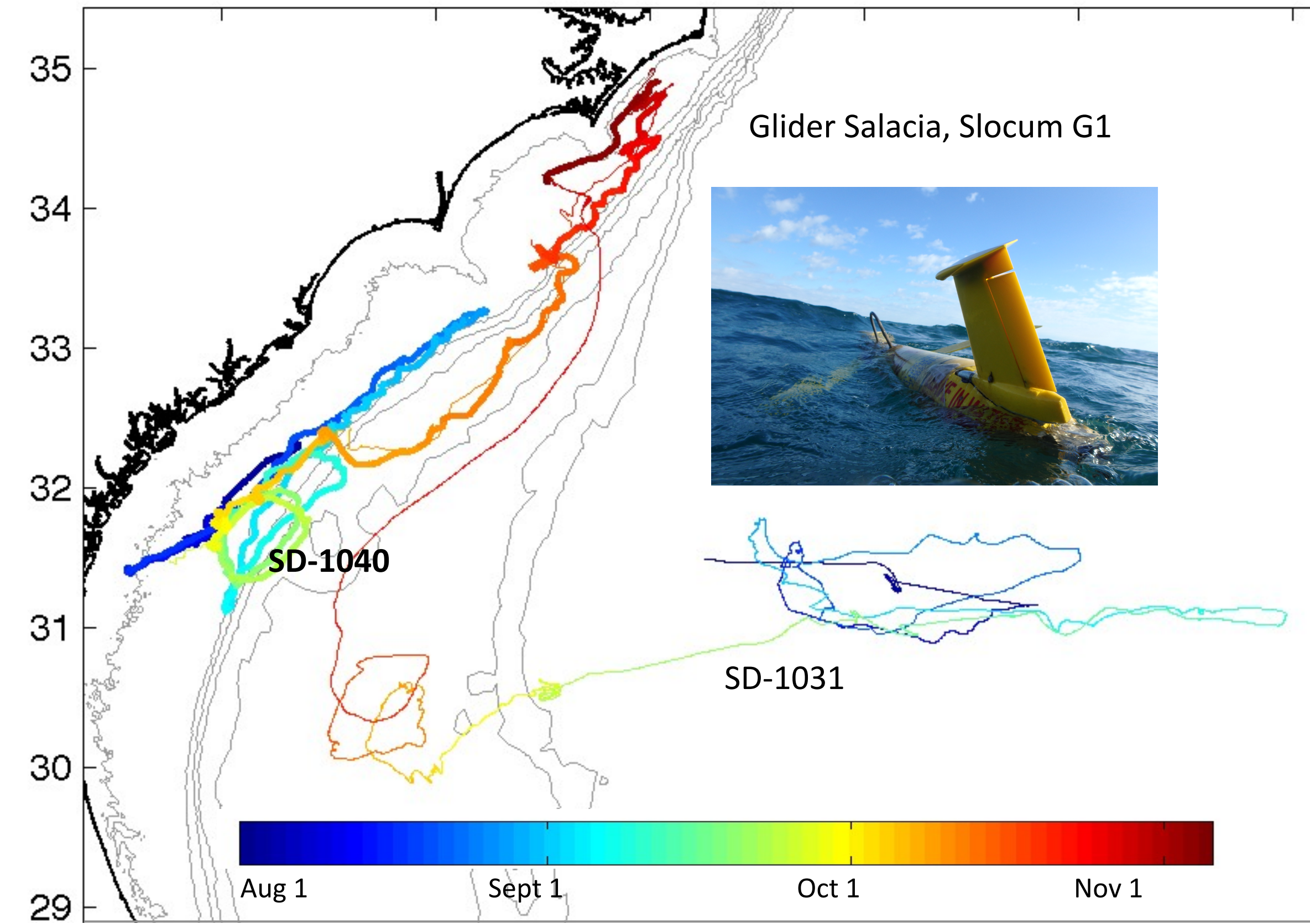# Coordinated Autonomous Surface Vehicle and Underwater Glider Operations in the Gulf Stream During Hurricane Season 2021

Catherine R. Edwards[1], Gregory Foltz[2], Chidong Zhang[3], Francis Bringas[2], Eugene Burger[3], Andy Chiodi[34], Ned Cokelet[3], Gustavo Goni[2], Hristina Hristova[34], Richard Jenkins[5], Cal Mordy[34], Chris Meinig[3], Dongxiao Zhang[34], Jun Zhang[26]
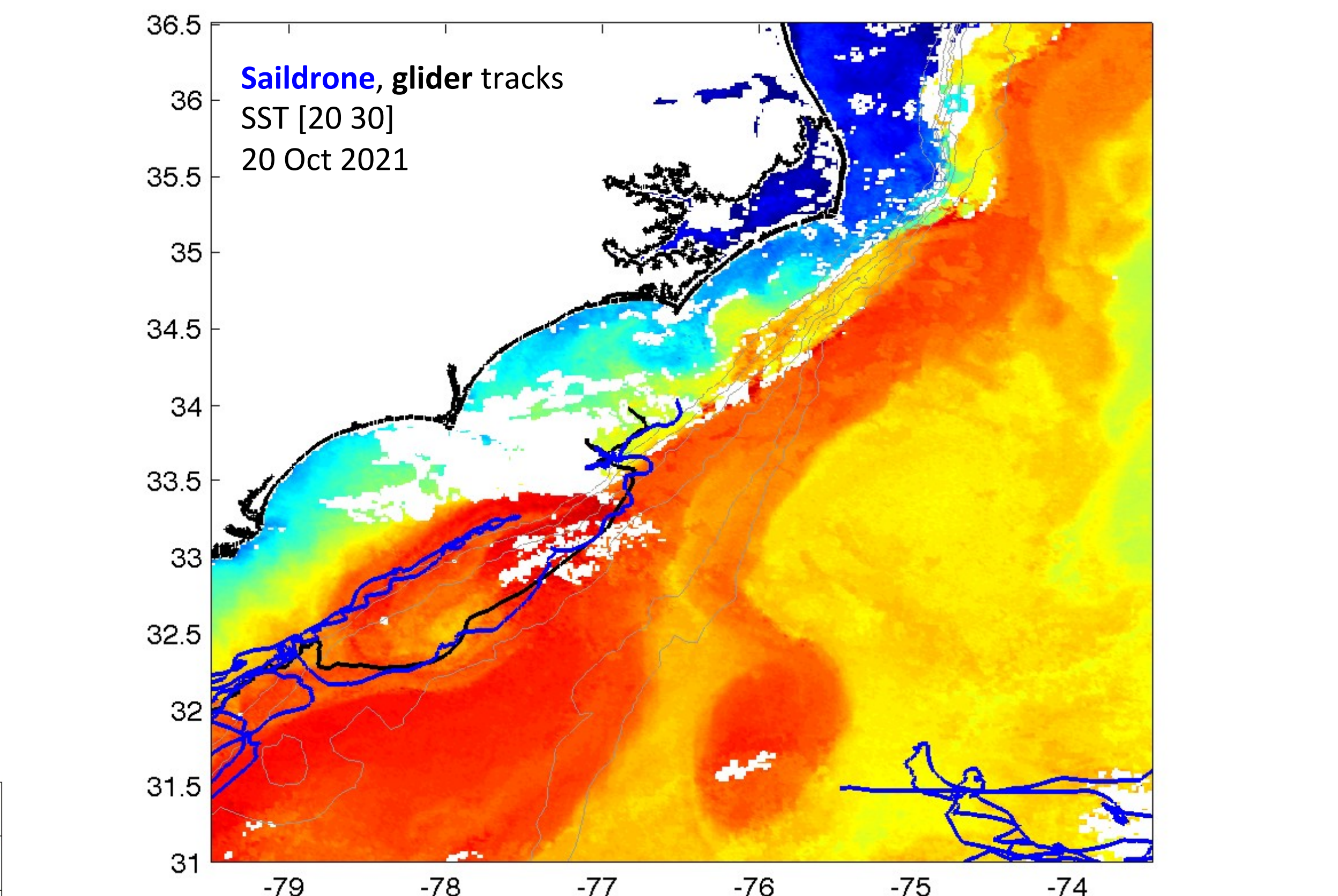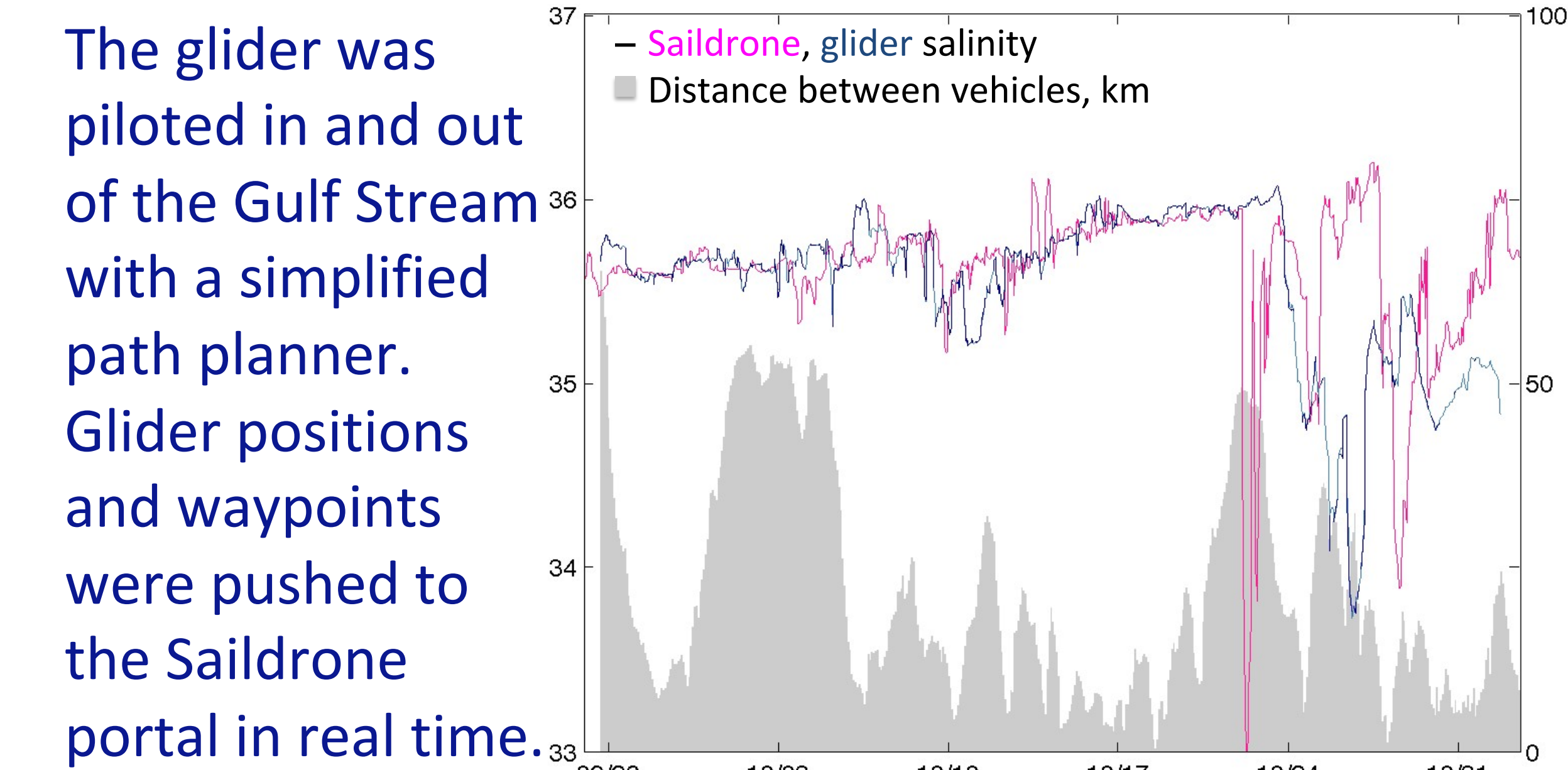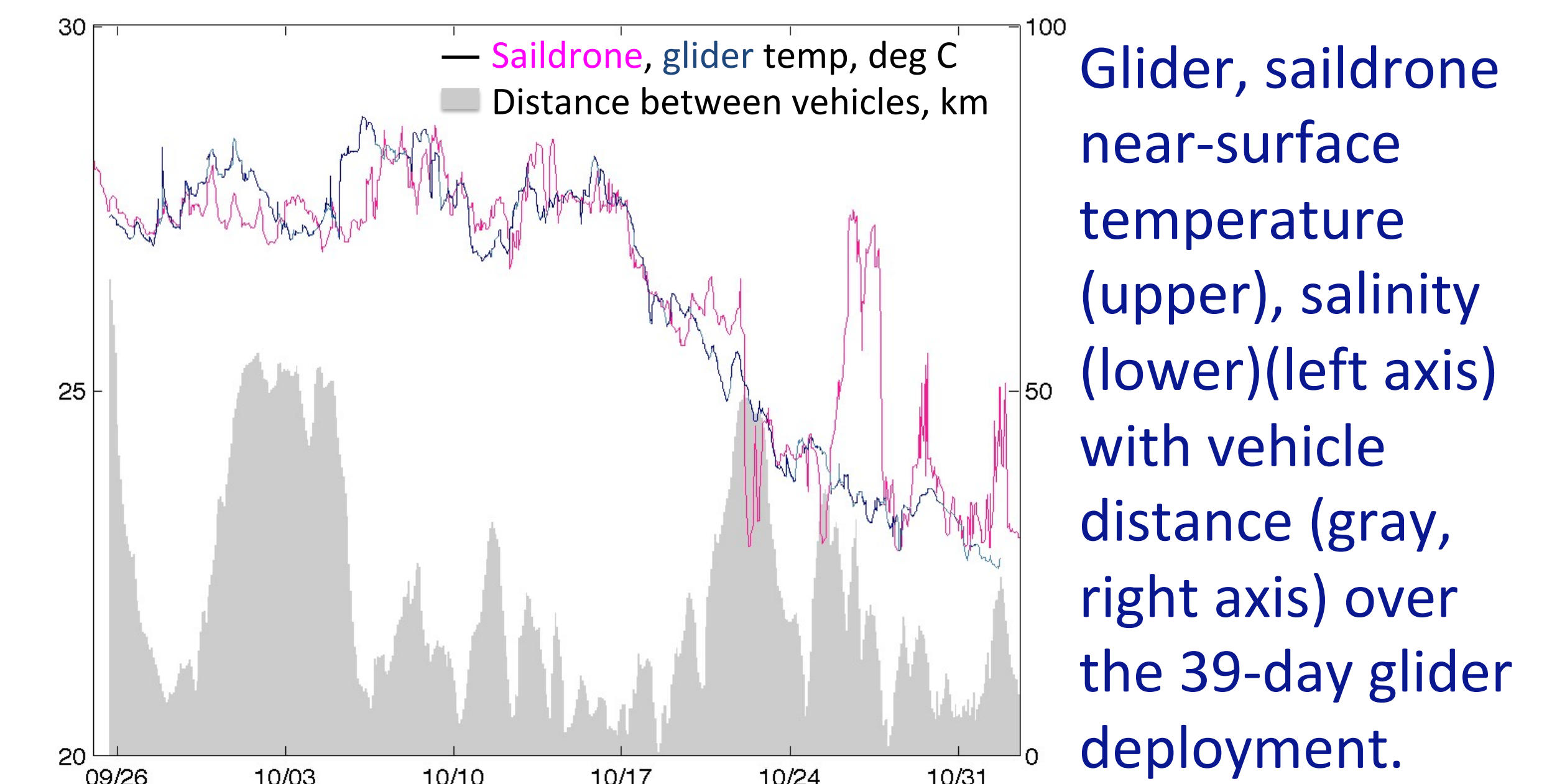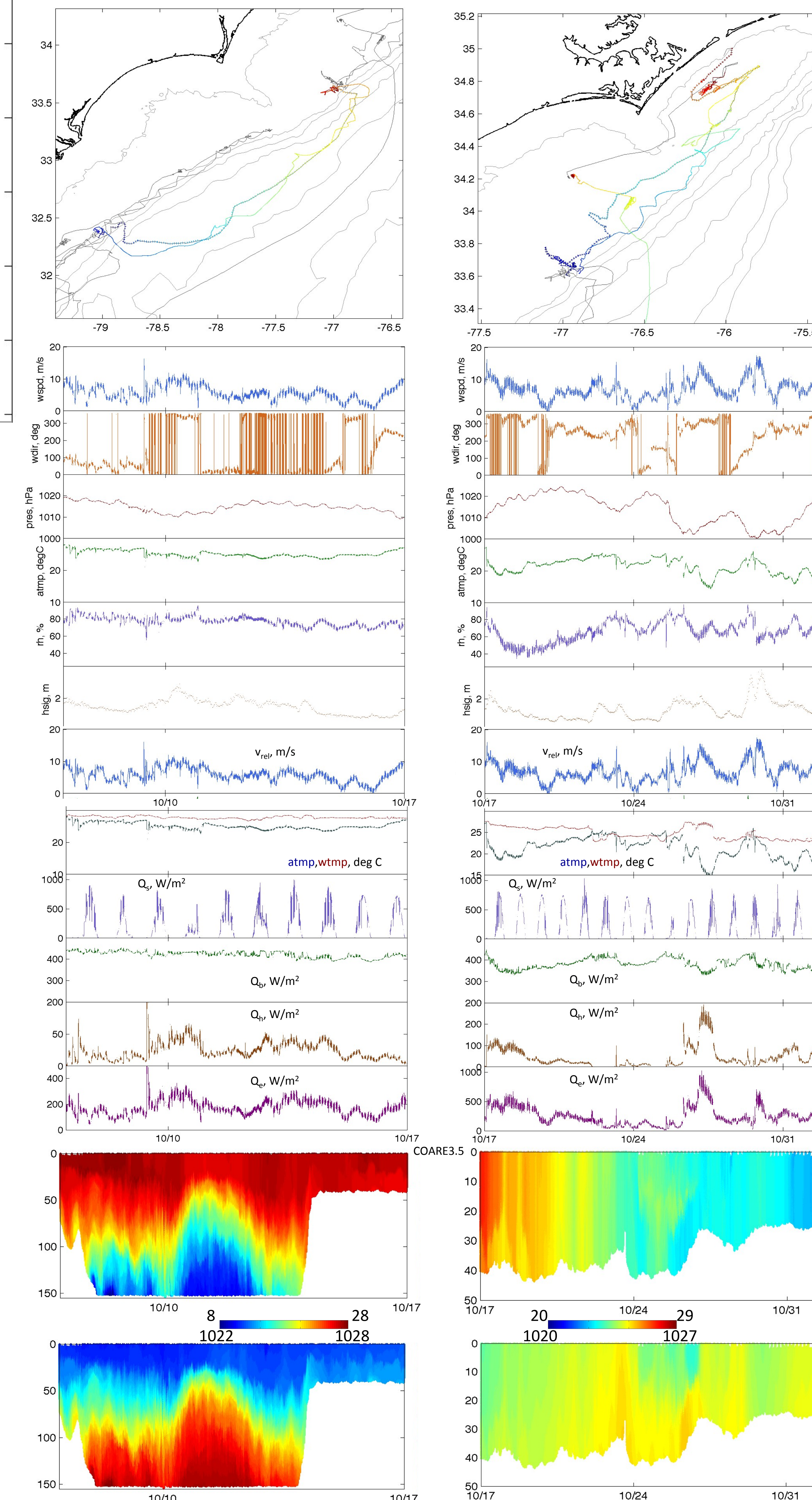
[1]Skidaway Institute of Oceanography, University of Georgia [2]NOAA AOML, [3]NOAA PMEL, [4]University of Washington, [5]Saildrone, [6]University of Miami

Mission overview

During the Atlantic hurricane season, 5 experimental Saildrone uncrewed surface vehicles (USVs) measured near-surface meteorological and upper ocean data in areas of high tropical cyclone heat potential and storm incidence. Three were paired with underwater gliders, including two vehicles operating in and near the Gulf Stream.
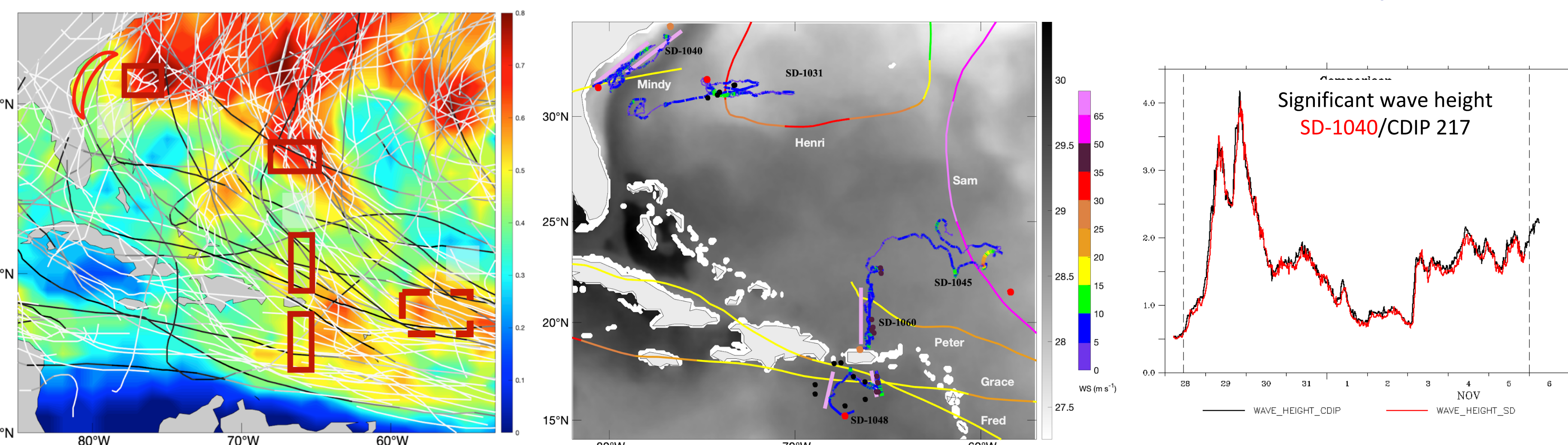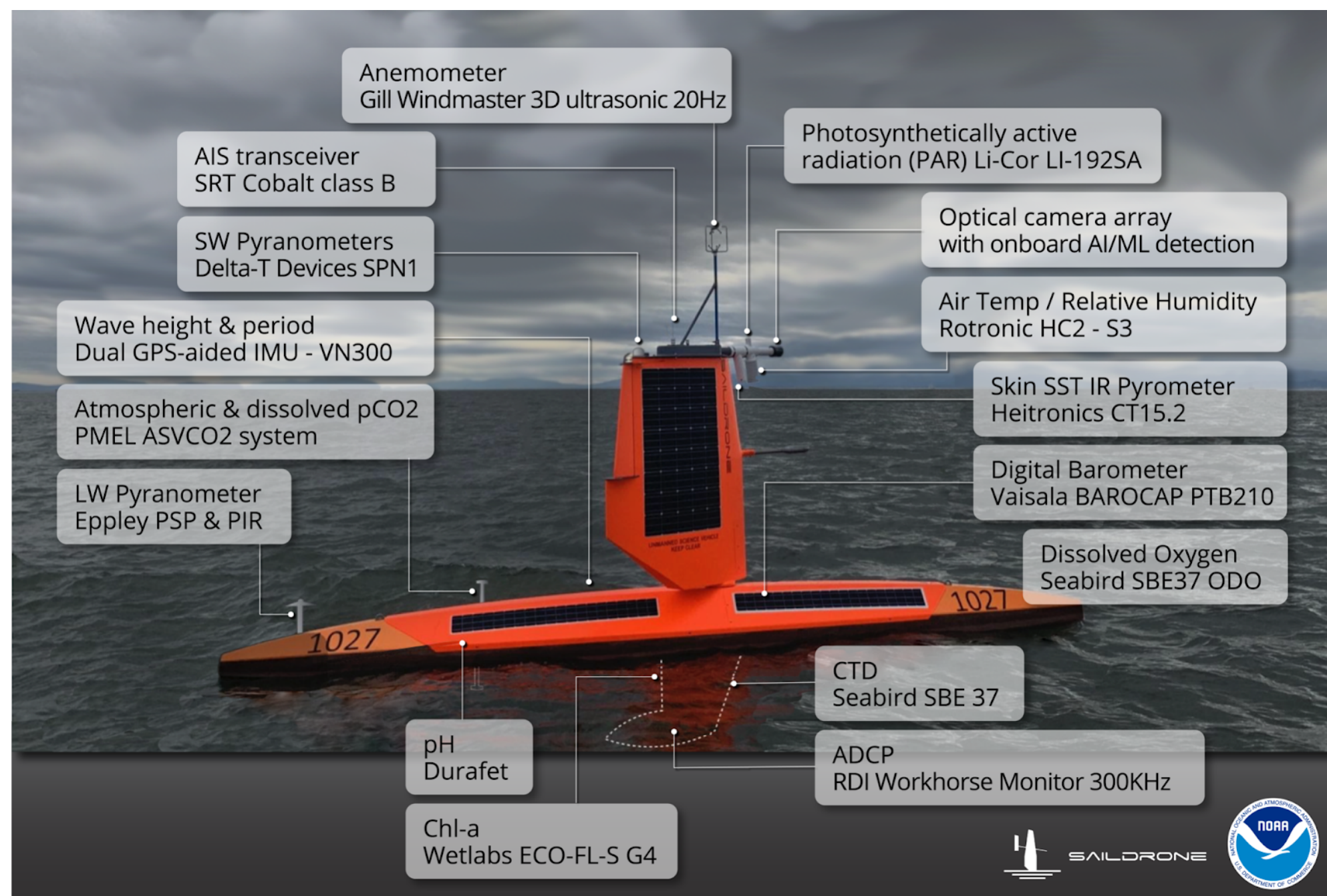

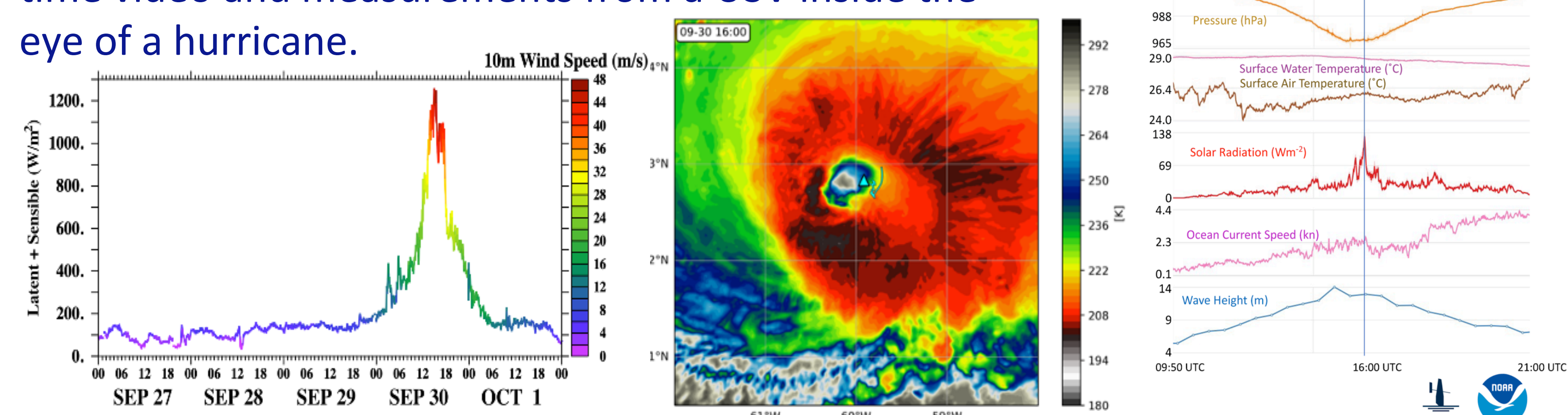Glider Salacia, Slocum G1

SD-1040

SD-1031

Cross-platform validation

With a modified wing to withstand hurricane-force winds, each saildrone was outfitted with meteorological and ocean sensors (left). During each ~100 day mission (August 1-November 5), the saildrones sampled near NDBC and CDIP buoys, as well as research vessels of opportunity, to cross-validate wind, wave, near-surface, and subsurface oceanographic data collected with traditional platforms.

Anemometer Gill Windmaster 3D ultrasonic 20Hz
AIS transceiver SRT Cobalt class B
SW Pyranometers Delta-T Devices SPN1
Photosynthetically active radiation (PAR) Li-Cor LI-192SA
Optical camera array with onboard AI/ML detection
Wave height & period Dual GPS-aided IMU - VN300
Air Temp / Relative Humidity Rotronic HC2 - S3
Atmospheric & dissolved pCO2 PMEL ASVCO2 system
Skin SST IR Pyrometer Heitronics CT15.2
LW Pyranometer Eppley PSP & PIR
Digital Barometer Vaisala BAROCAP PTB210
Dissolved Oxygen Seabird SBE37 ODO
CTD Seabird SBE 37
pH Durafet
ADCP RDI Workhorse Monitor 300KHz
Chl-a Wetlabs ECO-FL-S G4

Significant wave height
SD-1040/CDIP 217

WAVE_HEIGHT_CDIP
WAVE_HEIGHT_SD

Hurricane Sam

"Stormcatcher" SD-1045 was piloted to intercept Hurricane Sam, measuring 50+ m/s winds and providing the first real time video and measurements from a USV inside the eye of a hurricane.

10m Wind Speed (m/s)
09-30 16:00

Wind Gust (kn)
Wind Speed (kn)
Relative Humidity (%)
Pressure (hPa)
Surface Water Temperature (°C)
Surface Air Temperature (°C)
Solar Radiation (Wm²)
Ocean Current Speed (kn)
Wave Height (m)

Paired glider-saildrone data

wspd, m/s
wdir, deg
pres, hPa
atmp, degC
rh, %
hsig, m
v_np, m/s
atmp,wtmp, deg C
Q_n, W/m²
Q_s, W/m²
Q_b, W/m²
Q_L, W/m²

COARE3.5

Expanding autonomy

The 2021 field effort suggests that coordinated robotic surface and underwater vehicles can permit long endurance autonomous sampling of air-sea interaction in the Gulf Stream, where operational challenges motivate coordination through an intelligent, adaptive, and robust robotic network. Future work will involve modification of path planning software (GENIoS, with collaborator F. Zhang) to develop algorithms tailored to the constraints of saildrones and other USVs.

Glider, saildrone near-surface temperature (upper), salinity (lower)(left axis) with vehicle distance (gray, right axis) over the 39-day glider deployment.

Saildrone, glider temp, deg C
Distance between vehicles, km

The glider was piloted in and out of the Gulf Stream with a simplified path planner. Glider positions and waypoints were pushed to the Saildrone portal in real time.

Saildrone, glider salinity
Distance between vehicles, km

Saildrone, glider tracks
SST [20 30]
20 Oct 2021