

NOAA Operational Satellite Derived Oceanic Heat Content Products

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Ocean Surface Topography Science Team Meeting, Reston, VA., 20-23 October 2015

There are seven tropical cyclone "basins" where storms occur on a regular basis

OCEAN BASINS



1. Atlantic basin (North Atlantic Ocean, the Gulf of Mexico, and the Caribbean Sea)
2. Northeast Pacific basin (Mexico to the dateline)
3. Northwest Pacific basin (the dateline to Asia including the South China Sea)
4. North Indian basin (including the Bay of Bengal and the Arabian Sea)
5. Southwest Indian basin (from Africa to about 100E)
6. Southeast Indian/Australian basin (100E to 142E)
7. Australian/Southwest Pacific basin (142E to about 120W)



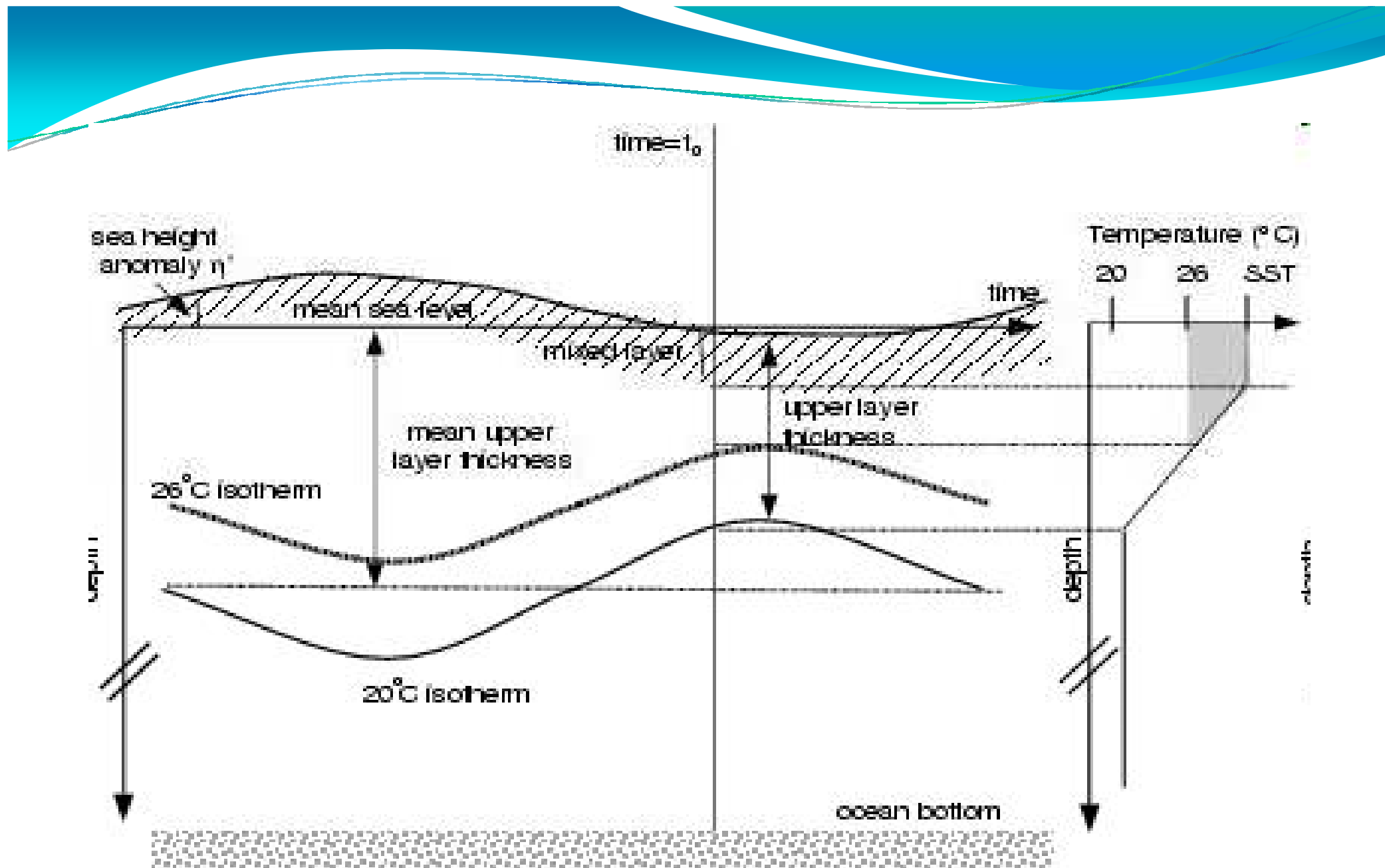
BACKGROUND

- Leipper and colleagues introduced the concept of Ocean Heat Content relative to 26 °C water.
- Concept was introduced at UM/RSMAS to use altimetry to estimate OHC for hurricane Opal (95) as storm deepened to cat 4 status over a warm core eddy (Shay et al., *MWR*, 2000).
- Combine various climatologies with objectively analyzed blended daily sea surface height anomaly fields from altimetry (TOPEX, Jason, GFO, and Envisat) with Reynolds SST where 26 °C isotherm depth is inferred from the depth of the 20C isotherm relative to SST at 0.25 degree resolution.
- transition RSMAS product to NHC (Mainelli, MS Thesis , RSMAS, 2000) through the NOAA Joint Hurricane Testbed program.
- Updated climatologies from WOA and US Navy GDEM and infer ocean mixed layer depth (Meyers MS Thesis, RSMAS, 2010).
- In situ temperature profiles (60,000 profiles from XBTs, floats, moorings and aircraft expendables) compared to satellite inferred isotherm depths and OHC in North Atlantic (Meyers et al., *JAOT*, 2014).
- Same approach for the North Pacific Ocean except for 275,000 profiles from 2000-2012 as part of McCaskill PhD research.
- Ongoing basic research linking enthalpy fluxes to OHC variability (Jaimes and Shay, *MWR*, 2015)



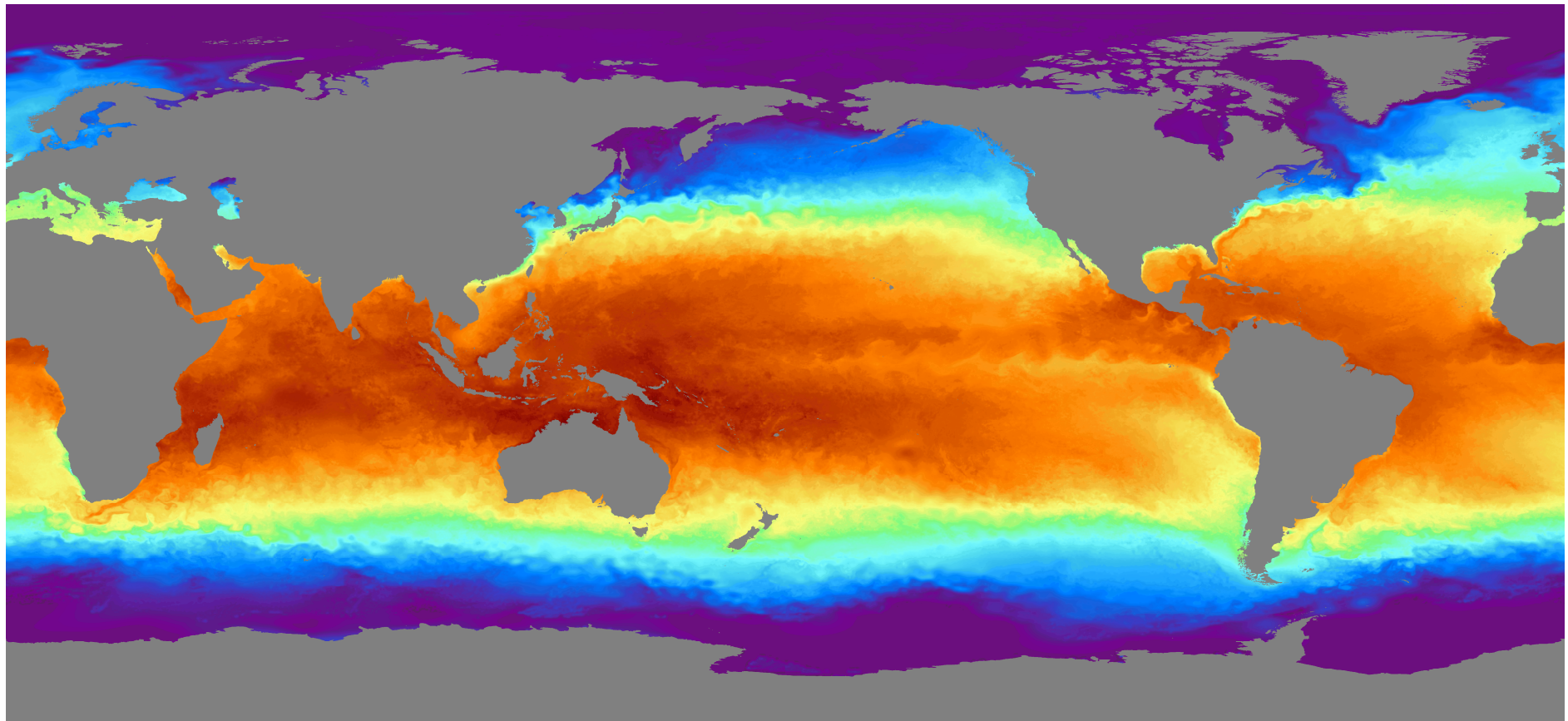
Oceanic Heat Content-Defined

- Measure of the integrated vertical temperature from the sea surface to the depth of the 26°C isotherm.
- Computed from the altimeter-derived isotherm depths in the upper ocean relative to 20°C.
- OHC values are estimated using four points:
 - the sea surface temperature obtained from NOAA/ NESDIS daily multi-sea surface temperatures at 5km degree resolution.
 - the altimeter-estimates of the 20°C isotherm within a two-layer reduced gravity scheme.
 - the depth of the 26°C isotherm from a climatologically relationship between the depths of the 20°C and 26°C isotherm.
 - Flexibility in estimating other isotherm depths (e.g., 25°C) then integrate.



NOAA/NESDIS

5-km Global Blended SST Analysis



0 5 10 15 20 25 30

SST / °C

Altimetry Data and Format (ASCII)

Products

Size/Frequency

- JASON-2
SSHa (daily) ~2.4 MB / 1 file/day
- SARAL
SSHa (daily) ~2.4 MB / 1 file/day
- CRYOSAT-2
SSHa (daily) ~2.2 MB / 1 file/day

SSHa- Sea Surface Height Anomaly



Oceanic Heat Content Product

- The OHC product measures the integrated vertical temperature from the sea surface to the depth of the 26 degree isotherm
- The Algorithm uses a reduced gravity model to estimate the 20 degree isotherm depth based on objectively analyzed blended sea surface height anomaly fields from operational altimeters (JASON-2, SARAL, Cryosat-2*) and GEO-Polar blended SST analyses (5km).
- OHC provides additional useful information about the ocean structure (including the mixed layer) than just SSTs can provide because it locates the energetic mesoscale eddy structure of currents that have deep, warm structures.

*Work in progress in assessing the addition of the Cryosat-2 Mission to the Operational OHC Product at NESDIS.

Ocean Heat Content (OHC) Product (North Atlantic Basin)

- 9/27/12 – North Atlantic Ocean Heat Content –operational
- 11/5/13 – North Pacific Ocean Heat Content - operational
- 9/2/15 – South Pacific Ocean Heat Content - operational
- OHC web site

http://www.ospo.noaa.gov/Products/ocean/ohc_natl.html

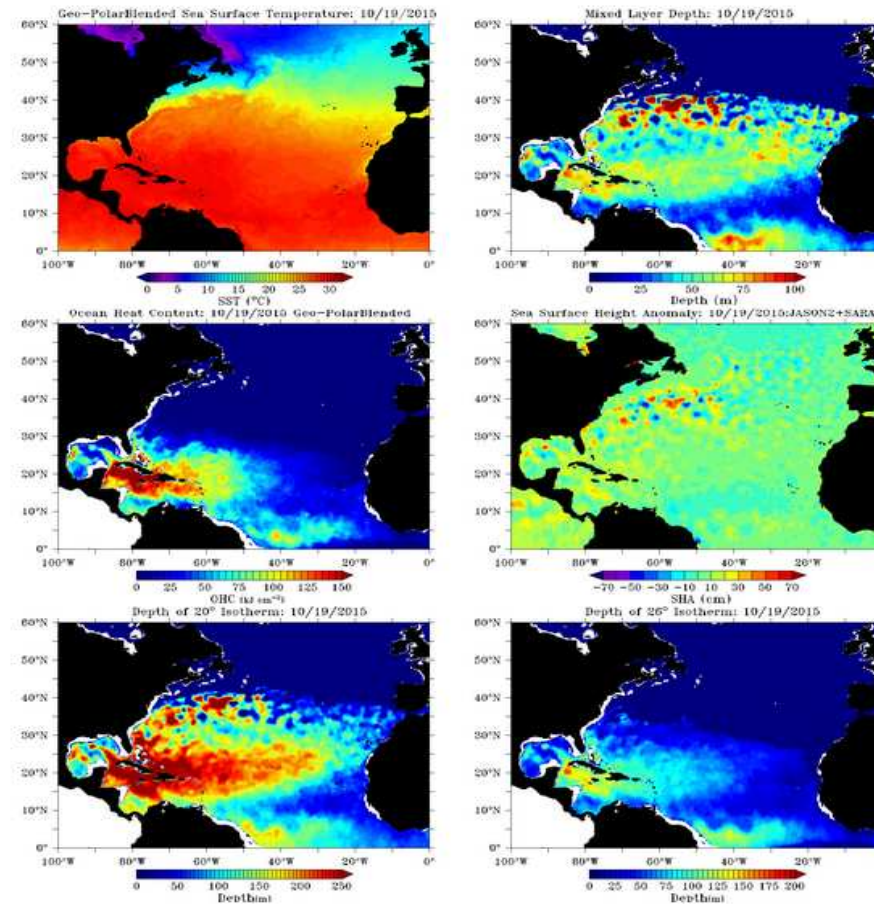
http://www.ospo.noaa.gov/Products/ocean/ohc_npac.html

http://www.ospo.noaa.gov/Products/ocean/ohc_spac.html

Ocean Heat Content (OHC) Product (North Atlantic Basin)

ORGANIZATION	SERVICES	PRODUCTS	OPERATIONS	<input type="text"/>	Q
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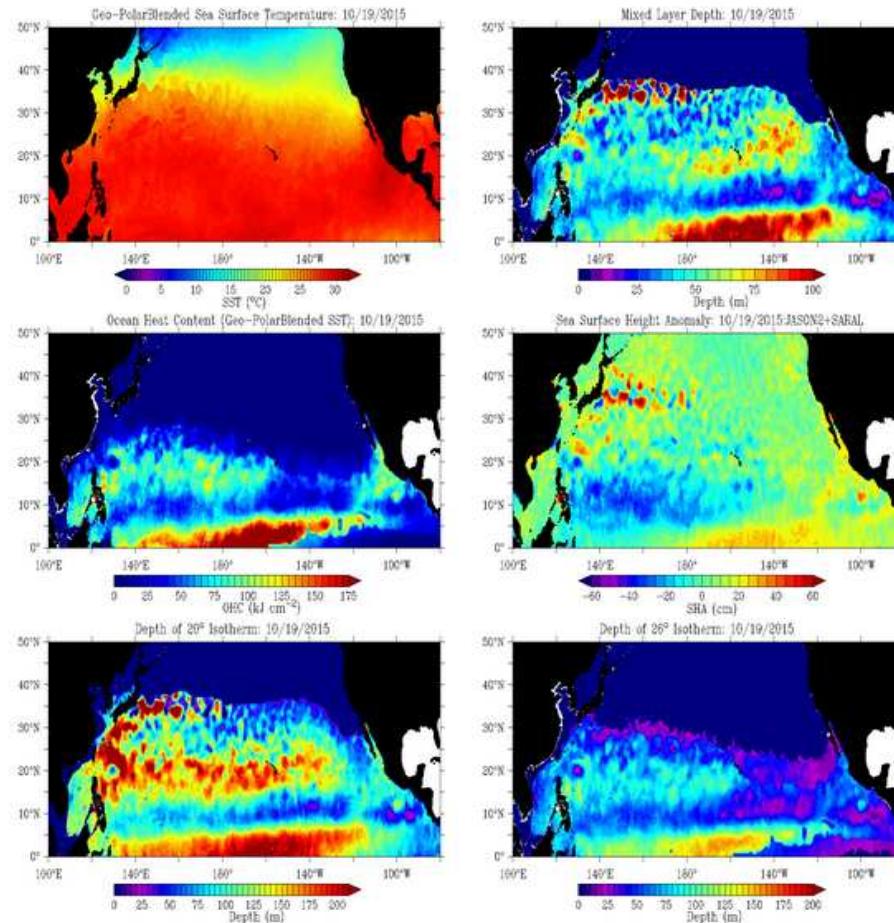
Satellite Ocean Heat Content Suite – North Atlantic



Ocean Heat Content (OHC) Product (North Pacific Basin)

ORGANIZATION SERVICES PRODUCTS OPERATIONS

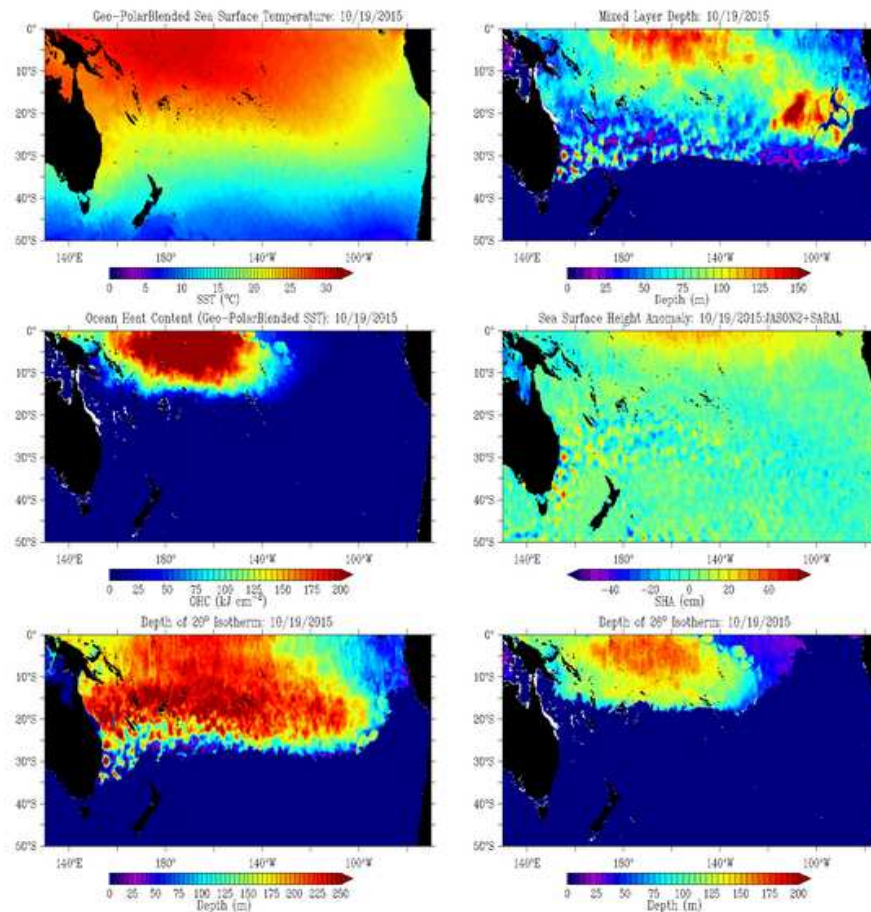
Satellite Ocean Heat Content Suite – North Pacific



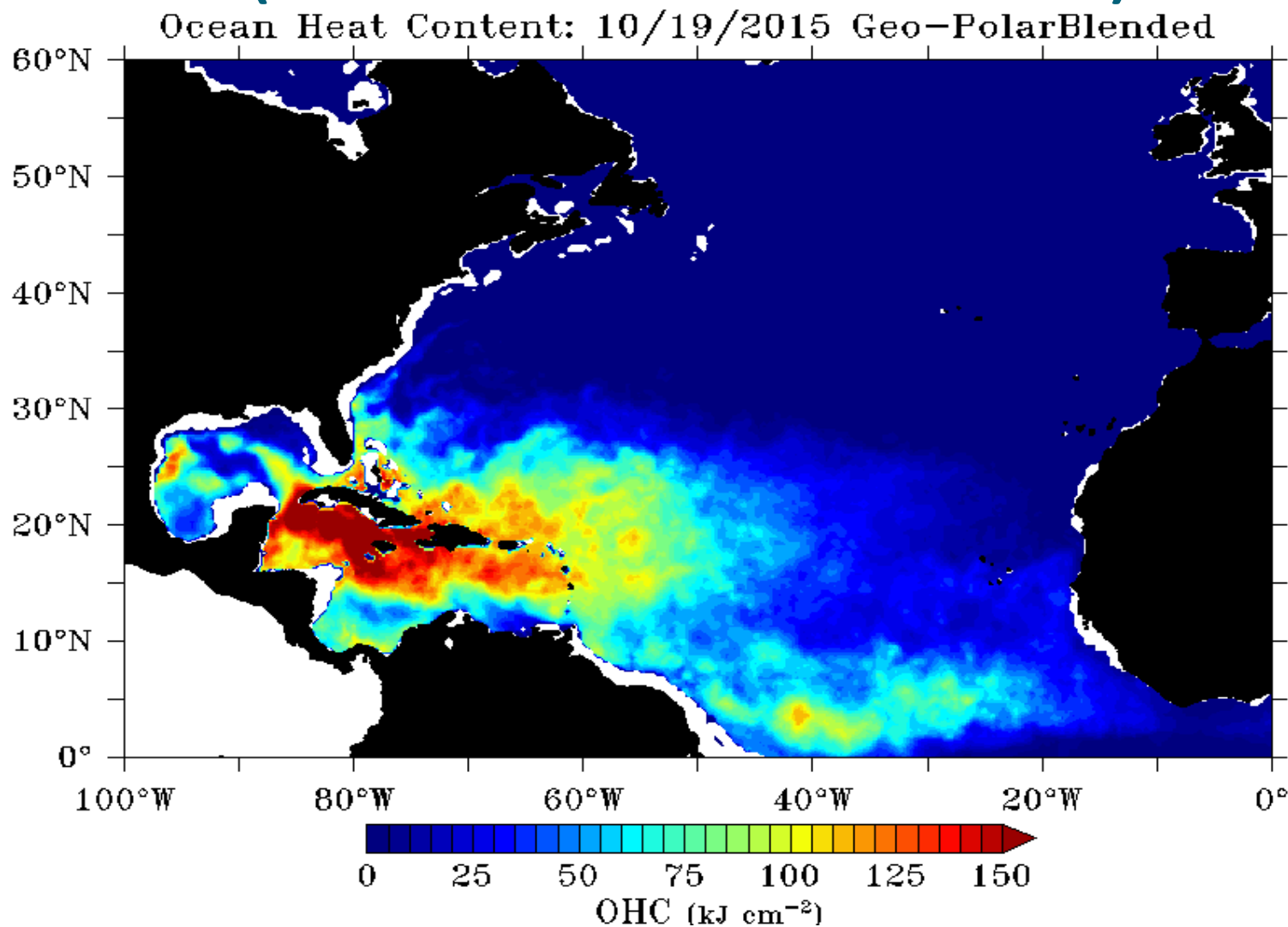
Ocean Heat Content (OHC) Product (South Pacific Basin)

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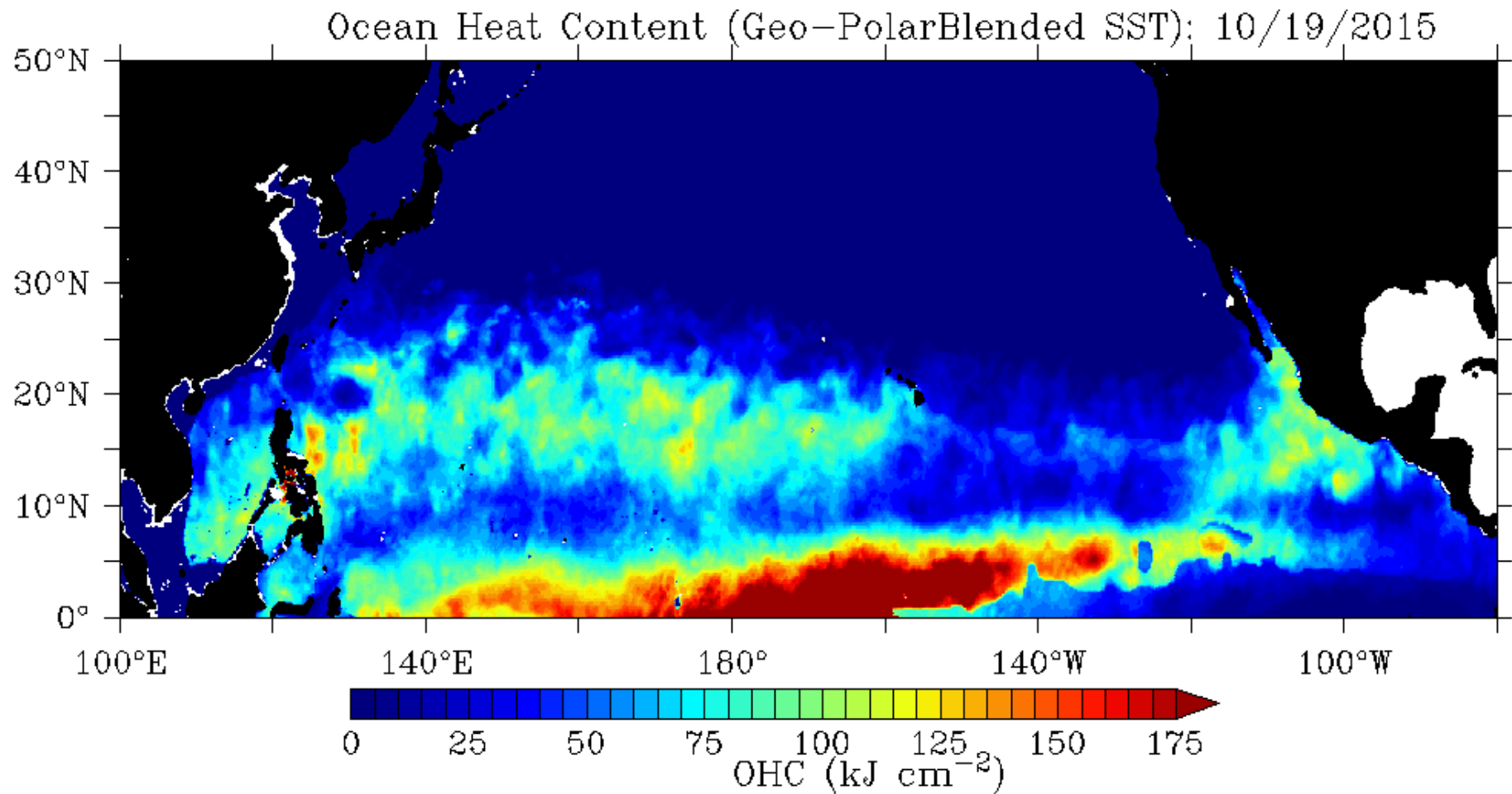
Satellite Ocean Heat Content Suite – South Pacific



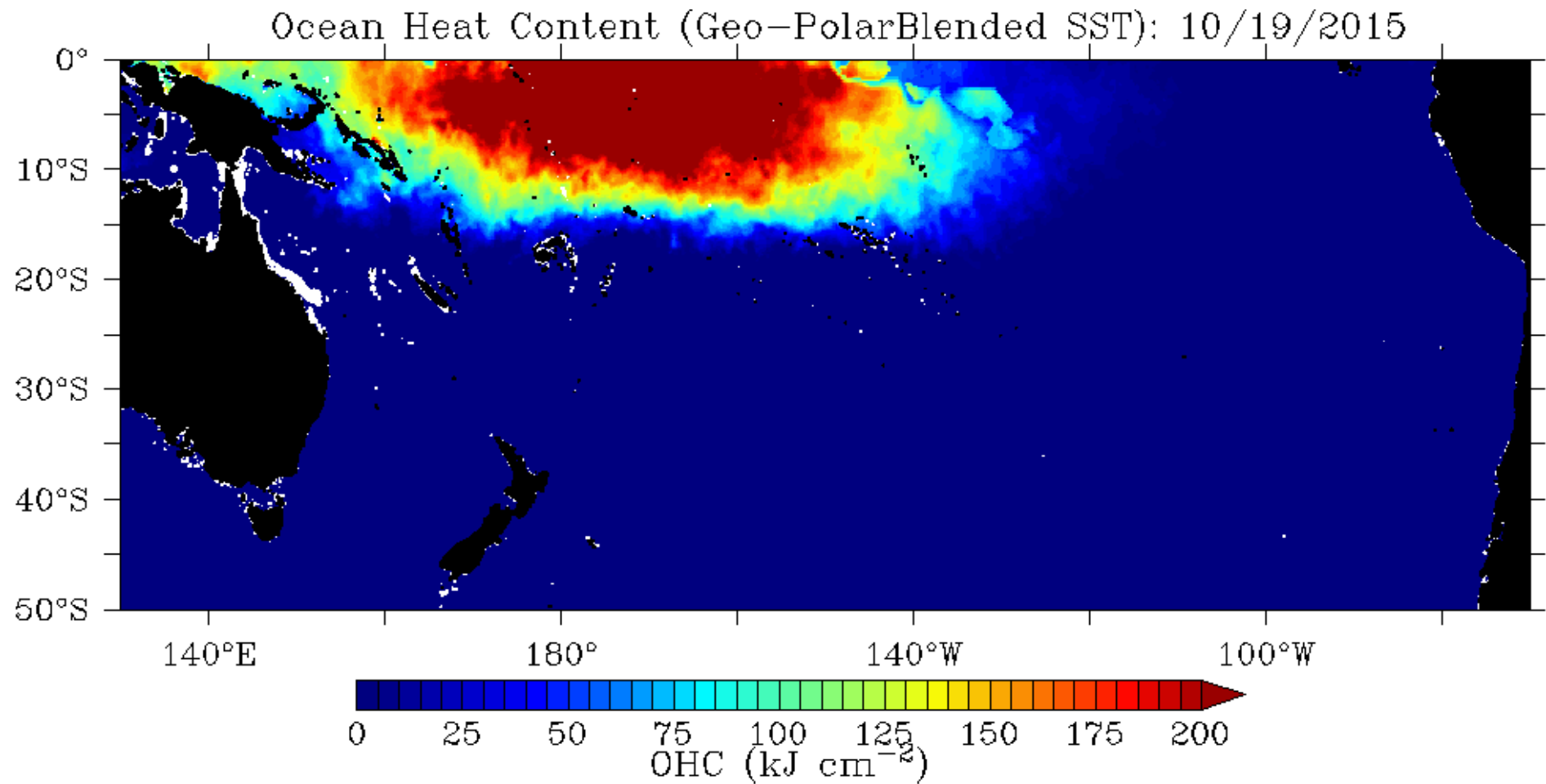
Ocean Heat Content (OHC) Product North Atlantic (North Atlantic Basin)



Ocean Heat Content (OHC) Product (North Pacific Basin)



Ocean Heat Content (OHC) Product (South Pacific Basin)



New OHC Product/ARGO Float Profiles Northern Atlantic Ocean Domain

Hurricane Earl's Rapid Intensification (2010) During NOAA IFEX and NASA GRIP Experiments

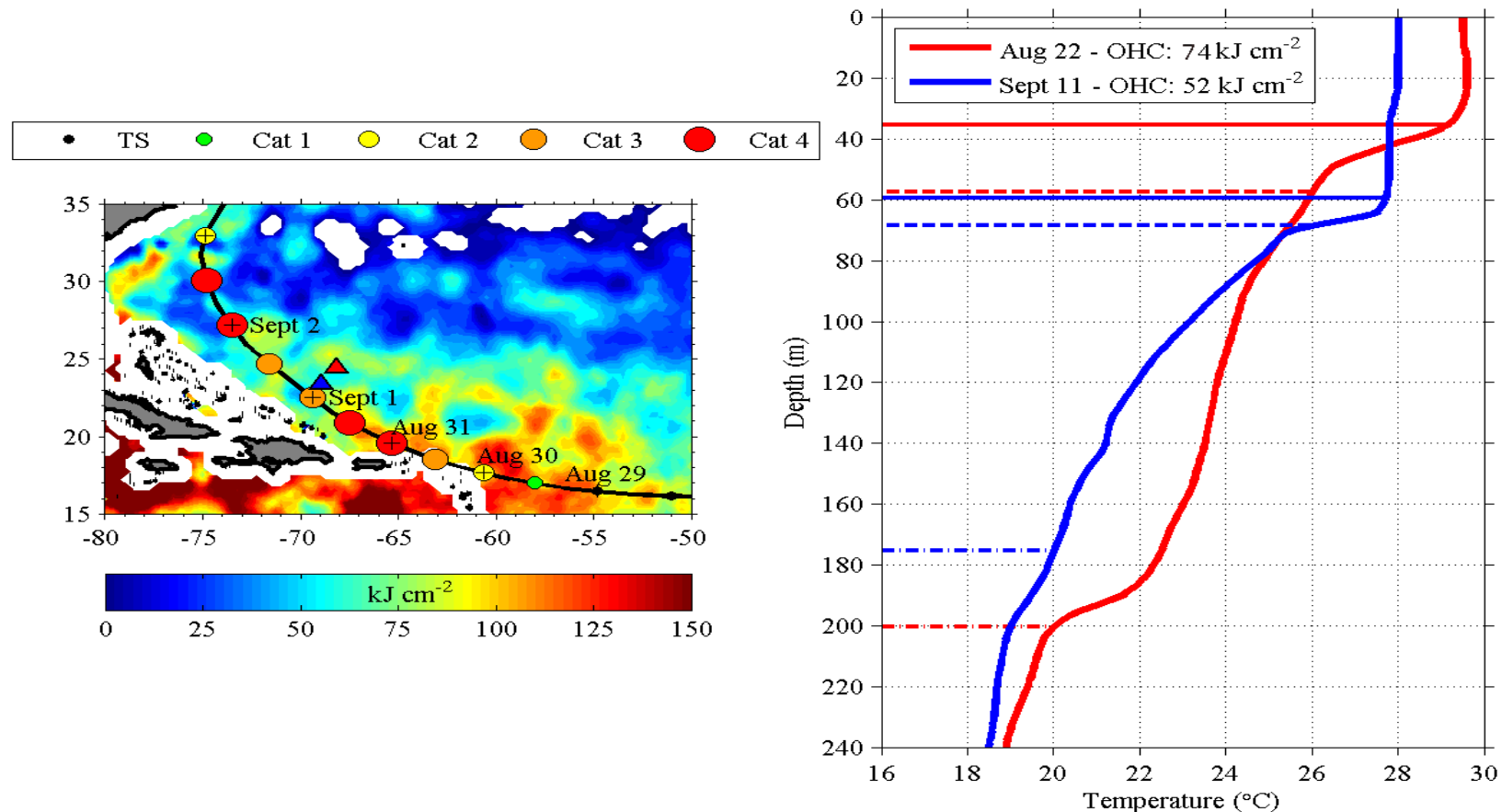
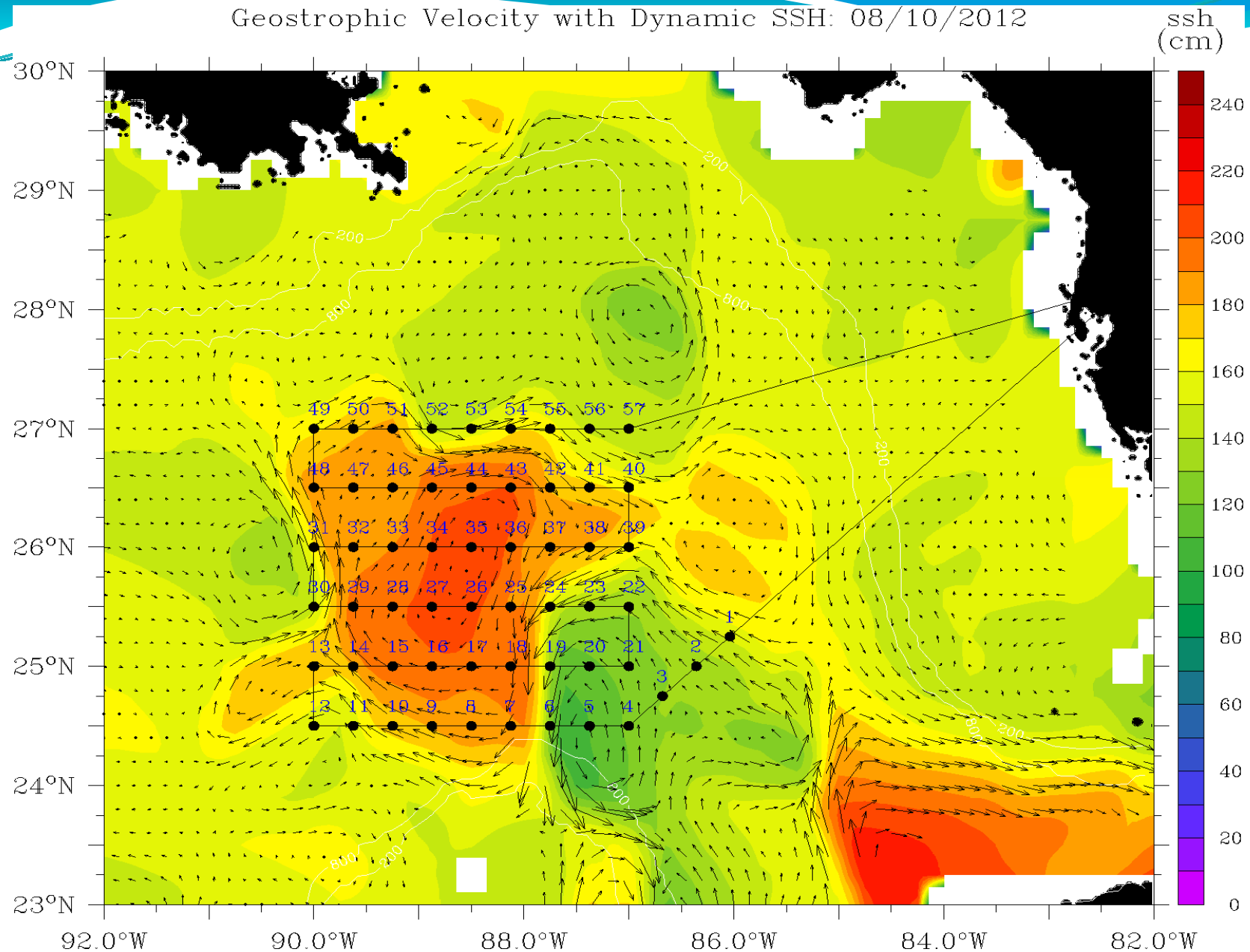
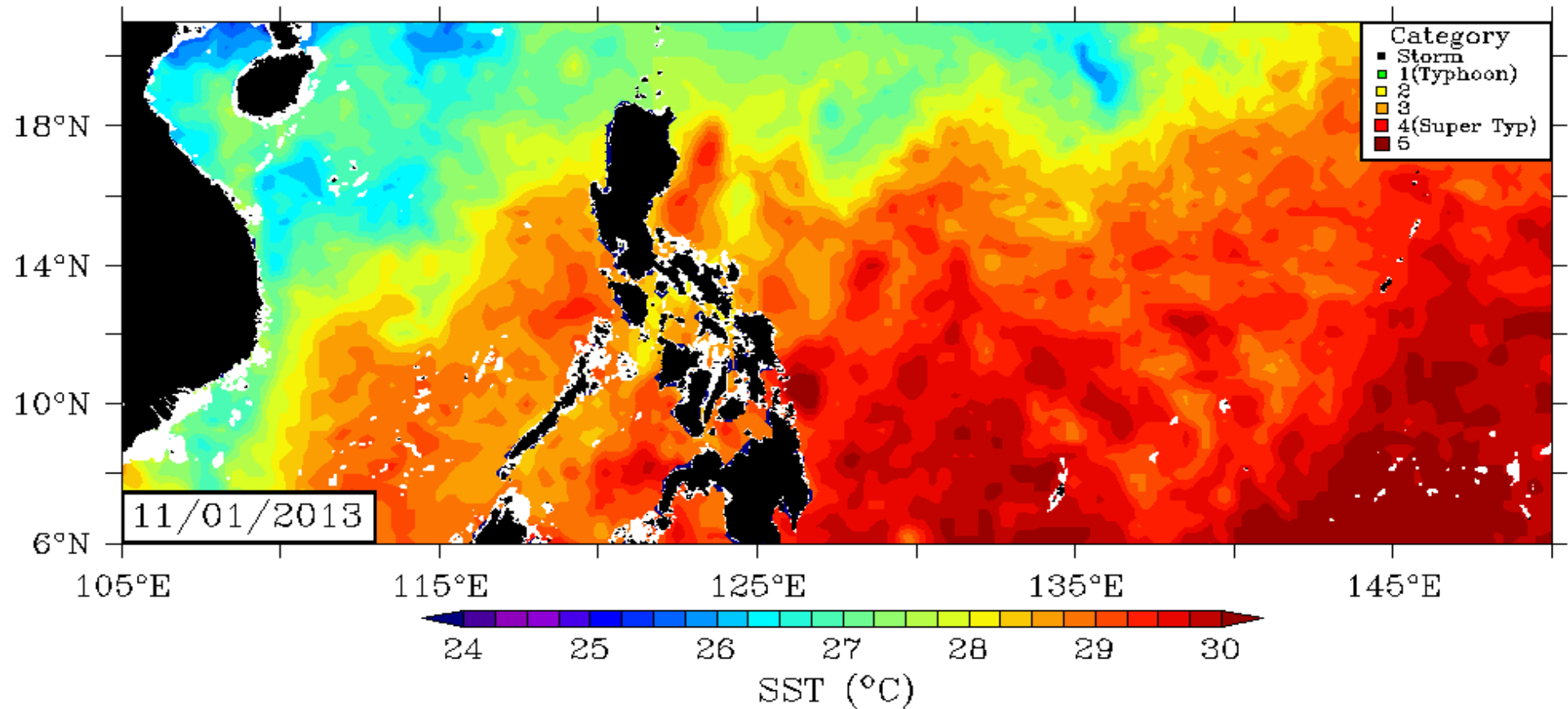


Illustration of the impact of Oceanic Heat Content on the rapid intensification of Hurricane Earl (2010).

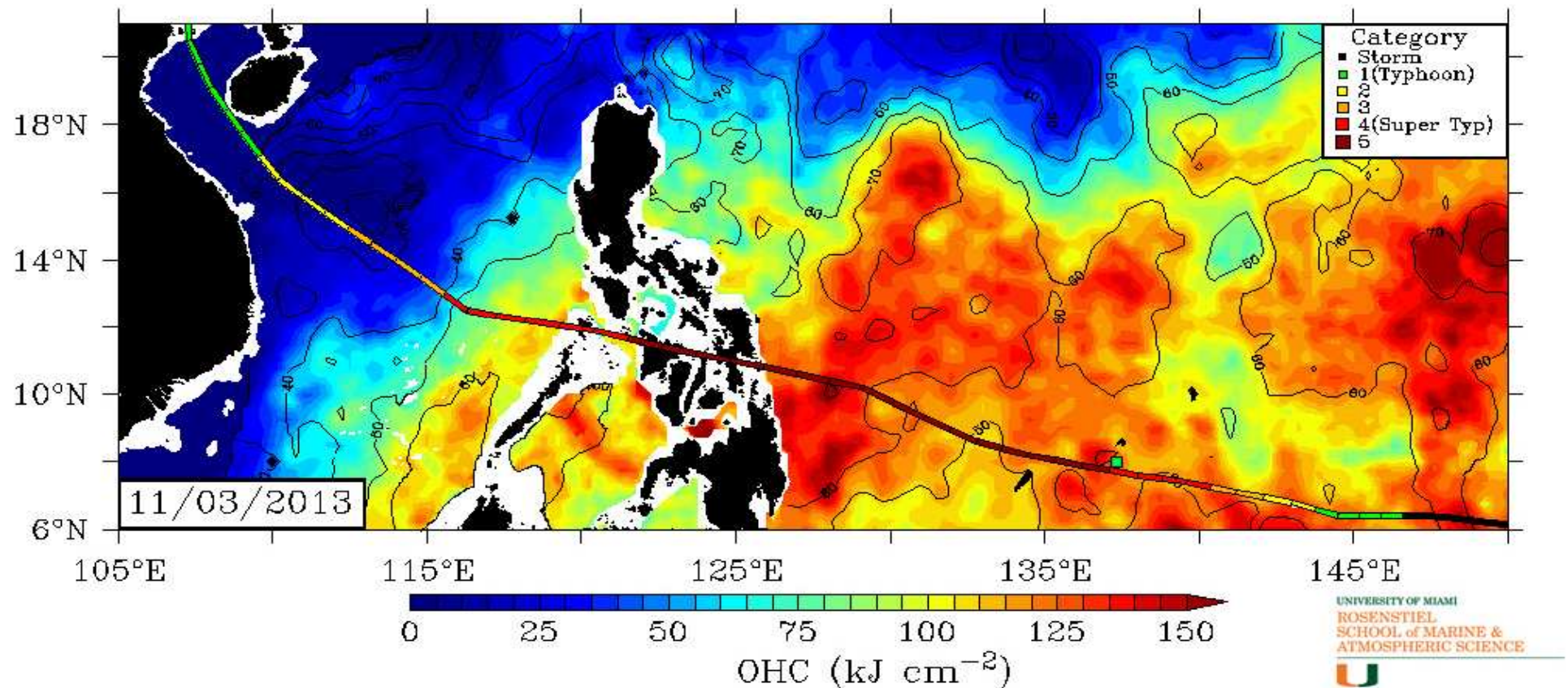
Geostrophic Velocity with Dynamic SSH: 08/10/2012



Typhoon Haiyan



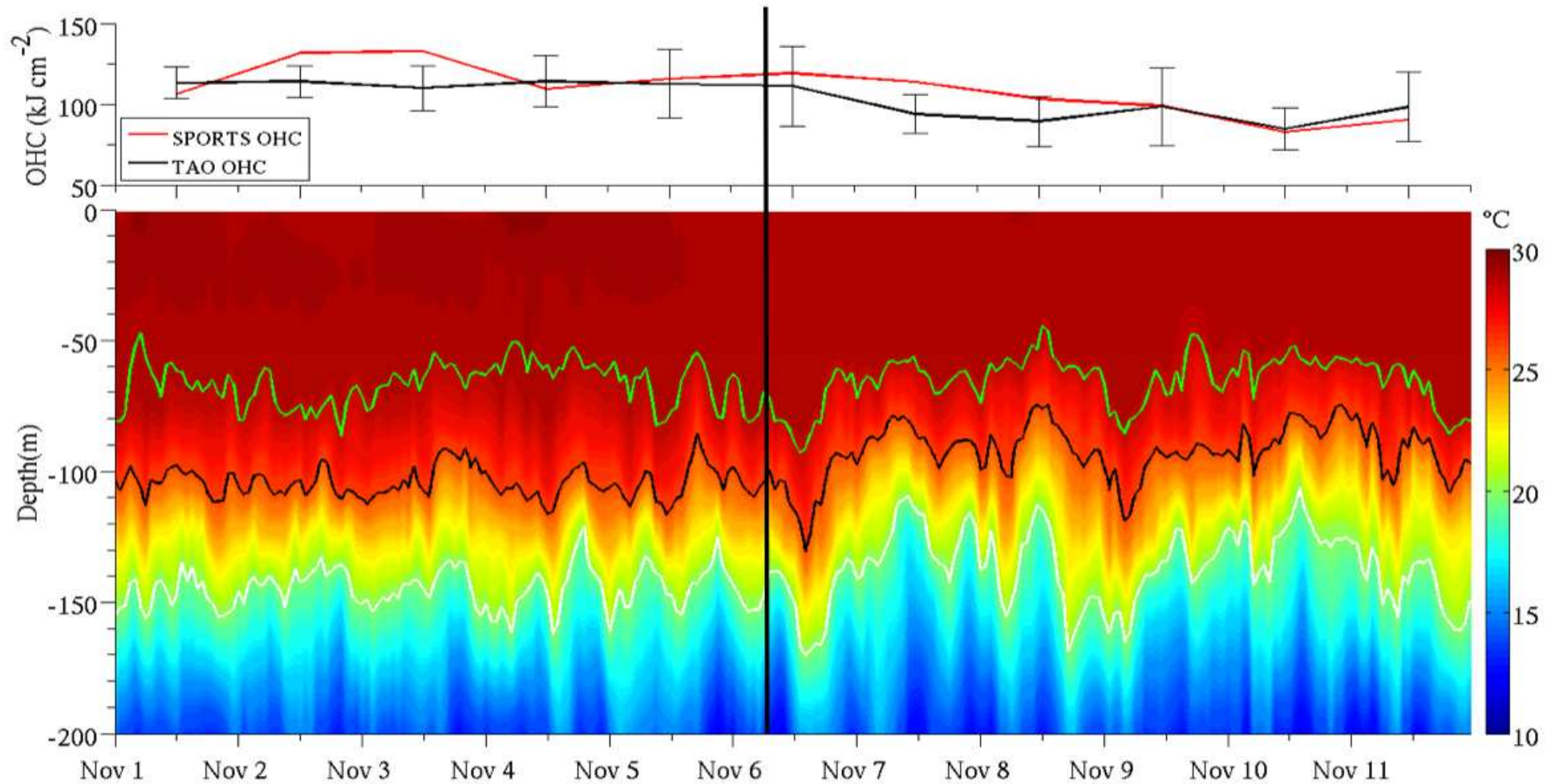
Impact of Oceanic Heat Content on the intensification of Super Typhoon Haiyan (Nov. 3-11, 2013)



State of Ocean Heat Content of Western Pacific during initiation of
Super Typhoon Haiyan
(includes SARAL/AltiKa sea surface height anomalies)

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Impact of Oceanic Heat Content on the intensification of Super Typhoon Haiyan (Nov. 3-11, 2013)



NOAA TAO mooring that measured $T(z)$ and $S(z)$ at hourly intervals
prior, during, and after Super Typhoon Haiyan

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Oceanic Heat Content Products

GLOBAL COVERAGE

- Remaining Basins :
 - **North Indian basin** (including the Bay of Bengal and the Arabian Sea)
 - **Southwest Indian basin** (from Africa to about 100E)
 - **Southeast Indian/Australian basin** (100E to 142E)

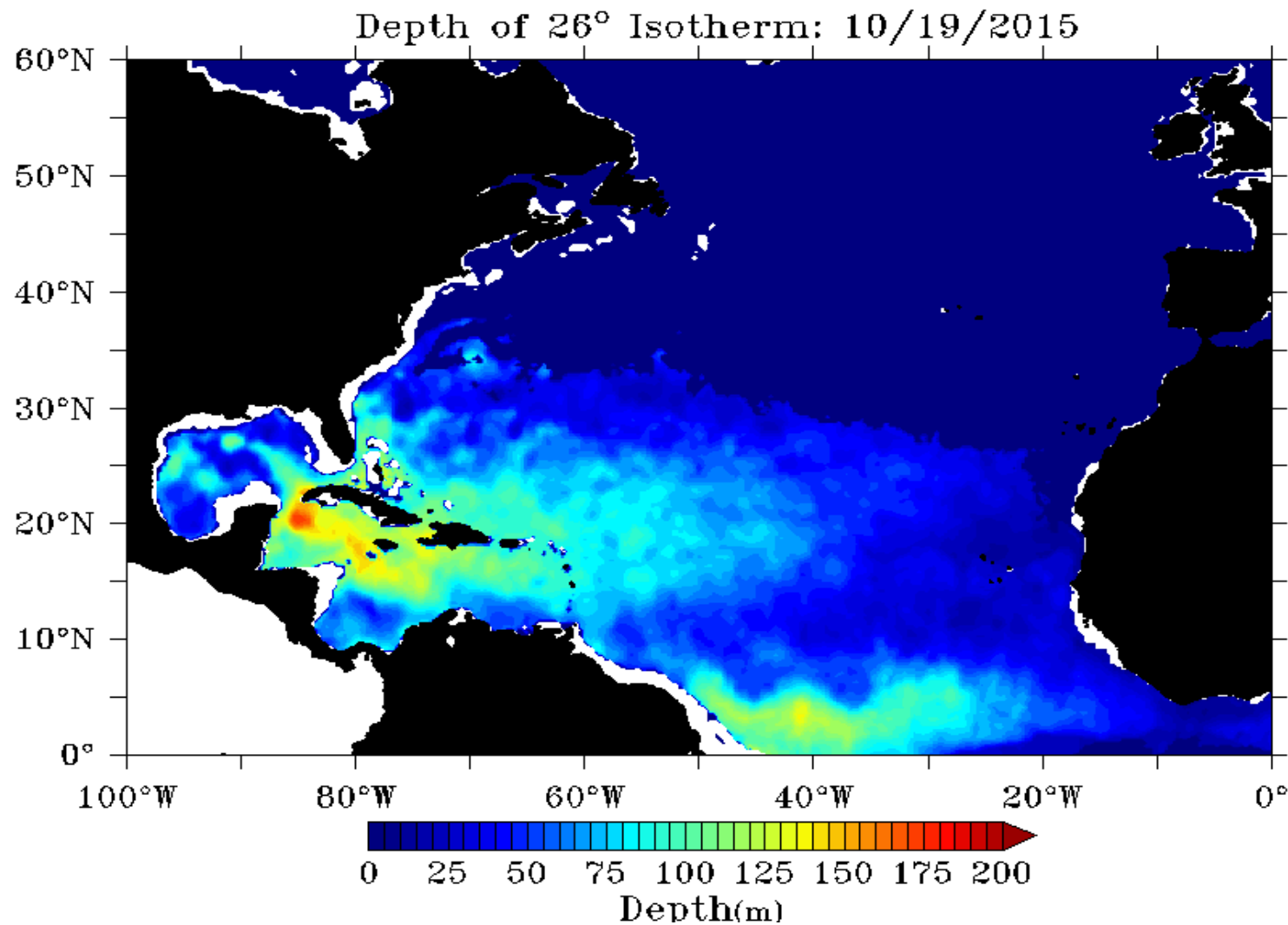
Ocean Heat Content Product

- NOAA Coral Reef Watch (CRW), which uses sea-surface temperature anomalies (SSTAs) to monitor the ocean conditions on coral reefs, will utilize the estimated isotherm depths to monitor temperature variations at depth.
- The National Hurricane Center (NHC) and the NWS Pacific Regional Office uses the operational OHC product to improve hurricane intensity forecasts and increase warning lead times for high impact events, which will reduce the loss of life and property.
- The Joint Typhoon Warning Center in Guam.

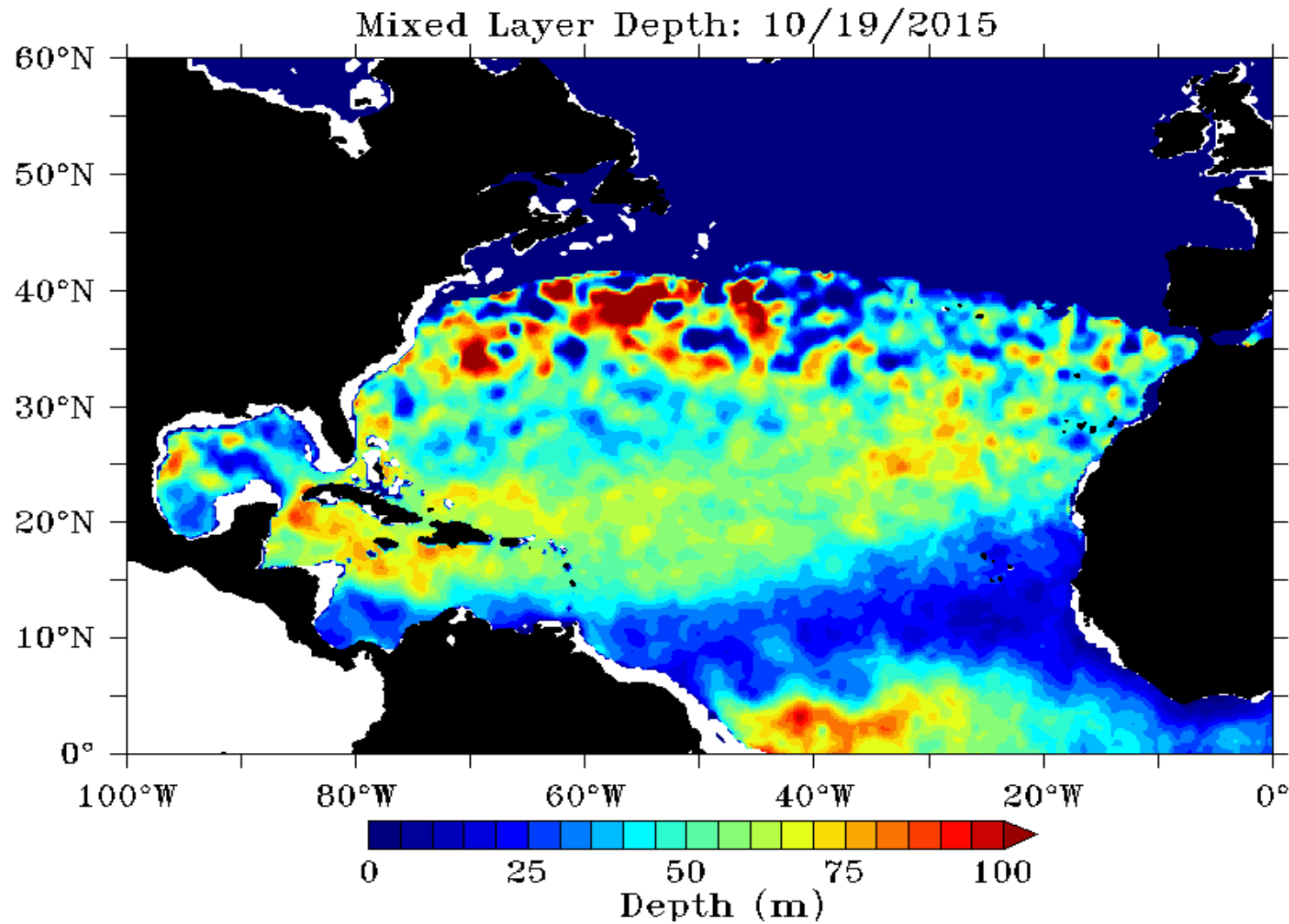


Backup slides

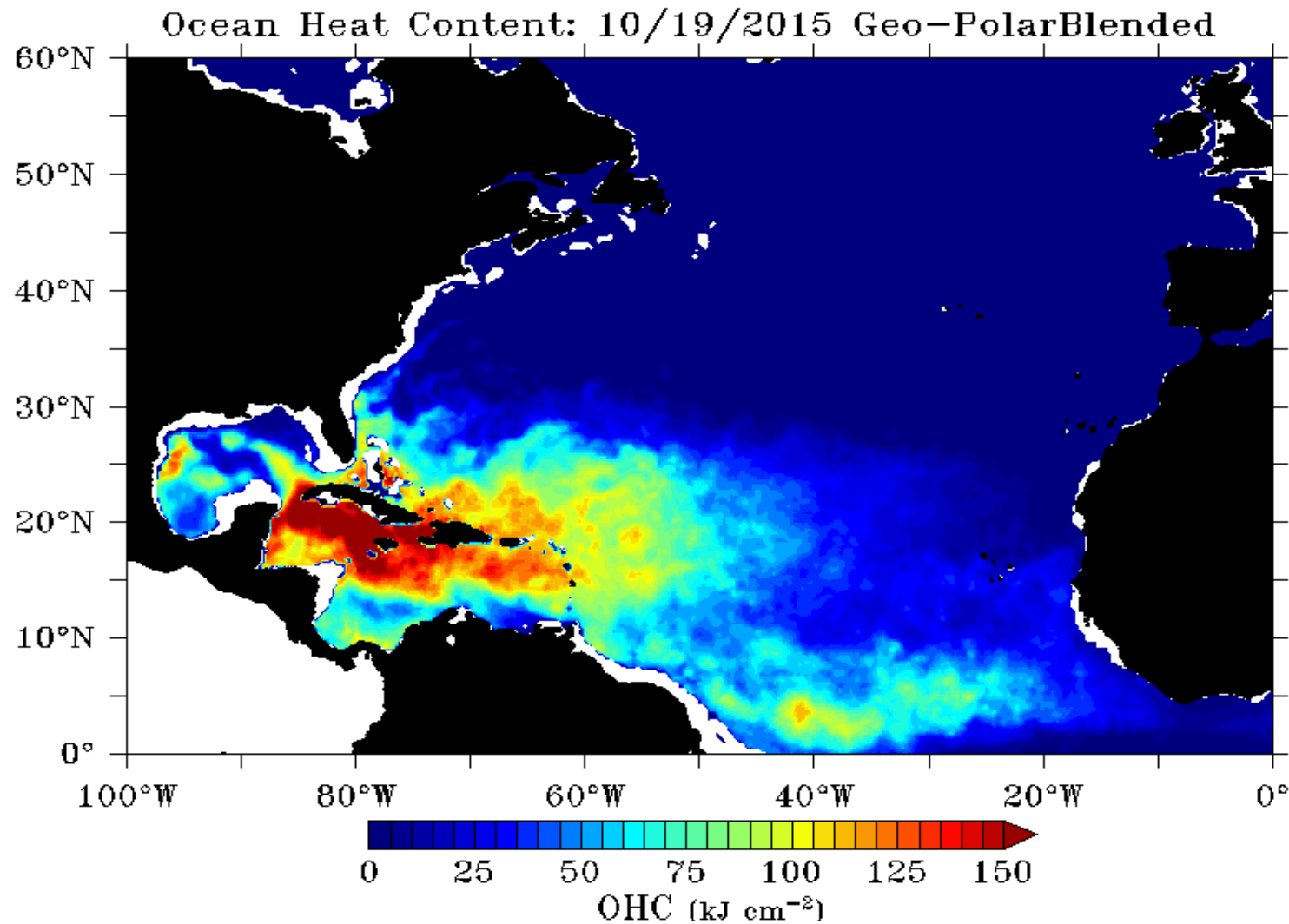
Depth of 26°C Isotherm



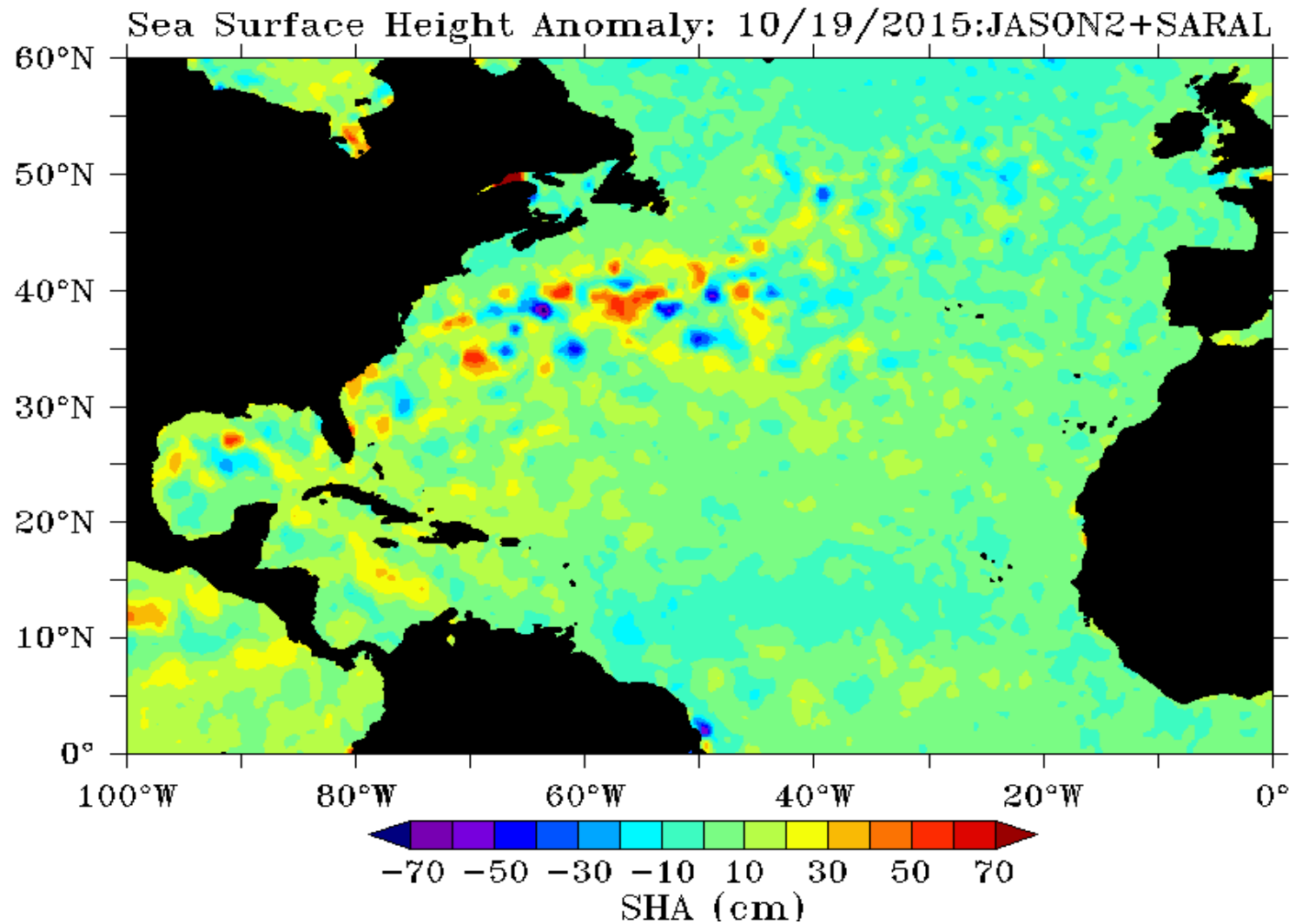
Mixed Layer Depth



Oceanic Heat Content



Sea Surface Height Anomaly



Sea Surface Temperature

