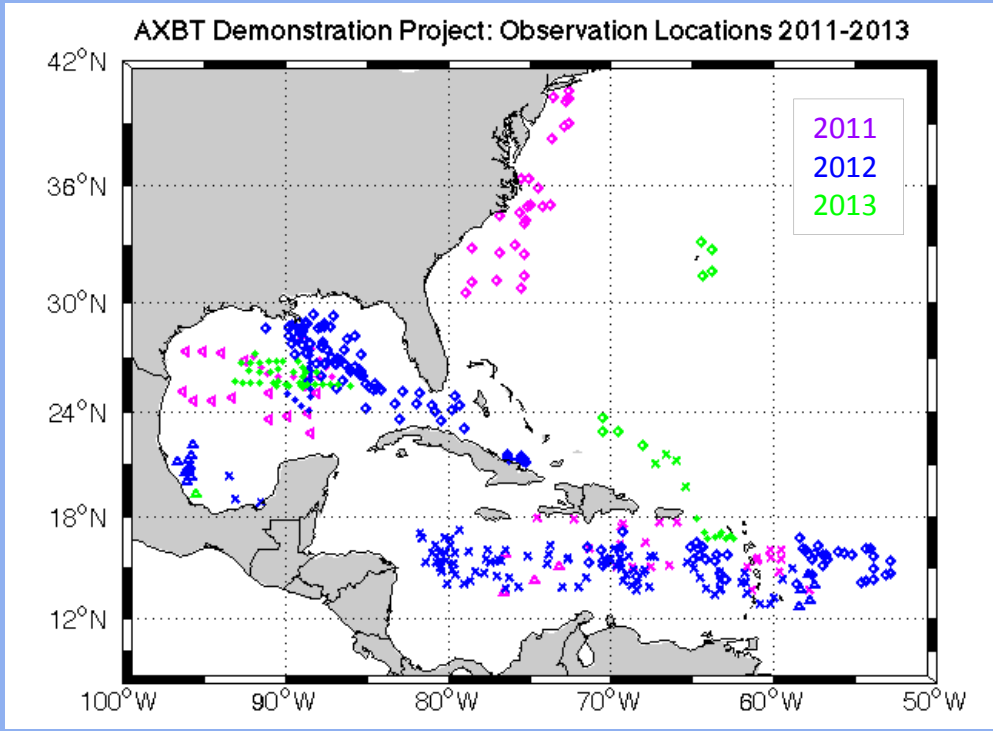
The AXBT Demonstration Project: Implementation, Impact, Collaboration, and Outlook



Elizabeth R. Sanabia[1] and Peter G. Black[2]

[1]United States Naval Academy [2]SAIC/NRL Monterey

The AXBT Demonstration Project

Overall Goal:

Increase hurricane forecast accuracy by assimilating ocean observations from beneath tropical cyclones into coupled numerical models in near-real time

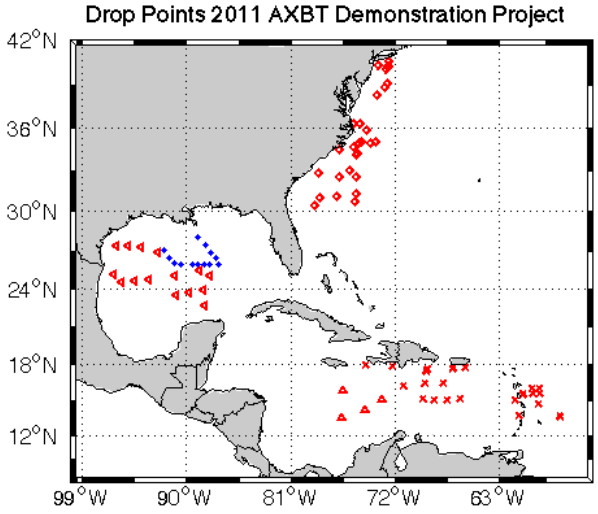
Incremental Objectives:

1. *Collect, process, and transmit AXBT data to coupled modeling centers in near-real time*
2. *Assimilate AXBT data into coupled models*
3. *Demonstrate improvement to ocean model initializations and forecasts*
4. *Demonstrate improvement to hurricane track and intensity forecasts*

AXBT Demonstration Project: Activity by Year

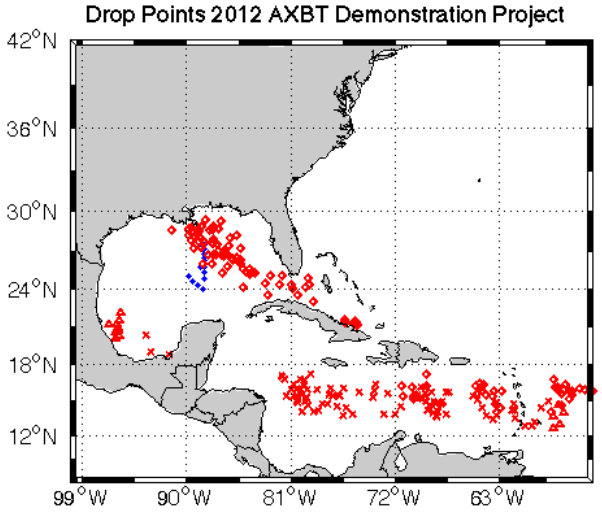
2011

- 28 July – 28 August
- 109 AXBTs deployed
  - 84 into RTDHS (77%)
- 12 flights
  - TS Don (2)
  - TS Emily (3)
  - TS Harvey (1)
  - Hurricane Irene (3)
  - Training /transit (2/1)



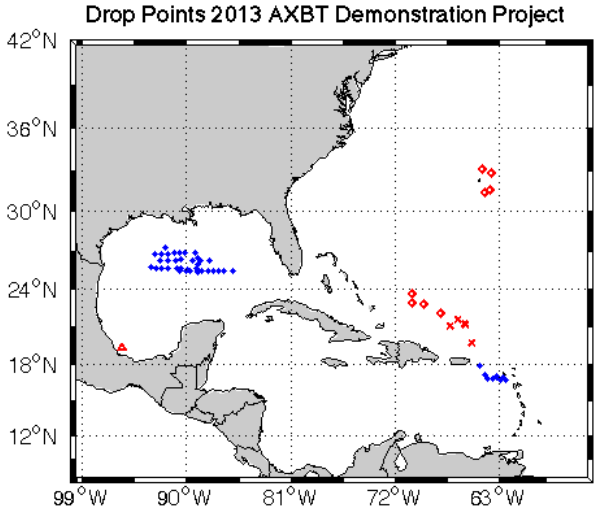
2012

- 31 July – 29 August
- 294 AXBTs deployed
  - 248 into RTDHS (84%)
- 23 flights
  - Hurricane Ernesto (8)
  - TS Helene (2)
  - Hurricane Isaac (12)
  - Training (1)



2013

- 20 July – 15 September
- 89 AXBTs deployed
- 14 flights
  - TD Dorian (2)
  - TS Fernand (1)
  - TS Gabrielle (2)
  - Training (9)



WC-130J in flight

Deploy → Collect → Process → Transmit

AXBT Data Path

AXBT Demonstration Project

53rd SATCOM Ground Station

Disseminate JJVV

NAVO

RTDHS → NCODA → NCOM

NRL MRY

COAMPS-TC

NDBC

Upload

GTS

NCEP/EMC

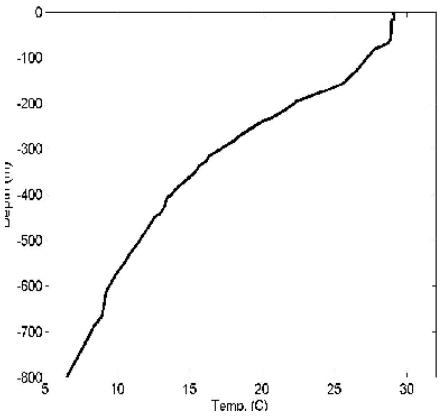
HWRF

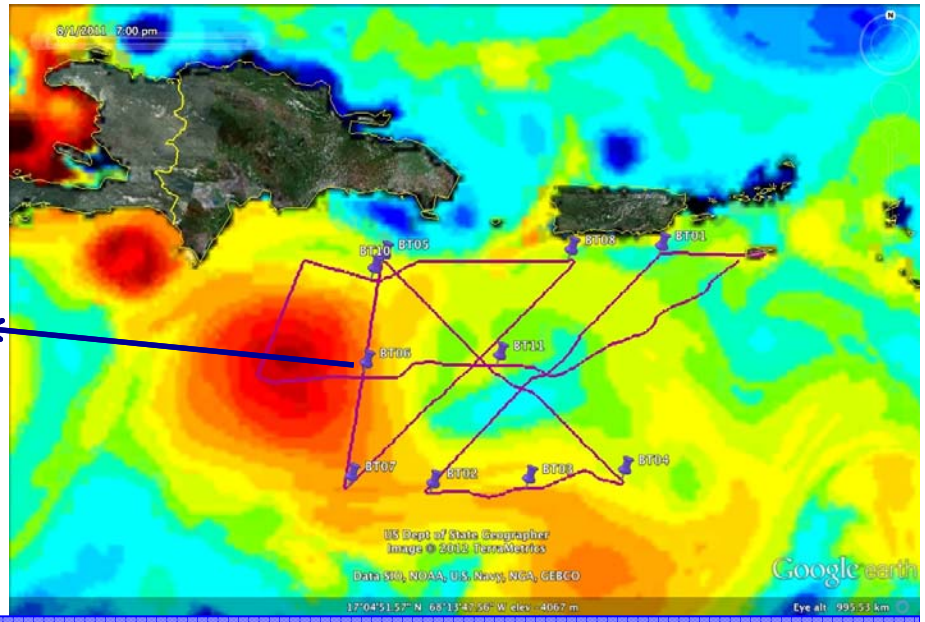
National Hurricane Center

AXBT 06 JJVV Message

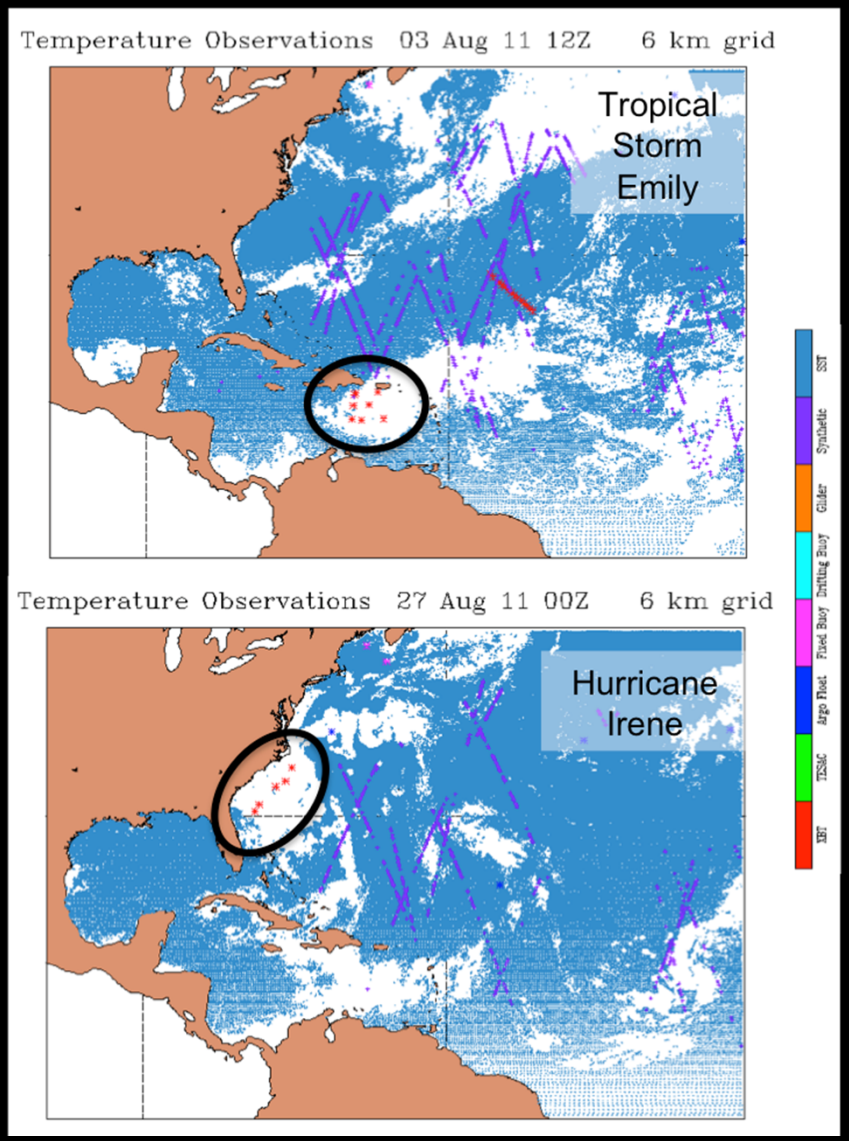
JJVV 03081 0741/ 716360 069460 88888
51099 00291 00291 00291 14291 19289
57289 66287 72284 80278 99901
08270 30265 39261 56256 73242
83234 90228 93224 99902 00222
14216 33206 36202 51194 59190
69185 73183 80181 99903 15163
26162 36157 48154 56152 88140
99904 00138 06134 26133 42129
48126 65123 99905 04115 31108
48105 74099 99906 11092 65089
87084 99907 11080 97066 99908
48065 AF306

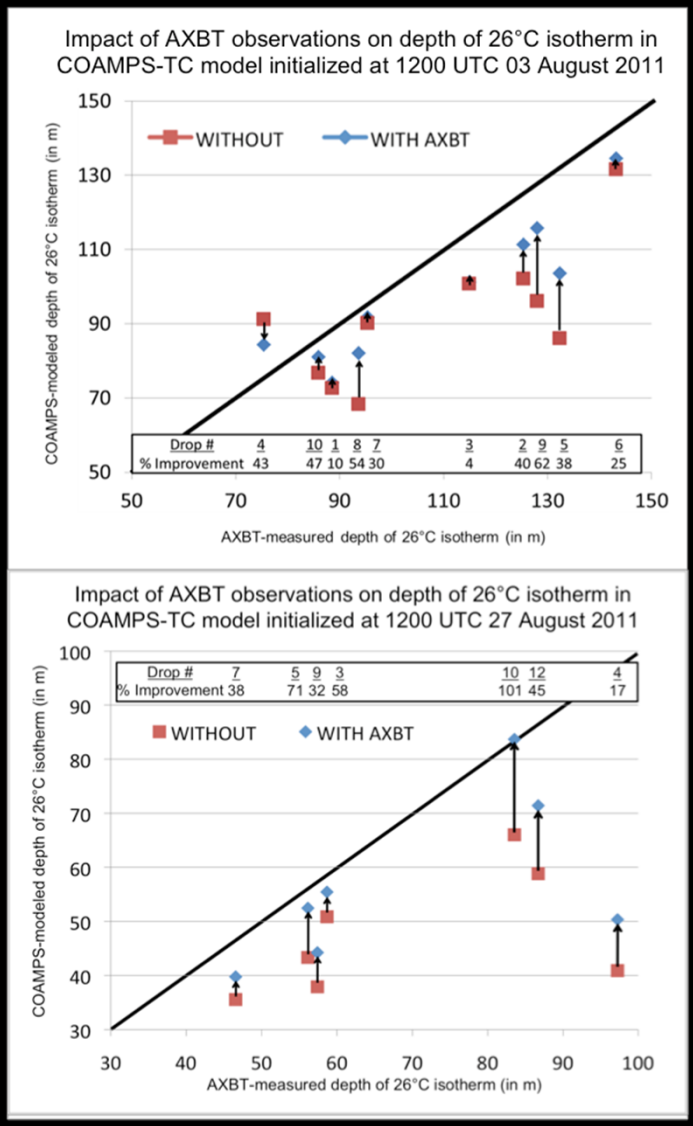
AXBT 06 Profile



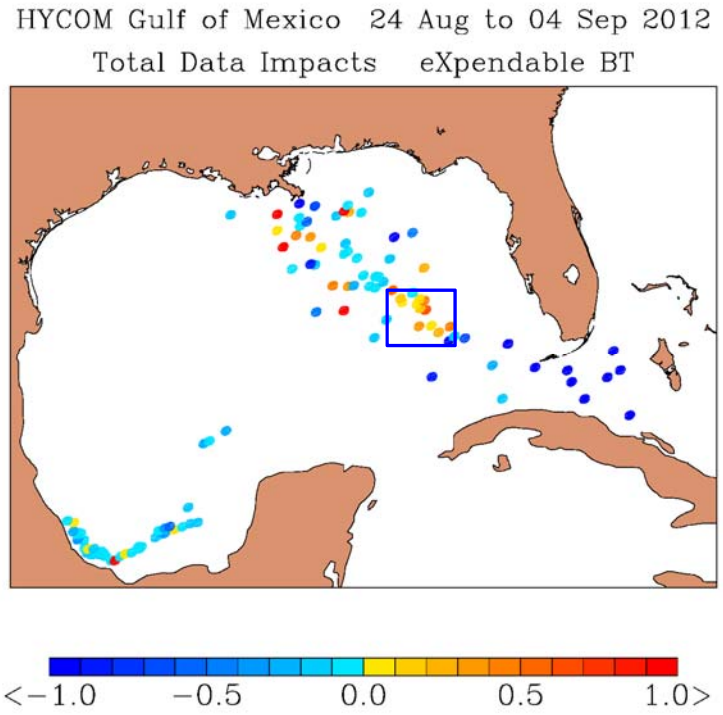


2011: AXBT data improve NCOM initial conditions



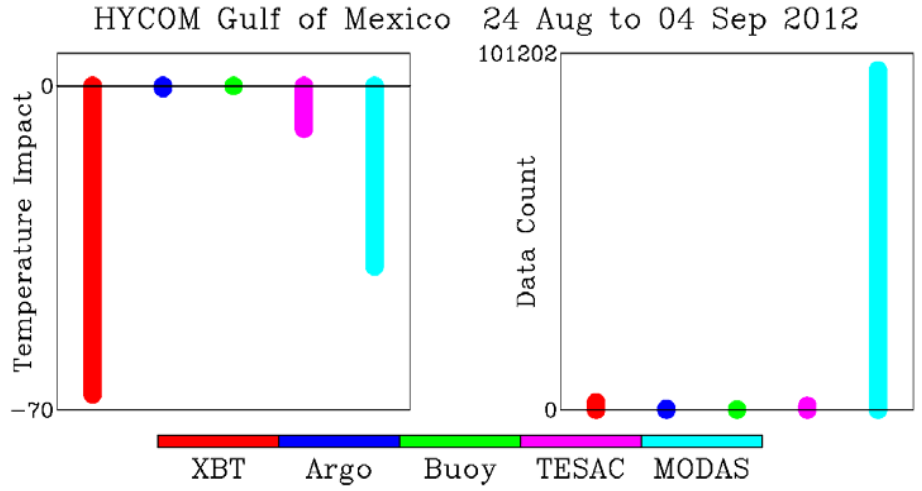


2012: HYCOM AXBT Data Impacts



The AXBT impact to HYCOM 48-h sea temperature forecast between 24 August and 04 September 2012. A negative value (cool color) is a beneficial impact (reduced the 48 hr forecast error in deg C according to the color). A positive value (warm color) means assimilation of the AXBT increased forecast error. The region affected by position reporting errors is outlined in blue.

SUCCESS*:** AXBTS HAD THE ***GREATEST TOTAL IMPACT ON REDUCING HYCOM MODEL ERROR DURING HURRICANE ISAAC.

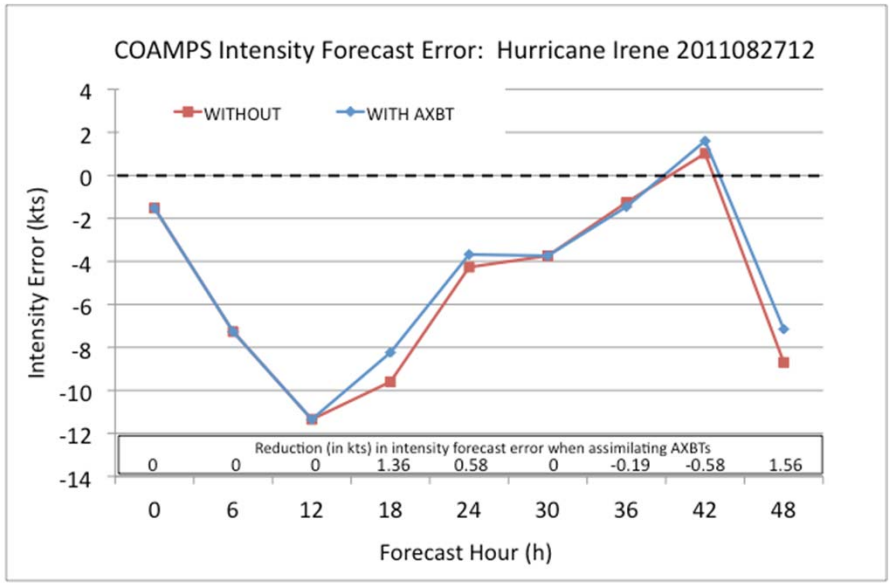


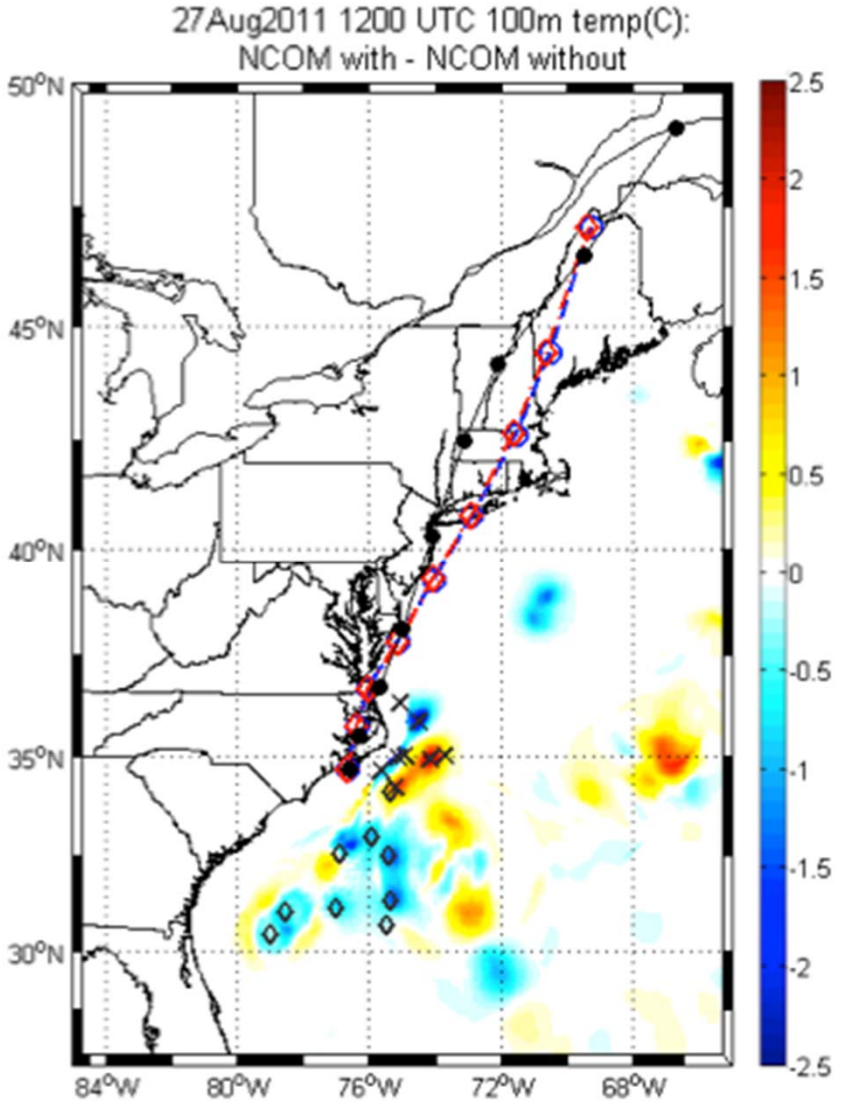
COAMPS-TC AXBT Data Impact: Irene (2011)

IRENE

- 0000 UTC 27 August 2011
  - *Little change in track and intensity errors*
  - Possibly due to model initial TC position located within the area with little SST/OHC difference

- 1200 UTC 27 August 2011
  - *Some improvement to intensity at multiple time steps (<5 kts)* when assimilating AXBTs
  - *Little change in track errors*

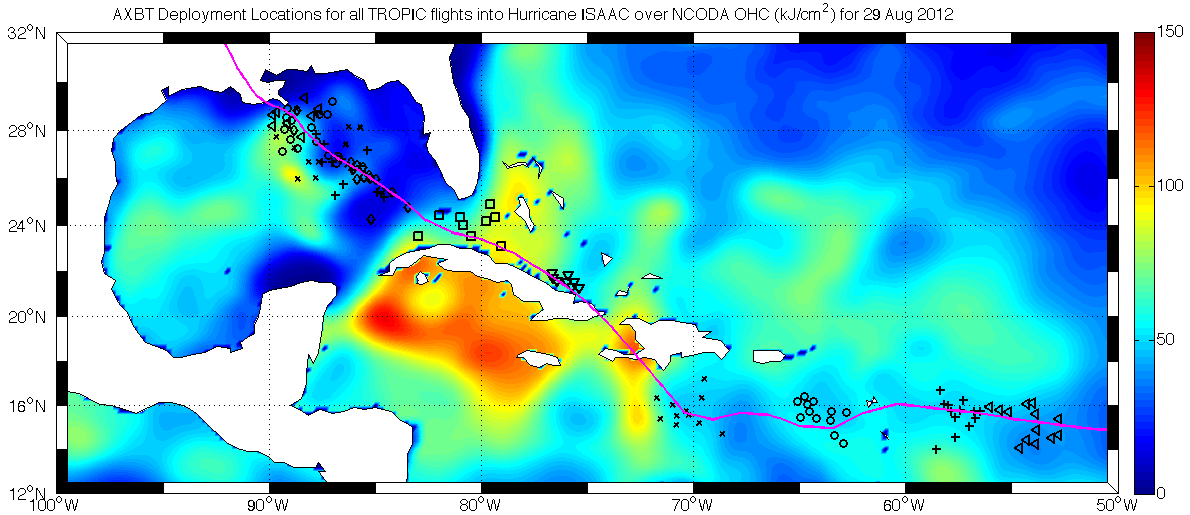


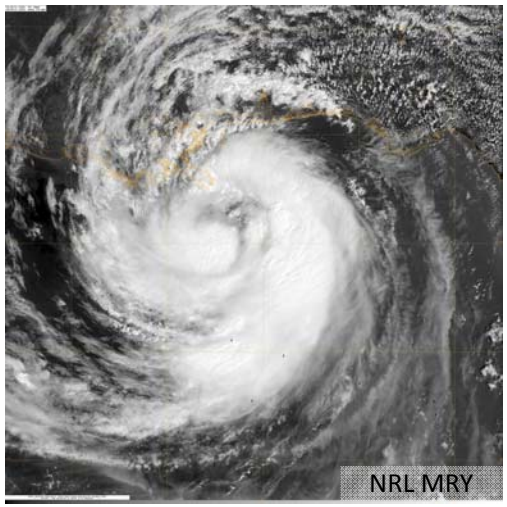


AXBT Impact Studies

- Results to date
  - Sanabia, E. R., B. S. Barrett, P. G. Black, S. Chen, and J. A. Cummings, 2013: Real-time upper-ocean temperature observations from aircraft during operational hurricane reconnaissance missions: AXBT demonstration project year one results. *Wea. Forecasting*, **28**, 1404-1422.
  - Yablonsky, R. M., I. Ginis, B. Thomas, V. Tallapragada, D. Sheinin, and L. Bernadet, 2014: Ocean Coupling in NOAA's Hurricane Weather Research and Forecasting (HWRF) model. *J. Atmos. Oceanic Technol.*, submitted.

- Current work
  - Isaac (2012) data denial study (COAMPS-TC, HWRF) and data impact study (COAMPS-TC, URI/GFDL)
  - Development of an optimal sensing strategy (COAMPS-TC)
    - Identify optimal vertical and horizontal resolutions for AXBT data in the model to aid in deployment planning
    - Progress toward a common data reporting format
  - Examination of PBL physics (COAMPS-TC, NOAA HRD)





Sources of ocean data in current coupled models

- *Coupled COAMPS-TC:*
  - Transition to operations in 2014
  - NCOM
  - Data assimilation through NCODA, which routinely accepts AXBT data
  - Adjoint to assess relative value

- *HWRF and GFDL:*
  - POM-TC
    - operational
    - coupled, however no observations are currently assimilated, initialization from GDEM (a climatology based on MOODS) and a feature-based procedure.
  - MPIPOM-TC
    - in testing
    - coupled, however no observations are currently assimilated, initialization from GDEM (a climatology based on MOODS) and a feature-based procedure.
  - Global RTOFS/HYCOM:
    - in testing
    - under consideration as an alternative to POM
    - data assimilation through NCODA, can routinely accept AXBT data

The AXBT Demonstration Project

Incremental Objectives:

	coupled COAMPS-TC	HWRF	GFDL
(1) Collect, process, and transmit AXBT data in near-real time	x	x	x
(2) AXBT data assimilation	x	/	x
(3) Ocean model initialization and forecast improvement	x		/
(4) Hurricane track and intensity forecast improvement	/		

Way Ahead – Continued Collaboration

- USNA
  - provide AXBT equipment operators
  - collect, process, and transmit AXBT data
  - facilitate coordination and collaboration
- 53rd WRS
  - continue as host squadron
  - incorporate AXBT operations into TC reconnaissance missions and training missions as feasible
- NDBC
  - support data pass-through to GTS
  - support data inter-comparisons as feasible
- NAVO
  - support ocean data receipt through RTDHS
  - conduct data assimilation in operational ocean models
  - conduct data inter-comparisons
- NOAA HRD / AOC
  - conduct coordinated operations to include ocean observations from various sensors beyond TC core region
  - streamline data format
  - collaborate on hardware and maintenance issues
- NRL Monterey
  - supply MOOS equipment
  - complete Isaac & Ernesto data denial studies
  - utilize adjoint suite to quantitatively assess the relative value of the AXBT observations
  - *conduct coordinated data denial testing*
- NCEP / EMC
  - conquer the ocean data assimilation challenge
  - *conduct coordinated data denial testing*
- URI / GFDL
  - continue feature-based data evaluation
  - *conduct coordinated data denial testing*

TROPIC Midshipmen
2011-2013

Questions?

Getting the Ocean Right:
A Tough Problem even without a TC