A High-Resolution 3D Hypoxia Model (GEM3D) for the Louisiana Shelf

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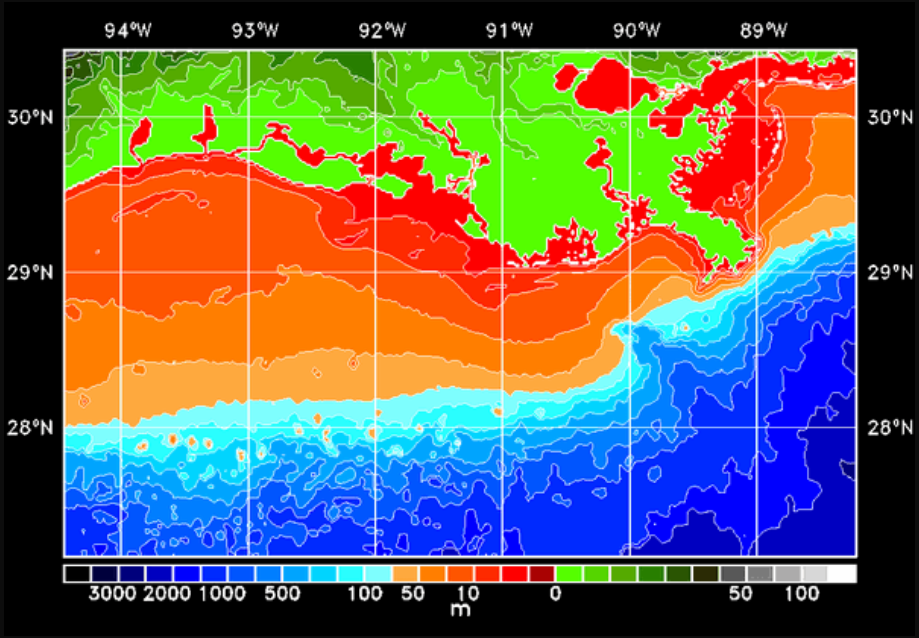
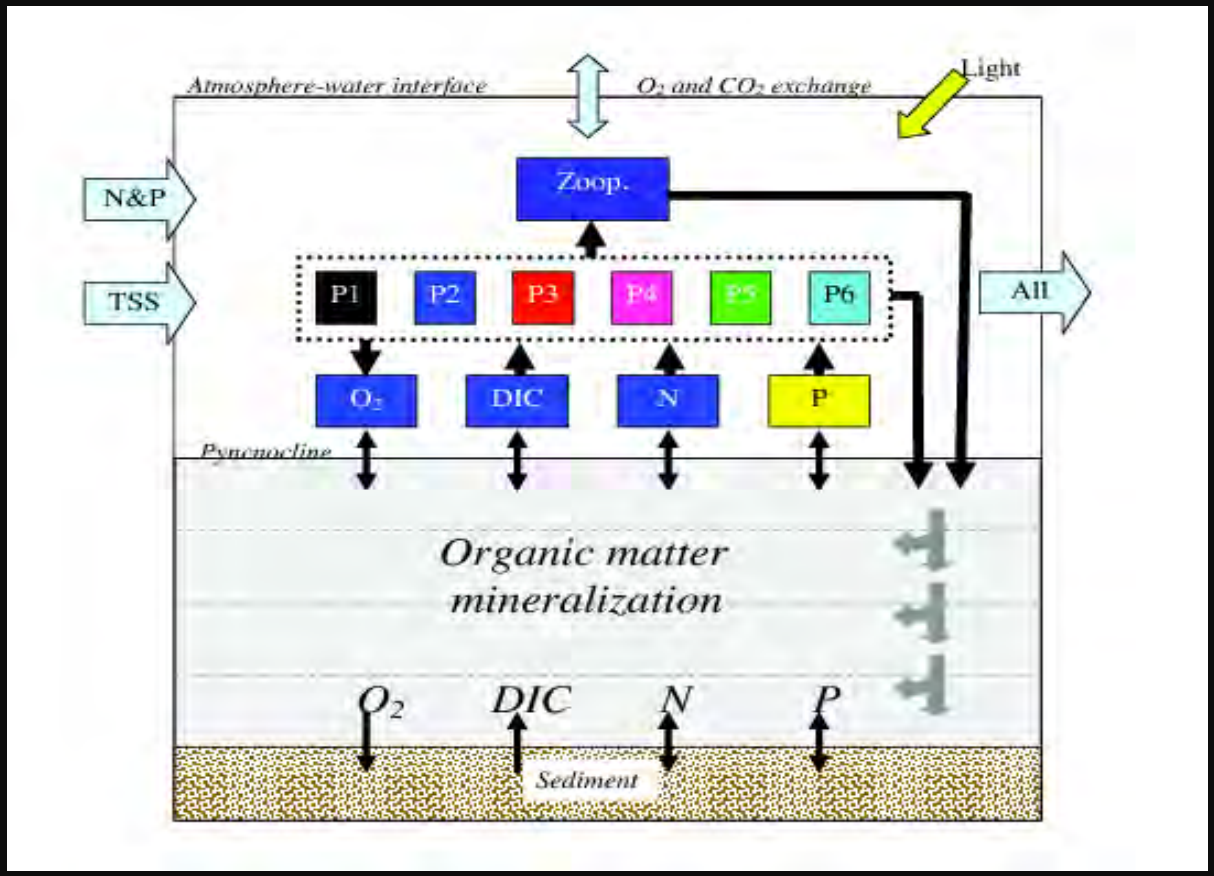


Forum for Gulf of Mexico Hypoxia Research Coordination and Advancement
17-18 April 2013, Stennis Space Center, Mississippi

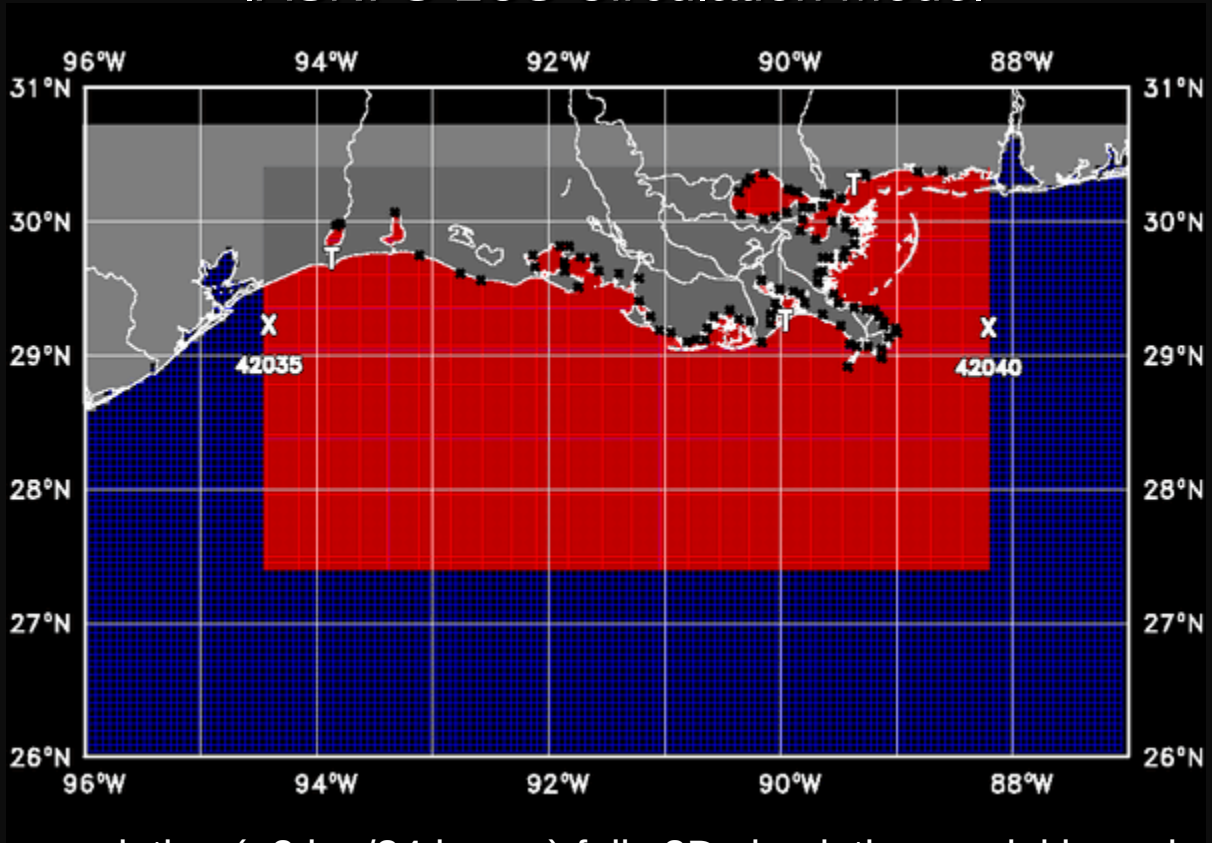
EPA General Environment Model (GEM)

Peter M. Eldridge and Daniel L. Roelke (2010, *Ecological Modeling*)



- Consists of a plankton food web model that has 6 phytoplankton groups and 1 zooplankton group
- A multi-element diagenetic model that traces oxygen, nitrogen, phosphate, carbon and various organic matters with exchange of O_2 and CO_2 at surface

IASNFS-LCS Circulation Model



- A fine resolution (~2 km/34 layers) fully 3D circulation model based on NCOM
- Nested in the Intra-Americas Sea Nowcast/Forecast System (IASNFS)
- 95 Rivers with real-time runoff

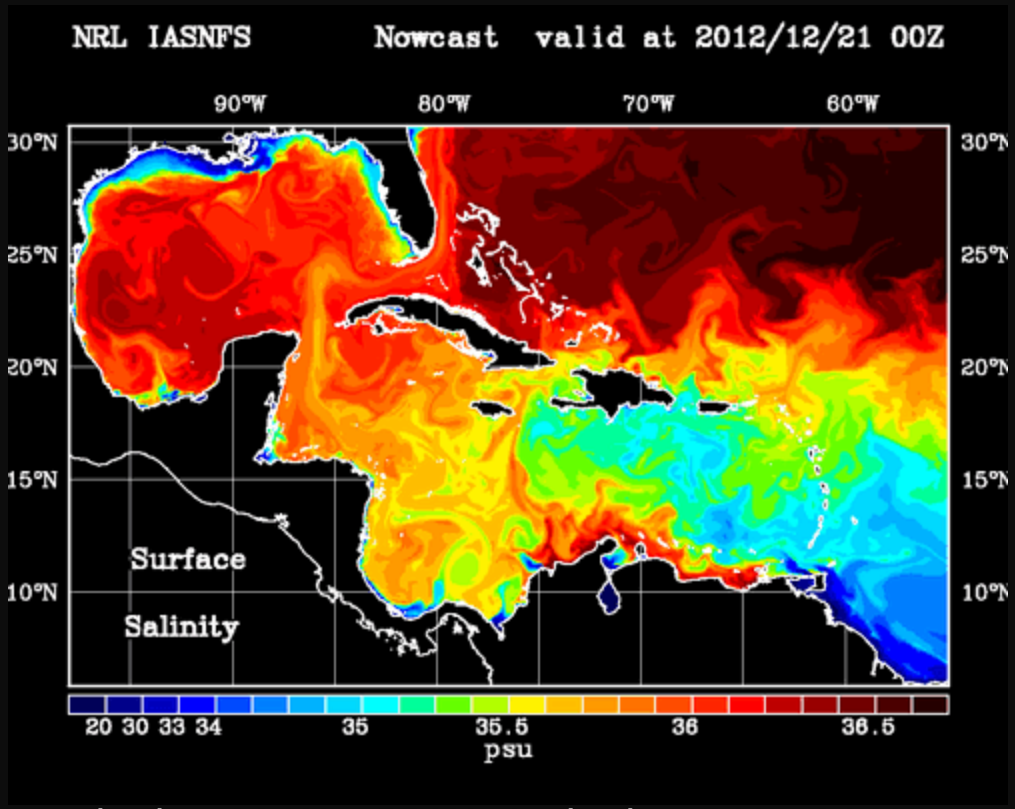
Ko, D.S., R.H. Preller, and P.J. Martin, 2003: An Experimental Real-Time Intra Americas Sea Ocean Nowcast/Forecast System for Coastal Prediction, *Proceedings*, AMS 5th Conference on Coastal Atmospheric & Oceanic Prediction & Processes, 97-100.

Ko, D.S., P.J. Martin, C.D. Rowley, and R.H. Preller, 2008: A real-time coastal ocean prediction experiment for MREA04, *J. Marine Systems*, 69, 17-28, doi:10.1016/j.jmarsys.2007.02.022.

Lehrter J.C. , D.S. Ko, M.C. Murrell, R.M. Greene, J.D. Hagy, B.A. Schaeffer, R.W. Gould, B. Penta, 2013: Nutrient transports and source/sink dynamics on the inner Louisiana continental shelf, *J. Geophy. Res*., submitted.

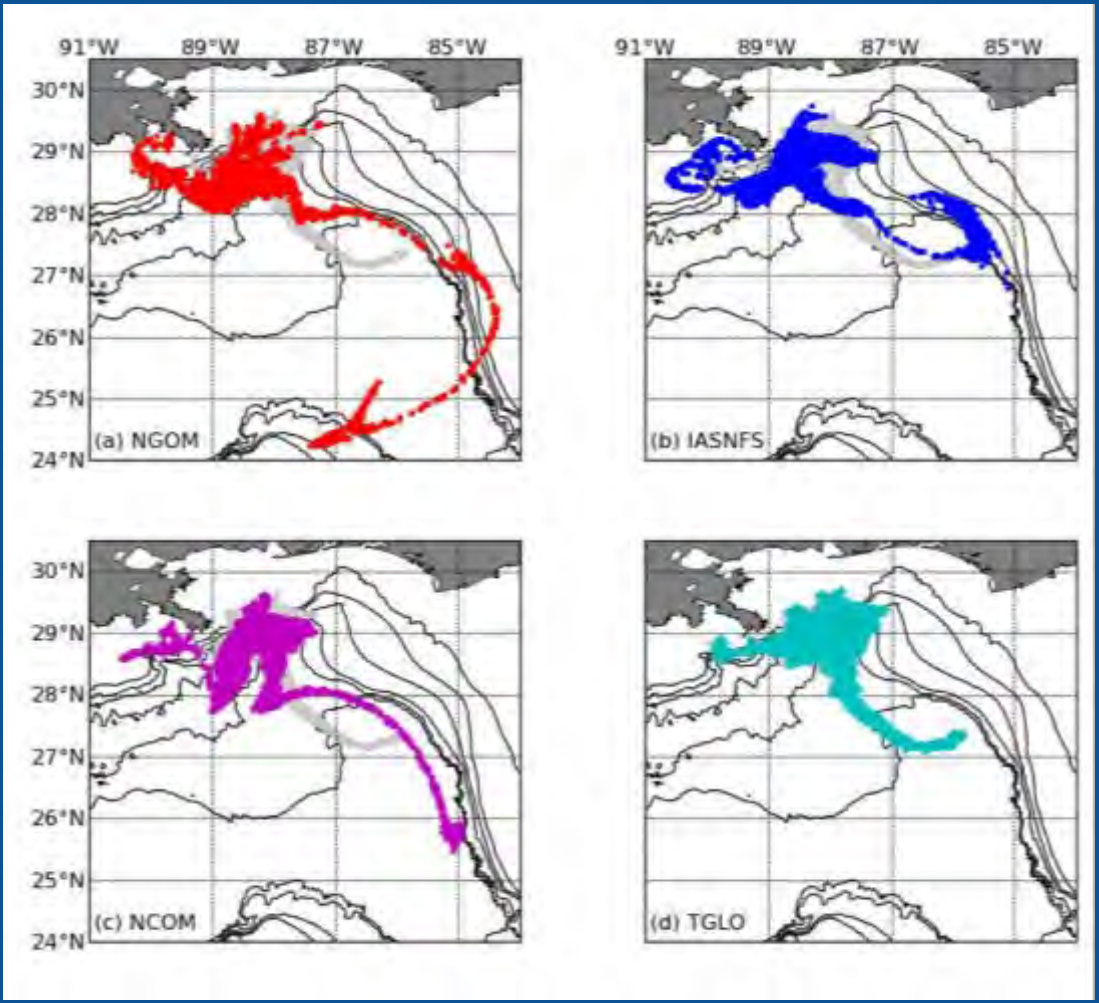
Intra-Americas Sea Nowcast/Forecast System (IASNFS)

From 2003 up-to-date



- Longitude : 98 W – 55 W; Latitude : 5 N – 31 N
- Horizontal Resolution : 1/24 Degree (~ 6 km)
- Vertical Resolution : 40 Layers (19 Layers on the shelf)
- 140 Rivers with real-time river discharge

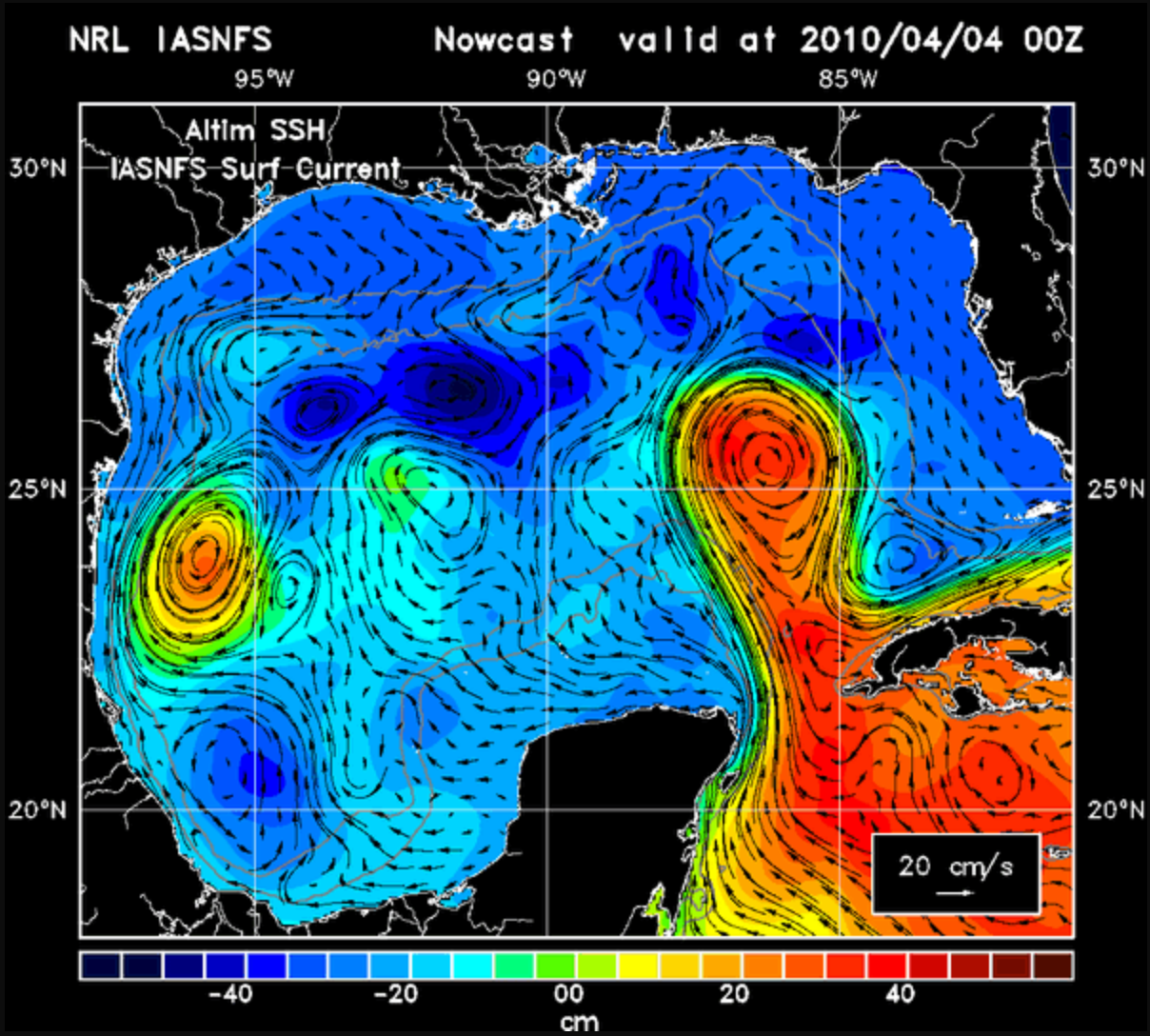
http://www7320.nrlssc.mil/IASNFS_WWW



Predicted particle distributions for 20 May initialized from 17 May satellite analysis (shown in gray) using surface currents from (a) NOAA NGOM model, (b) NRL IASNFS model, (c) NAVO Global NCOM model, and (d) TGLO model.

IASNFS Current over Altimeter SSH

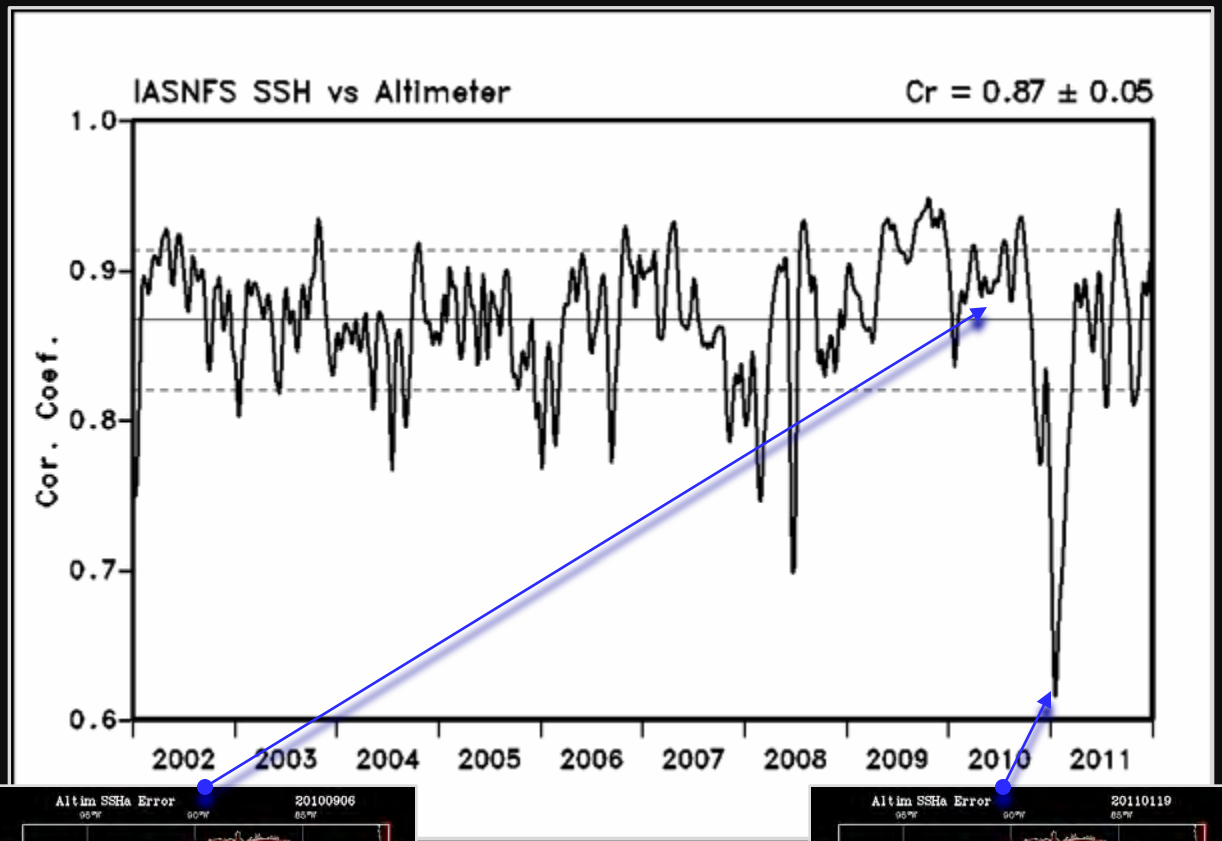
IASNFS Current (5-day average) is consistent with Altimetry

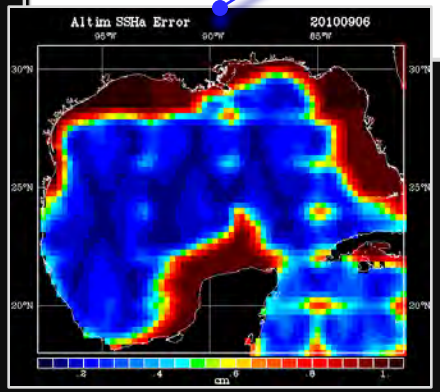


IASNFS SSHa vs Altimetry Analysis

In deep water > 500m

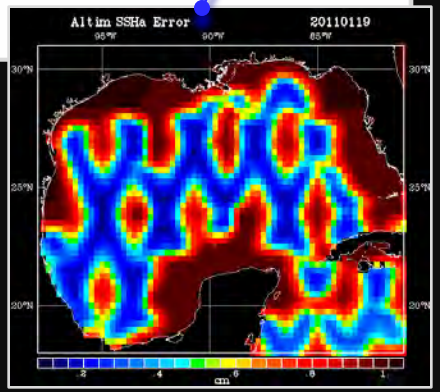
Overall very good correlation except during the period when altimetry analysis has large errors



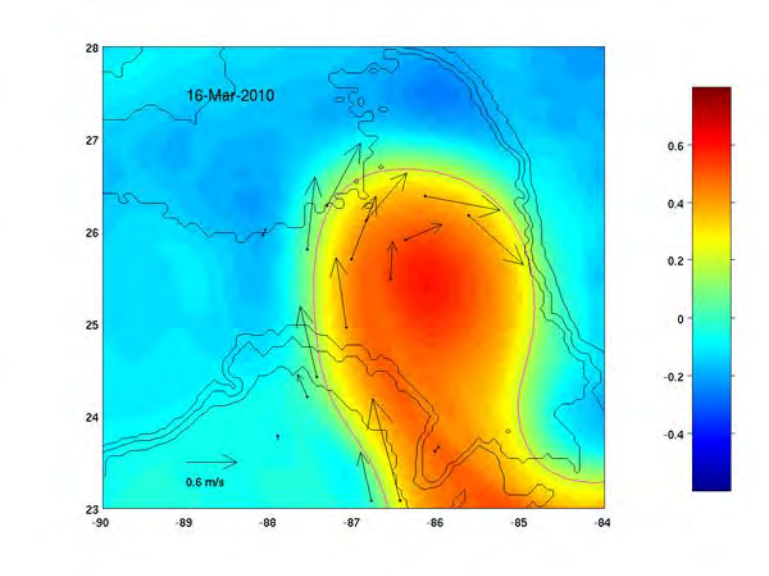


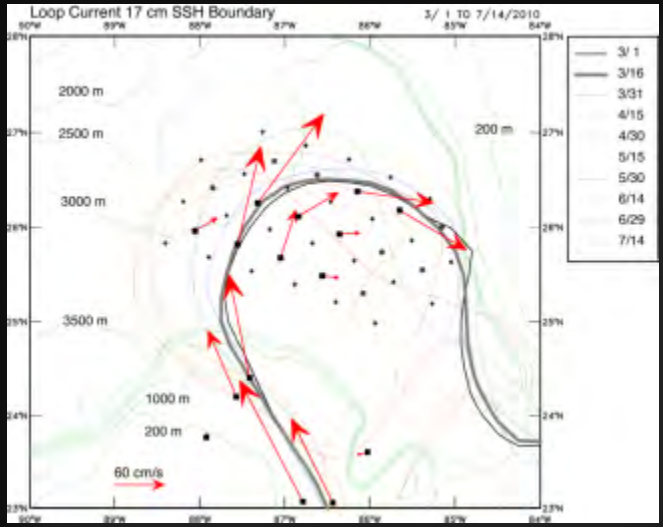
Altimetry analysis relative error

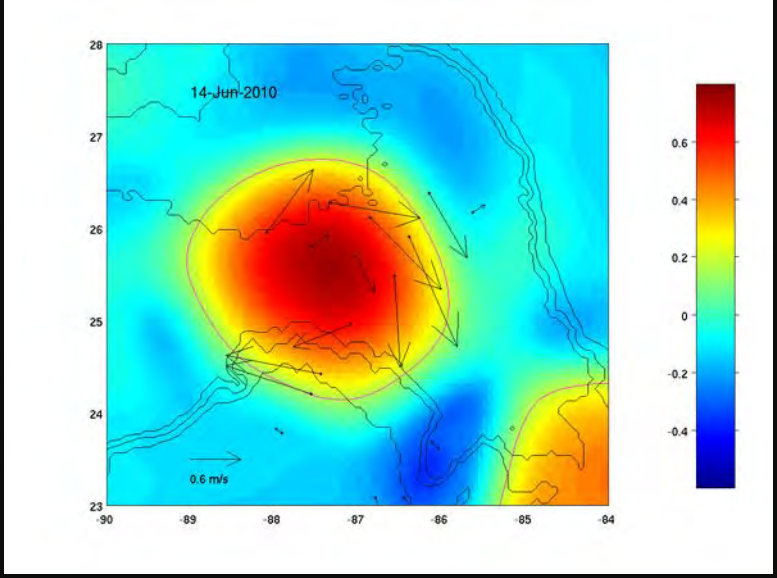
Blue: small error
Dark red: large error

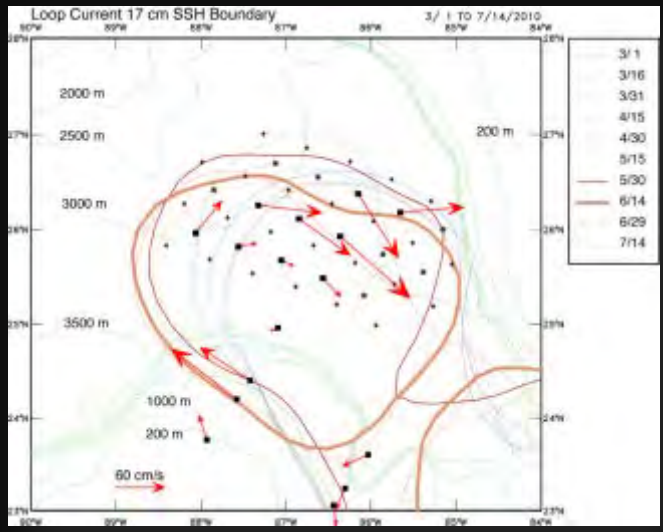


IASNFS Currents vs Mooring Observation



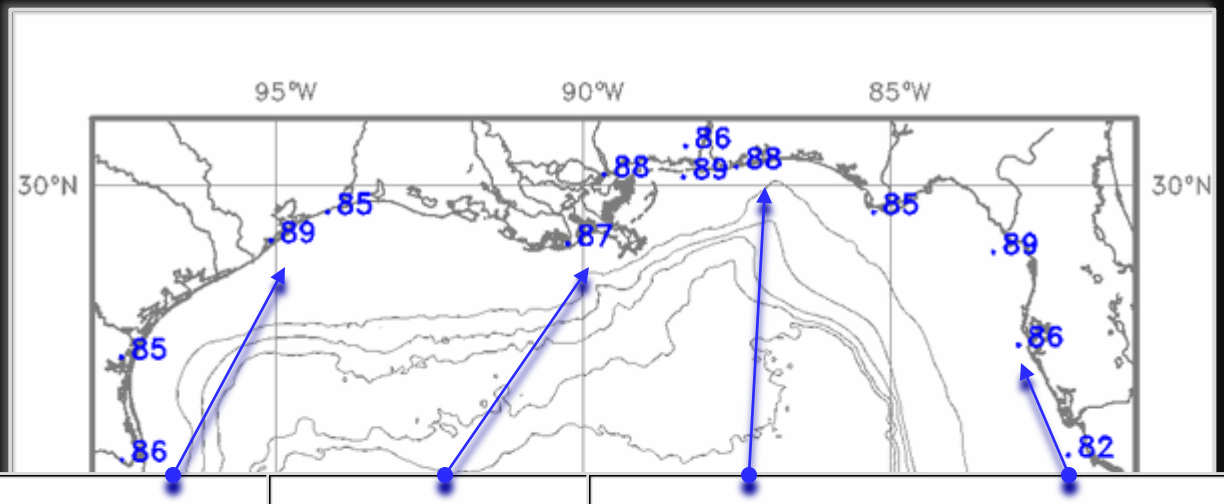


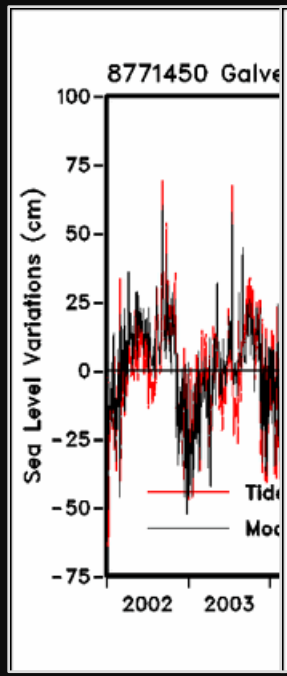


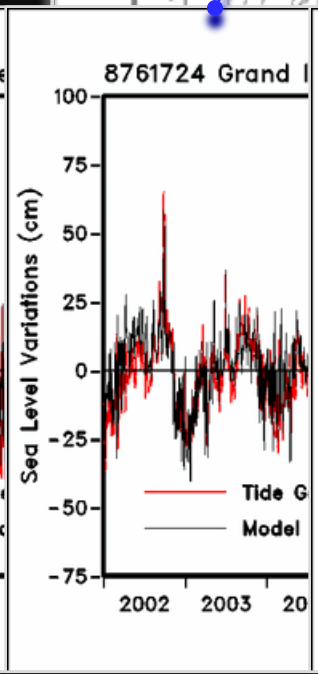


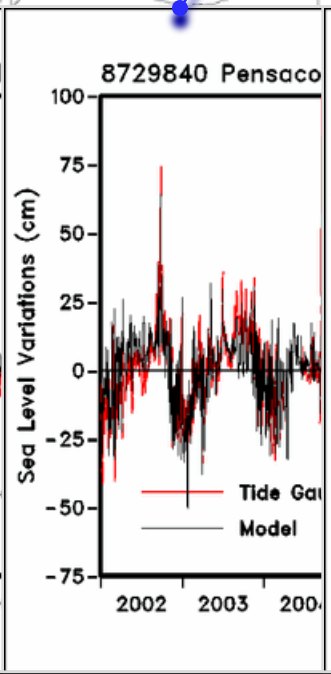
IASNFS SSH Variation vs NOS Tide Gauge

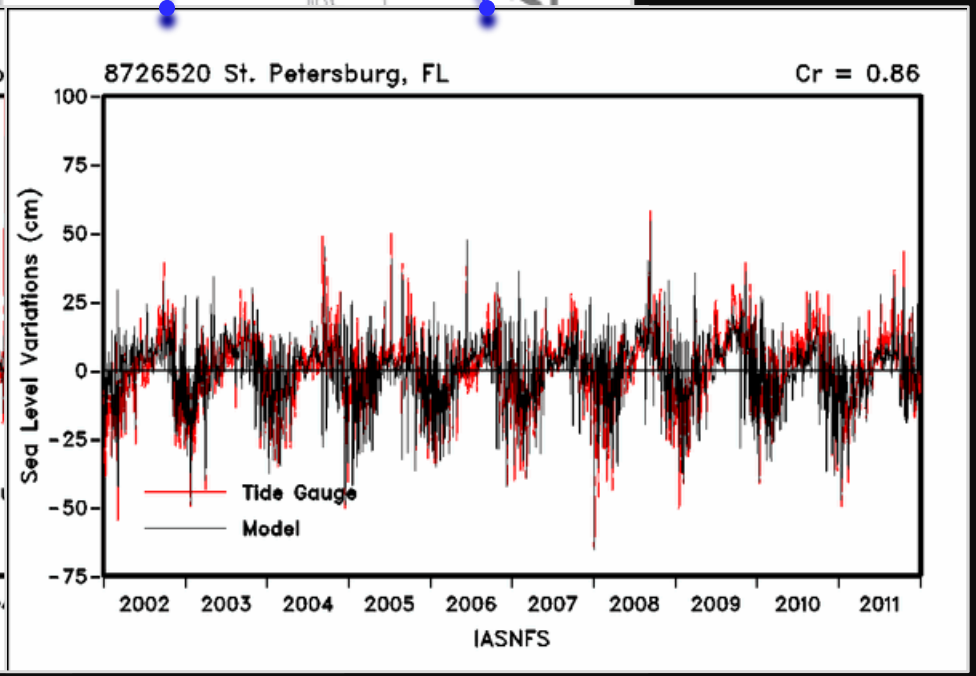
Overall very good correlation





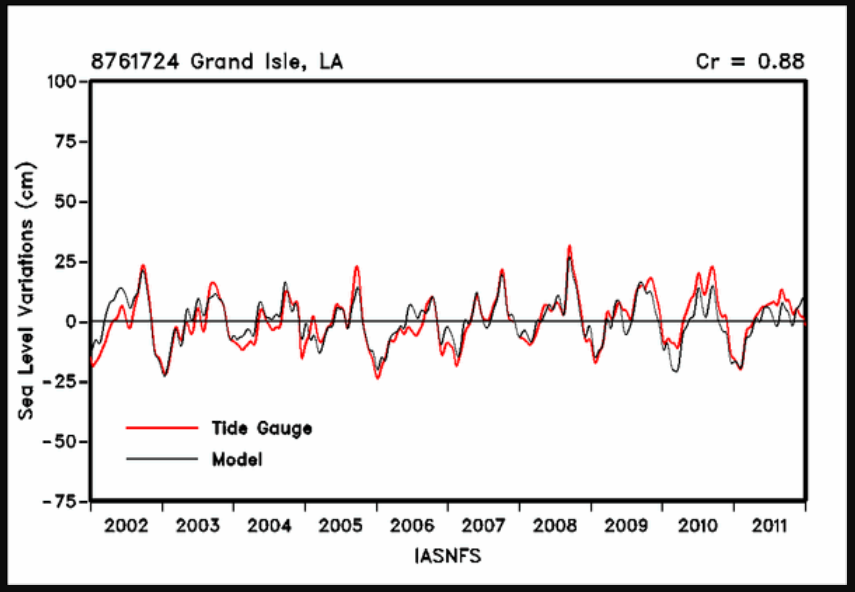


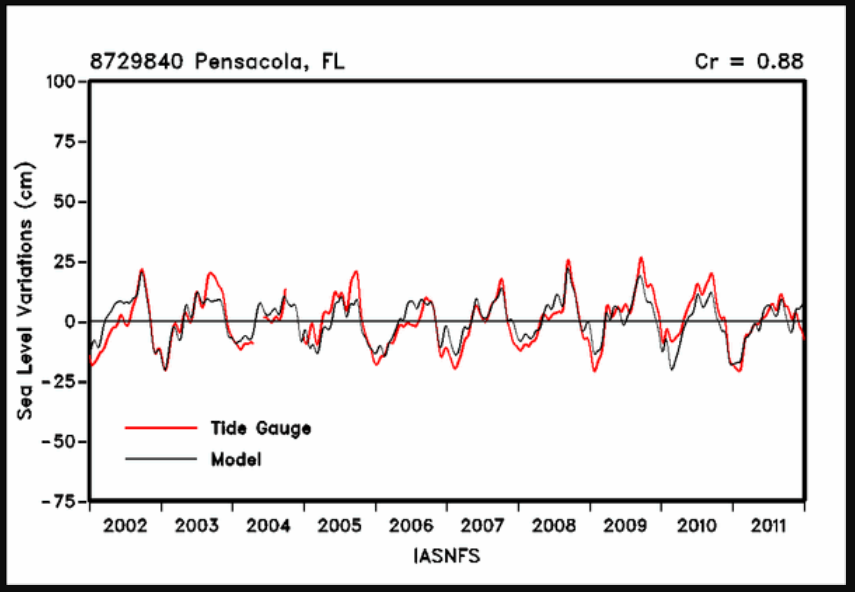


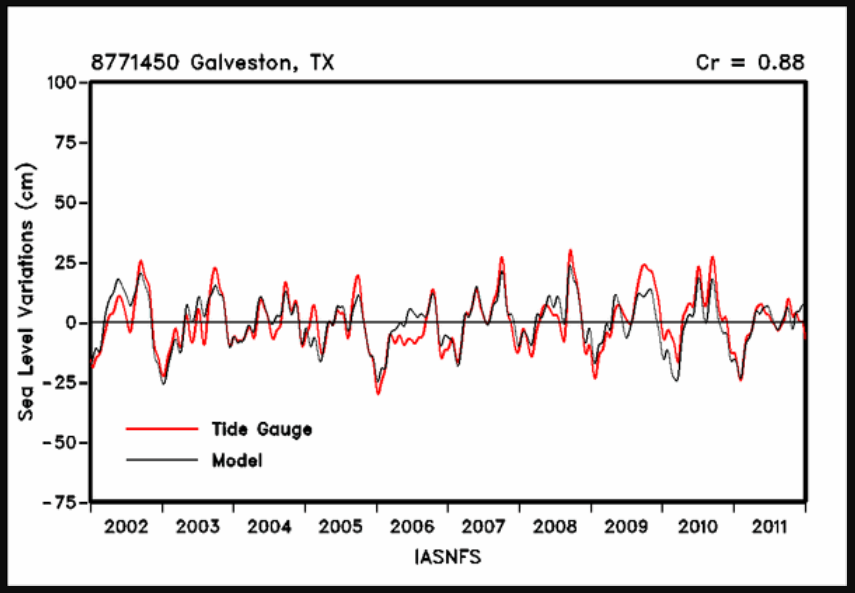


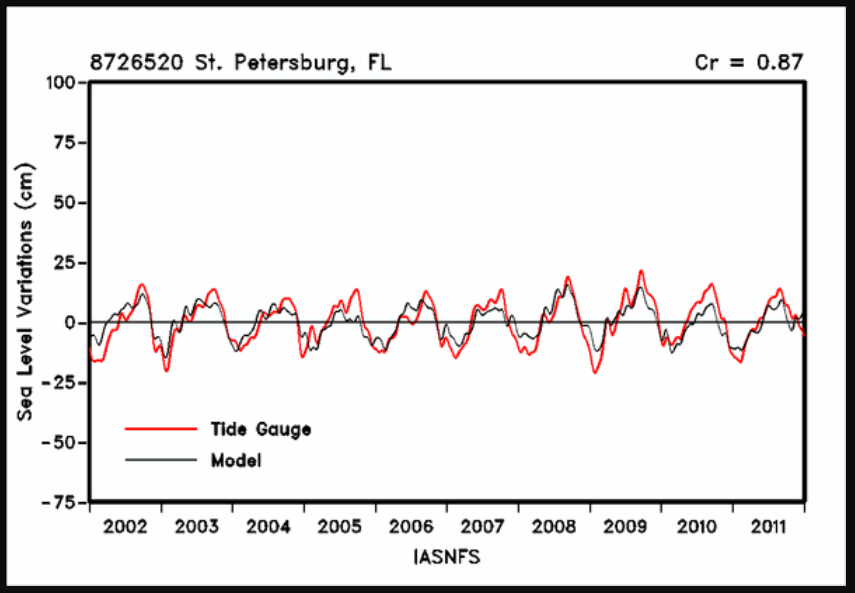
IASNFS SSH Variation vs NOS Tide Gauge

Monthly



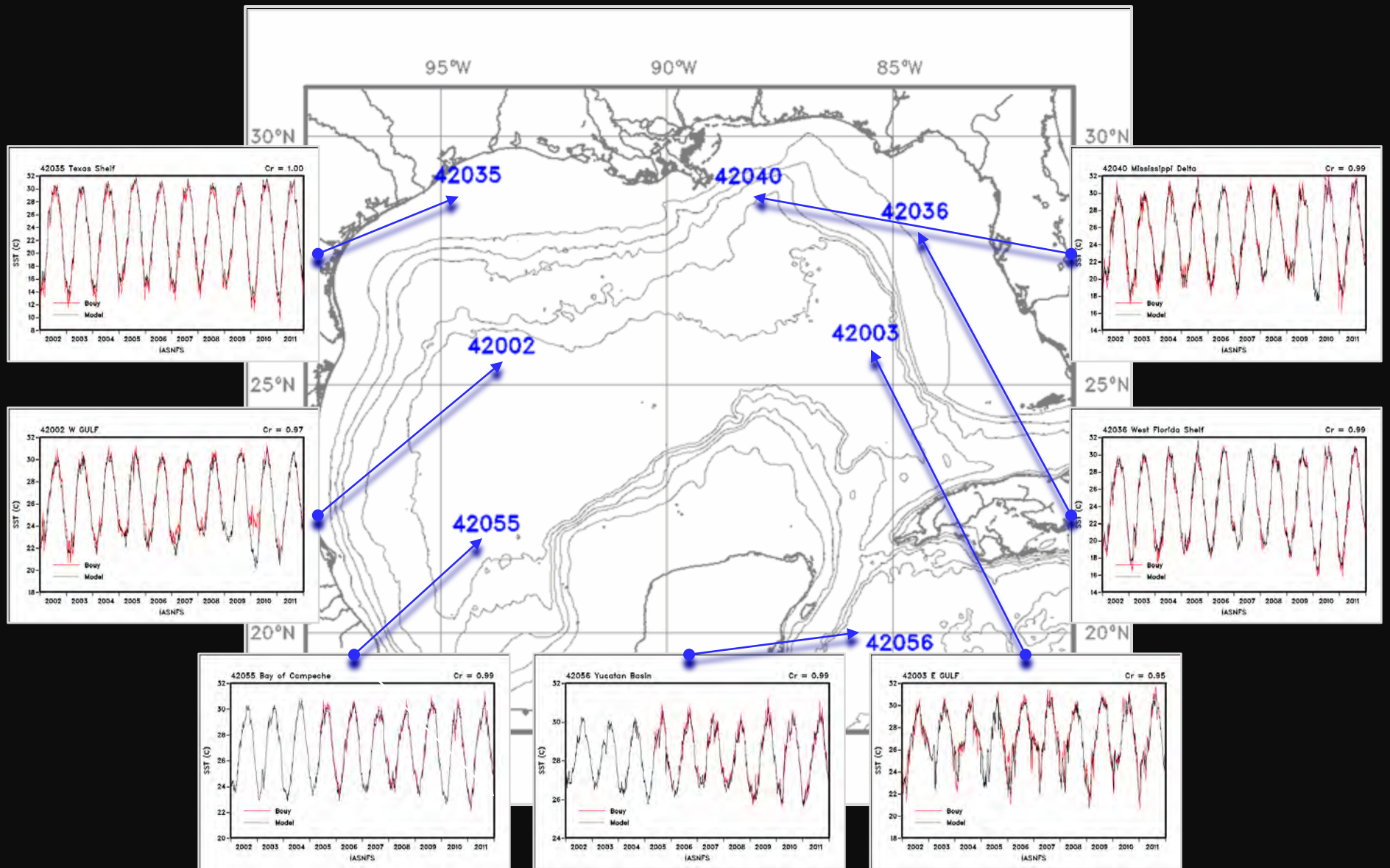






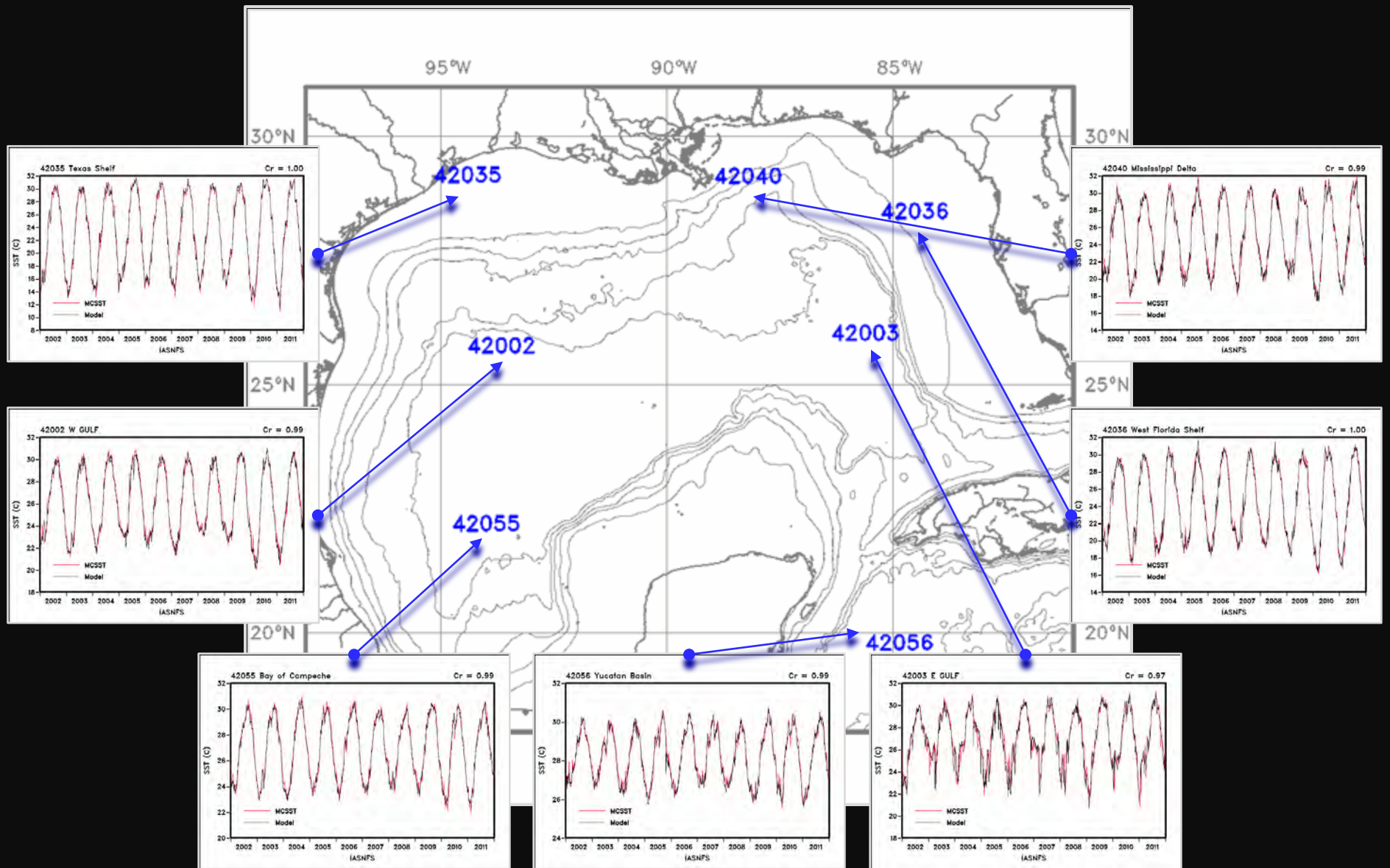
IASNFS SST vs NDBC Buoy

Very good correlation



IASNFS SST vs MCSST

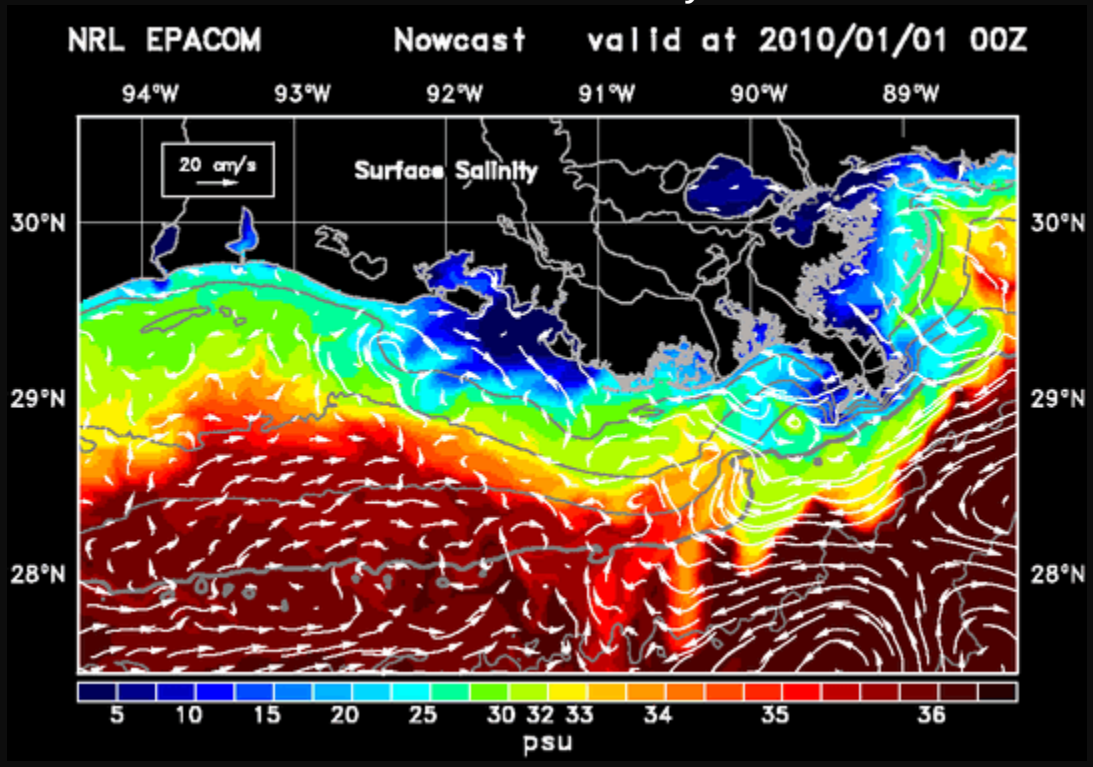
Very good correlation



IASNFS-LCS Simulation

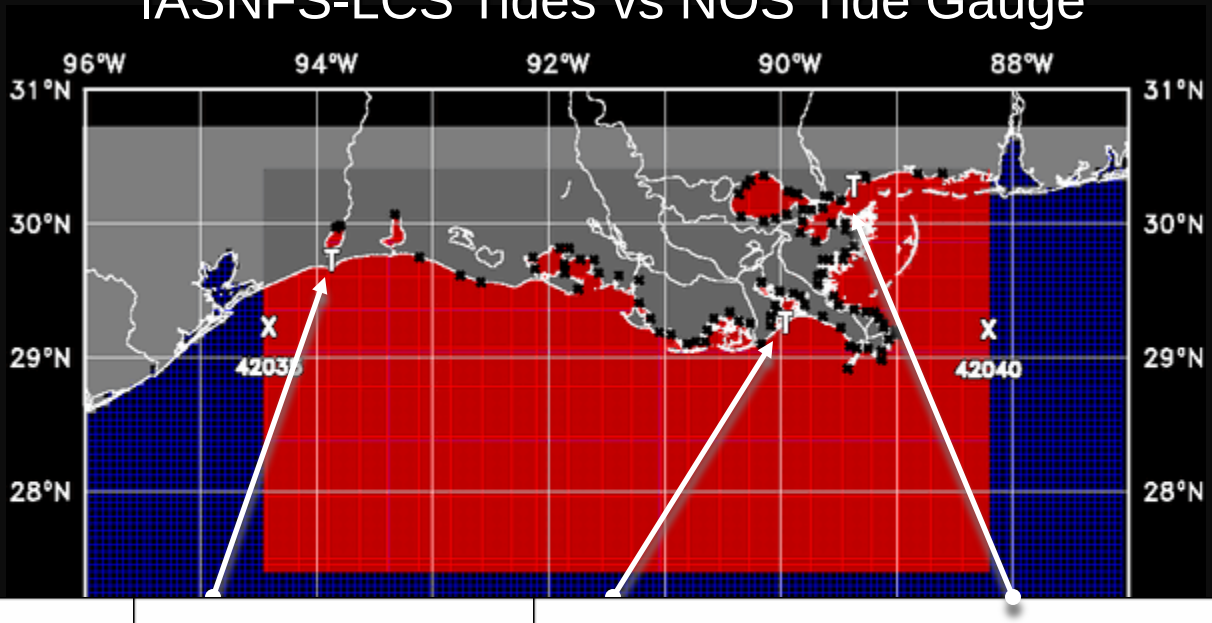
From 2002 to 2012

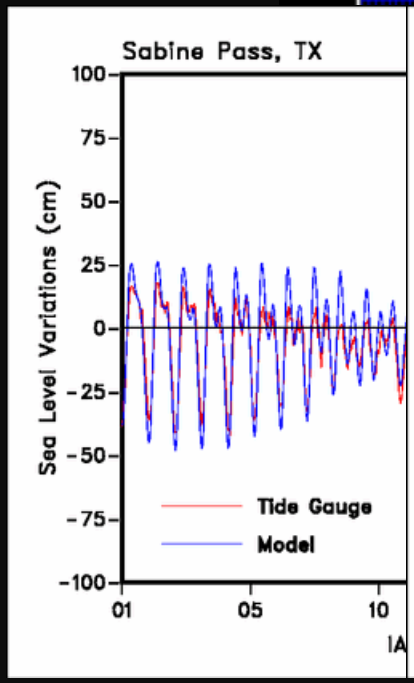
Surface Salinity

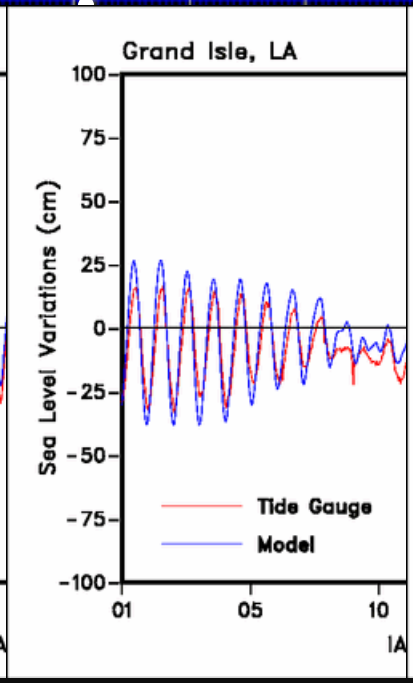


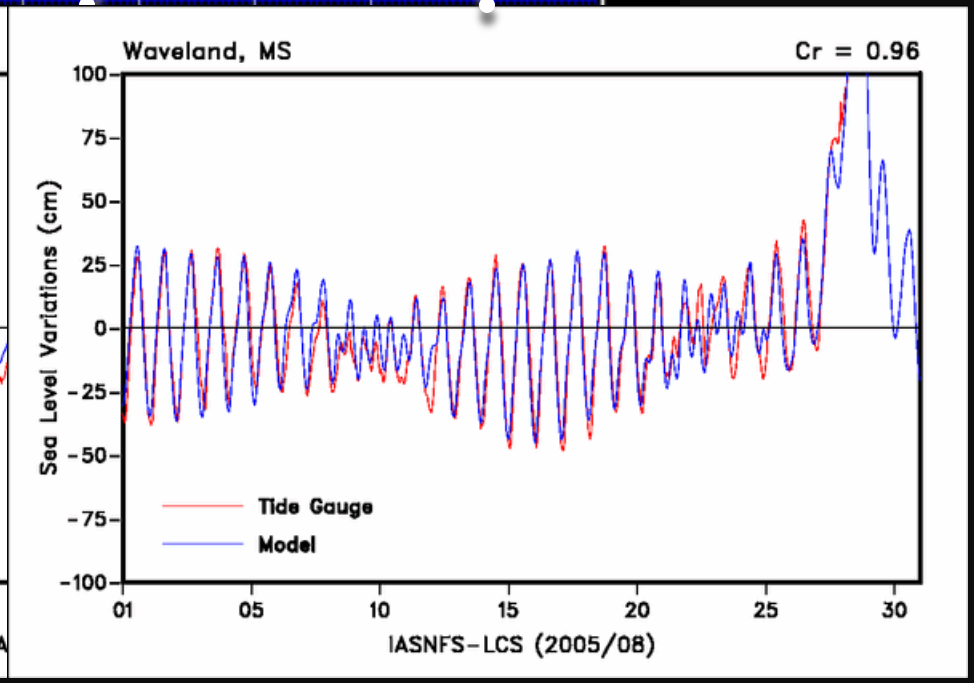
http://www7320.nrlssc.navy.mil/IASNFS_WWW/EPANFS_WWW/

IASNFS-LCS Tides vs NOS Tide Gauge

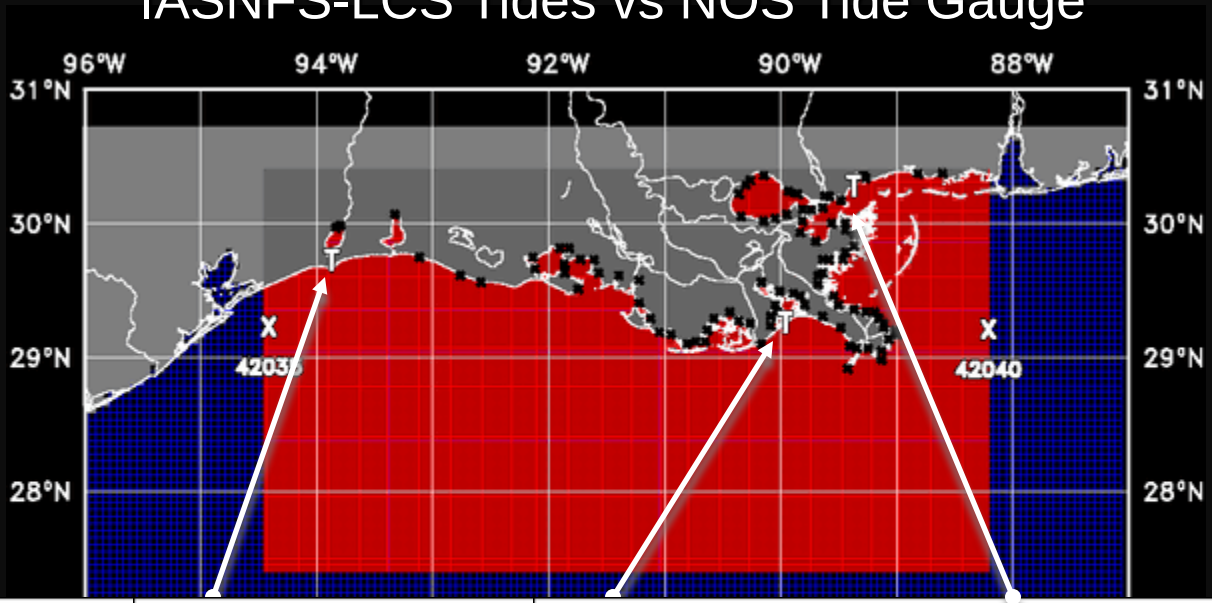


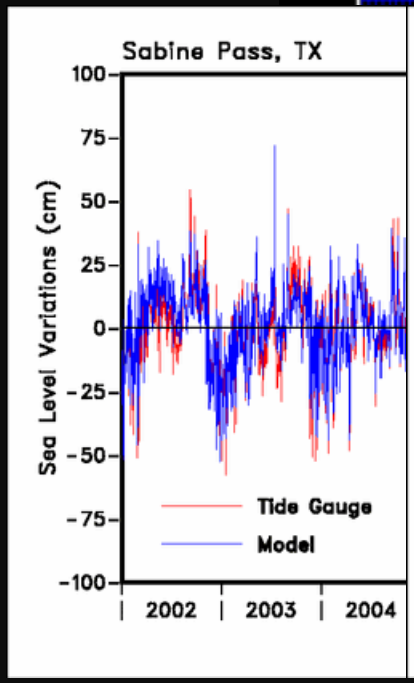


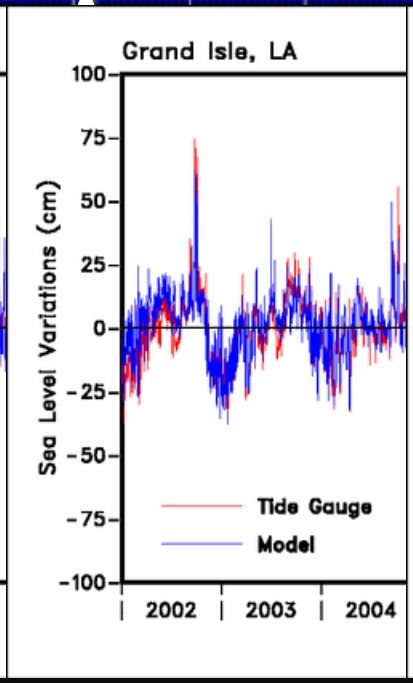


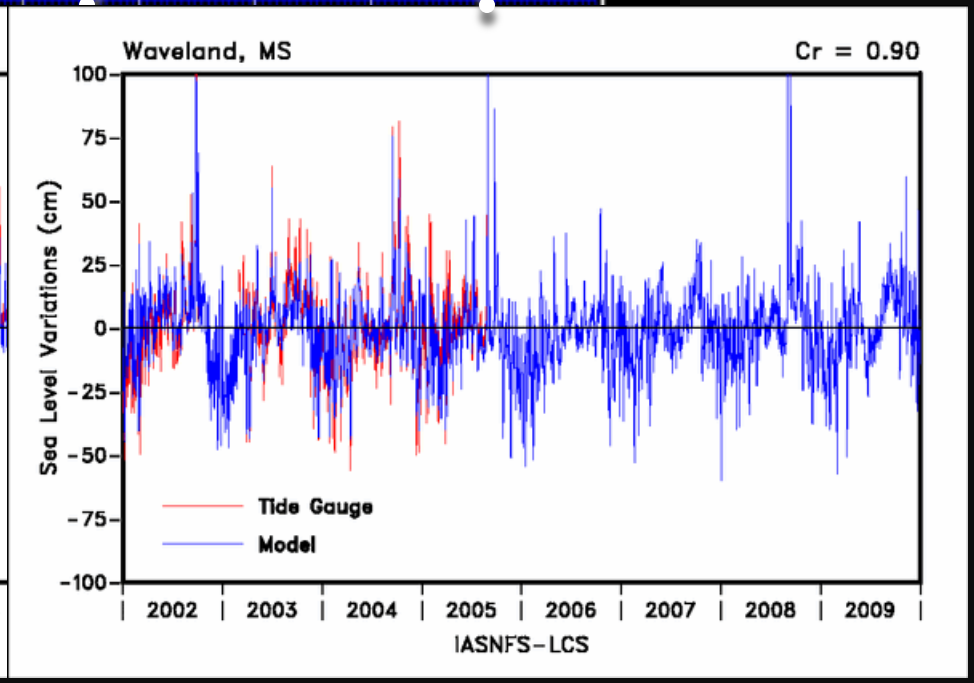


IASNFS-LCS Tides vs NOS Tide Gauge

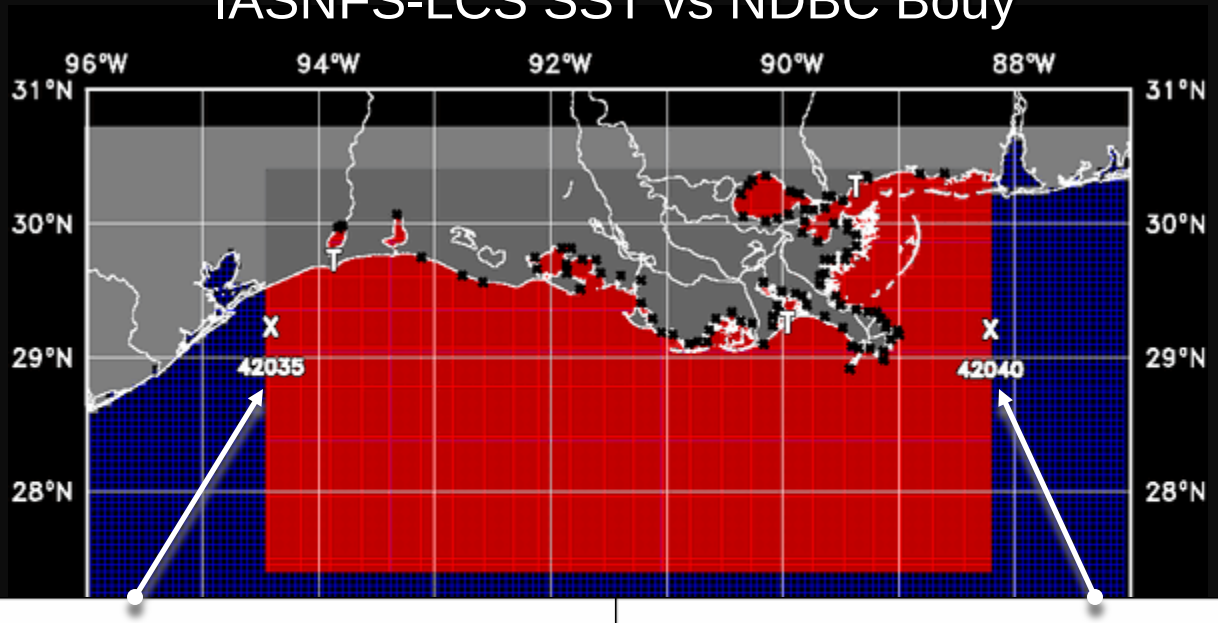


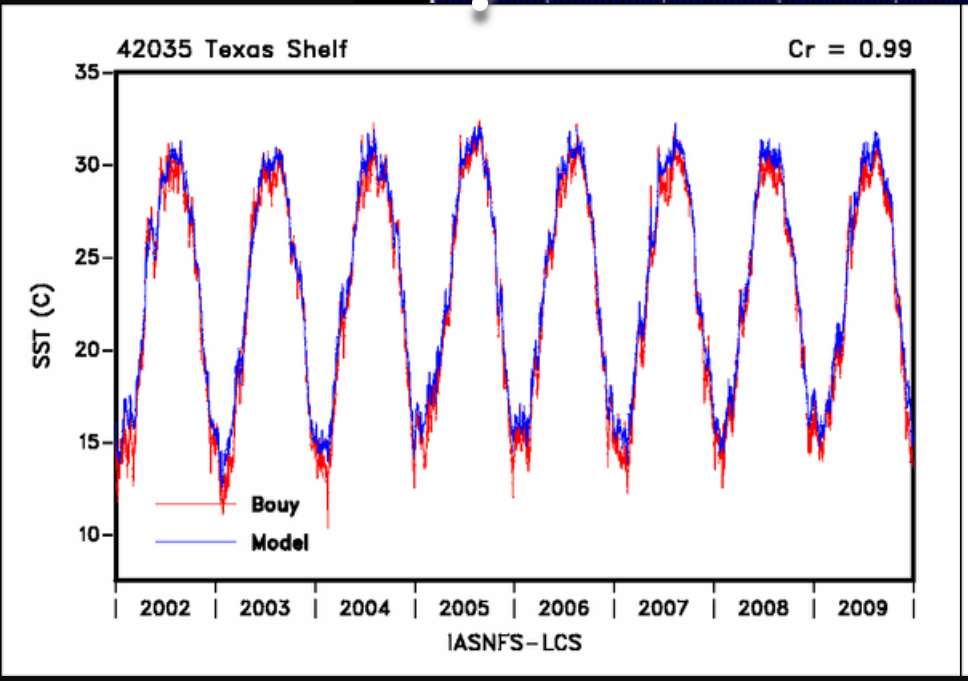


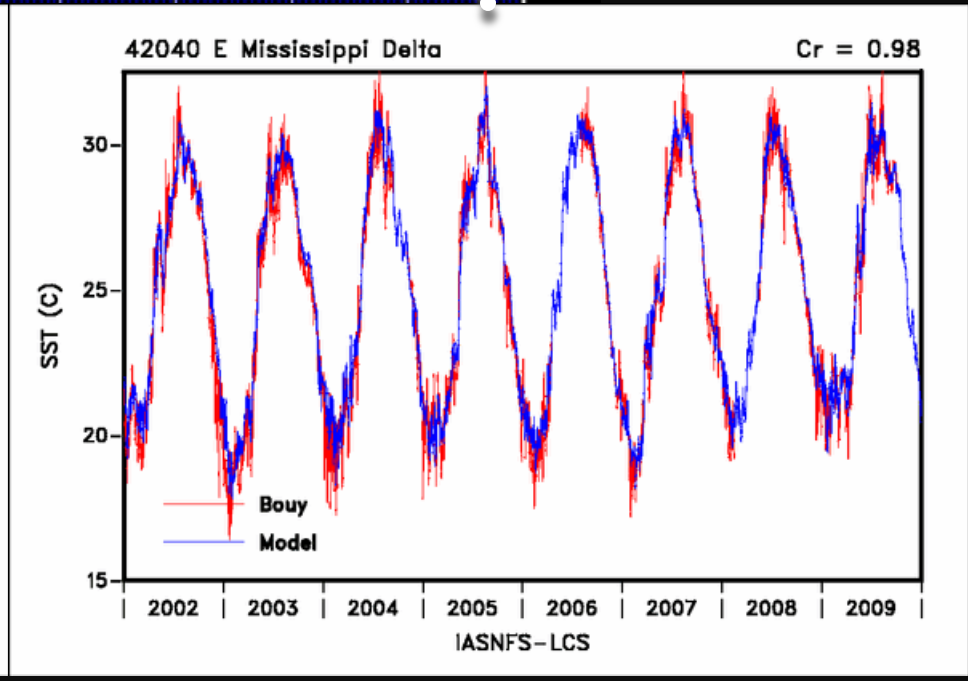




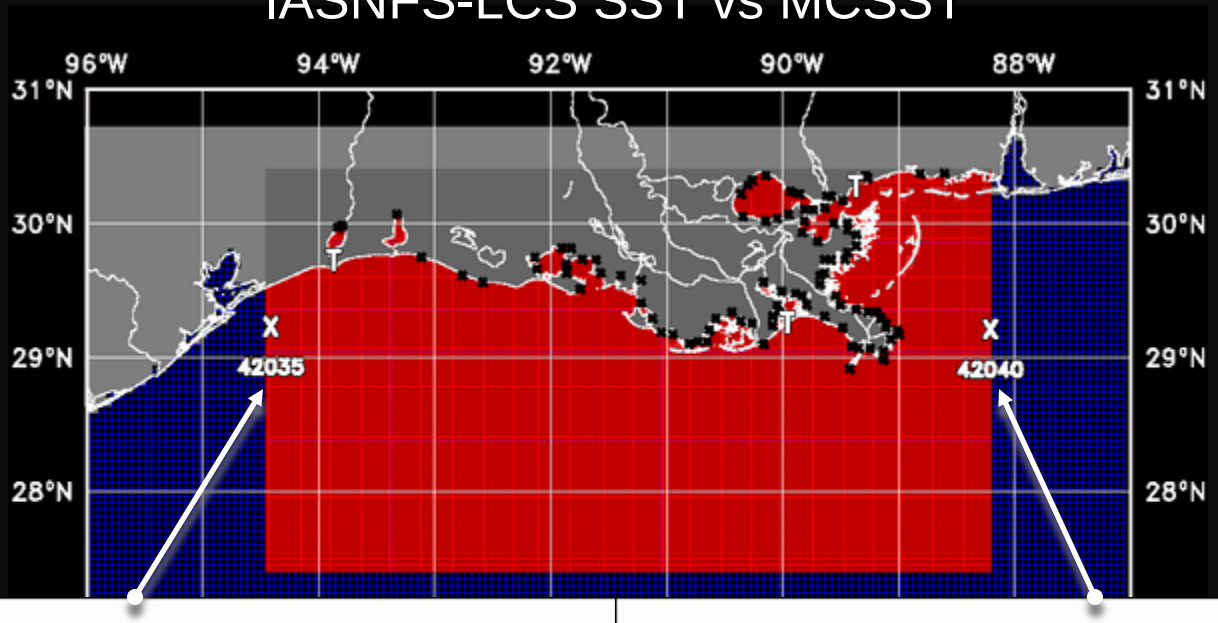
IASNFS-LCS SST vs NDBC Bouy

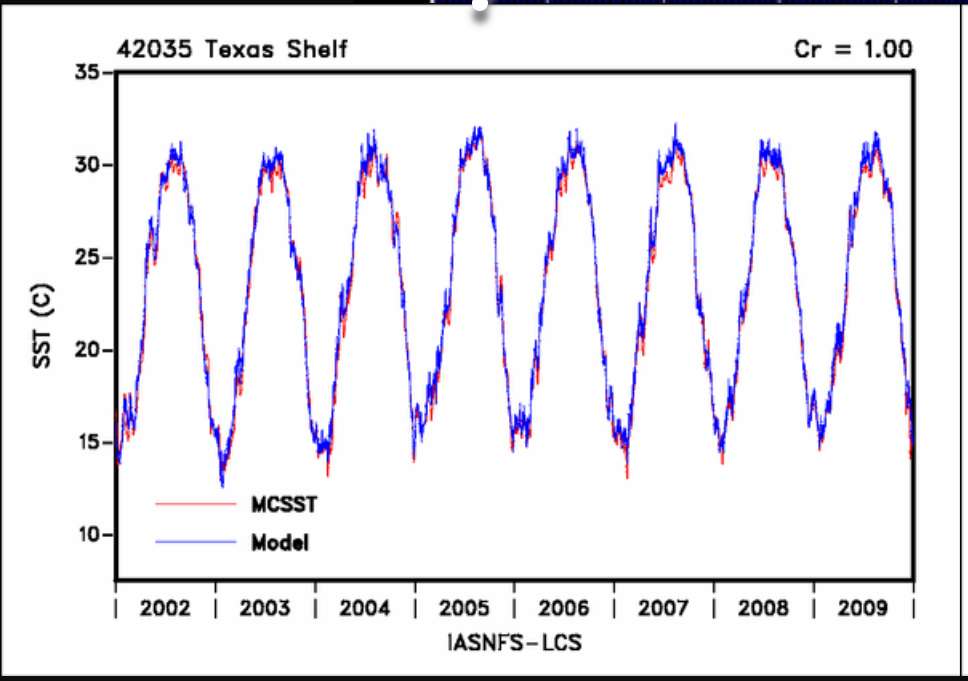


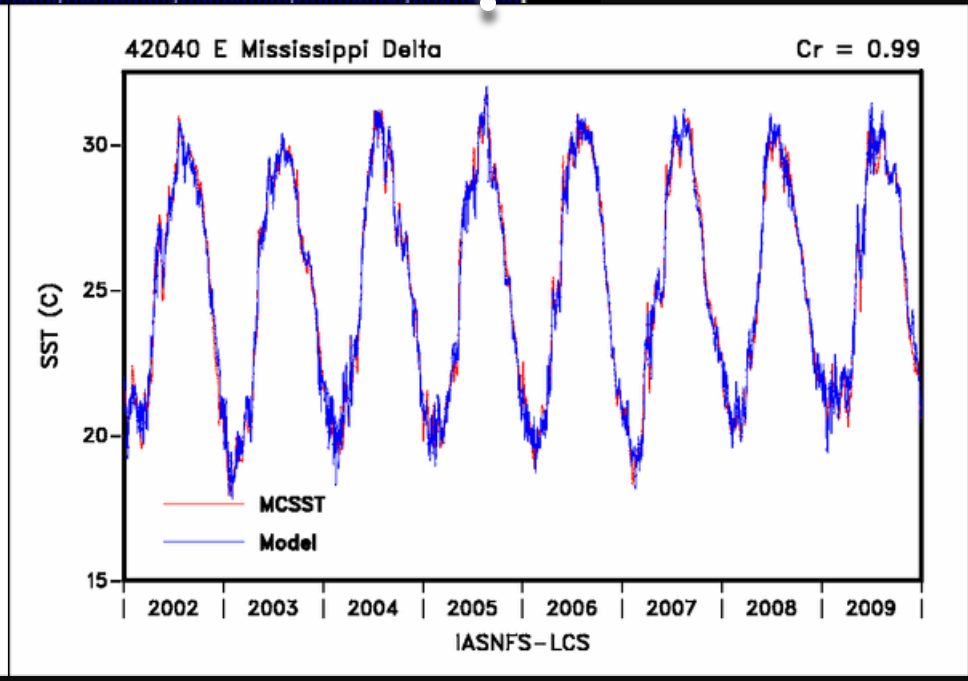




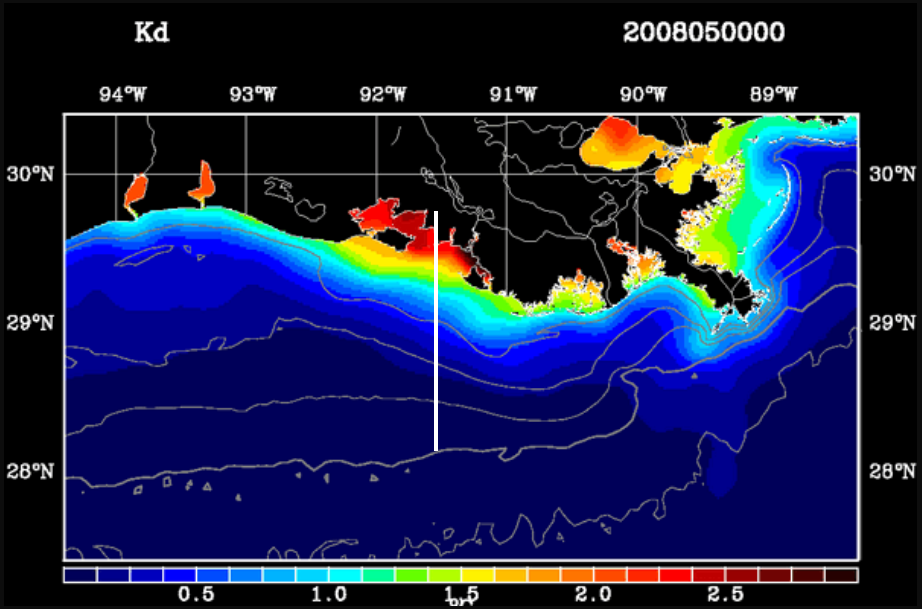
IASNFS-LCS SST vs MCSST



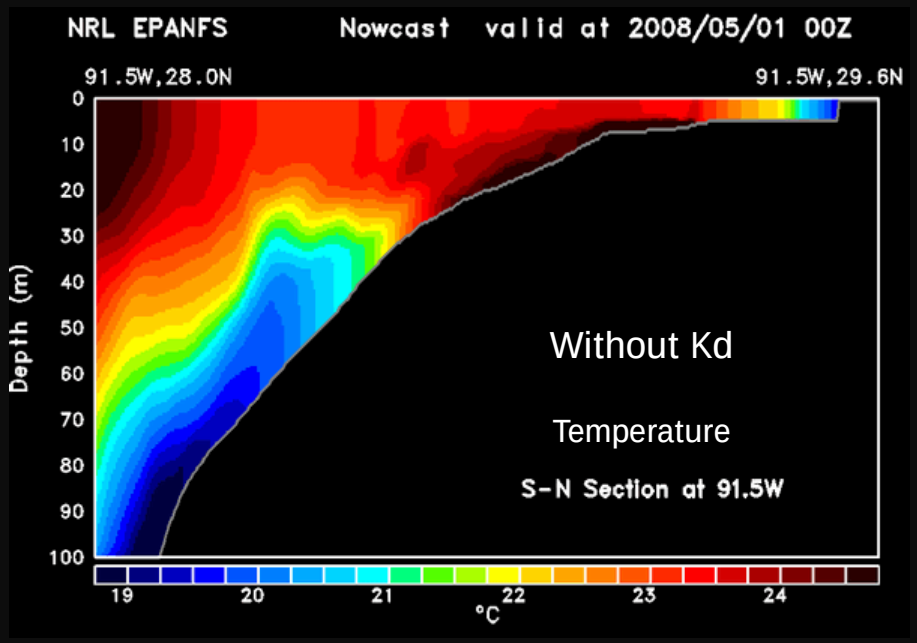


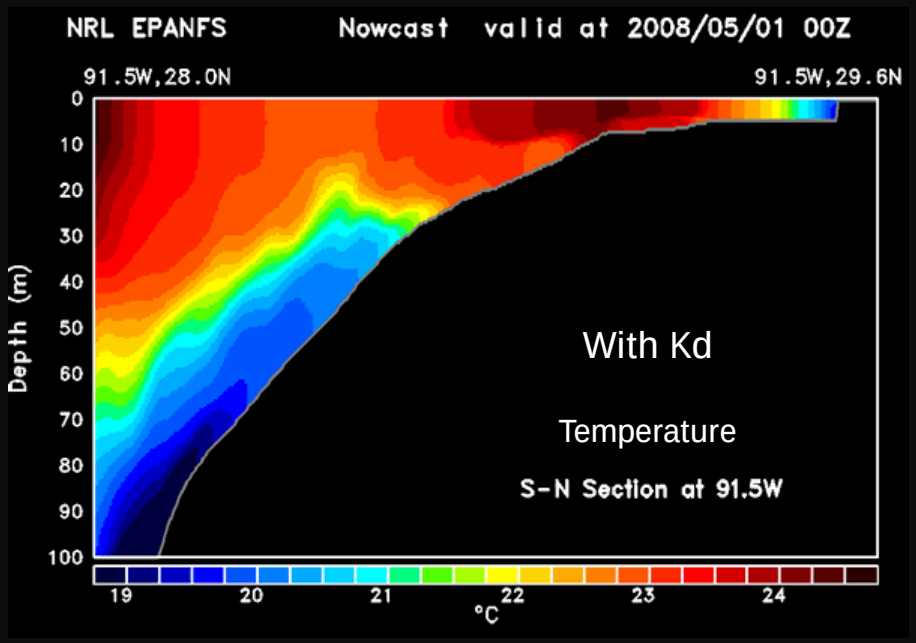


IASNFS-LCS Simulation with Kd

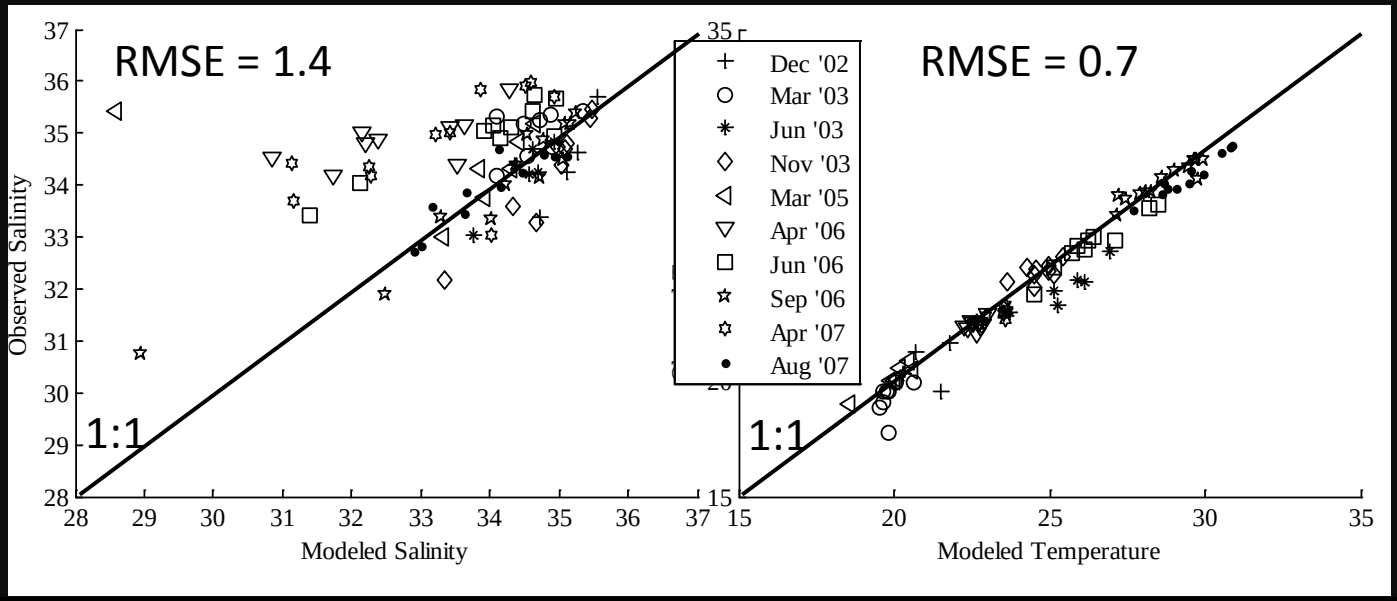


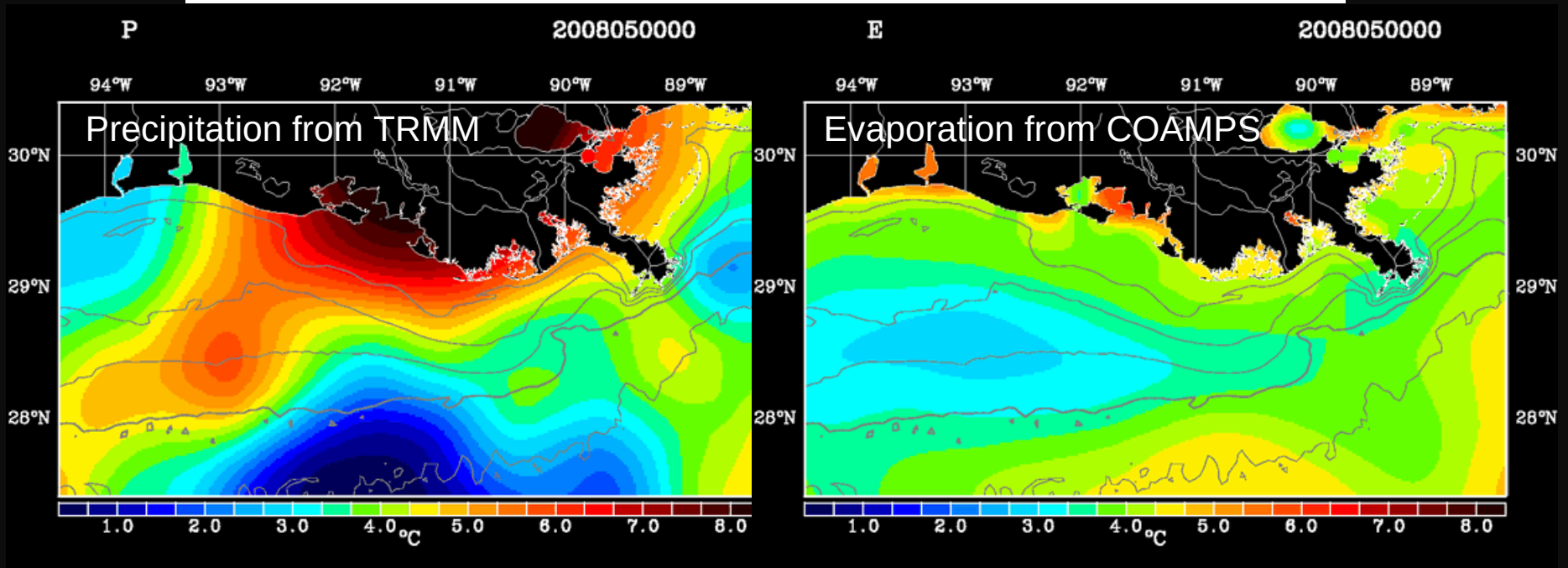
Kd from SeaWiFS/MODIS



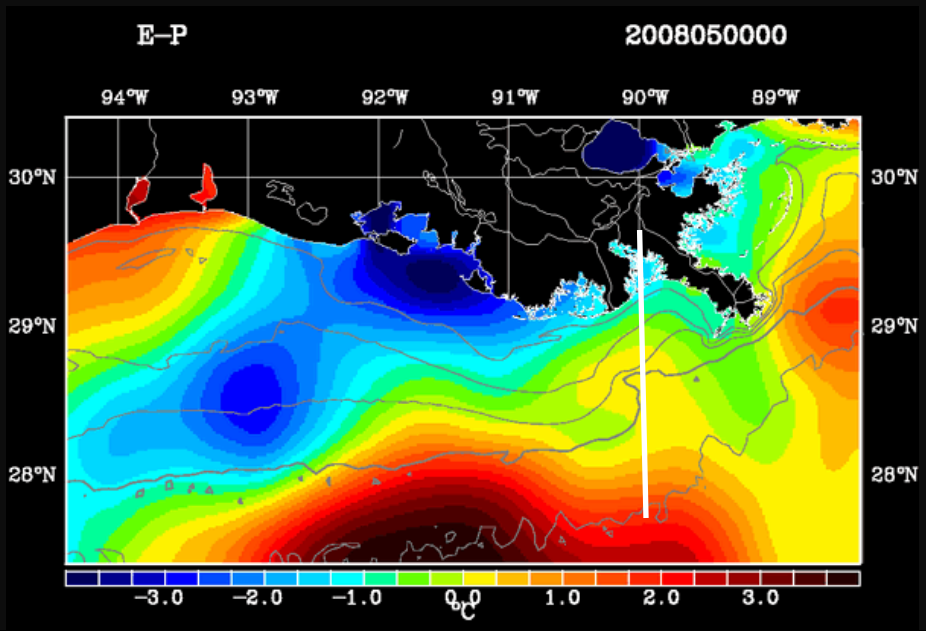


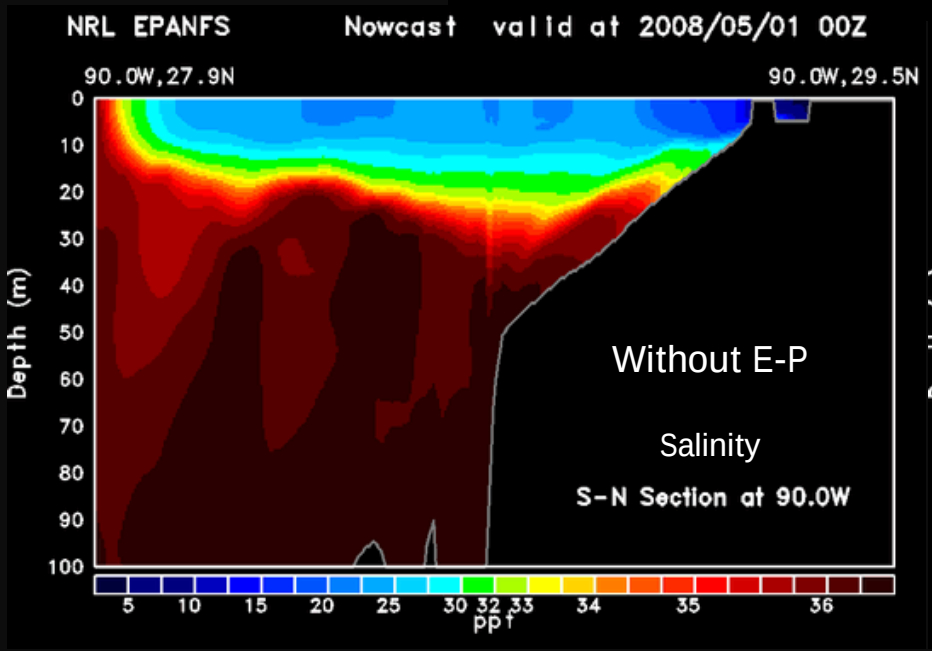
IASNFS-LCS Simulation with E-P

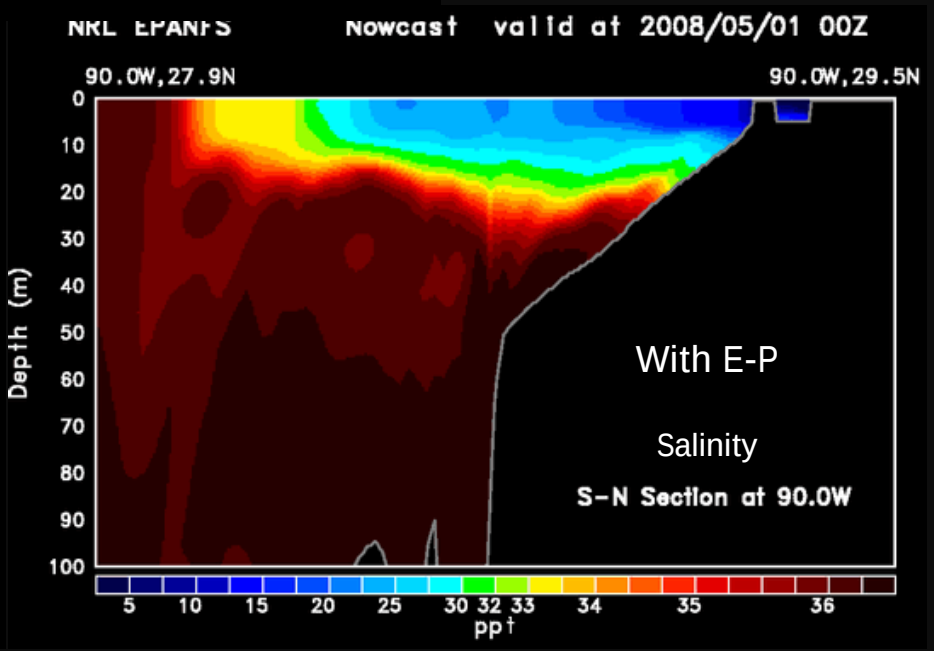




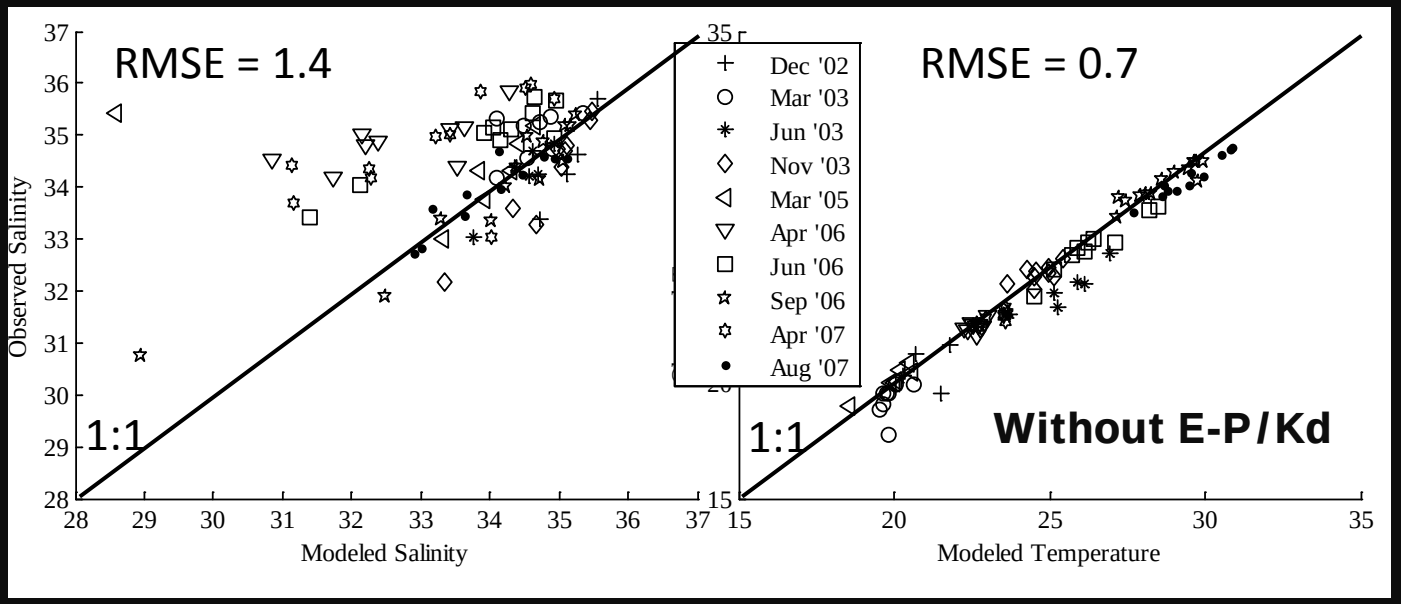
IASNFS-LCS Simulation with E-P

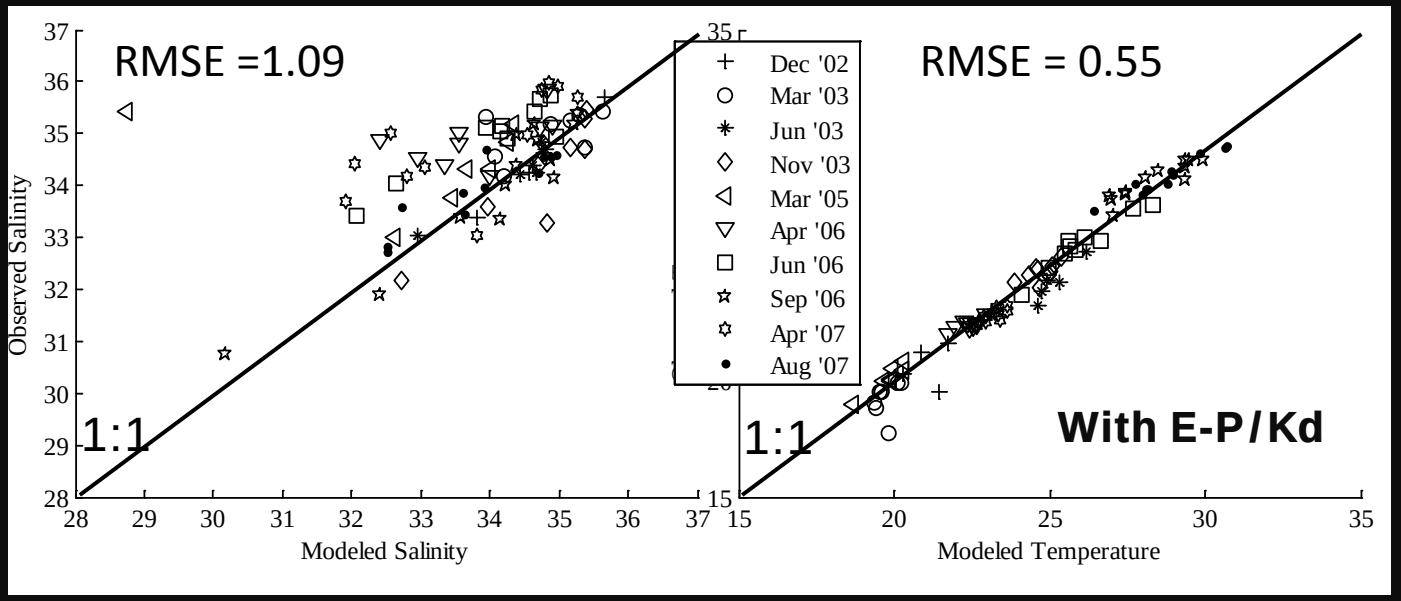






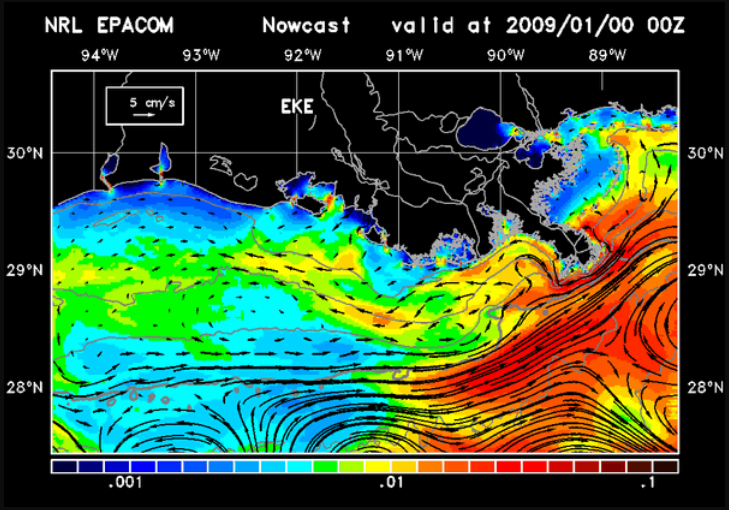
IASNFS-LCS Simulation with E-P/Kd

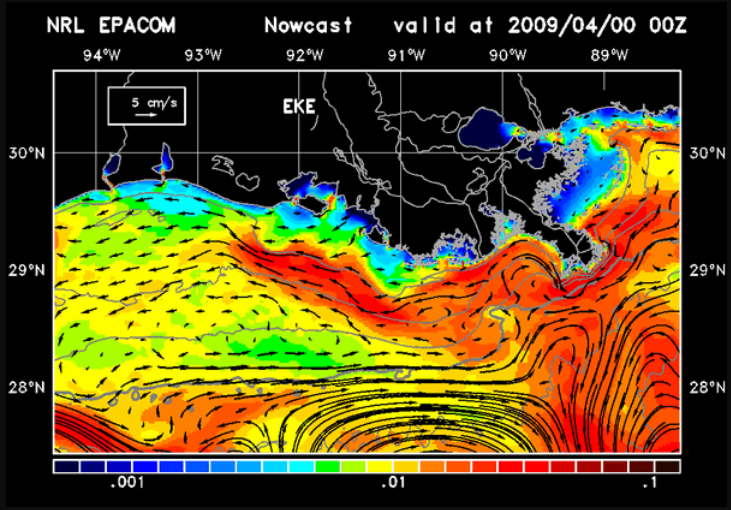


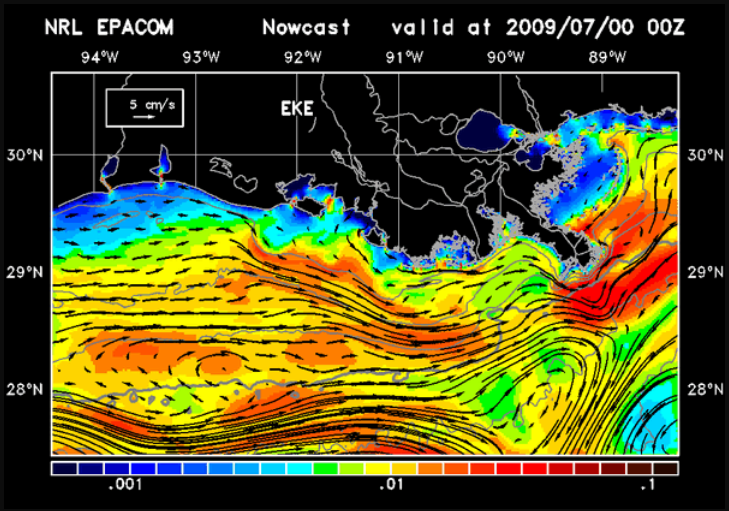


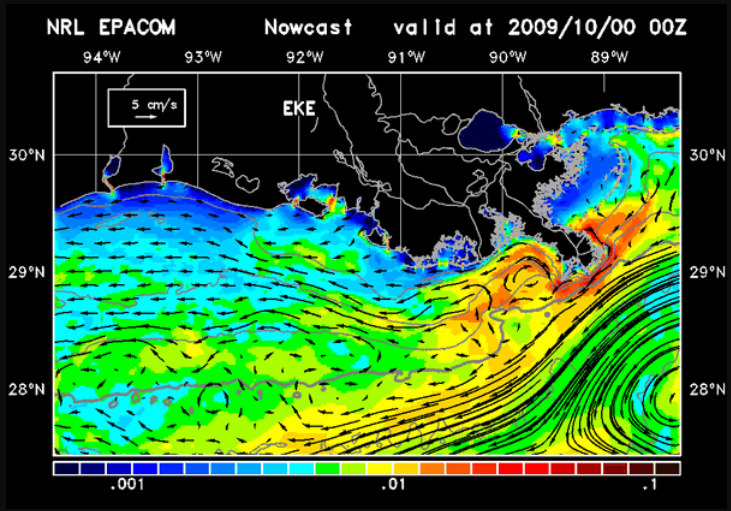
IANFS-LCS Simulation - Flow Pattern

Monthly Mean Current (vectors) & EKE (colors)



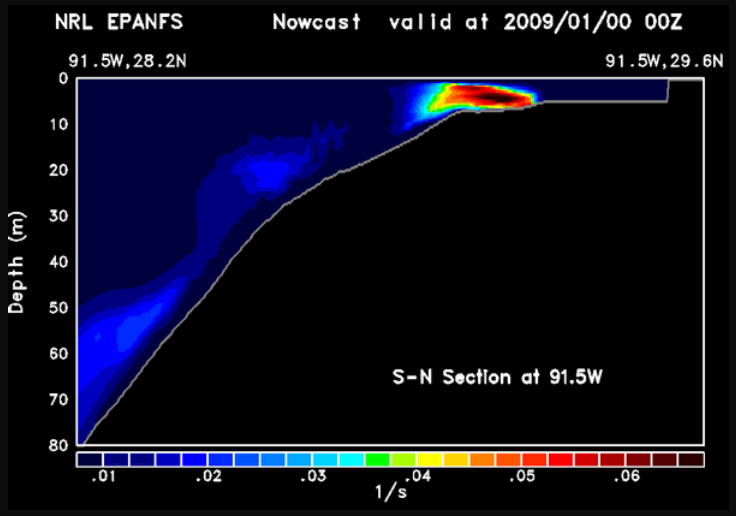


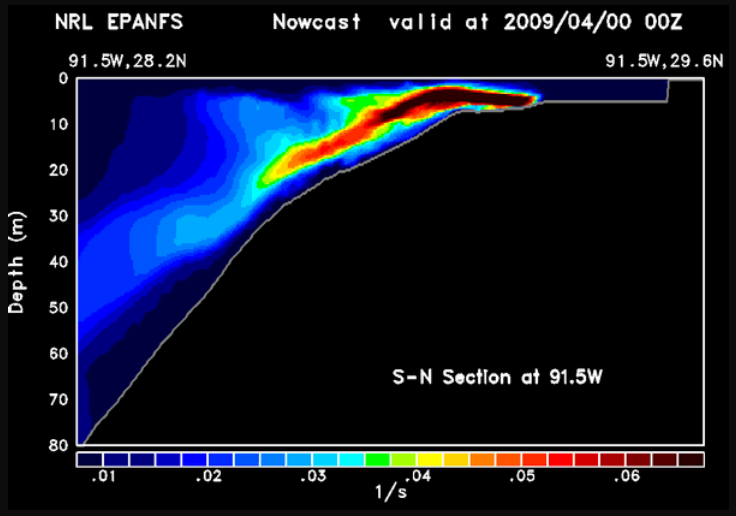


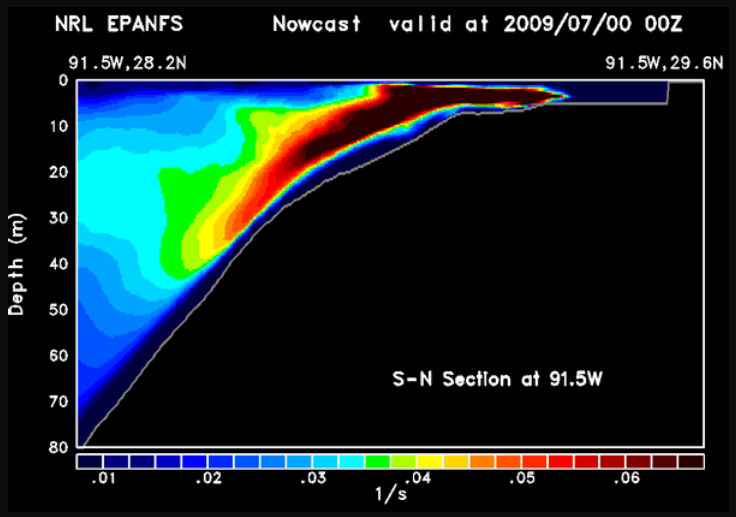


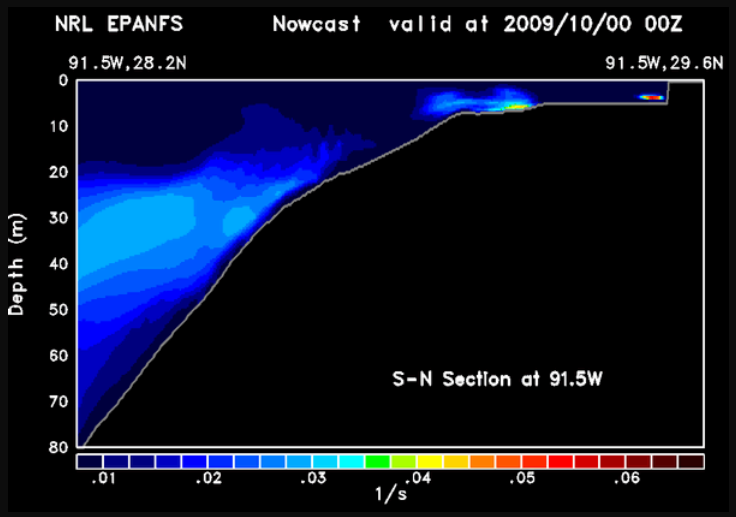
IASNFS-LCS Simulation - Stratification

Seasonal Stratification On the Louisiana Shelf
(Brunt-Vaisala / Buoyancy Frequency)



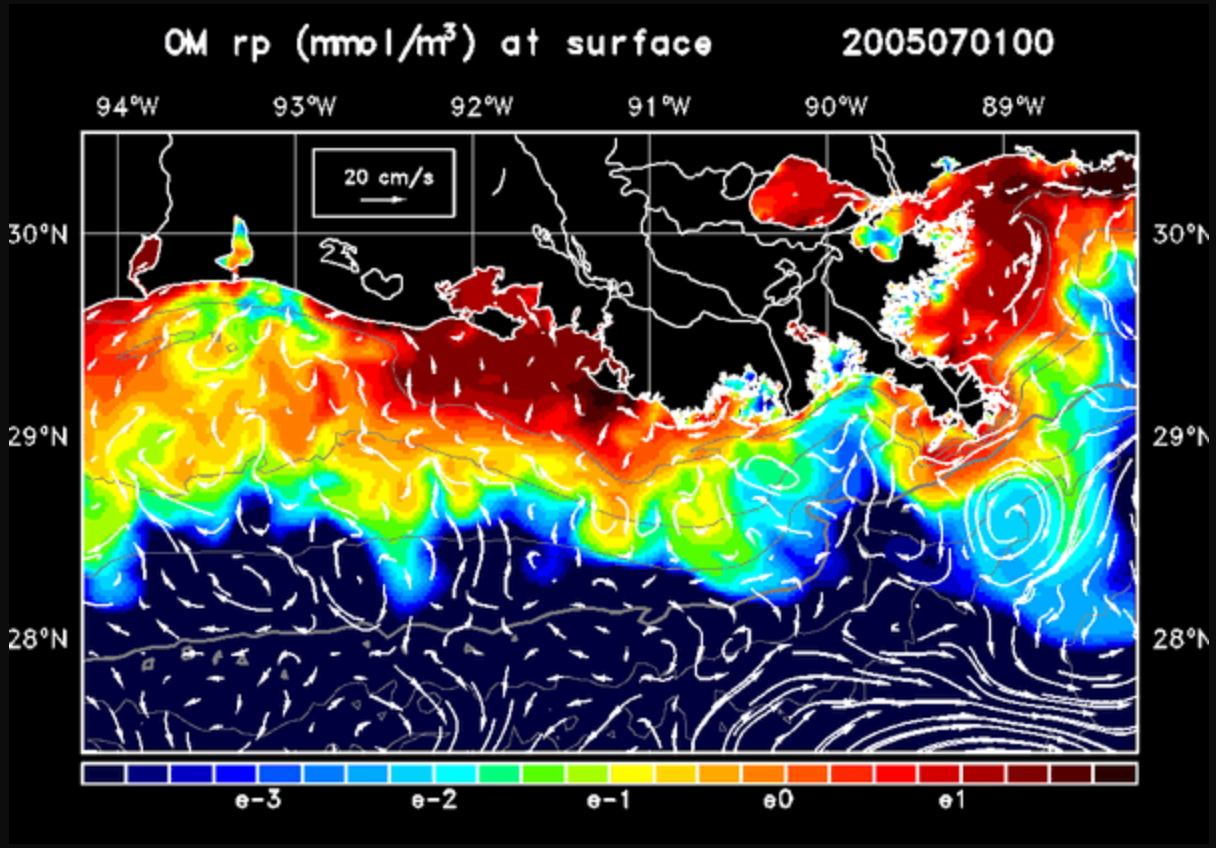






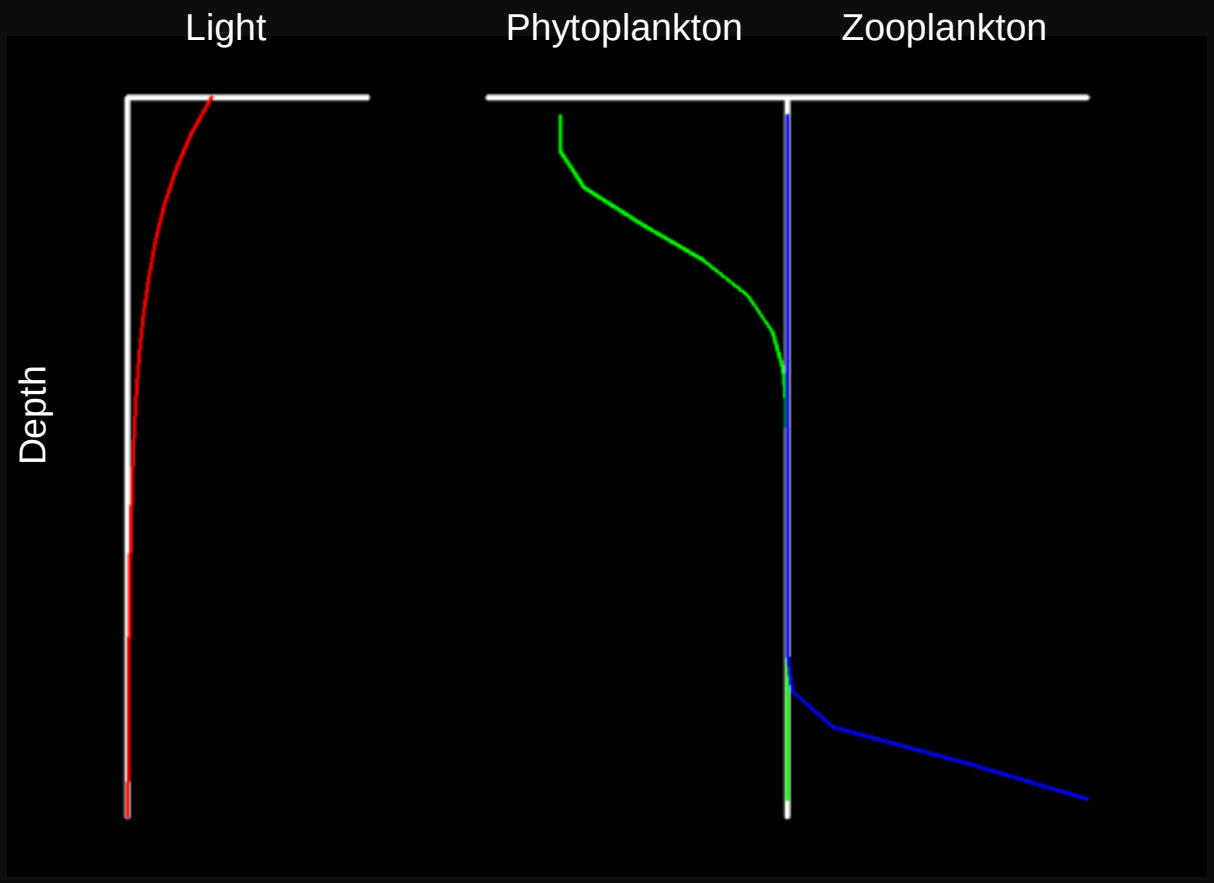
GEM3D Simulation – Riverine OM

Horizontal Variation due to River Runoff, Settling,
3D Current Advection and Vertical Mixing



GEM3D Simulation of Plankton Dynamics

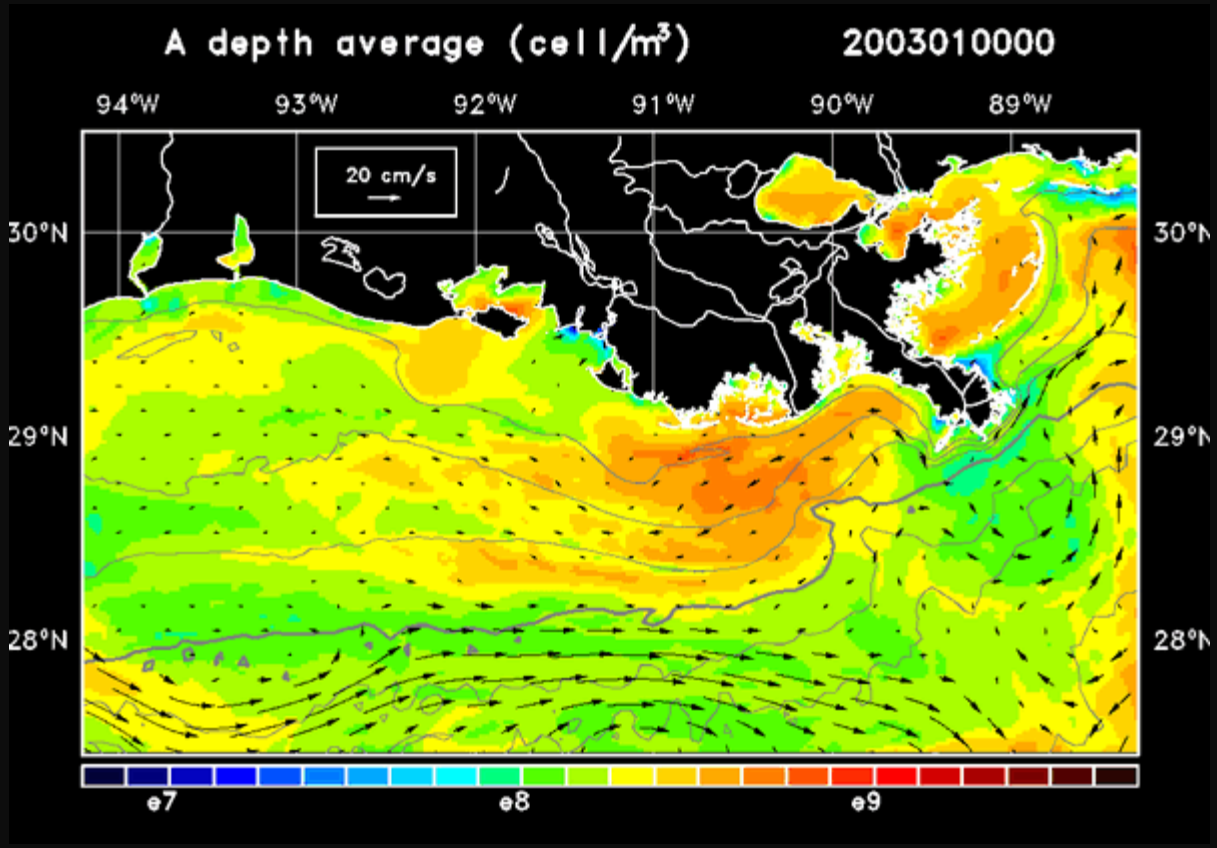
Vertical Variation is also due to Migration, Growth, Death and 3D Advection by the Current



Day-Night Variation

GEM3D Simulation - Phytoplankton

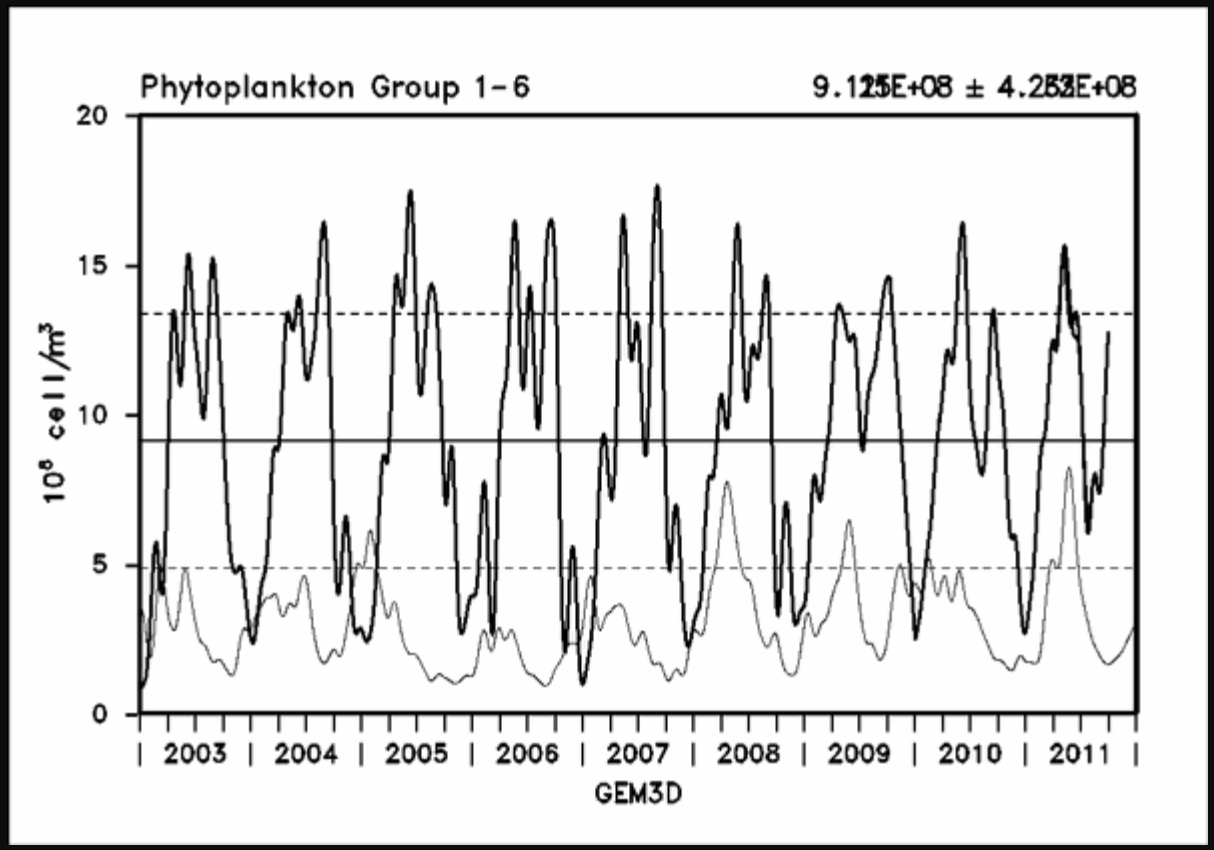
Total (Monthly Average)



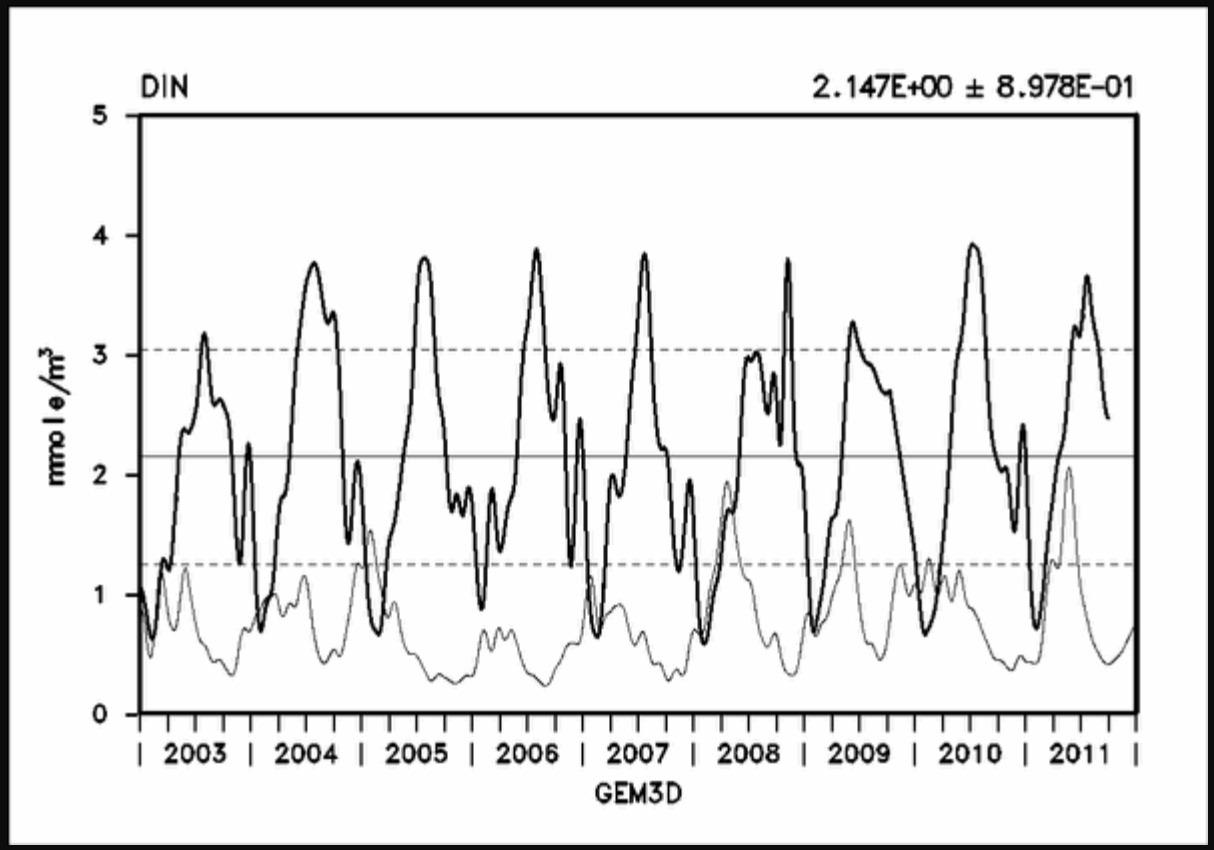
- Initialized with NOAA NODC monthly DIN, DIP and DO climatology
- The monthly climatology is also used for the open boundary conditions
- Real-time daily river runoff from USACOE/USGS

GEM3D Simulation - Phytoplankton

Total 6 Groups

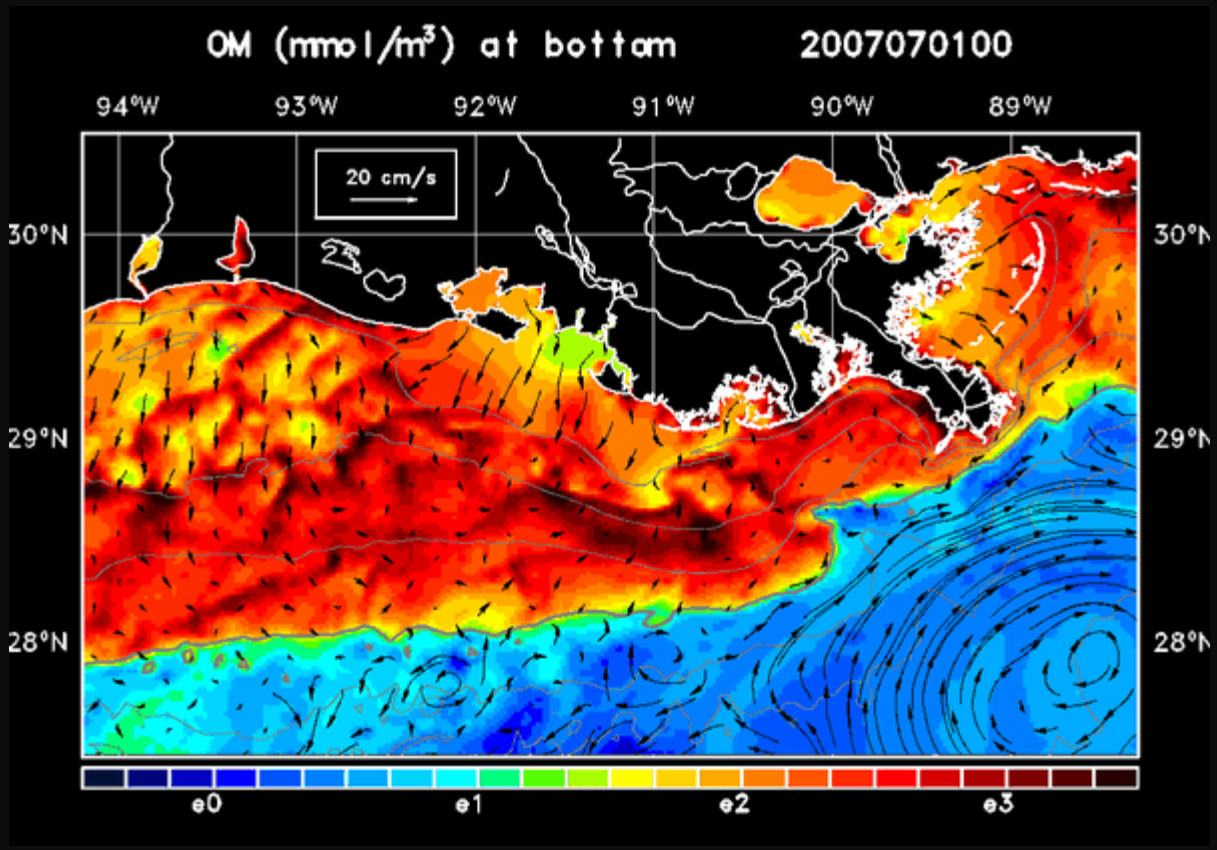


GEM3D Simulation - DIN



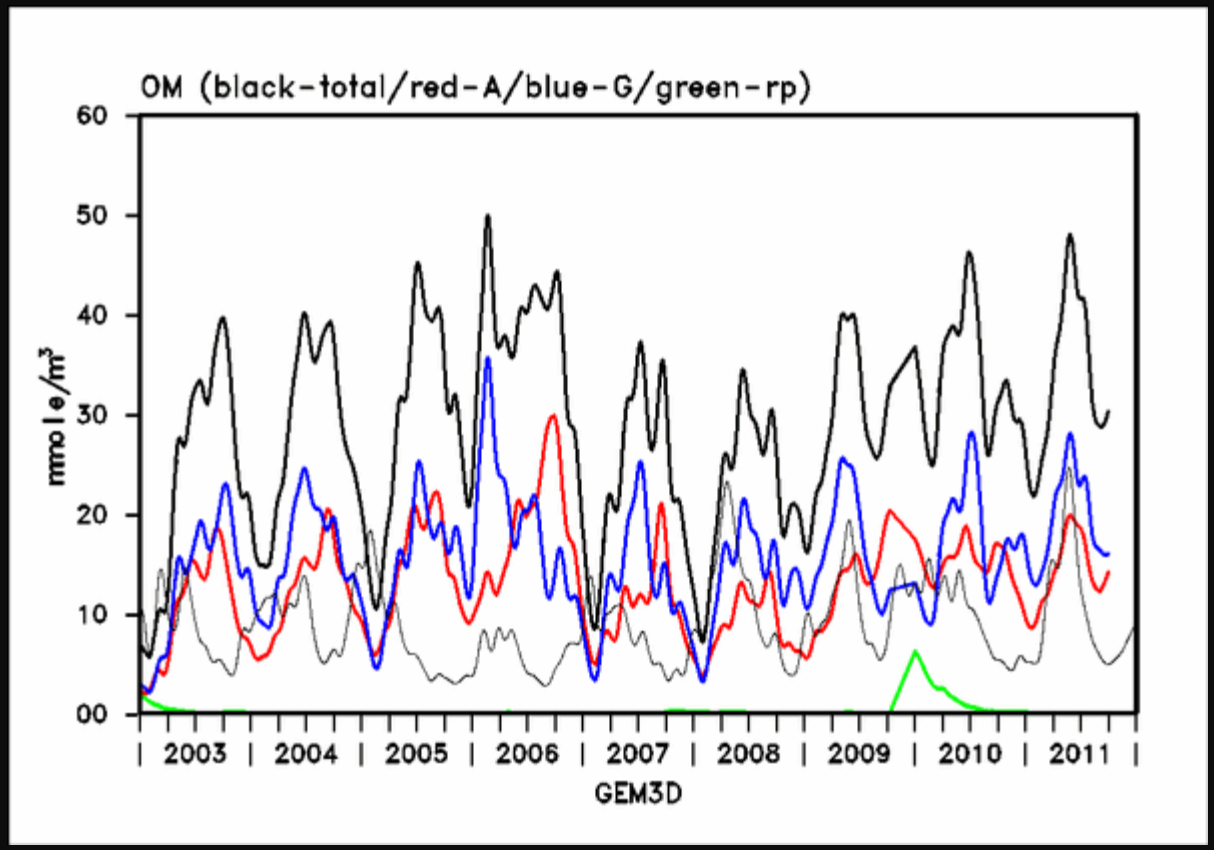
GEM3D Simulation - OM at Bottom

Daily



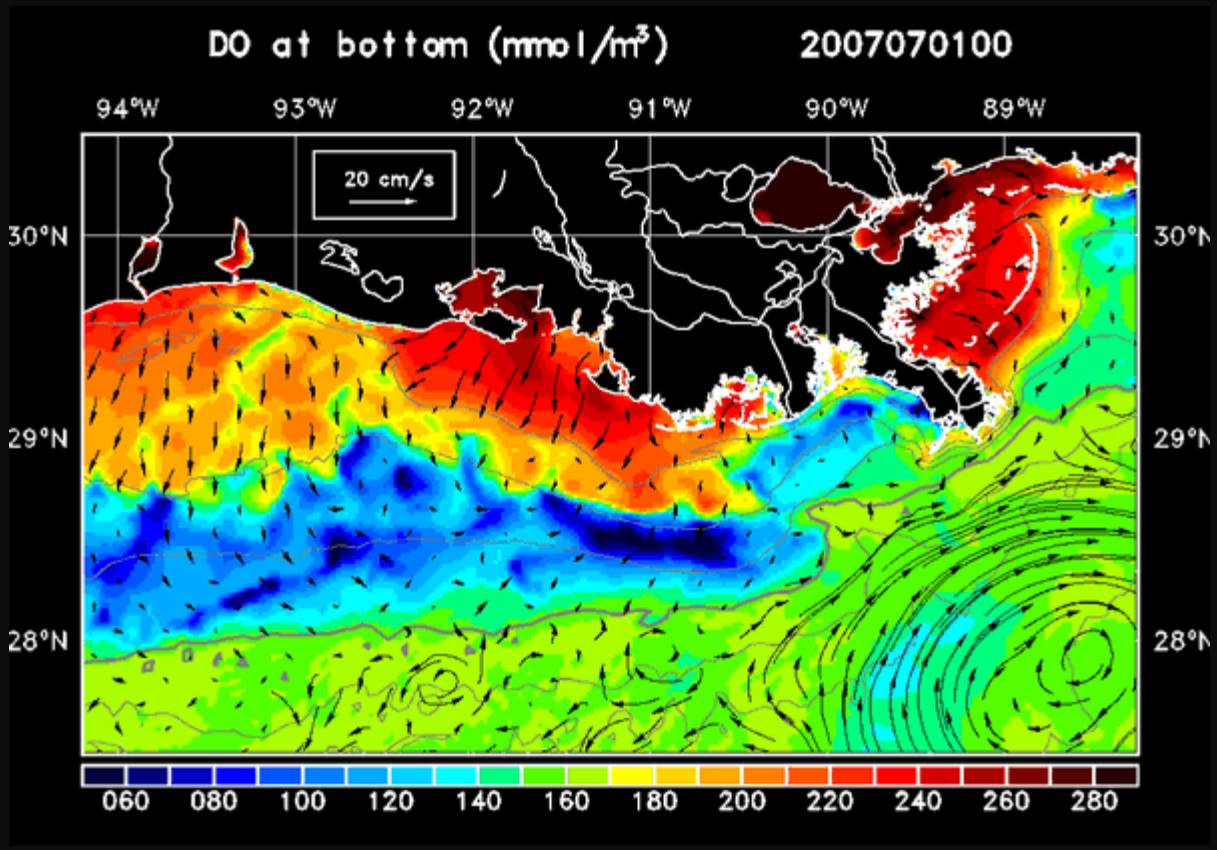
GEM3D Simulation – OM

3 Groups



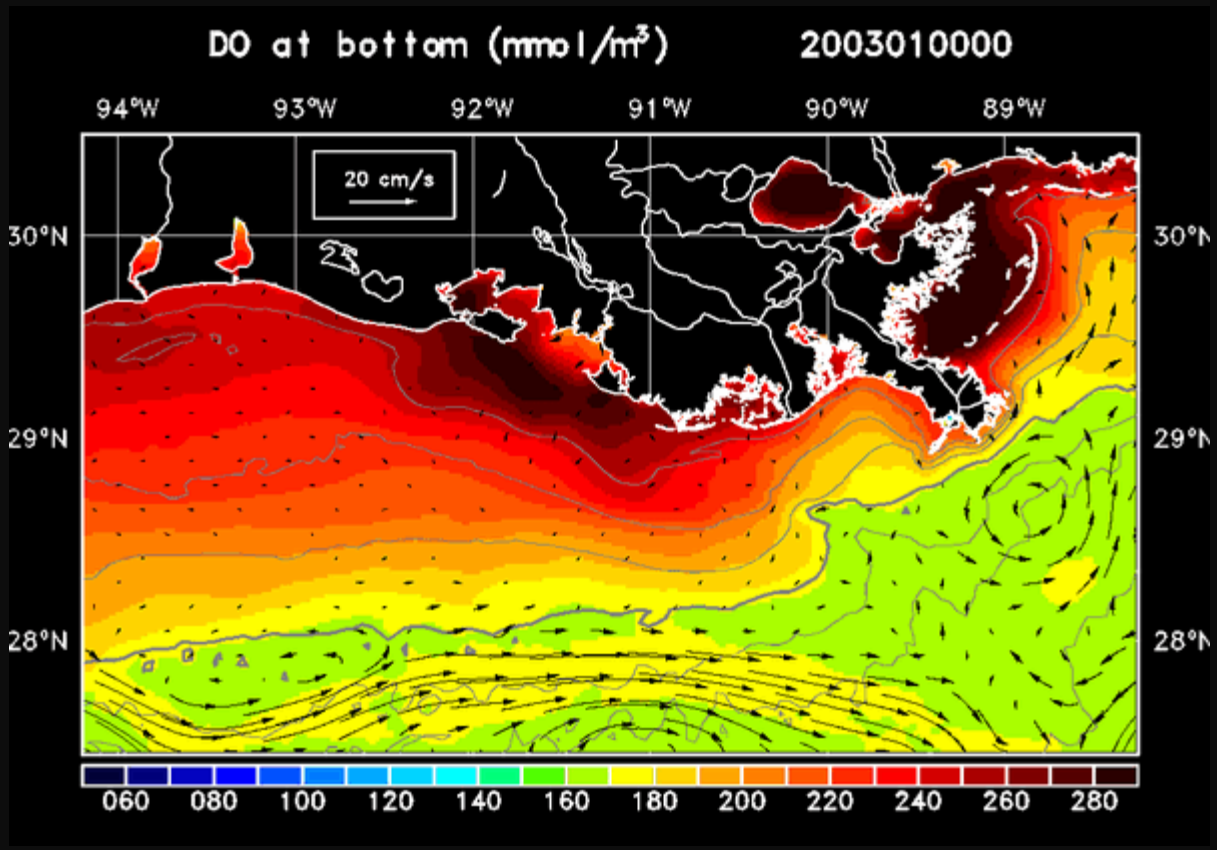
GEM3D Simulation - Bottom Water DO

Daily

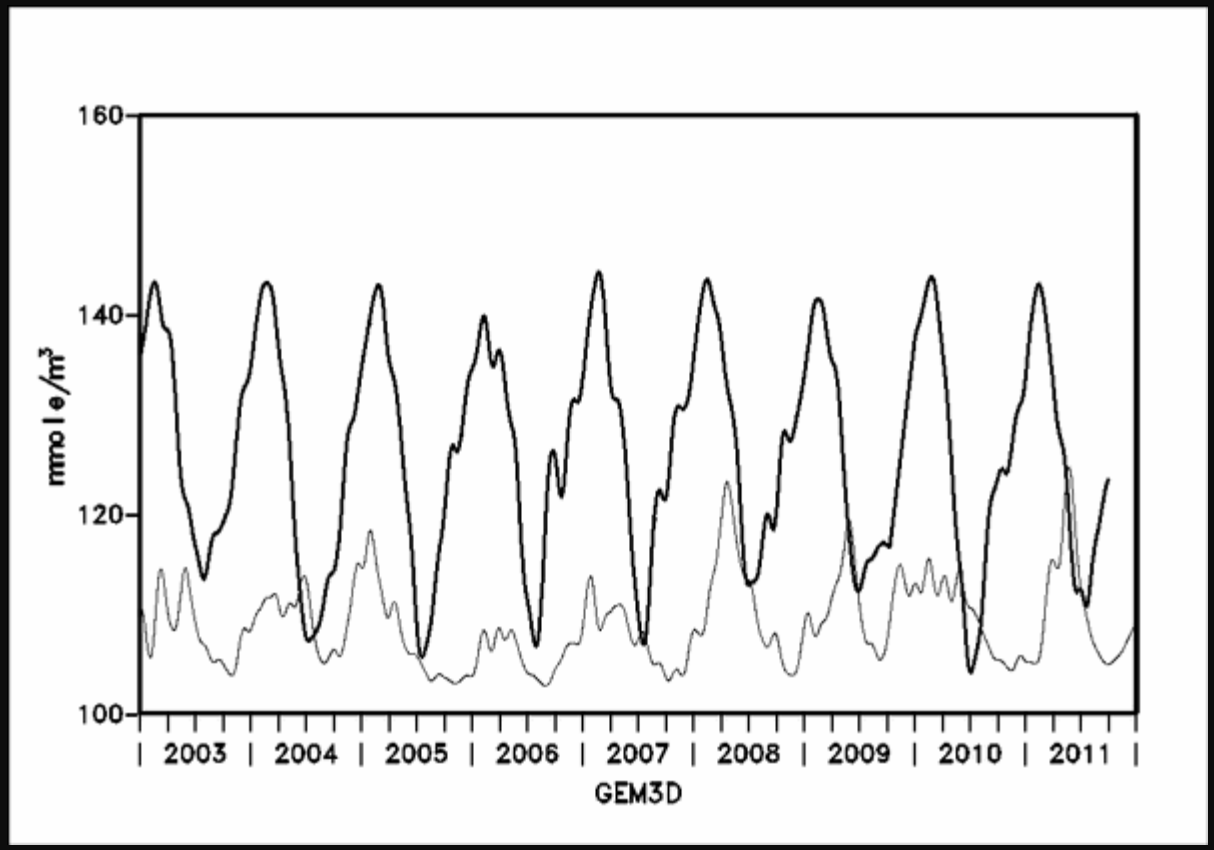


GEM3D Simulation - Bottom Water DO

Monthly Average

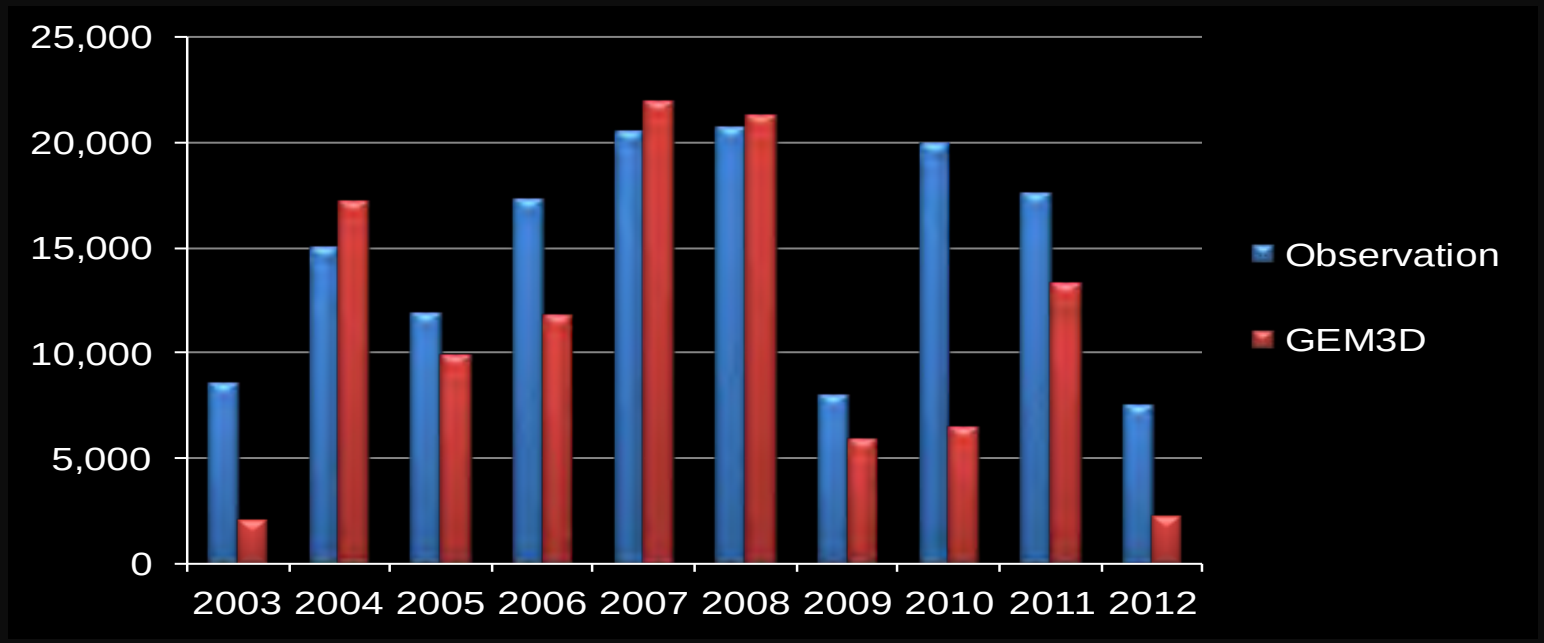


GEM3D Simulation - DO



EPA-GEM3D Simulation - Area of Bottom Water Hypoxia

Each Season from 2003 to 2012



Observation

Year	Square Kilometers	Square Miles
1998	12,480	4,811
1999	20,000	7,710
2000	4,400	1,696
2001	20,720	7,988
2002	22,000	8,481
2003	8,560	3,300
2004	15,040	5,798
2005	11,840	4,564
2006	17,280	6,662
2007	20,500	7,903
2008	20,720	7,988
2009	8,000	3,084
2010	20,000	7,722

- Comparison of Observation to the model predicted area of bottom water hypoxia that is persistent over 10 days or over 15 days for the season.
- The observed area of bottom water hypoxia is an estimation based on ship surveys. The estimation for 2011 is 17,548 km^2 (LUMCON). For 2012 is 7,480 km^2 (Jul 27).
- For 2010, the hypoxic zone is in part located at Texas shelf out of model domain.