

Observing hurricanes with saildrones



Greg Foltz

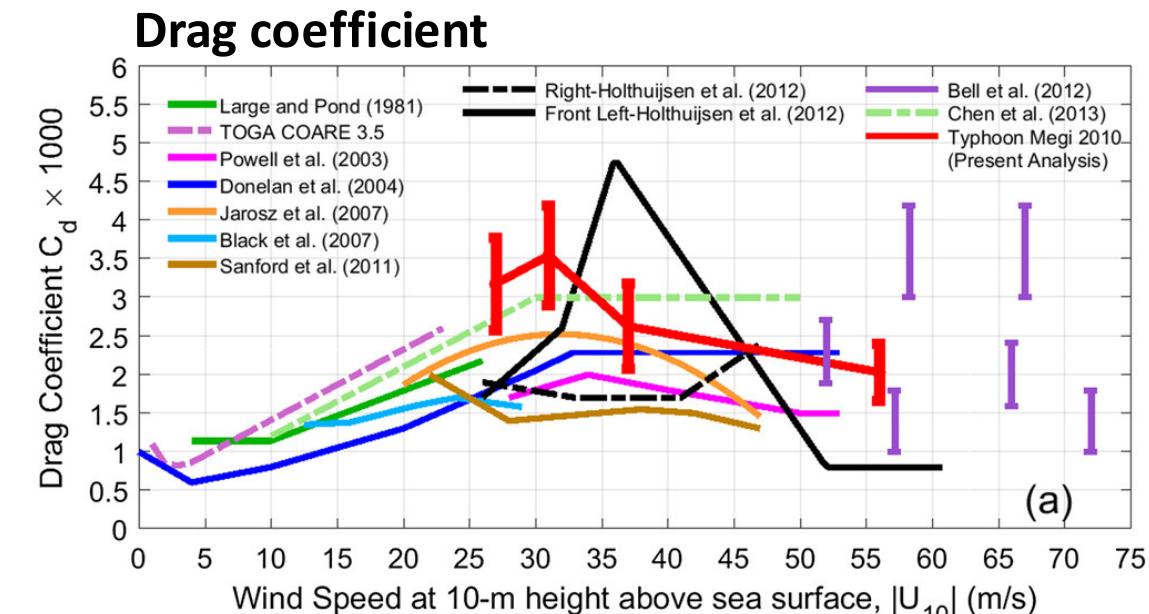
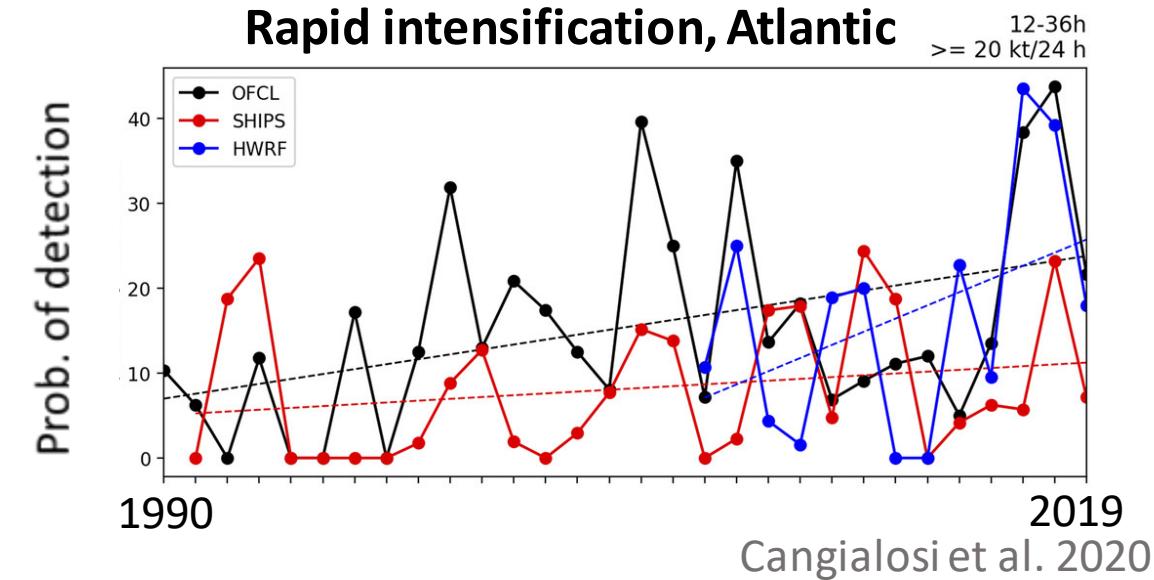
NOAA's Atlantic Oceanographic and
Meteorological Laboratory

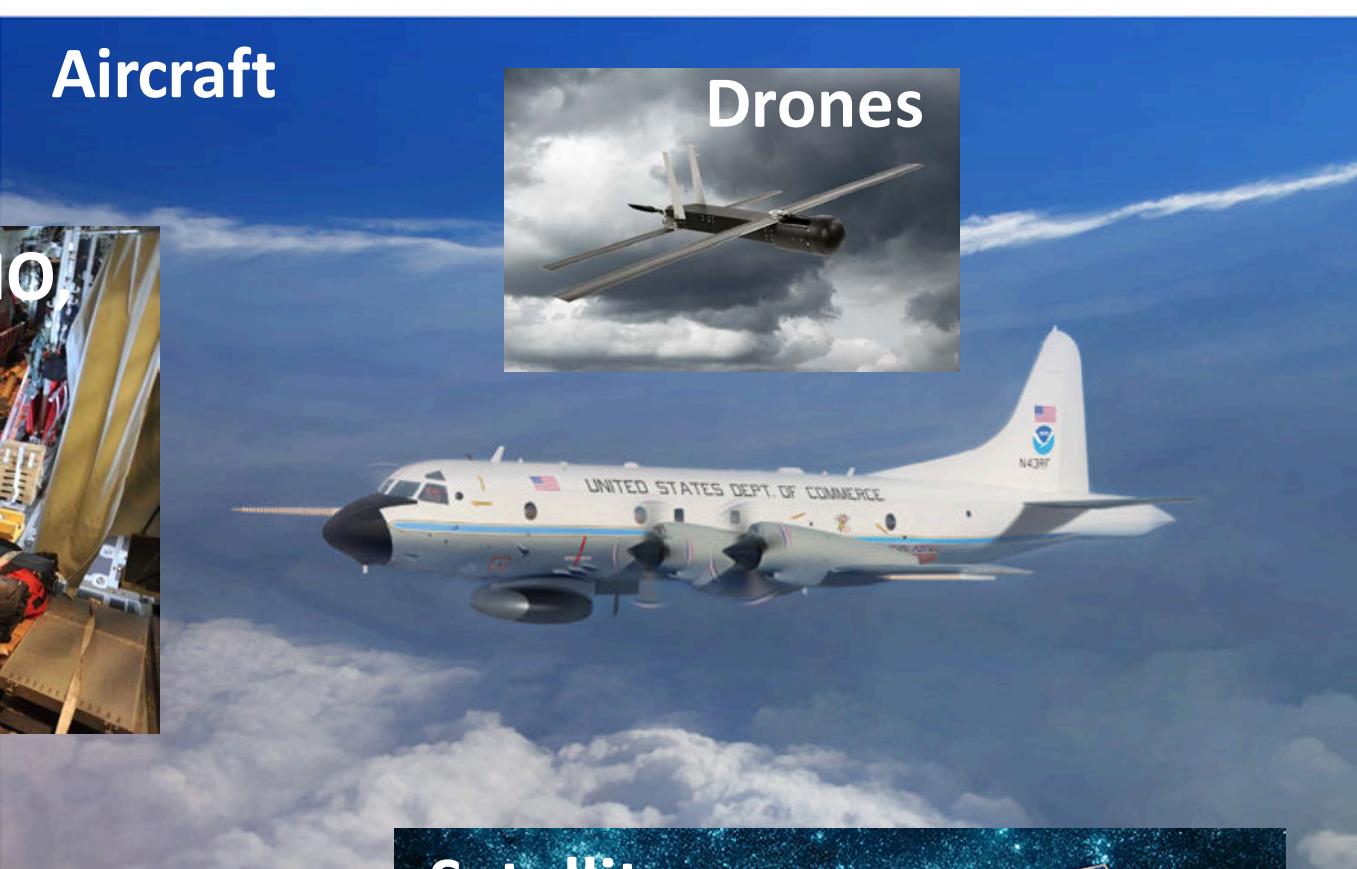
Challenges:

- Hurricane intensity prediction
- Rapid intensification

Needs:

- Improved understanding of hurricane processes
- Improved forecast models, initial conditions





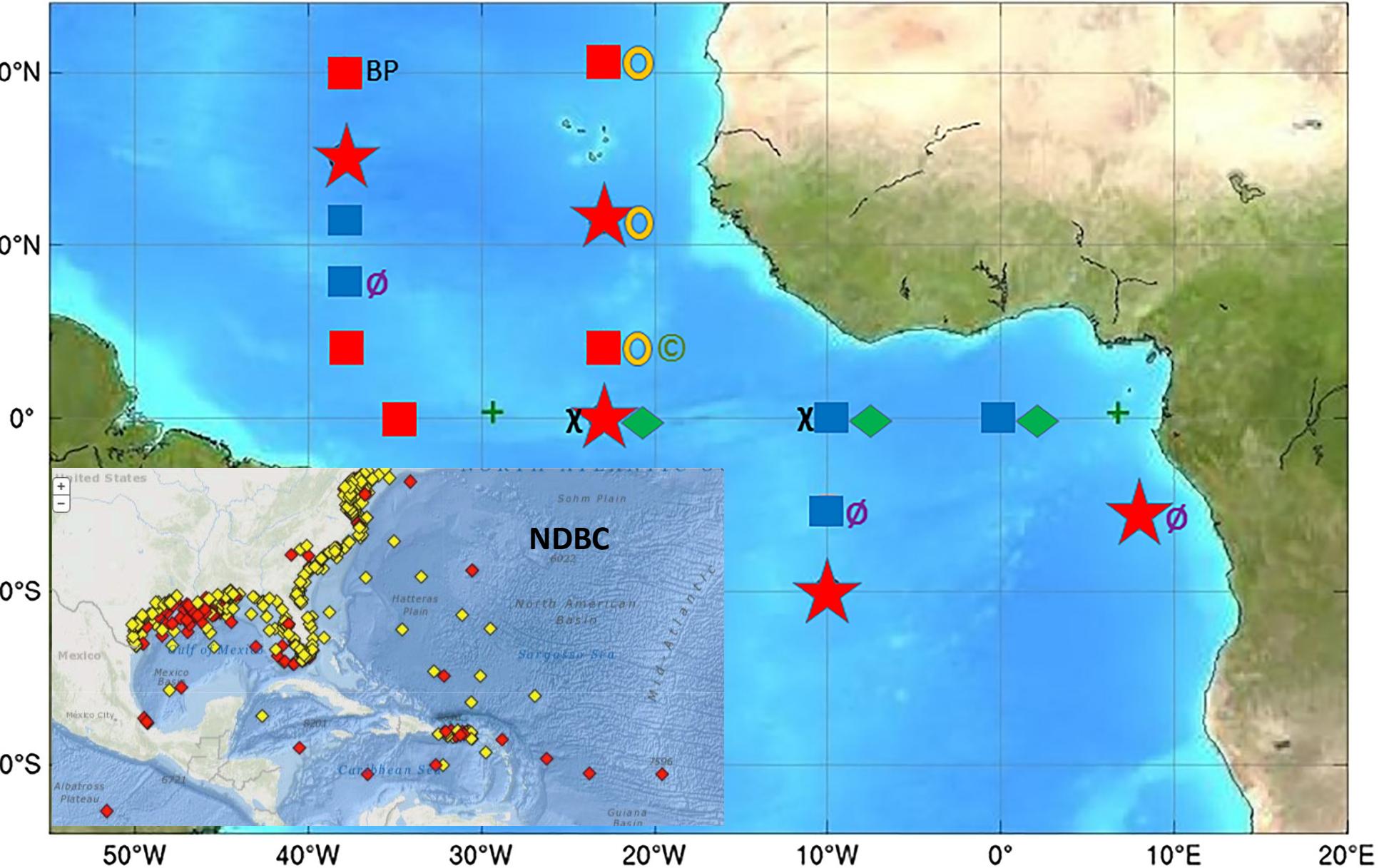
PIRATA (1997 – 2022)

Max. 1-hr wind speed:
26 m s⁻¹

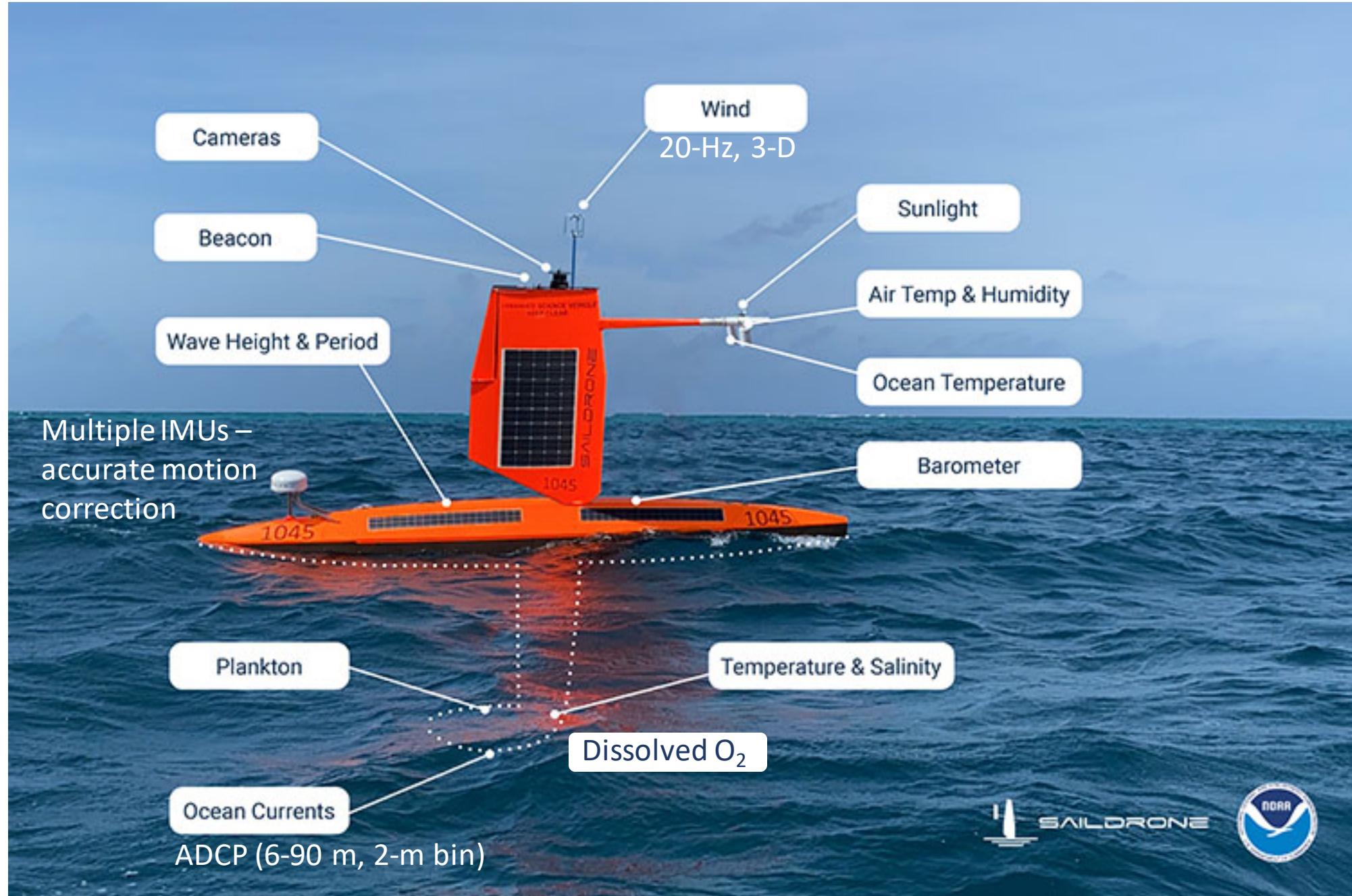
Hurricane Lorenzo:
14.6°N, 38.2°W,
45 m s⁻¹ sustained,
September 2019



Credit: EUMETSAT







Propelled
by wind

Sensors
powered by
solar
radiation



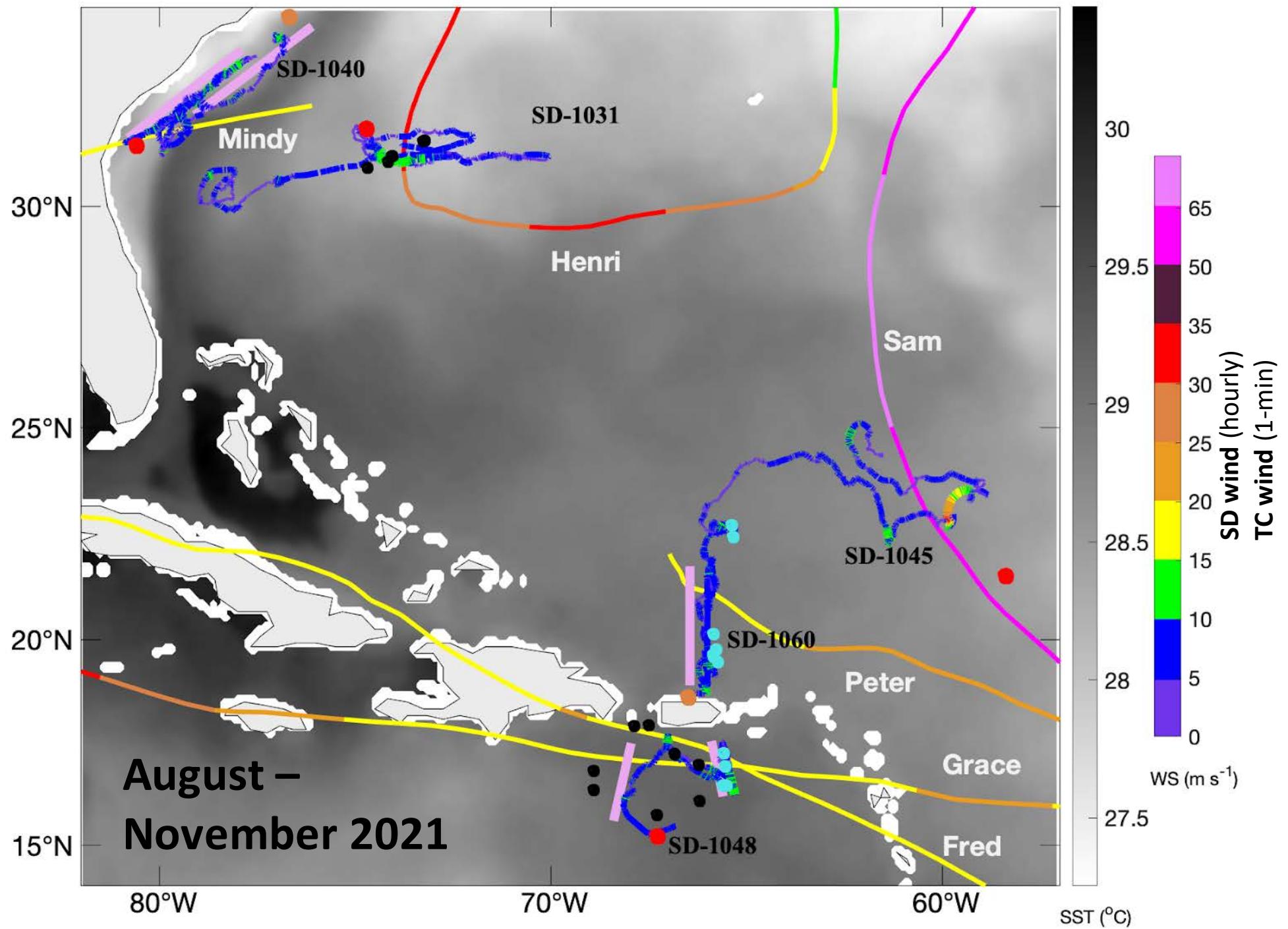
1-min. averages transmitted to GTS every 2 hours (1-hr latency):

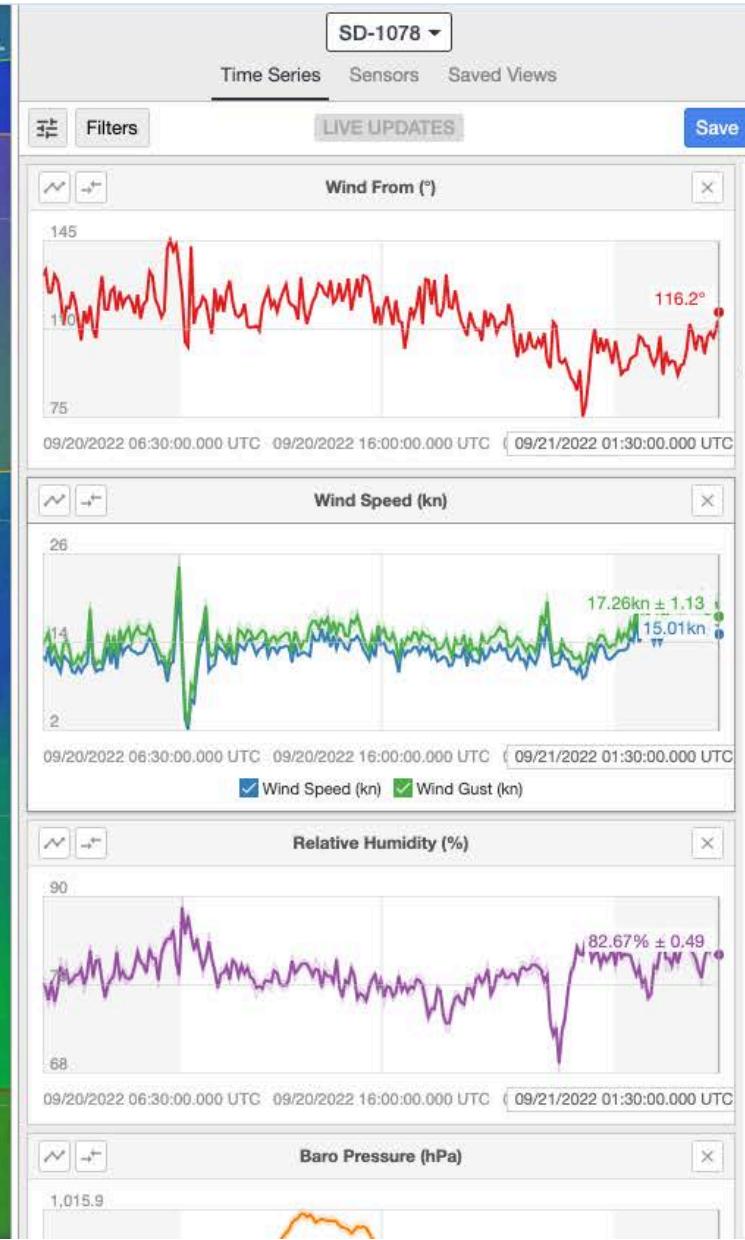
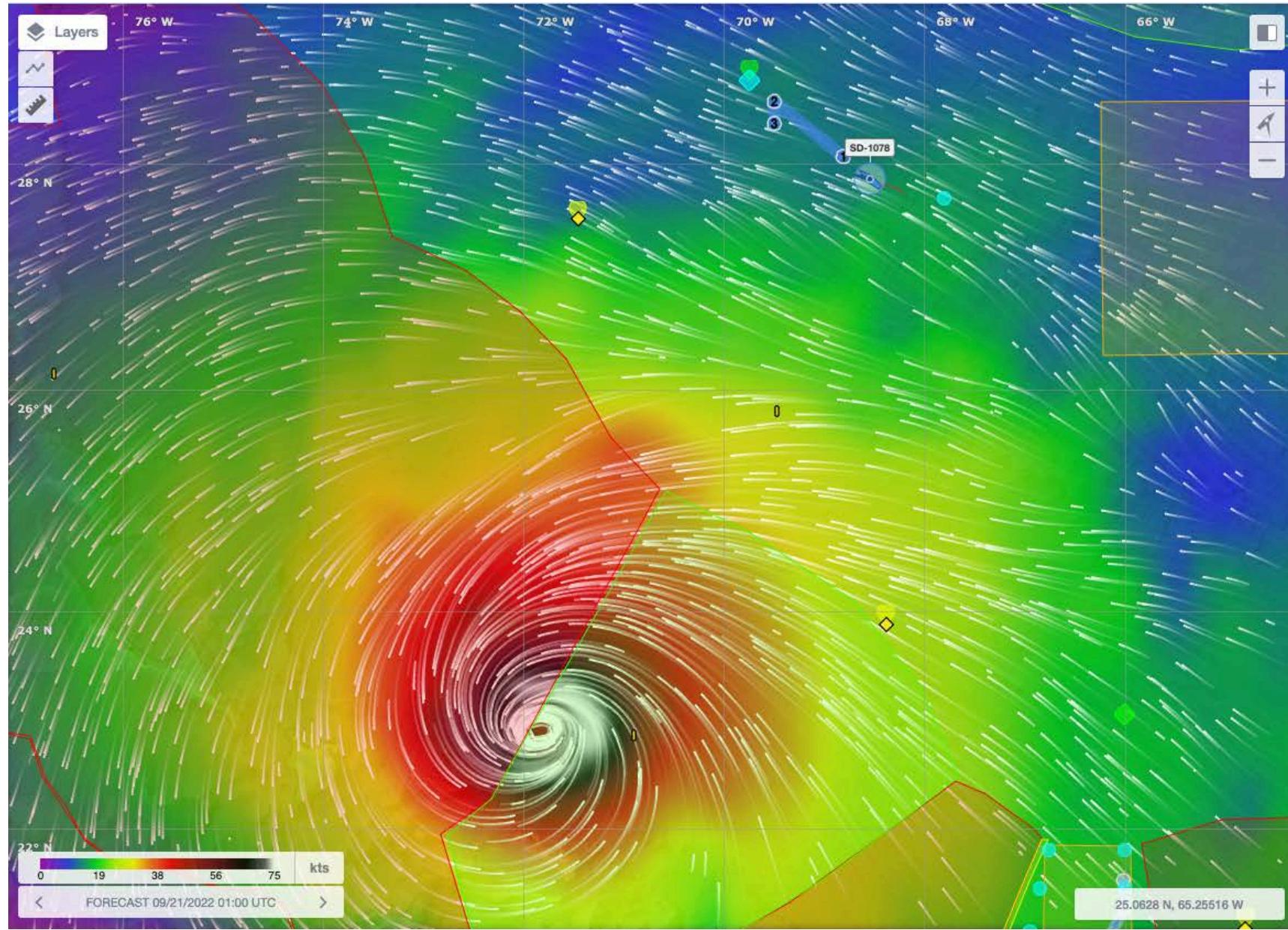
- Sea surface temperature
- Sea surface salinity
- Air temperature
- Relative humidity
- Surface pressure
- Wind speed + direction
- Dominant wave height + period

Assimilated into global forecast models (ECMWF, UKMO, Canadian); NOAA/EMC is working on operational assimilation

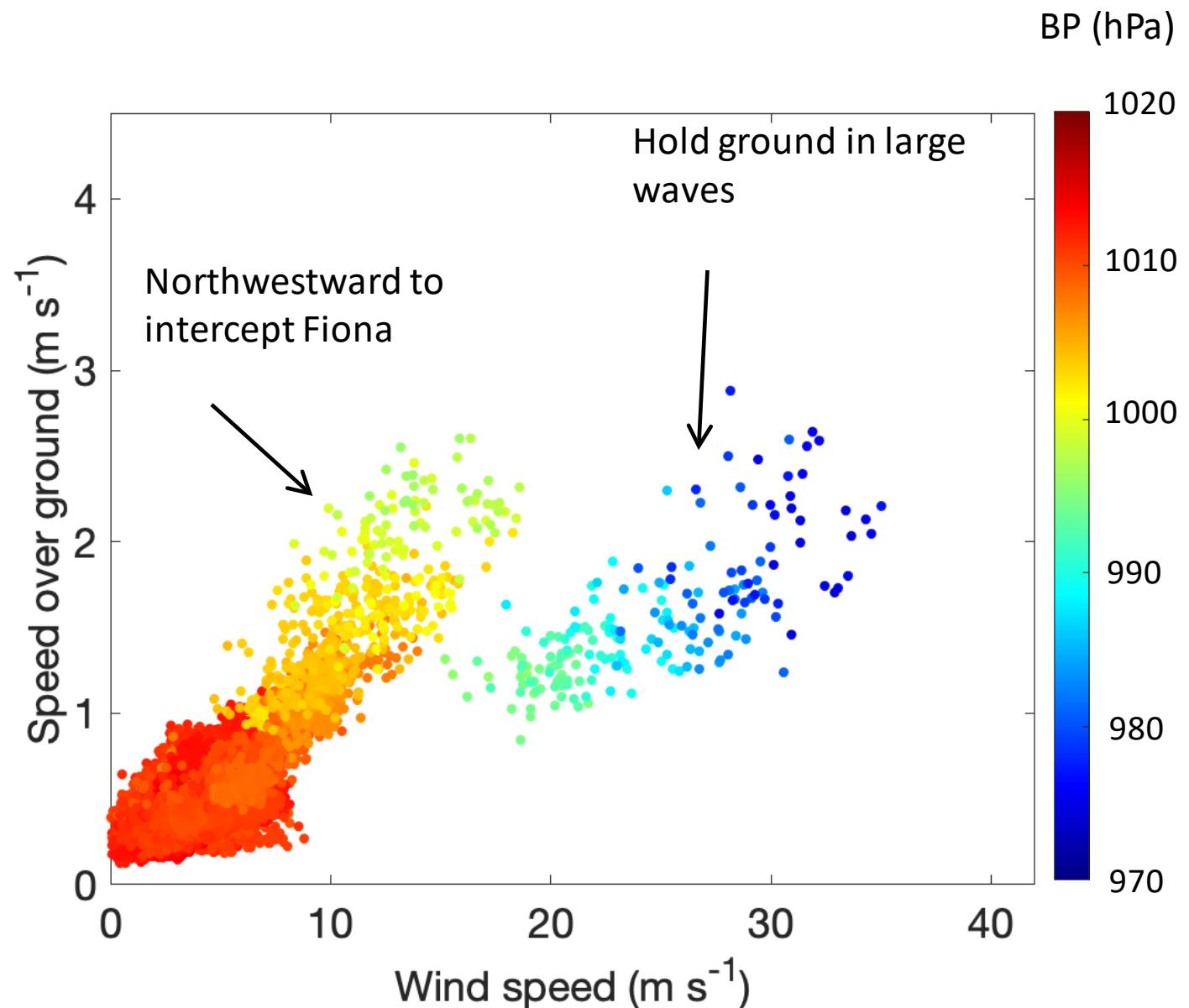
~ 100 GB of high-res data recorded per drone (90 days)

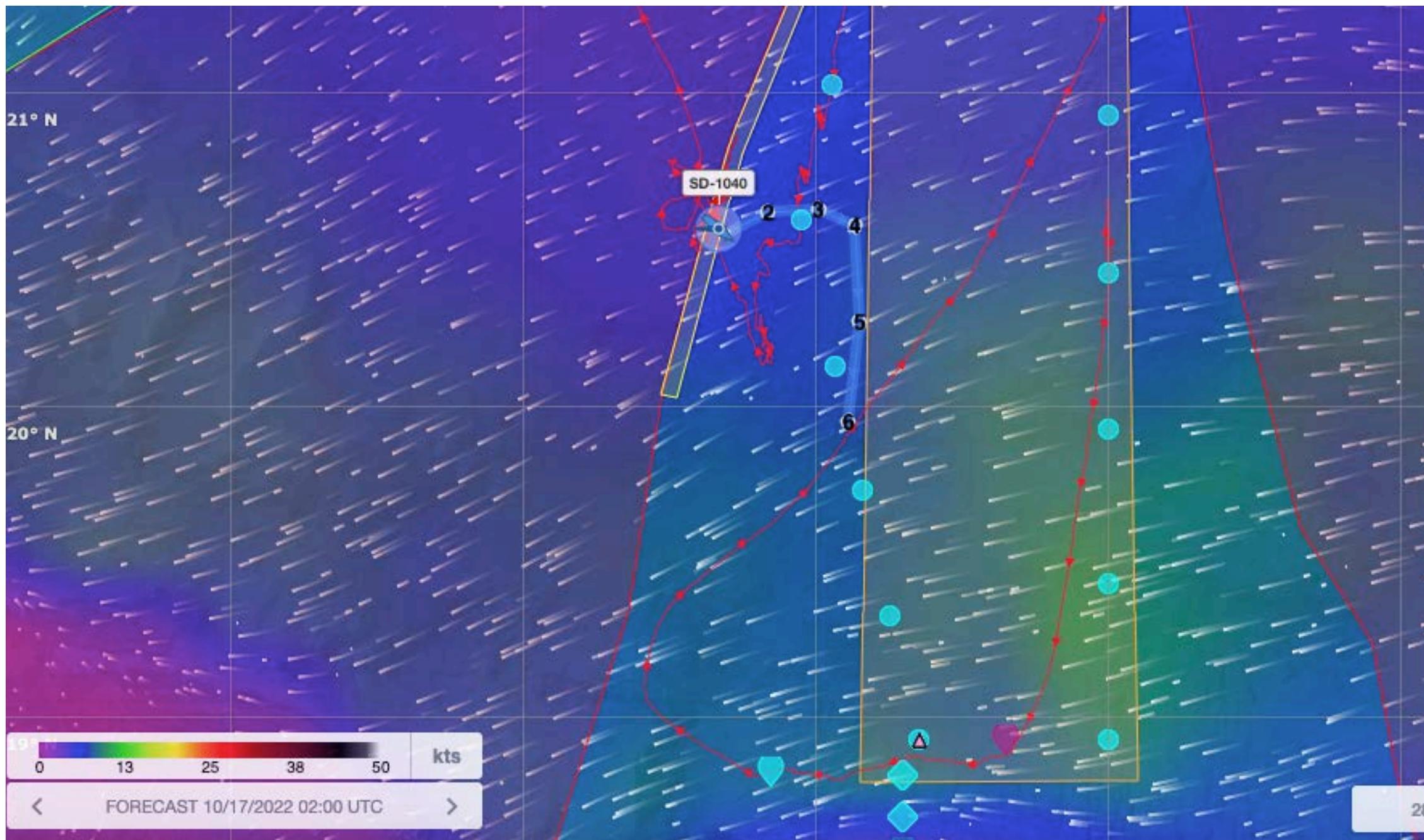






SD-1078 (Fiona)



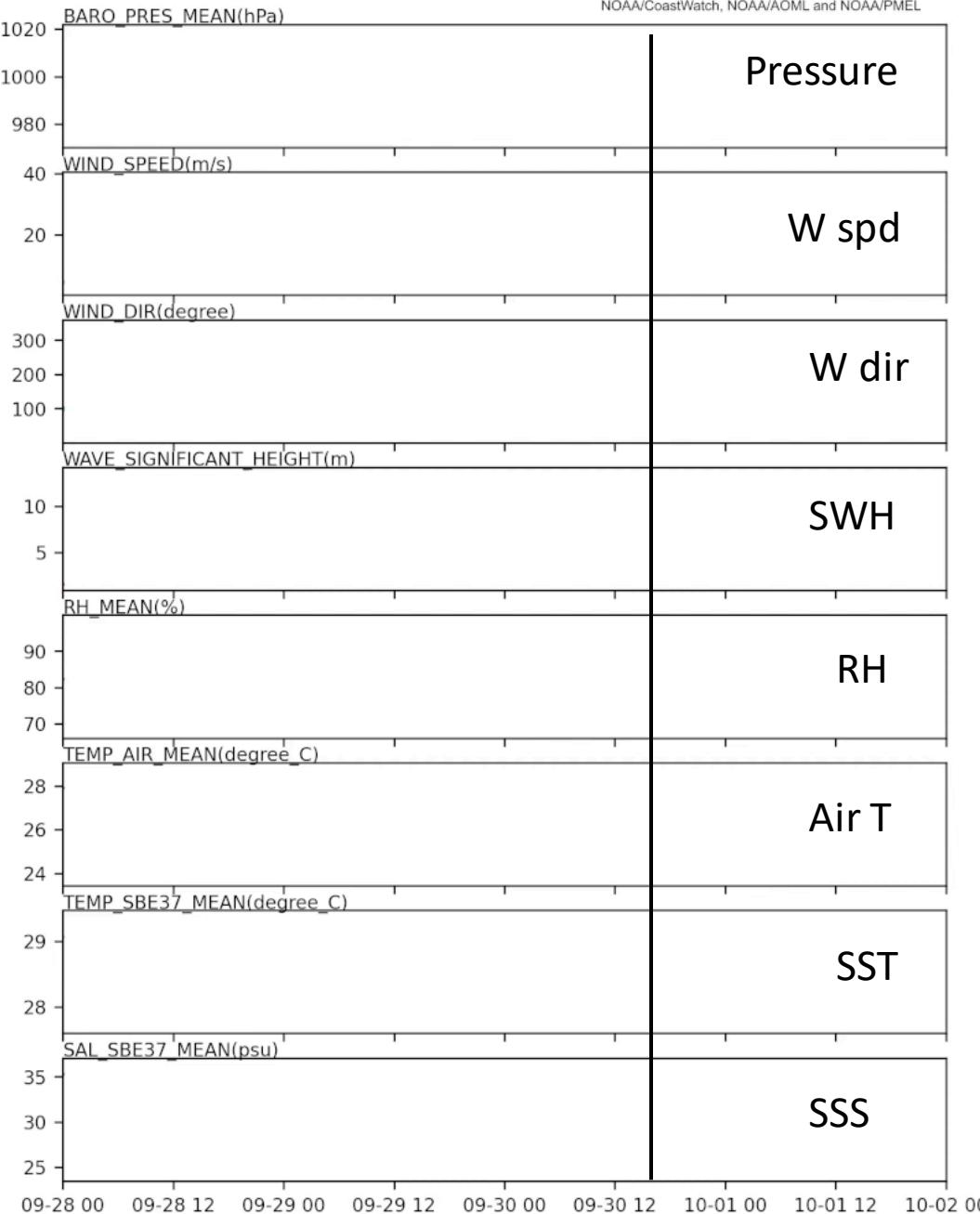
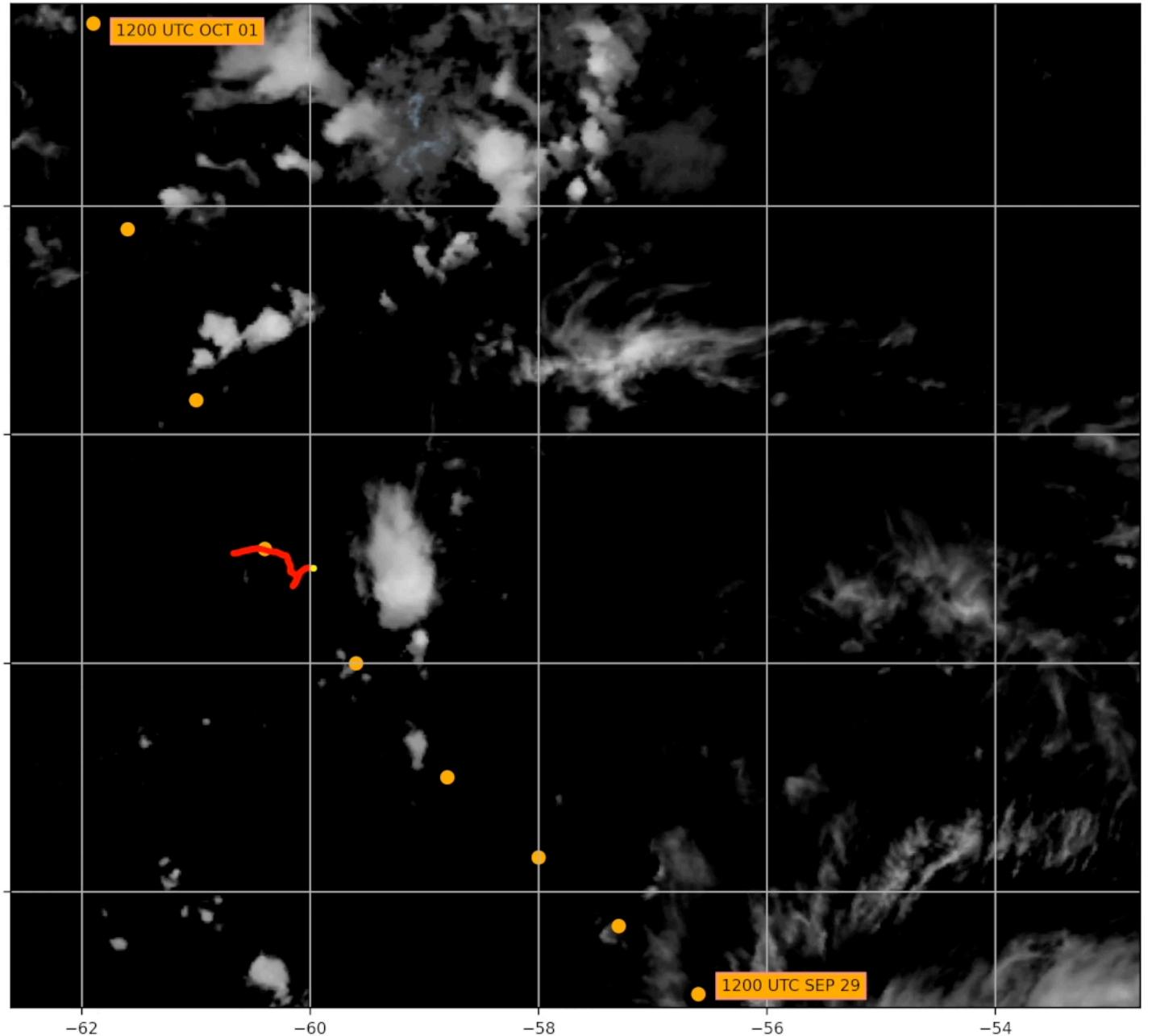


Hurricane SAM (2021)

Saildrone observations and track (red), hurricane track (orange) and GOES-16 true color imagery (background)



NOAA/CoastWatch, NOAA/AOML and NOAA/PMEI

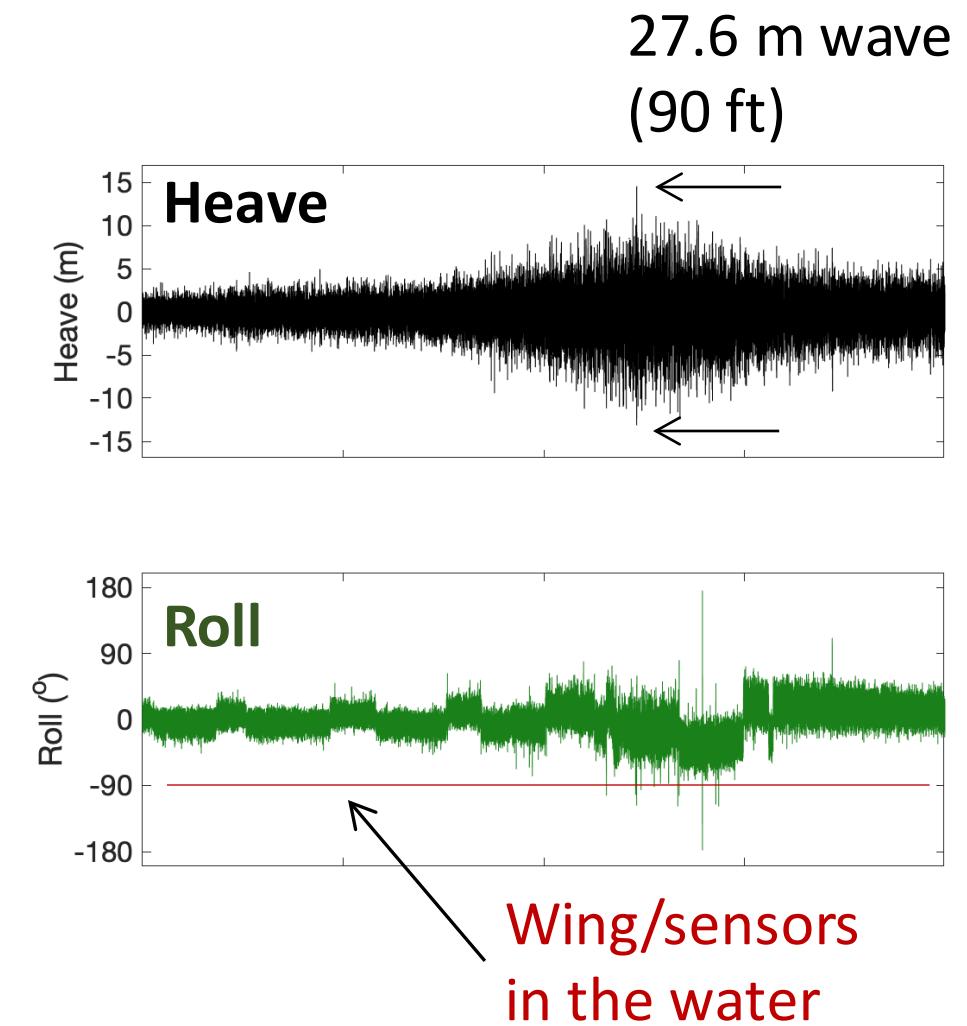
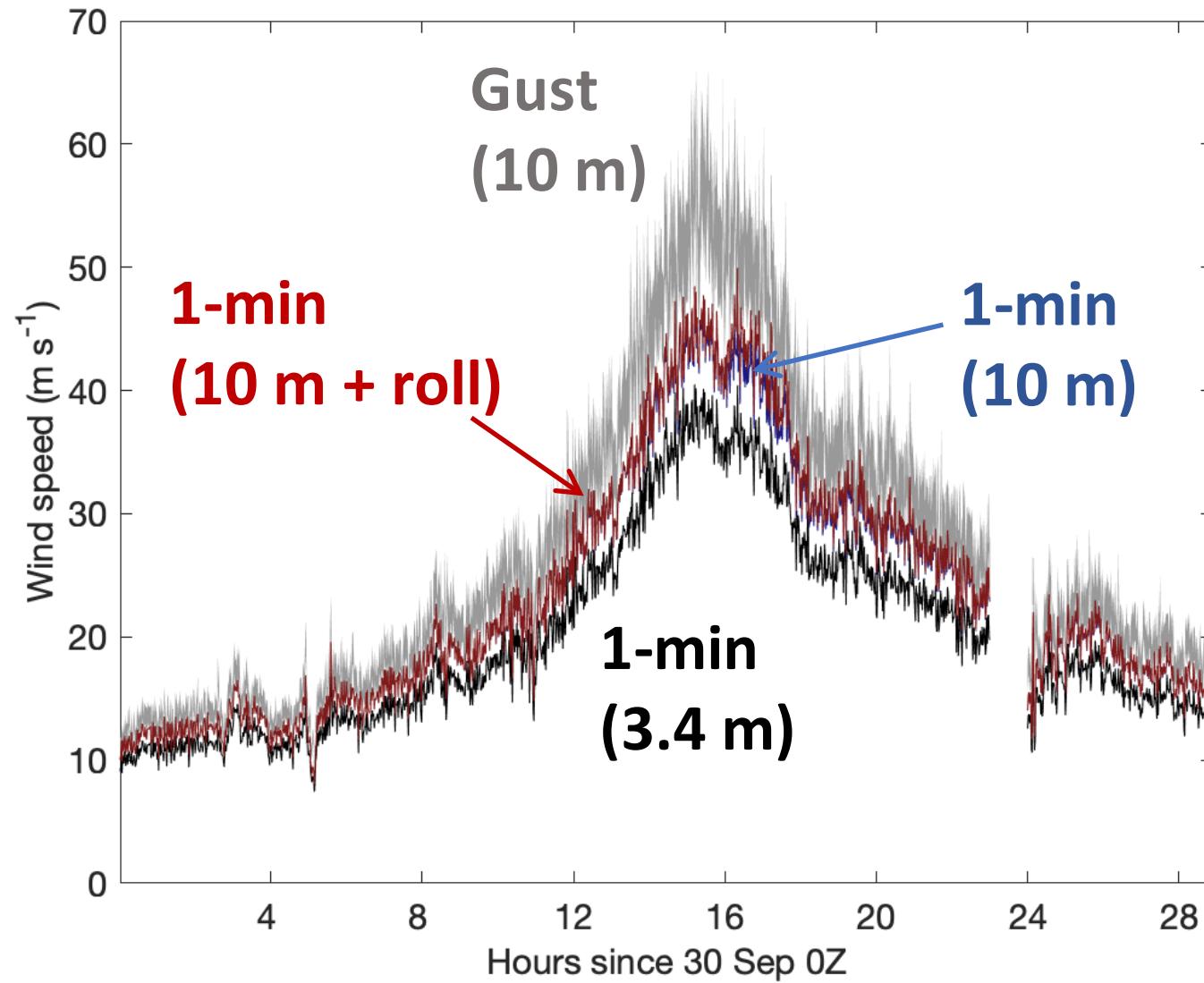


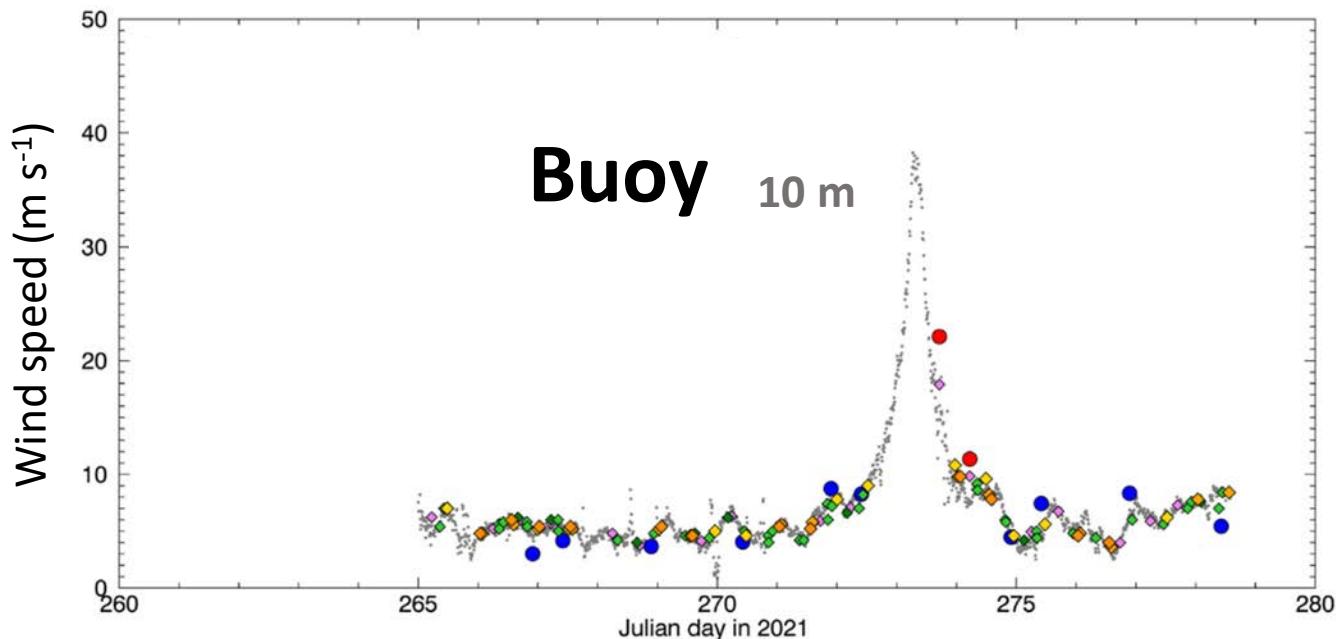
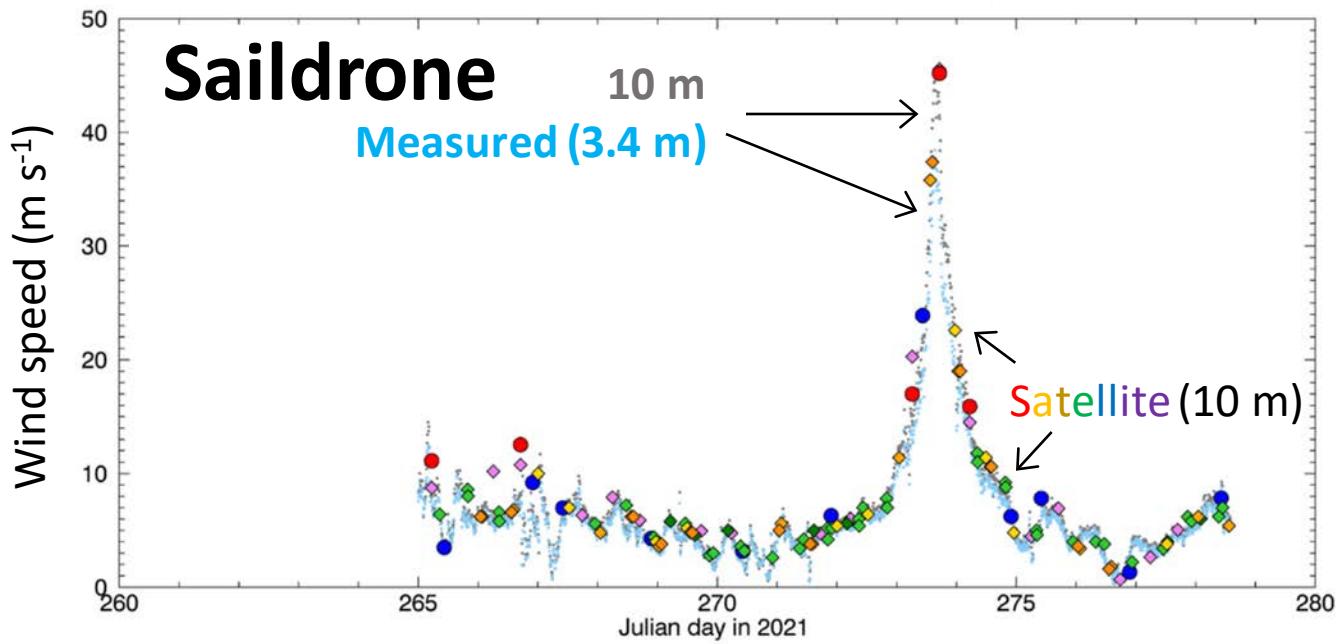
Captured by SD 1045's onboard camera during
Category 4 Hurricane Sam, Sept. 30 2021



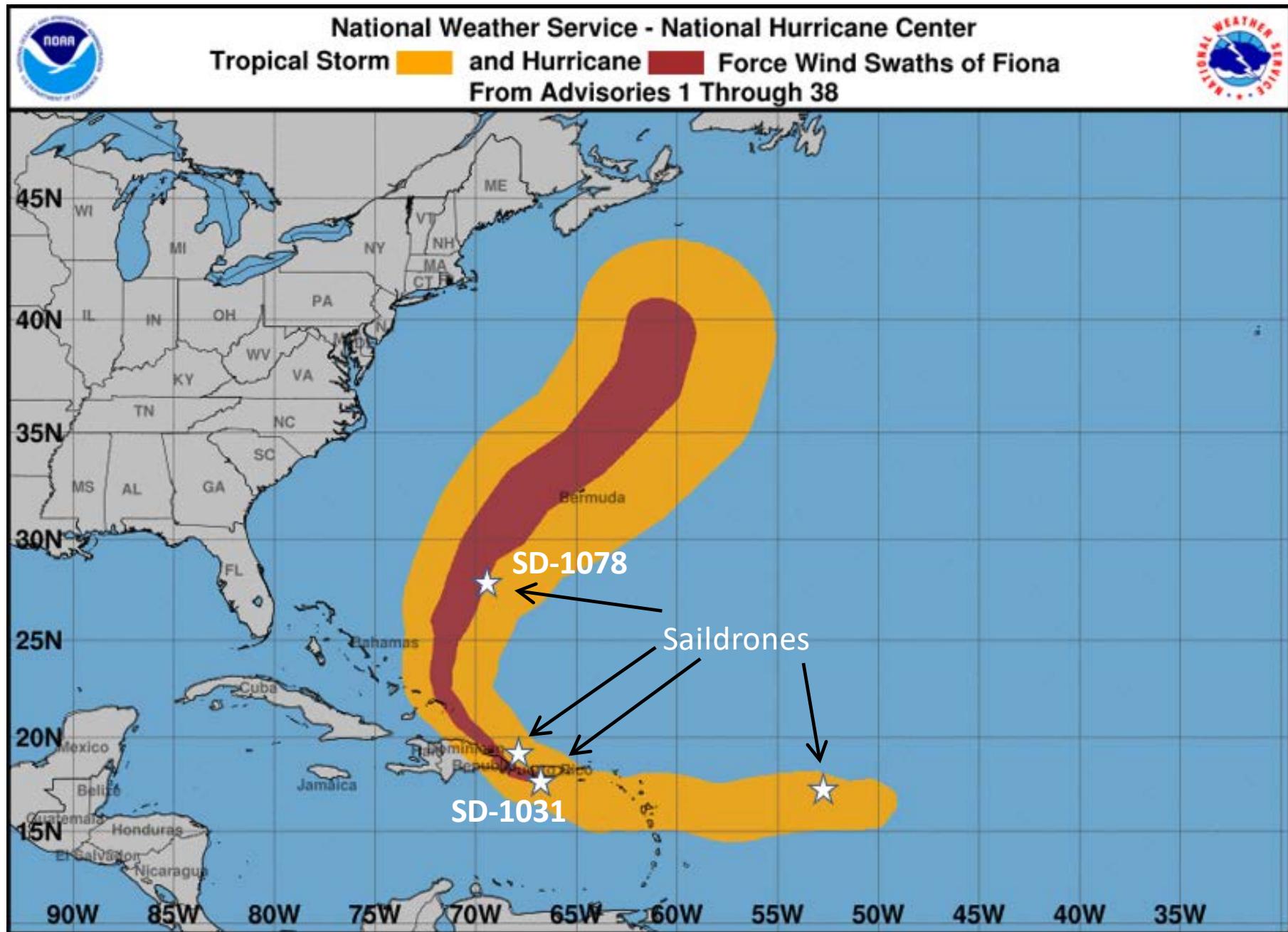
SAILDRONE

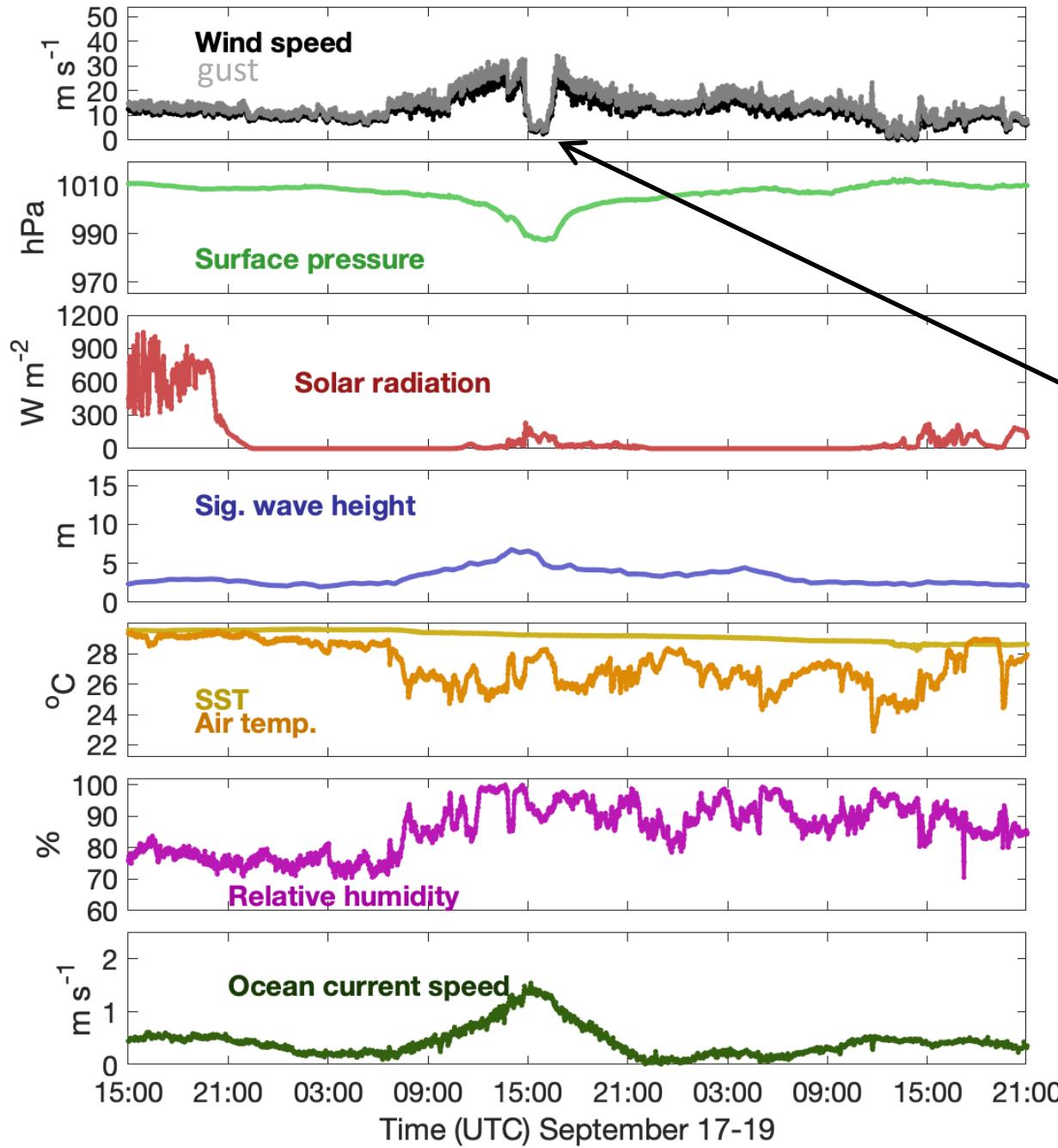






Hurricane Fiona (Sep 2022)

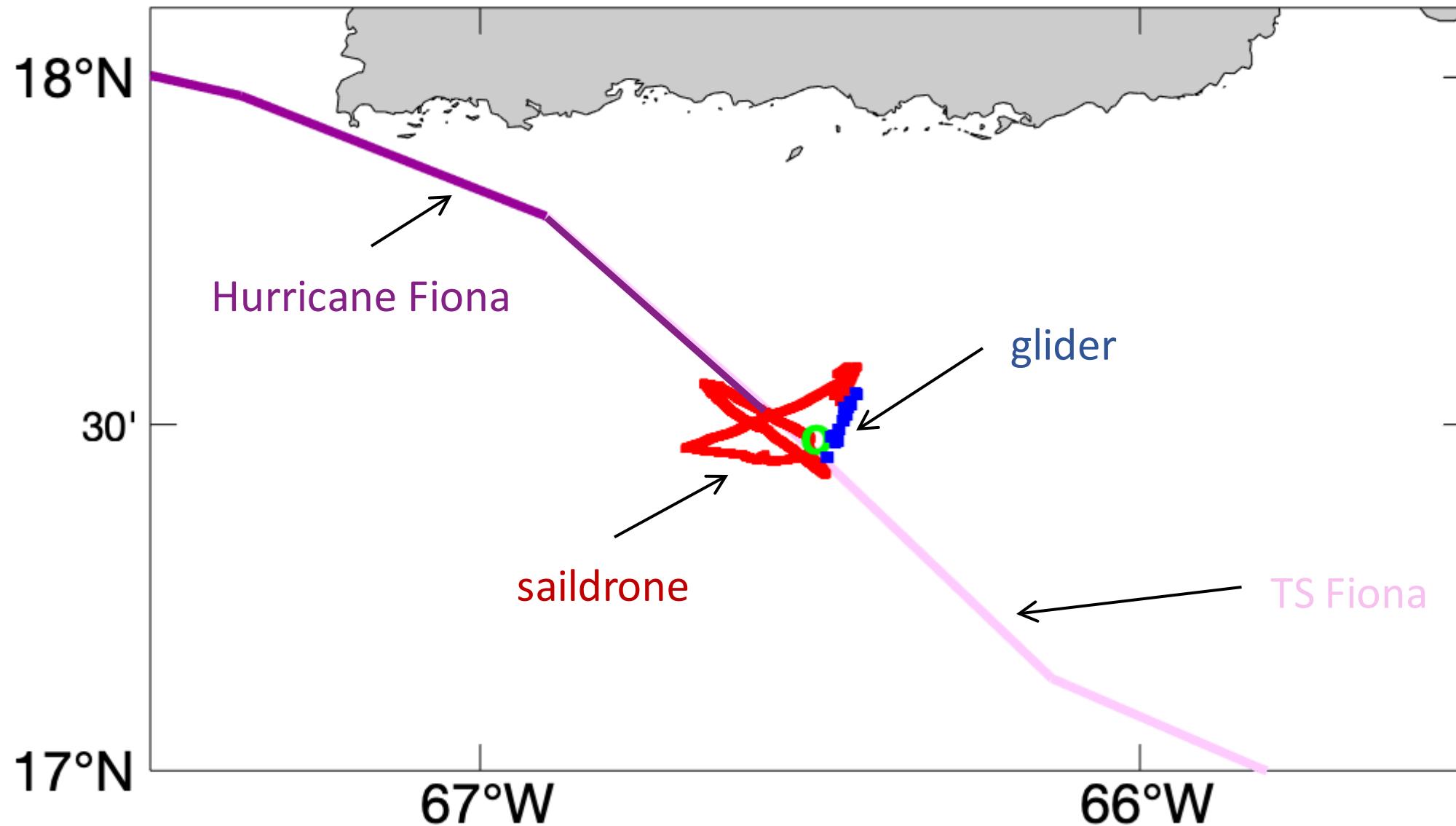


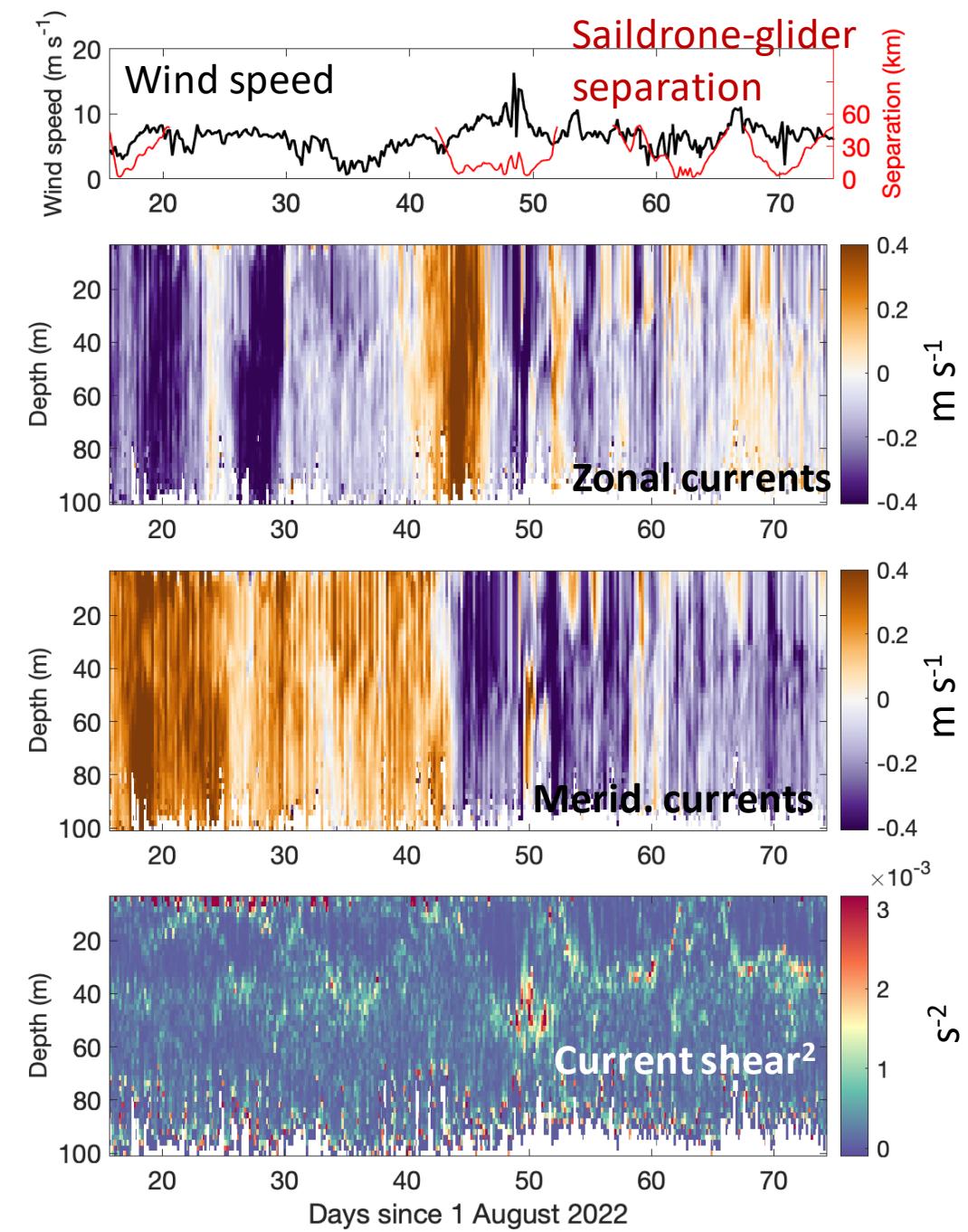
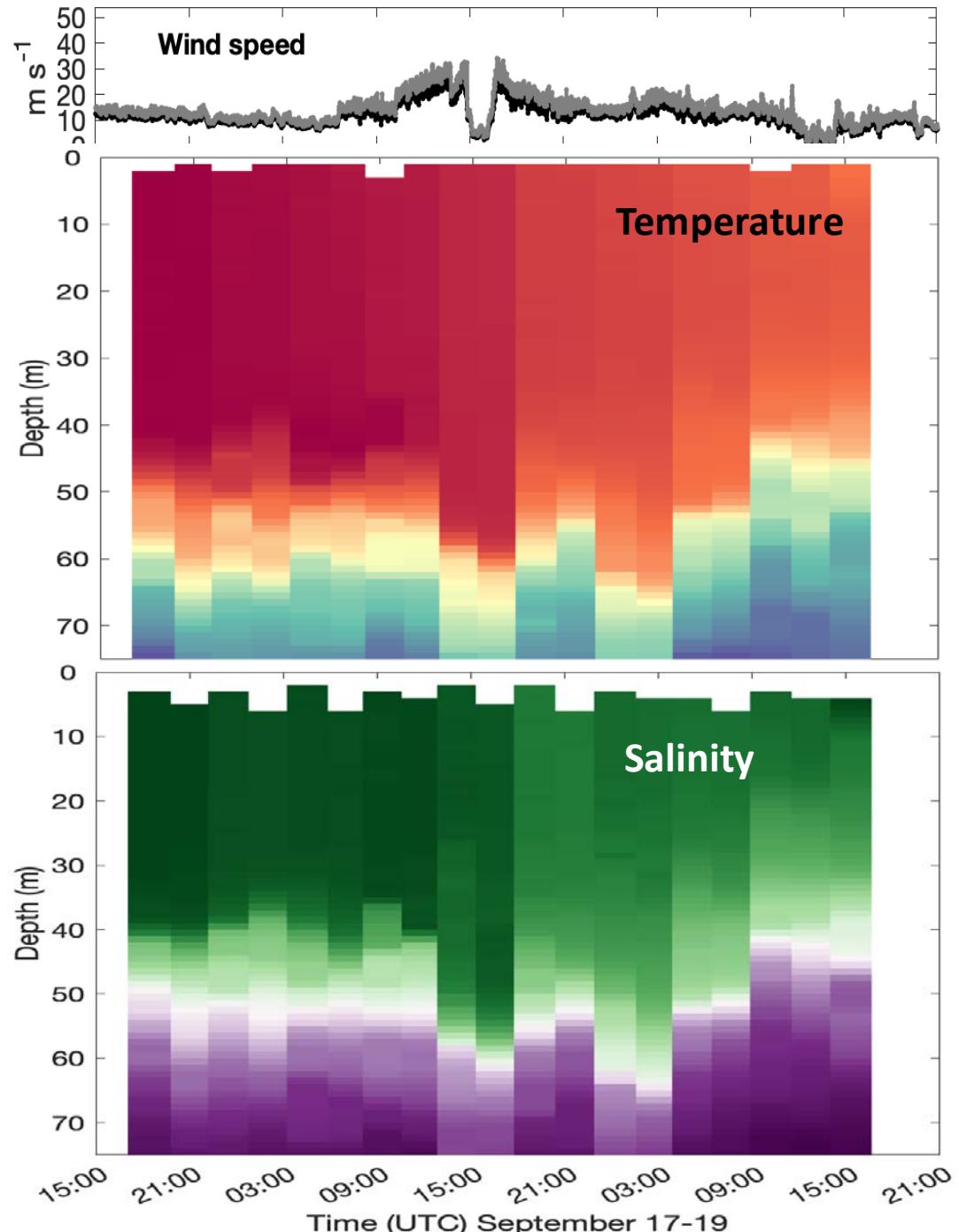


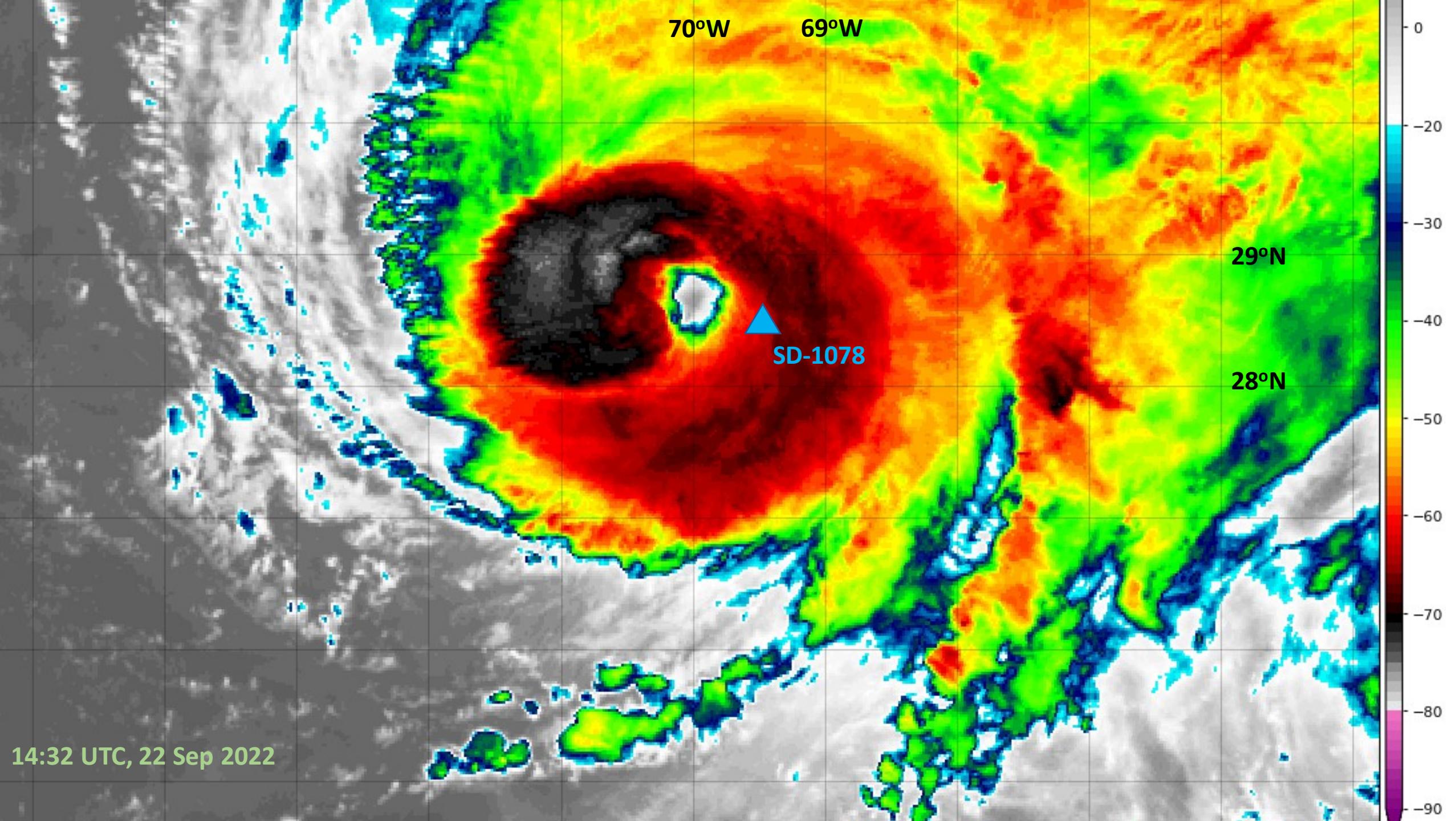
SD-1031 (south of PR)

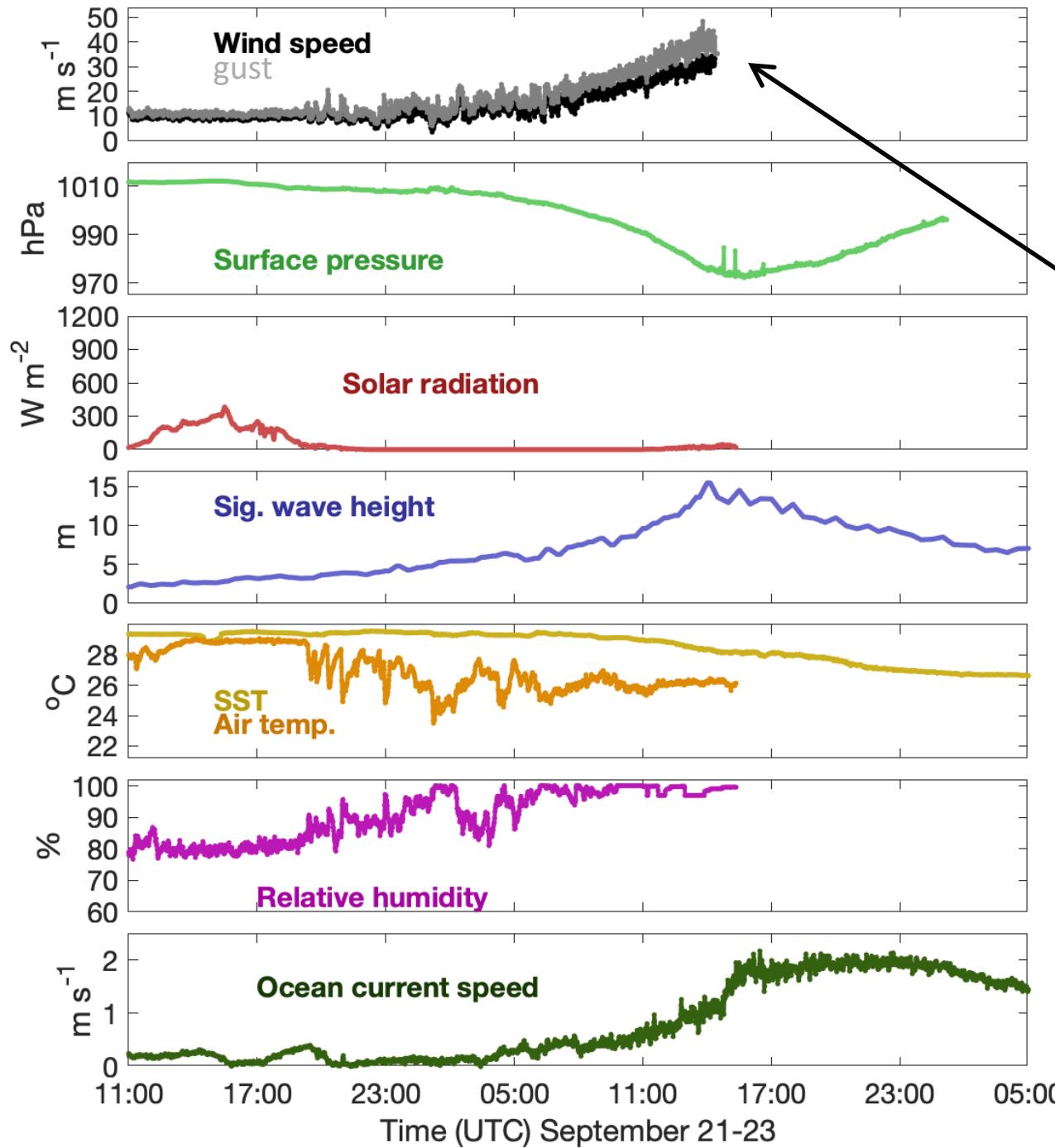
Eye of Fiona passed directly over, one hour after intensifying to a hurricane.

Coordination with ocean glider





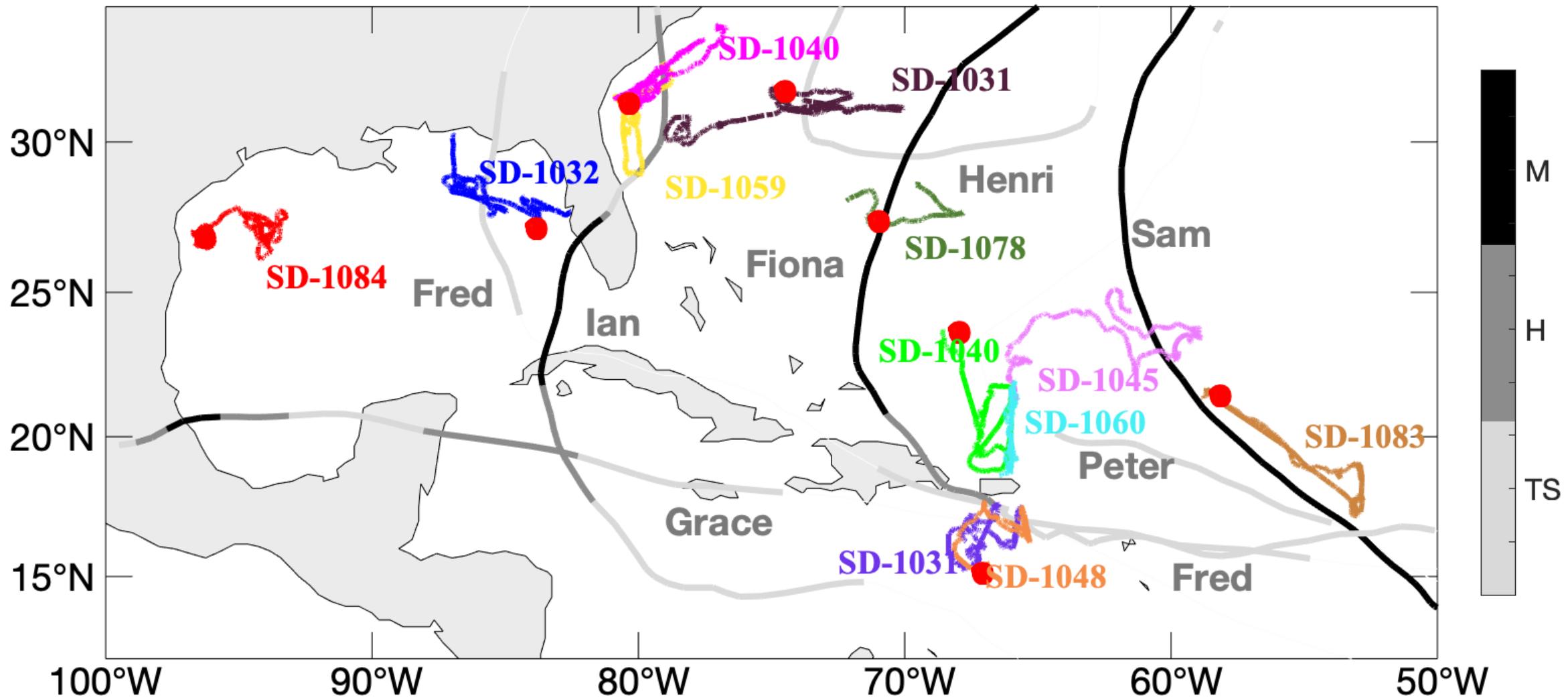


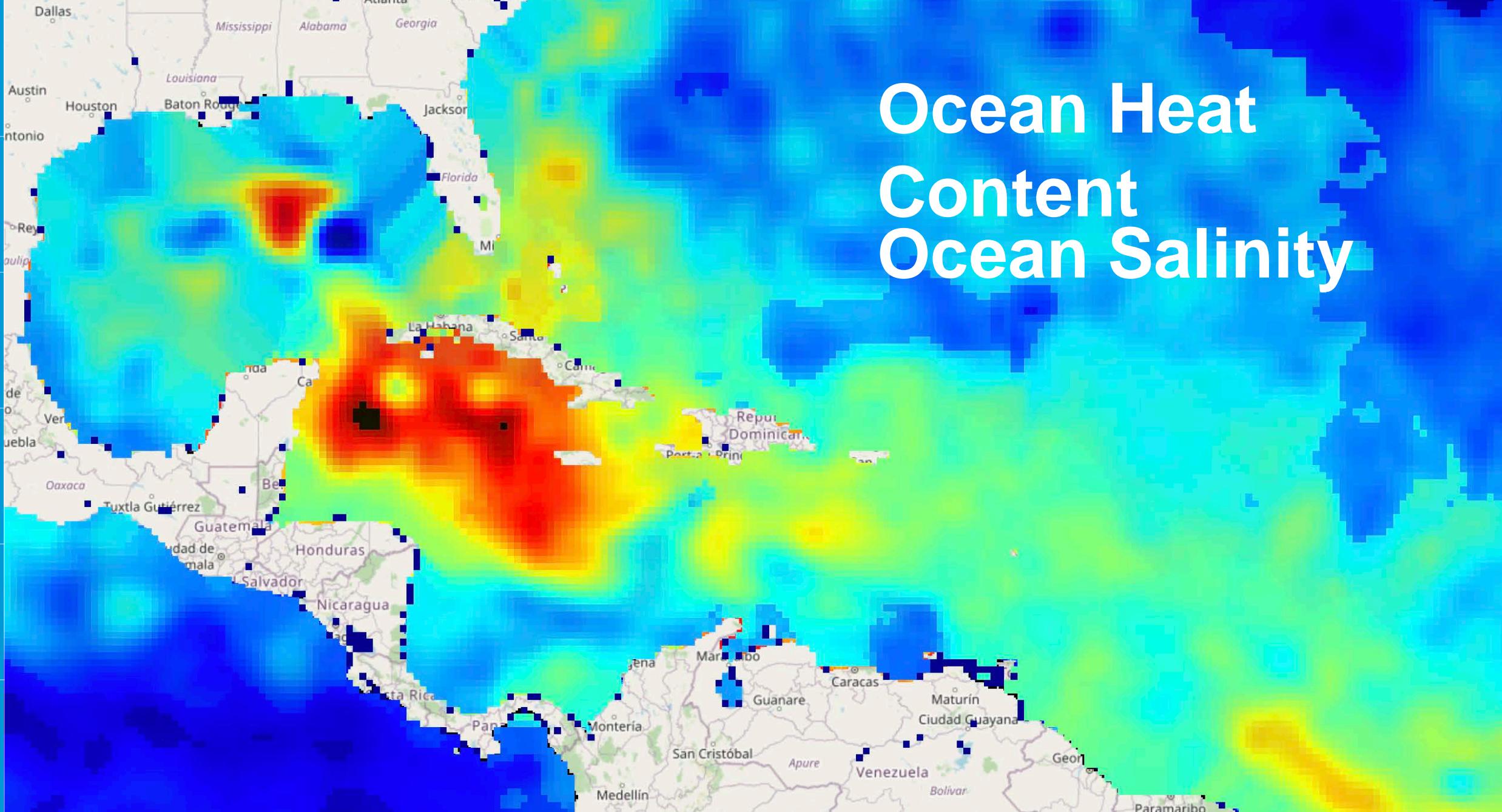


SD-1078 (Fiona)

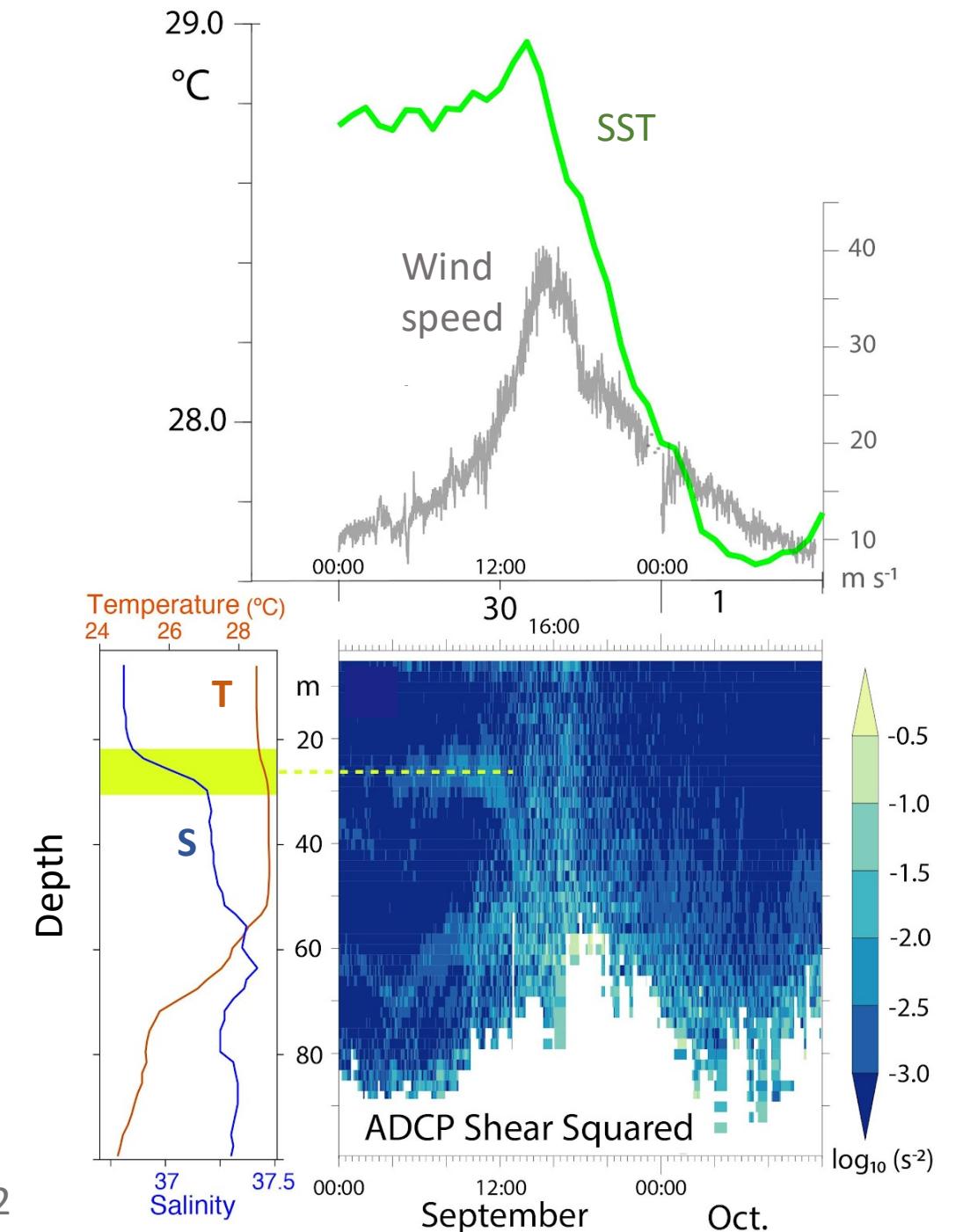
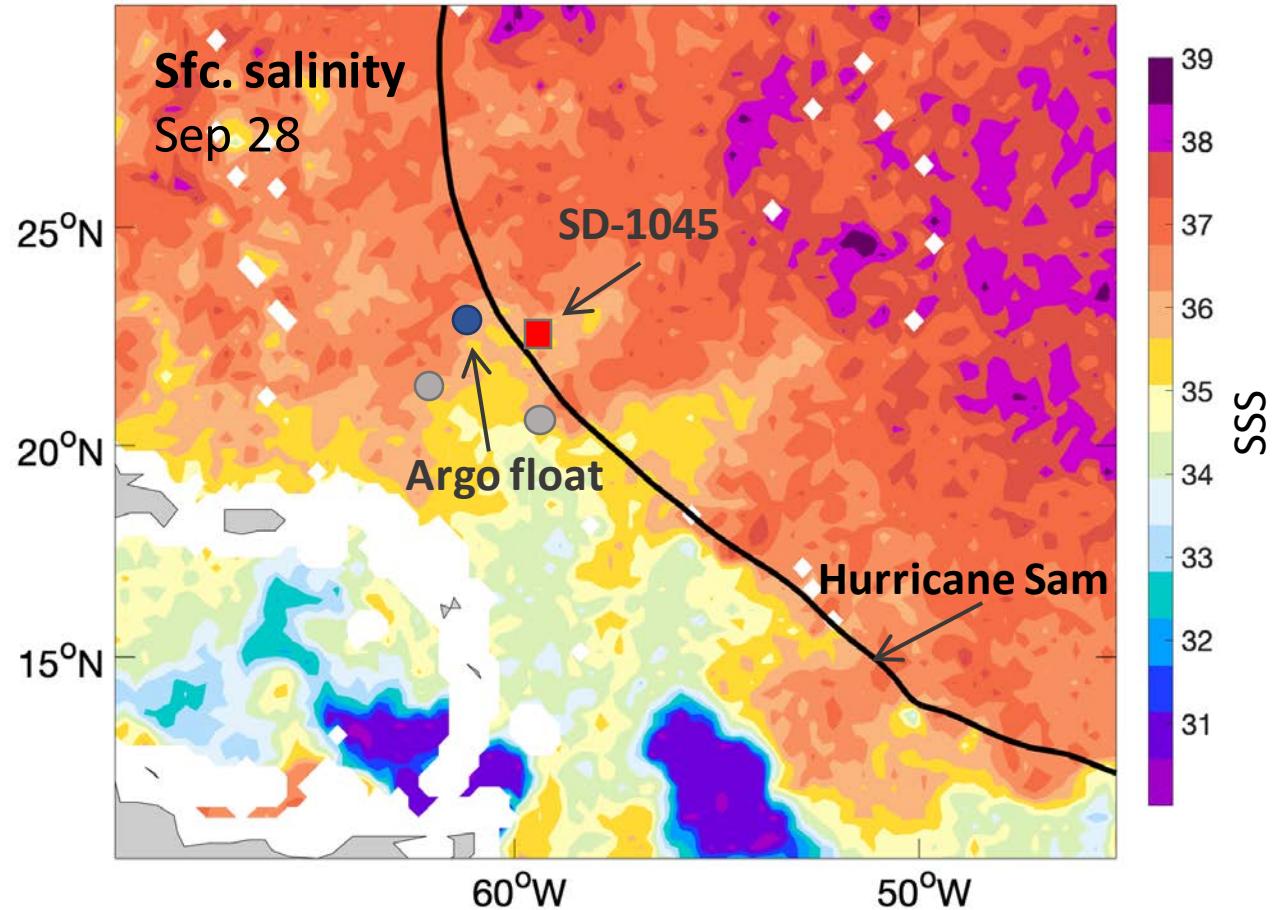
Wing/sensor failure in
hurricane-force winds,
50-ft waves

2021 and 2022 saildrone hurricane missions





Ocean Heat Content Ocean Salinity



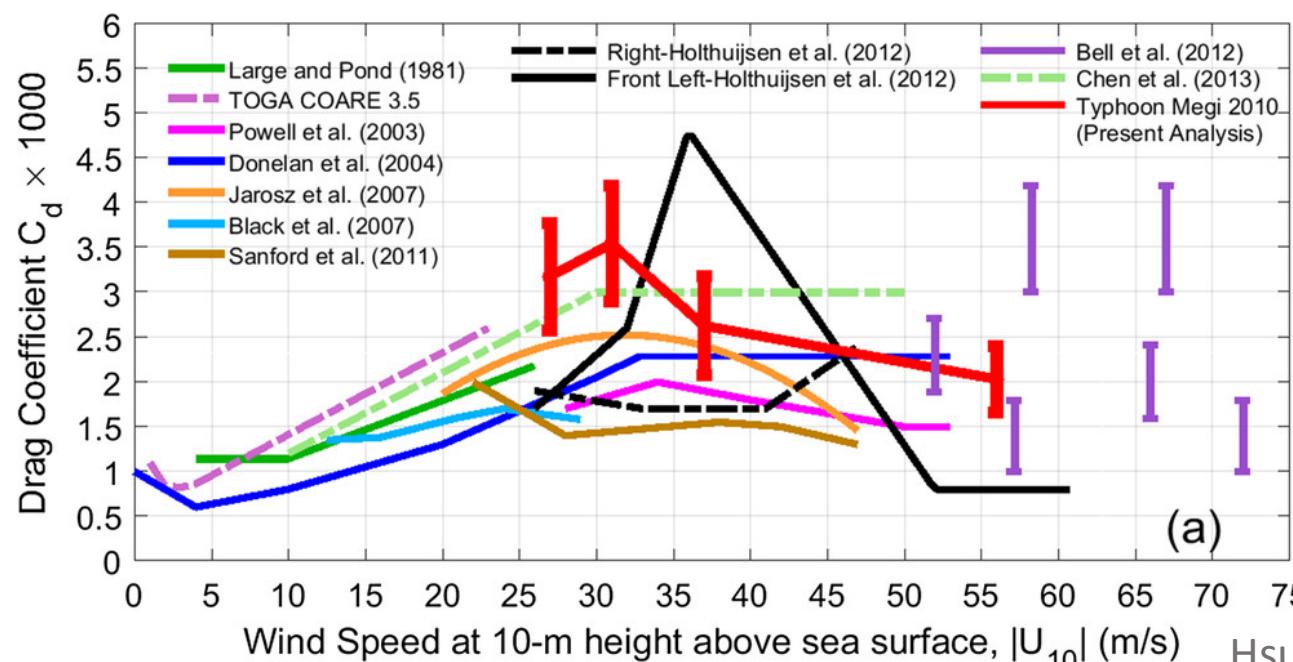
C_d

$$\tau = \rho C_d \overline{U_{10}^2}$$

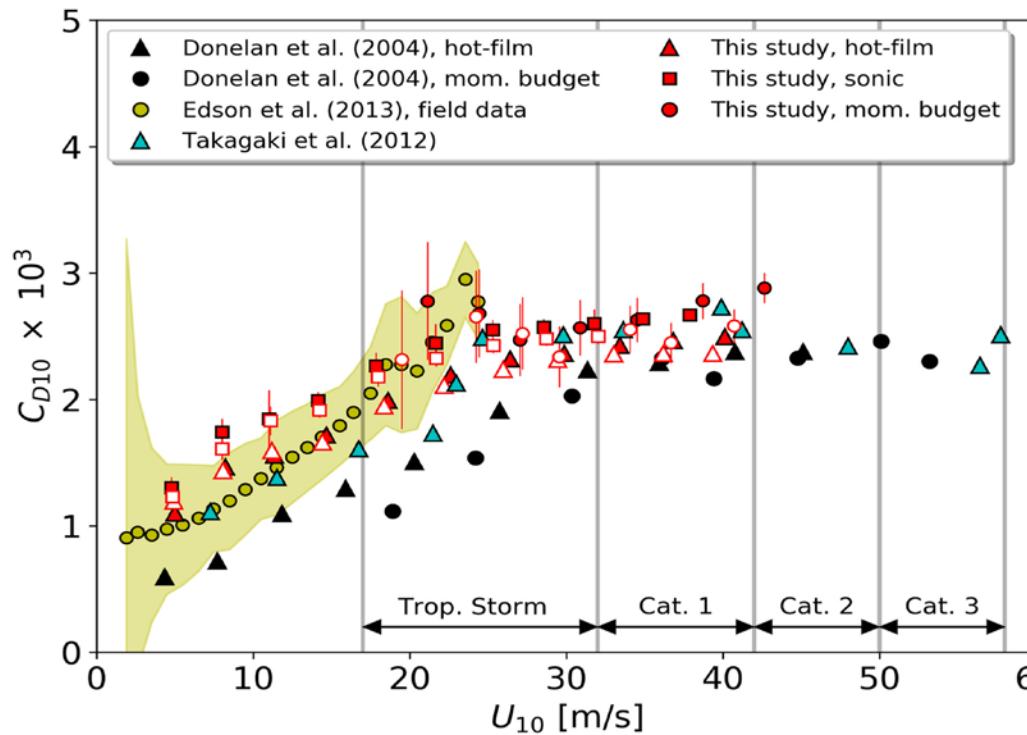
↑ ↑

SD-1045 data
(20 Hz, 5-min.
mean)

$$\tau \approx \tau_t = -\rho \overline{U'w'}$$

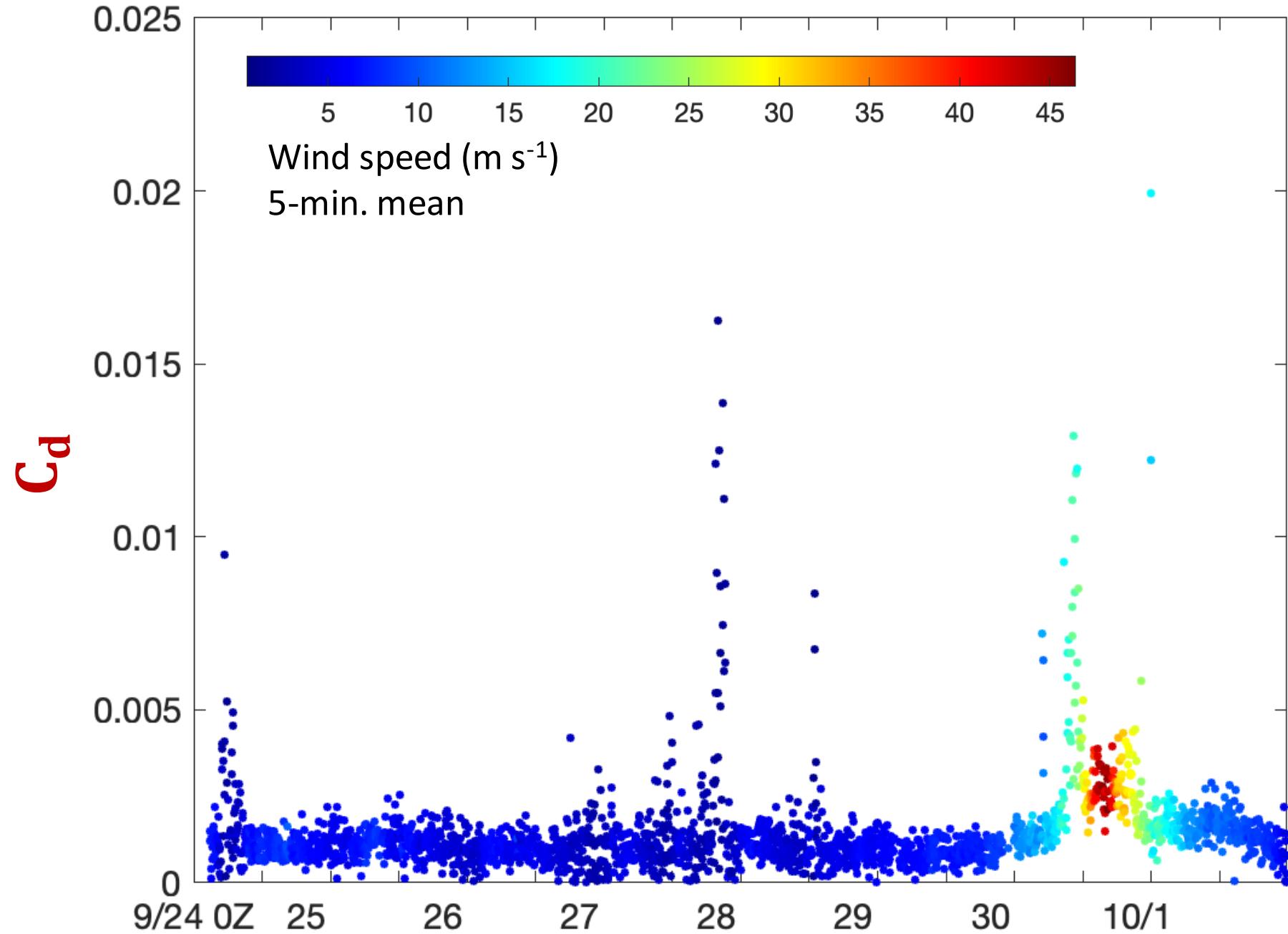


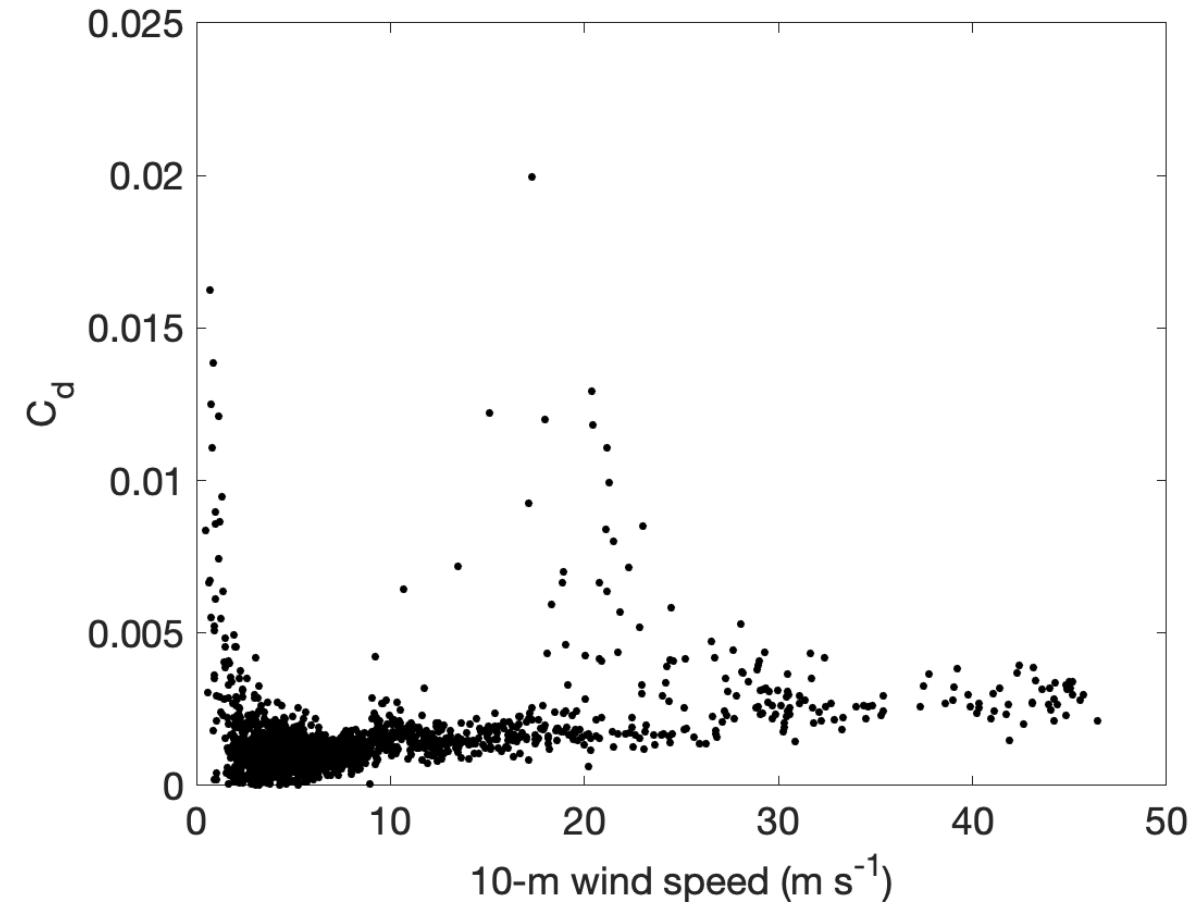
Hsu et al.
2017



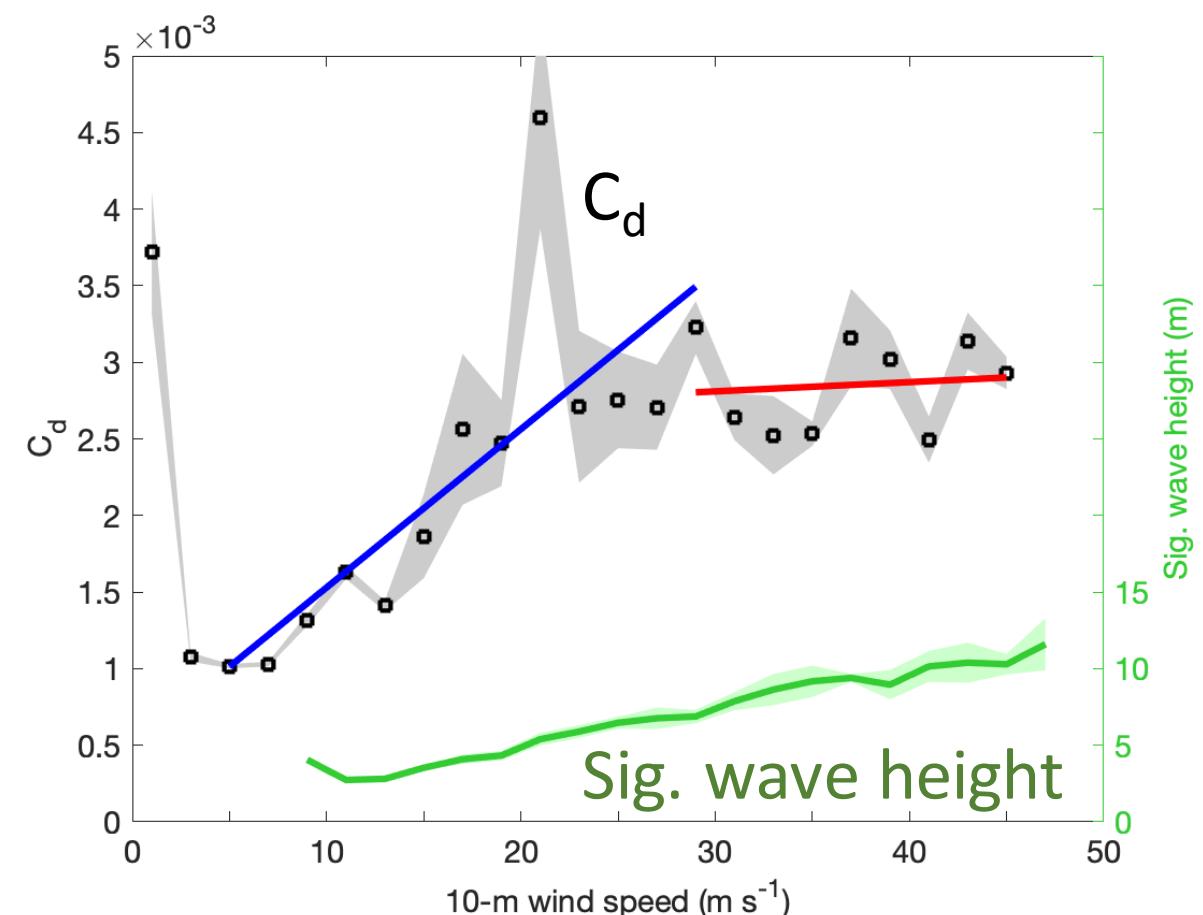
Curcic et al.
2020

$$\tau = -\rho \overline{U'w'}$$
$$= \rho C_d \frac{\overline{U'^2}}{U_{10}^2}$$





C_d vs. wind speed



Plans (funding requests) for 2023 and 2024

- Paired saildrones
- Test rapid deployment from land
- Test larger vehicle with electric motor and winch
- Inclusion of saildrone data in NOAA's forecast models

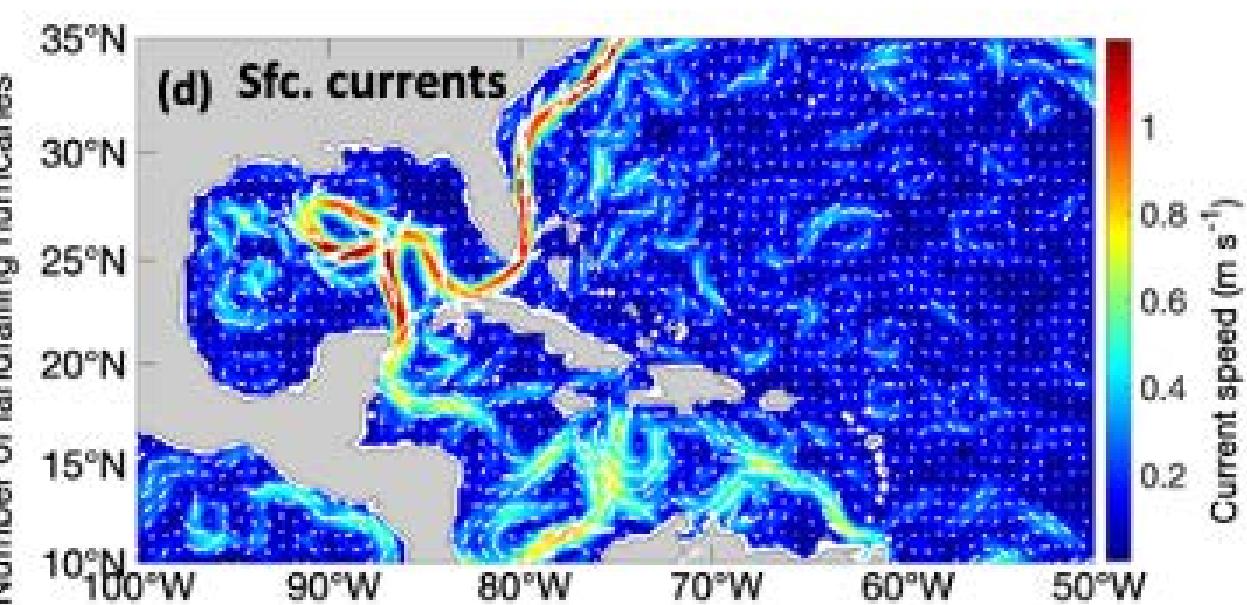
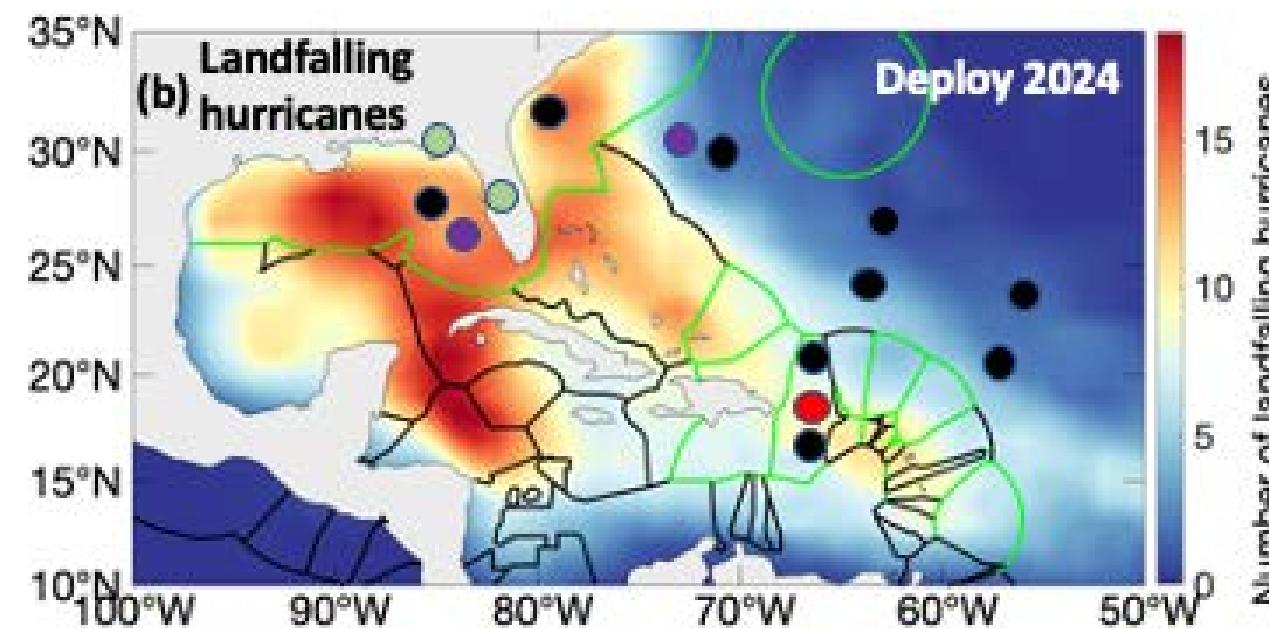
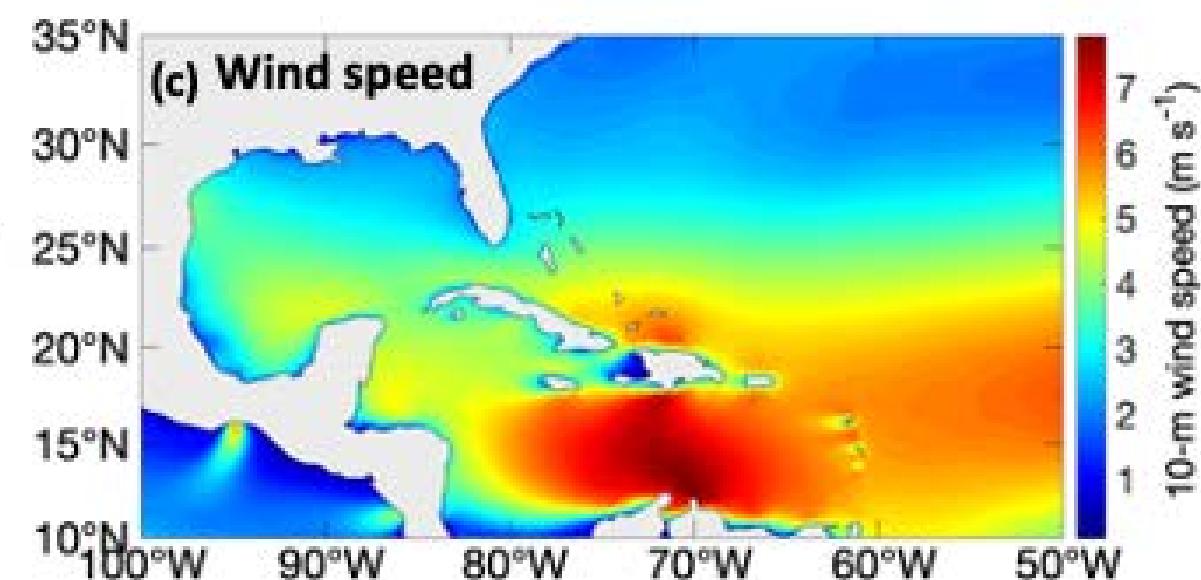
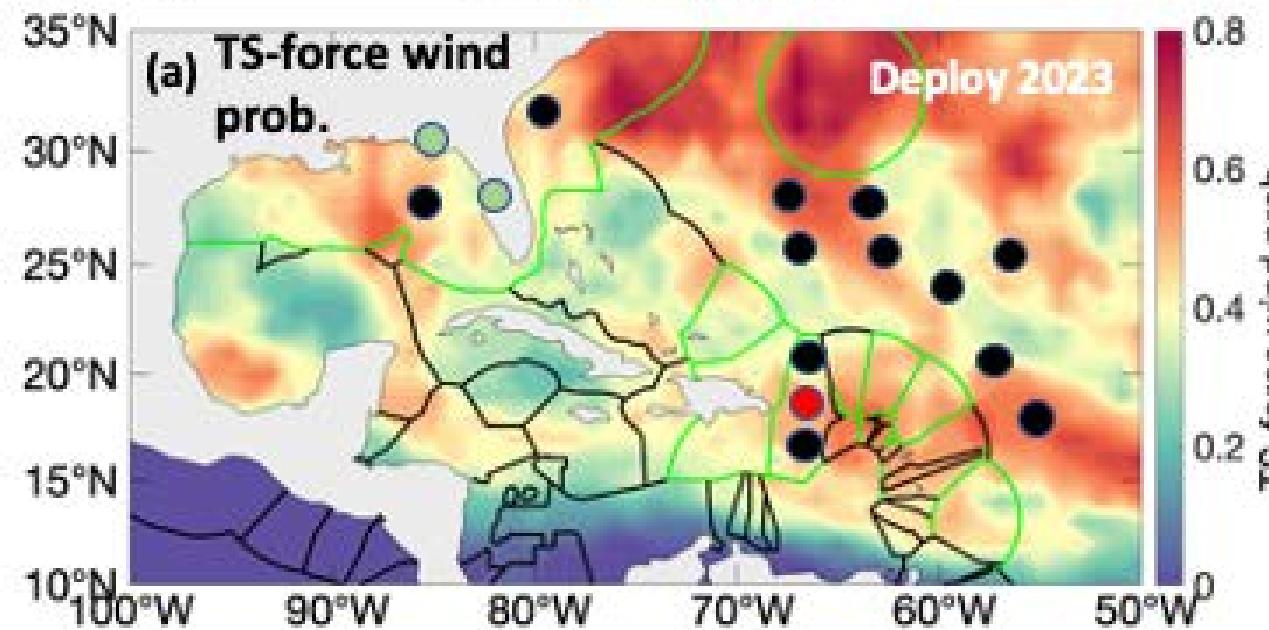


● Deploy ahead of TC

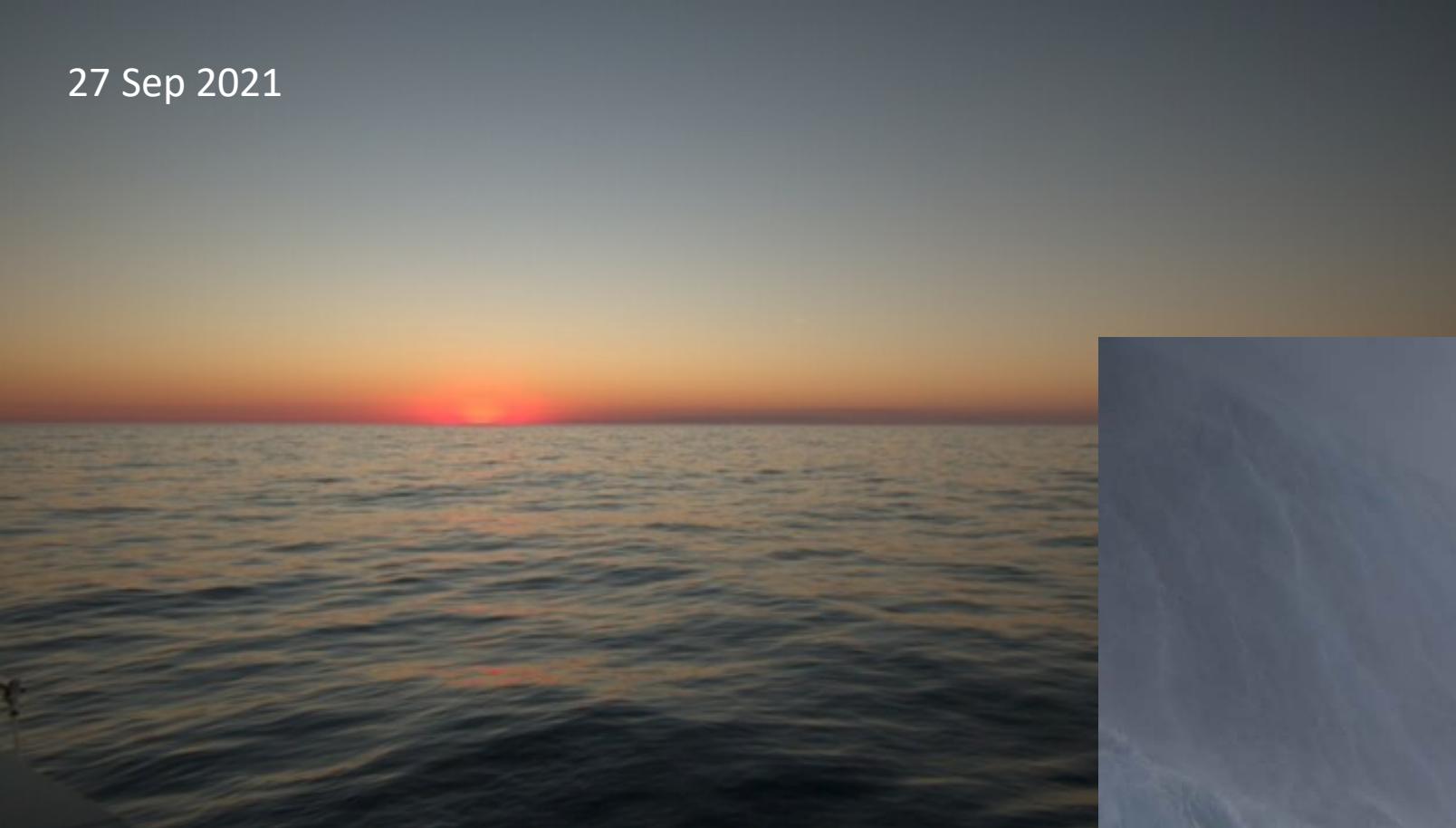
● Deploy if vehicle failure

● Normal deployment

● Normal deployment (Voyager)



27 Sep 2021



30 Sep 2021

