Creation of the Systematically Merged Pacific Ocean Regional Temperature and Salinity (SPORTS) Climatology
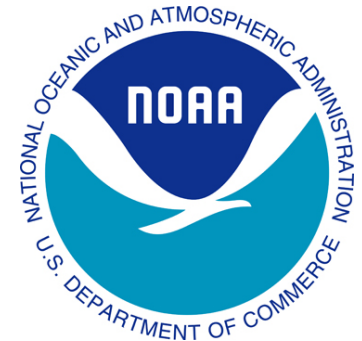# For Typhoon Intensity Forecasts: Haiyan

C. E. McCaskill, L. K. Shay, and J. K. Brewster

NOAA NESDIS

Motivation

- Ocean Heat Content (OHC) and tropical cyclones (TC)
  - Estimate OHC (and Evaluate Product)
    - Create a climatology (SPORTS) for OHC estimation following Meyers et al.(*JAOT*, 2014) for SMARTS
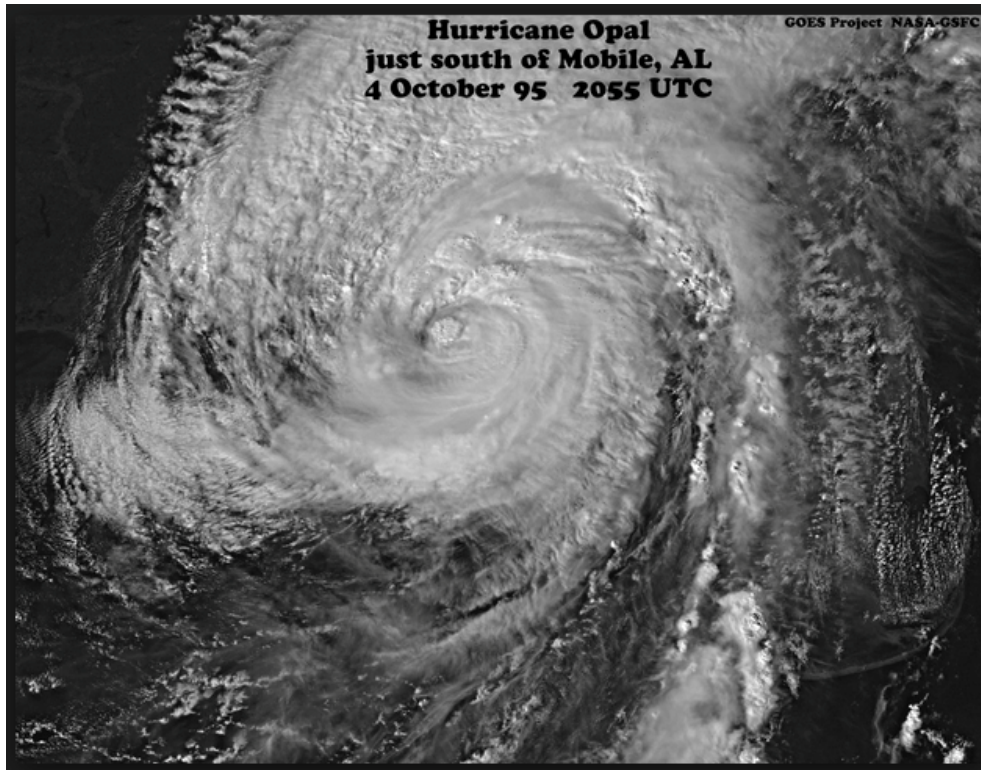

Super Typhoon Megi as seen from NASA's Terra satellite at 1am EDT Sunday 17 Oct 2010

Background

- OHC is an important factor in hurricane intensification
  - Opal, 1995 (Shay et al., 2000)
  - Katrina, 2005 (Jaimes and Shay, 2009)
  - Ivan, 2004 (Mainelli et al., 2008)
  - Megi, 2010
  - Haiyan, 2011
  - Proven to improve Statistical Hurricane Intensity Prediction Scheme (SHIPS) intensification forecasting
    (DeMaria et al., 2005; Mainelli et al., 2008)

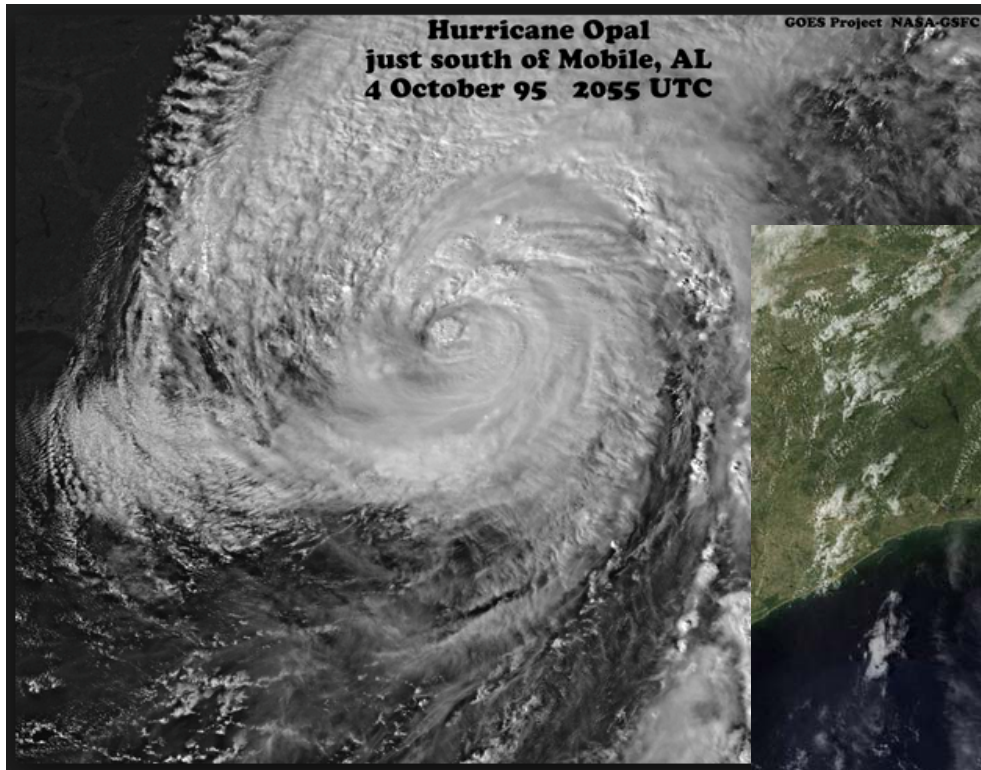# Background

...tor in hurricane

...000)

...d Shay, 2009)

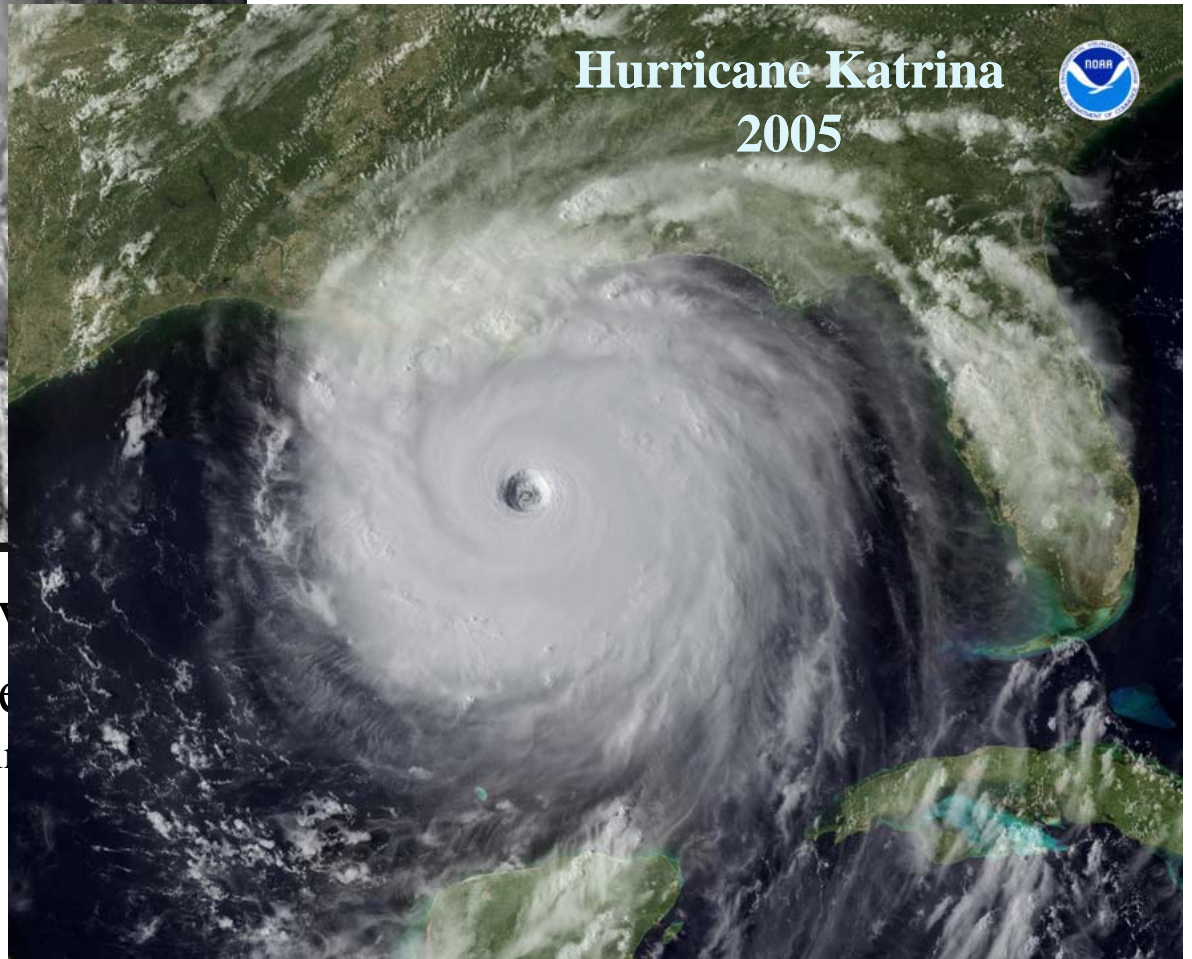..., 2008)

□ Proven to improve Statistical Hurricane Intensity Prediction Scheme (SHIPS) intensification forecasting (DeMaria et al., 2005; Mainelli et al., 2008)
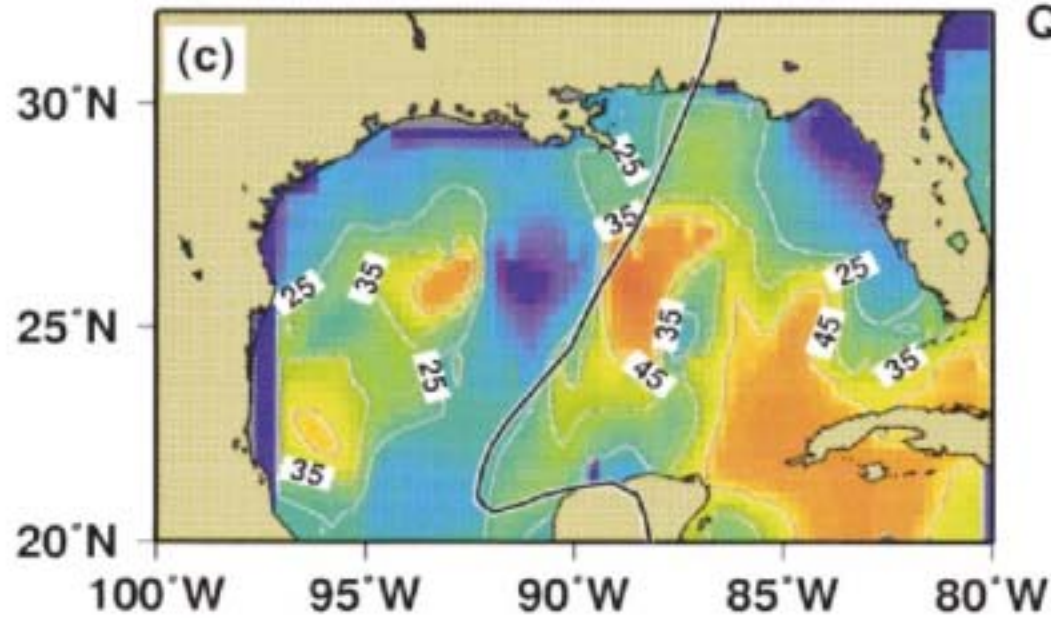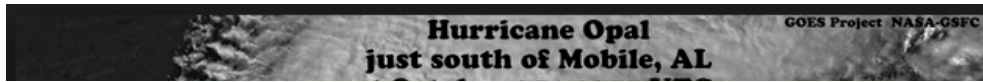
Background

Hurricane Opal
just south of Mobile, AL
4 October 95   2055 UTC

GOES Project NASA-GSFC

tor in hurricane

Hurricane Katrina
2005

□ Proven to improv
Prediction Scheme
(DeMaria et al., 2005; Mai

Background

Hurricane Opal
just south of Mobile, AL
GOES Project NASA-GSFC

$Q(Kcal\ cm^{-2})$

Hurricane Katrina
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- Proven to improv
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Background

Hurricane Opal
just south of Mobile, AL
GOES Project NASA-GSFC

Q(Kcal cm^{-2})
55

ne

Hurricane Katrina
2005

Wind Speed (mph)
- >155 (cat.5)
- 131 – 155 (cat.4)
- 111 – 130 (cat.3)
- 96 – 110 (cat.2)
- 74 – 95 (cat.1)
- 39 – 73 (TS)
- 0 – 38 (TD)

OHC (kJ cm^{-2})
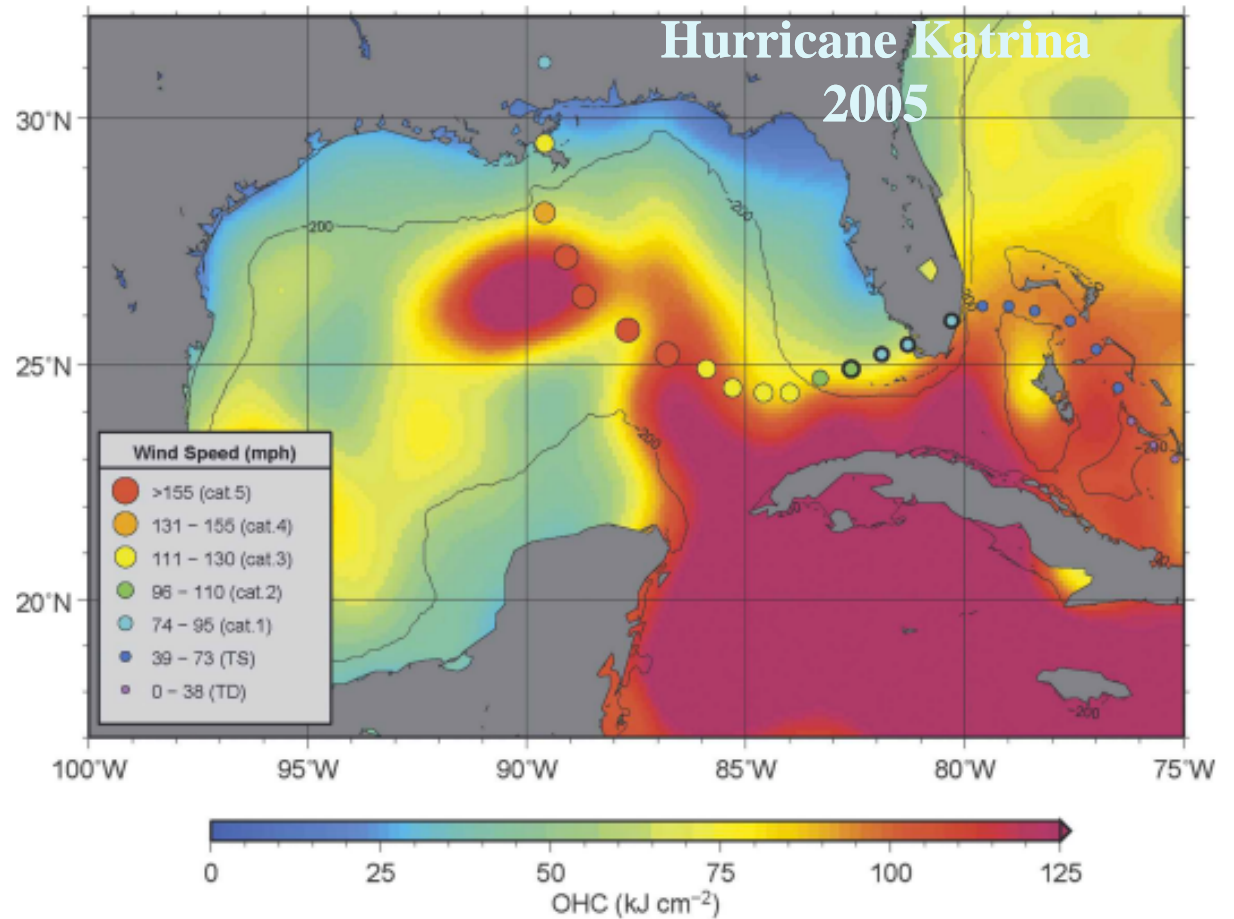
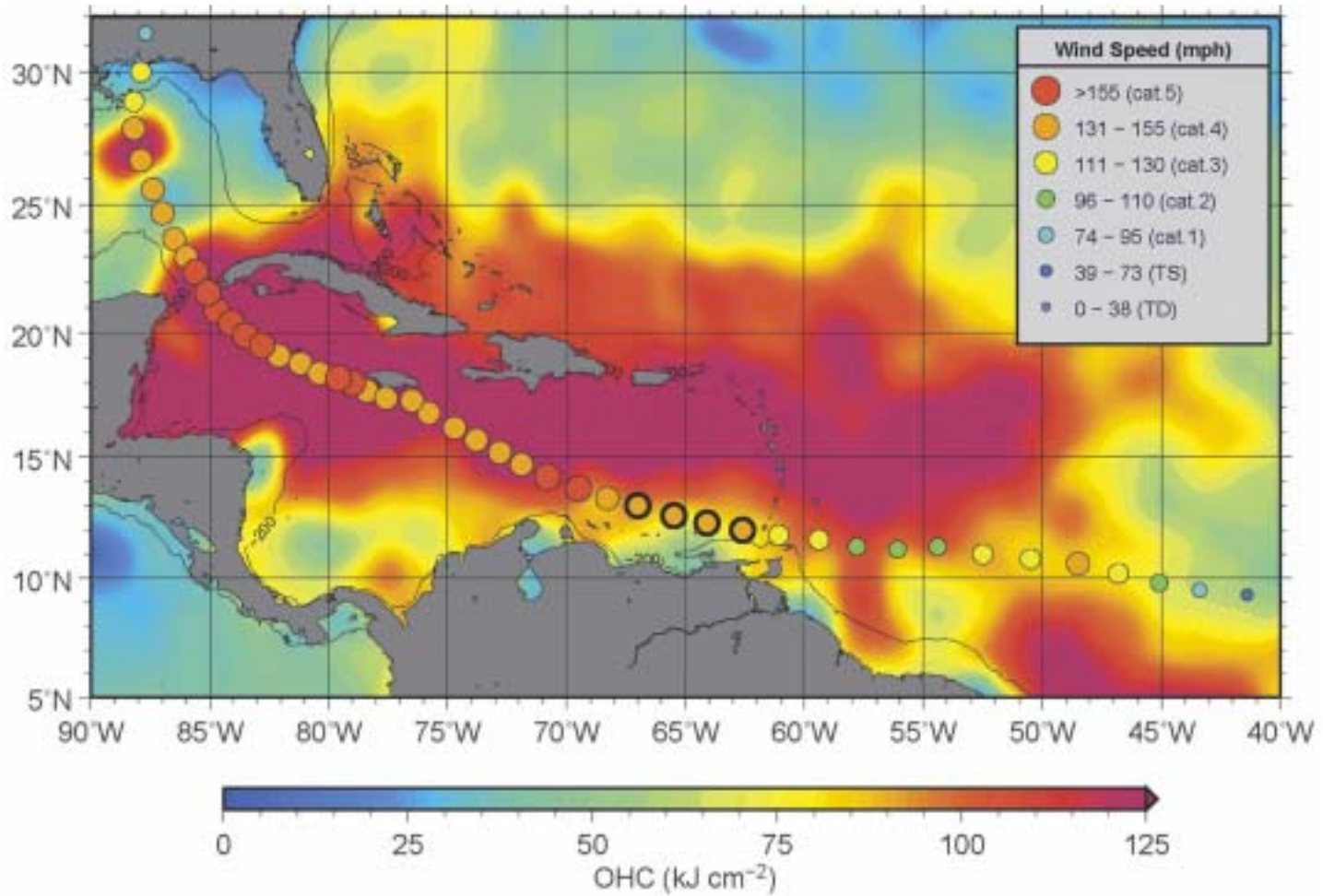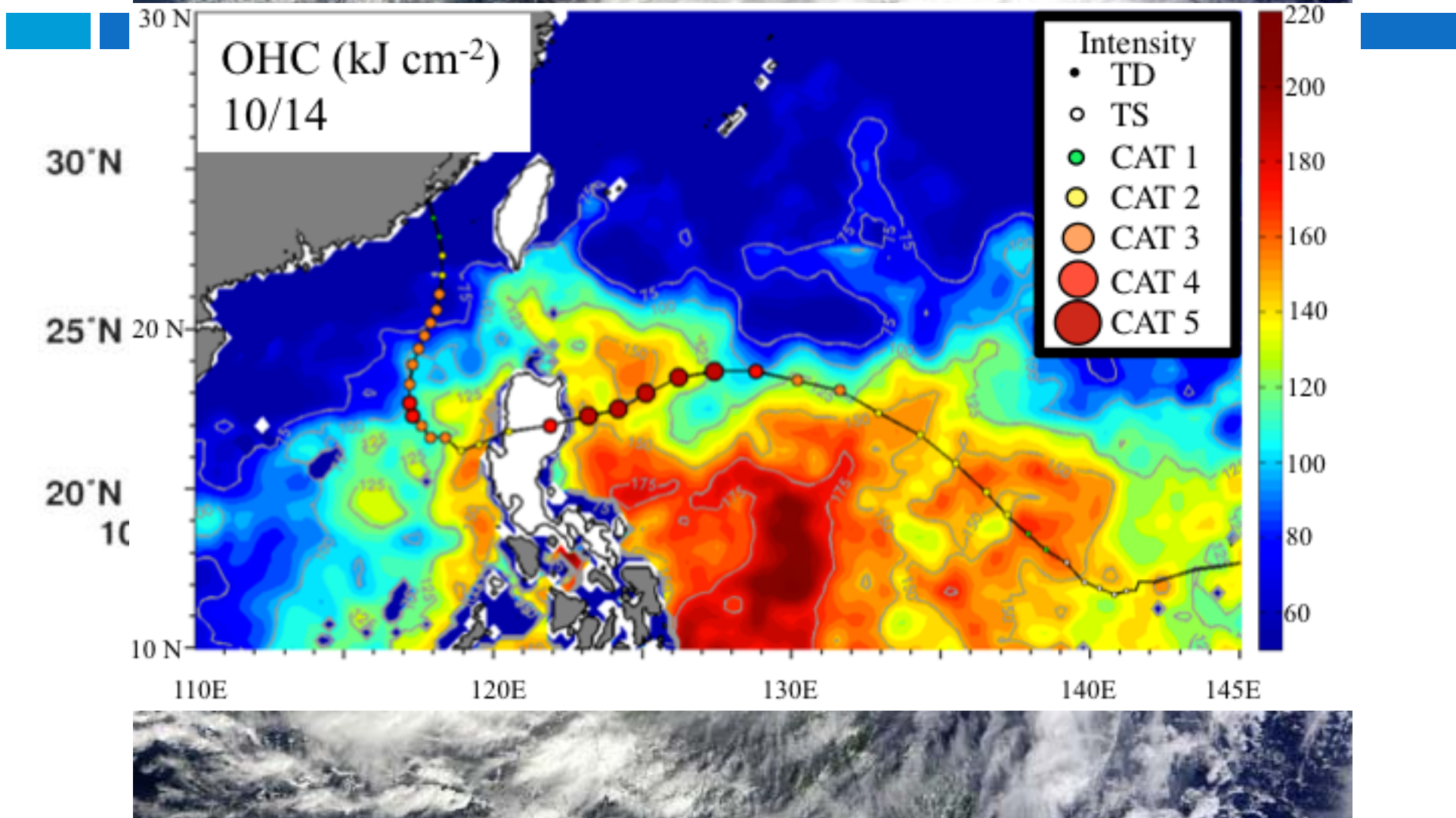□ Proven to in
Prediction Sc
(DeMaria et al., 200

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Hurricane Ivan
2004

Hurricane Ivan
2004

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Typhoon Megi
2010

Typhoon Megi
2010

OHC (kJ cm^{-2})
10/14

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Conceptual Model

- SST – Sea Surface Temperature

- MLD – Mixed Layer Depth

- D26 – Depth of the 26°C isotherm

- D20 – Depth of the 20°C isotherm

- OHC – Ocean Heat Content

  - Integrated Thermal Energy

    Leipper (1967)

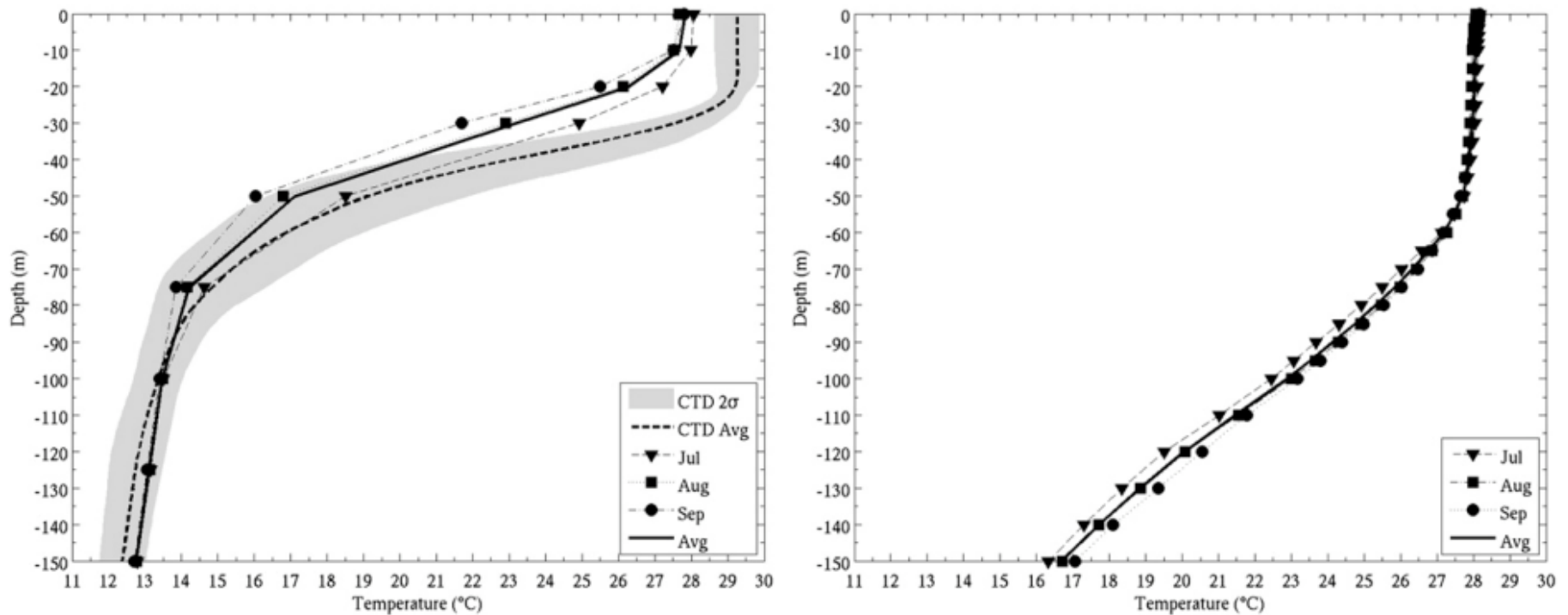$$OHC = c_p \rho \int_{D26}^{Sfc} (T_z - 26°)dz$$

26°C   SST

OHC

MLD

D26

Depth

D20→

Temperature →
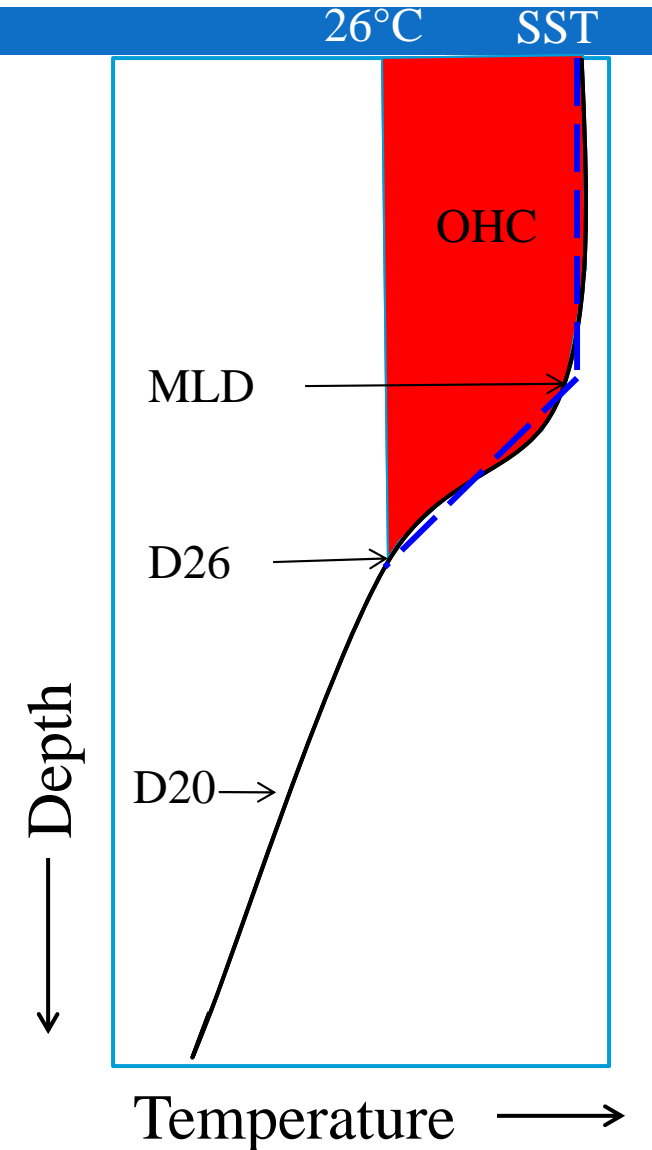
Basin-Wide SPORTS OHC

2.5-layer model uses SPORTS climatology
with daily SSHA and SST to estimate daily OHC

October 17th, 2010 OHC (kJ/cm^2)
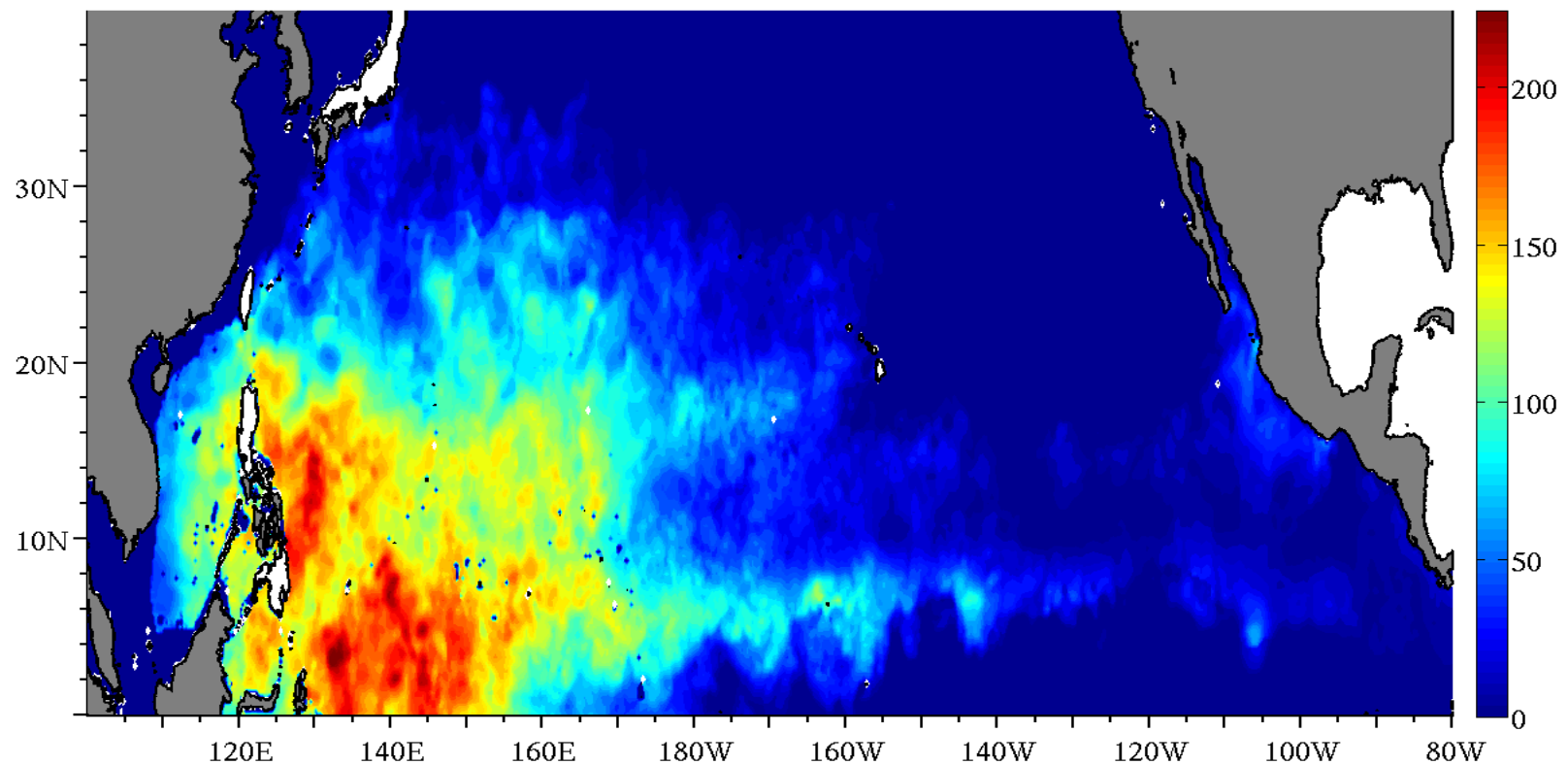
Climatologies for SPORTS

- Generalized Digital Environmental Model v3.0 (GDEM)
- GDEM v2.1
- World Ocean Atlas 2001 (WOA)

(Figure from Shay and Brewster, 2010)

SPORTS Climatology

- Weighted blend of GDEM v2.1 and WOA climatologies
  - Based on **267,540** quality controlled in-situ profiles
  - Measuring accuracy of each climatology

$$RMSD = \sqrt{\frac{\Sigma(x'_i - x_i)^2}{n}}$$

  - Weighting equation for SPORTS value

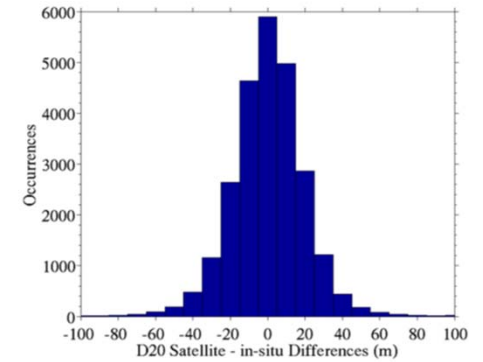$$x_{SPORTS} = \frac{x_{GDEM\,2}RMSD^2_{WOA} + x_{WOA}RMSD^2_{GDEM\,2}}{RMSD^2_{GDEM\,2} + RMSD^2_{WOA}}$$
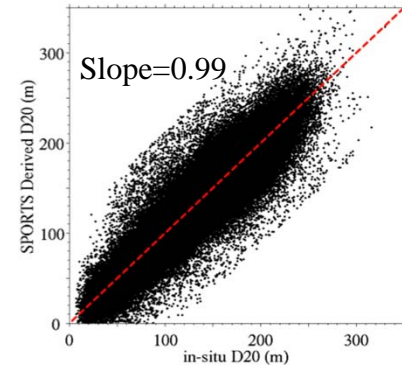
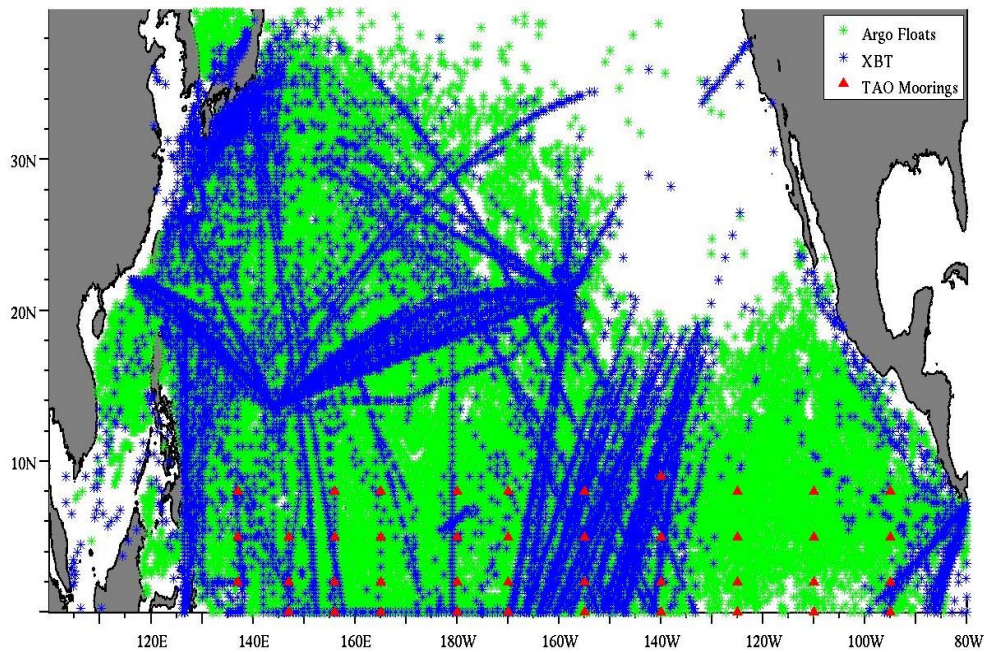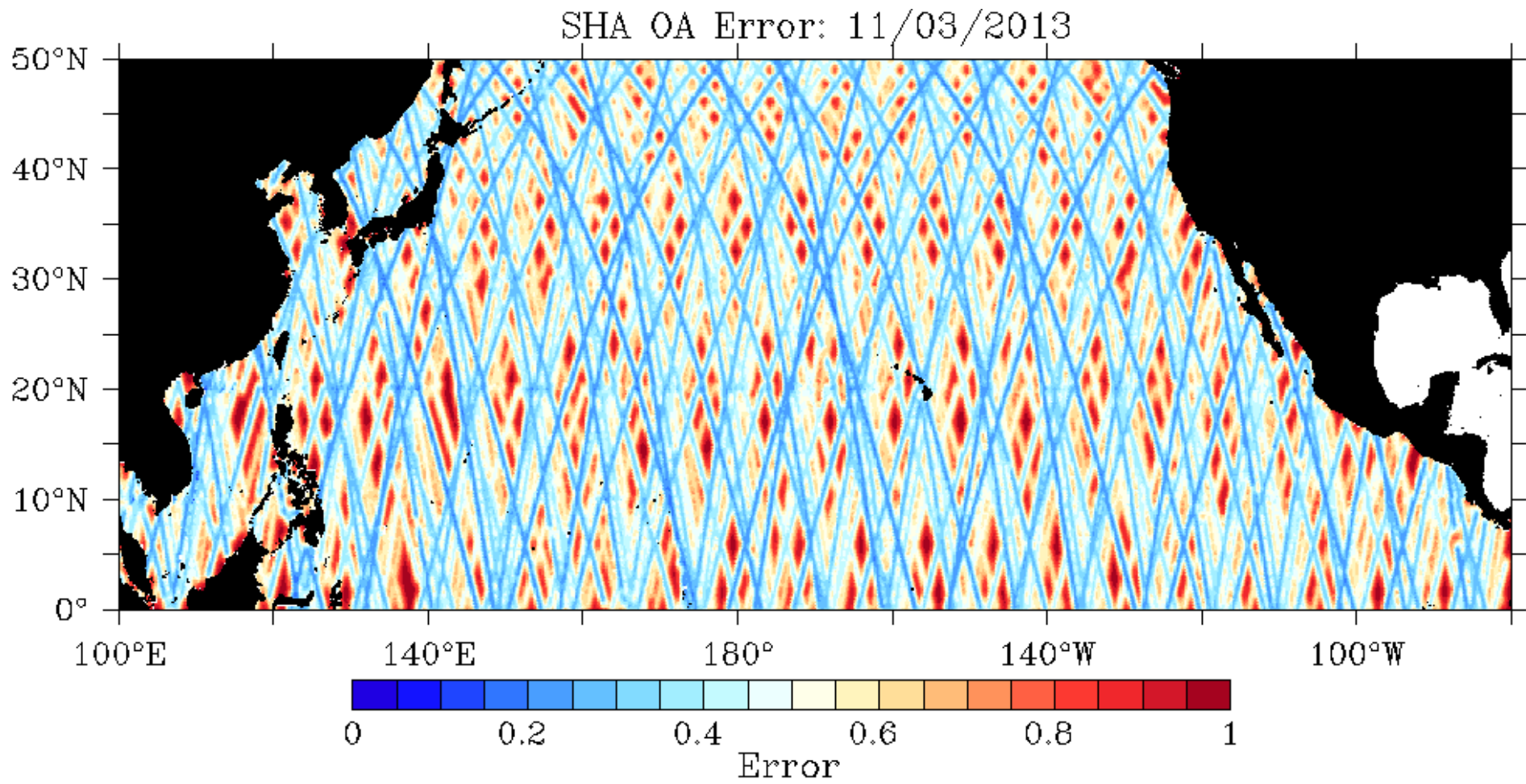# SPORTS Weighting Maps
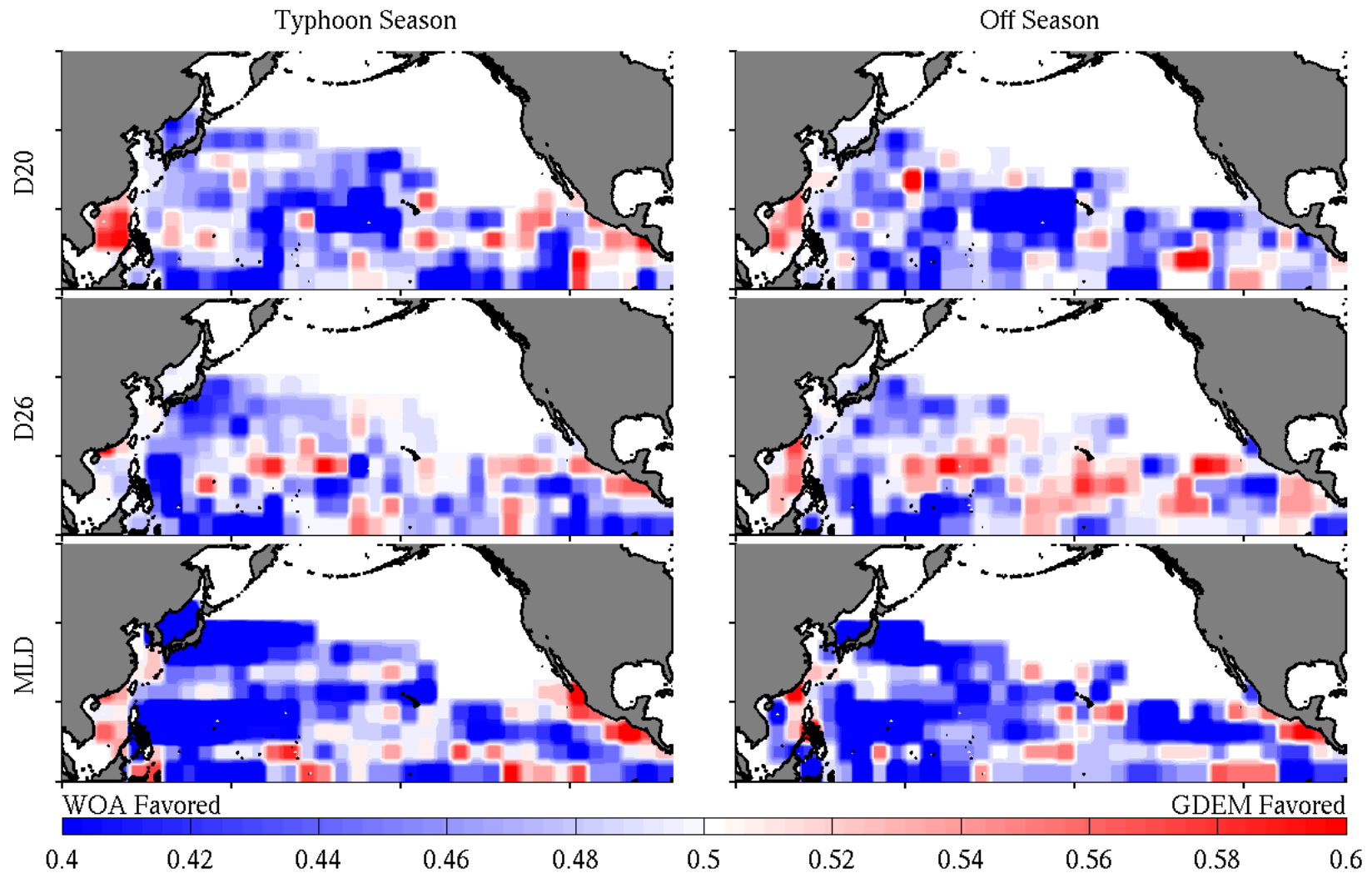
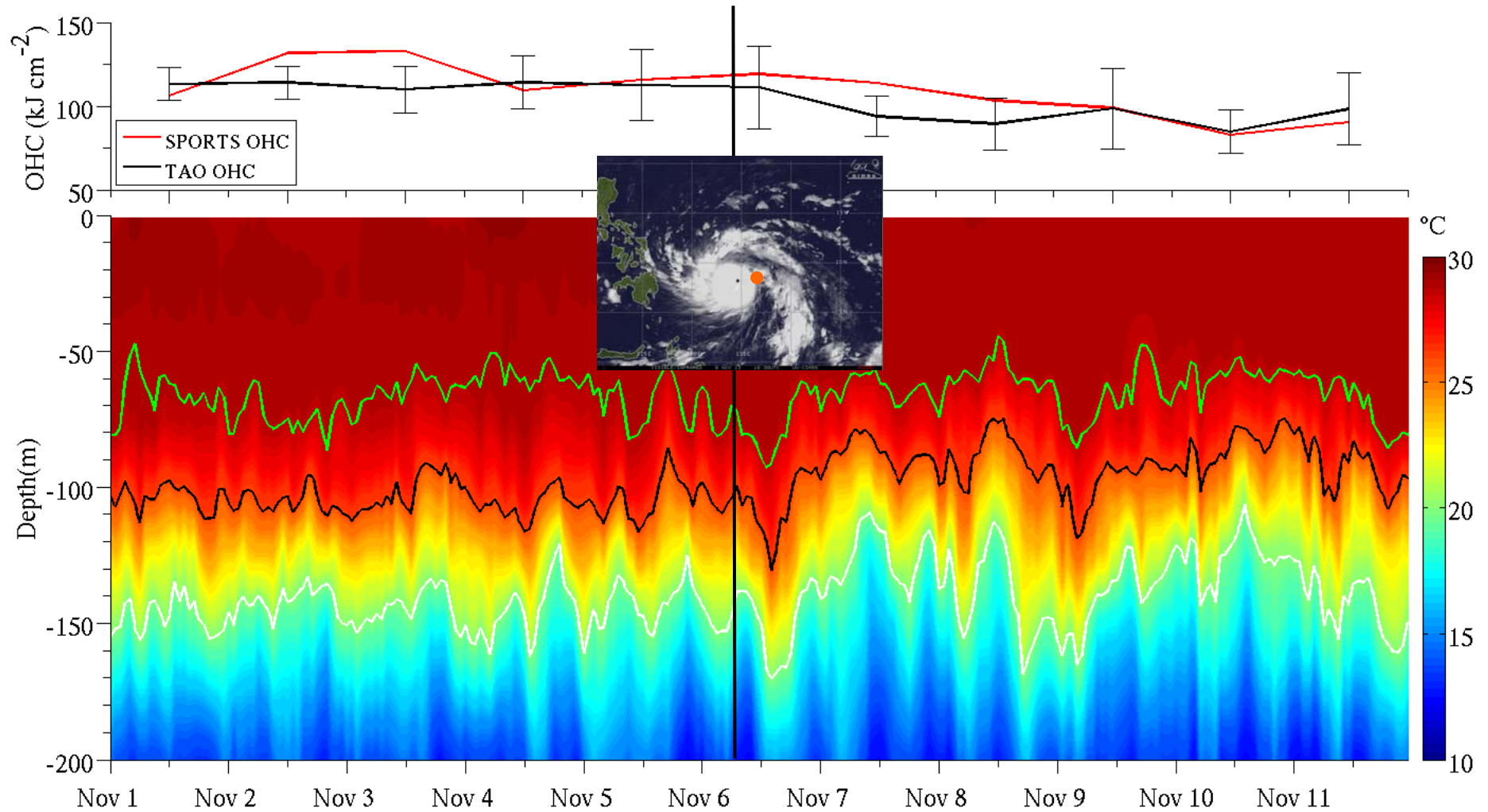# SPORTS Verification

~267,540 qc-ed data points over 12-yr period (00-2011)
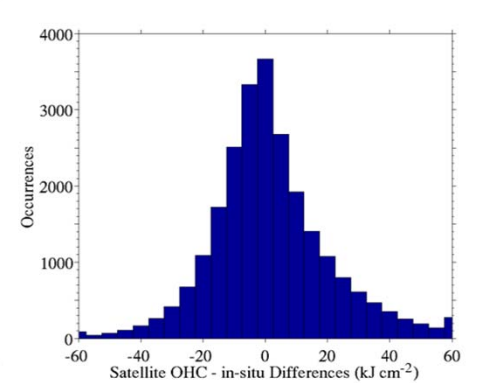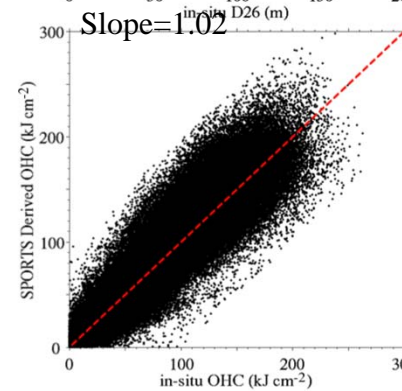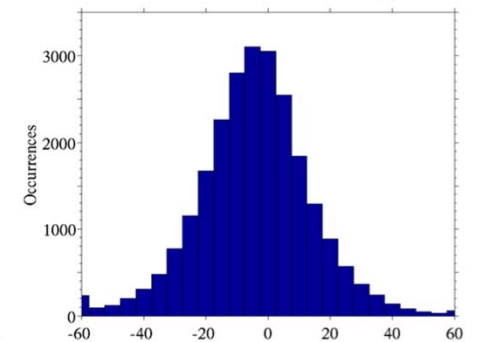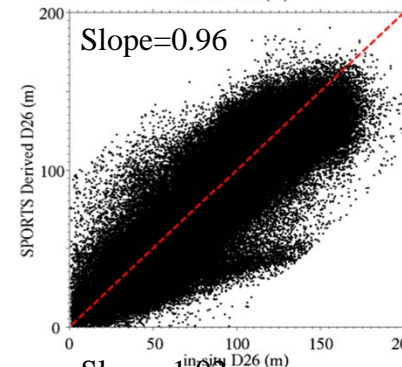
SSHA Mapping Error Field From Mariano and Brown (DSR, 1992)
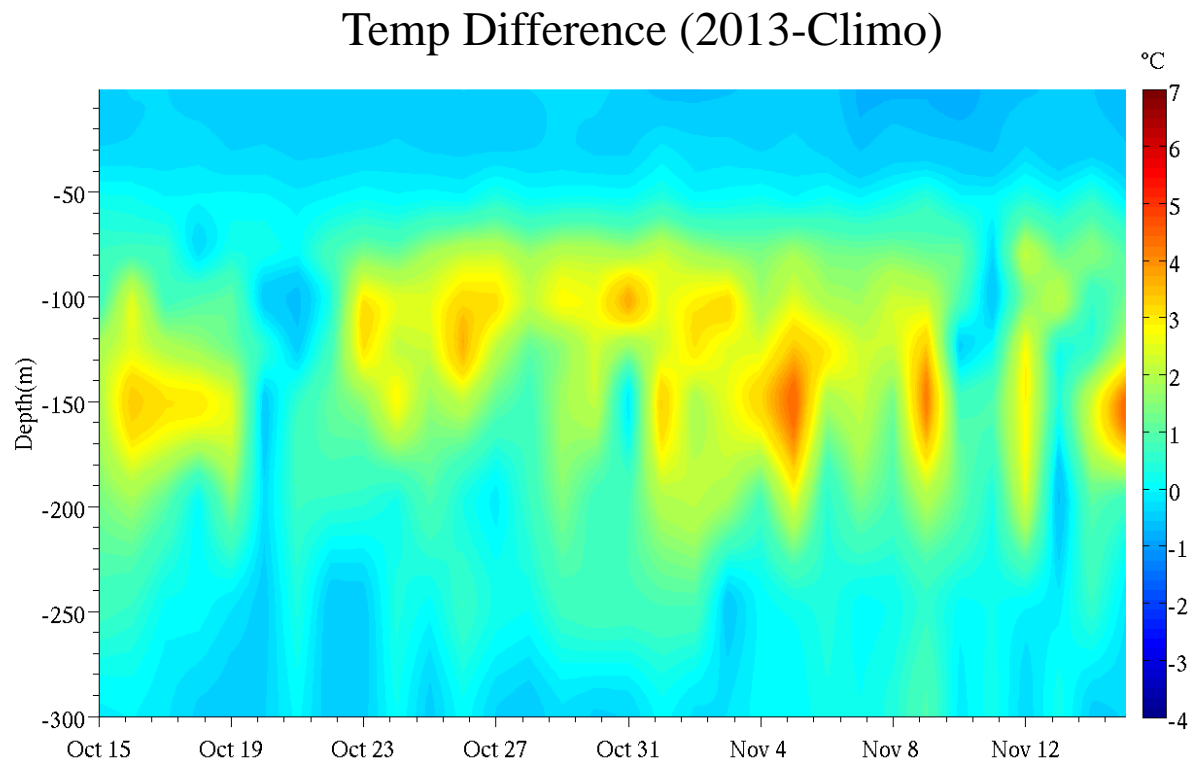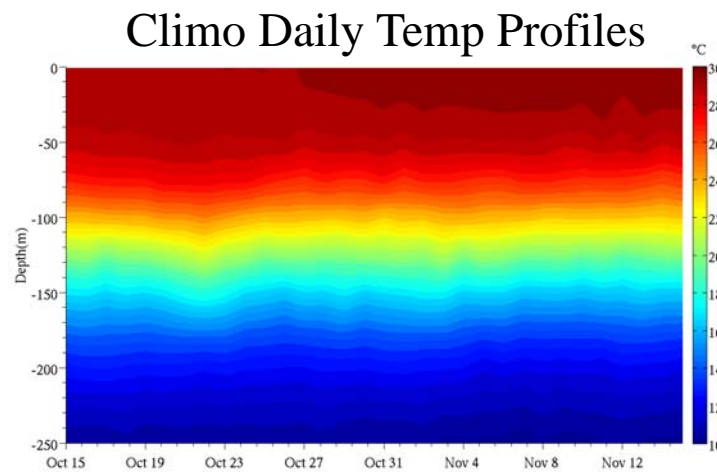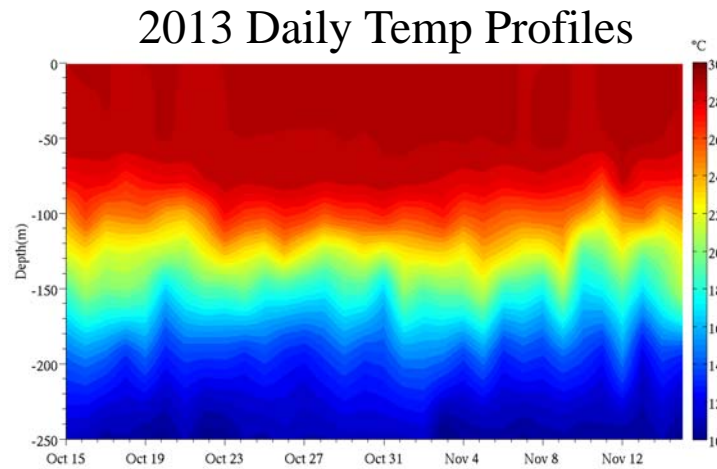

SHA OA Error: 11/03/2013

SPORTS in Action – Typhoon Haiyan
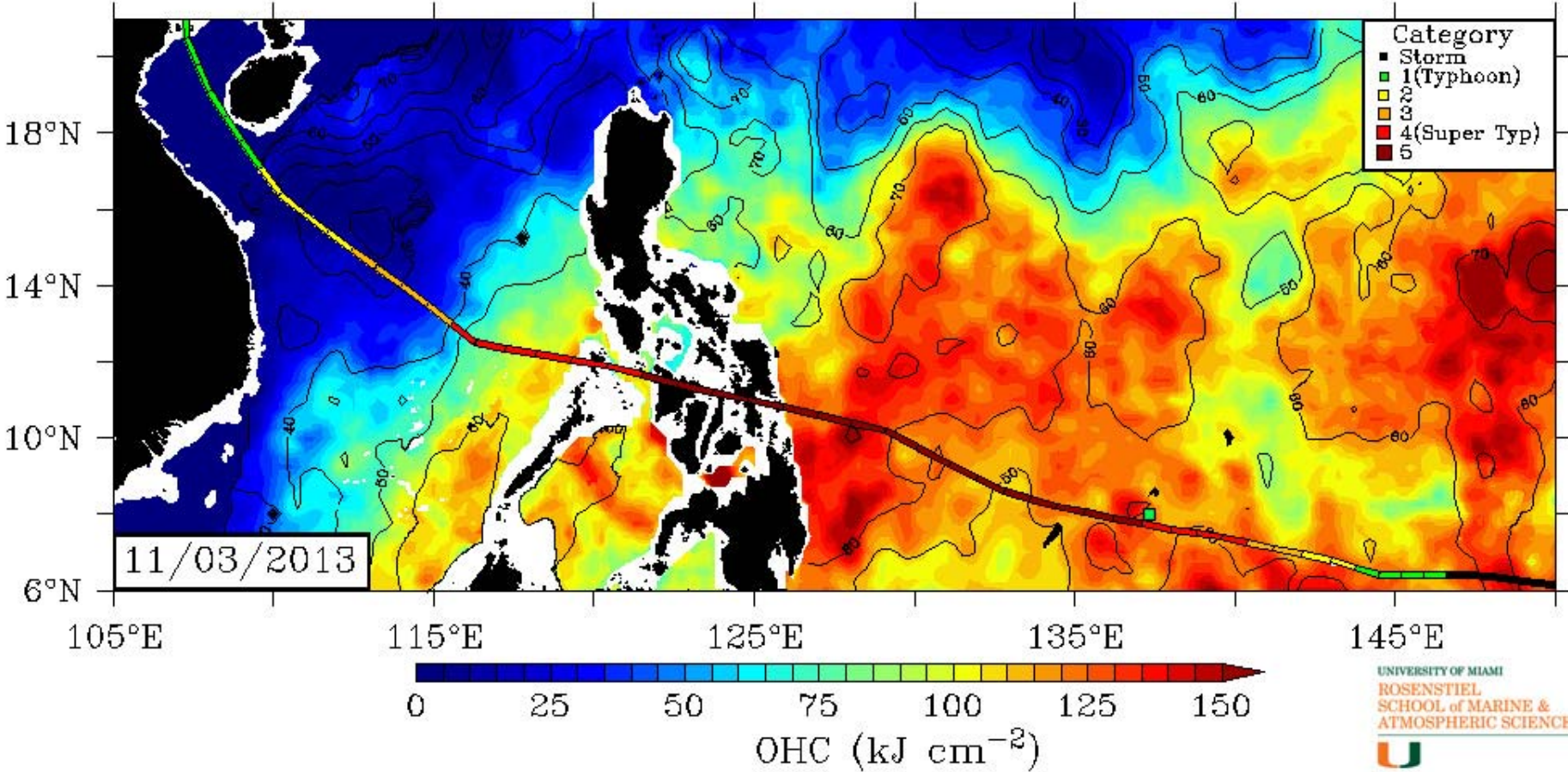
T(z) Time Series During Haiyan at TAO Mooring

Obs and Climatological T(z) (left) and Difference (right)

2013 Daily Temp Profiles

Climo Daily Temp Profiles

Temp Difference (2013-Climo)

S(z) Time Series During Haiyan at TAO Mooring

24-hr Low-Pass Filtered 10-m Currents During Haiyan
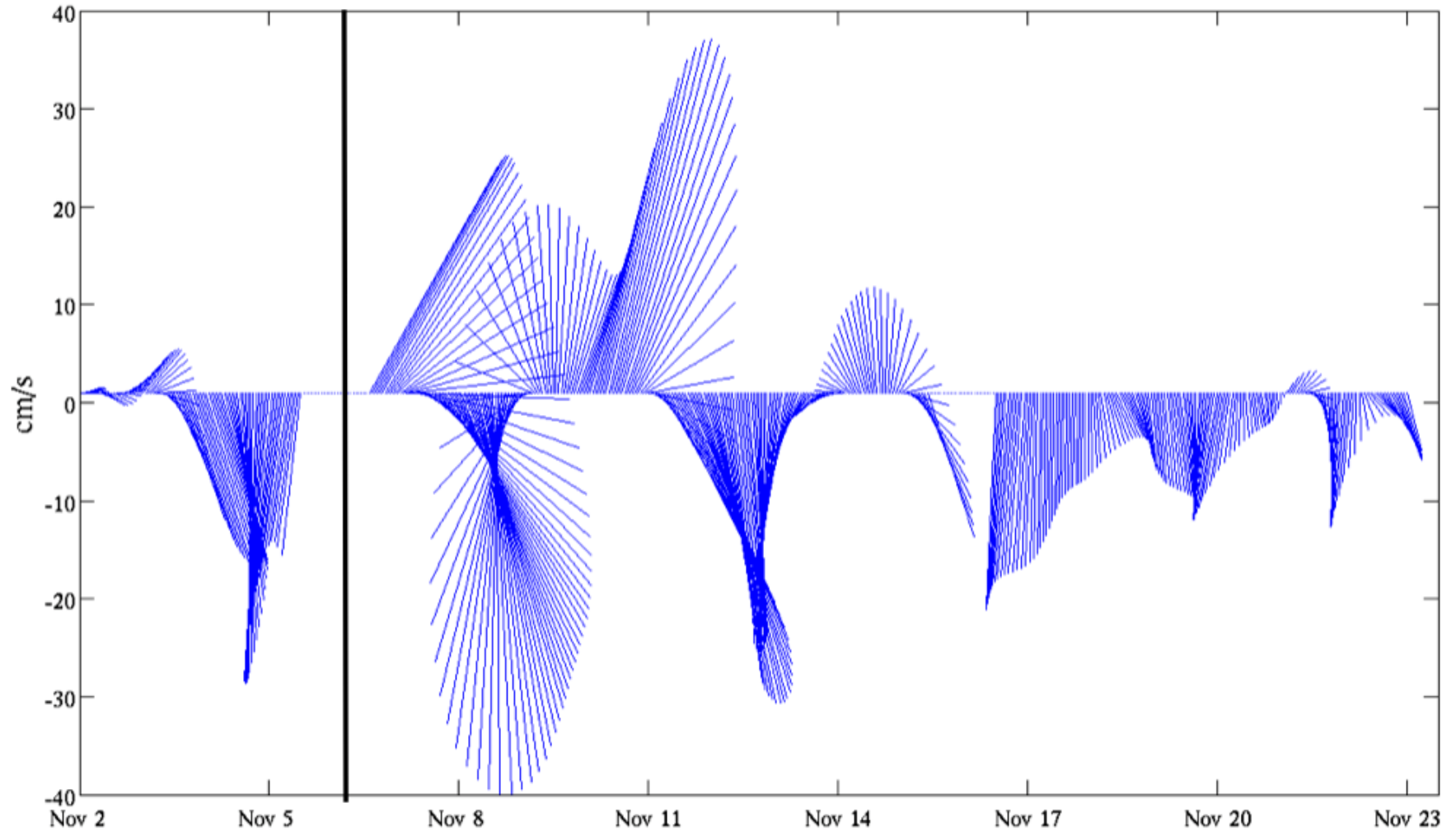
Concluding Remarks

- 2.5 Layer model used to calculate OHC basin wide
- Satellite OHC good estimation (267,000 thermal Profiles!)
- Super Typhoon Haiyan
  - Intensified and sustained over high OHC (SSTs were relatively flat)
  - Progress on TAO mooring
    - Pre-storm conditions
      - In Situ OHC agreement with SPORTS
      - Warming at depth relative to climatology, Cooling in Mixed Layer
      - Salinity max below MLD.
    - Oceanic Response
      - Reduction in OHC
      - Tightening of salinity gradient
      - Near-Inertial Current response at 8N periods of ~3 days
    - ARGO Float Analyses