Cyclone Global Navigation Satellite System (CYGNSS)

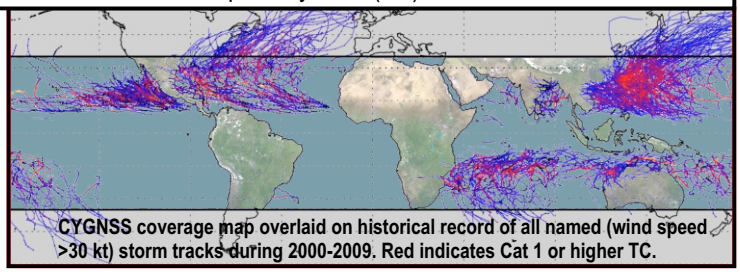
Science Goal and Objectives

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.

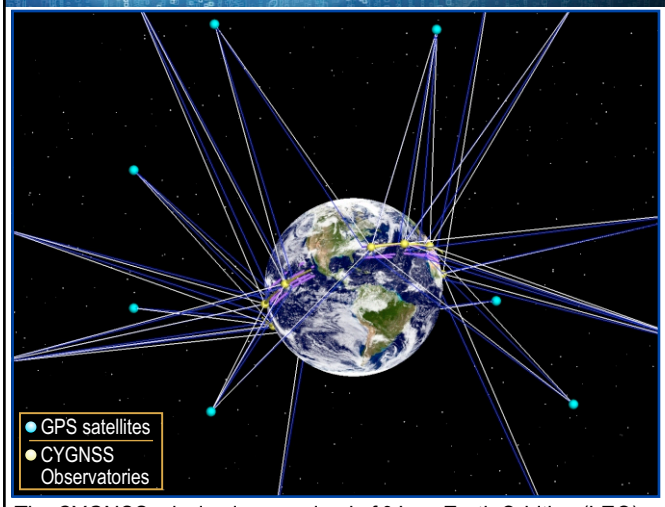


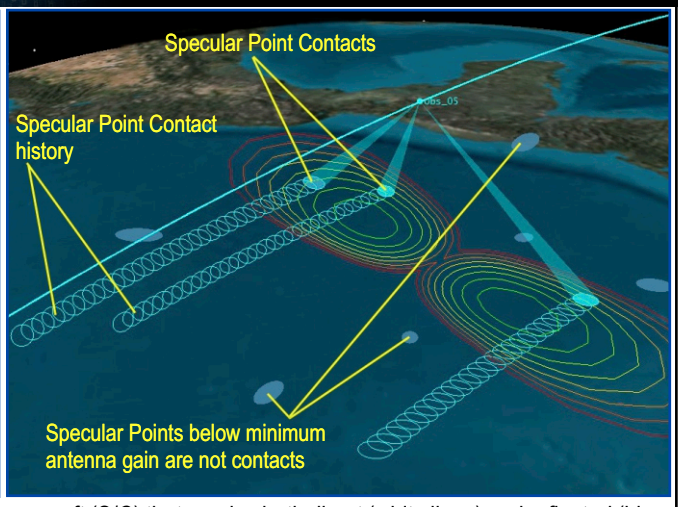
CYGNSS coverage map overlaid on historical record of all named (wind speed >30 kt) storm tracks during 2000-2009. Red indicates Cat 1 or higher TC.

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

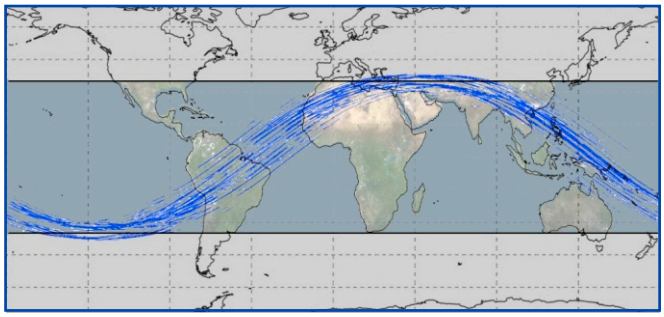
Mission Overview

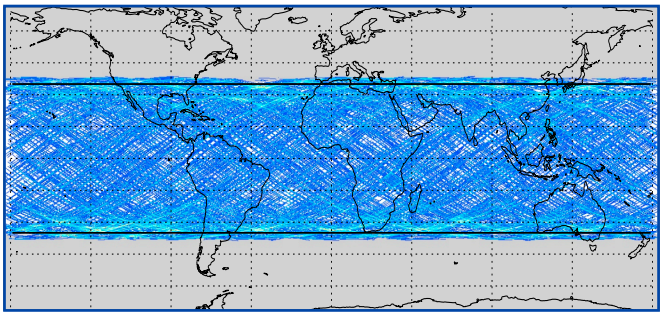




The CYGNSS mission is comprised of 8 Low Earth Orbiting (LEO) spacecraft (S/C) that receive both direct (white lines) and reflected (blue lines) signals from GPS satellites. The direct signals pinpoint LEO S/C positions, while the reflected signals respond to ocean surface roughness, from which wind 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

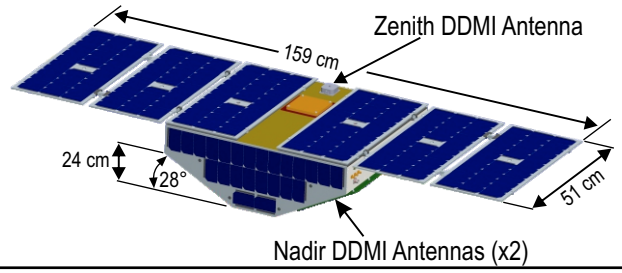




The 8 LEO S/C orbit at an inclination of 35°, and are each capable of measuring 4 simultaneous reflections, resulting in 32 wind measurements per second across the globe. Ground tracks for 90 minutes (left) and a full day (right) of wind samples are shown above. The number of S/C, their orbit altitudes 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.

Cyclone Global Navigation Satellite System (CYGNSS)

Observatory



Key Flight Segment Characteristics

Observatory

- *Configuration:* Accommodate DDMI antennas and 100% DDMI duty cycle
- *Mass (ea):* 27.5 kg
- *Power:* 34.7 W (Available: 55.0 W)
- *Attitude:* 3-axis stabilized, nadir-pointed, 1.2° (3σ) knowledge and 2.3° (3σ) control
- *Communication:* 4 Mbps S-band

Launch Vehicle (LV), NASA (GFE)

- *Altitude:* 500 km
- *Inclination:* 35°
- *Injection mass:* 271.5 kg
- *Launch:* Oct 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

CYGNSS achieves its science goal for $102M (w/o LV) through low risk, innovative implementation:

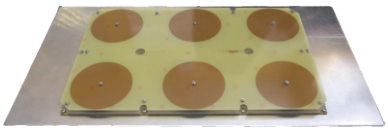
- Large technical margins
- High heritage
- Simple operations
- COTS components
- NASA LV
- Existing infrastructure

Delay Doppler Mapping Instrument (DDMI)

Delay Mapping Receiver (DMR)

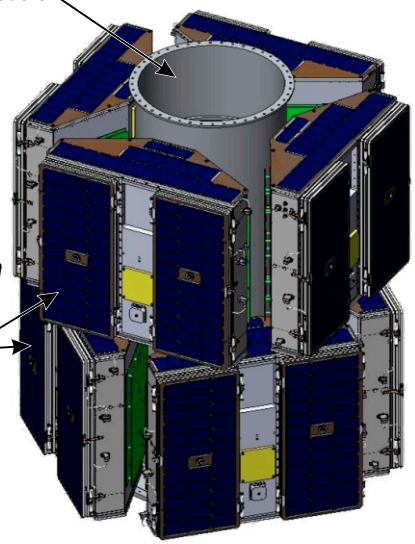
Zenith S-band Ant

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 supplied by Sierra Nevada Corporation

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: Microsatellite
DM	Deployment Module: Interface to LV; deploys constellation
FS	Flight segment: Constellation + DM
Observatory	Integrated DDMI and microsatellite
Constellation	All 8 observatories

CYGNSS Team

University of Michigan Department of Atmospheric, Oceanic & Space Sciences
Principal Investigator: C. Ruf
Deputy PI: D. Posselt
Constellation Scientist: A. Ridley

Southwest Research Institute
Project Manager: J. Scherrer
Project Systems Engineer: R. Rose
Mission Operations Lead: D. Rose

Surrey Satellite Technology, U.S.
DDMI Program Manager: E. Hockenberry

Sierra Nevada Corporation
Deployment Module Lead: B. Anthony

Mission Timeline

2013	2014	2015	2016	2017	2018	2019
Phase A / Phase B		Phase C	Phase D	Phase E		Phase F
▲ SRR	▲ PDR	▲ CDR		▲ Launch		