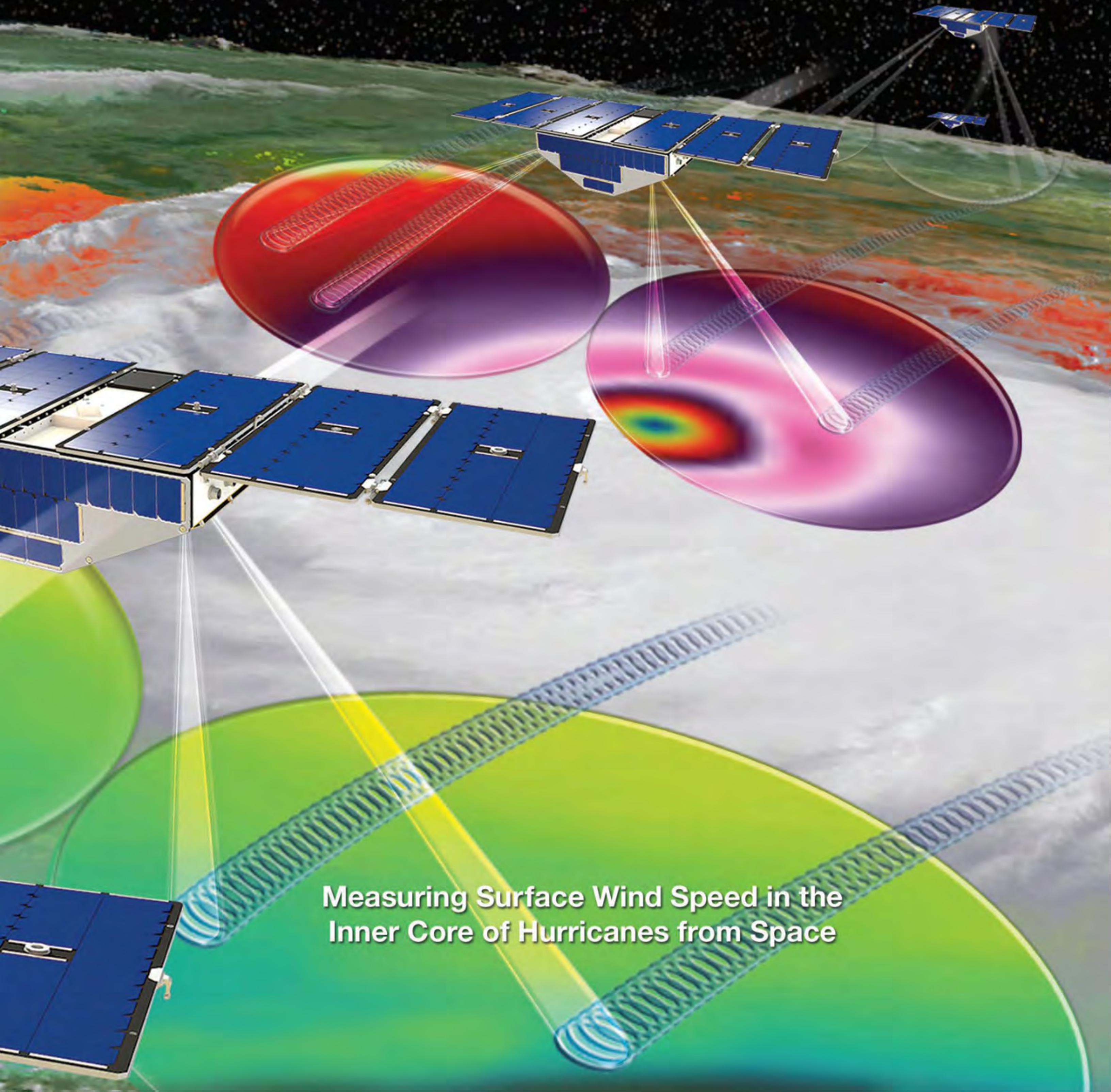
National Aeronautics and Space Administration

CYGNSS

Cyclone Global Navigation Satellite System



Acknowledgements

CYGNSS
cygnss-michigan.org
science.nasa.gov/missions/cygnss

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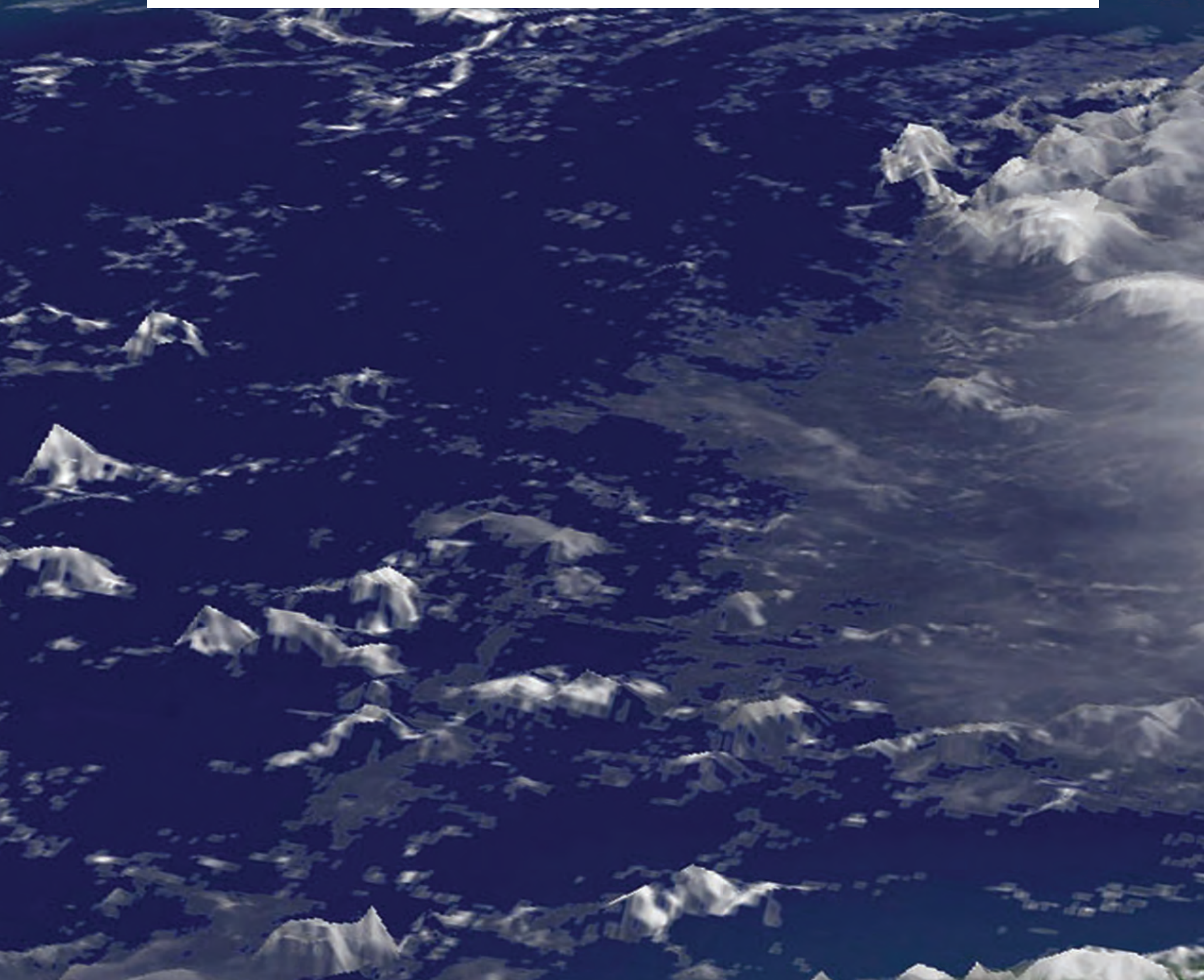

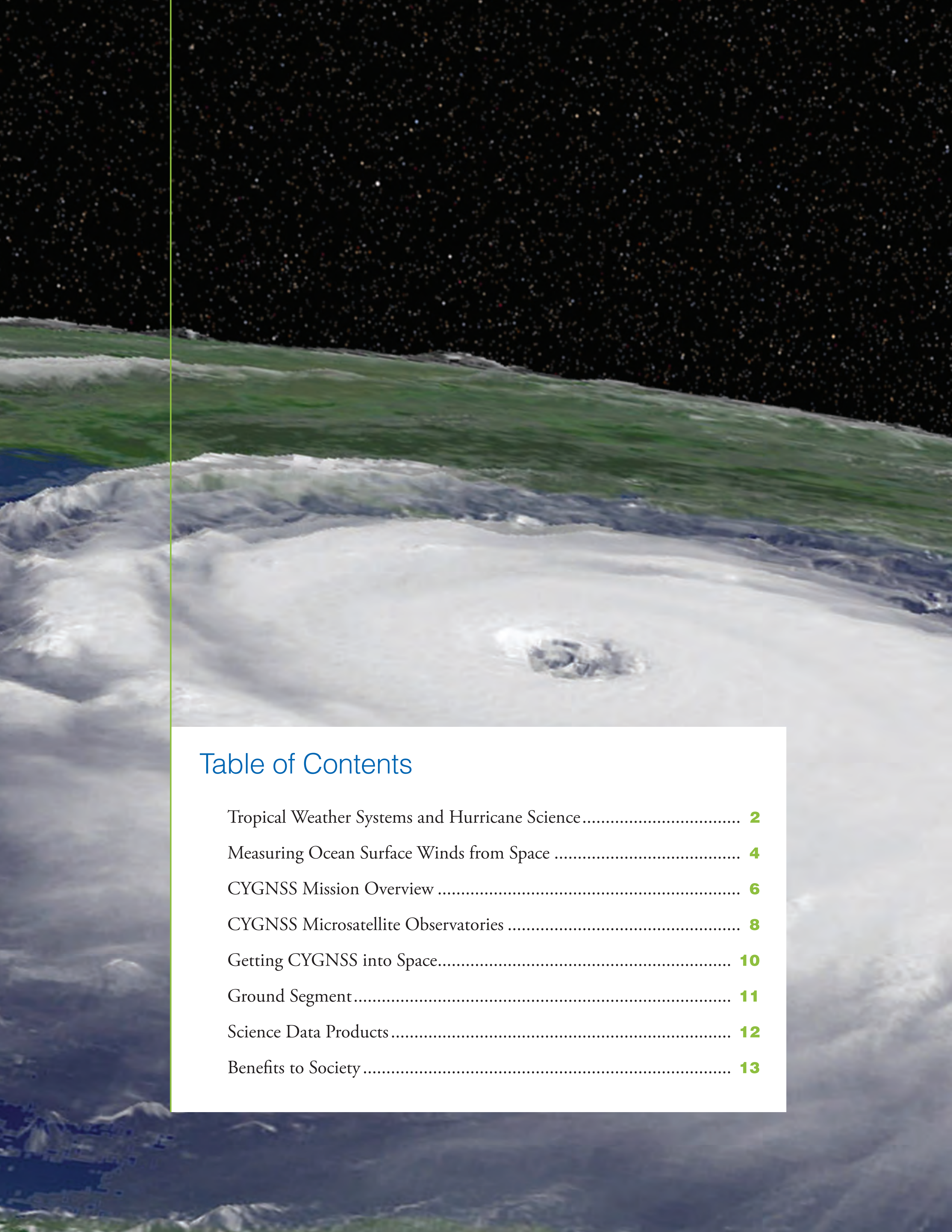

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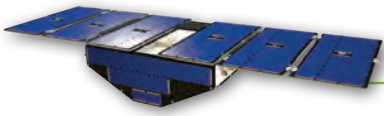


Photo credit: Patrick McKay

Photo credit: United Nations/Marco Dormino

Photo credit: U.S. Air Force/Tech. Sgt. Paul Flipse

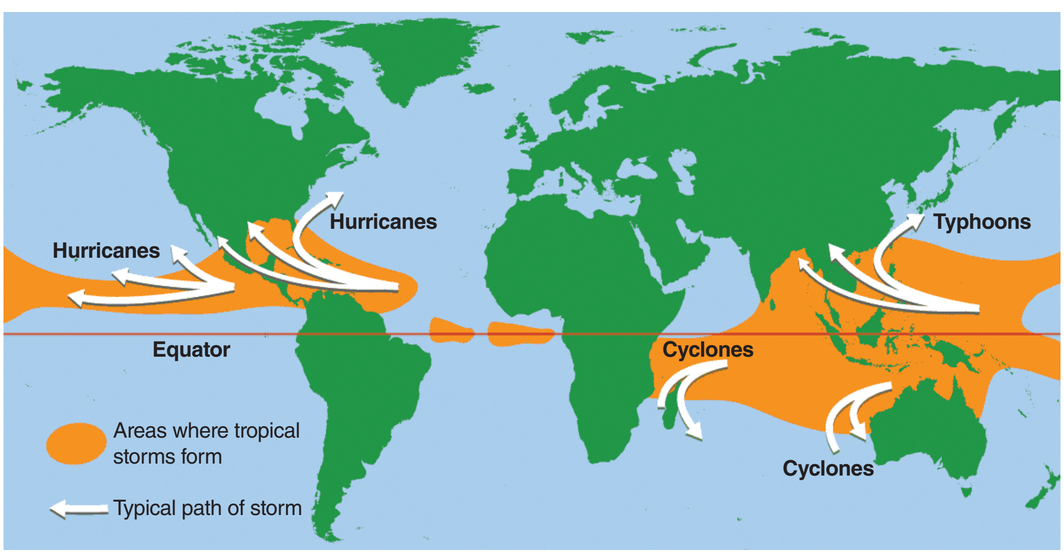
Several hazards are associated with tropical cyclones including very heavy rainfall, damaging winds, inland flooding, storm surge, and even tornadoes.

Tropical cyclones are rapidly rotating low-pressure systems that originate over the tropical oceans and include tropical depressions, tropical storms, hurricanes, and typhoons. Tropical cyclones with maximum sustained surface winds less than 39 miles per hour (mph), or ~63 kilometers per hour (kph), are called *tropical depressions*. Tropical cyclones with maximum sustained winds between 39 and 73 mph (~63 to 118 kph) are called *tropical storms*. Once a tropical cyclone's maximum wind speeds reach 74 mph (119 kph), it is called a *hurricane*. In the Western Pacific, a hurricane is called a *typhoon*, while in the Southern Hemisphere these storms are simply referred to as *cyclones*.

The peak "season" for tropical cyclone activity varies across each of the major ocean basins, typically occurring during the time of year when each ocean basin's water temperatures are the warmest. These seasons are as follows: Atlantic Basin (June 1 through November 30), East Pacific Basin (May 15 through November 30), West Pacific Basin (all year), North Indian Basin (April through June and late September through early December), South Indian and Australian Basins (late October through May), and Southwest Pacific (late October through early May).

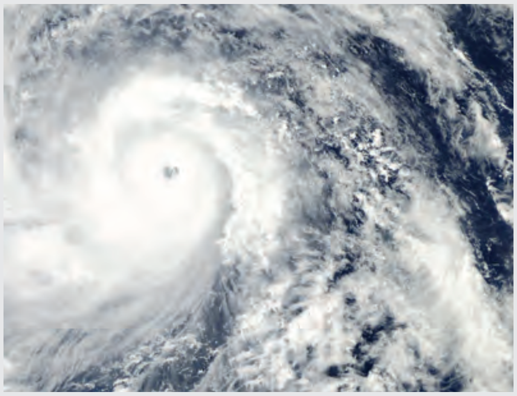
As their name implies, tropical cyclones typically form in the tropical and subtropical regions of the Earth (between 5° and 30° latitude, in both hemispheres). High sea surface temperatures (around 80 °F, or 26 °C) provide the warm and humid atmospheric conditions needed for thunderstorm development. In addition, this region of the Earth typically experiences weak changes in wind speed and direction with height, called *vertical wind shear*. This lack of wind shear, combined with Earth's Coriolis effect, allows thunderstorms to strengthen and begin rotating, respectively.

In the Northern Hemisphere, hurricane winds rotate counterclockwise around a center of low

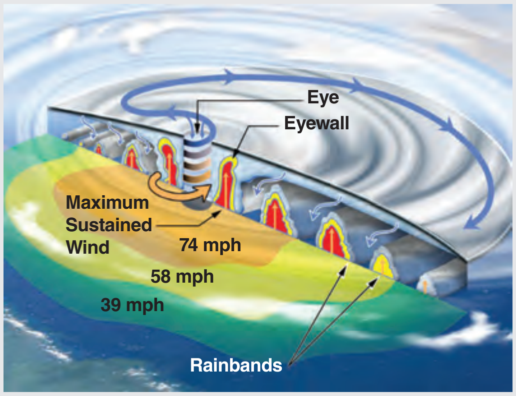


In the Atlantic, Caribbean, and Central Pacific, tropical cyclones are called hurricanes, while in the Western Pacific they are called typhoons. In the Southern Hemisphere they are simply called cyclones. Image credit: NASA atmospheric pressure, called the *eye*. (In the Southern Hemisphere, the rotation is clockwise.) The eye of the storm is characterized by subsiding (i.e., sinking) air, cloudless skies, and very light winds. Surrounding the eye is a ring of intense thunderstorms that produce heavy rainfall and strong winds, known as the *eyewall*. The eyewall region of the storm is where the tallest and strongest thunderstorms are found, as well as the strongest surface winds.

Tropical cyclone track forecasts have improved in accuracy by approximately 50% since 1990, largely as a result of improved weather forecast models and assimilation of satellite data. By contrast, during that same period, there has been very little improvement in the accuracy of intensity forecasts. The limited improvement in intensity forecasts is likely the result of inadequate observations of the storm's inner core, including the eyewall and intense inner rainbands of the storm.



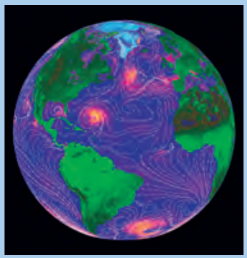
The Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on NASA's Aqua satellite acquired this natural color image of Super Typhoon Haiyan as it moved west toward the coast of the Philippines. Credit: NASA's Earth Observatory



This cross section shows the internal structure of a hurricane, composed of rain bands and strong cyclonic surface winds and upper air outflow. Image credit: Southwest Research Institute

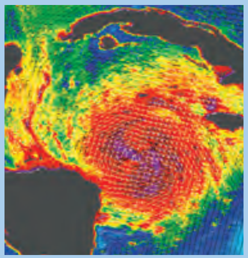
Importance of Atmospheric Winds

The winds associated with atmospheric motion over the surface of the Earth cover a wide range of horizontal spatial scales. *Planetary scale winds*, such as those associated with the tropical easterlies, range from ~3107 to 1243 miles (5000 to 2000 kilometers). *Synoptic scale winds*, such as those associated with mid-latitude weather systems, range from ~1243 to 124 miles (2000 to 200 kilometers). *Mesoscale winds*, such as those associated with thunderstorms and tropical cyclones, range from ~124 to 1.2 miles (200 to 2 kilometers). *Microscale winds*, such as those which drive the heat and moisture fluxes from the ocean that fuel tropical cyclones, occur on scales less than 1.2 miles (2 kilometers). The characterization of winds across each of these scales is critical to our ability to monitor and predict the evolution, movement, and intensification of tropical cyclones across the global tropics.



Planetary Scale Winds

Synoptic Scale Winds



Mesoscale Winds

Microscale Winds

Photo credit: U.S. Navy/Jim Brooks

Measuring Ocean Surface Winds from Space

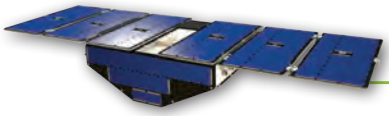


Photo credit: Michael Mol

Land-based weather monitoring station, Holland, Michigan

Land-based weather stations, such as those located at airports, provide an extensive description of hourly surface wind flow over much of the Earth's land surface. However, given that the ocean covers approximately 70% of the Earth's surface, satellite observations from space are needed to provide global coverage.

Around the time of World War II, several nations began to experiment with radar technology as part of their defense systems. Noise observed in the received signals during these early surface-based radar measurements over ocean surfaces was found to be the result of winds over the ocean. This finding resulted in the development of a number of radar remote sensing systems designed specifically to measure ocean surface winds. Since the 1970's, NASA has carried out a series of missions that have focused on monitoring winds over the ocean surface from space. The first attempt to measure winds from space occurred when NASA built a "technology demonstration" instrument that flew onboard NASA's Skylab—the United States' first space station—from 1973 to 1979. This successful demonstration showed that remotely sensed measurements of ocean surface winds were indeed possible using space-based scatterometers. NASA launched its second scatterometer, the SeaSat-A Scatterometry System (SASS), onboard the SeaSat-A satellite in 1978. While the mission was short-lived (June to October of that year), SASS was able to confirm that space-based scatterometry was an effective tool for making accurate ocean surface wind measurements.

It was not until nearly twenty years later, in August 1996, that NASA would launch its next scatterometry mission, called the NASA Scatterometer (NSCAT), onboard the Japan Aerospace Exploration Agency's Advanced Earth Observing Satellite (ADEOS-I).

Timeline of NASA Scatterometry Observations

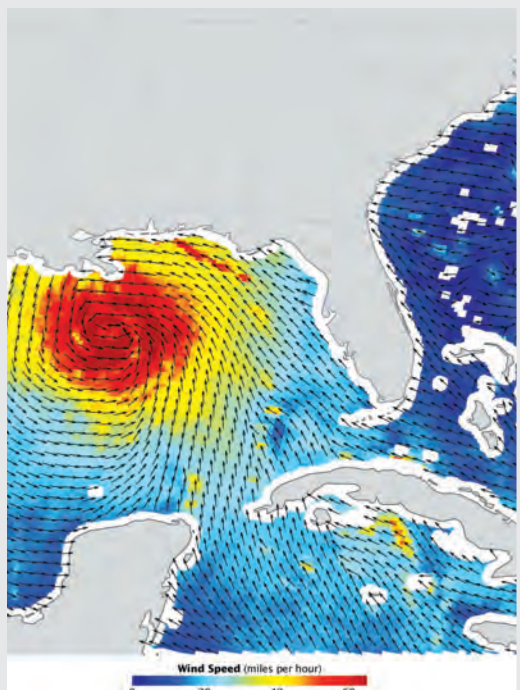
NSCAT operated continuously at a microwave frequency of 13.995 gigahertz, using backscatter data from the instrument's radar to generate 268,000 globally distributed wind vectors (both speed and direction) each day. Every two days, NSCAT measured wind speeds and directions over at least 90% of ice-free ocean surfaces at a resolution of 31 miles (50 kilometers). Like some of its predecessors, the mission was short-lived; the solar panels on the ADEOS-I satellite ceased to function properly, ending the mission less than a year following its launch in July 1997.

Following the end of the NSCAT mission, NASA's Jet Propulsion Laboratory built two identical SeaWinds scatterometry instruments. The first launched in 1999 on NASA's Quick Scatterometer (QuikSCAT) satellite. SeaWinds used a rotating dish antenna to send microwave pulses at a frequency of 13.4 gigahertz down to the Earth's surface. The characteristics of the returned signal were used to estimate surface wind speed and direction with an accuracy of ± 2 meters per second (4.5 miles per hour) and ± 20 degrees, respectively, at a resolution of approximately 15.5 miles (25 kilometers). The second SeaWinds instrument launched onboard the Japanese ADEOS-II satellite in 2002. However, ADEOS-II experienced a failure within a year of the launch. The SeaWinds instrument on QuikSCAT continued to operate until 2009.

With the loss of the functionality of both SeaWinds instruments (on QuikSCAT and ADEOS-II), NASA refurbished a spare QuikSCAT instrument to fly on the International Space Station (ISS), called the ISS Rapid Scatterometer (ISS-RapidScat), which was installed on the station in 2014. Like QuikSCAT, ISS-RapidScat measures both wind speed and direction over the ocean surface at a resolution of approximately 15.5 miles (25 kilometers).

While radar scatterometers have been used to provide high-resolution measurements of ocean-surface wind speed and direction, they cannot observe the inner core of a hurricane because it is obscured by intense precipitation in the eyewall and inner rainbands. In addition, the rapidly evolving stages of the tropical cyclone life cycle occur on relatively short timescales (i.e., hours, days), and are poorly sampled by conventional polar-orbiting, wide-swath satellite imagers that generally pass over a particular spot on Earth, at most, twice daily.

In 2016, the Cyclone Global Navigation Satellite System (CYGNSS) will become NASA's first satellite mission to measure surface winds in the inner core of tropical cyclones, including regions beneath the eyewall and intense inner rainbands that could not previously be measured from space. These measurements will help scientists obtain a better understanding of what causes variations in tropical cyclone intensity, helping to improve our ability to forecast tropical cyclones such as Hurricane Katrina.

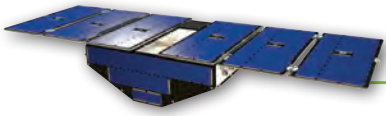


This map, derived using data acquired by NASA's QuikSCAT, shows Hurricane Katrina's wind speeds on August 28, 2005. Credit: NASA's Earth Observatory

Given that the ocean covers approximately 70% of the Earth's surface, satellite observations from space are needed to provide global coverage.

Photo credit: Robert Smith

CYGNSS Mission Overview



CYGNSS Constellation Characteristics

Orbit: non-synchronous

Altitude: ~317 mi (510 km)

Inclination: 35°

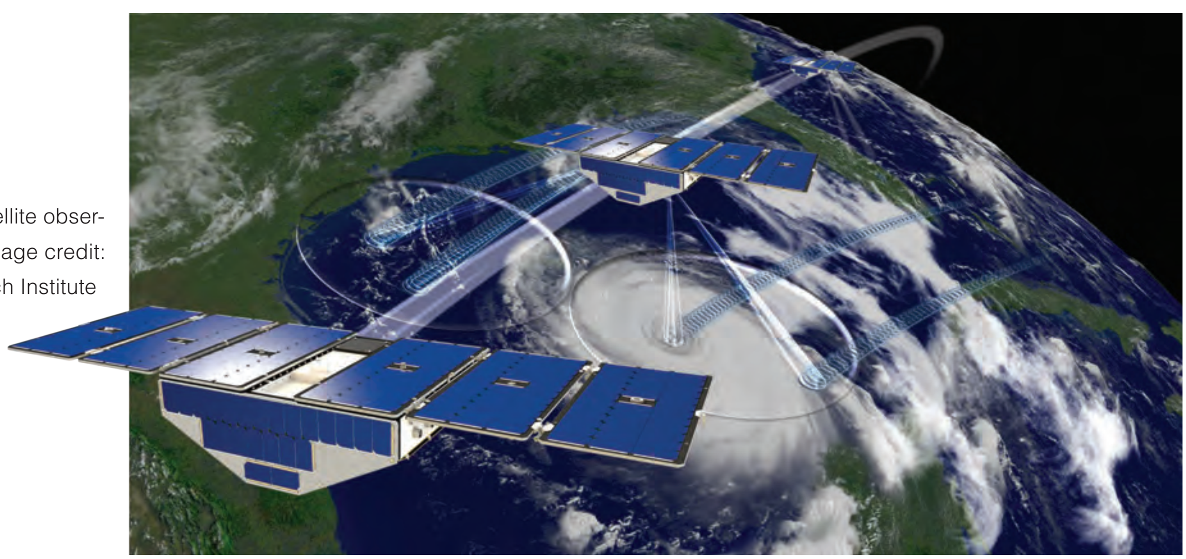
Period: 95 minutes

Revisit Times:
3 hours (median)
7 hours (mean)

CYGNSS is a NASA Earth System Science Pathfinder Mission that will collect the first frequent space-based measurements of surface wind speeds in the inner core of tropical cyclones. Made up of a constellation of eight microsatellites, the observatories will provide nearly gap-free Earth coverage using an orbital inclination of approximately 35° from the equator, with a mean (i.e., average) revisit time of seven hours and a median revisit time of three hours. This inclination will allow CYGNSS to measure ocean surface winds between 38° N and 38° S latitude. This range includes the critical latitude band for tropical cyclone formation and movement.

CYGNSS will measure the ocean surface wind field with unprecedented temporal resolution and spatial coverage, under all precipitating conditions, and over the full dynamic range of wind speeds experienced in a tropical cyclone. The mission will accomplish this through an innovative combination of all-weather performance global positioning system (GPS)-based scatterometry with the sampling properties of a dense constellation of eight observatories.

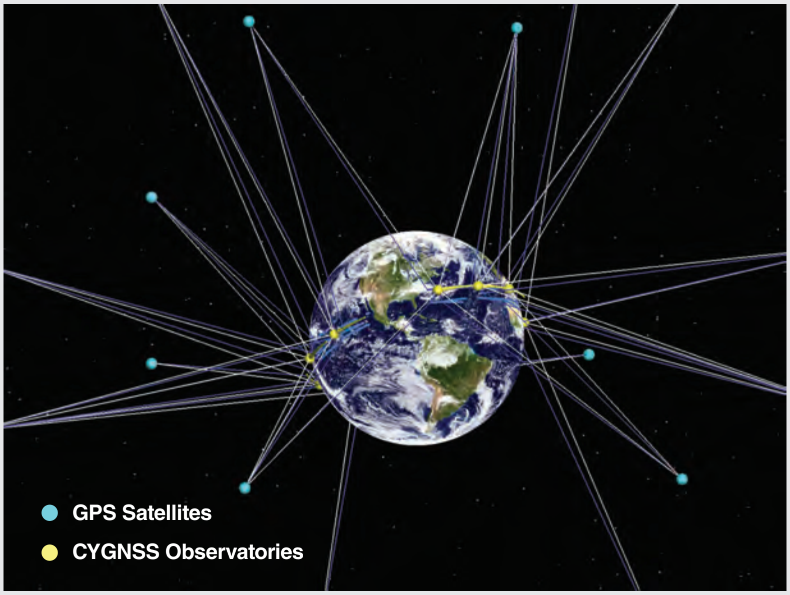
What makes CYGNSS unique is that it will be NASA's first mission to perform surface remote sensing using an existing Global Navigation Satellite System (GNSS)—a satellite constellation that is used to pinpoint the geographic location of a user's receiver anywhere in the world. A number of GNSS systems are currently in operation, including: the United States' Global Positioning System (GPS), the European Galileo,



CYGNSS microsatellite observatories in orbit. Image credit: Southwest Research Institute the Russian Federation's Global Orbiting Navigation Satellite System (GLONASS), and the Chinese BeiDou system. CYGNSS will use the United States' GPS constellation.

Unlike radar scatterometers (like ISS-RapidScat) that both *emit* microwave radar pulses and *receive* their backscattered signals, CYGNSS's eight microsatellites will only *receive* scattered GPS signals. Additionally, the microwave radar pulses used by existing radar scatterometers degrade when passing through the intense rainfall typically observed within hurricane eyewalls, thus limiting their utility in measuring the wind speeds in this critical region of the storm. The scattered GPS signals, on the other hand, operate at a much lower microwave frequency utilized by the GPS constellation that is able to penetrate thick clouds and precipitation around the eyewall and provide the first opportunity to remotely measure inner-core wind speeds.

The goal of the mission is to study the relationship between ocean surface properties (i.e., wind), moist atmospheric thermodynamics, radiation, and convective dynamics in the inner core of a tropical cyclone. This will allow scientists to determine how a tropical cyclone forms, whether or not it will strengthen, and if so by how much. The successful completion of these goals will allow the mission to contribute to the advancement of tropical cyclone forecasting and tracking methods.

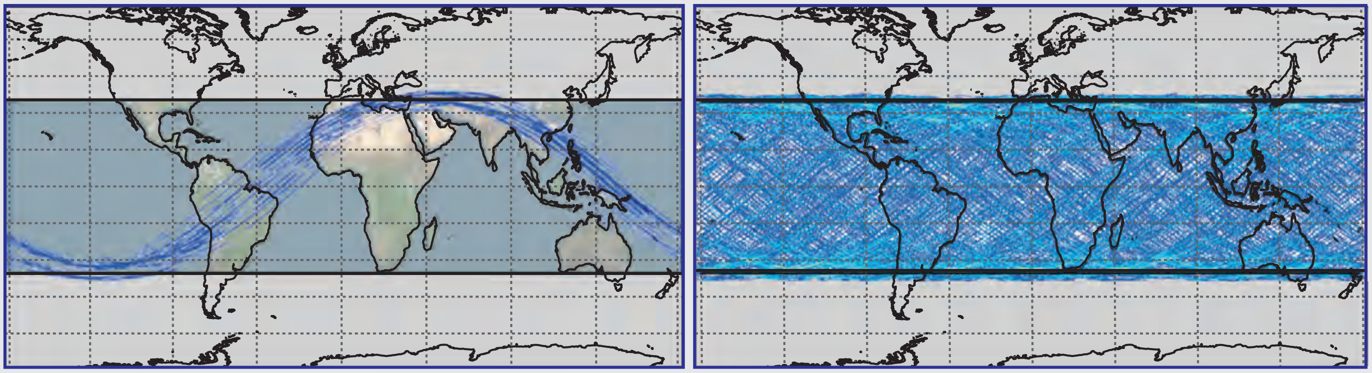


The CYGNSS mission is comprised of eight low Earth orbiting spacecraft (yellow dots closest to the Earth's surface) that receive both direct and scattered signals from GPS satellites (light blue dots further from the Earth's surface). Image credit: University of Michigan

Key Science Objectives

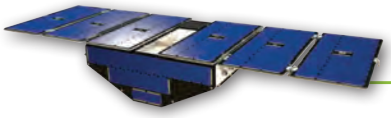
CYGNSS will measure ocean surface wind speed in all precipitating conditions, including those experienced within the inner core of tropical cyclones.

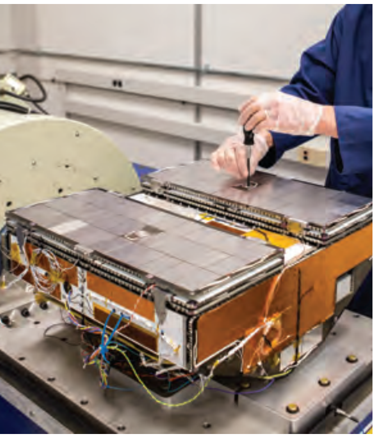
CYGNSS will measure ocean surface wind speed within the inner core of tropical cyclones with sufficient frequency to resolve their formation and rapid intensification.



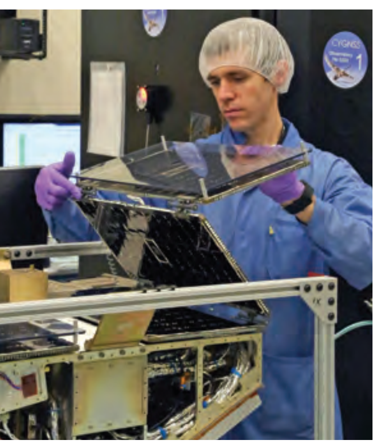
A benefit of using a constellation of microsatellite observatories is that they will pass over the same spot on the ocean more frequently than a single satellite would, resulting in better resolution of changes in the ocean's surface on short time scales. These maps show sample ground tracks between 35° N and 35° S latitude from the CYGNSS microsatellite observatories for 95 minutes [*left*] and a full day [*right*]. Image credit: University of Michigan

CYGNSS Microsatellite Observatories





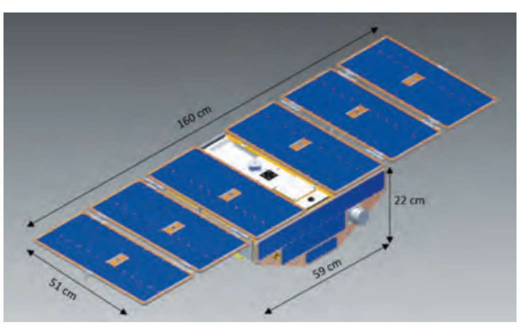
CYGNSS undergoing calibration, December 12, 2014. Photo credit: University of Michigan



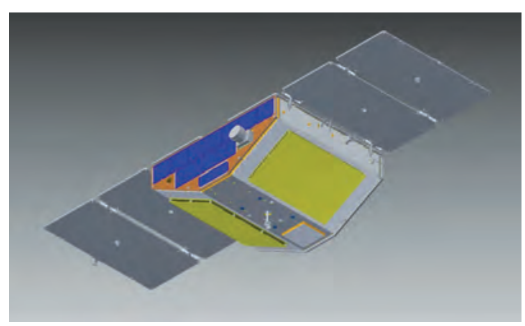
Installation of CYGNSS solar panels on February 4, 2016. Photo credit: Southwest Research Institute

Prior to full deployment, each CYGNSS observatory will have the length, width, and height dimensions of approximately 20 x 23 x 8.6 inches (51 x 59 x 22 centimeters). In orbit, each observatory will deploy solar panels such that its final width will reach a wingspan of 63 inches (160 centimeters), a typical wingspan of a full-grown swan. The observatories will use under 60 watts of power (less than an incandescent light bulb), and weigh less than ~66 pounds (30 kilograms). The solar panels will be used to collect incoming radiation (energy) from the Sun to recharge the onboard batteries that power the observatories.

The measurement methodology to be employed by the CYGNSS observatories will rely on the characterization of the signal propagation from the existing GPS constellation located approximately 12,427 miles (20,000 kilometers) above the Earth's surface, as well as on the nature of the scattering of these signals by the ocean surface. The observatories will each carry a Delay Doppler Mapping Instrument (DDMI), which consists of a Delay Mapping Receiver (DMR) electronics unit, two nadir-pointing (i.e., downward-pointing) antennas for collecting the GPS signals scattered off of the ocean surface, and a single zenith-pointing (i.e., upward-pointing) antenna for collecting the direct GPS signals. The DMR on each observatory consists of a single traditional GPS navigation receiver (to support standard GPS geo-location capability, navigation, and timing functions), and four customized GPS receivers to perform the remote sensing signal processing. The scattered GPS signals from the ocean surface received by each of the four GPS receivers will be used to generate Delay Doppler Maps (DDMs), from which ocean surface wind speeds are retrieved. More specifically, each observatory will generate four DDMs per second, resulting in 32 simultaneous wind measurements by the complete constellation.



Top view and overall dimensions of a CYGNSS observatory. Image credit: University of Michigan

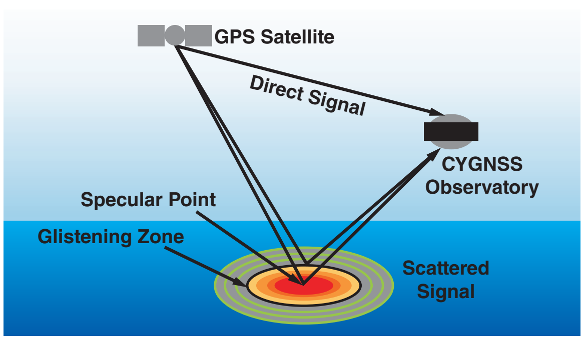


Bottom view of a CYGNSS observatory. Image credit: University of Michigan

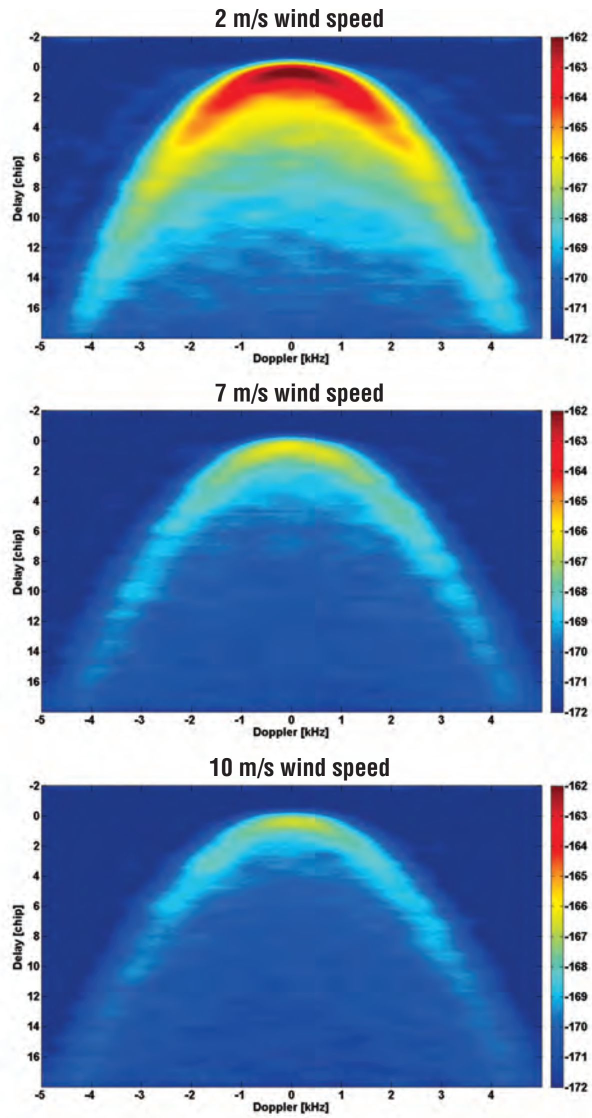
Delay Doppler Maps

The color scale of a DDM denotes the power in the signals scattered by the ocean surface and received by the DDMI, where red shades indicate the strongest scattering. The y-axis represents the time delay between the direct (from the GPS) and scattered (from the ocean) received signals, while the x-axis represents the shift in frequency between the direct and scattered received signals. The two axes are normalized with respect to the delay and Doppler shift at the *specular point*, the spot on the ocean surface where the scattered signal strength is largest.

Wind speed is estimated from the DDM by relating the region of strongest scattering (the dark red region) to the ocean surface roughness. A smooth ocean surface will reflect a GPS signal directly up toward the CYGNSS observatory, producing a strong received signal. A roughened ocean will result in more diffuse scattering of the signal in all directions, resulting in a weaker received signal. Therefore, strong received signals represent a smooth ocean surface and calm wind conditions, while weak received signals represent a rough ocean surface and high wind speeds. The exact relationship between received signal strength and wind speed is provided by the CYGNSS wind speed retrieval algorithm.

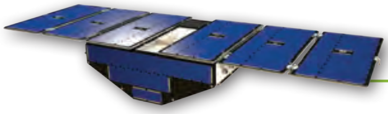


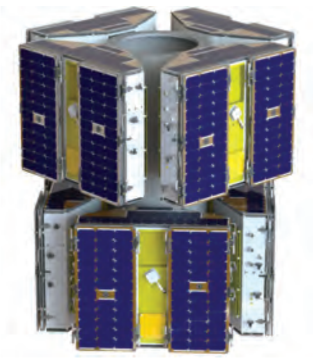
Each CYGNSS observatory will receive a direct signal from a GPS satellite as well as signals scattered off of the ocean surface. As depicted in the image above, the direct signal is transmitted from the orbiting GPS satellite and received by the single zenith-pointing antenna (i.e., top side), while the scattered GPS signal scattered off the ocean surface is received by the two nadir-pointing antennas (i.e., bottom side). The specular point is the location on the surface where all of the scattering originates if the surface is perfectly smooth. With a roughened surface, the scattering originates from a diffuse region called the glistening zone that is centered on the specular point. Image credit: University of Michigan



Example of Delay Doppler Maps for 2, 7, and 10 meter per second (m/s) wind speeds [*top to bottom*]. The images show how progressively stronger wind speeds, and therefore progressively rougher sea surfaces, produce a weaker maximum signal (at the top of the "arch") and a scattered signal along the arch that is closer in strength to the maximum. A perfectly smooth surface would produce a single red spot at the top of the arch. Image credit: University of Michigan

Getting CYGNSS into Space: Launch and Deployment





Deployment module that will perform the sequential release of four microsatellite observatory pairs. Image credit: Sierra Nevada Corporation

The CYGNSS constellation is scheduled for launch in late 2016 from NASA's Kennedy Space Center in Cape Canaveral, Florida. The single launch vehicle for the constellation will be an Orbital ATK Pegasus XL expendable rocket. Affixed to the bottom of an Orbital ATK L-1011 *Stargazer* airliner, the Pegasus rocket will be carried to an altitude of approximately 39,000 feet (11.8 kilometers). Upon reaching this altitude, the aircraft will release the Pegasus rocket, which will then ignite and boost the eight observatories, attached to a Sierra Nevada Corporation deployment module (DM), into low Earth orbit (LEO) approximately 317 miles (510 kilometers) above the Earth's surface. The eight observatories will be arranged on the DM in two tiers, with four observatories in each tier. The observatories will be released from the DM in a sequence of four, oppositely positioned microsatellite observatory pairs, which will ensure the stability of the DM during the release sequence.

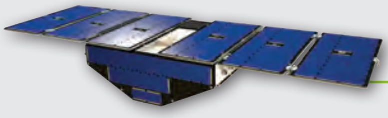
Orbital ATK L-1011 *Stargazer*. Image credit: Orbital ATK

Pegasus XL expendable rocket affixed to the bottom of the L-1011 *Stargazer*. Image credit: NASA

The CYGNSS constellation is scheduled for launch in late 2016 from NASA's Kennedy Space Center in Cape Canaveral, Florida.

[*Below*] Artist's rendering of deployment of CYGNSS microsatellite observatories. Image credit: University of Michigan

Ground Segment



The CYGNSS ground segment consists of: a Mission Operations Center (MOC), located at the Southwest Research Institute's Planetary Science Directorate in Boulder, Colorado; a Science Operations Center (SOC), located at the University of Michigan's Space Physics Research Laboratory in Ann Arbor, Michigan; and a Ground Data Network, operated by Universal Space Network and consisting of existing Prioranet ground stations in South Point, Hawaii; Santiago, Chile; and Western Australia, approximately 248 miles (400 kilometers) south of Perth.

Mission Operations Center

Throughout the mission, the MOC is responsible for mission planning, flight dynamics, and command and control tasks for each of the observatories in the constellation. The MOC also coordinates operational requests from all facilities and develops long-term operations plans. Primary MOC tasks include:

- coordinating activity requests;
- scheduling ground network passes;
- maintaining the Consultative Committee for Space Data Systems (CCSDS) File Delivery Protocol (CFDP) ground processing engine;
- collecting and distributing engineering and science data;
- tracking and adjusting the orbit location of each observatory;
- trending microsatellite data;
- creating real-time command procedures or command loads required to perform maintenance and calibration activities; and
- maintaining configuration of on-board and ground parameters for each observatory.

Science Operations Center

The SOC will be responsible for the following items related to calibration/validation activities, routine science data acquisition and special requests, and data processing and storage. Primary SOC tasks include:

- supporting DDMI testing and validation both prelaunch and on-orbit;
- providing science operations planning tools;
- generating instrument command requests for the MOC;
- processing Level 0 through 3 science data; and
- archiving Level 0 through 3 data products, DDMI commands, code, algorithms, and ancillary data at NASA's Physical Oceanography Distributed Active Archive Center.

Ground Data Network

CYGNSS contracted with Universal Space Network to handle ground communications because of their extensive previous experience with missions similar to CYGNSS. Each of the observatories in the CYGNSS constellation will be visible to the three ground stations within the Universal Space Network for periods that average between 470 and 500 seconds of visibility per pass. Each observatory will pass over each of the three ground stations (Hawaii, Chile, Australia) six-to-seven times each day, thus providing a large pool of scheduling opportunities for communications passes. MOC personnel will schedule passes as necessary to support commissioning and operational activities. High-priority passes will be scheduled to support the solar array deployment for each observatory.

For all subsequent stages, the MOC schedules nominal passes for the Universal Space Network stations for each observatory in the constellation per the Universal Space Network scheduling process. Each observatory can accommodate gaps in contacts with storage capacity for greater than 10 days' worth of data with no interruption of science activities.

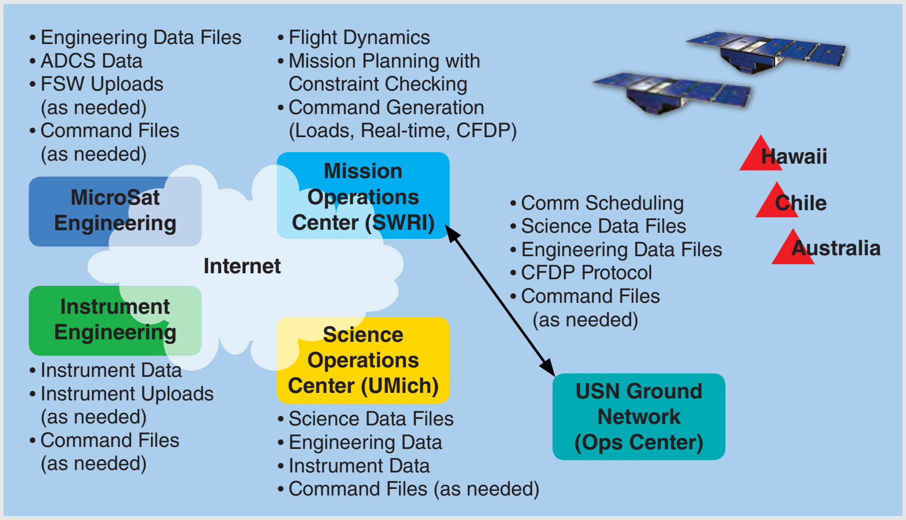
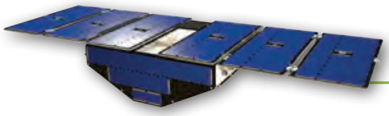


Diagram showing an overview of the components of the CYGNSS ground system.

Science Data Products



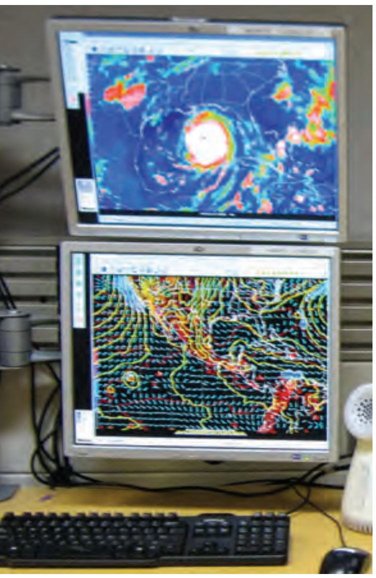


Photo credit: David July

Satellite imagery displayed on a workstation at the National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center (NHC) in Miami, Florida.

The CYGNSS mission will produce three levels of science data products for public distribution through NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC). Data from CYGNSS will be freely available for download at *podaac.jpl.nasa.gov*.

The maximum data latency from spacecraft downlink to PO.DAAC availability is six days for all three data levels.

Level 1 Products: Delay Doppler Maps

The goal of Level 1 science data processing is to produce DDMs of calibrated bistatic radar cross section. All Level 1 science data products are provided at a time resolution of 1 hertz.

Level 2 Products: Wind Speed Retrieval and Mean Squared Slope

The Level 2 wind speed product is the spatially averaged wind speed over a ~9.7 x 9.7 square mile (25 x 25 square kilometer) region centered on the specular point. While the primary objective of the CYGNSS mission is measurement of ocean surface winds, Level 1 products can also be related to the mean square slope (MSS) of the ocean surface, which is crucial for understanding the physical processes at the air–sea interface.

Level 3 Products: Gridded Wind Speed and Mean Squared Slope

The Level 3 gridded wind speed product is derived from the Level 2 wind speeds by averaging them in space and time on a 0.2° latitude/longitude grid. Each Level 3 gridded wind file covers a one-hour time period for the entire CYGNSS constellation. The Level 3 MSS product is a similarly gridded version of the Level 2 MSS product.

Calibration and Validation Objectives

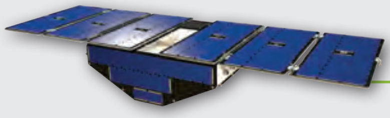
The CYGNSS calibration and validation objectives are to:

- verify and improve the performance of the sensor and science algorithms;
- validate the accuracy of the science data products; and
- validate the utility of CYGNSS wind products in the marine forecasting and warning environment.

For satellite ocean wind remote sensing, validation typically involves collocating measurements with numerical weather model wind fields. This allows a relatively large number of collocation measurements to be obtained in a short amount of time. Since model winds are generally not reliable enough to properly validate very low or very high wind speeds, other comparison data are required. Validated wind speed data from satellite sensors, such as scatterometers, can be compared more directly and provide higher wind speed validation truth. Validation at the highest wind speeds in tropical cyclones will require utilizing data collected from aircraft-based measurements such as GPS dropsondes or other remote sensing equipment that might be onboard, such as the Stepped Frequency Microwave Radiometer or the Imaging Wind and Rain Airborne Profiler that fly onboard the NOAA Hurricane Hunter aircraft.

Another facet of the validation effort will include training forecasters at the NOAA NHC to use CYGNSS wind retrievals. At the end of hurricane season, the retrievals will be provided to the forecasters so they can evaluate their effectiveness during their post-season storm analysis. The objectives of this effort will be to evaluate the value of these data in the operational environment and to get validation feedback from forecasters. Experience has shown that viewing the data from a forecaster's perspective can reveal performance issues that can remain hidden in global statistics.

Benefits to Society



The National Hurricane Center has noted that Hurricane Katrina was the costliest, and one of the deadliest, hurricanes in U.S. history. Much of the catastrophic damage that was caused by the storm has been attributed to the wind-generated storm surge that exceeded 20 feet (6 meters) above high tide across parts of the central Gulf Coast as the storm moved onshore. The intensity of Hurricane Katrina's winds varied between Category 1 (winds 74 to 94 mph) and Category 5 (winds > 155 mph) as the storm moved through the Gulf of Mexico and toward the Gulf Coast during the period of August 26-29, 2005. The ability to monitor and predict the rapid changes in hurricane intensity such as those observed with Hurricane Katrina is critical to hurricane forecasters, hydrologists, emergency managers, and other community leaders who together are responsible for protection of the health and welfare of coastal communities.

The Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA's Terra satellite captured this image of Hurricane Katrina on August 28, 2005, at 1:00 PM Eastern Daylight Savings Time. Credit: NASA's Earth Observatory

CYGNSS will measure surface winds in the inner core of tropical cyclones, including regions beneath the eyewall and intense inner rainbands that could not previously be measured from space. These measurements will help scientists obtain a better understanding of what causes the intensity variations in tropical cyclones, such as those observed with Hurricane Katrina.

The surface wind data collected by the CYGNSS constellation are expected to lead to:

- improved spatial and temporal resolution of the surface wind field within the precipitating core of tropical cyclones;
- improved understanding of the momentum and energy fluxes at the air-sea interface within the core of tropical cyclones and the role of these fluxes in the maintenance and intensification of these storms; and
- improved forecasting capabilities of tropical cyclone intensification.

Combined, these accomplishments will allow NASA scientists and hurricane forecasters to provide improved advanced warning of tropical cyclone intensification, movement, and storm surge location and magnitude, thus aiding in the protection of human life and coastal community preparedness.

Science Data Distribution

Data from CYGNSS will be freely available for download at

podaac.jpl.nasa.gov

Mission Partners

University of Michigan Department of Climate and Space Sciences and Engineering

University of Michigan Space Physics Research Laboratory

Southwest Research Institute

Surrey Satellite Technology, UK

Sierra Nevada Corporation

Orbital ATK

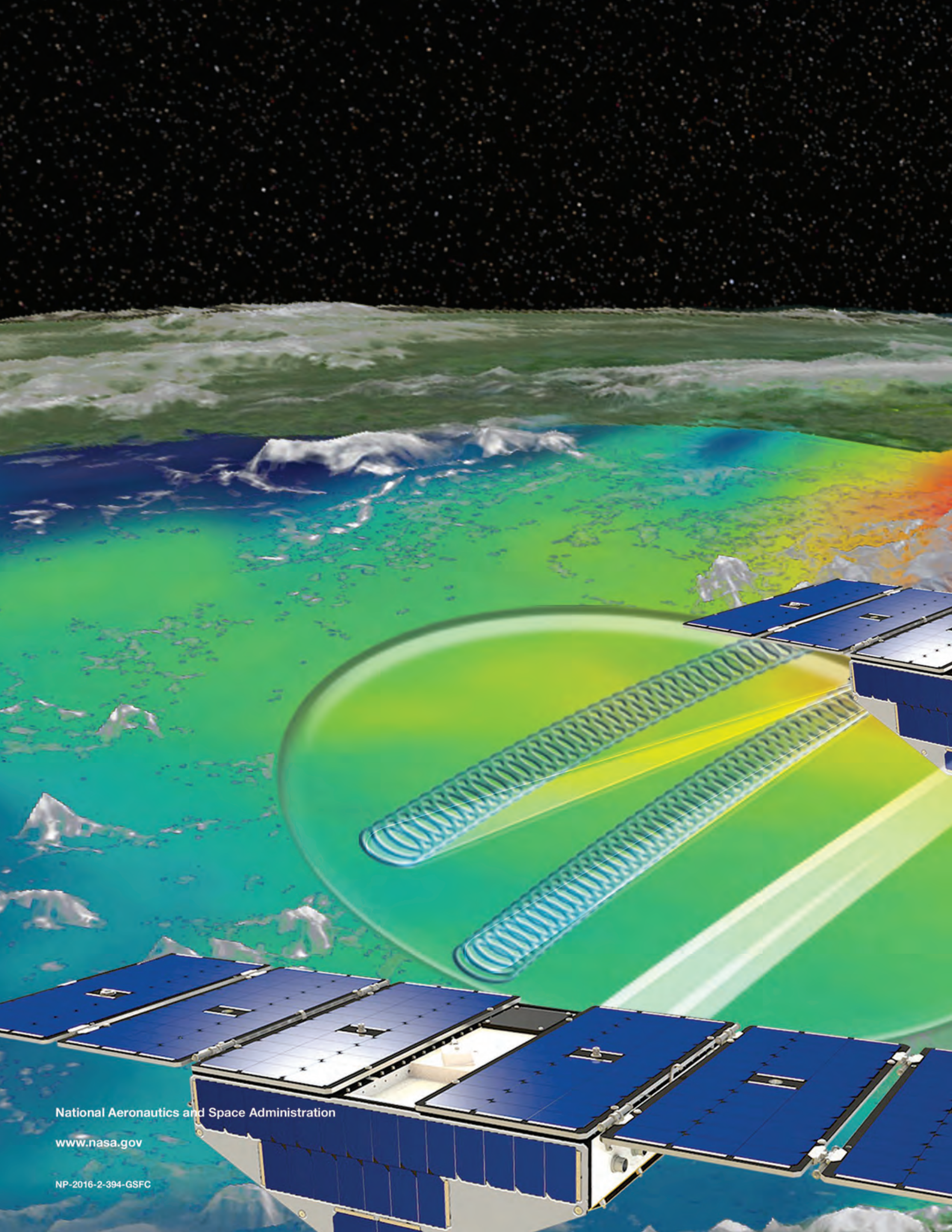
NASA Science Mission Directorate

NASA Earth System Science Pathfinder Program

NASA Langley Research Center

NASA Kennedy Space Center

Photo credit: NASA



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