Status of 1/25° Global HYCOM Simulations

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Background

- The 1/25° HYCOM/NCODA/CICE system (~3.5 km mid-latitude resolution) is scheduled to replace the 1/12° GOFS 3.1 at the Naval Oceanographic Office in FY16
- Preliminary hindcast of 1/25° HYCOM/NCODA ran on Navy DSRC Cray XT5 (Einstein), but it is not currently running on the new Navy DSRC IBMs
  - Hindcast length: May 2010 through January 2012
- Development path of 1/25° non-assimilative model is somewhat lagged due to cost and time
  - HPC Grand Challenge project supplies computer resources
- Miscellaneous results from various 1/25° non-assimilative simulations are presented here along with a process study that focuses on the Labrador Sea

1/25° global HYCOM: GLBa0.04-04.0

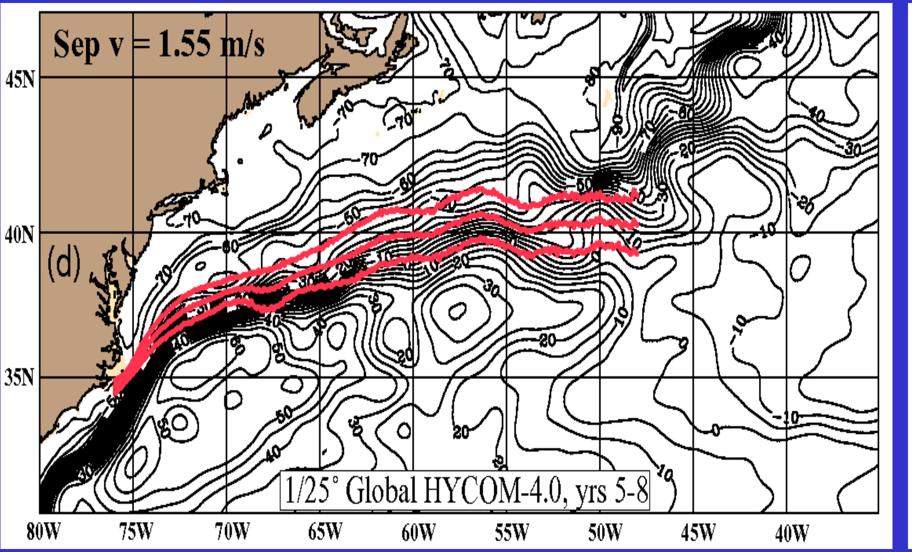
- Initialized from rest using T & S from GDEM 3.0
- Spun-up for 10 years with ERA40 climatology
- Topography from a modified version of NRL DBDB2
  - 5 m isobath as land-sea boundary
- Built-in energy loan (thermodynamic) sea ice model
- 32 layers, non-assimilative, no tidal forcing
- Relax SSS toward the Polar Science Center climatology

1/25° global HYCOM: GLBa0.04-04.1/04.2

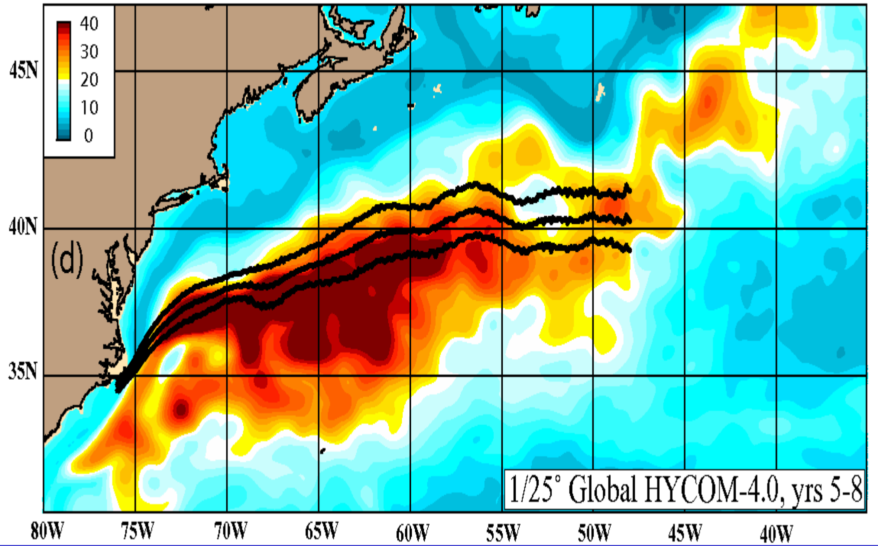
- Initialized from GLBa0.04-04.0
- Interannual 0.5° NOGAPS forcing: 2003-2010
- Long-term NOGAPS wind stress mean was replaced by ERA40 mean for consistency on the large scale

GLBa0.04 simulations often produce a realistic and robust Gulf Stream

SSH mean over years 5-8



SSH variability over years 5-8

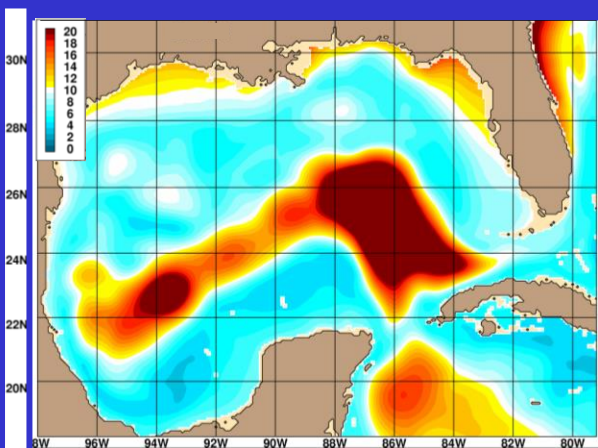


Figures 11 & 12 from Hurlburt et al. (2011, Operational Oceanography)

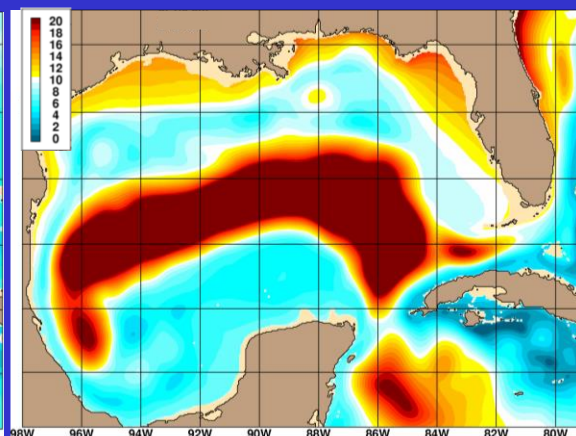
This was the best-to-date representation of the Gulf Stream from non-assimilative HYCOM; Kuroshio looked equally good

Impact of Increasing Horizontal Resolution on RMS SSH Variability in the Gulf of Mexico Region

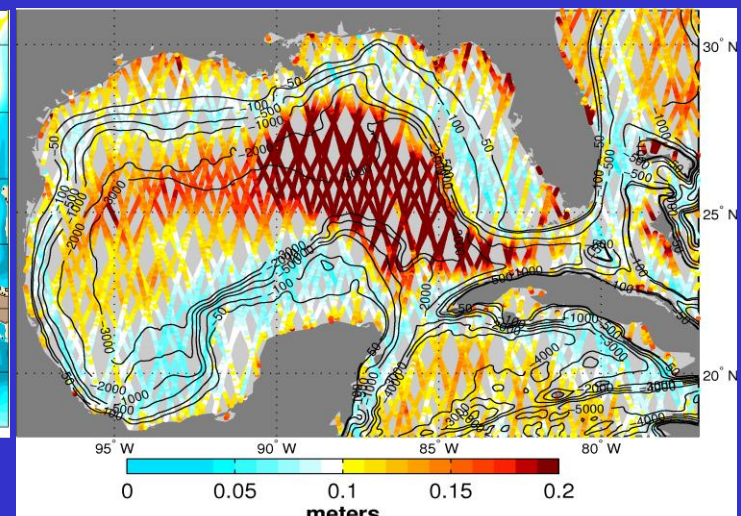
1/12° Global HYCOM



1/25° Global HYCOM



From satellite altimeter data



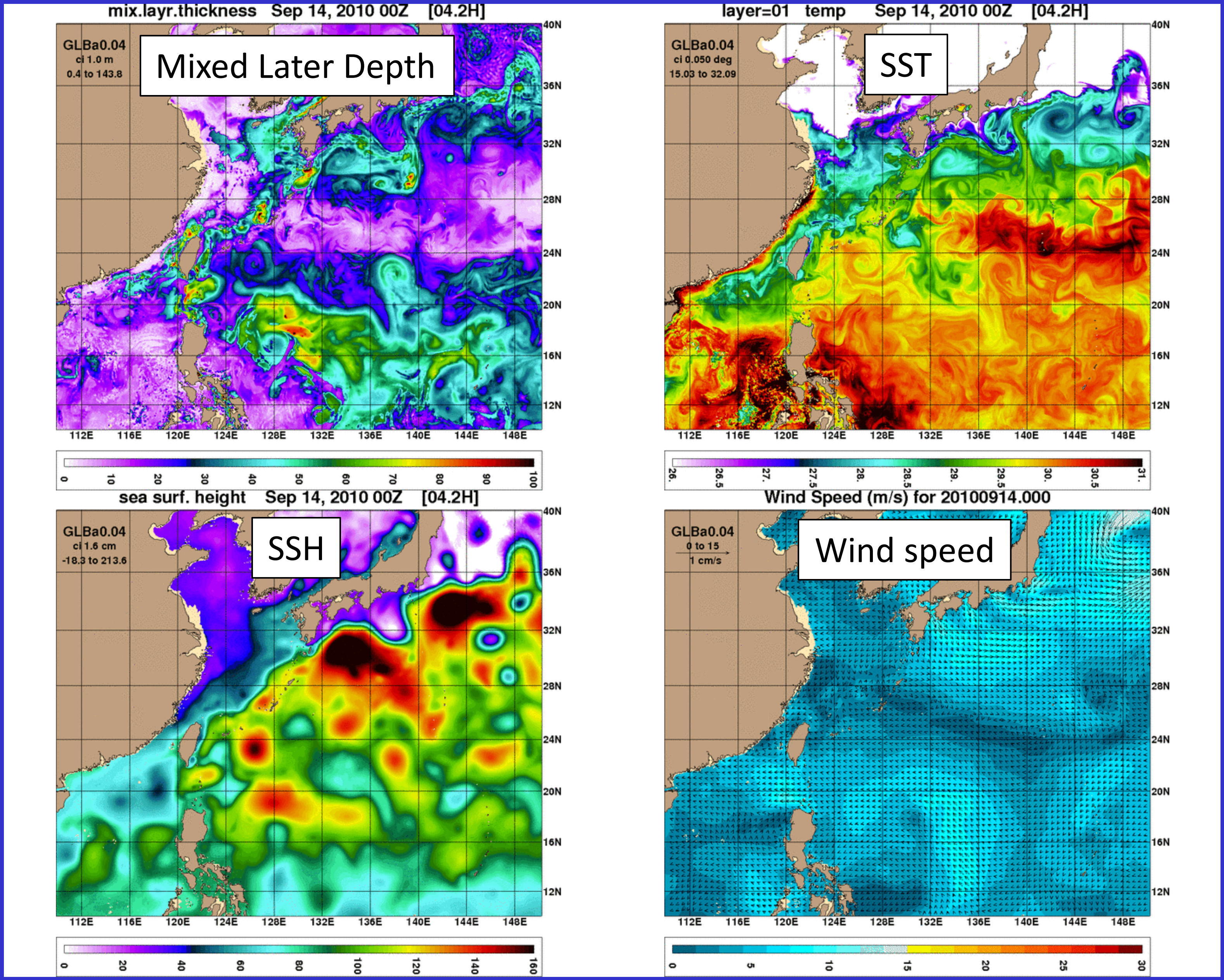
– Core of high variability is farther north at 1/25° in western Gulf

– Higher variability extends farther to the west at 1/25°

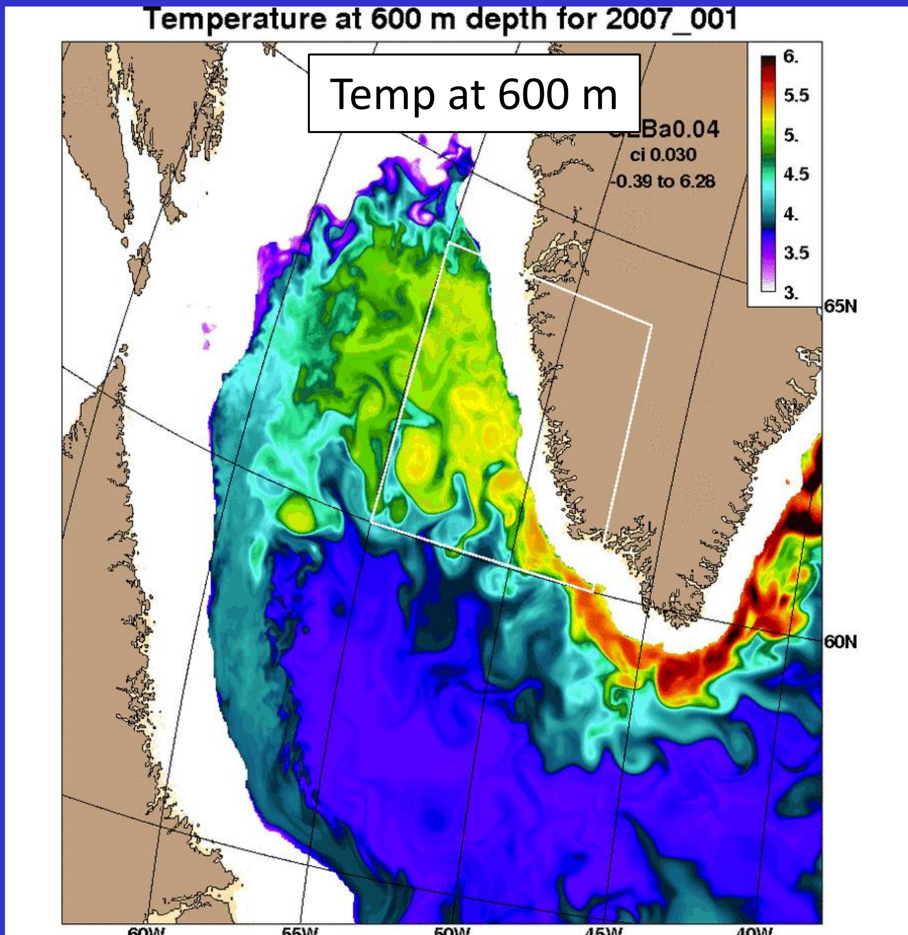
Response to Tropical Storms

- ONR sponsor S. Harper asked us to investigate the upper ocean response to tropical storms as part of the Impact of Typhoons on the Ocean in the Pacific (ITOP) project – what is the response in existing global models?
- See an upper ocean response in 1/25° HYCOM but it is muted because of the weaker than observed atmospheric signal in 0.5° NOGAPS
  - Typhoon Fanapi had Category 3 winds but only Tropical Storm force winds in NOGAPS
- Anticipate NAVGEM to perform better if distributed on 0.33° grid
  - OPTEST showed improved tropical cyclone statistics

Upper Ocean Response to Typhoon Fanapi: Sept 2010



Impact of Irminger Ring Generation on the Labrador Sea Deep Convection

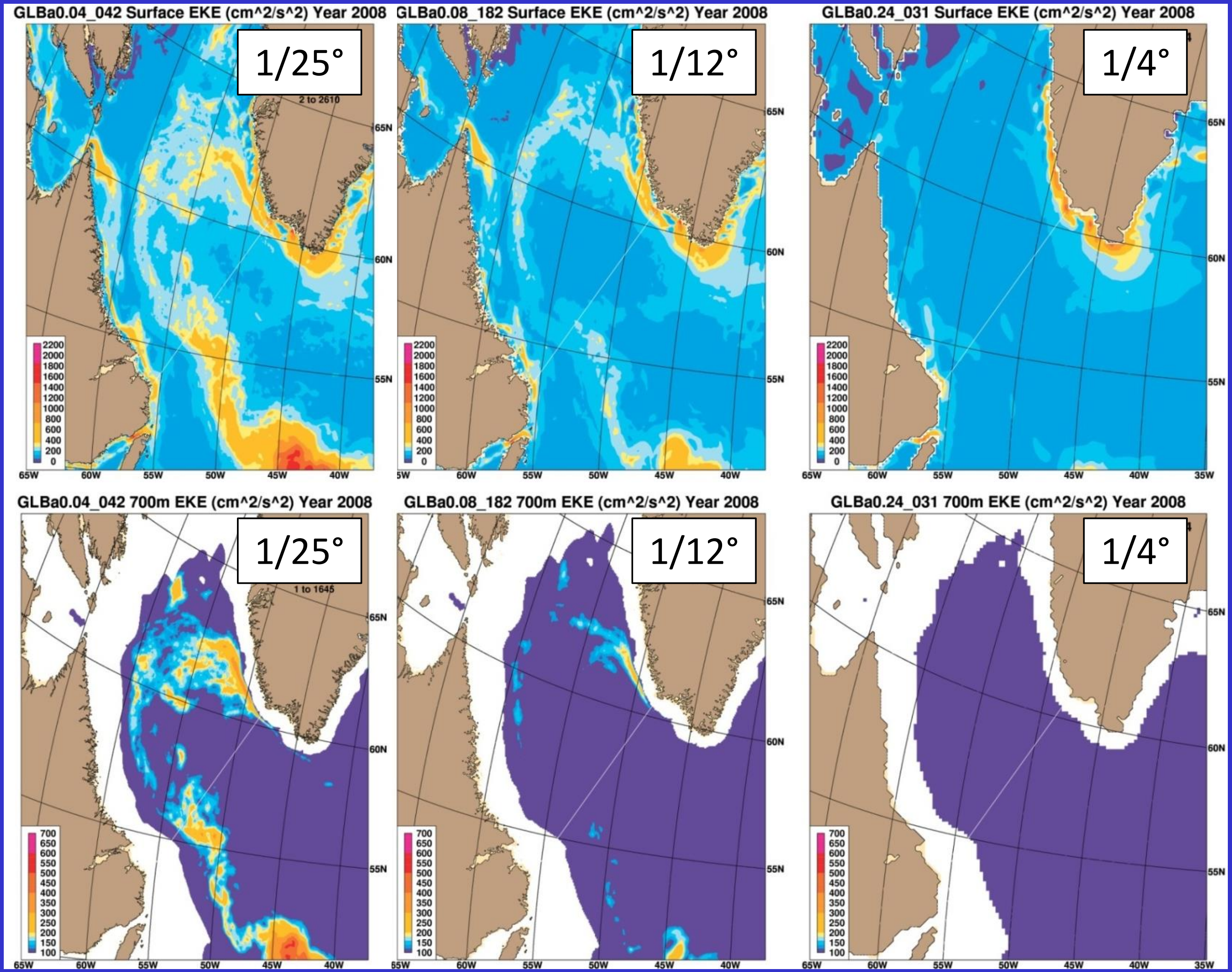


- Fan et al. (2013, JPO):
  - Irminger Rings transport buoyant fresh and warm water to Labrador Sea providing resistance to deep convection
  - Formed off west coast of Greenland where topographic slope changes
  - Diameters range from 15-70 km
  - Significant barotropic component to these eddies

Impact of Increasing Horizontal Resolution on EKE

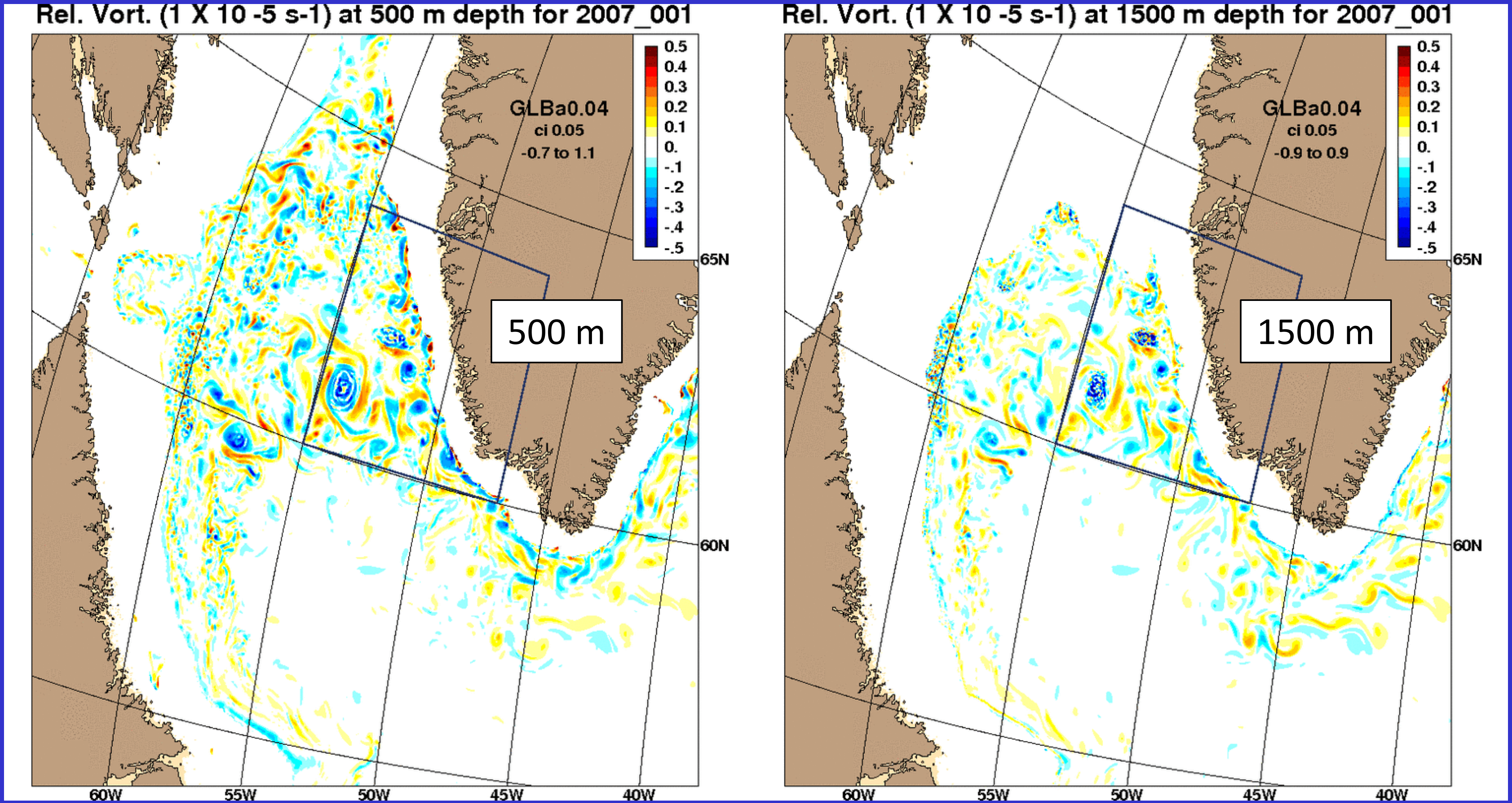
2008 mean: EKE 0 m

EKE 700 m



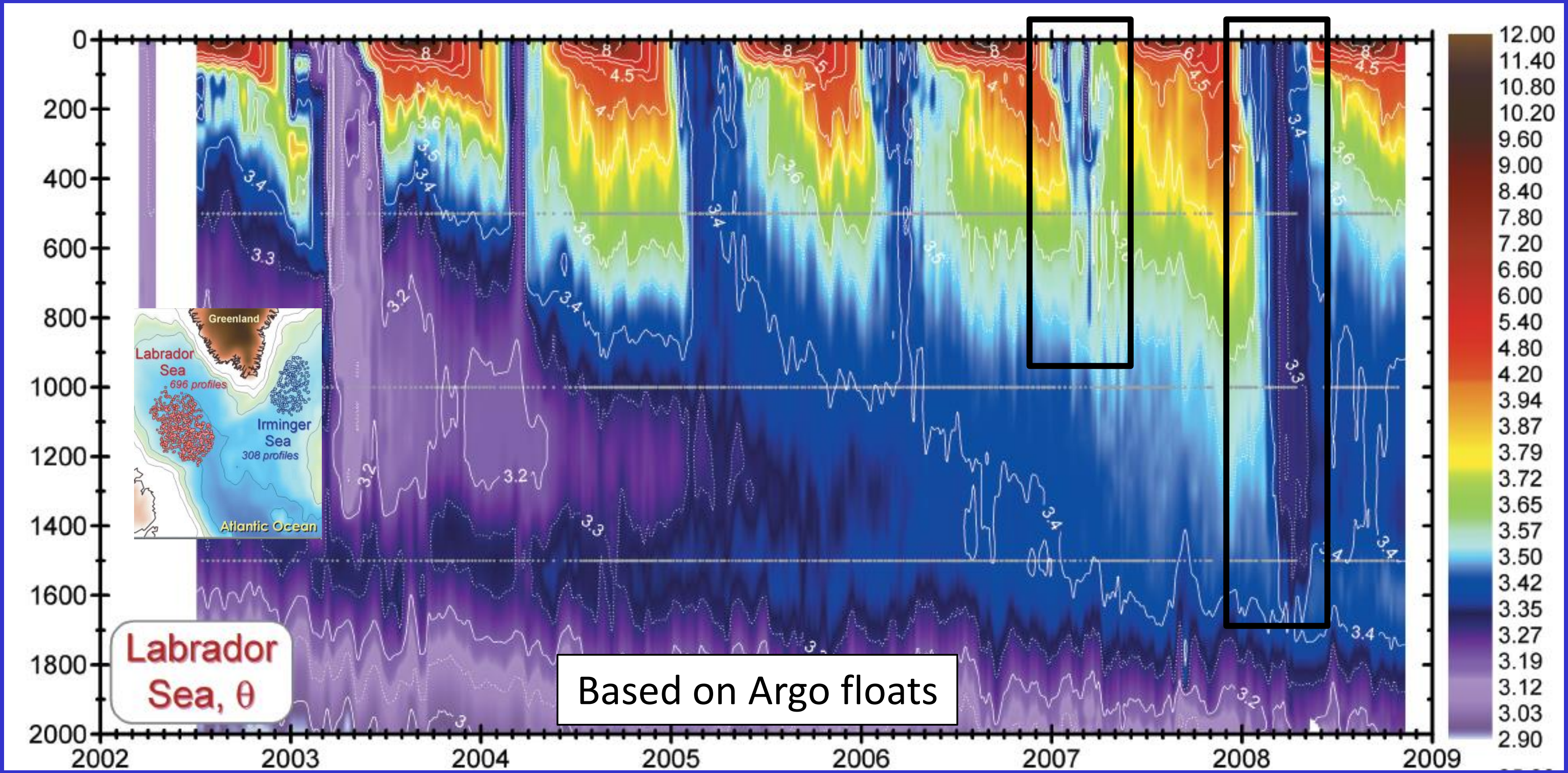
Better representation of Irminger Rings in 1/25° HYCOM

Strong Barotropic Component of Simulated Irminger Rings



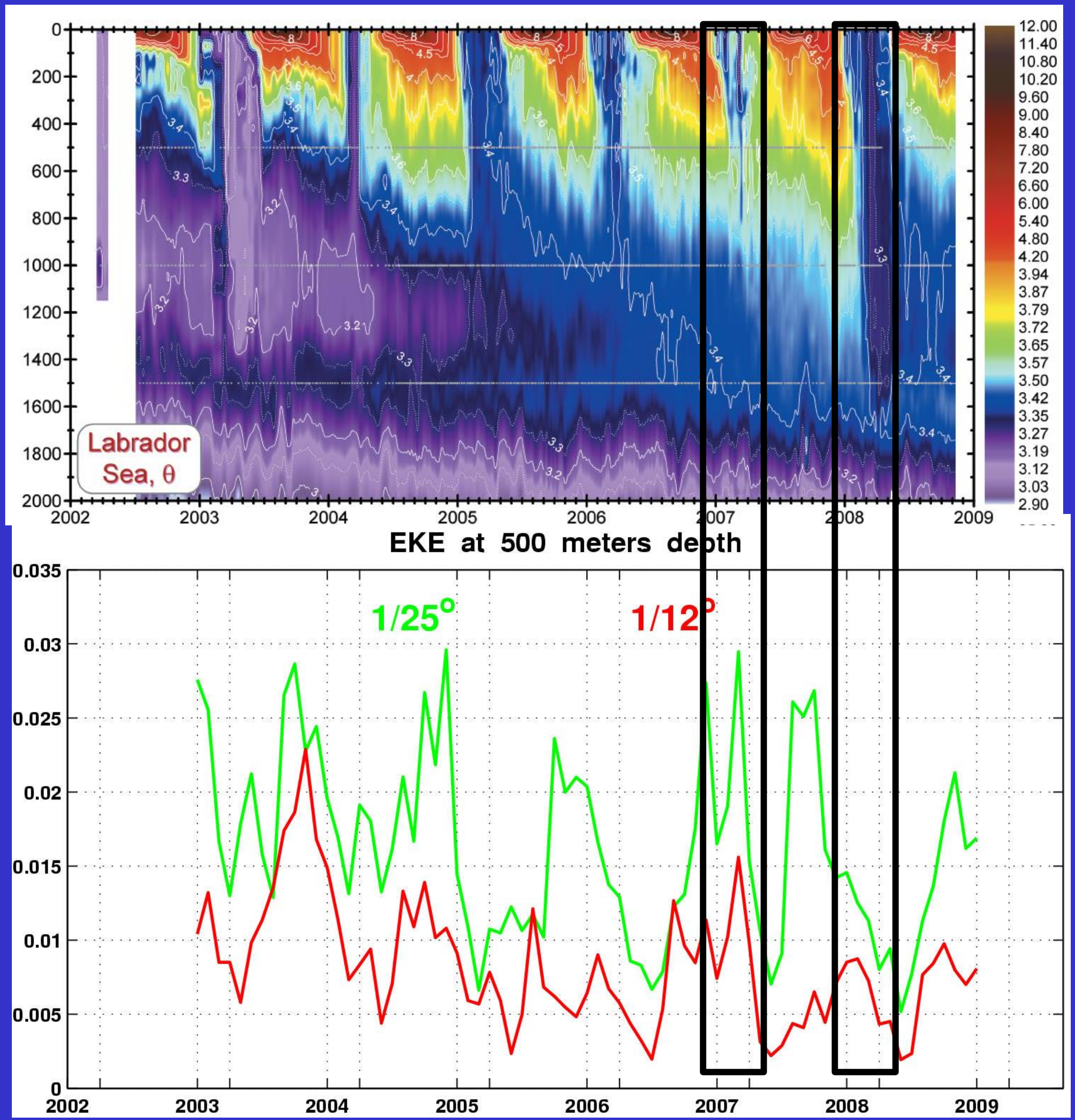
Significant relative vorticity signature of Irminger Rings even at 1500 m

Significant Difference in Labrador Sea Deep Convection in 2007 and 2008



The observations of Yashayaev and Loder (2009, GRL) show shallow (deep) Labrador Sea mixed layer during the 2007 (2008) winter season. That is primarily due to weak (strong) wind events (heat loss from the ocean to the atmosphere) during the 2007 (2008) winter season and a secondary hypothesis is an increase (decrease) in the generation of Irminger Rings during the 2007 (2008) winter season.

The EKE Time Series Supports the Secondary Hypothesis of Irminger Rings Impacting Winter Deep Convection



EKE at 500 m in eddy generation region

1/25° global HYCOM: GLBb0.04-01.2

- Initialized from GLBa0.04-04.0
- Spun-up for 9 years with ERA40 climatology
- Topography from a modified version of GEBCO
  - 10 cm isobath as land-sea boundary

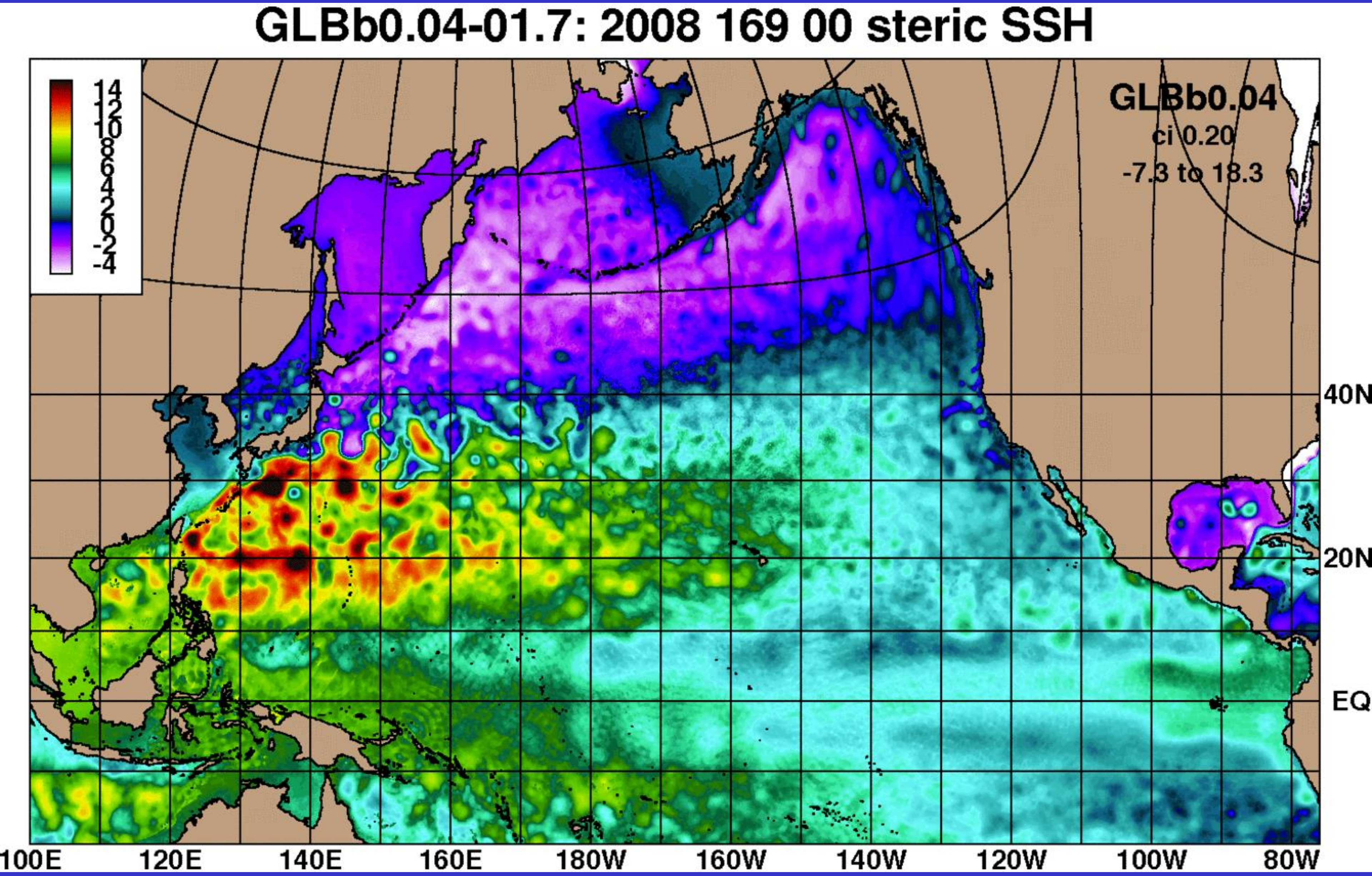
1/25° global HYCOM: GLBb0.04-01.5

- Initialized from GLBb0.04-01.2
- Interannual 0.5° NOGAPS forcing: Jan 2007 – Dec 2011
- No tidal forcing

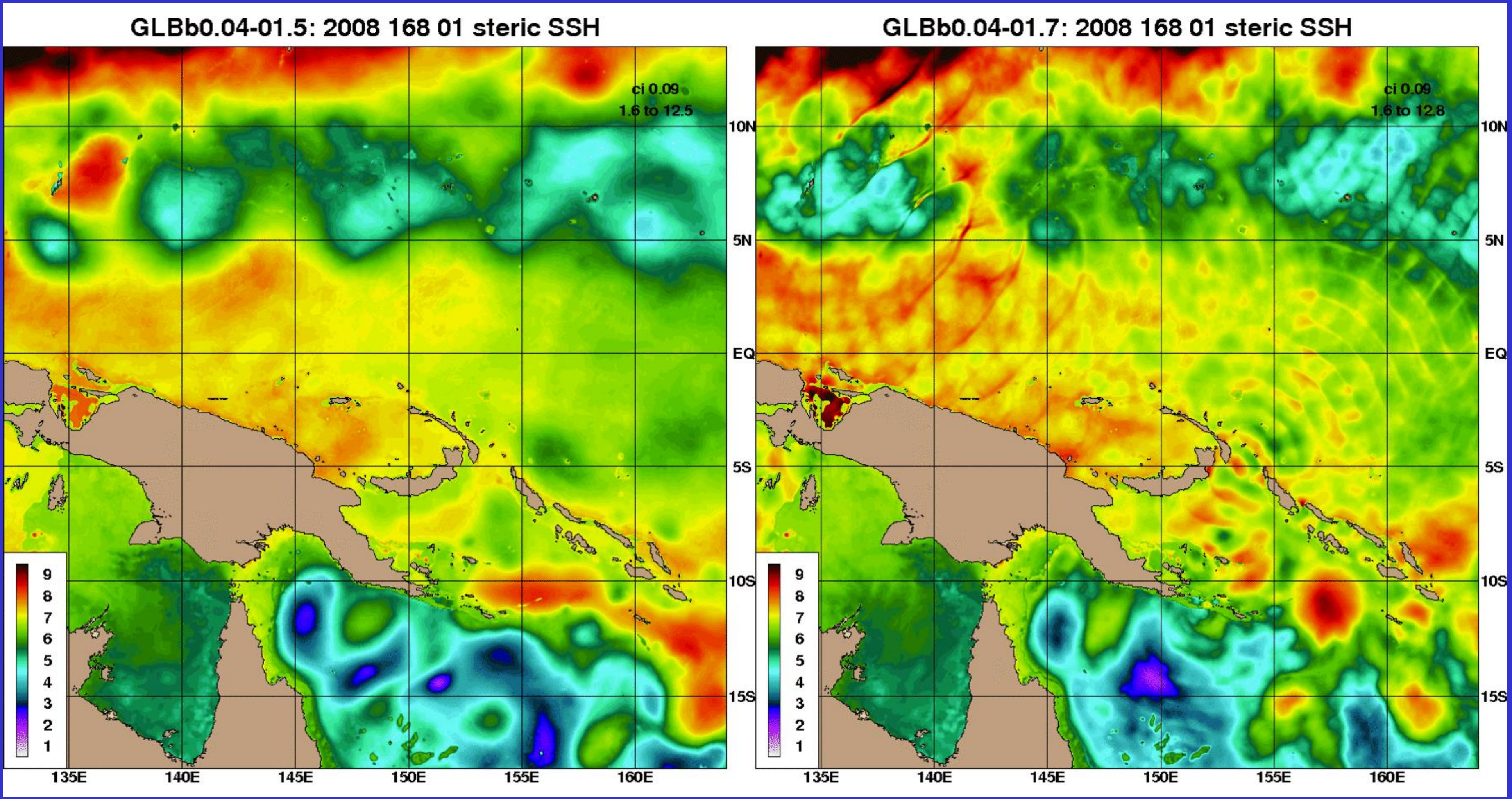
1/25° global HYCOM: GLBb0.04-01.7

- Initialized from GLBb0.04-01.5
- Interannual 0.5° NOGAPS forcing: Jul 2007 – Jan 2011
- Tidal forcing

1-hourly Steric SSH



Internal Tidal Signature Seen in Steric Sea Surface Height



No Tides

Tides