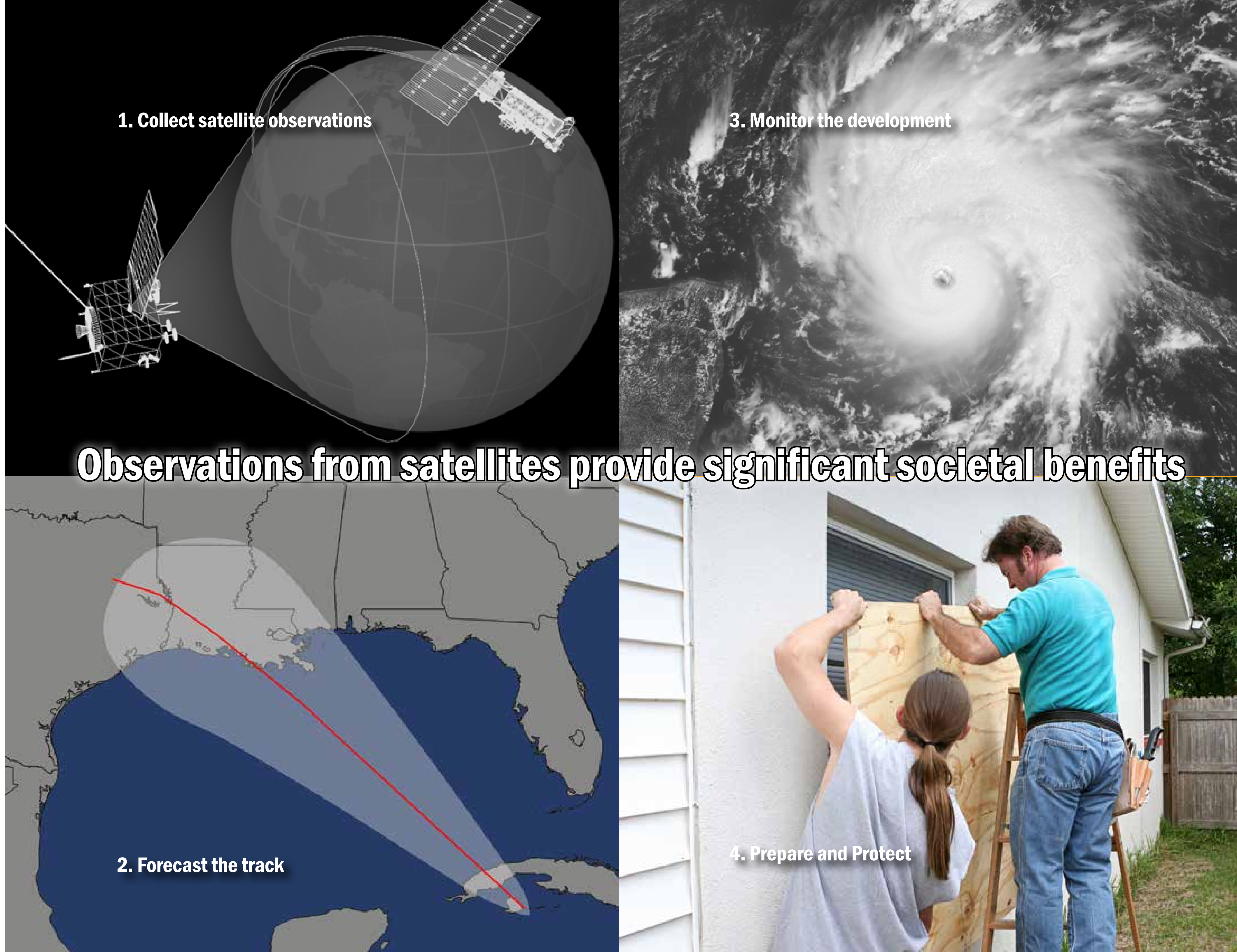
Meeting the Challenges

In the coming decade, our Nation faces many challenges, including likely water shortages in the Western and Southwestern States, the possibility of extensive severe tornado outbreaks, possible widespread river flooding events, and many more environmental challenges and concerns. STAR scientists are working hard to ensure our communities and economy can tackle these environmental challenges sustainably in the long-term.

Helping our communities, society, and economy develop and grow in a sustainable manner while remaining resilient to environmental change remains one of the Nation's greatest challenges over the next decade.

STAR is already playing its part and continues to maximize the return on the national investment in satellite-based remotely sensed environmental information. STAR will continue to ensure environmental monitoring remains indispensable to policy makers, businesses, academia, and government organizations for the benefit of society and the economy.

Top: This image of the Whitewater-Baldy Complex Fire in New Mexico was taken by the VIIRS instrument aboard the Suomi NPP spacecraft on June 4, 2012.; Middle: A Suomi NPP satellite pass captured the smoke plumes emanating from fires across the Western U.S. on August 14th, 2012; Bottom: A fire burns grass and brush. (Image credit: (top) University of Maryland; (middle) NOAA Visualization Laboratory; (bottom) Shutterstock.com)



NOAA is where science earns value