

NOAA/AOML – CARICOOS Hurricane Underwater Glider Operations

Gustavo Jorge Goni¹

Francis Bringas¹

George Halliwell¹

Ricardo Domingues^{2,1}

Jili Dong³

Grant Rawson^{2,1}

Ulises Rivero¹

Thomas Sevilla^{2,1}

Julio Morell⁴

Sang-Ki Lee¹

Hyun-Sook Kim³

Luis Pomales⁴

Becky Baltles⁵

Richard Bouchard⁶

Yamil Rodriguez⁷

1 NOAA Atlantic Oceanographic and Meteorological Laboratory - AOML, Miami, Florida, USA

2 University of Miami, Cooperative Institute for Marine and Atmospheric Studies - CIMAS, Miami, Florida, USA

3 NOAA Environmental Modeling Center, College Park, Maryland, USA

4 University of Puerto Rico, Mayaguez, Puerto Rico, and Caribbean Coastal Ocean Observing System - CARICOOS

5 NOAA Integrated Ocean Observing System – IOOS, Silver Spring, MD, USA

6 NOAA National Data Buoy Center, Stennis, Miss, USA

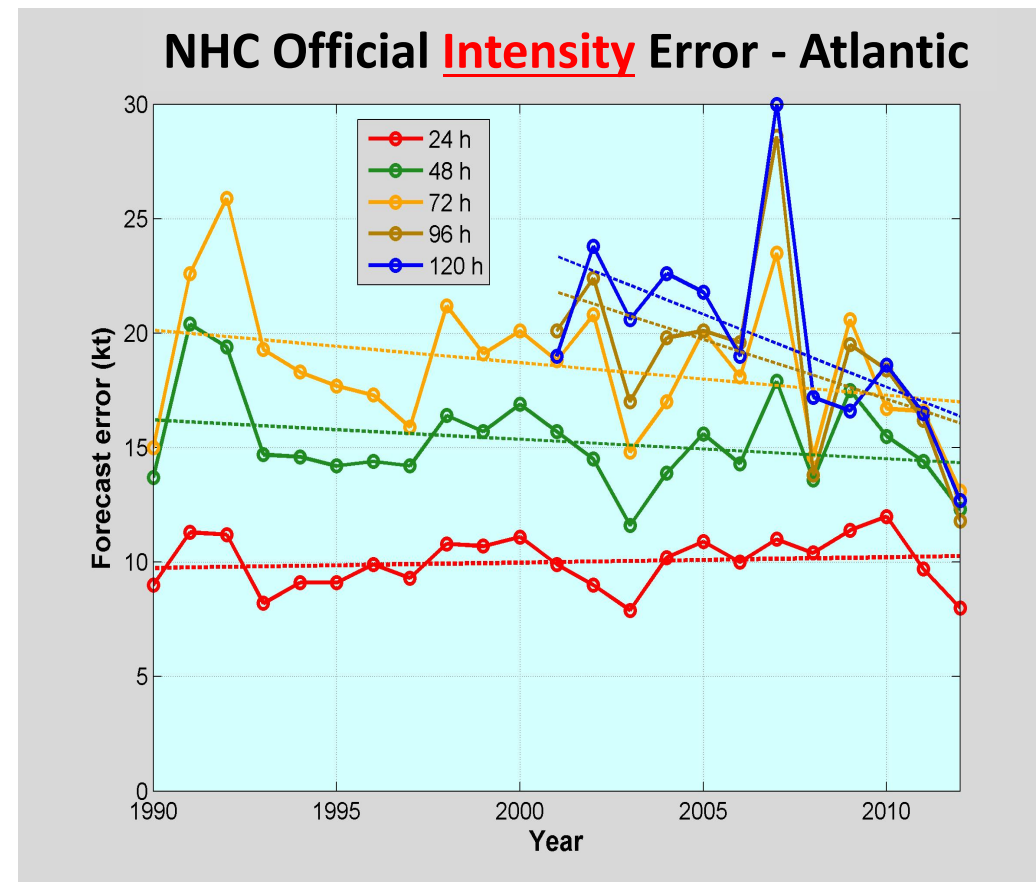
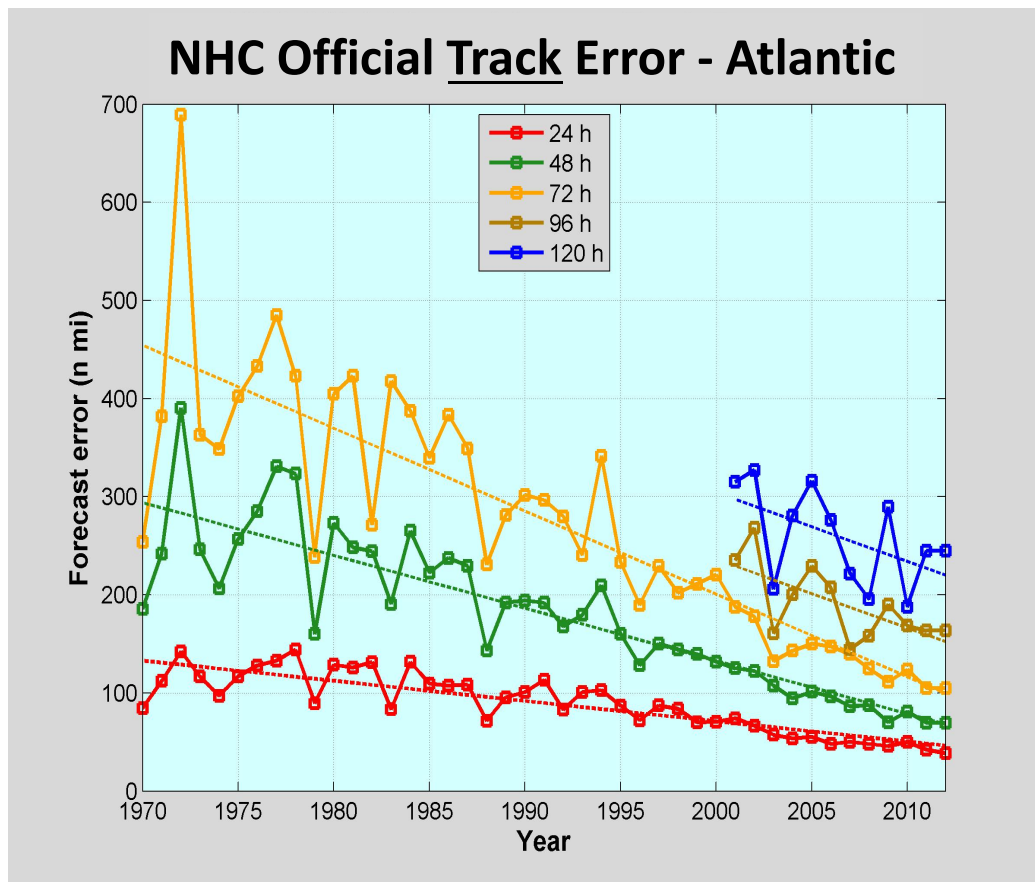
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CARICOOS

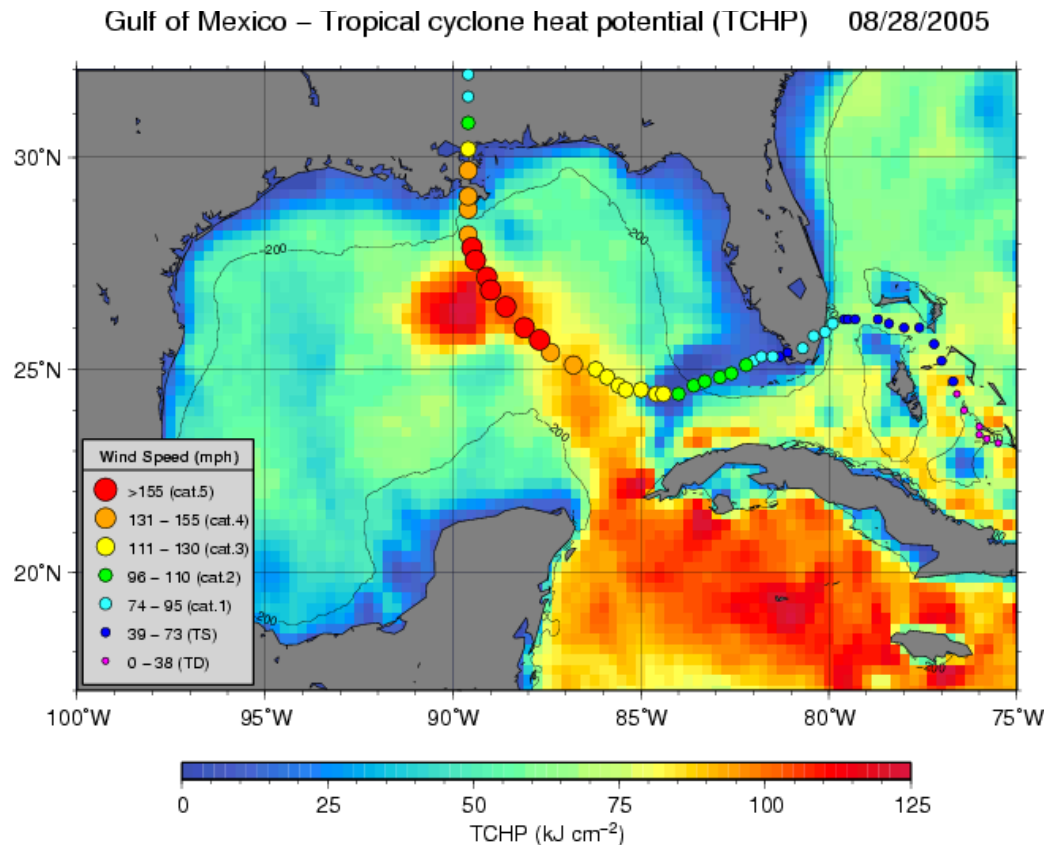


Tropical Cyclone Intensity and Track Forecasts Error



Role of the Ocean in Tropical Cyclone Intensification

Rapid Intensification of Hurricane Katrina (2005)



Katrina (2005) intensified rapidly from category 3 into a category 5 hurricane in less than 12 hours as it travelled over a warm ocean eddy

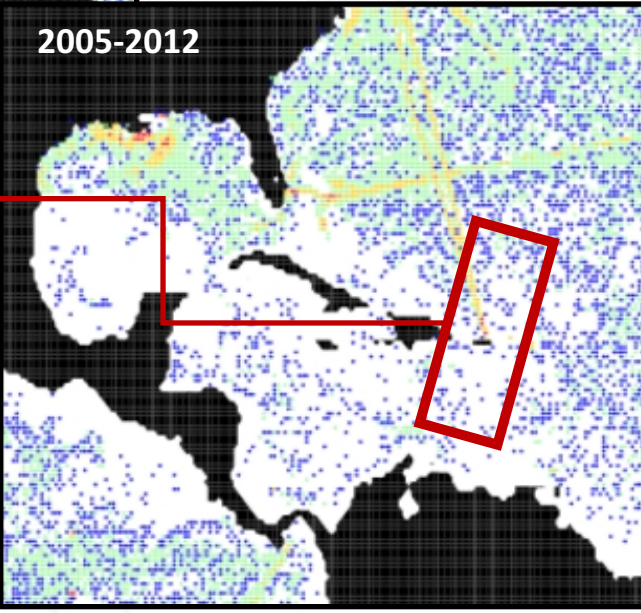
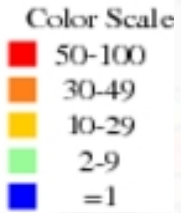
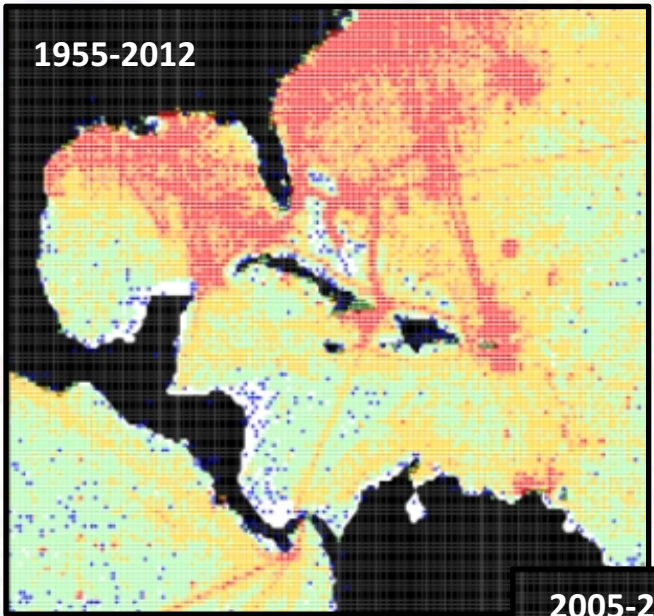


Other examples:

- Opal (1995) [Shay et al., 2000]
- Ivan(2004), Wilma (2005) [Mainelli et al., 2008]



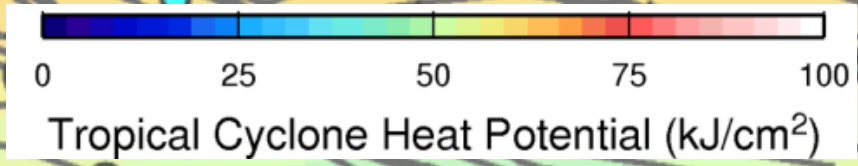
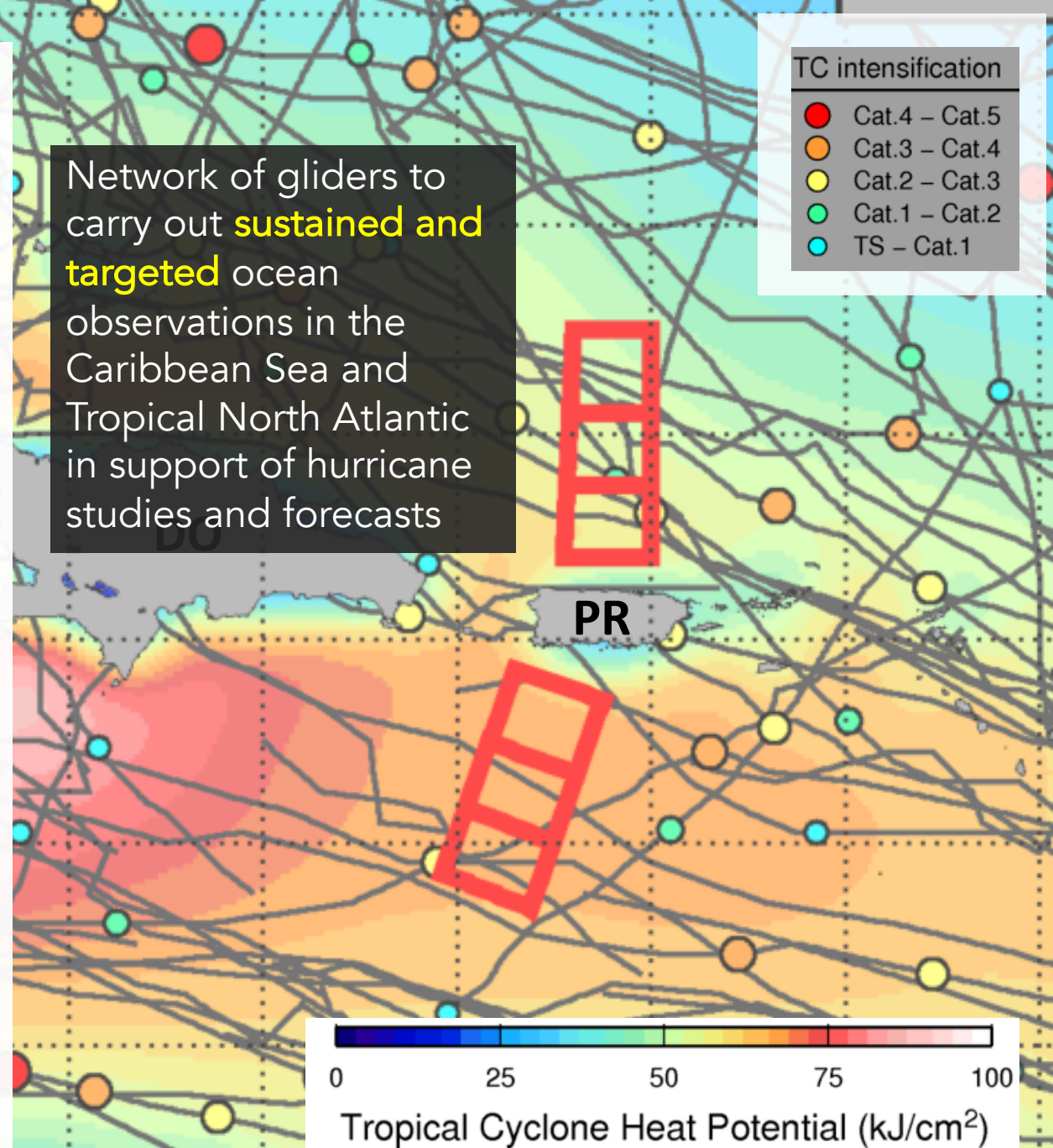
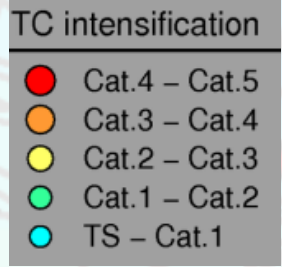
World Ocean Atlas 2013: # of Temperature profiles



Number of obs.
< 200

Need for UOHC obs.!

Network of gliders to carry out **sustained and targeted** ocean observations in the Caribbean Sea and Tropical North Atlantic in support of hurricane studies and forecasts



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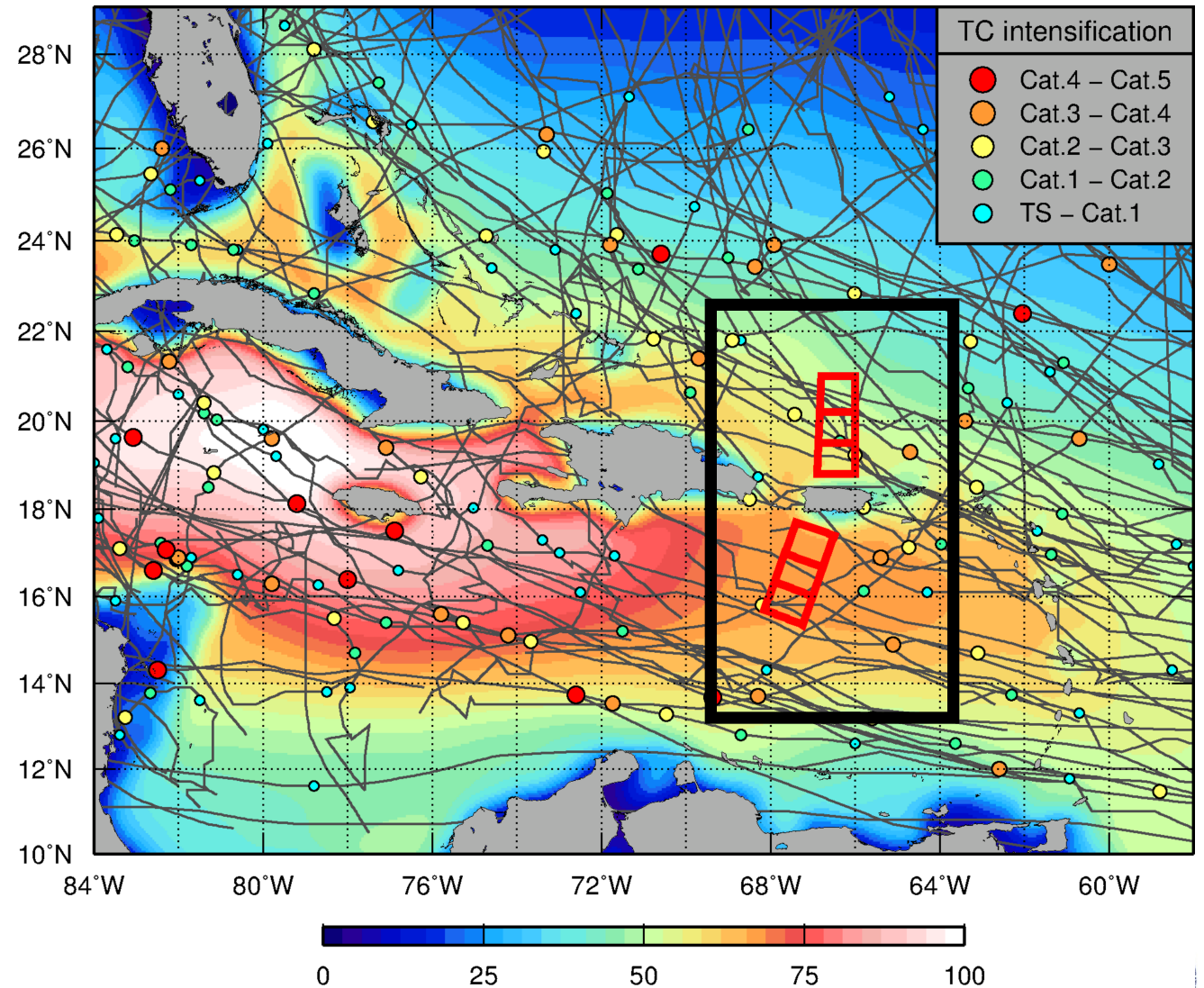
Goal

Enhance our understanding of air-sea interaction processes during hurricane force wind events.

Objectives

- Assess impact of hurricane force winds on upper ocean density structure, and
- Assess impact of ocean profile data from underwater gliders in hurricane intensity forecasts.

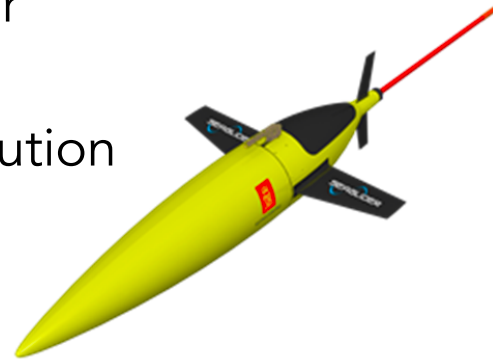
<http://www.aoml.noaa.gov/phod/gliders>



NOAA/AOML – CARICOOS Hurricane Underwater Glider Operations

Underwater gliders

- Autonomous Underwater Vehicles
- High-quality / high-resolution observations
 - 5 dives per day
 - ~3km hor. Resolution
 - 4-5 months endurance

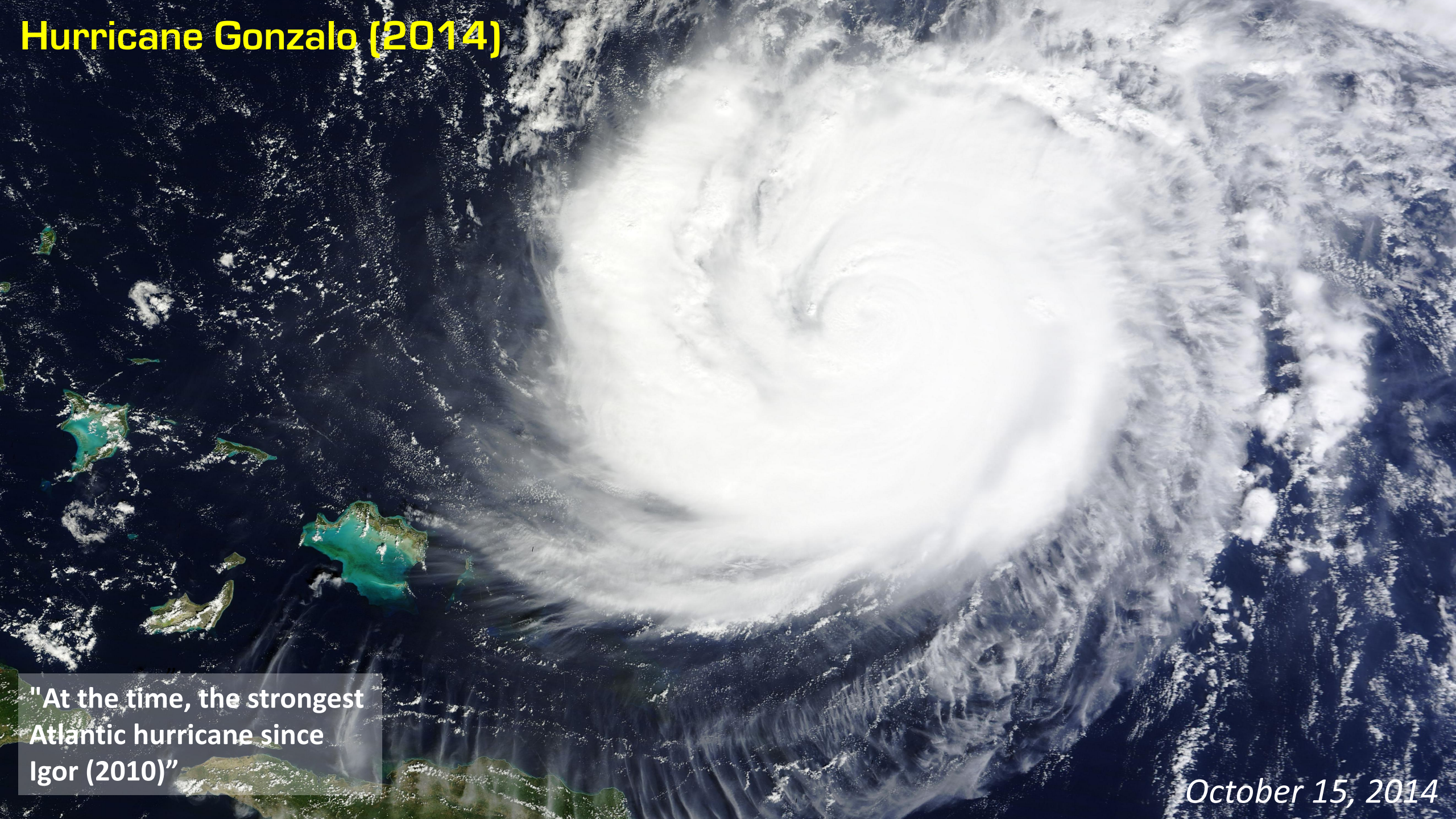


- Large variety of sensors
 - Temperature
 - Salinity
 - Dissolved Oxygen
 - Chlorophyll-a



Glider operations started in July 2014



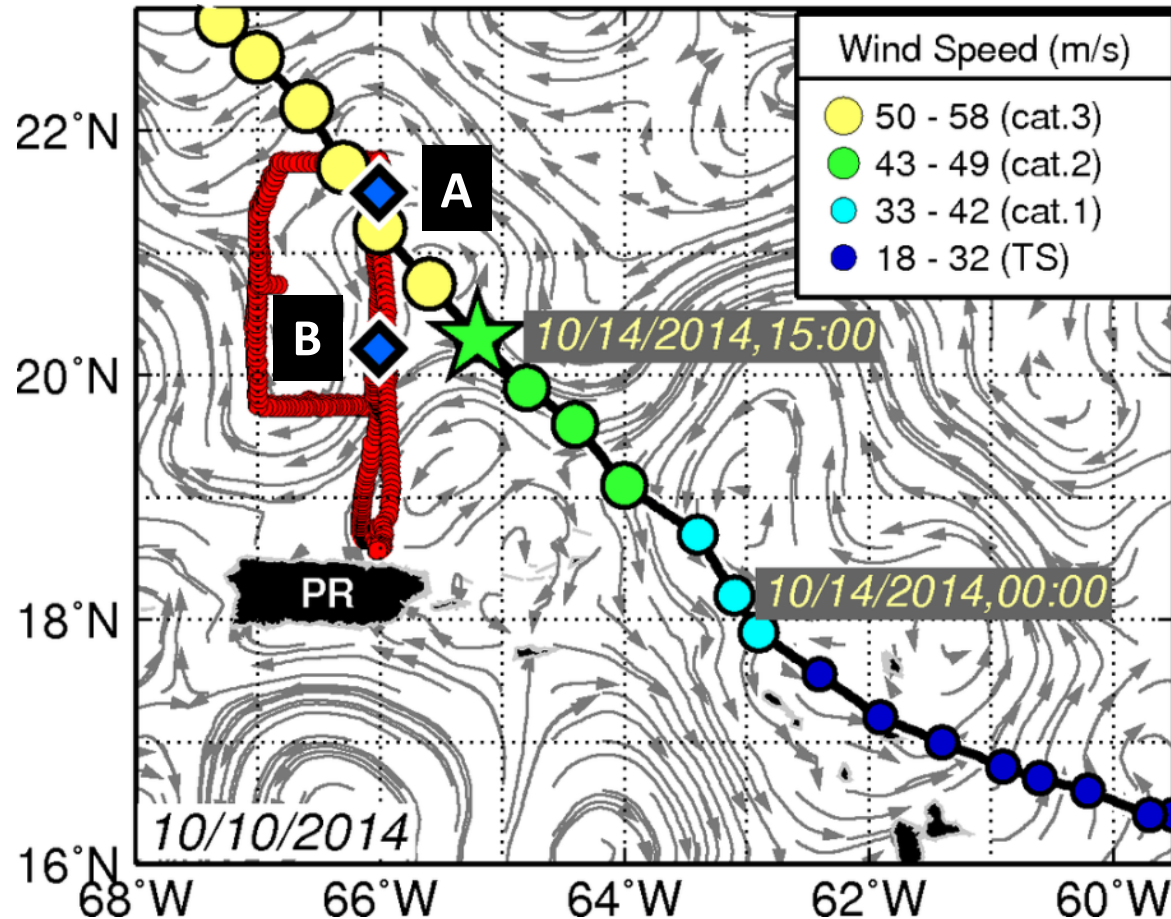


Hurricane Gonzalo (2014)

"At the time, the strongest Atlantic hurricane since Igor (2010)"

October 15, 2014

Hurricane Gonzalo (2014)



PR – Puerto Rico

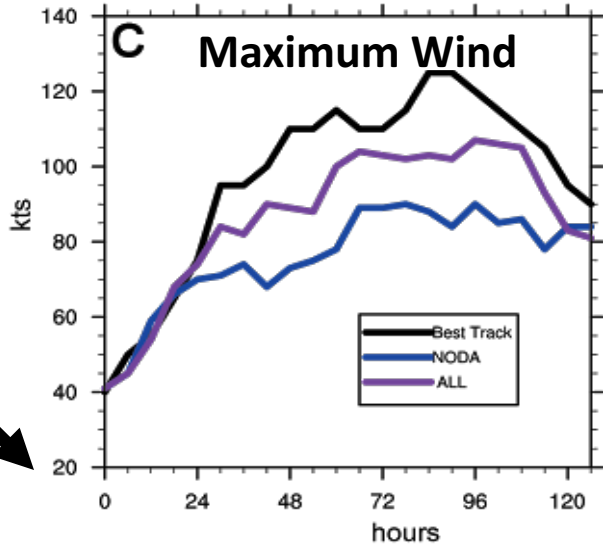
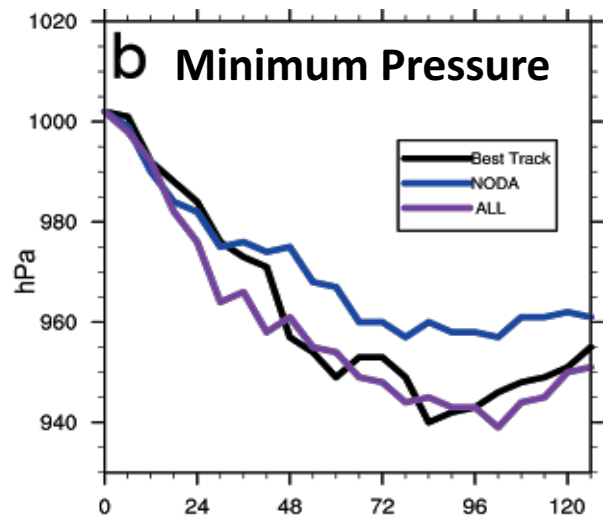
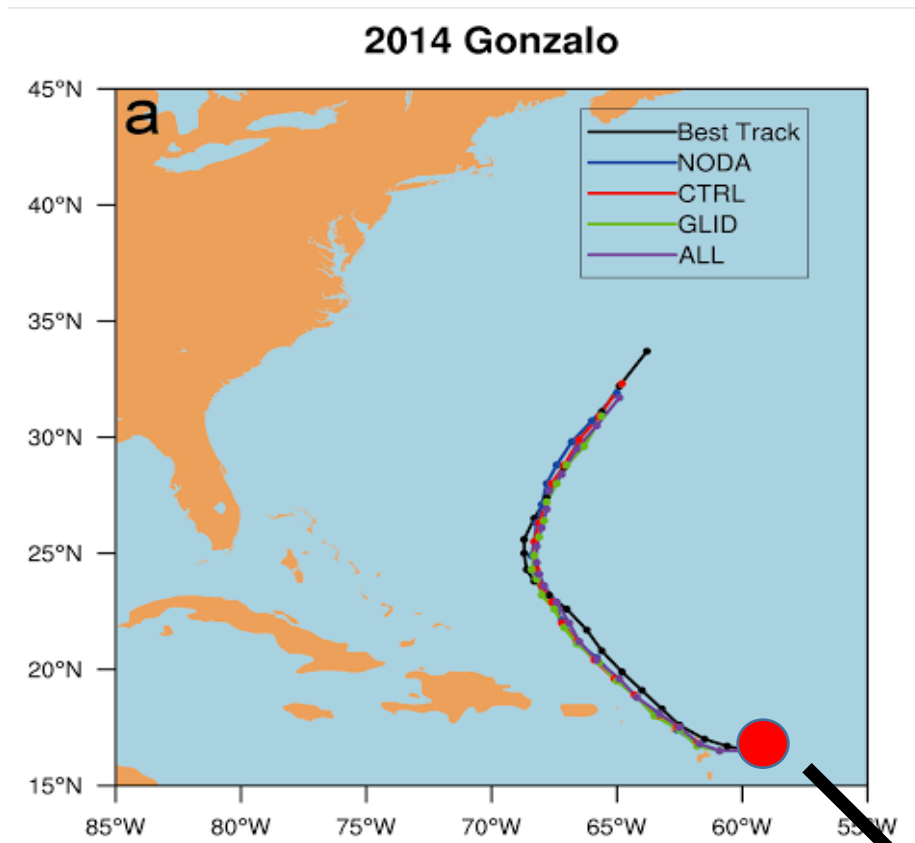
Analysis

1st Stage: Assess the upper ocean response forced by winds of Hurricane Gonzalo: **Domingues et al., (2015)**

2nd Stage: Assess the impact of assimilating the glider data on the actual forecast of Hurricane Gonzalo: **Dong et al., (under revision)**



AOML Underwater Glider Observations: Impact of ocean data on Hurricane Gonzalo coupled Forecast



- NOAA-NHC Best Track**
- HYCOM-HWRF: no data**
- HYCOM-HWRF: ALL data**
- HYCOM with no data assimilated
- HYCOM with all ocean data assimilated

- Experiment with no data assimilation largely underestimates the intensity of Hurricane Gonzalo
- Pressure: assimilation of ocean obs. allowed for 100% error reduction
- Maximum wind: assimilation of ocean obs. reduced ~50% the error in terms of maximum wind

HWRF-HYCOM: NOAA's next generation hurricane forecast model

HWRF - Hurricane Weather and Research Forecast model

HYCOM- Hybrid Coordinate Ocean Model

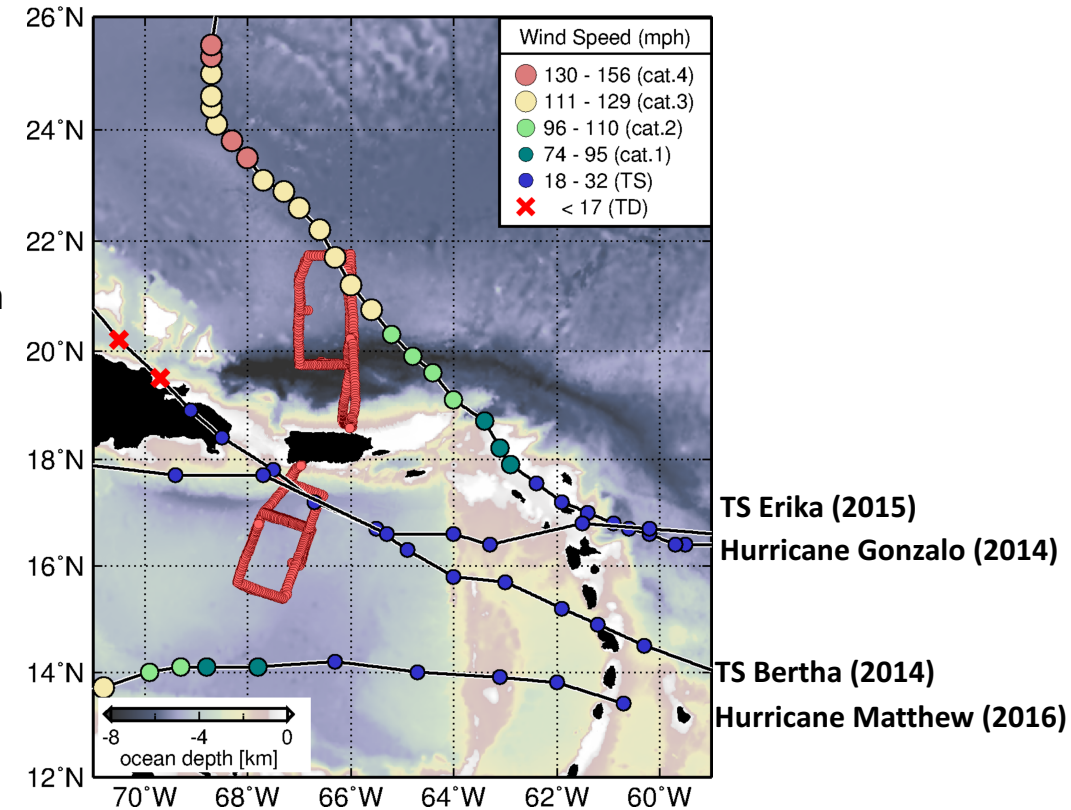


Summary:

- Underwater gliders can provide critical temperature and salinity profile data in real-time even during tropical cyclone wind conditions.
- Over 10,000 profiles of each observed parameter, such as temperature, salinity, dissolved oxygen, and chlorophyll concentration have been collected during the first two years of the NOAA/AOML-CARICOOS Hurricane Underwater Glider Operations
- One case study, with significant results during Hurricane Gonzalo (2014), indicates that glider data improves ocean initialization when assimilated within HYCOM-HWRF model.

Future work:

- Continue collecting ocean profile data, with enhanced glider network.
- Assess optimal observational strategy to improve TC intensity forecast using a suite of ocean observations.
- Further collaboration with other institutions interested in monitoring the UOHC in support of Tropical Cyclone intensification studies and forecasts



- Domingues, R., G. Goni, F. Bringas, S.-K. Lee, H.-S. Kim, G. Halliwell, J. Dong, J. Morell, and L. Pomales (2015), Upper ocean response to Hurricane Gonzalo (2014): Salinity effects revealed by targeted and sustained underwater glider observations, *Geophys. Res. Lett.*, 42, doi:10.1002/2015GL065378.
- Dong et al, Impact of underwater glider data on Hurricane Gonzalo (2014) forecast, 2016, *to be submitted*.

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Thank you

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