Cyclone Global Navigation Satellite System (CYGNSS)

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.

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.

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

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Mission Timeline

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
- COTS components
- High heritage
- NASA LV
- Simple operations
- Existing infrastructure

Terminology Key

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