



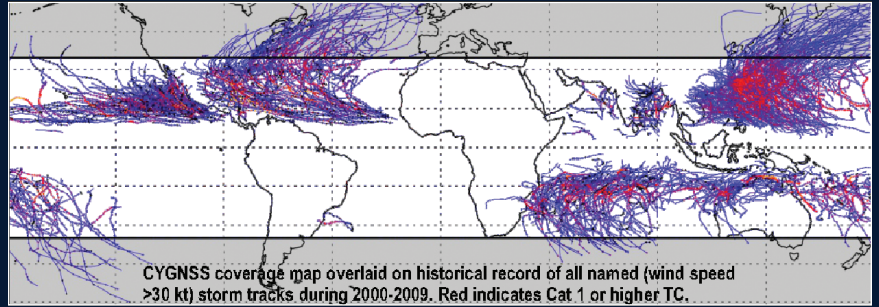
# Cyclone Global Navigation Satellite System (CYGNSS)

## 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:

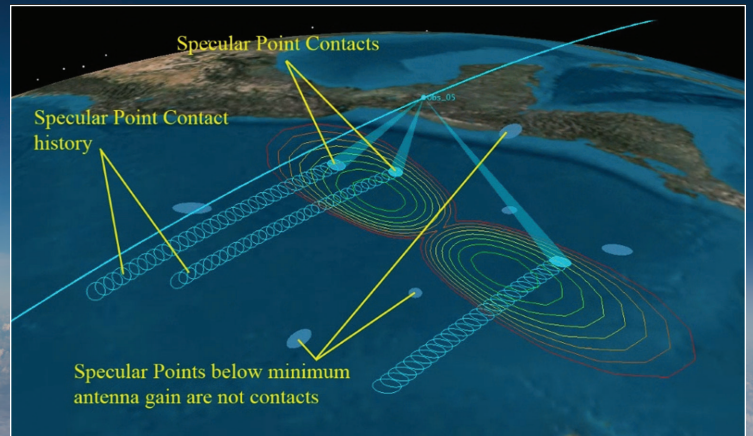
- Measure ocean surface wind speed in all precipitating conditions, including those experienced in the TC eyewall
- Measure ocean surface wind speed in the TC inner core with sufficient frequency to resolve genesis and rapid intensification
- Support the operational hurricane forecast community by producing 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.



### Importance to NASA

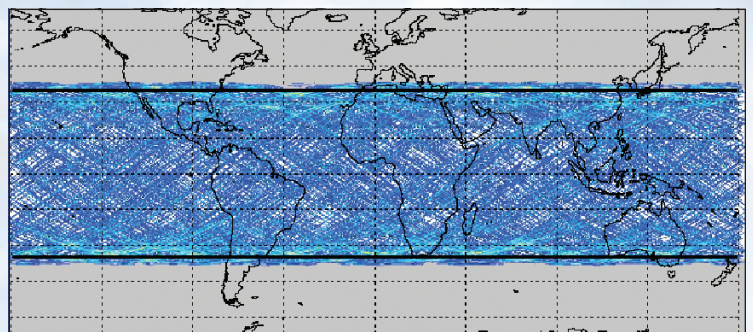
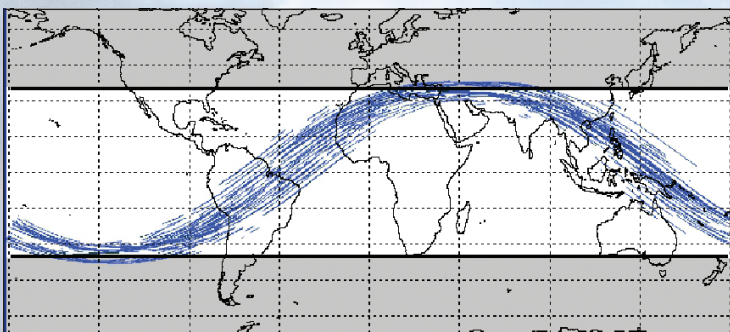
- Resolve TC inner core dynamics and energetics, leading to fundamental improvements in our understanding of the genesis and intensification processes
- Provide post-QuikScat ocean wind measurement capability recommended by NRC Decadal Survey with enhanced coverage and performance in precipitating and 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 and reflected signals from GPS satellites. The direct signals pinpoint LEO S/C position, while the reflected signals respond to ocean surface roughness, from which wind speed is retrieved. GPS bistatic scatterometry measures ocean surface winds at all speeds and under all levels of precipitation, including TC conditions. Launch and S/C deployment, shown on the left, occurred on Dec 15, 2016. In the right figure, instantaneous wind samples are indicated by individual blue circles. Five minutes of wind samples are shown.

## MISSION DESIGN



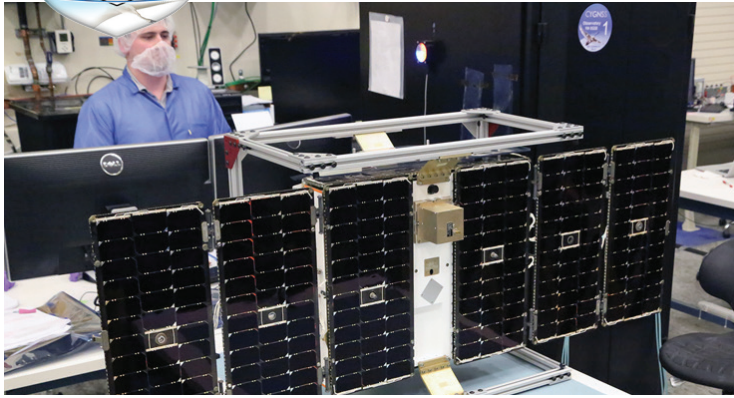
The 8 LEO S/C orbit at an inclination of 35°, and are each capable of measuring 4 simultaneous reflections, resulting in 32 wind measurements per second across the globe. Ground tracks for 90 minutes (left) and a full day (right) of wind samples are shown above. The number of S/C, their orbit altitudes 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° (3 $\sigma$ ) knowledge and 2.3° (3 $\sigma$ ) control
- Communication: 4 Mbps S-band

#### Launch Vehicle (LV), NASA (GFE)

- Altitude: 520 km
- Inclination: 35°
- Injection mass: 271.5 kg
- Launch: Dec 15, 2016

#### Deployment Module (DM)

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

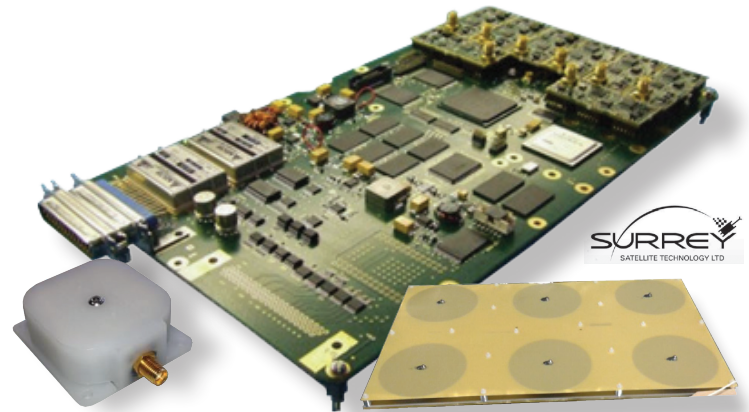
CYGNSS achieves its science goal for \$102M (w/o LV) through low risk, innovative implementation:

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

### TERMINOLOGY KEY

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

## DELAY DOPPLER MAPPING INSTRUMENT (DDMI)



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

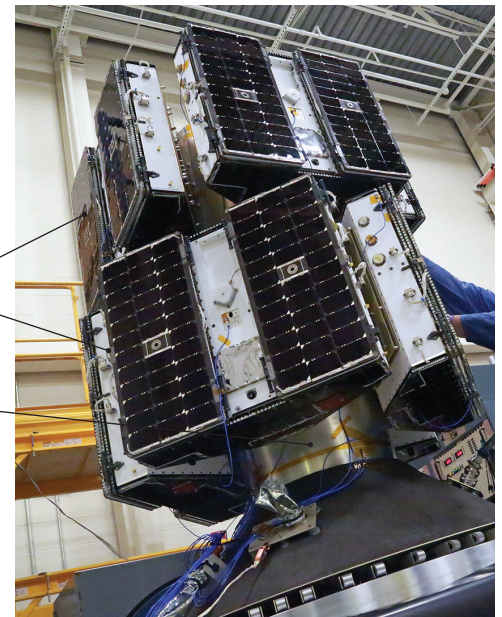
### FLIGHT SEGMENT INTEGRATION

DM Design uses reliable SNC QwkNut release actuator

Observatory separation scheme achieves managed Science configuration in <60 days

Observatories are integrated into 2 tiers, 4 vehicles per tier

Deployment Module



### CYGNSS TEAM

#### University of Michigan Climate and Space Department Space Physics Research Laboratory

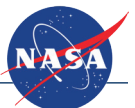
Principal Investigator: C. Ruf  
Cal/Val Scientist: D. McKague  
Constellation Scientist: A. Ridley  
Science Operations Center Lead: T. Butler

#### Southwest Research Institute

Mission Operations Center Lead: J. Redfern  
Systems Engineering: W. Wells

#### NASA

Earth System Science Pathfinder Program Manager: G. Stover



### MISSION TIMELINE

