Sustained and Targeted Ocean Observations for Improving Atlantic Tropical Cyclone Intensity and Hurricane Seasonal Forecasts

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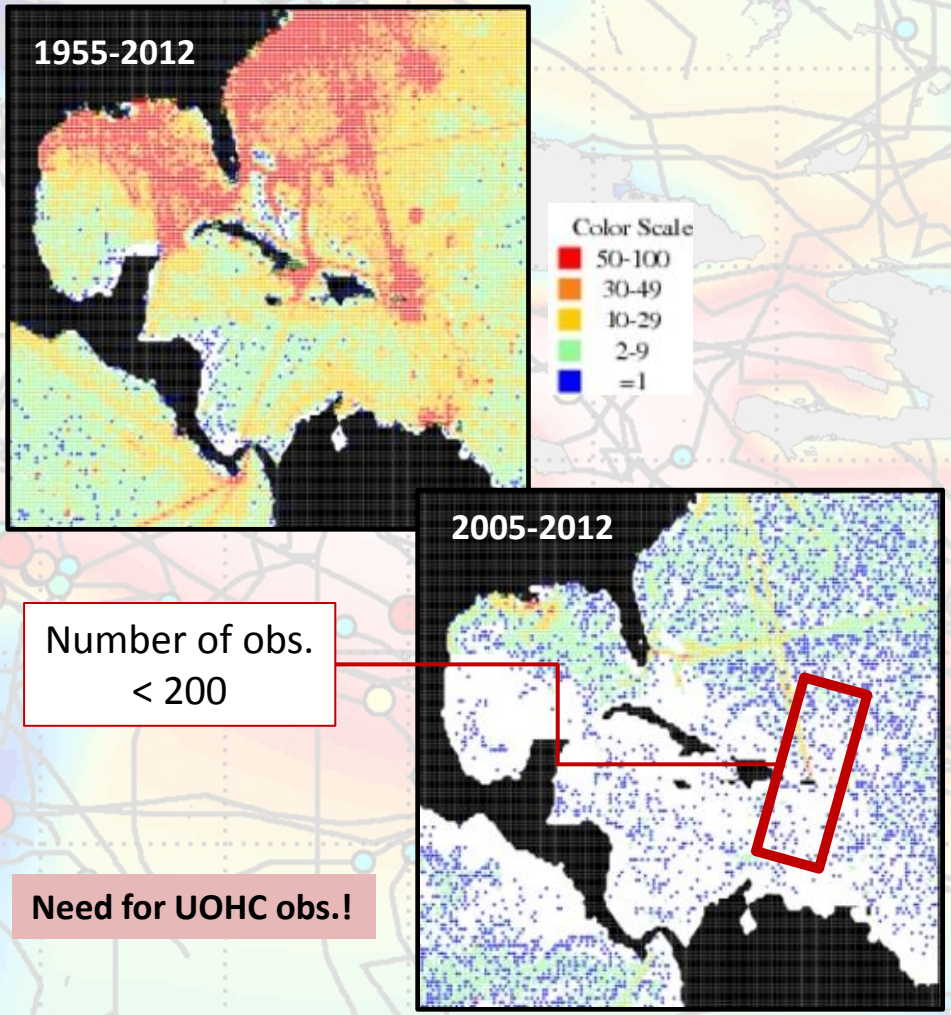
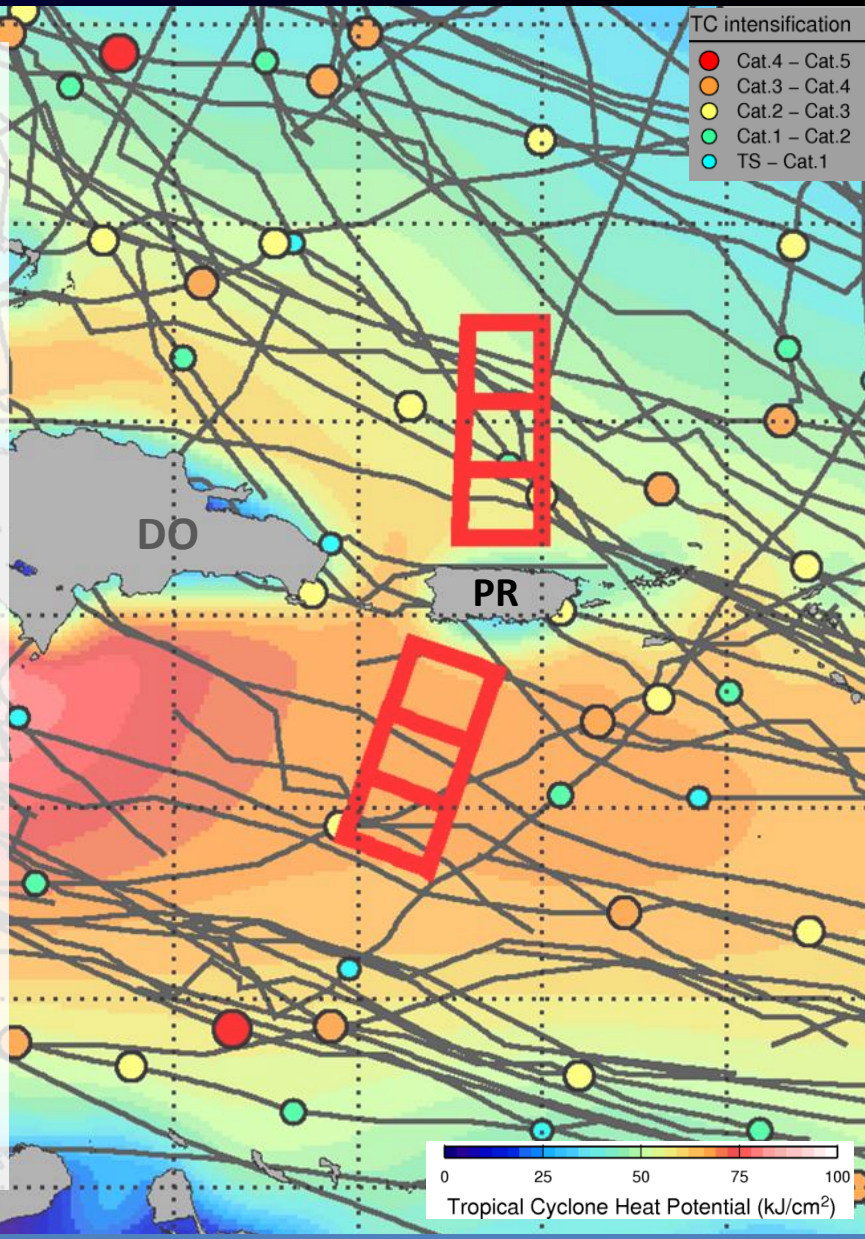
Motivation

World Ocean Atlas 2013: # of Temperature profiles



Number of obs. < 200

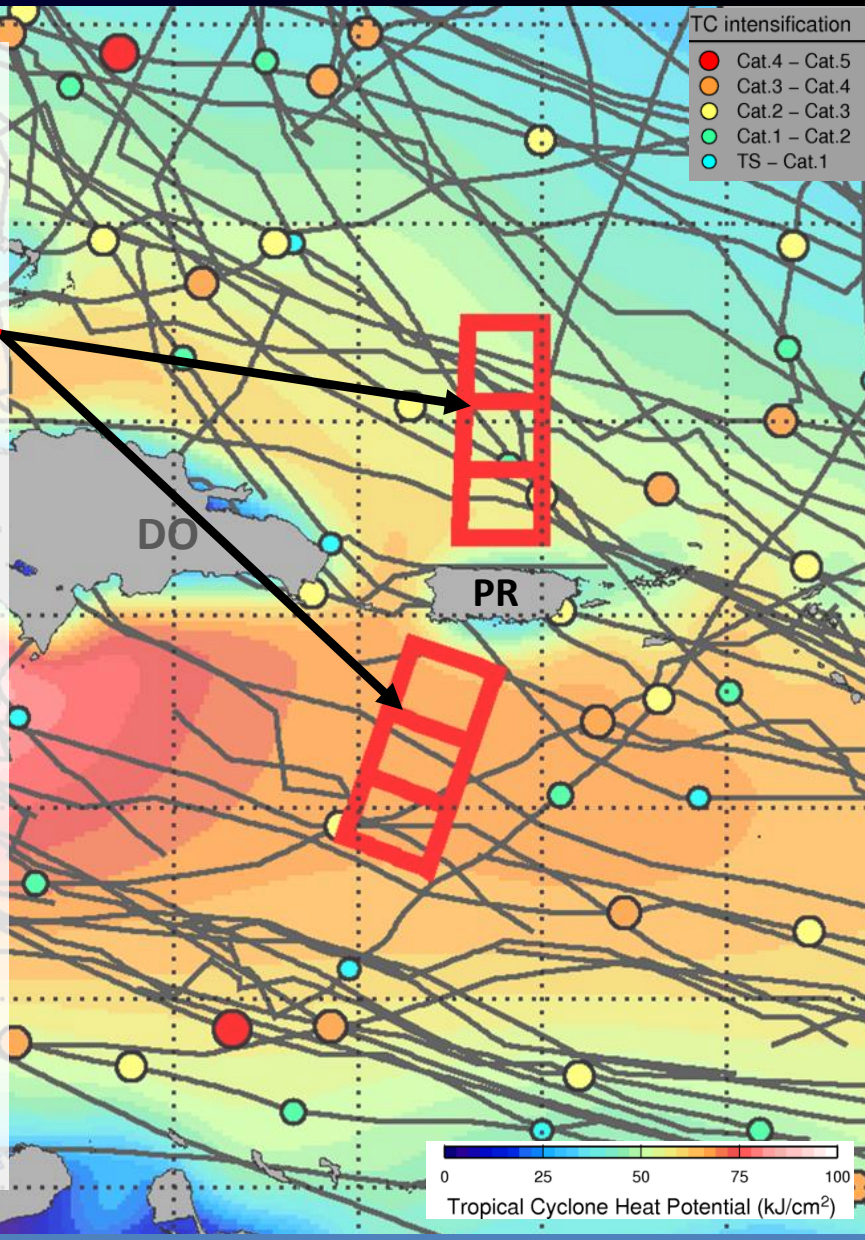
Need for UOHC obs.!



Goal

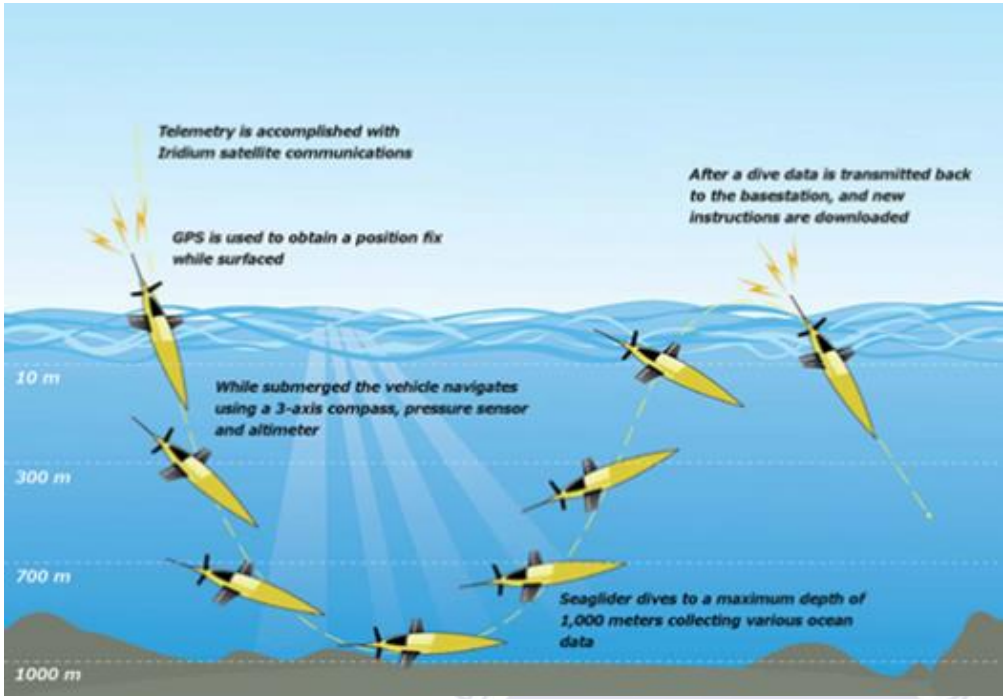
NOAA/AOML proposed a multi-insitutional effort with the goal of:

- Implementing a network of underwater gliders to carry out sustained and targeted ocean observations
  - Investigate the response of the ocean to hurricane force winds
  - Improve understanding about the role that the ocean plays in the intensification of tropical cyclones
  - Help improve tropical cyclone seasonal and intensity forecasts

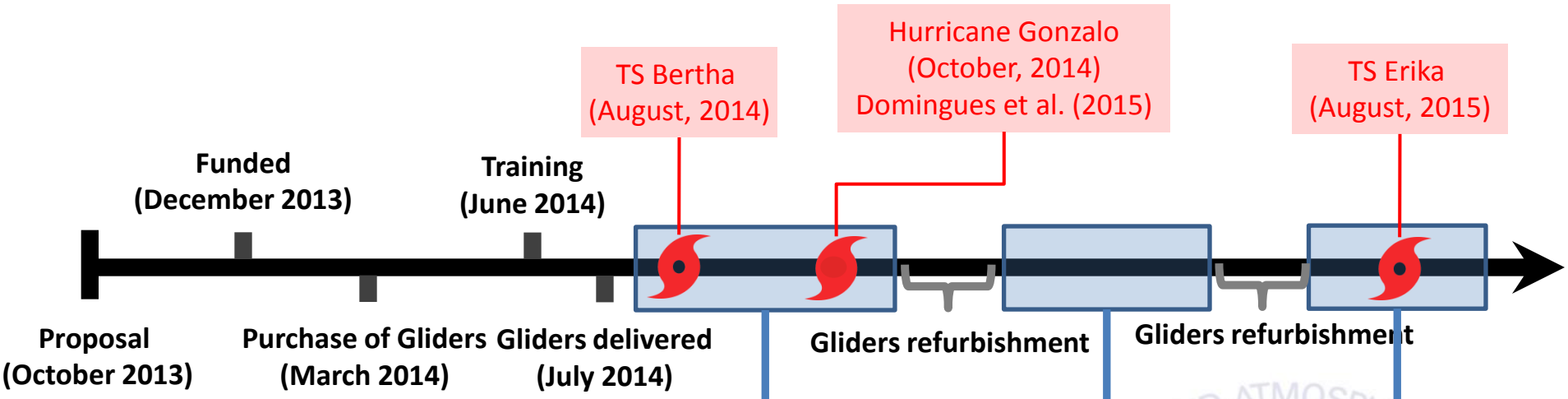


What is an underwater glider?

- Autonomous Underwater Vehicle (AUV)
  - No motor or propellor
  - Uses changes in buoyancy and fixed wings to create forward momentum
  - Remotely operated
- Can be fitted with a big variety of oceanographic sensors
  - CTD, Dissolved Oxygen, Chlo-a, CDOM, pCO_2, and etc.
  - Surface and depth-averaged currents
- Specifications
  - Dives to 1000m
  - 5 Dives p/day (10 profiles)
  - ~3km horizontal resolution
  - Travel 15-20 km per day
  - 4-5 months of battery life



Timeline of AOML's glider operations



Mission 01
Hurricane Season 2014

- Period: July – November 2014
- Deployments
  - Tropical North Atlantic
  - Caribbean Sea

✓ 2844 T & S profiles collected

Mission 02
Off Hurricane Season

- Period: February – April 2015
- New Oxygen Sensor Added!
- Deployments
  - Caribbean Sea

✓ 2022 T, S, & DO profiles collected

Mission 03
Hurricane Season 2015

- Currently Underway
- Deployments in July 2015
  - Tropical North Atlantic
  - Caribbean Sea

✓ Over 1000 T, S, & DO profiles collected so far.

Data distribution

Real time data distribution

- PhOD/AOML website

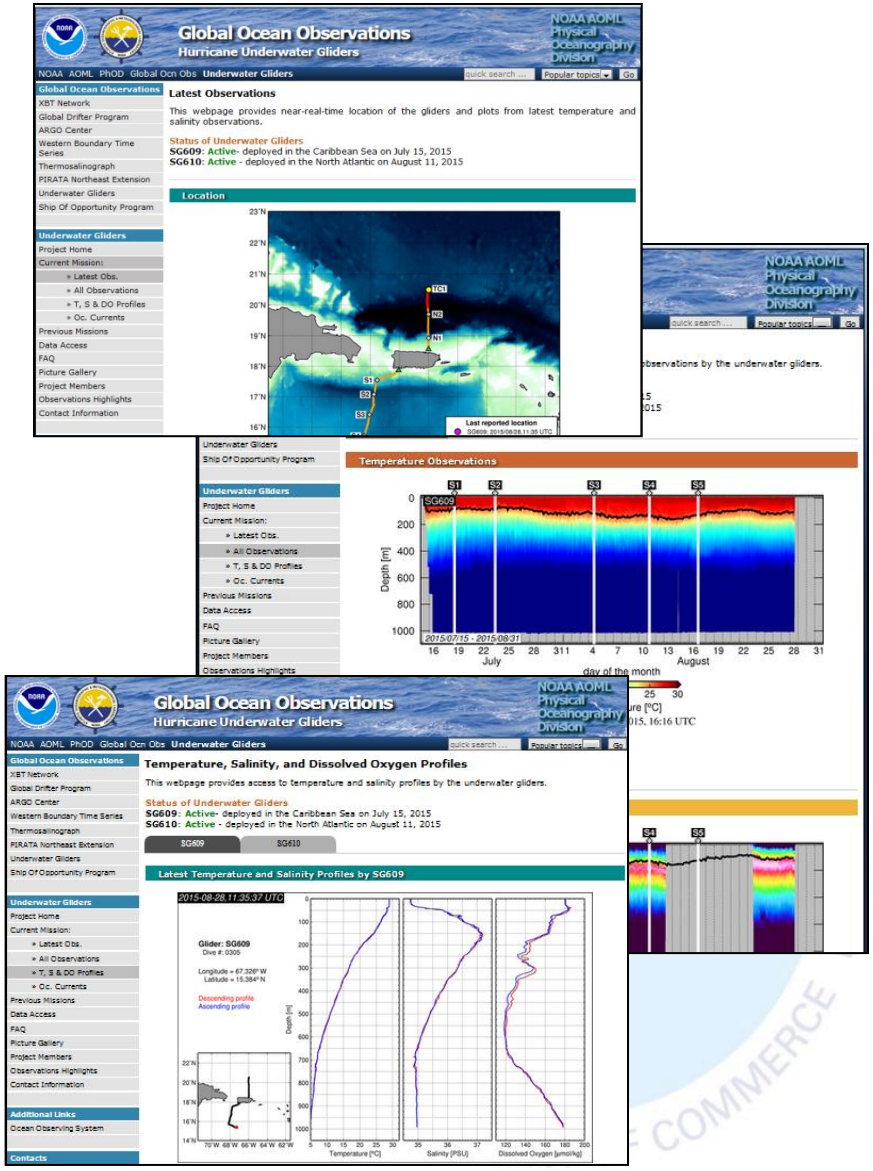
  http://www.aoml.noaa.gov/phod/gliders

  - Current and past location of gliders
  - All observations
  - Individual T, S & DO profiles
  - Data Access

- NOAA's Integrated Ocean Observing System - IOOS

  http://www.ioos.noaa.gov/

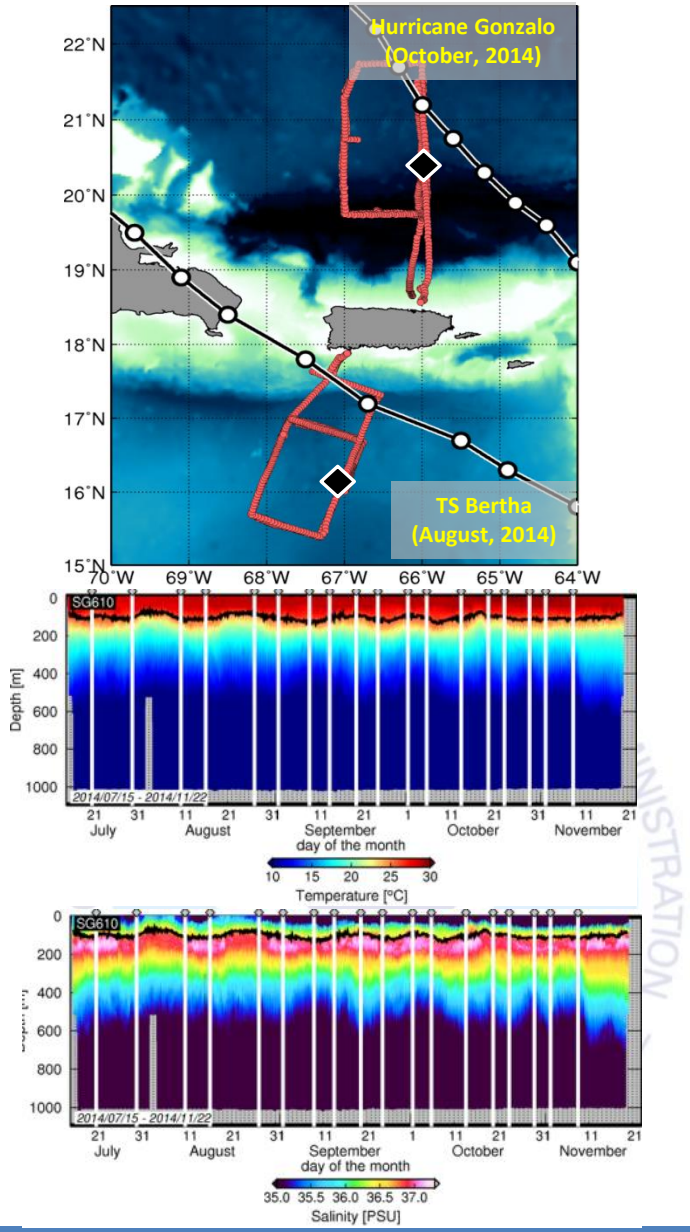
- Global Telecommunications System – GTS
  - Assimilated into forecasting systems



Mission 01 – Hurricane Season 2014

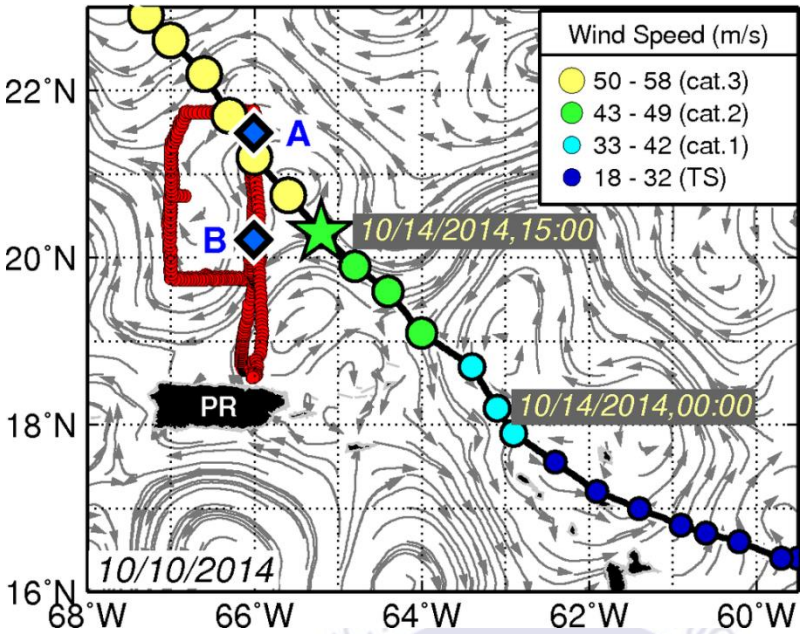
Summary - Mission 01: Hurricane Season 2014

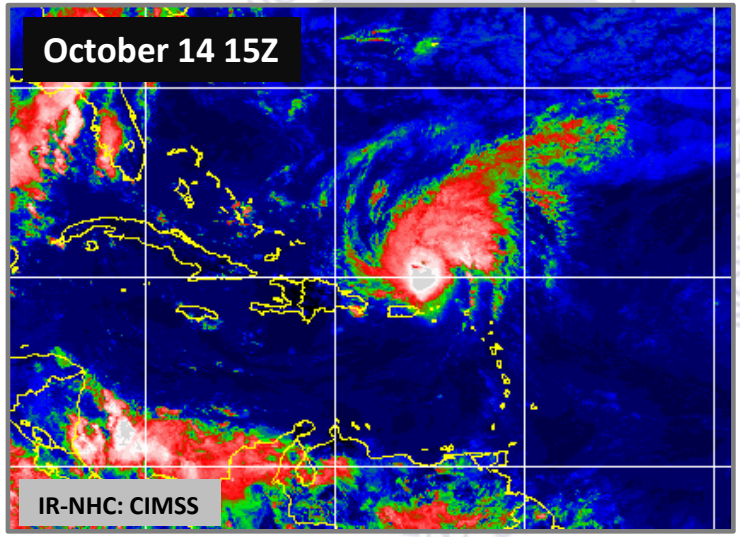
- *Period: July – November, 2014*
- *Location*
  - *Tropical North Atlantic*
  - *Caribbean Sea*
- 2844 T & S profiles collected
  - 1356 from Tropical North Atlantic
  - 1488 from Caribbean Sea
- Observations include data collected during TC wind conditions
  - Tropical Storm Bertha
  - Hurricane Gonzalo
    - Domingues et al., (2015),
    - Goni et al. (2015)



Hurricane Gonzalo (2014)

- TC Gonzalo (October 12)
  - Category 1 (October 13 21Z)
  - Category 2 (October 14 00Z)
  - Category 3 (October 14 15Z)
- October 14 15Z
  - Hurricane Gonzalo travelled 85km northeast from the location of one glider
- Sampling strategy
  - Prestorm (October 8-13)
    - T & S observations along section AB
  - During storm (October 13-15)
    - T & S time-series at site B
  - Poststorm
    - 1st poststorm section AB (October 15-23)
    - 2nd poststorm section AB (October 23-28)
  - Total of 228 T & S profiles





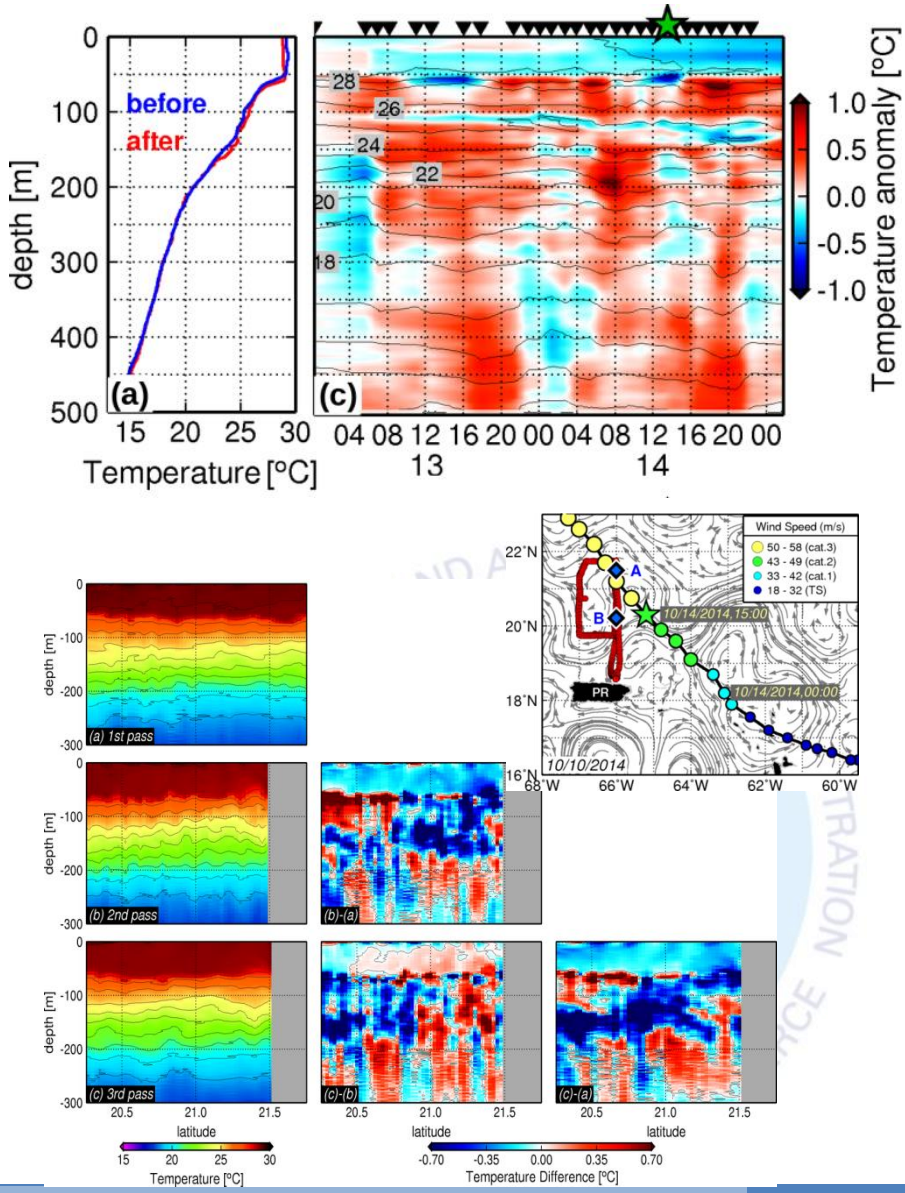
Domingues, R., G. Goni, F. Bringas, S.-K. Lee, H.-S. Kim, G. Halliwell, J. Dong, J. Morell, and L. Pomales (2015), Upper ocean response to Hurricane Gonzalo (2014): Salinity effects revealed by targeted and sustained underwater glider observations, Geophys. Res. Lett., 42, doi:10.1002/2015GL065378.

Ocean response to Hurricane Gonzalo

Domingues et al. (2015)

Main findings

- Complex upper-ocean response linked with multiple ocean processes
- Important role of salinity: -> Small surface cooling of 0.4C
  - Barrier layer has likely reduced the hurricane forced turbulent mixing
- Partial recovery of the upper-ocean 11 days after the storm
- HWRF-HYCOM overestimated upper ocean cooling -> salinity effects were absent in model simulations



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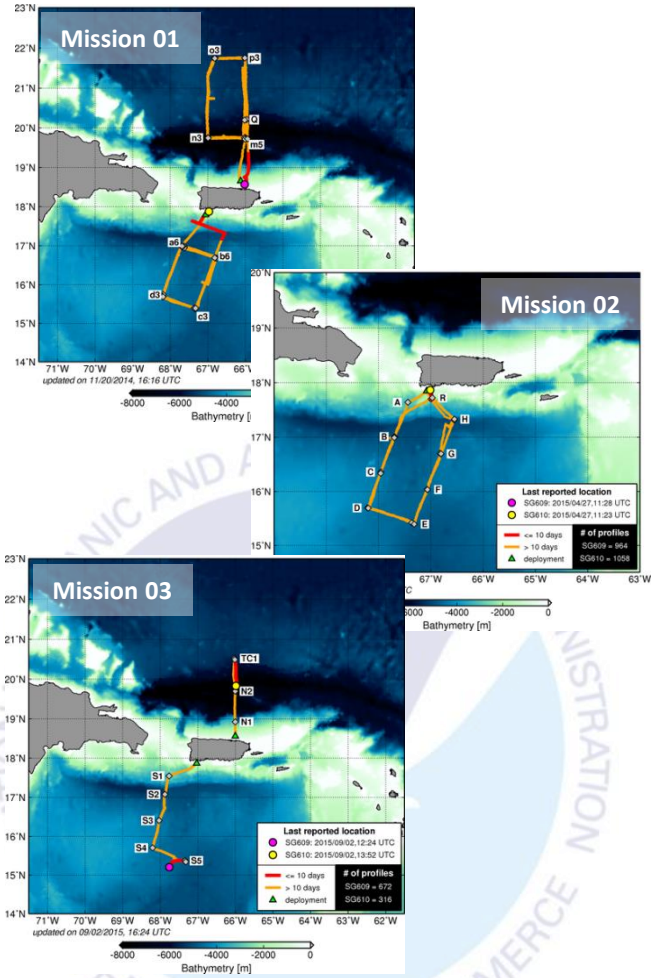
Summary

- A network of underwater gliders has been implemented in the Tropical North Atlantic and Caribbean Sea
- To date, over 6000 profiles were collected in these areas, including observations under TC conditions

- Glider observations under Hurricane Gonzalo
  - Small surface cooling: 0.4C -> Barrier layer has likely reduced the hurricane forced turbulent mixing
  - Observations suggested the influence of multiple processes forced by hurricane winds.
  - The results obtained during Hurricane Gonzalo emphasize the value of the targeted and sustained observations obtained by underwater gliders.
- Future work

  Glider observations will continue in 2016
  - ✓ Repeat transects
  - ✓ New glider starting in January 2016
  - ✓ New sensors: Chlo-a, CDOM



Thank you

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More information: http://www.aoml.noaa.gov/phod/gliders