COMPARISON OF THE 1/25° ASSIMILATED HYCOM TO OBSERVATIONS IN THE LOOP CURRENT

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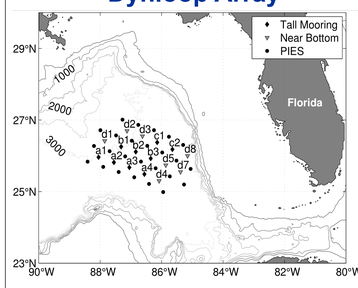
Introduction

Dynloop Array



Motivation: Observational window is limited in time and space, HYCOM provides a mechanism for further dynamical analysis.

- What are the pathways of deep energy generated under the Loop Current?
- What are the trigger mechanisms for Loop Current meanders that lead to Loop Current Eddy separations?

Goal: Assess HYCOM's simulation of Gulf of Mexico circulation using observations from the Dynloop experiment.

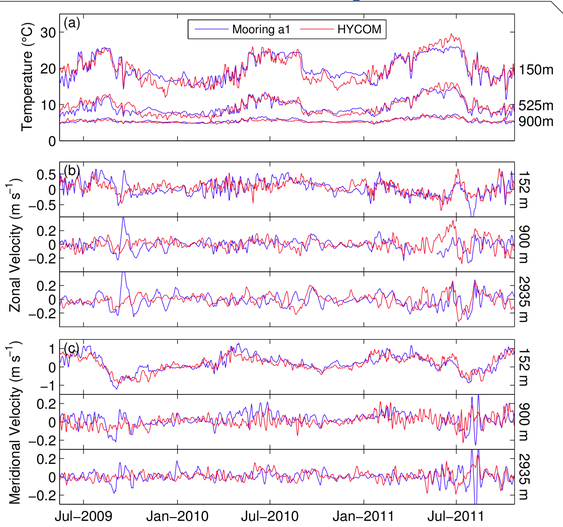
DynLoop Array

- Placed in Loop Current Eddy formation region
- Provided full water-column measurements
- 9 tall and 7 near-bottom moorings, 25 PIES

Model:

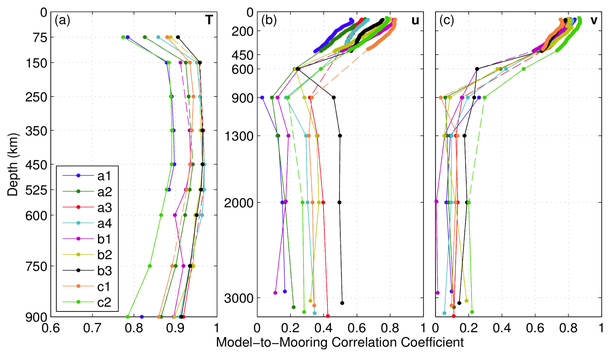
- 1/25° Gulf of Mexico HYbrid Coordinate Ocean Model
  - (I0.04, 31.0)
- ~3.5 km latitudinal resolution
- Assimilates satellite SSH and SST

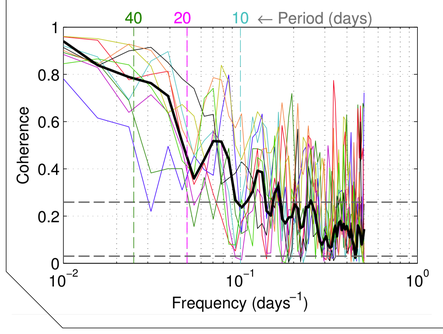
Time Series Comparisons



(Above) Model-to-mooring comparison at a1 shows decreasing correlation with depth. This trend was evident in all tall-mooring comparisons.

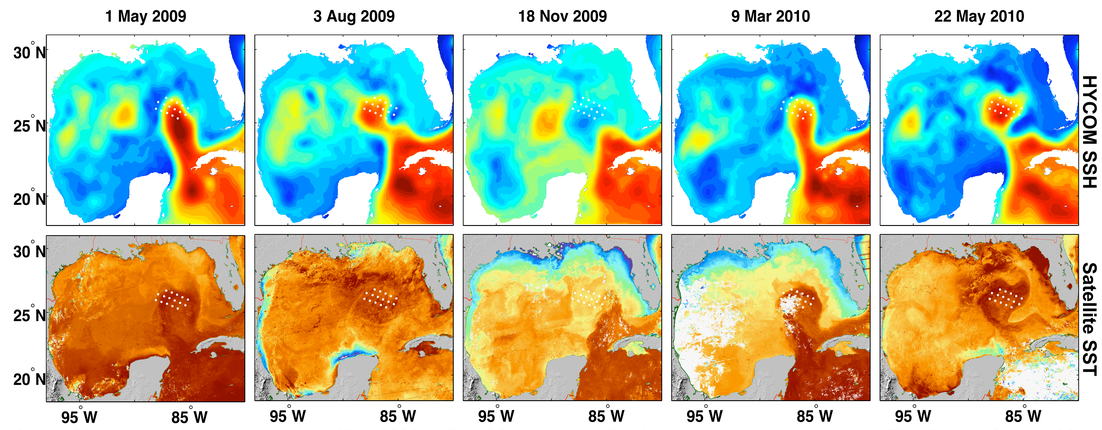
(Below) Array-averaged model-to-mooring correlations in the thermocline are 0.94, 0.52, and 0.65 for (a) temperature, (b) zonal, and (c) meridional velocity, respectively.





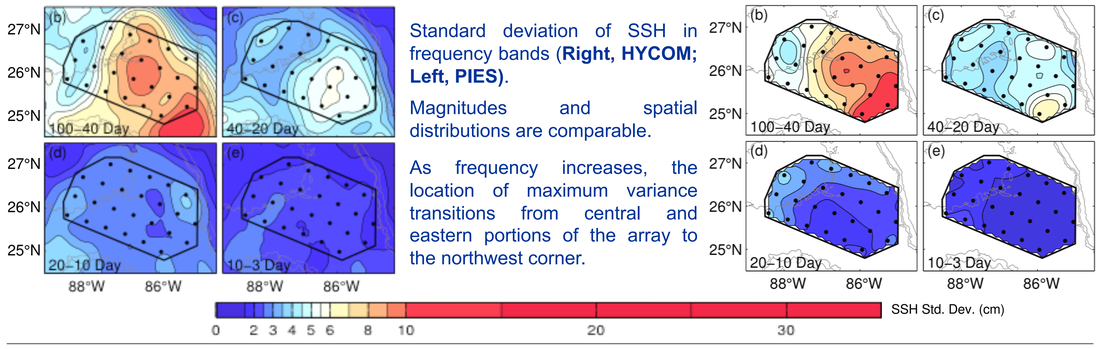
(Left) Model-mooring 150m temperature coherence falls-off around 1/20 days^{-1}, the Nyquist frequency of Jason-1,2 and TOPEX altimeters.

Spatial Comparisons



In the 30 months of data acquisition (May 2009 – Oct. 2011), three LC eddies formed and separated. The August 3rd and May 22nd panels show the formation of LC Eddies Ekman and Franklin, respectively. Mooring locations indicated by white dots.

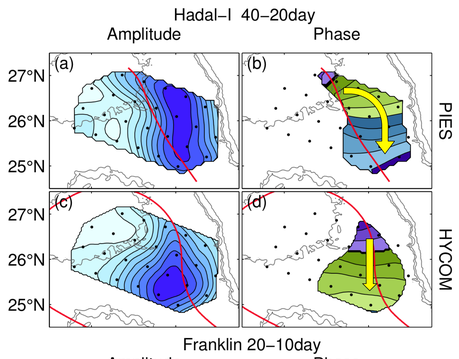
Satellite SST Images: Johns Hopkins Univ. Ocean Remote Sensing Group



Standard deviation of SSH in frequency bands (**Right, HYCOM; Left, PIES**).

Magnitudes and spatial distributions are comparable.

As frequency increases, the location of maximum variance transitions from central and eastern portions of the array to the northwest corner.



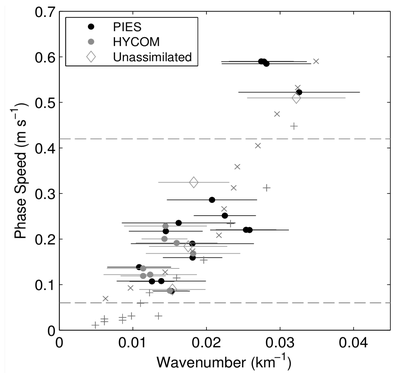
To determine the amplitude and phase propagation of SSH variability CEOFs were calculated for four time intervals (Ekman, Franklin, Hadal-1, Hadal-II) for the four frequency bands.

(Top Left) SSH CEOF comparisons show similar amplitude, phase, and propagation direction for the Hadal-I interval (1 Mar. to 1 Aug. 2011) in the 40—20 day band between PIES and HYCOM.

(Bottom Left) PIES show a clockwise propagation pattern, but HYCOM is difficult to interpret for the Franklin interval (1 Feb. to 1 Sep. 2010) in the 20—10 day band.

Phase speeds were estimated from the spatial gradient of the CEOF phases

$$c_p = \frac{2\pi f_{central}}{\nabla \phi_{ceof}}$$



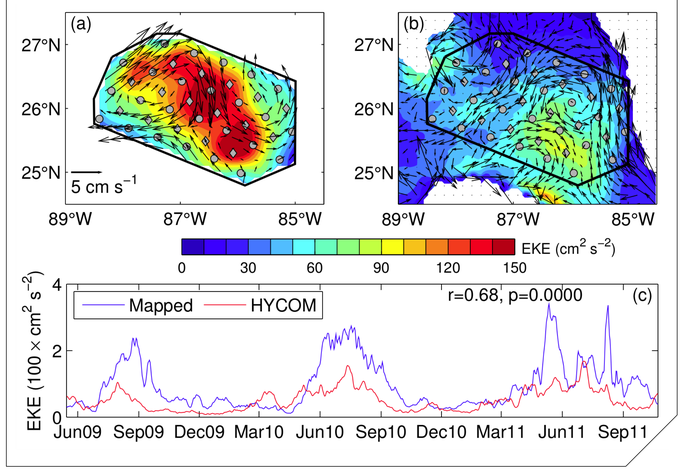
(Above) Phase speeds agree well between PIES and HYCOM for 100—20 day bands. Estimates from HYCOM 20—3 day bands were not realistic. Phase speeds from an identical, but *unassimilated,* model compare well with PIES. Both fall in the range for Gulf Stream meanders estimated by Kontoyiannis & Watts (1994) and Lee & Cornillon (1996).

Conclusions

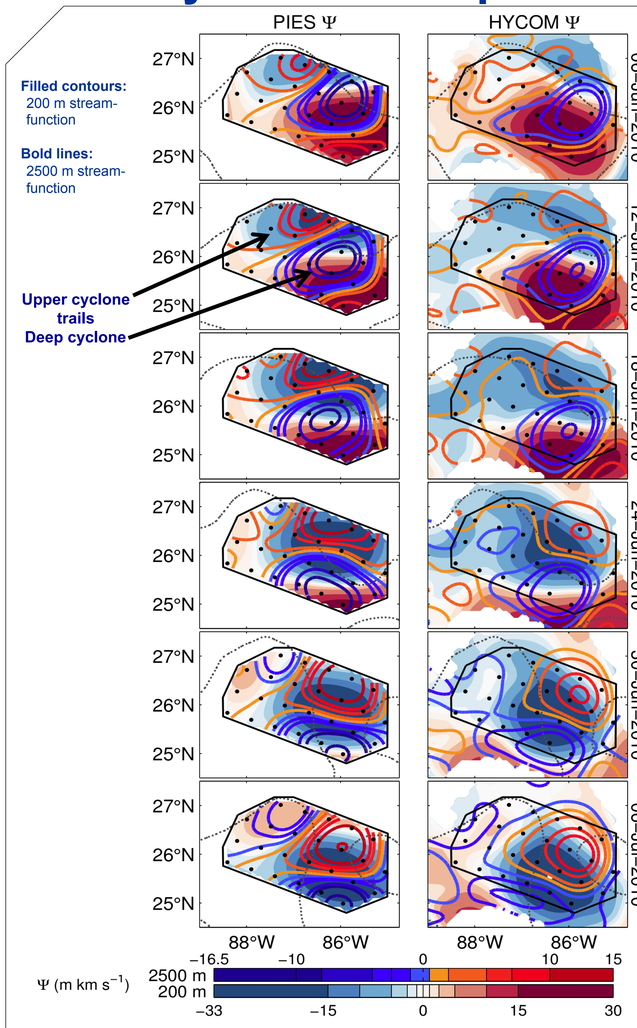
- **Moderate to high array-averaged correlations in the thermocline: T: 0.94, u: 0.52, v: 0.65.**
- **Coherence between model and observations notably decreases for frequencies higher than the altimeter Nyquist frequency (1/20 days^{-1}; Jason-1/2 & TOPEX).**
- **Model simulates Loop Current Frontal Eddy characteristics (amplitude, spatial pattern, phase speed, wavenumber) in the 100—40 and 40—20 day bands.**
- **Both model and observed deep EKE increase during Loop Current Eddy separation, although modeled deep EKE is about half that observed.**
- **Within the 100—40 day band, the model reproduces patterns indicative of baroclinic instability – a vertical offset between upper and deep streamfunctions.**

Deep EKE

Spatial EKE patterns match only in the southeastern portion of the array, but array-averaged EKE time series show a correlation of 0.68, and peak together. HYCOM EKE is approximately half that of observations.



Eddy Franklin Separation



Observations show an increase in deep EKE during Loop Current Eddy formation. Deep eddies develop with signature vertical phase tilts between upper and deep, characteristic of baroclinic instability. This pattern was observed in both HYCOM and PIES 100—40 day streamfunctions.

Acknowledgements

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References:

Kontoyiannis, H., Watts, D.R., 1994. Observations on the variability of the gulf stream path between 74W and 70W. J. Phys. Oceanogr. 24, 1999-2013.

Lee, T., Cornillon, P., 1996. Propagation and growth of gulf stream meanders between 75 and 45W. J. Phys. Oceanogr. 26, 255-241.