Small Satellite Reliability TIM
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Lessons Learned from the CYGNSS Mission

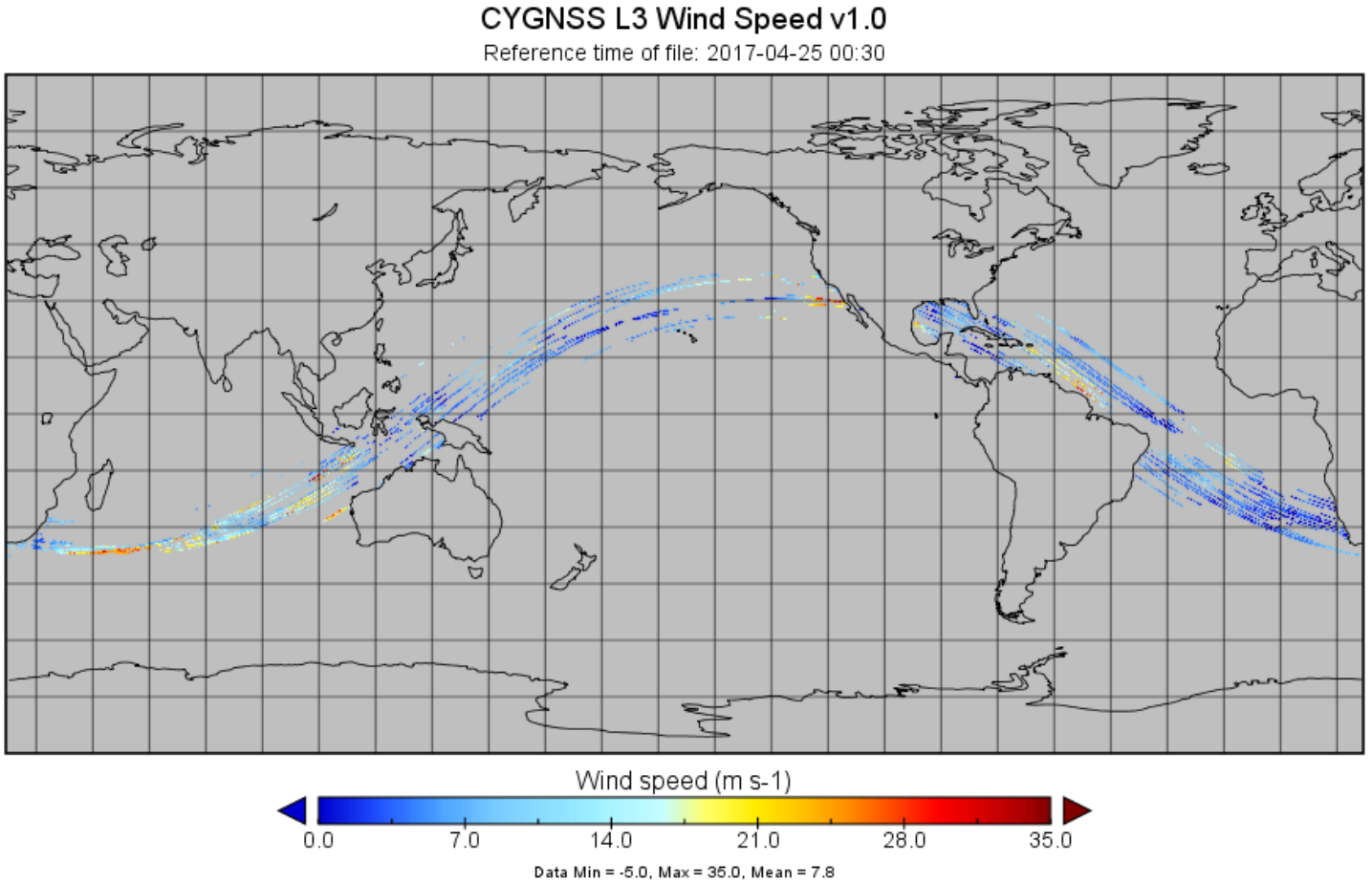
Chris Ruf
Principal Investigator, NASA CYGNSS Mission
Professor of Atmospheric Science and Electrical Engineering
University of Michigan

CYGNSS Mission Summary

- CYGNSS Objectives
  - Measure ocean surface wind speed in all precipitating conditions, including those experienced in the tropical cyclone (TC) eyewall
  - Measure ocean surface wind speed in the TC inner core with sufficient frequency to resolve genesis and rapid intensification
- CYGNSS Mission Design
  - Eight satellites in low earth orbit at 35^{o} inclination, each carrying a four-channel modified GPS receiver making bistatic radar measurements of GPS signals scattered by the Earth surface

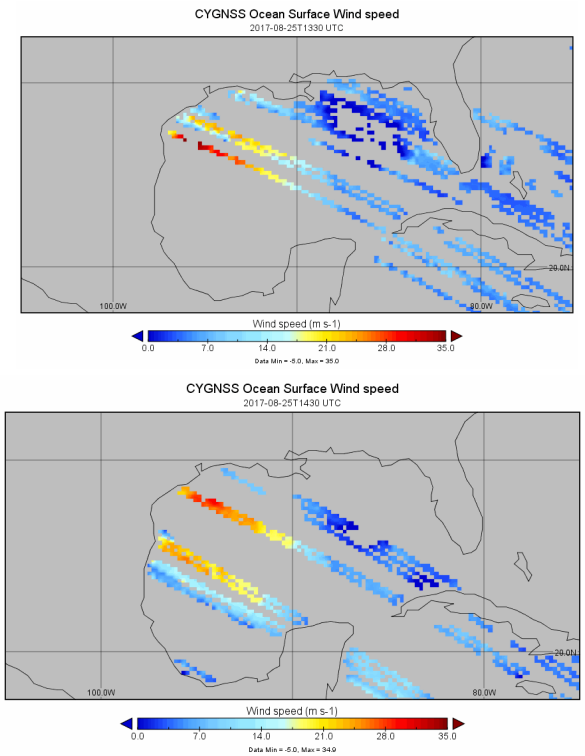
Example of Level 3 Gridded Wind Speed Product (25 Apr 2017)

- Hourly CYGNSS ocean surface winds; L3 v1.0 product

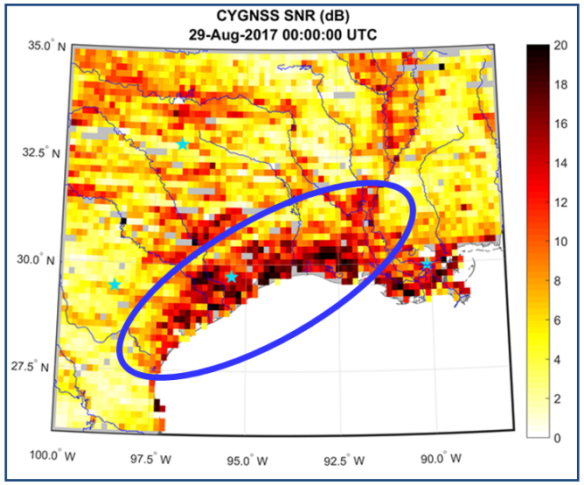


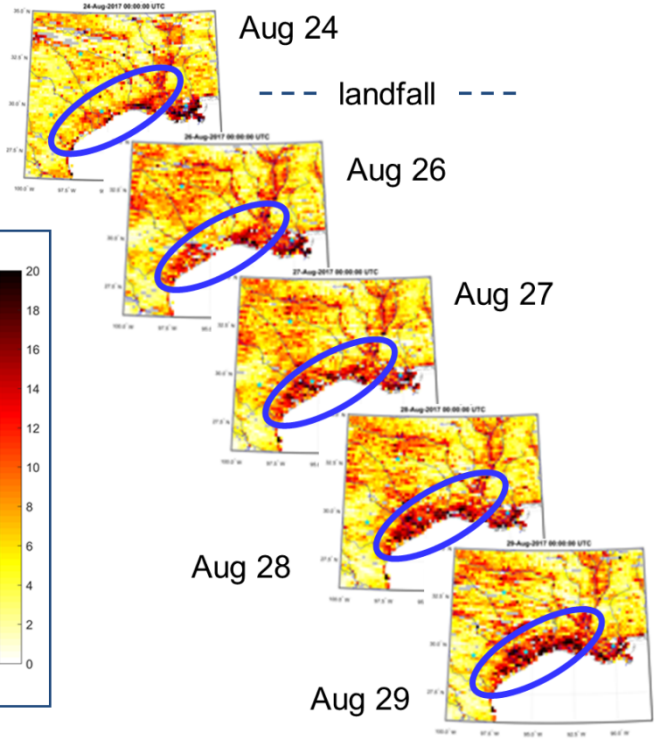
CYGNSS On-Orbit Highlights

- CYGNSS Level 3 gridded surface wind speed data product (v1.1) at 1300-1400 and 1400-1500 UTC on 25 Aug 2017, prior to Hurricane Harvey landfall at ~0300 UTC on 26 Aug 2017



- (right) Time lapse SNR images in Houston metro region
  - Large increases in SNR indicate flooding inundation
- (below) Aug 29 SNR image with coastal flooding circled

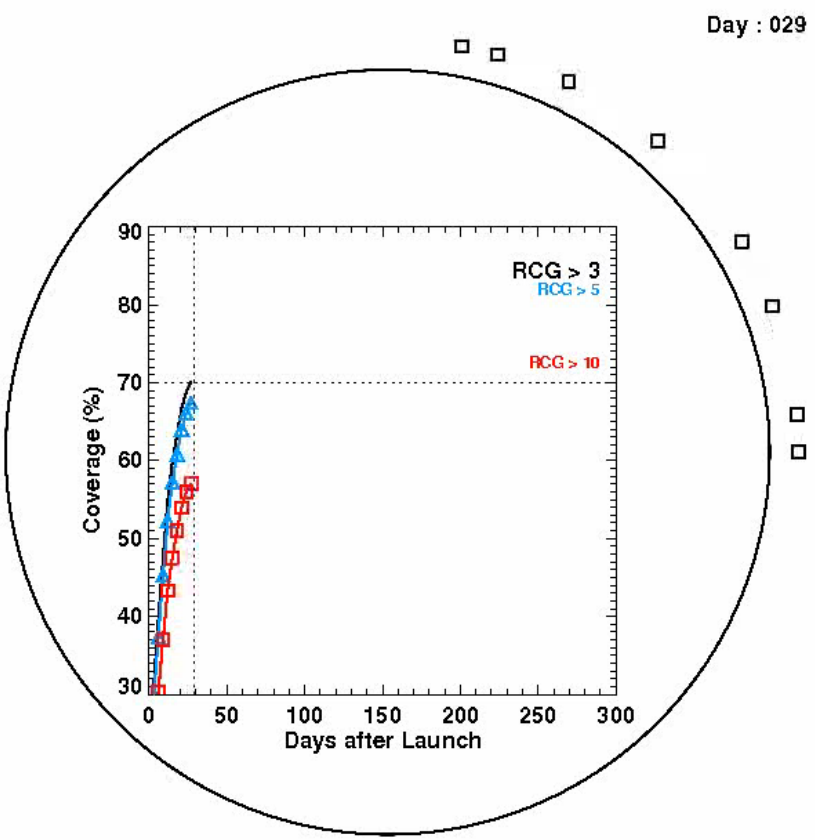




(courtesy Mary Morris, NASA/JPL)

Constellation-level Redundancy for Meeting Science Requirements

- Science Earth coverage requirement of >70% within 24 hr is usually met by 6 s/c and always met by 7



Science Payload Lessons Learned

- Science Payload
  - A number of calibration algorithm corrections were needed or are still in development. The inadequacies of the Day 1 algorithms resulted primarily from limitations in the pre-launch testing, modeling and simulations that were performed. (these sorts of post-launch corrections are not uncommon with larger missions, too)

Ground Operations Lessons Learned

- Ground Operations
  - In order to efficiently manage a constellation of 8 s/c, automated ground contacts and data flow all the way to the SOC are a necessity
  - There is a significant learning curve (still underway, although things are getting better) to understanding the autonomous data flow requirements, development of the procedures, and testing and troubleshooting of the implementation