

# The Rain, Ocean, and Atmosphere Radar System (ROARS) The 2025 Hurricane Season

**Paul S. Chang<sup>1</sup>, Zorana Jelenak<sup>1,3</sup>, Joe Sapp<sup>1,2</sup>, and Casey Shoup<sup>1,2</sup>**

<sup>1</sup>National Oceanic and Atmospheric Administration/NESDIS/STAR,

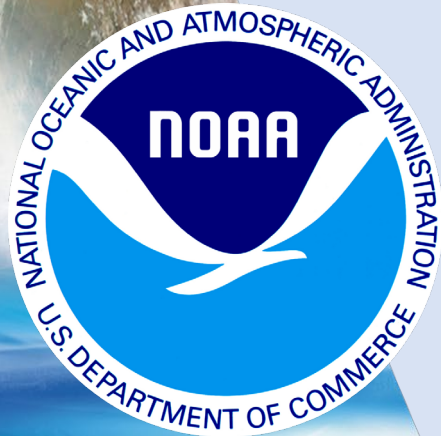
<sup>2</sup>Global Science & Technology, Inc. (GST),

<sup>3</sup>University Corporation for Atmospheric Research (UCAR)

**Tim Maese, Jim Carswell, Richard Roy, Jim Hunziker, Cliff Cobb and Emily Mazzola**

**Agile Radar**

**NOAA Aircraft Operations Center**

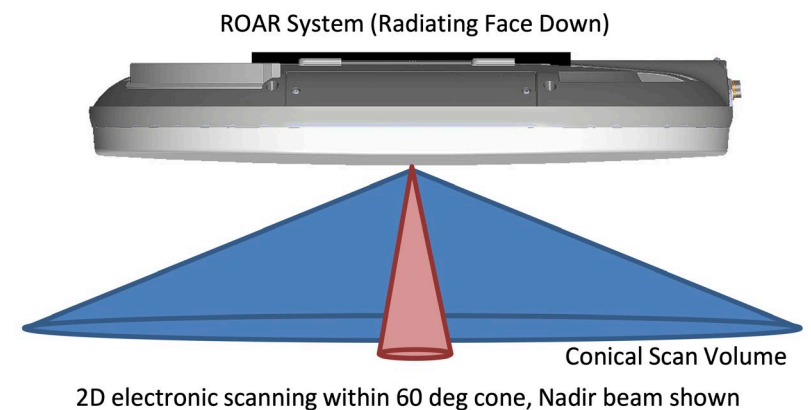


**National Environmental  
Satellite, Data, and Information  
Service**

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# Rain, Ocean and Atmosphere Radar System: ROARS

- An innovative radar system that combines the functionality of a **Doppler profiling radar, altimeter and scatterometer** into a single compact and robust radar system
  - Dual frequency (X-band and Ku-band)
  - Electronically steerable dual frequency antenna
    - 360 degrees in azimuth and out to 60 degrees from nadir
    - Automatic compensation for aircraft attitude changes



# ROARS– Rain, Ocean, Atmosphere Radar System



SPECIFICATION	ROARS X-Ku Band Radar (Single Face)
Frequency Range	13.75 to 14.5 GHz (Beam 1) <b>14.25 GHz</b> 10.7 to 12.5 GHz (Beam 2) <b>11.6 GHz</b>
Peak Transmit Power	80W (up to 50% duty) on each beam (minimum)
Electronic Scan Volume	± 60° Azimuth and Elevation
Antenna Gain / Beamwidth	Up to 34 dBi (Beam 1) – 2 degree (boresight) Up to 35 dBi (Beam 2) – 2.2 degree (boresight)
Polarization	Electronically Variable Linear (V, H, slant, etc.)
Weather Detection (< 18 dBZ)	> 100 km (no attenuation)
PRF Ranges	10 Hz to 25 kHz
Pulse Widths	0.1 us to 100 us, LFM or CW pulses
Power Consumption (@ 10% transmit duty)	~ 500 W @ 24-36 VDC input power (max)
Weight	~38 kg (not including mounting structure)
Temperature Range	-40 °C to +70 °C (operating) -40 °C to +85 °C (storage)

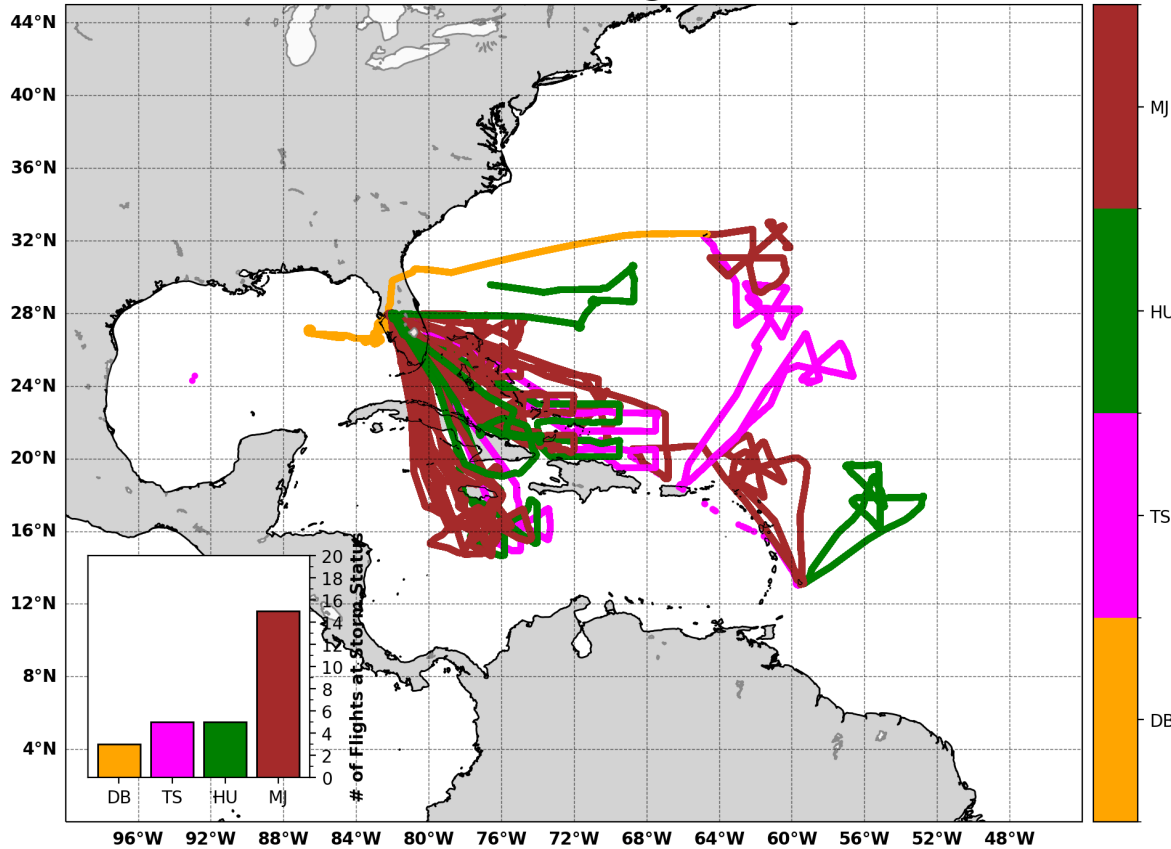


# ROARS P3 Evolution

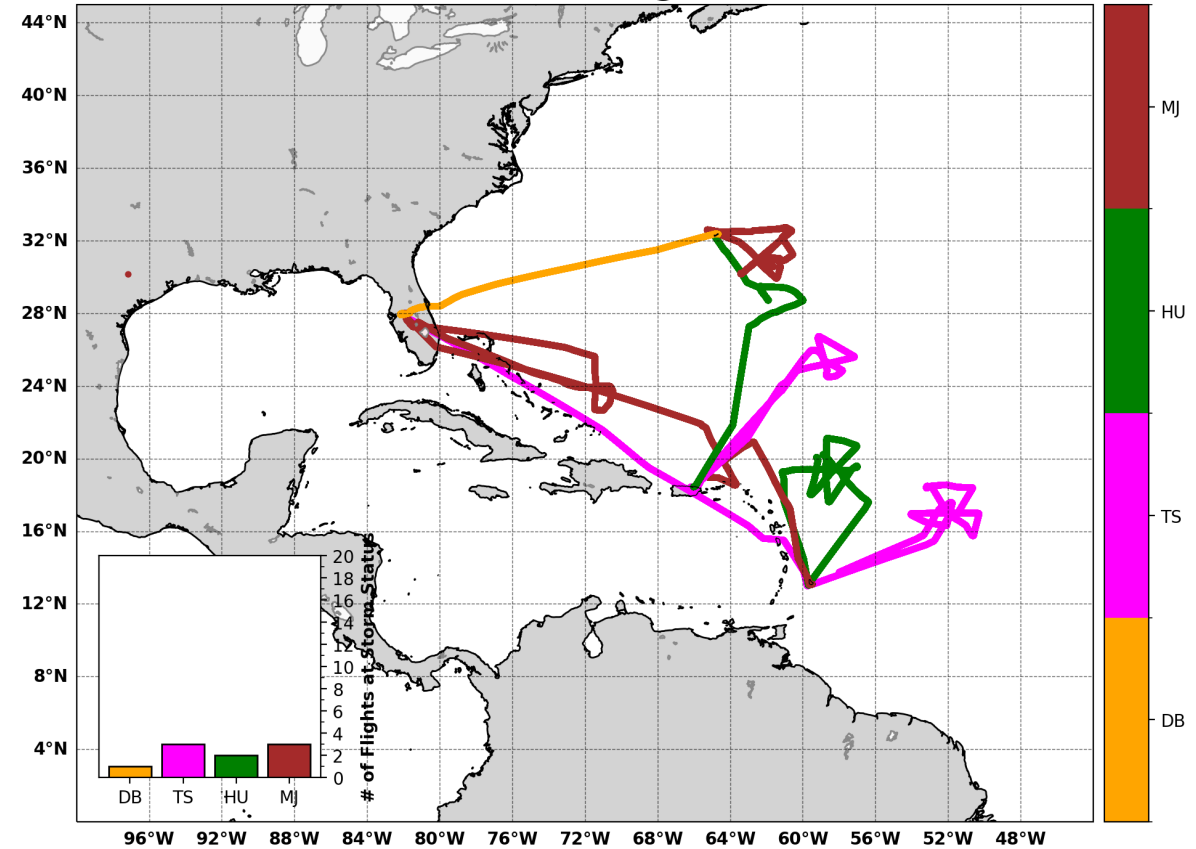
- First generation ROARS initially installed on N42 during the Ocean Winds Winter 2025 experiment
  - Many challenges with lots of knowledge gained
- Led to a collaboration to install a ROARS on each NOAA P-3 for the 2025 and 2026 hurricane season
  - 2025 hurricane season targeted instrument configuration testing and data collection for retrieval algorithm development
  - 2026 hurricane season objective is to have retrievals for Doppler winds, scatterometer winds and significant wave height running in real-time
- Planning for test flights in the beginning of the 2026 hurricane season when the tropics should still be quiet

# 2025 Hurricane Season Wind Collections with ROARS

2025 Hurricane Season Flight Paths (N42RF)



2025 Hurricane Season Flight Paths (N43RF)



Installed on N43: ROARS (Ku-band)  
IWRAP  
KaIA

Installed on N42: ROARS (Ku, X-band)

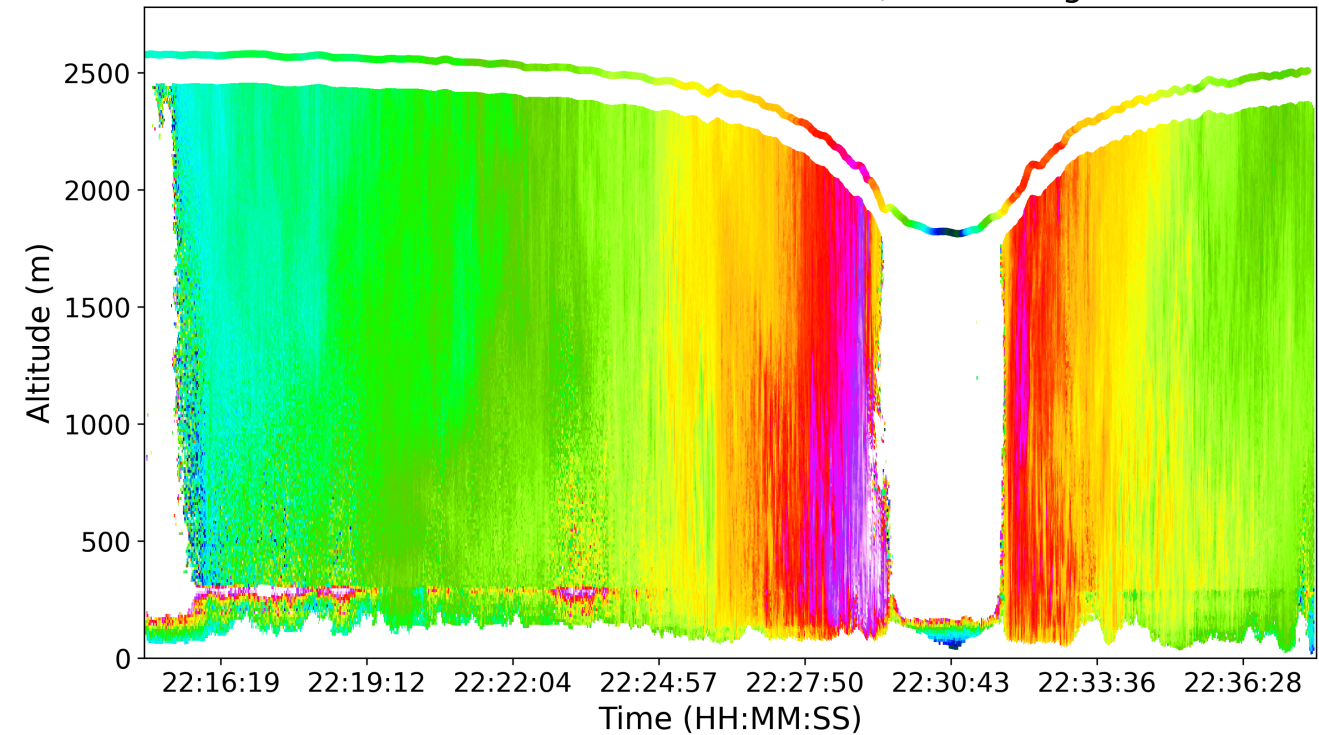


# Hurricane Melissa 3D Atmospheric Wind Observation with ROARS

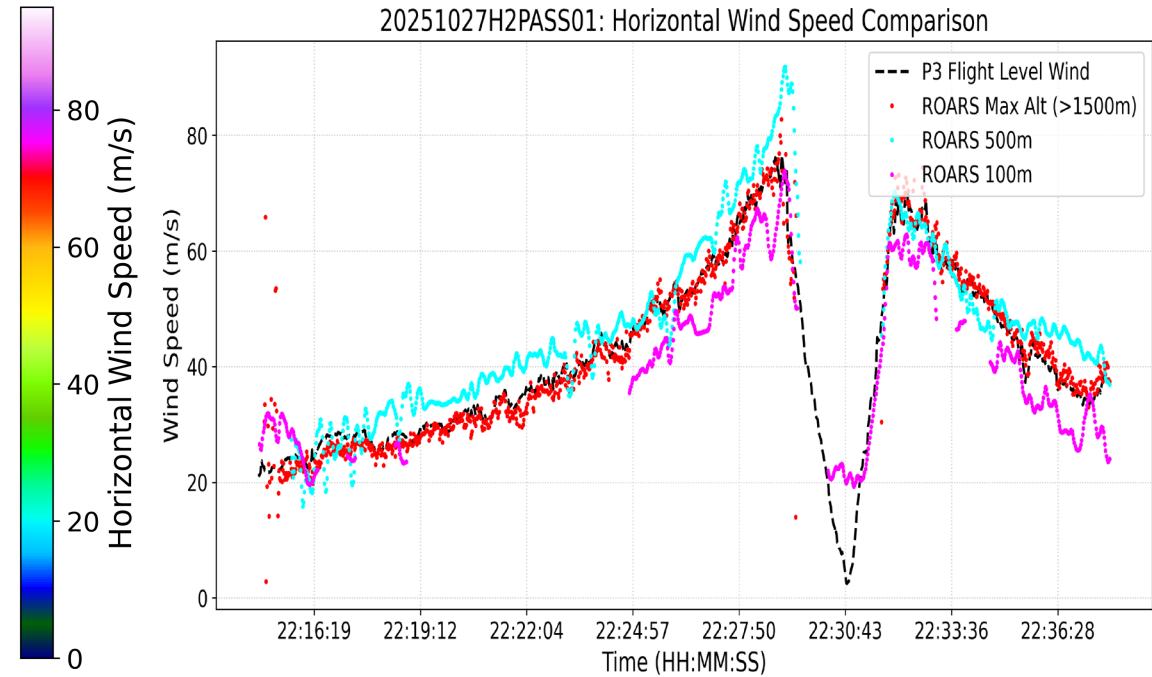
- **Preliminary Doppler wind plots** derived from X-band pulse-pair (short-pulse) data; aircraft motion has been removed.
- **Near-surface winds (~100 m)** are contaminated by surface returns; interpret with caution. This limitation is expected to be mitigated with spectral wind retrievals.
- **500 m winds** are not affected by surface contamination and are more reliable in these plots.
- **Low-scatterer regions (little or no rain)** produce noisy wind retrievals, most evident in the hurricane center.
- **Outbound pass 20251028H1** shows Doppler velocity folding, visible as abrupt transitions from high to much lower wind speeds.
- **Color scale limits** vary between some plots.
- **Significant Wave Height (SWH)** results are very preliminary, based on the KaIA SWH retrieval, and do not yet account for ROARS instrument specifics.

# Hurricane Melissa 20251027H2

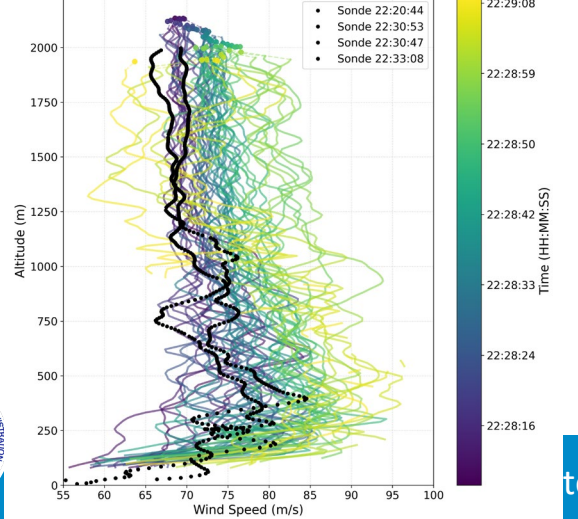
## 20251027H2PASS01: Horizontal Wind Profiles (with P3 Flight Track Overlay)



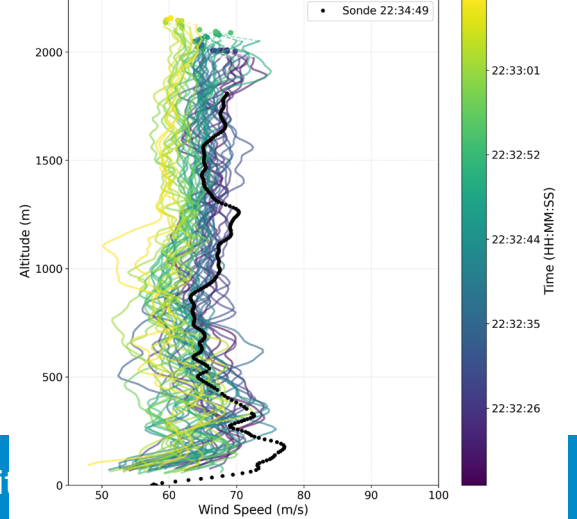
## 20251027H2PASS01: Horizontal Wind Speed Comparison



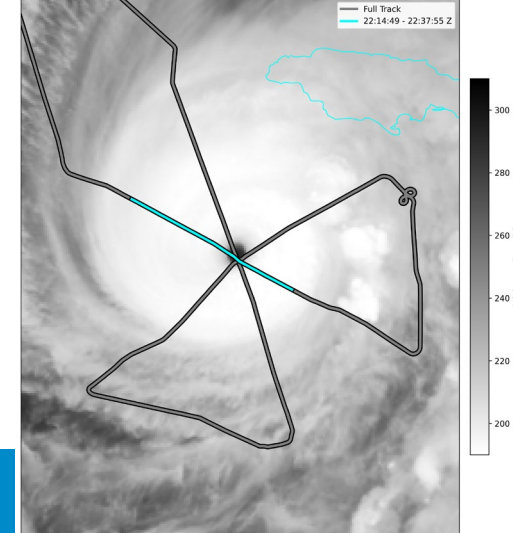
## 20251027H2PASS01: Inbound Wind Profiles (800-860s)



## 20251027H2PASS01: Outbound Wind Profiles (1050-1100s)



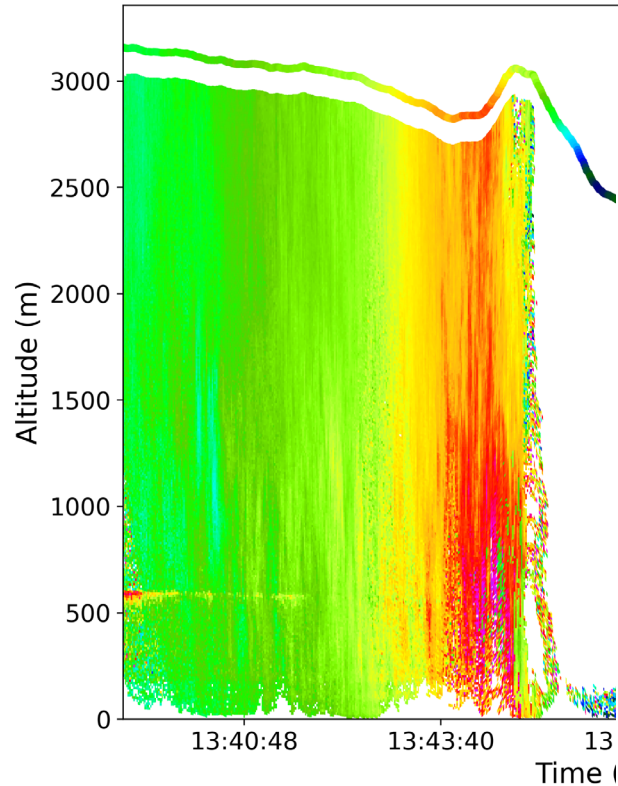
## Hurricane Melissa (IR Night) 2025-10-27 Flight



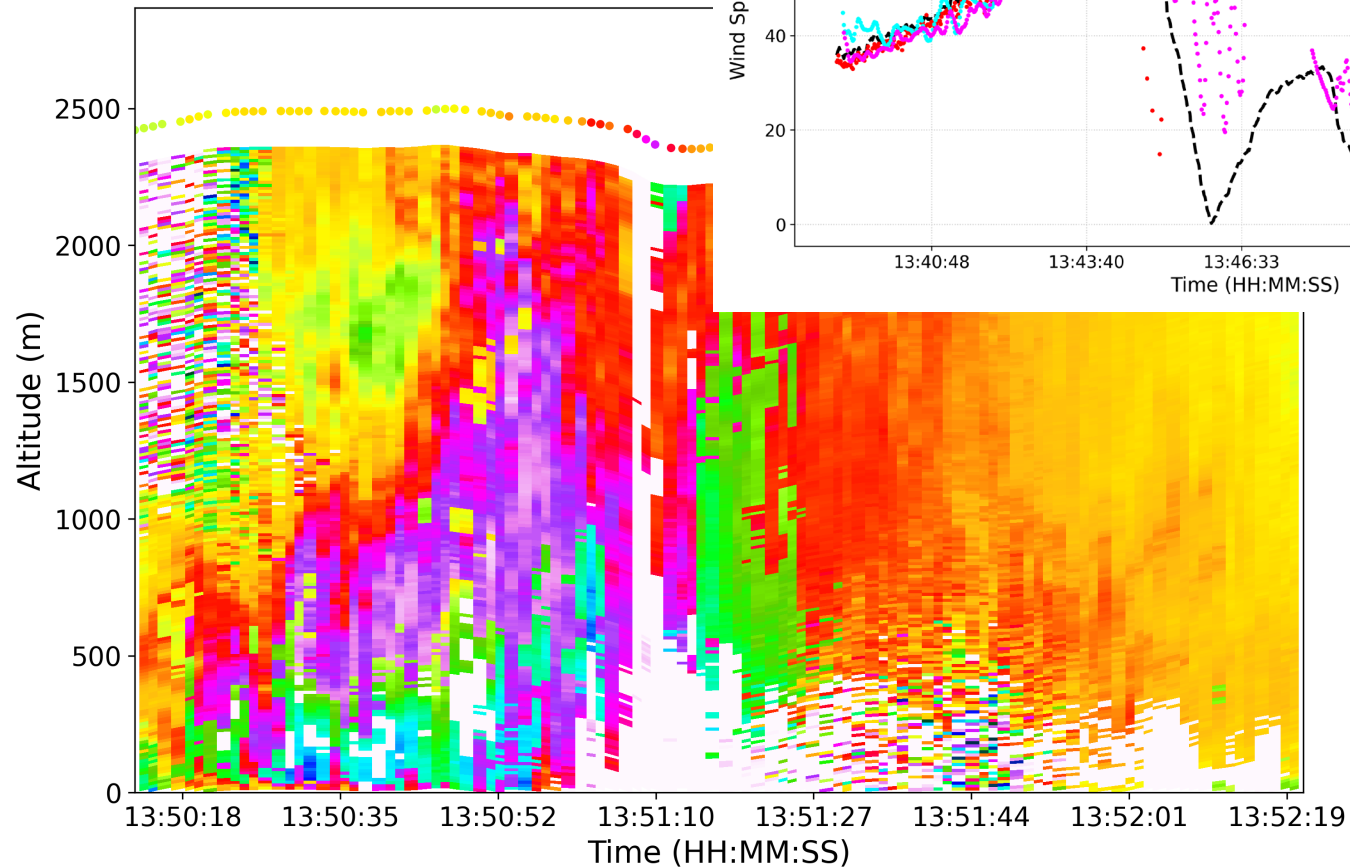
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# Hurricane Melissa 20251028H1

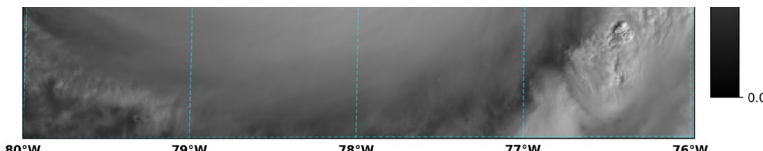
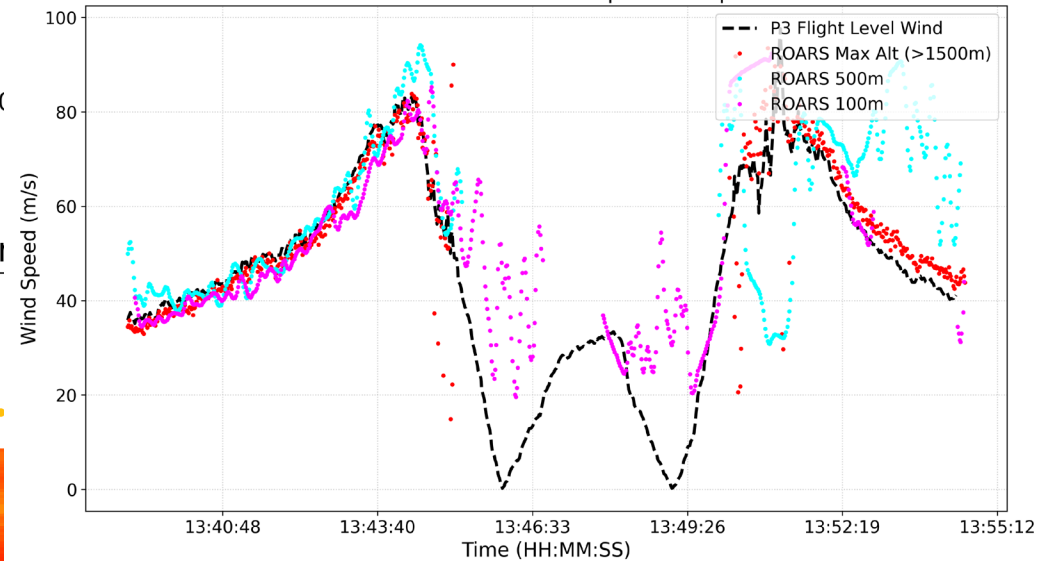
20251028H1PASS01: Horizontal Wind Profiles (with P3 Flight Track Overlay)



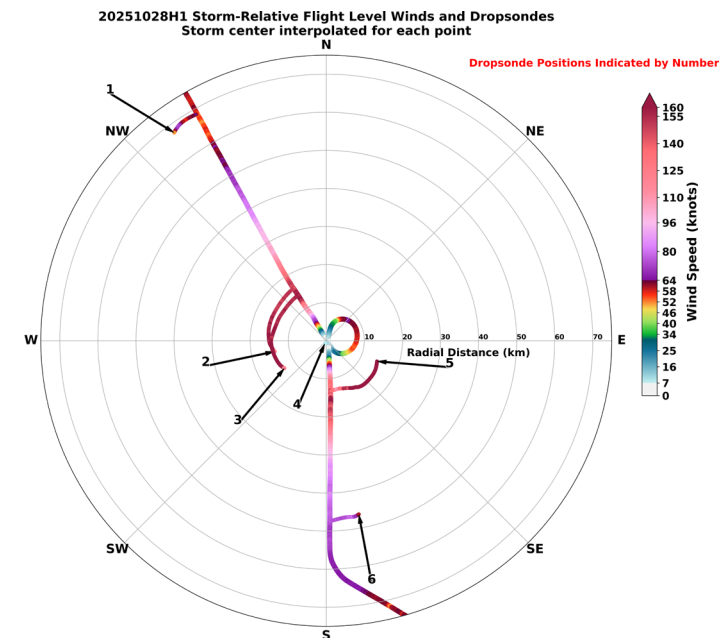
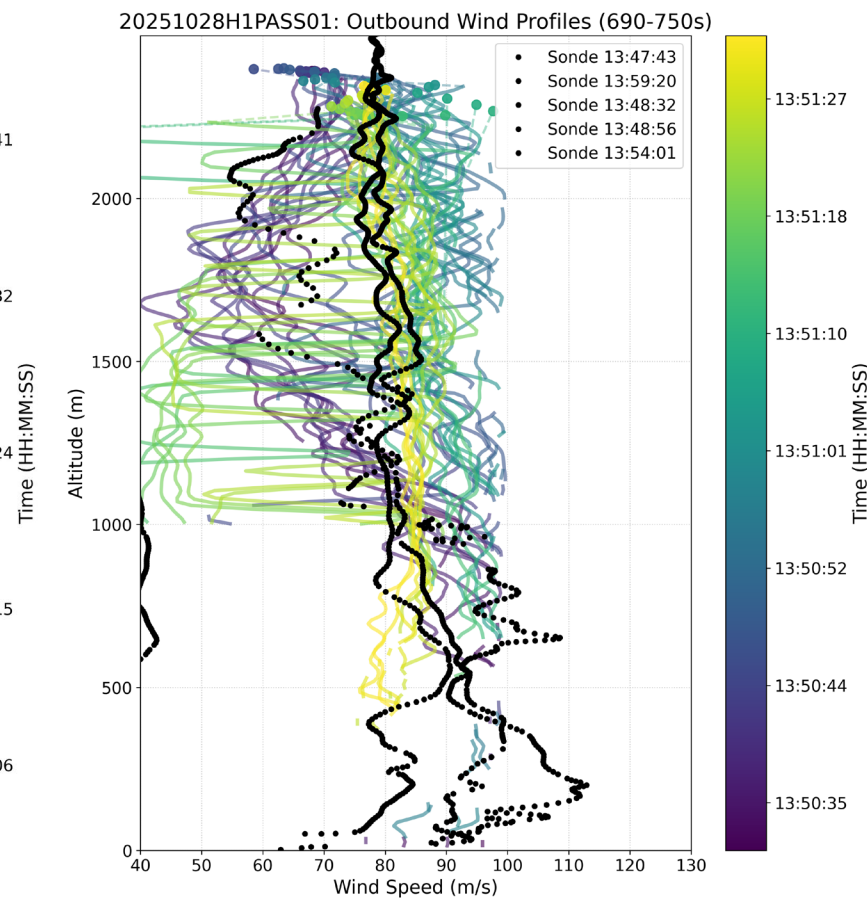
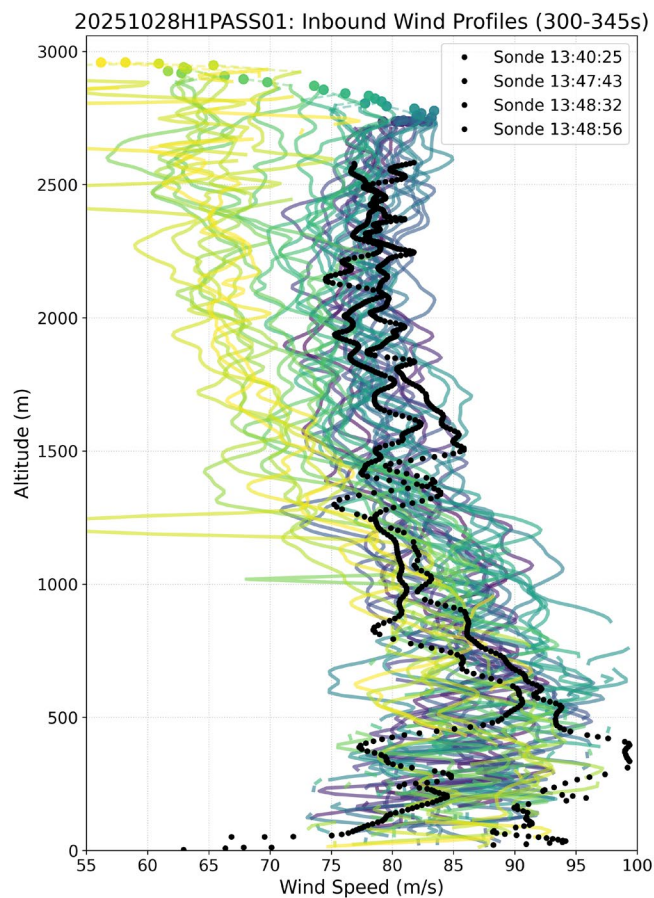
20251028H1PASS01: Zoomed Outbound



20251028H1PASS01: Wind Speed Comparison

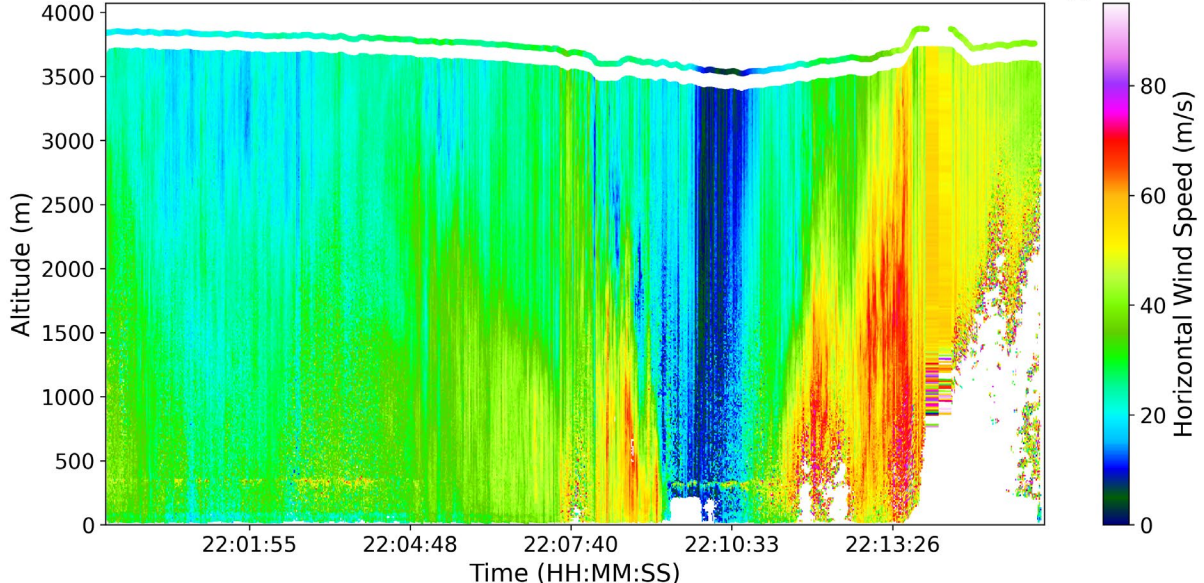


## Wind Profile Comparisons: Sonde vs ROARS

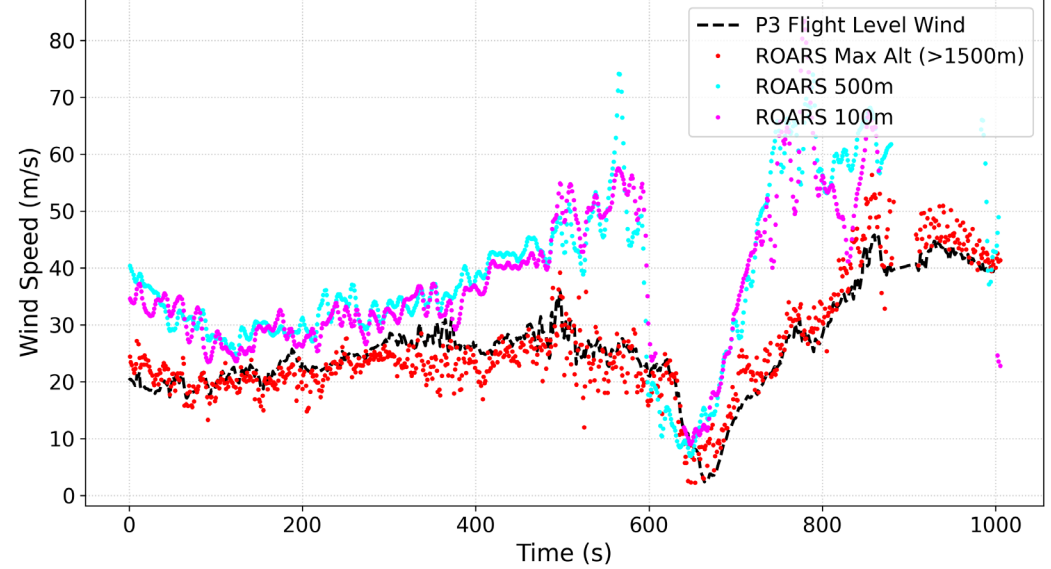


# Hurricane Melissa 20251028H2

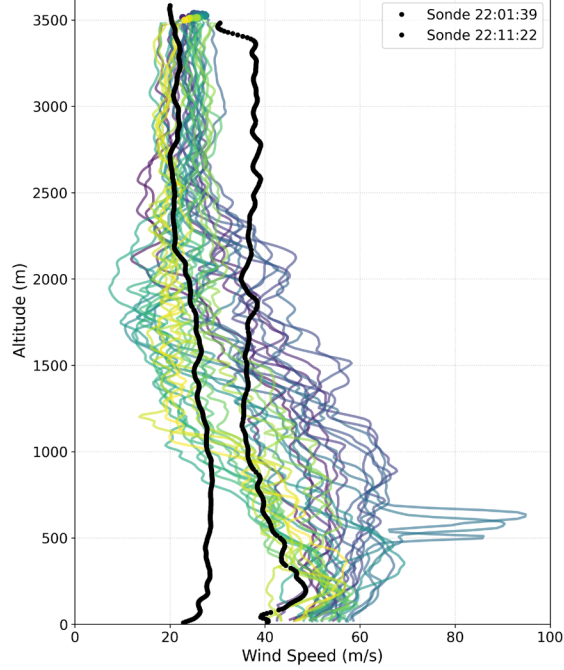
20251028H2PASS01: Horizontal Wind Profiles (with P3 Flight Track Overlay)



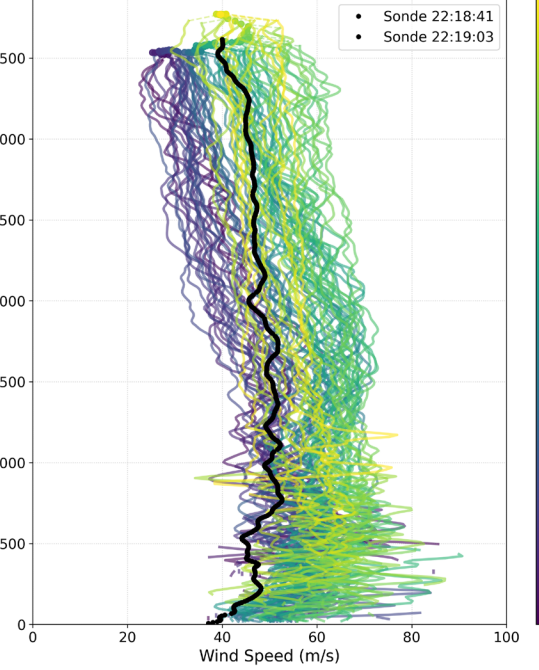
Horizontal Wind Speed Comparison at Different Altitudes



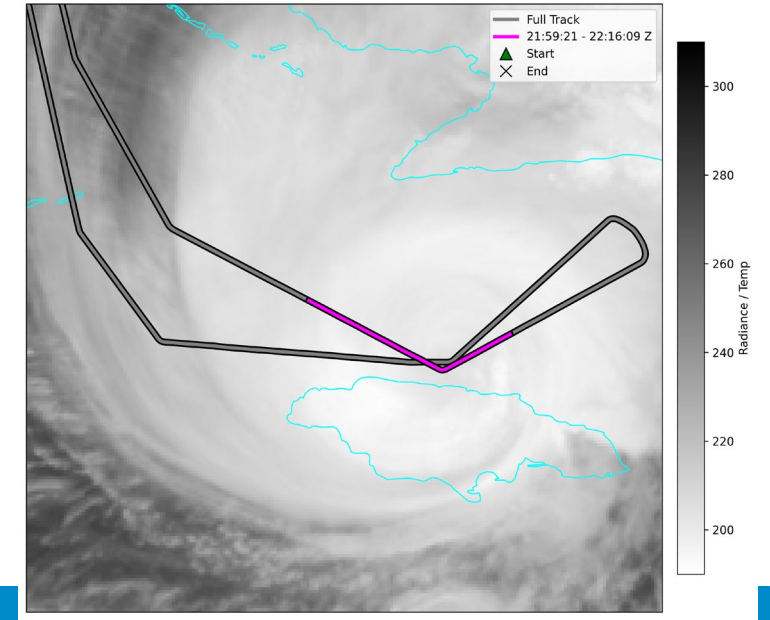
20251028H2PASS01: Inbound Wind Profiles (550-590s)



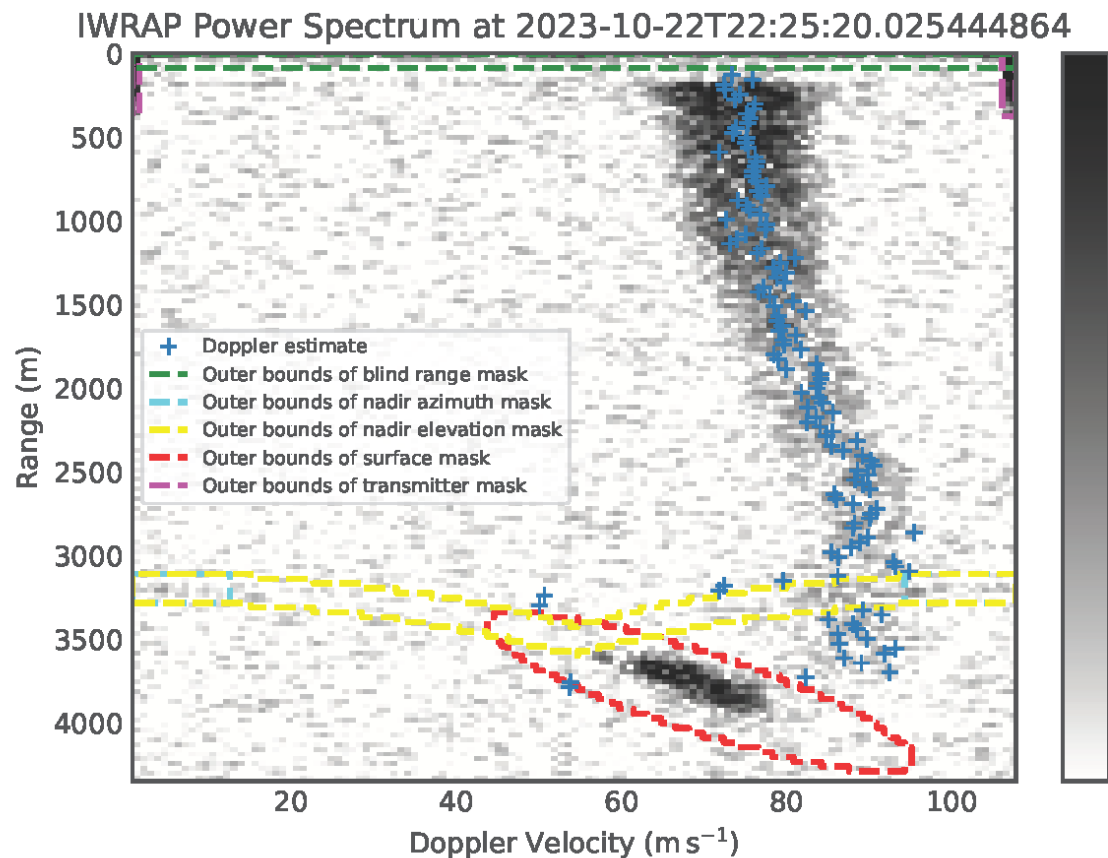
20251028H2PASS01: Outbound Wind Profiles (780-890s)



Flight Track Over Imagery 2025-10-28

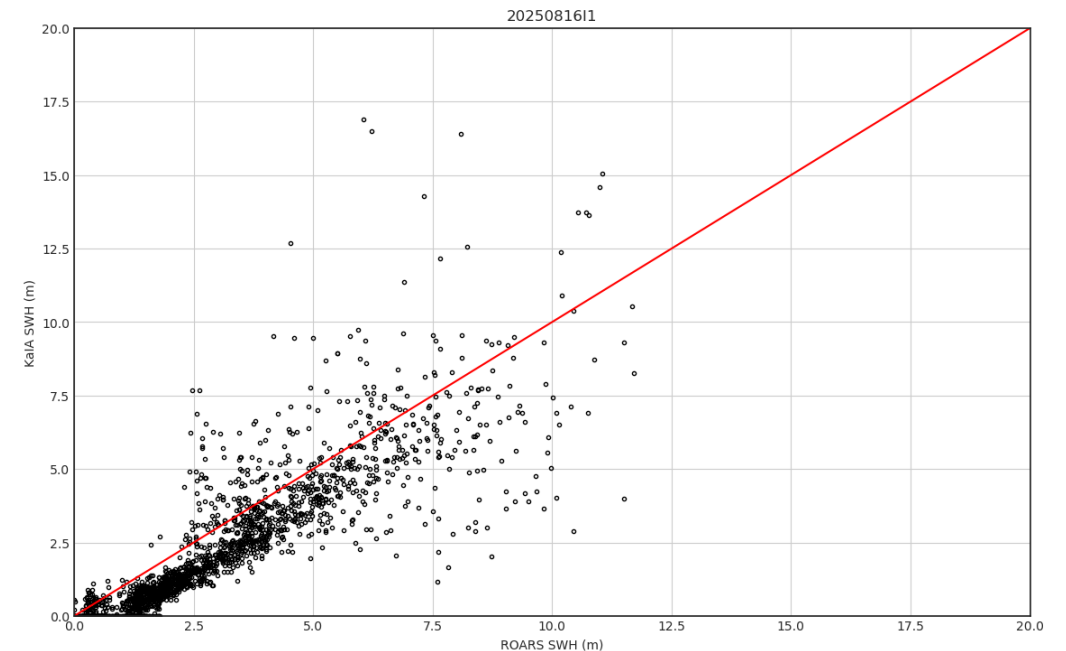
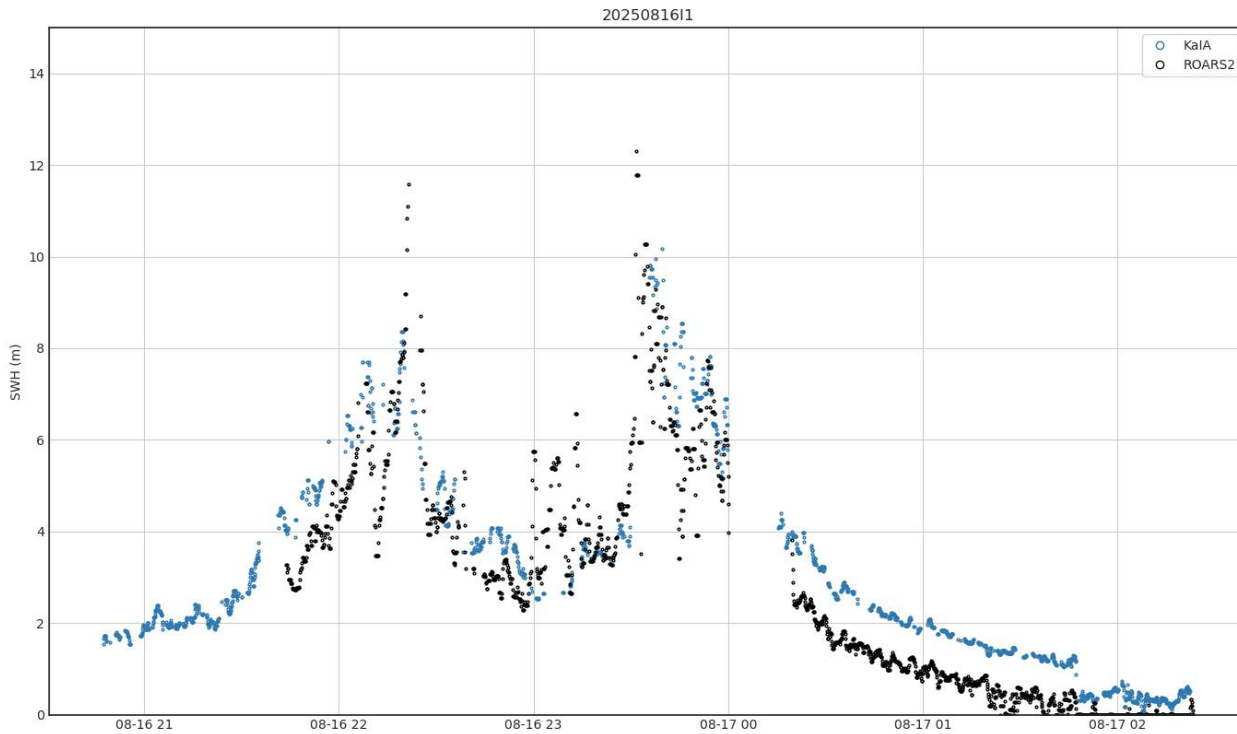


# Spectral Processing - Value Of Raw Measurement Collections



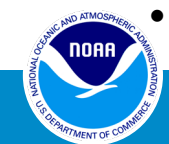
- At lower altitudes precipitation volume backscatter is contaminated by the 1) nadir reflection from the surface backscatter and the 2) surface backscatter at the range gates closer to the ocean.
- If not properly removed surface echo can bias wind
- High bias – surface mask too large
- Low bias – surface mask too small

# Very Preliminary ROARS Significant Wave Height Retrievals



ROARS data pushed through KaIA SWH processor

- ROARS data not fully calibrated yet
- SWH processor not configured specifically for ROARS



# Outcomes

- **Improved situational awareness** for hurricane specialists, directly supporting warning and forecast decisions
- **Increased value from reconnaissance flights** through expanded and higher-impact data products
- **Enhanced inner-core observations** to support high-resolution hurricane models
- **Improved model initialization and validation**
- **Advanced understanding of inner-core processes** and their role in tropical cyclone evolution
- **Improved forecast guidance** and more confident interpretation of observations
- **Independent validation for satellite observations** in the tropical cyclone environment
- **Validated satellite data** for operational use by forecasters and numerical models