

# Evaluation of CYGNSS-Based TC Structure and Intensity Estimates

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# Motivation

## We want to diagnose: intensity, size, structure

- Why?
  - Destructive potential
  - Informs forecasting applications
    - Analysis of current situation informs forecasts
    - Categorize storms, and analyze wind field
  - Enables scientific studies and applications
    - Seek greater understanding of processes that govern TC lifecycles
    - Identify warning signs



NASA astronaut Randy Bresnik photographed Super Typhoon Noru on August 1, 2017, as the International Space Station passed overhead. He shared images of the massive storm on social media, writing, "Super Typhoon #Noru, amazing the size of this weather phenomenon, you can almost sense its power from 250 miles above."

Photo Credit: NASA

# How Can CYGNSS help us?

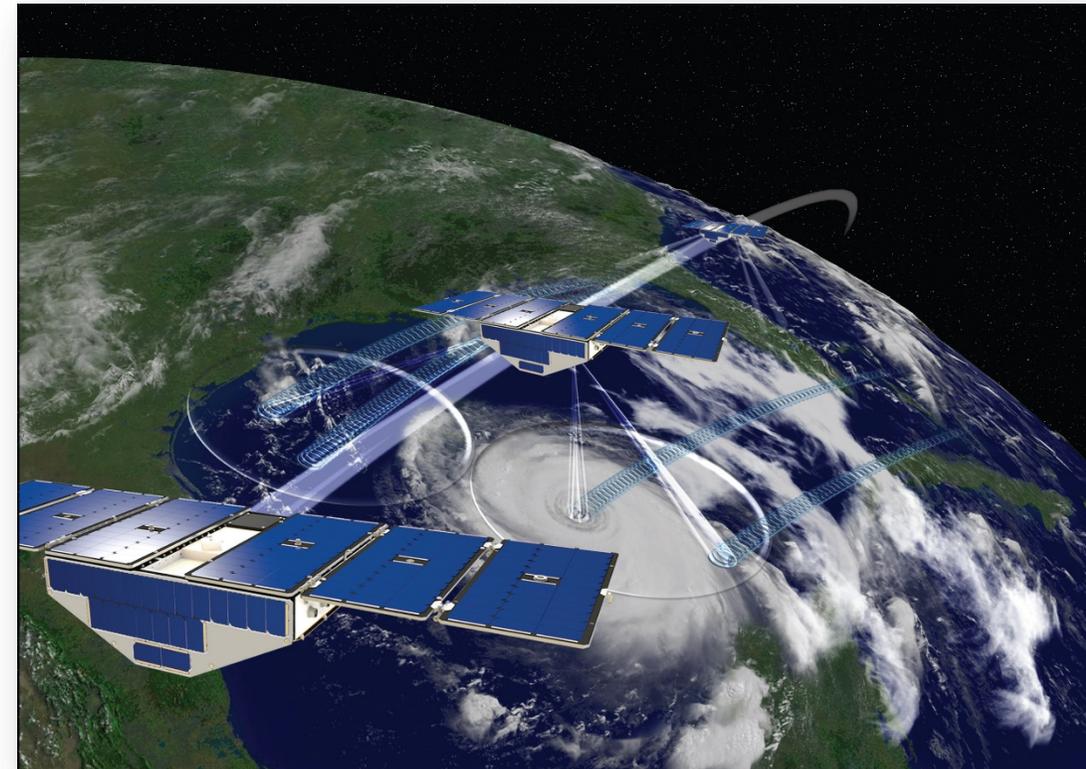
Provides observations of surface wind speed in **all precipitating conditions**

**Rapid revisit** to capture periods of intensification

- median: 3 hours, mean: 7 hours

Objectives:

1. How can we use CYGNSS data to diagnose **size and structure**?
2. Evaluate performance
3. Learn from the good and bad cases



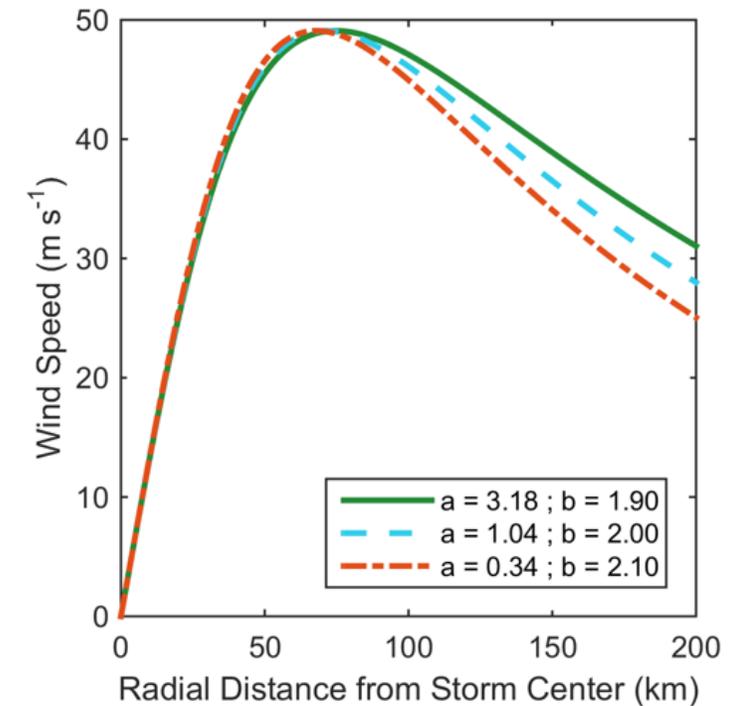
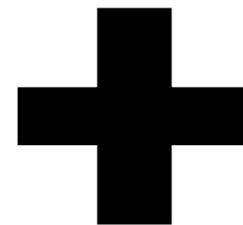
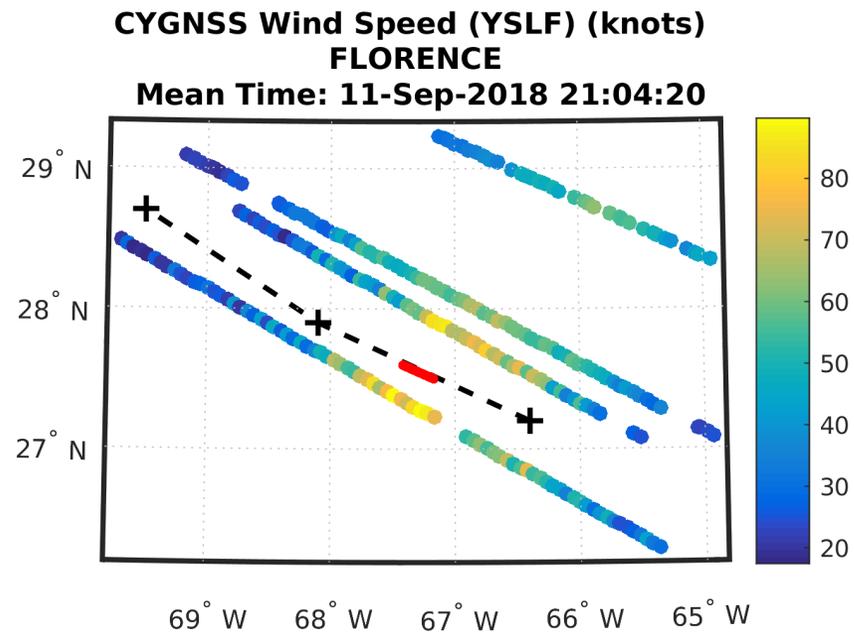
# Challenge: CYGNSS-based diagnosis of TC structure, size

## Challenges:

- Pseudo-random sub-sampling
- Noisy observations
- 25-km Resolution

## Solution:

- Use a parametric wind model to connect tracks

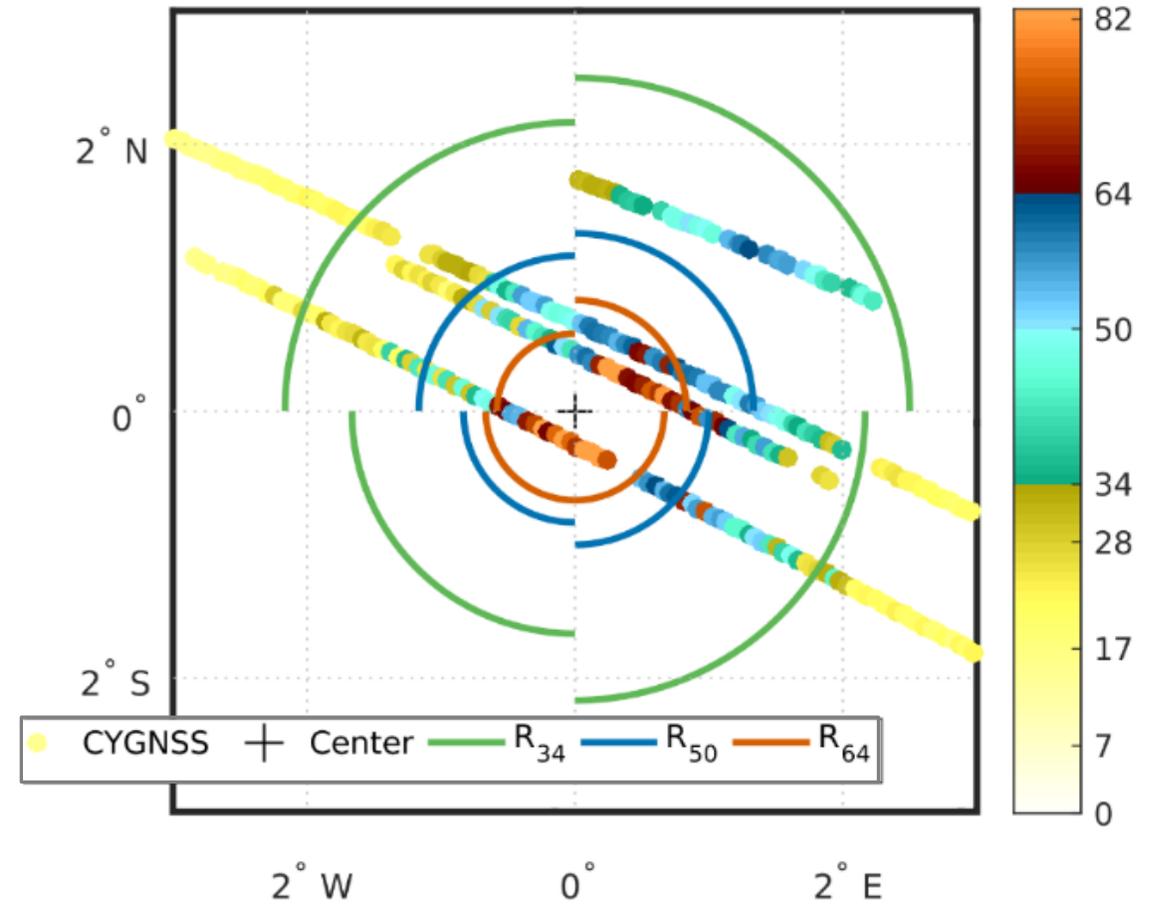


# Preliminary Example: Hurricane Florence, 11-Sep-2018, ~ 21 UTC

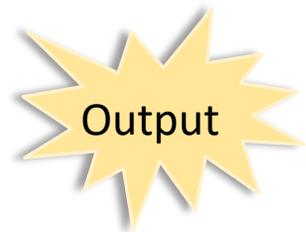
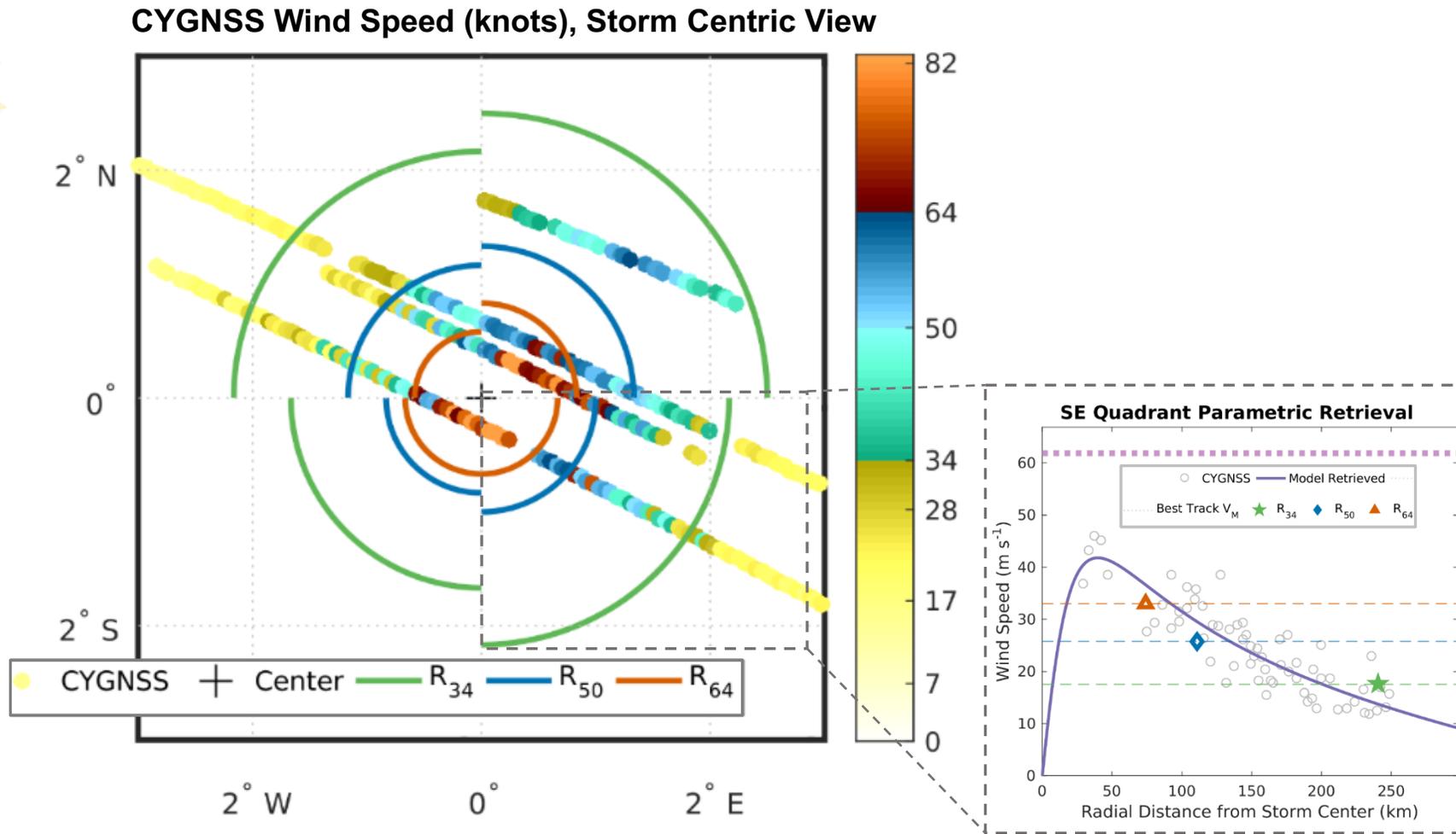
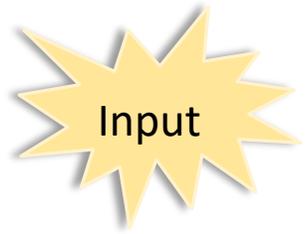
Procedure:

1. Coordinate transformation → storm centric
2. Subset observations within quadrant
3. Parametric Wind Model Algorithm

## CYGNSS Wind Speed (knots) Storm Centric View

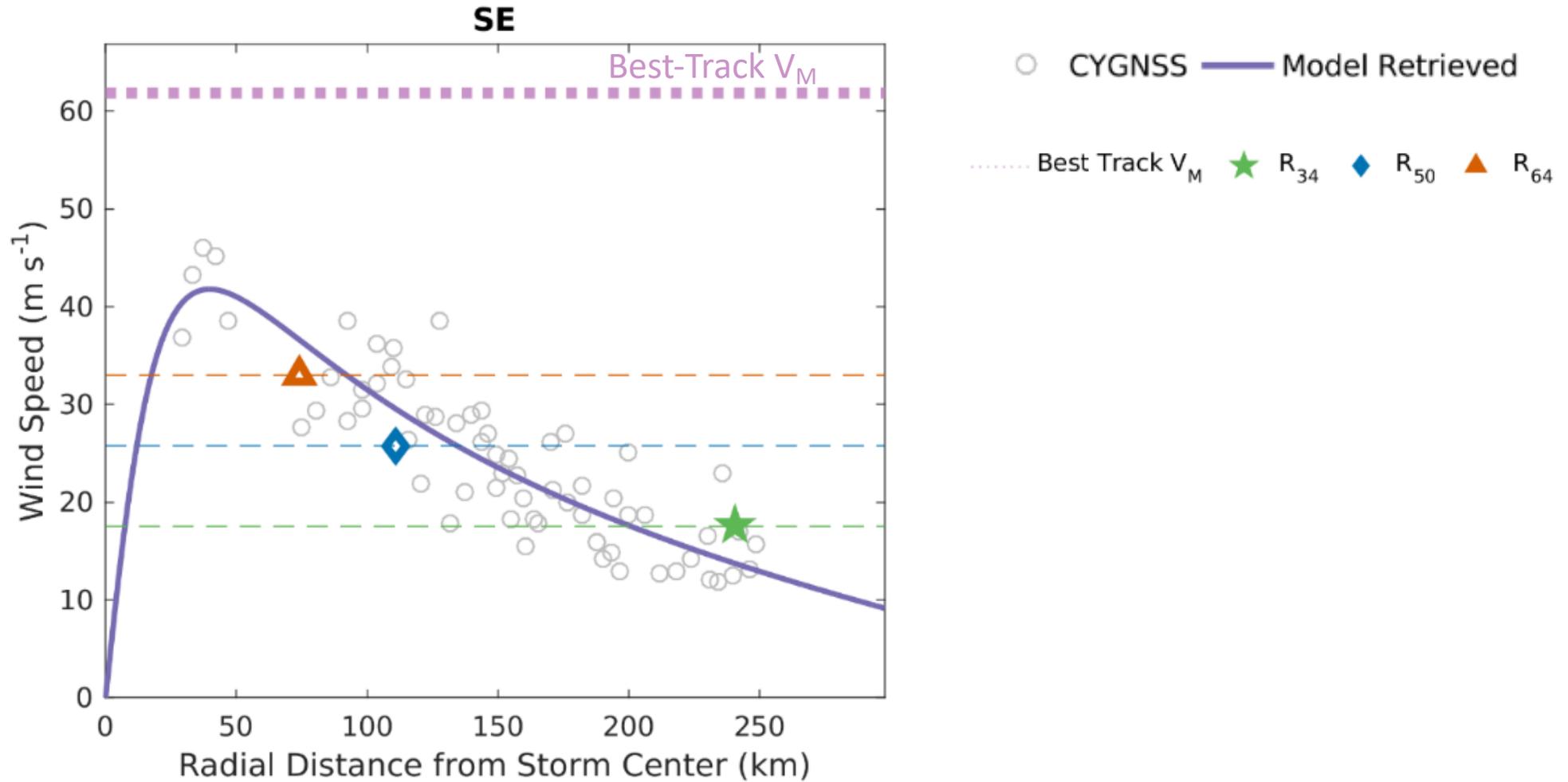


# Preliminary Example: Hurricane Florence, 11-Sep-2018, ~ 21 UTC



# SE Quadrant Retrieval

Preliminary Example: Hurricane Florence, 11-Sep-2018, ~ 21 UTC



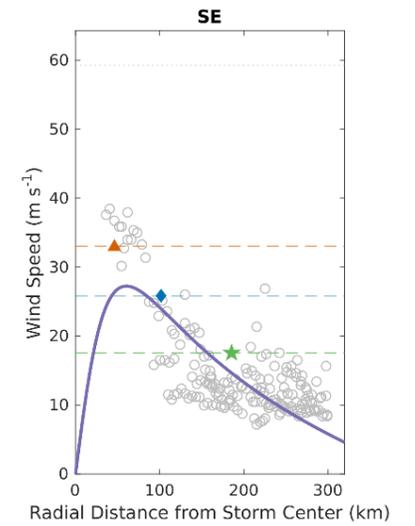
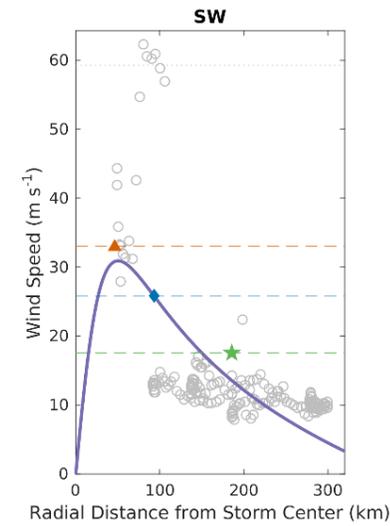
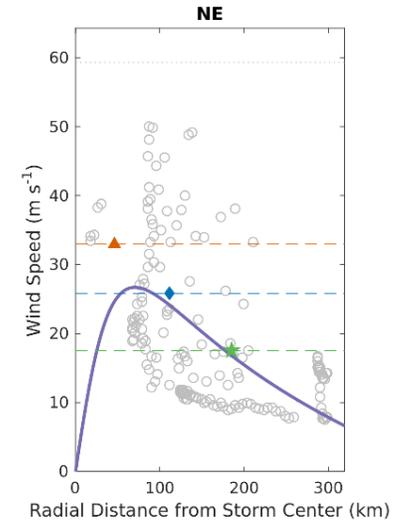
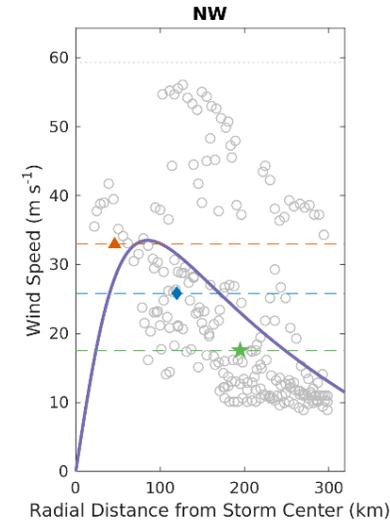
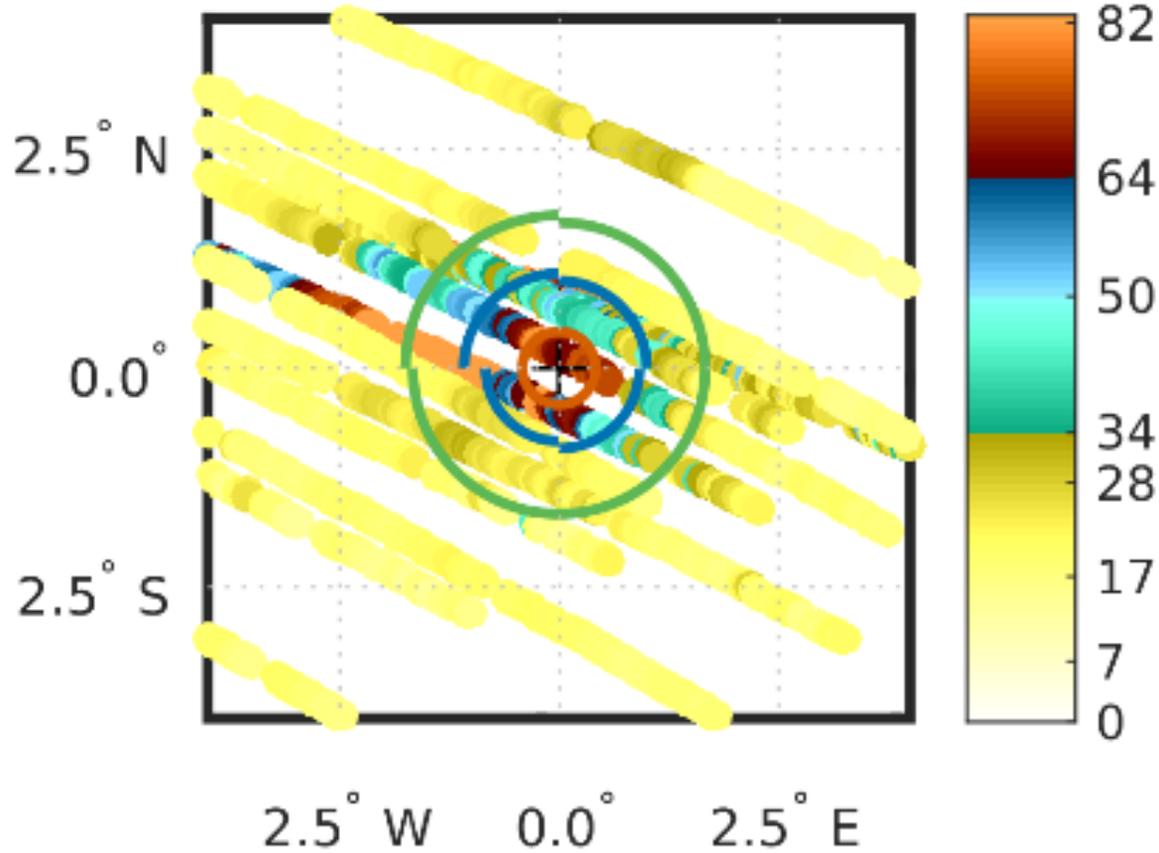
# Examples

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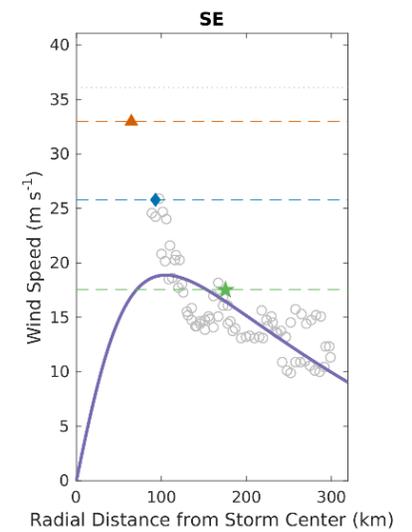
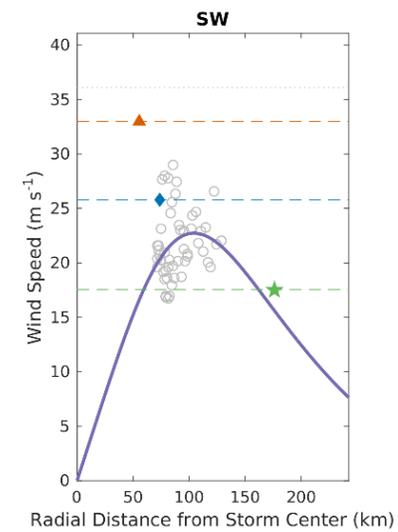
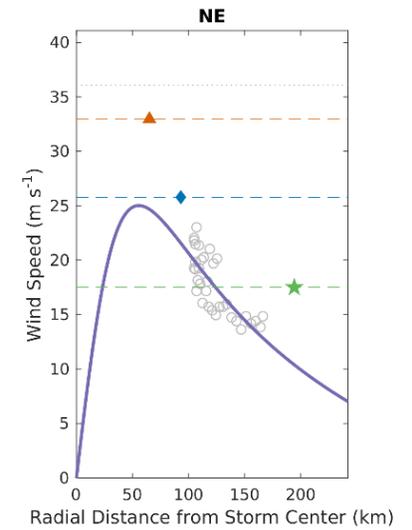
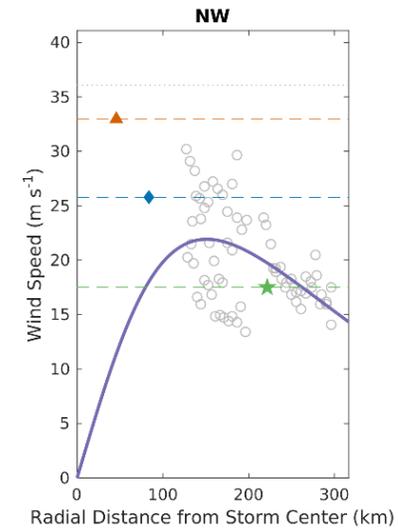
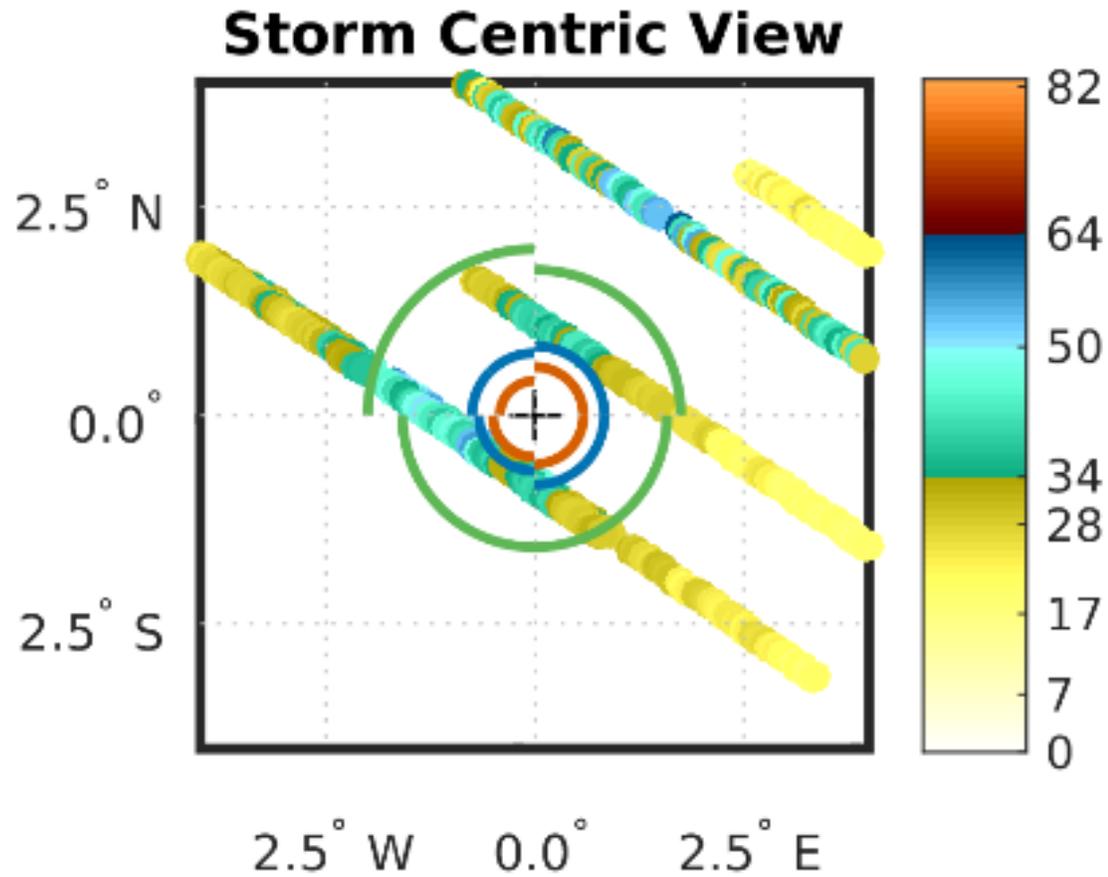
2017 DATA

NORU 10:13 30-Jul  $\Rightarrow$  11:54 30-Jul-2017

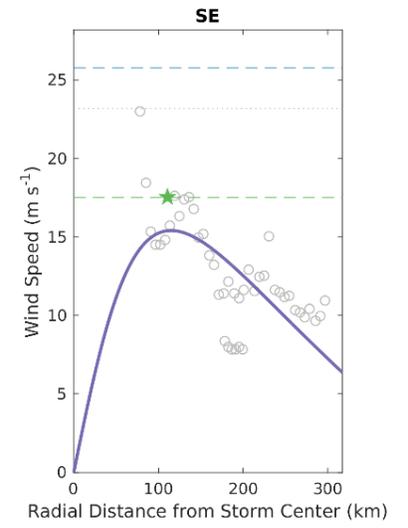
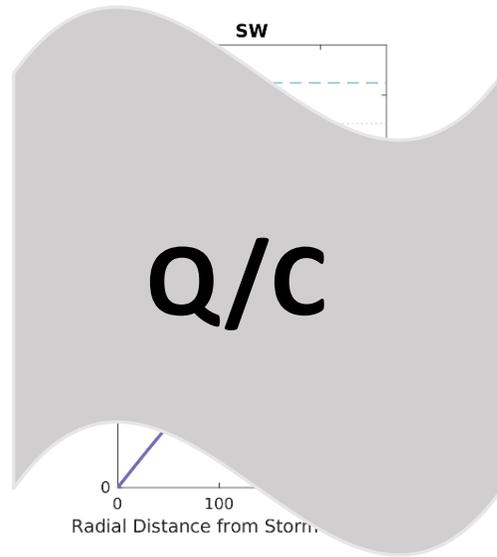
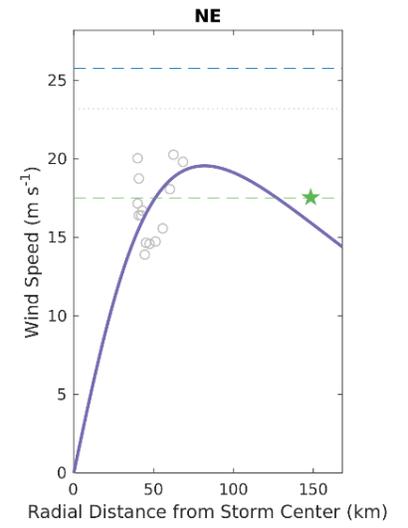
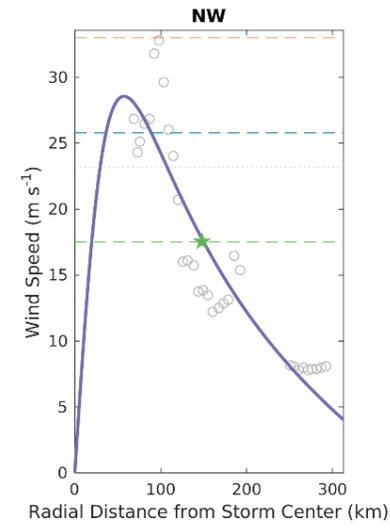
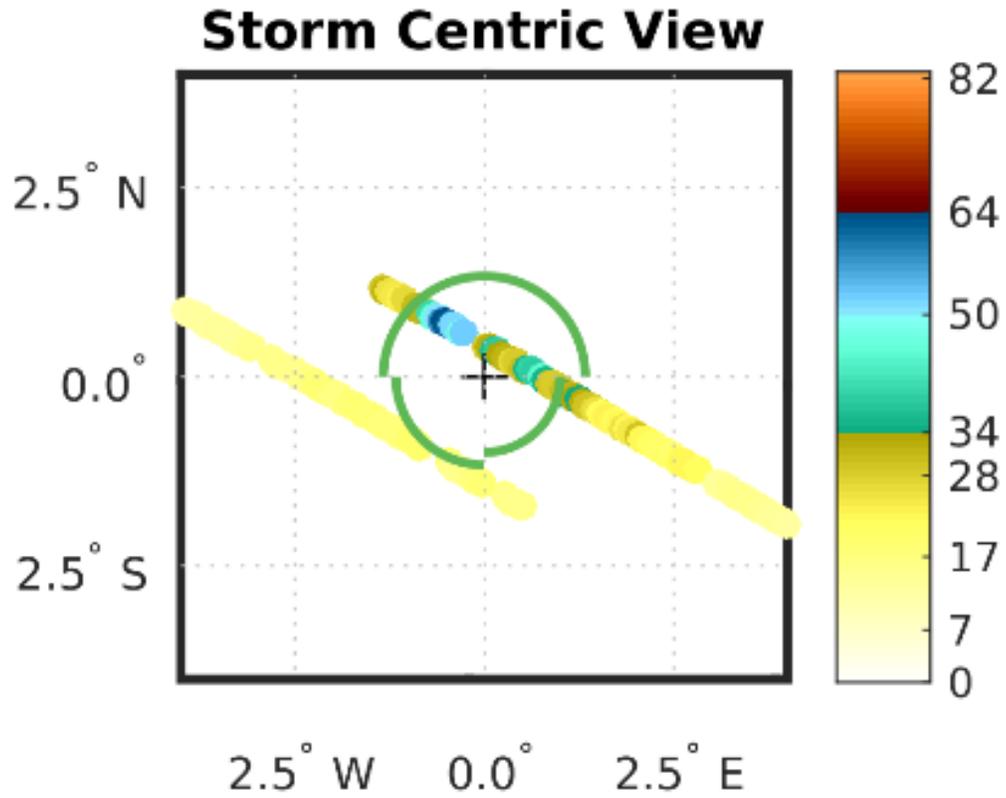
### Storm Centric View



OCKHI 04:45 04-Dec  $\Rightarrow$  04:59 04-Dec-2017

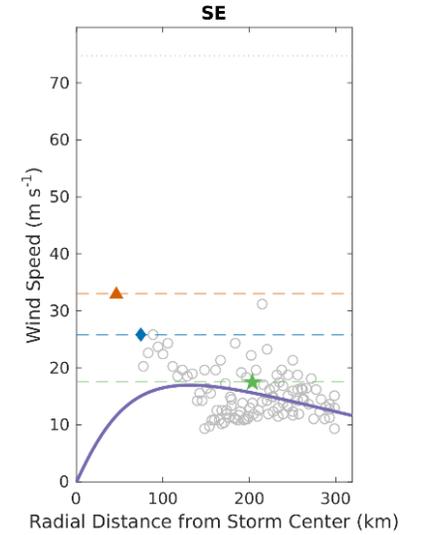
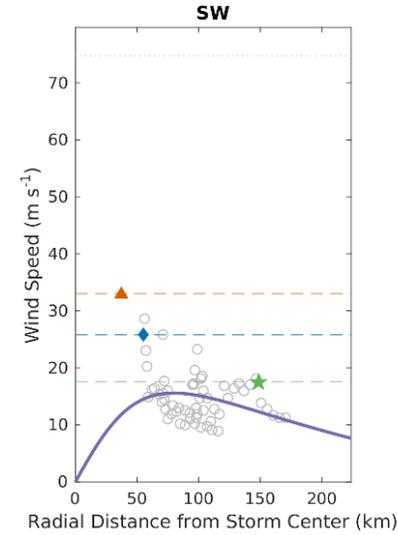
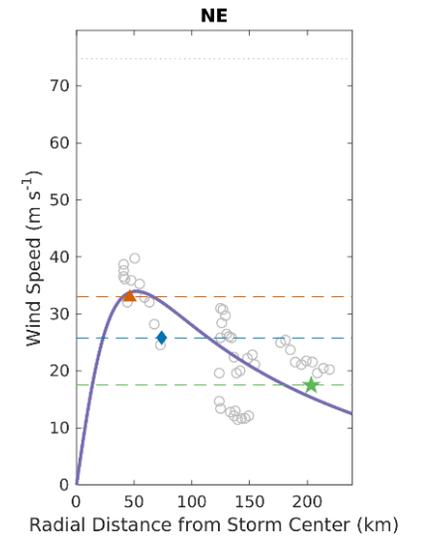
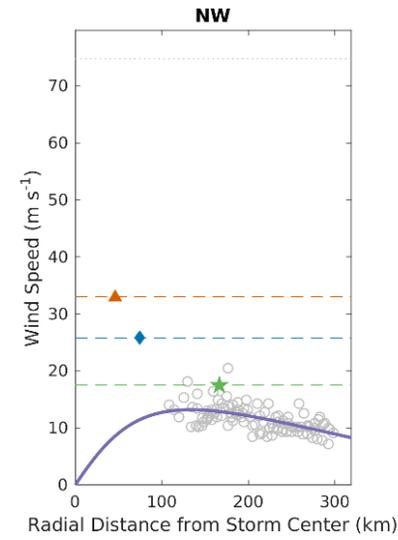
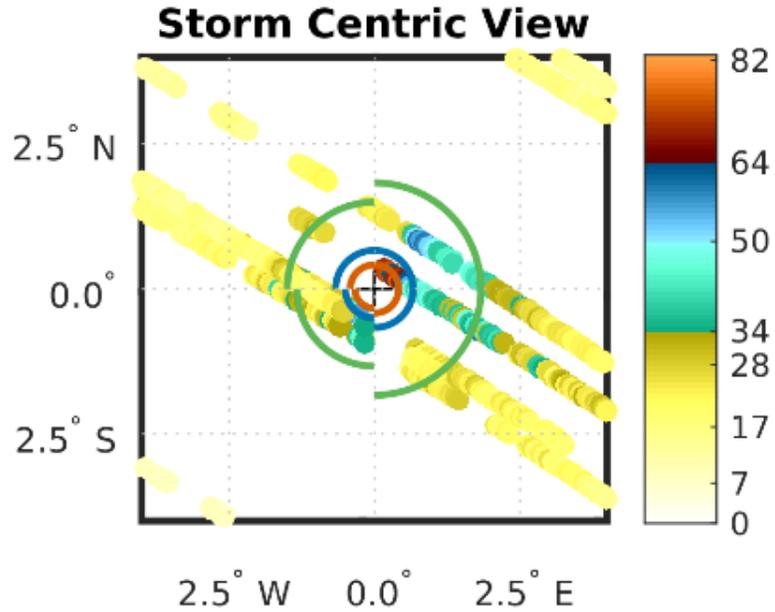
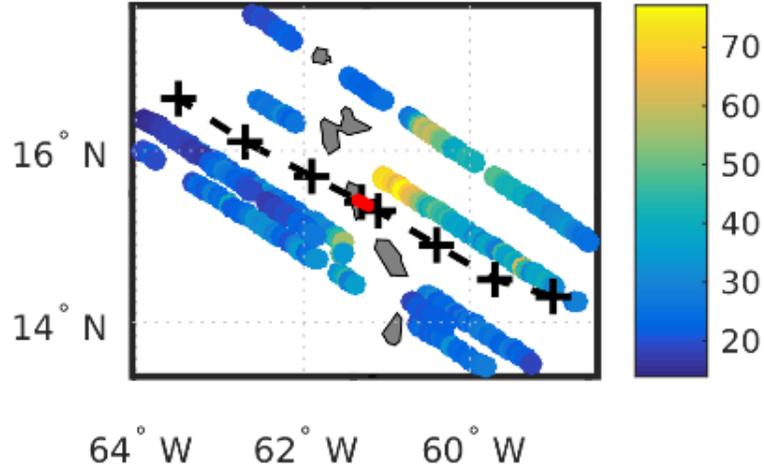


NORMA 04:59 17-Sep  $\Rightarrow$  05:14 17-Sep-2017



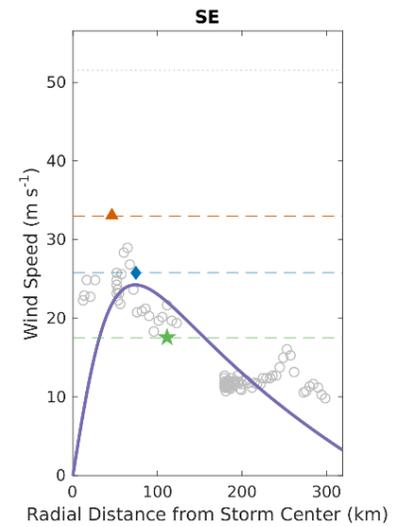
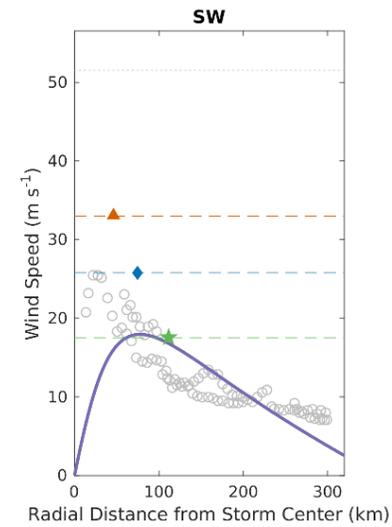
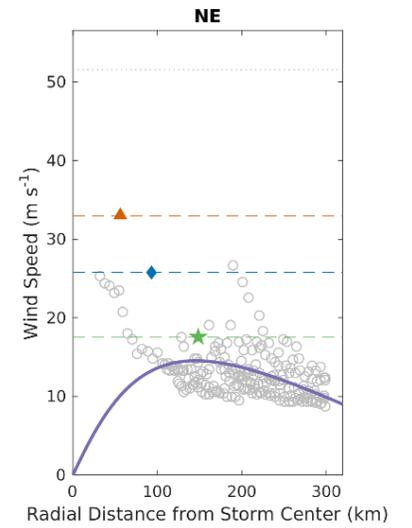
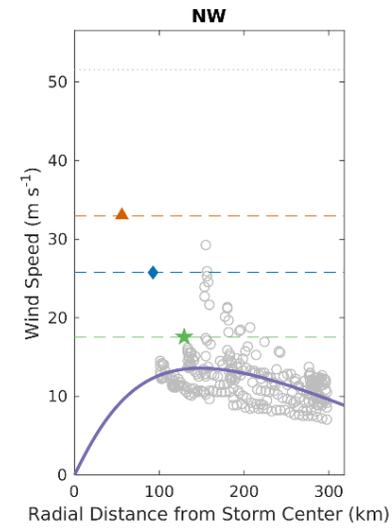
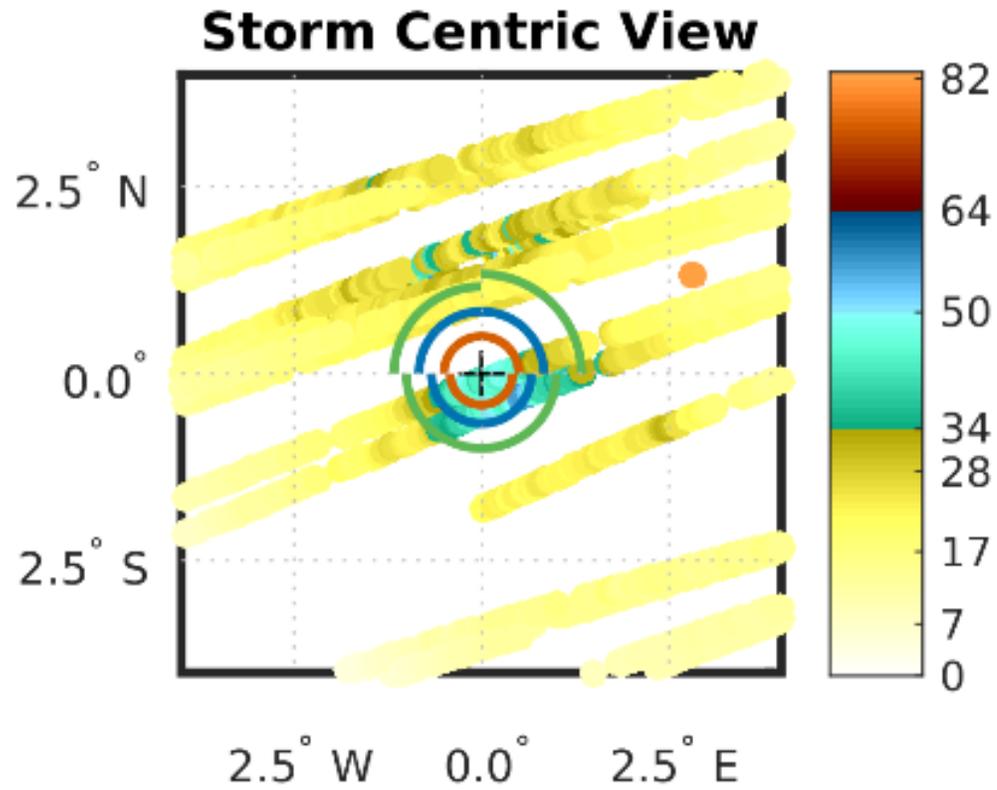
MARIA 00:44 19-Sep  $\Rightarrow$  01:35 19-Sep-2017

### CYGNSS Wind Speed (YSLF) (knots)



LEE 13:17 27-Sep  $\Rightarrow$  14:16 27-Sep-2017

RMW 15 nm!

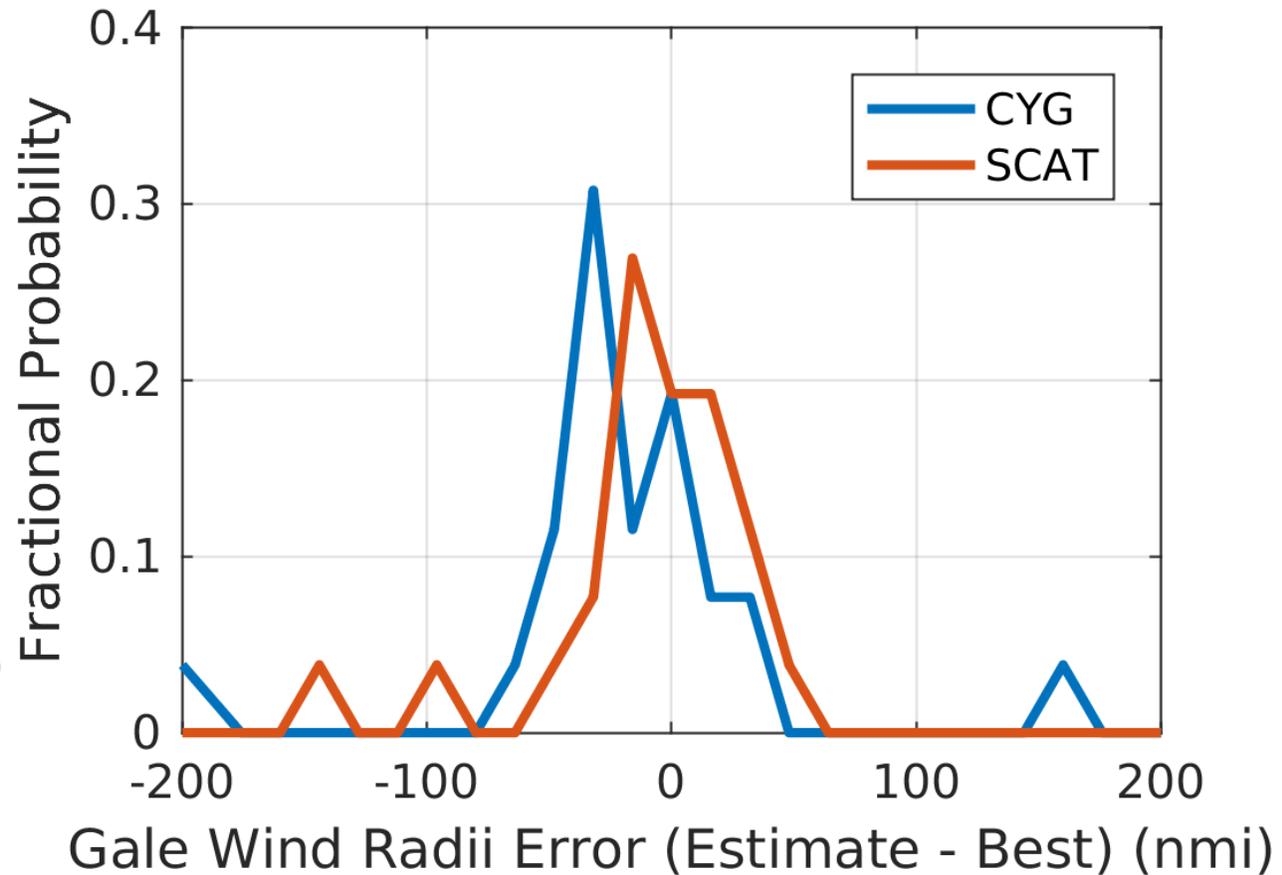
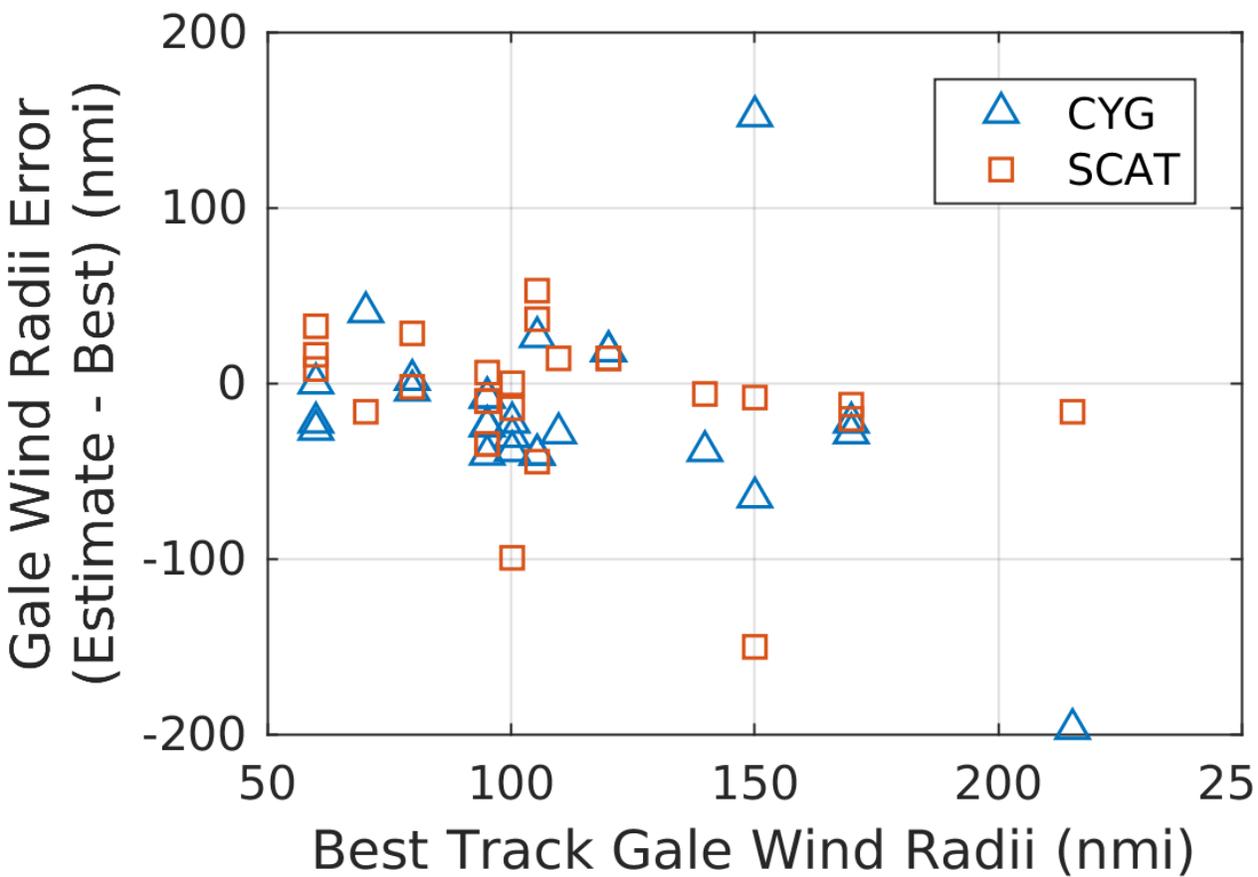


# Overall performance stats

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2017 DATA, CASES WITH SCATTEROMETER DATA AVAILABLE FOR  
COMPARISON

# Compare Cases within 1.2 hours



# Summary

**Objective estimates** of gale wind radii from scatterometers and CYGNSS **compared**

CYGNSS-based estimates of gale wind radii are shown here to be **promising**

CYGNSS could be **complimentary** to scatterometry for these applications

**Future work** includes further evaluation of all the products developed originally in Morris and Ruf (2017a,b)

- Morris, M., and C. Ruf, “Estimating Tropical Cyclone Integrated Kinetic Energy with the CYGNSS Satellite Constellation,” *J. Appl. Meteor. Climatol.*, 2017.
- Morris, M., and C. Ruf, “Determining Tropical Cyclone Surface Wind Speed Structure and Intensity with the CYGNSS Satellite Constellation,” *J. Appl. Meteor. Climatol.*, 2017.

# Acknowledgments:

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*Buck Sampson (NRL)*

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For more information, contact Mary Morris:

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