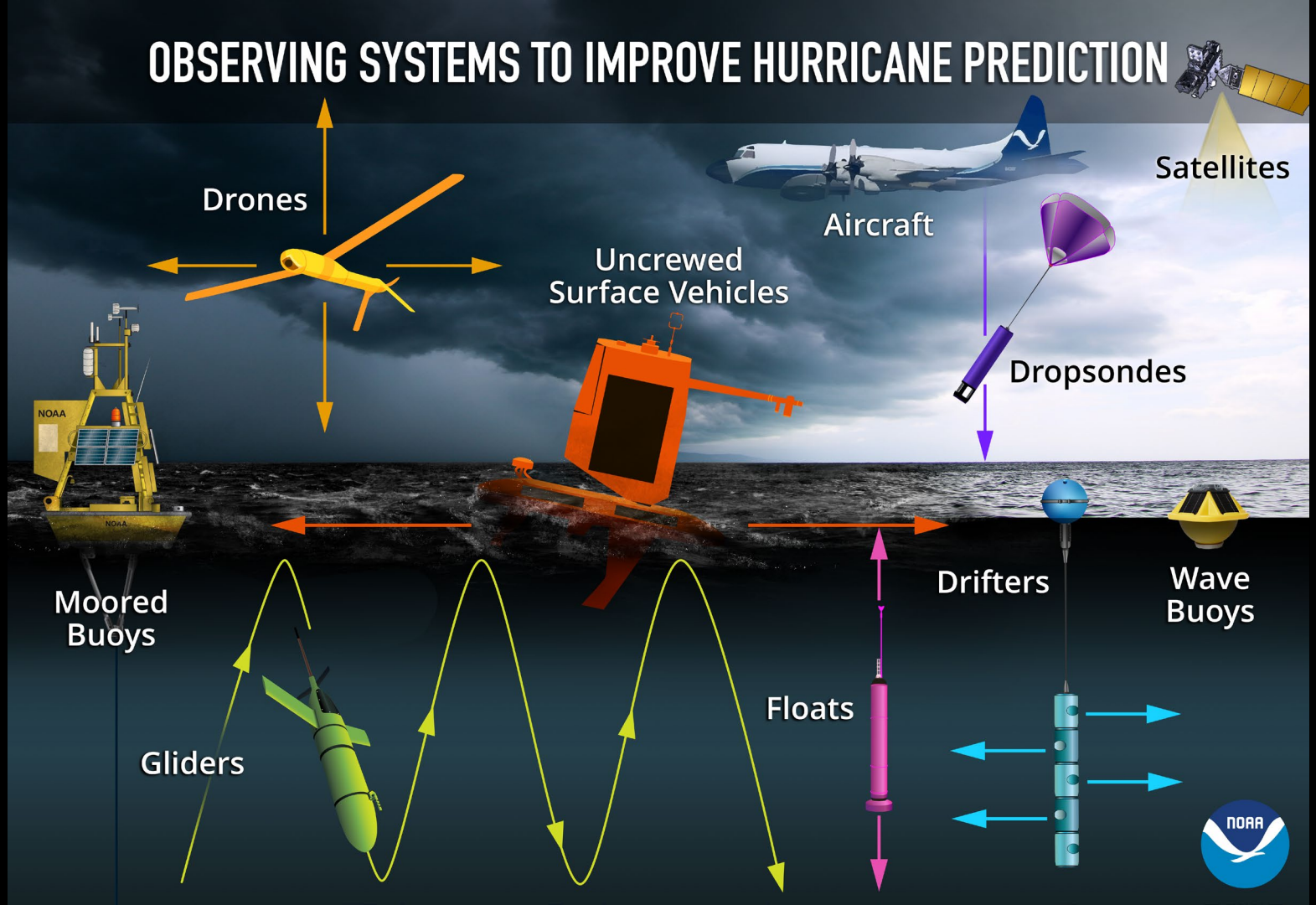

Oshen C-Star USV (2025)

Rutgers Hurricane Glider (2025)

# Uncrewed Marine Systems for Hurricane Observations

**Lev Looney (NOAA/AOML & UMiami/CIMAS)**, Gregory Foltz, Dongxiao Zhang, Grant Rawson, Cheyenne Stienbarger, Kathleen Bailey, Matthieu Lènaff, and **many more**

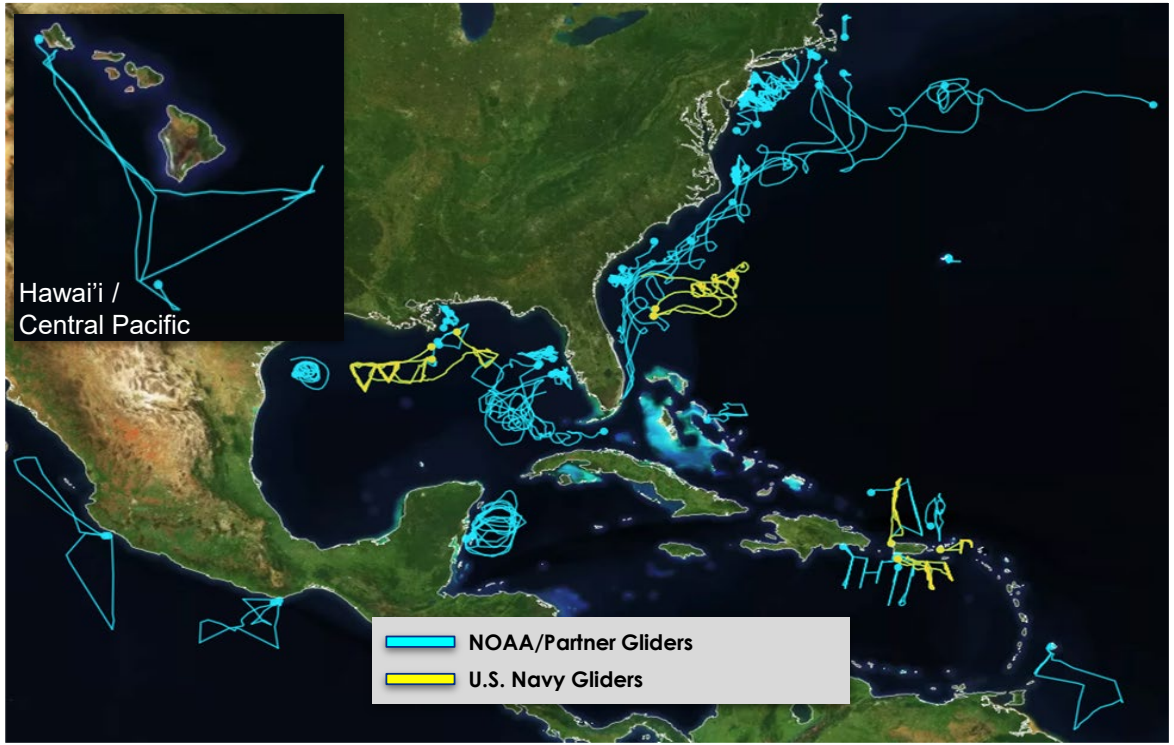
National Oceanic and Atmospheric Administration
U.S. Department of Commerce


OBSERVING SYSTEMS TO IMPROVE HURRICANE PREDICTION
Satellites
Drones
Aircraft
Uncrewed
Surface Vehicles
Dropsondes
NOAA
NOAA
Moored
Buoys
Drifters
Wave
Buoys
Floats
Gliders
NOAA

# Below the Surface: History

- **2014**: NOAA's Atlantic Oceanographic and Meteorological Laboratory deploys 2 gliders from Puerto Rico
- **2018**: NOAA's Integrated Ocean Observing System begins coordinating hurricane glider work
- **2018**: NOAA and U.S. Navy partner to deploy additional gliders
- **2023**: NOAA's Global Ocean Monitoring and Observing Program begins overseeing the coordination of observing platforms
- **2018 – 2025**:
  - ~100,000 profiles/year to GTS
  - 30+ partners

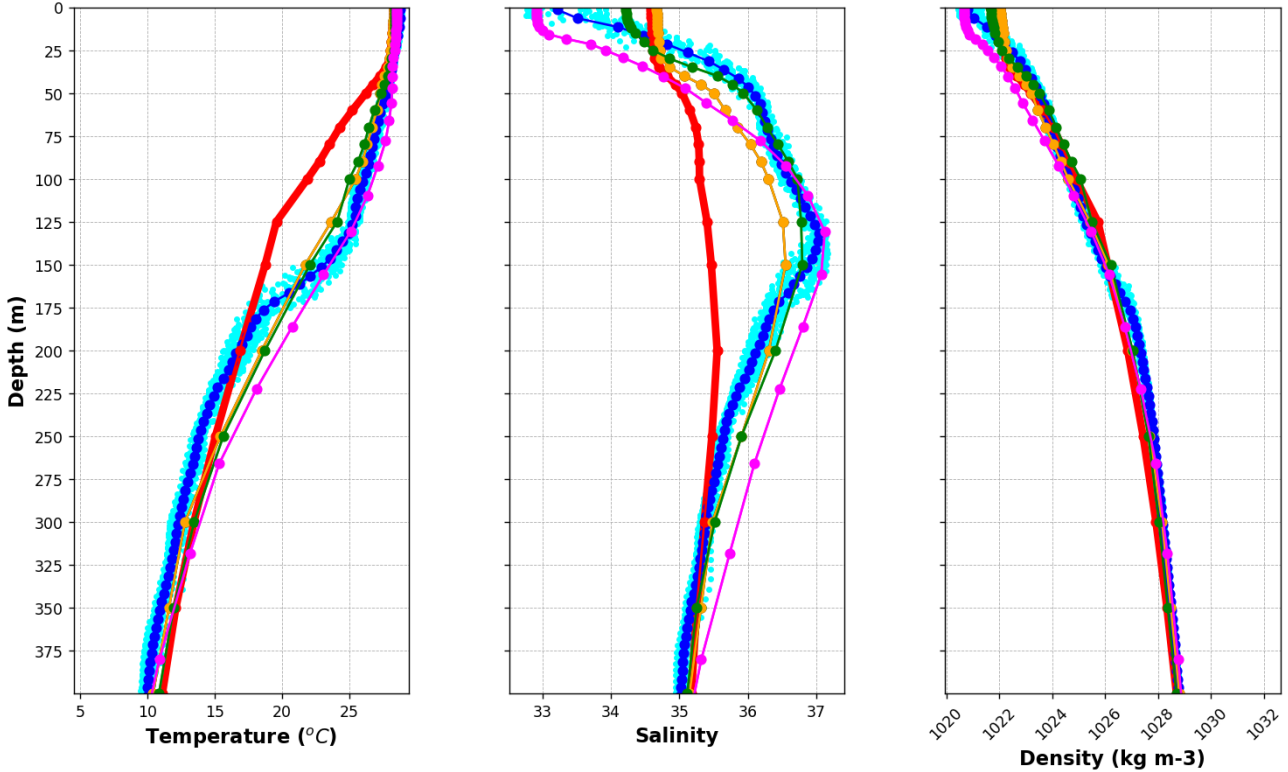
# Below the Surface: Present




## 2025 Glider Numbers

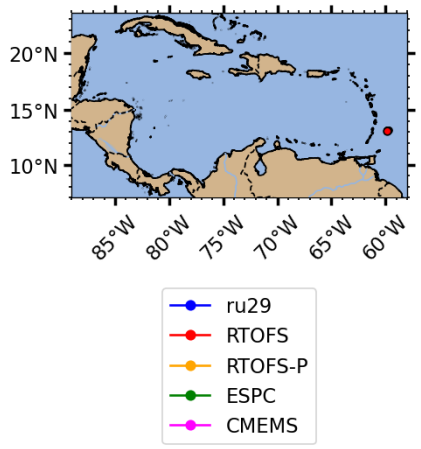
- 80 Glider Deployments
- >90k profiles collected & transmitted to GTS
- 2 gliders deployed from Hawai`i for central Pacific hurricane monitoring
- Additional missions via international partnerships:
  - 2 gliders around Bermuda
  - 8 gliders around Mexico
  - 1 glider around Barbados

# Below the Surface: Models




**Comparison Date: 2025-07-16**

**Glider: ru29**
**Profiles: 22**
**First: 2025-07-16 00:25:10**
**Last: 2025-07-16 23:47:36**
**Method: Nearest-Neighbor**




*Ocean Heat Content (kJ/cm^2) - Glider: 64.7789, RTOFS: 37.1015, RTOFS (Parallel): 50.6383, ESPC: 52.1993, CMEMS: 83.4706, NESDIS: 83.4762,*

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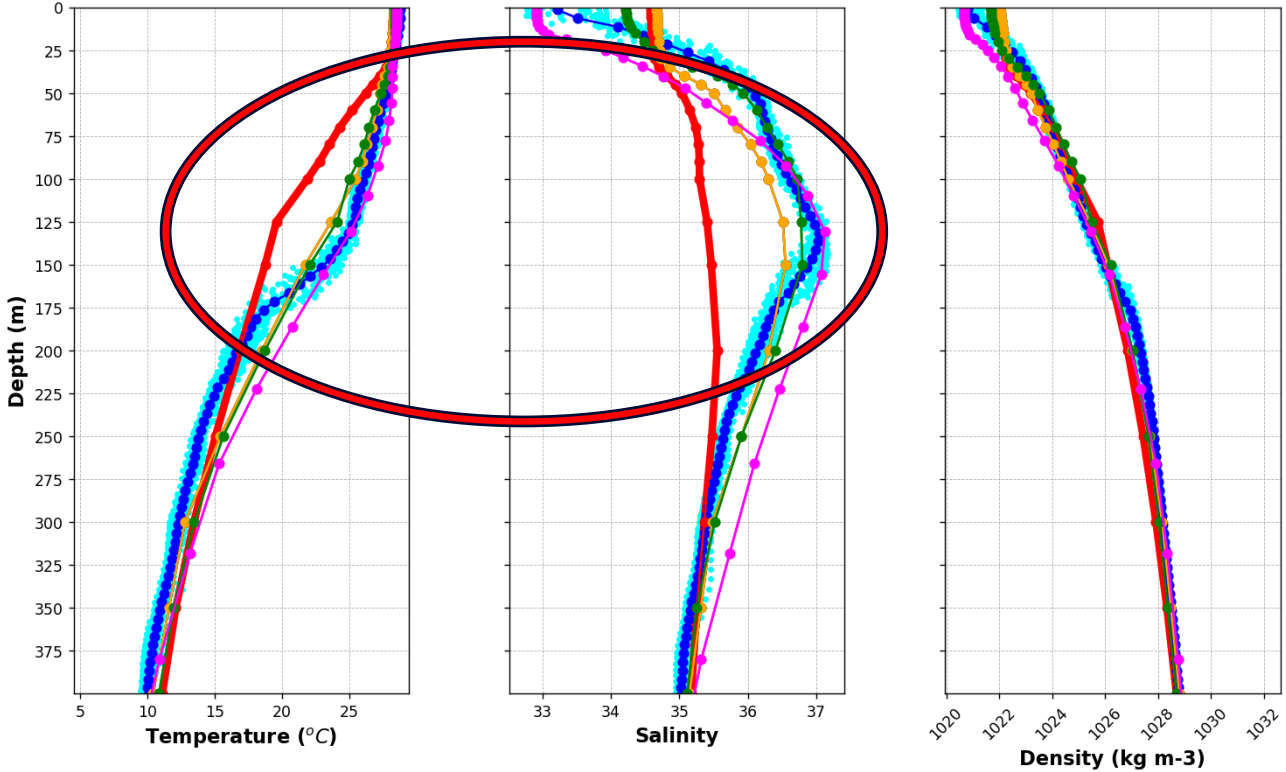


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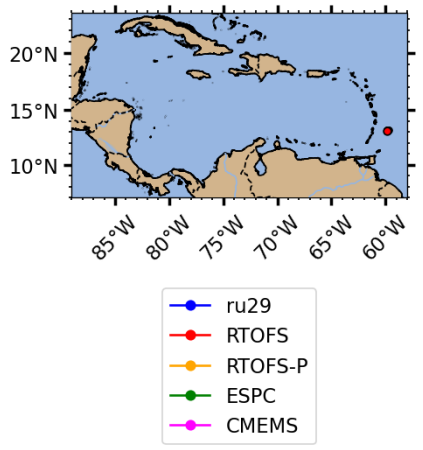


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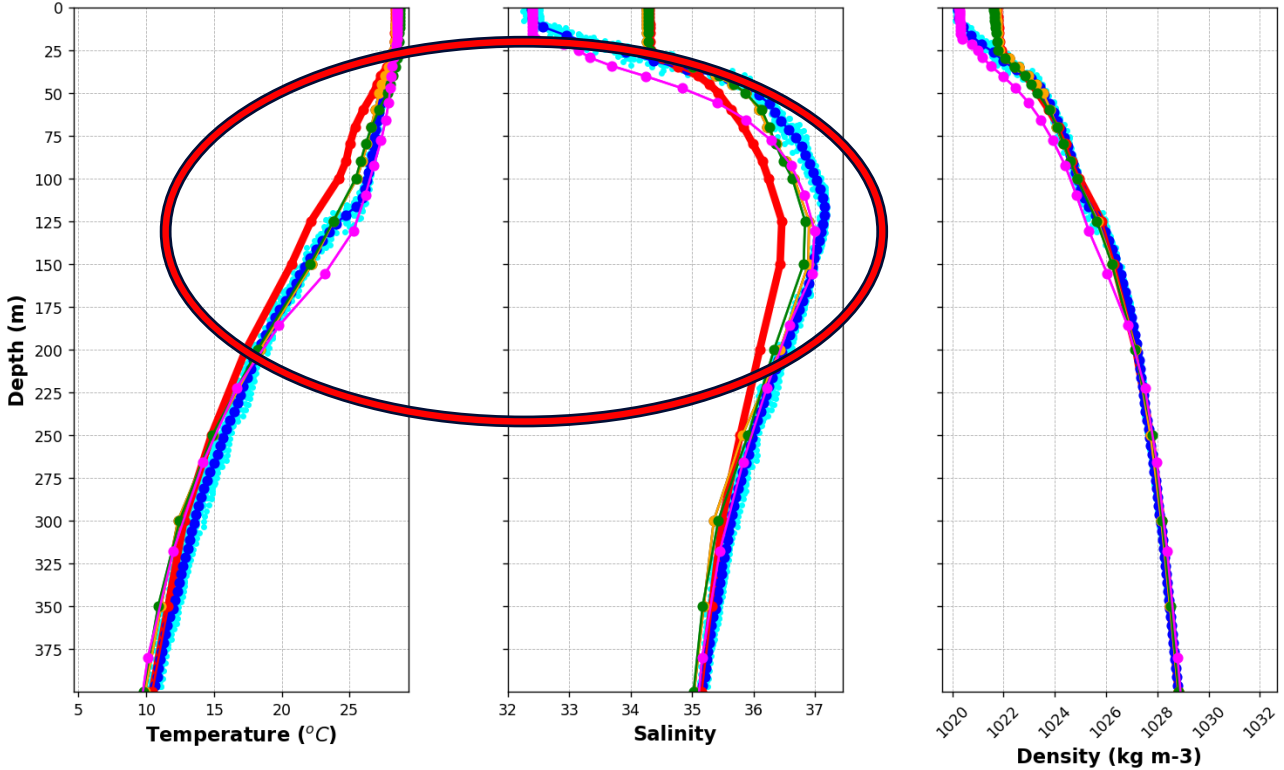
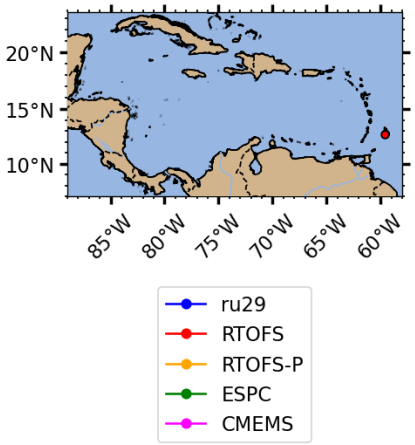



**Comparison Date: 2025-07-21**

**Glider: ru29**
**Profiles: 14**
**First: 2025-07-21 00:31:09**
**Last: 2025-07-21 22:13:00**
**Method: Nearest-Neighbor**



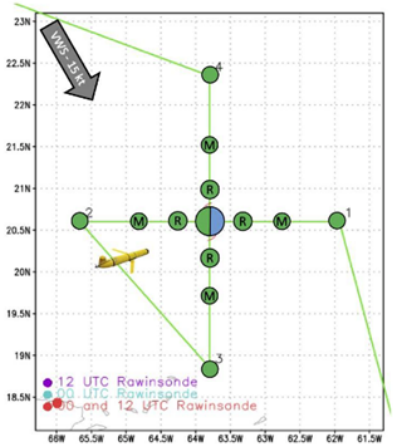

*Ocean Heat Content (kJ/cm^2) - Glider: 64.0652, RTOFS: 41.7157, RTOFS (Parallel): 51.4132, ESPC: 62.0807, CMEMS: 75.9580, NESDIS: 76.4399,*

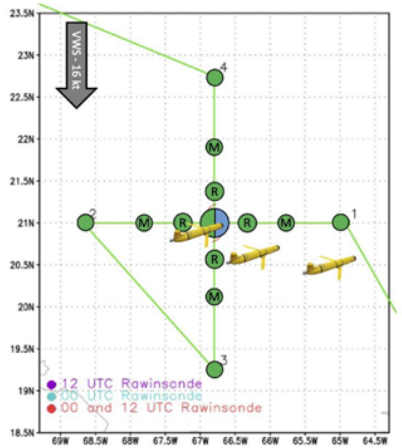
# 2025 Hurricane Field Program-APHEX

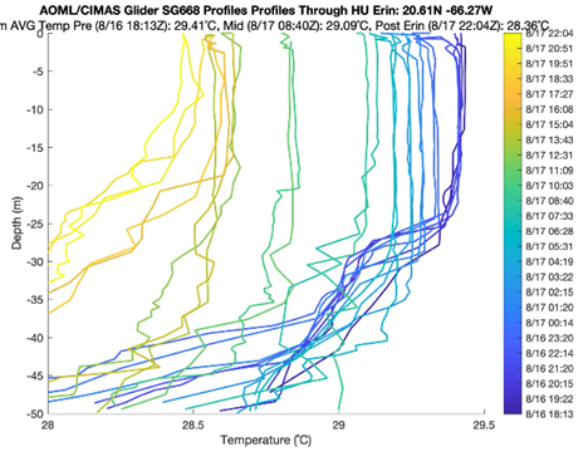
*Collaborations*

## Hurricane Gliders

- Multiple gliders along the path of Erin as a Major Hurricane – 1 with turbulence probes
- Gliders were overflown and dropsondes targeting the gliders released
- Glider data was shared to NHC in real-time and was cited in a discussion
  - *"Second, as Erin grows in size, its footprint of cool upwelling will also grow, and could potentially encroach on its inner core. Several AOML/CIMAS gliders have been near the inner core of Erin over the past 24 hours, and their in-situ observations indicate that Erin has already cooled the waters in its vicinity up to 1C over the past day. This rate of ocean cooling near Erin is likely to continue increasing as the storm grows in size and slows over the next 48-60 h. Thus, the intensity forecast shows gradual weakening beginning after a short round of intensification"*



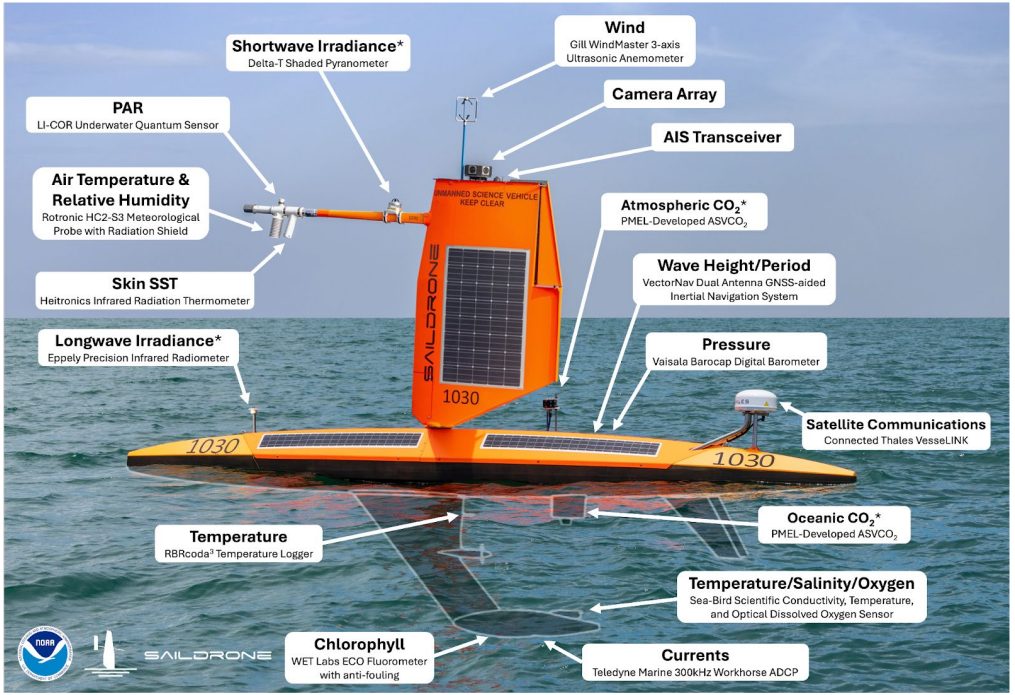

## Experiments, Modules, & Coordination

- CHAOS

*Note: Slide shown during Hurricane Erin Hurricane Field Program Debrief*

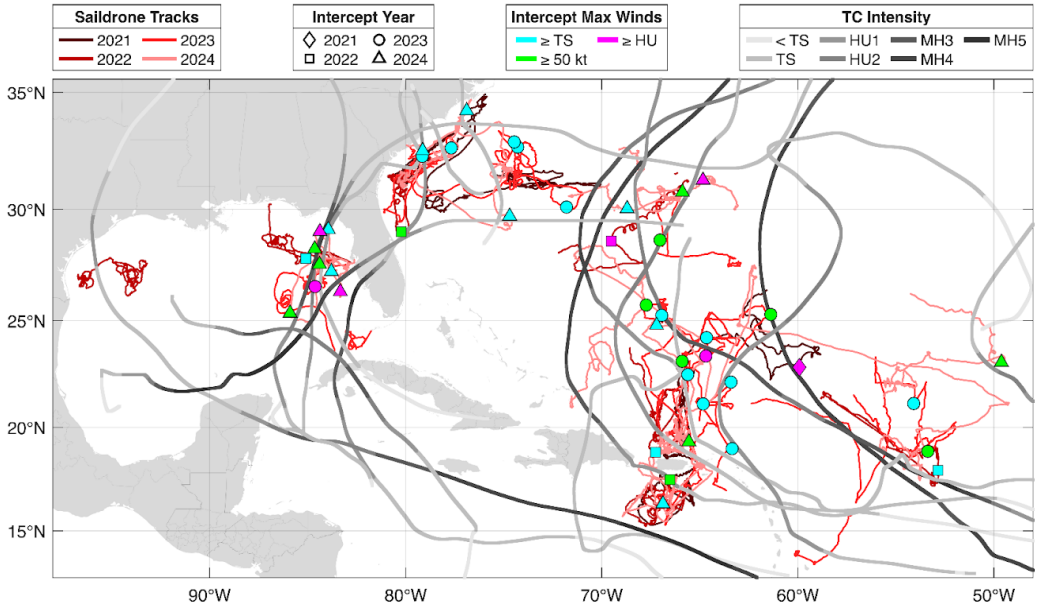
# At the Surface: History

- 2021: NOAA partners with Saildrone for hurricane observations



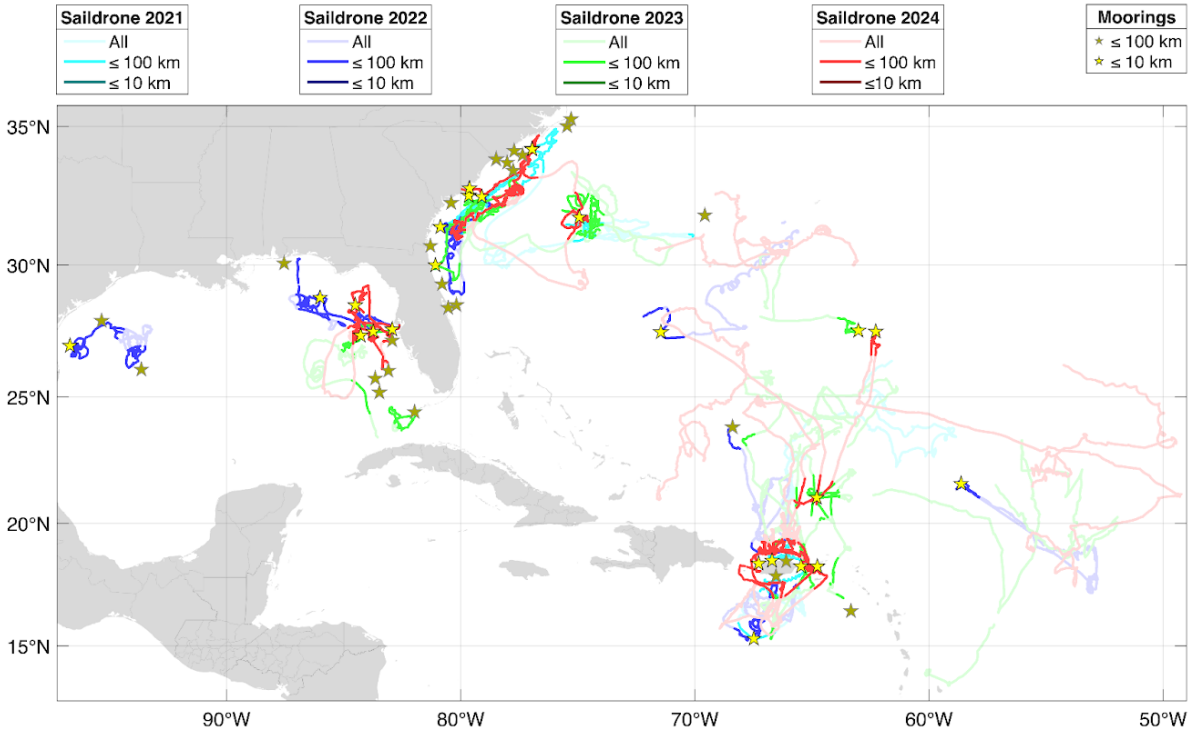
# At the Surface: History

- 2021: NOAA partners with Saildrone for hurricane observations
- 2021 - 2024:
  - 36 deployment
  - 200,000 km traveled
  - 43 intercepts
  - 300 hours in tropical storm winds
  - 5 hours in hurricane force winds
  - 500 hours in significant waves >5 m
  - 22 hours in significant waves >10 m
  - 41 NHC Advisories



# At the Surface: Validation

- Validate with moorings
- 1200 days within 100 km
  - Wind, air temperature, SST, significant wave height all compare well
  - RH and Dominant wave period need further investigation
  - Pressure reveals concerns



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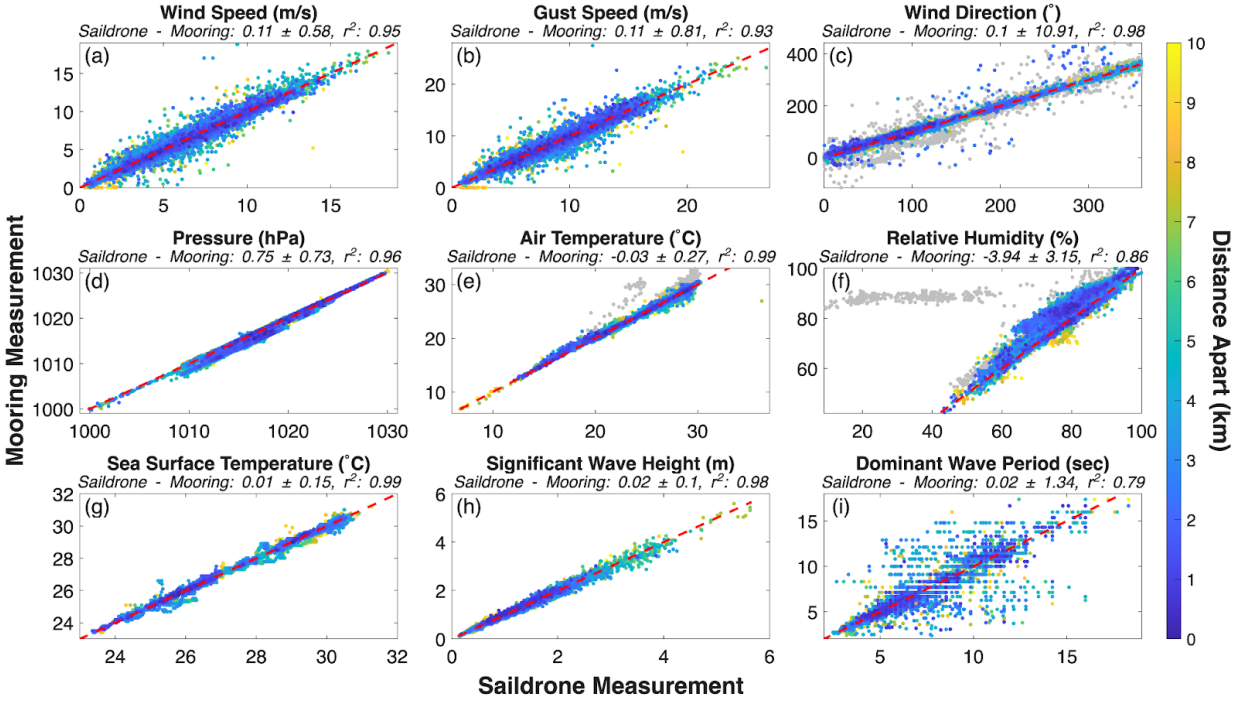

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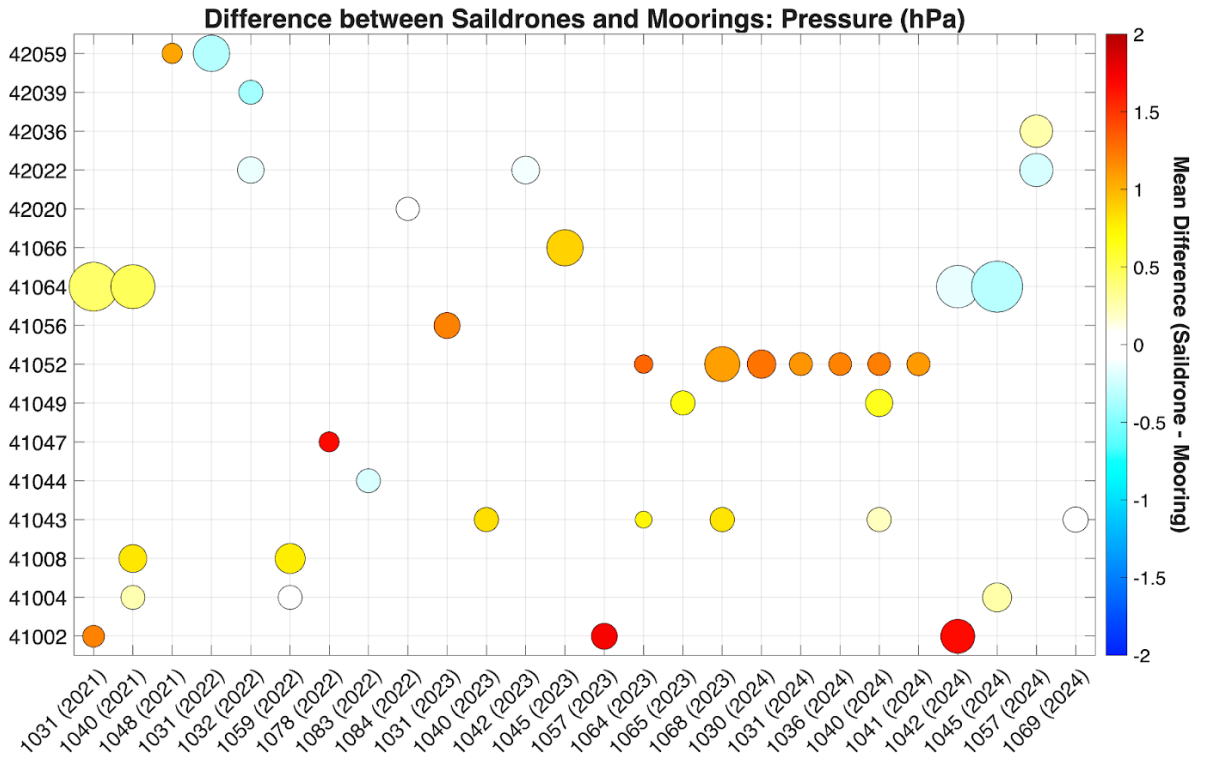
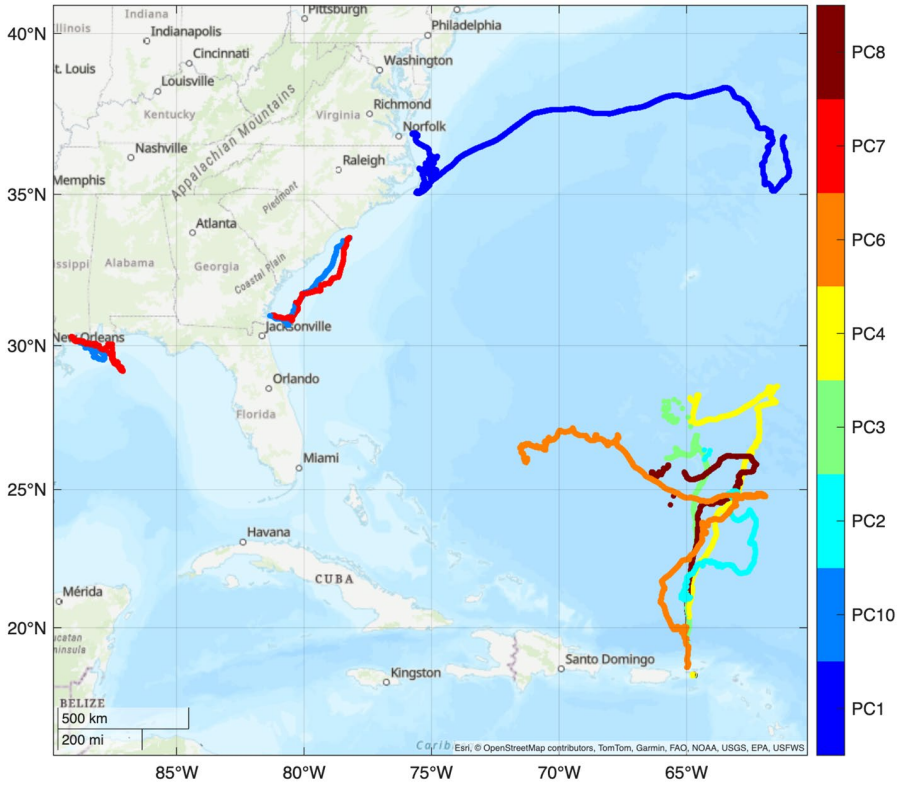


# At the Surface: 2025

- Small (1.2 m), light weight (100 lb) USV
- Capable of 100 day missions
- 75% cheaper than previous USVs
- Max speed over water of ~2.5 kt with an onboard integrated thruster
- Real-time 2D Winds, AT/RH, Pressure, & SST with higher resolution upon recovery
- Sensors very low (0.66 m)
    - Challenge of converting to 10 m
- Has a camera

# At the Surface: 2025

- **8 C-Stars** deployed for over **330 days** at sea, traveling over **9,000 miles**
- **Rapid Deployment** ahead of Imelda



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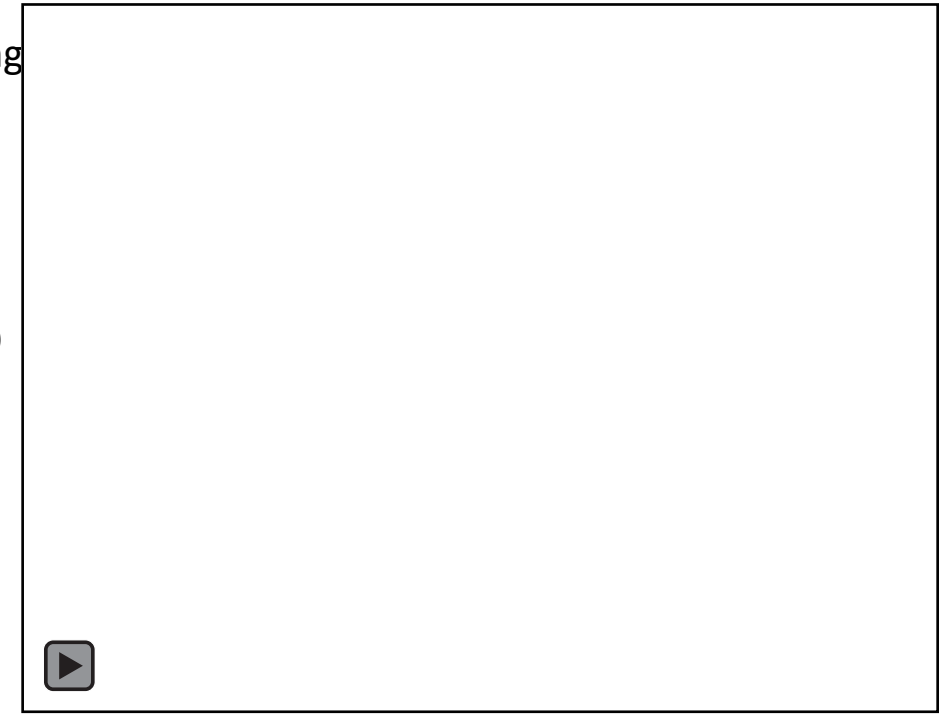

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- Real-time data sent to GTS, **assimilated into GFS,** and shared with NHC
  - Humberto Advisory: "*An OSHEN C-Star drone recently measured a minimum pressure near 955 mb in the eyewall of Humberto with gusts to hurricane strength at an anemometer height of about 2 feet (0.5 m).*"

*Photos from Oshen C-Star PC3 in Humberto*
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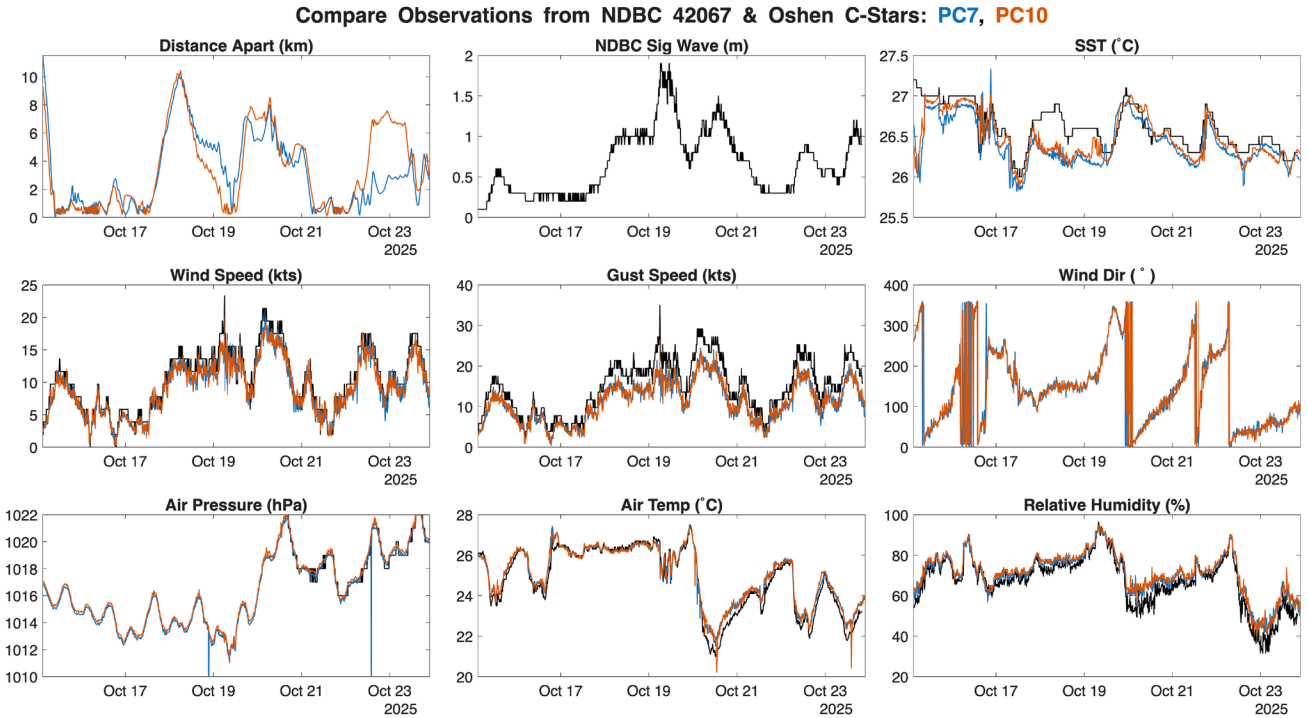
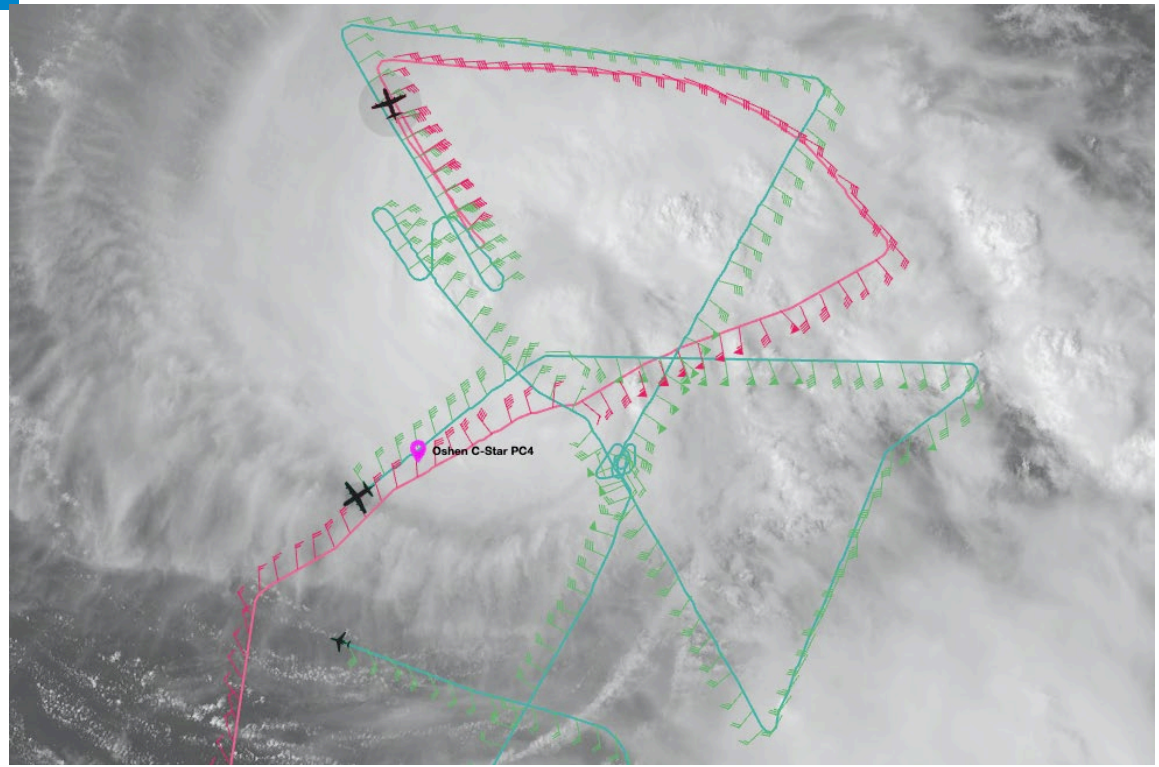
# At the Surface: 2025

- C-Stars compare well with moorings



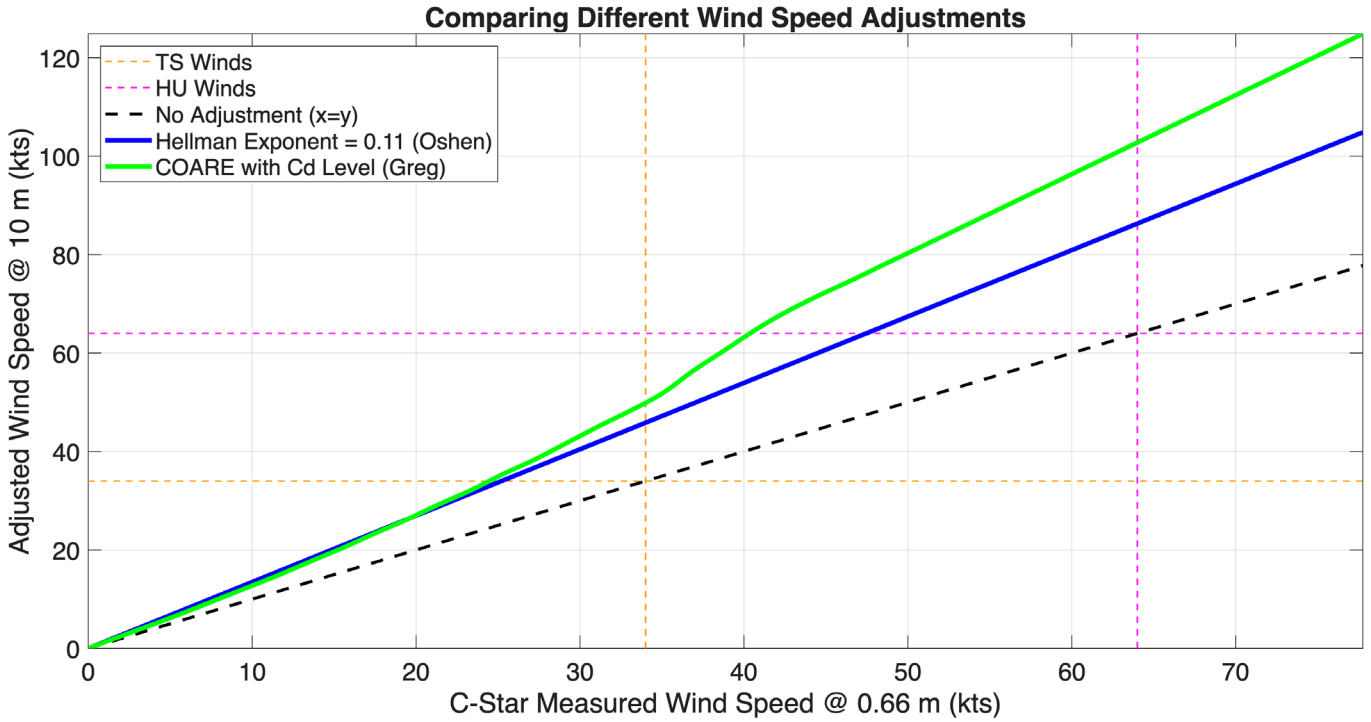
# At the Surface: 2025

- C-Stars compare well with moorings
- Coordinated with NOAA Aircraft



# At the Surface: 2025

- C-Stars compare well with moorings
- Coordinated with NOAA Aircraft
- **Challenge**: Wind at 0.66 m.

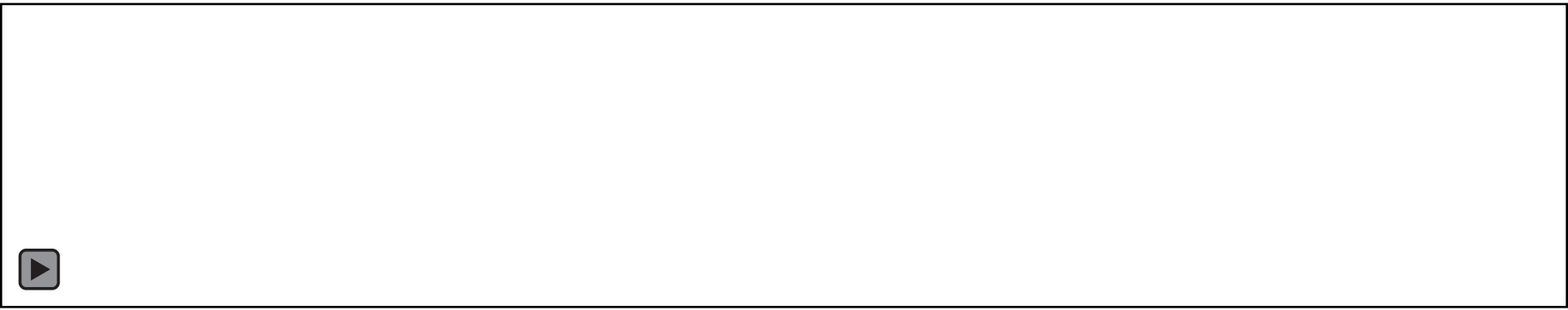


# At the Surface: 2026 Test

- **Chance Maritime's MC40**
- ~40 ft USV
- Cruise 4 kts, max 7 kts
- 90+ day mission
- Onboard winch
- Livestream video
- Drifter deployments
- Testing for extremes

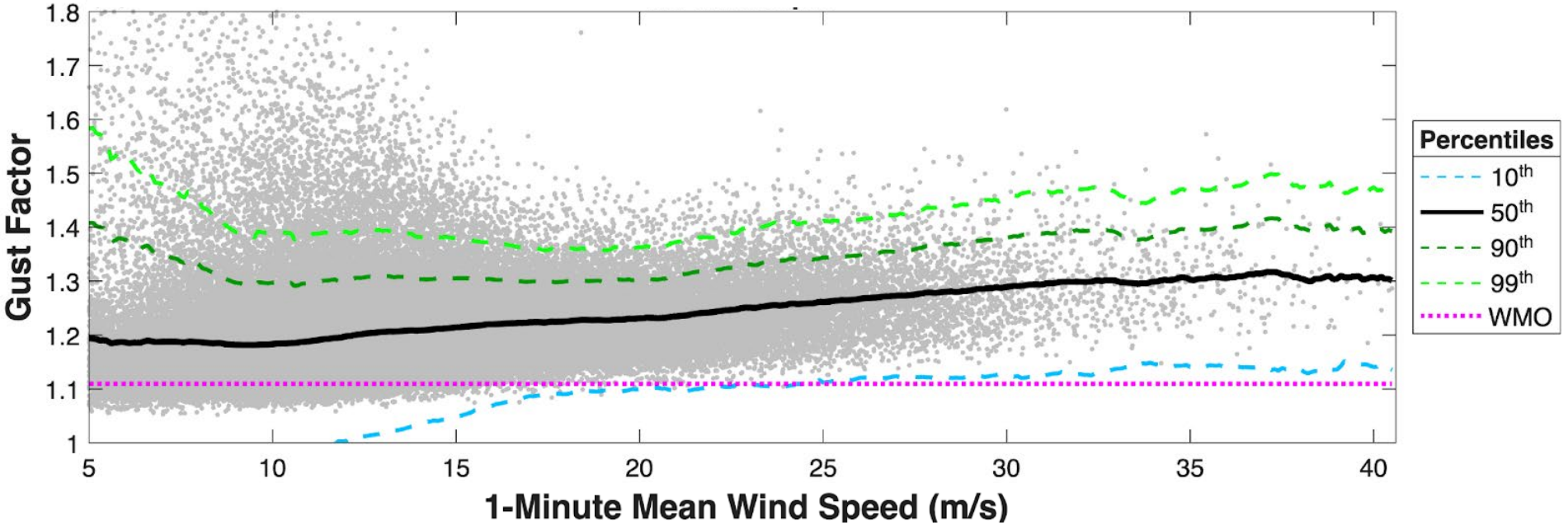

*Photos of Chance Maritime's MC40*

# At the Surface: 2026 Test with Chance Maritime's MC40



*Photos of Chance Maritime's MC40*
*DO NOT SHARE WITHOUT PERMISSION*

# At the Surface: Science



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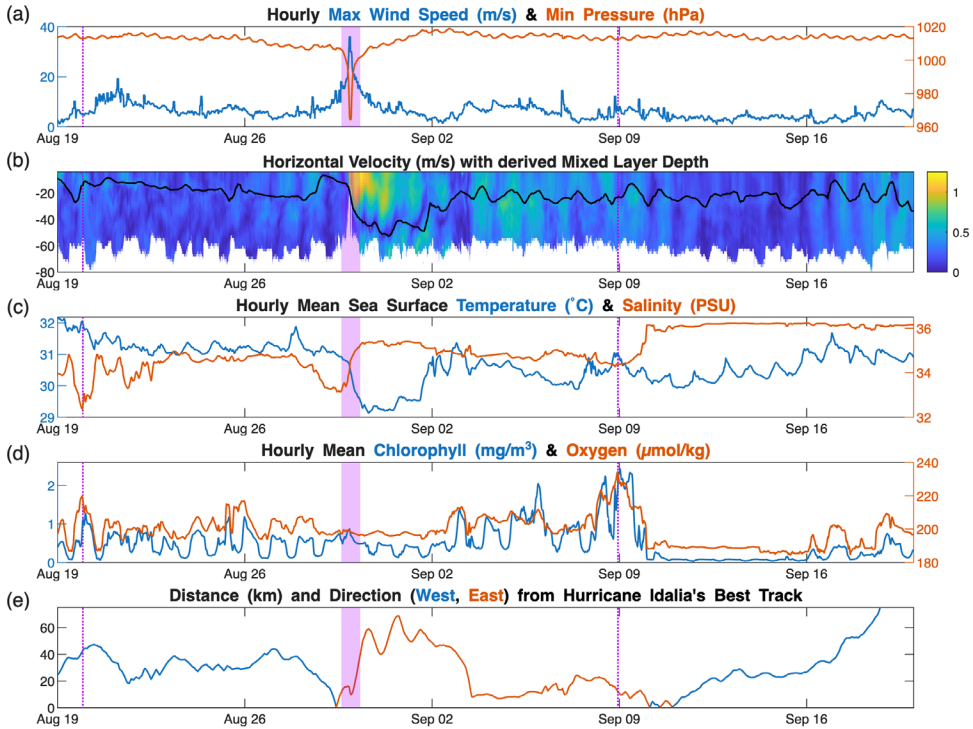


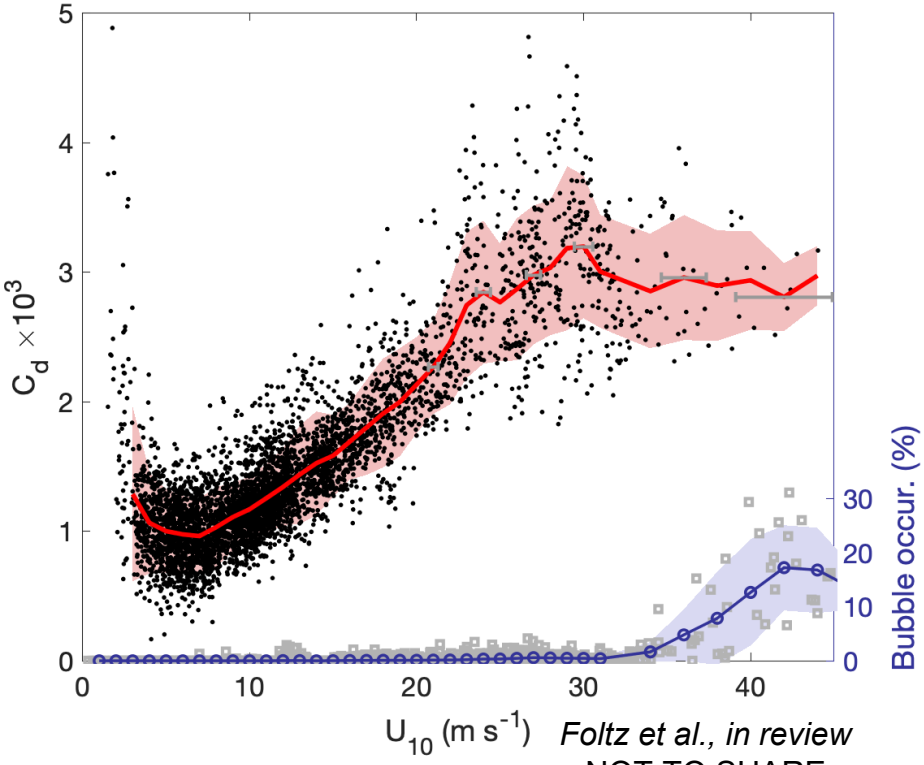


*Foltz et al., in review*

*McWhorter et al., 2026*

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# THANK YOU

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**Gliders**

**USVs**