# Cyclone Global Navigation Satellite System (CYGNSS)

## Science Goal and Objectives

<table>
<thead>
<tr>
<th>Primary Objectives:</th>
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<tr>
<td>• Measure ocean surface wind speed in all precipitating conditions, including those experienced in the TC eyewall.</td>
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<td>• Measure ocean surface wind speed in the TC inner core with sufficient frequency to resolve genesis and rapid intensification.</td>
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<tr>
<th>Secondary Science:</th>
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<tr>
<td>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.</td>
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<thead>
<tr>
<th>Importance to NASA:</th>
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<tr>
<td>• Resolve TC inner core dynamics and energetics, leading to fundamental improvements in our understanding of the genesis and intensification processes.</td>
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<td>• Provide post-QuikScat ocean wind measurement capability recommended by NRC Decadal Survey with enhanced coverage and performance in precipitating and high wind conditions.</td>
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<td>• Initiate an operational hand-off of unique observing capabilities to the operational hurricane forecast community.</td>
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## 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.
Cygnite Global Navigation Satellite System (CYGNSS)

**Mission Timeline**

<table>
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<tr>
<th>Phase</th>
<th>Year</th>
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<tr>
<td>A</td>
<td>2015</td>
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<tr>
<td>B</td>
<td>2016</td>
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<tr>
<td>C</td>
<td>2017</td>
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<tr>
<td>D</td>
<td>2018</td>
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<tr>
<td>E</td>
<td>2019</td>
</tr>
<tr>
<td>F</td>
<td>2020</td>
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**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 2.3° (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
- **Launch:** 10-Sept-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**

**Terminology Key**

- **DDMI:** Delay Doppler Mapping Instrument
- **DDR:** Delay Mapping Receiver
- **S/C:** Spacecraft
- **DM:** Deployment Module
- **FS:** Flight segment
- **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

**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).