Cyclone Global Navigation Satellite System **(CYGNSS)**

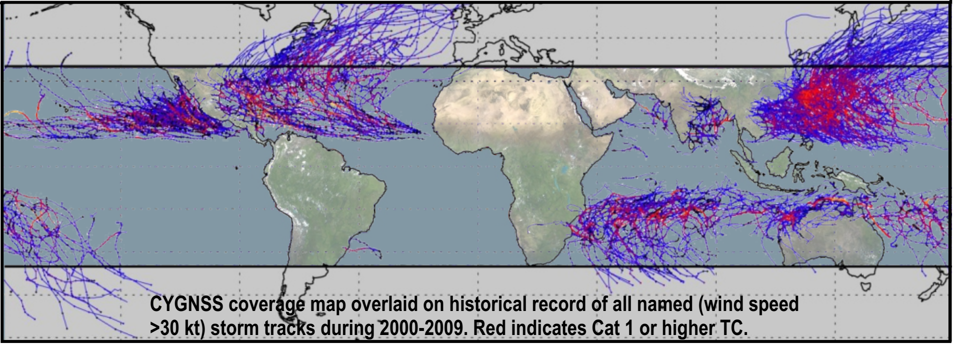
Science Goal and Objectives

The CYGNSS Science Goal is to understand the coupling between ocean surface properties, moist atmospheric thermodynamics, radiation, and convective dynamics in the inner core of a Tropical Cyclone (TC).

Primary Objectives:

- Measure ocean surface wind speed in all precipitating conditions, including those experienced in the TC eyewall
- Measure ocean surface wind speed in the TC inner core with sufficient frequency to resolve genesis and rapid intensification

Secondary Science: Support the operational hurricane forecast community by producing and providing ocean surface wind speed data products, and helping them assess the value of these products for use in their retrospective studies of potential new data sources.

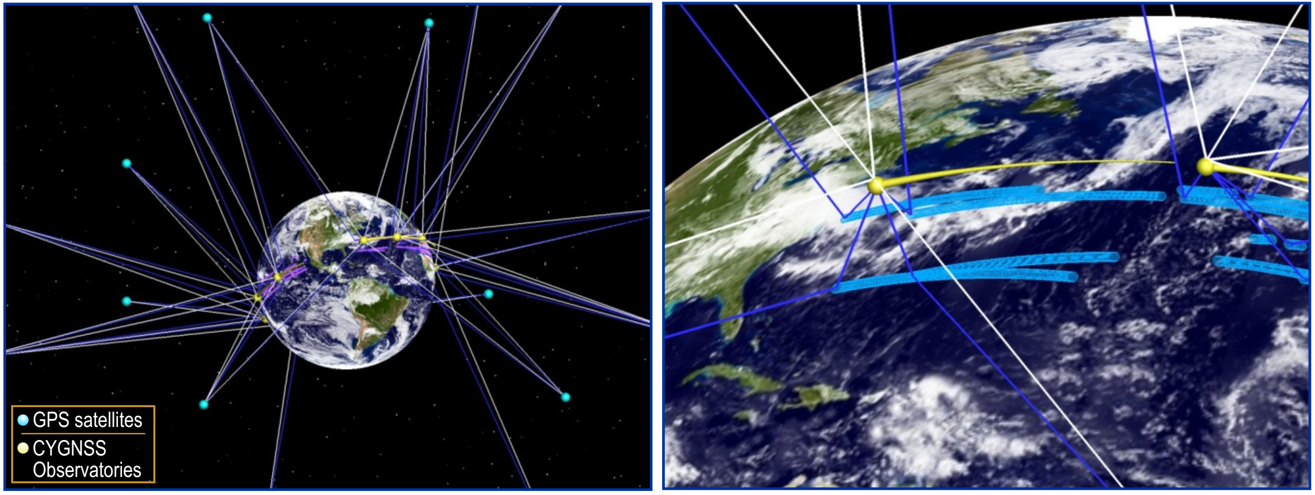


CYGNSS coverage map overlaid on historical record of all named (wind speed >30 kt) storm tracks during 2000-2009. Red indicates Cat 1 or higher TC.

Importance to NASA

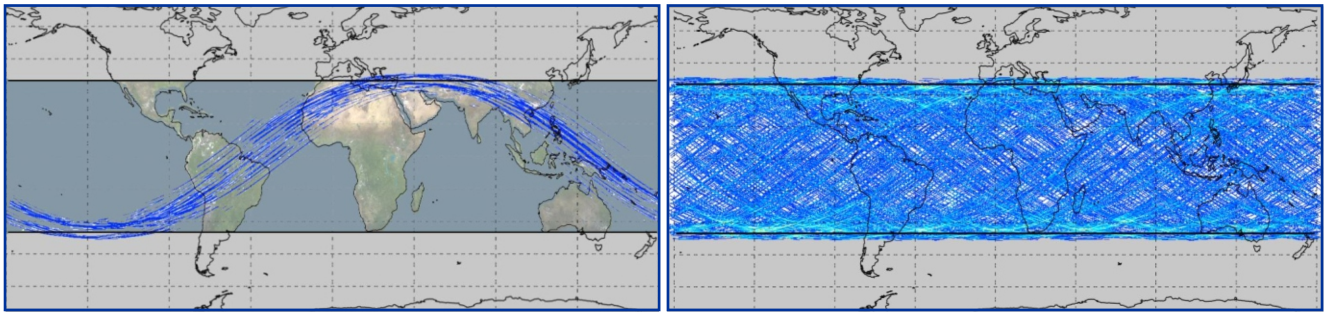
- Resolve TC inner core dynamics and energetics, leading to fundamental improvements in our understanding of the genesis and intensification processes
- Provide post-QuikScat ocean wind measurement capability recommended by NRC Decadal Survey with enhanced coverage and performance in precipitating and high wind conditions
- Initiate an operational hand-off of unique observing capabilities to the operational hurricane forecast community

Mission Overview



The CYGNSS mission is comprised of 8 Observatories that receive both direct (white lines) and reflected (blue lines) signals from GPS satellites. The direct signals pinpoint CYGNSS Observatory positions, while the reflected signals respond to ocean surface roughness, from which wind speed is retrieved. GPS bi-static scatterometry measures ocean surface winds at all speeds and under all levels of precipitation, including TC conditions. In the right figure, instantaneous wind samples are indicated by individual blue circles. Five minutes of wind samples are shown.

Mission Design



The 8 LEO S/C orbit at an inclination of 35°, and are each capable of measuring 4 simultaneous reflections, resulting in 32 wind measurements per second across the globe. Ground tracks for 90 minutes (left) and a full day (right) of wind samples are shown above. The number of S/C, their orbit altitudes and inclinations, and the alignment of the antennas are all optimized to provide unprecedented high temporal-resolution wind field imagery of TC genesis, intensification and decay.

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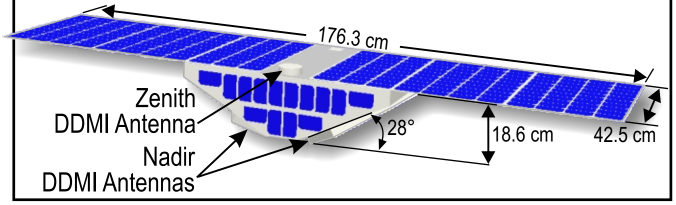
Observatory



Key Flight Segment Characteristics

Observatory

- *Configuration:* Accommodate DDMI antennas and 100% DDMI duty cycle
- *Power:* 48.8 W (Available: 70.1 W EOL, Margin: 30.3%)
- *Attitude:* 3-axis stabilized, pitch momentum-biased nadir-pointed, 2.1° (3σ) knowledge and 2.8° (3σ) control (horizon sensors, magnetometer, pitch momentum wheel, torque rods)
- *Communication:* 1.25 Mbps S-band with 6.7 dB margin provides 31% Science data downlink margin
- *Mass (ea):* 17.6 kg (Margin: 59%)

Launch Vehicle (LV), NASA (GFE)

- *Altitude:* 500 km
- *Inclination:* 35°
- *Injection mass:* 174.6 kg
- *LV Margin (Pegasus):* 106%
- *Launch:* 10-Feb-2016

Deployment Module (DM)

- 8 observatory deployment
- Provides pre-launch S/C Command &Telemetry, and battery trickle charge interface
- 2 tier design to facilitate I&T

Delay Doppler Mapping Instrument (DDMI)

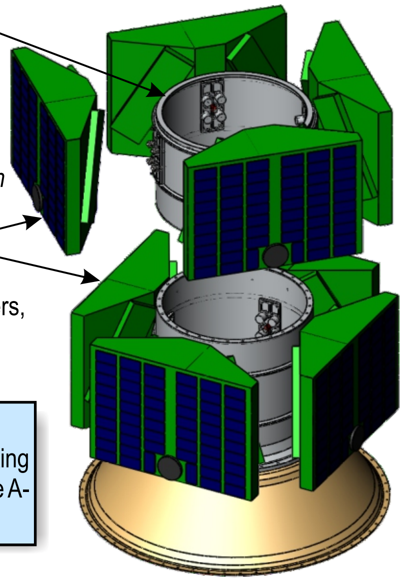
Delay Mapping Receiver (DMR)

Zenith S-band Ant

Nadir Science Antennas

The DDMI consists of the **Surrey DMR**, plus a **Zenith** and 2 **Nadir antennas** also supplied by Surrey.

Flight Segment Integration



Deployment Module

Tier design allows easy integration and handling, which are then simply stacked for launch

Observatories are integrated into 2 Deployment Module tiers, 4 vehicles per tier

CYGNSS achieves its science goal for $150M through low risk, innovative implementation:

• large technical margins • COTS components • high heritage • NASA LV • simple operations • existing infrastructure • proven management tools and processes and large cost reserve (31% of all Phase A-D costs excluding the LV).

Cost	$RY	$FY 14
PI Managed Cost	151.28M	150.00M
Total Mission Cost	151.80M	150.49M
Contributed Cost	518K	495K

Terminology Key

CYGNSS Element	Definition
DDMI	Delay Doppler Mapping Instrument: Instrument/Payload; DMR + 2 nadir and 1 zenith antennas
DMR	Delay Mapping Receiver: GNSS receiver core; enhanced DSP
S/C	Spacecraft: Nanosatellite
DM	Deployment Module: Interface to LV; deploys constellation
FS	Flight segment: Constellation + DM
Observatory	Integrated DDMI and S/C
Constellation	All 8 observatories

CYGNSS Team

University of Michigan
Principal Investigator: C. Ruf
Project Scientist: A. Ridley

Southwest Research Institute
Project Manager: J. Scherrer
Project Systems Engineer: R. Rose
Spacecraft Lead: J. Eterno
Mission Operations Lead: M. Reno

Surrey Satellite Technology, U.S.
DDMI Program Manager: B. Johnson

NASA Ames Research Center
Deployment Module Lead: E. Agasid

Mission Timeline