An Overview of Shelf Hypoxia Efforts in the SURA Super-Regional Modeling Testbed

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IOOS Testbed Project

- **5 teams, 64 scientists/analysts**
- **SURA is overall lead**
- **One year project (May 2010-11)**
  - **NCE to Dec 2011**
- **Multi-sector engagement**
  - **federal, academia, industry**
- **Goals:**
  - o Less about models than process
    - o Enable modeling and analysis
  - o Stable infrastructure focus
    - o testing environment
    - o tools
    - o standard observations
    - o ***transition to operations (R2O)***

Coastal Inundation
Gulf & Atlantic Coast
Rick Leuttich, UNC-CH

Shelf Hypoxia
Gulf of Mexico
John Harding, NGI

Estuarine Hypoxia
Chesapeake Bay
Carl Friedrichs, VIMS

Cyber Infrastructure
Eoin Howlett, ASA

Testbed Advisory
Evaluation Group
Rich Signell, USGS

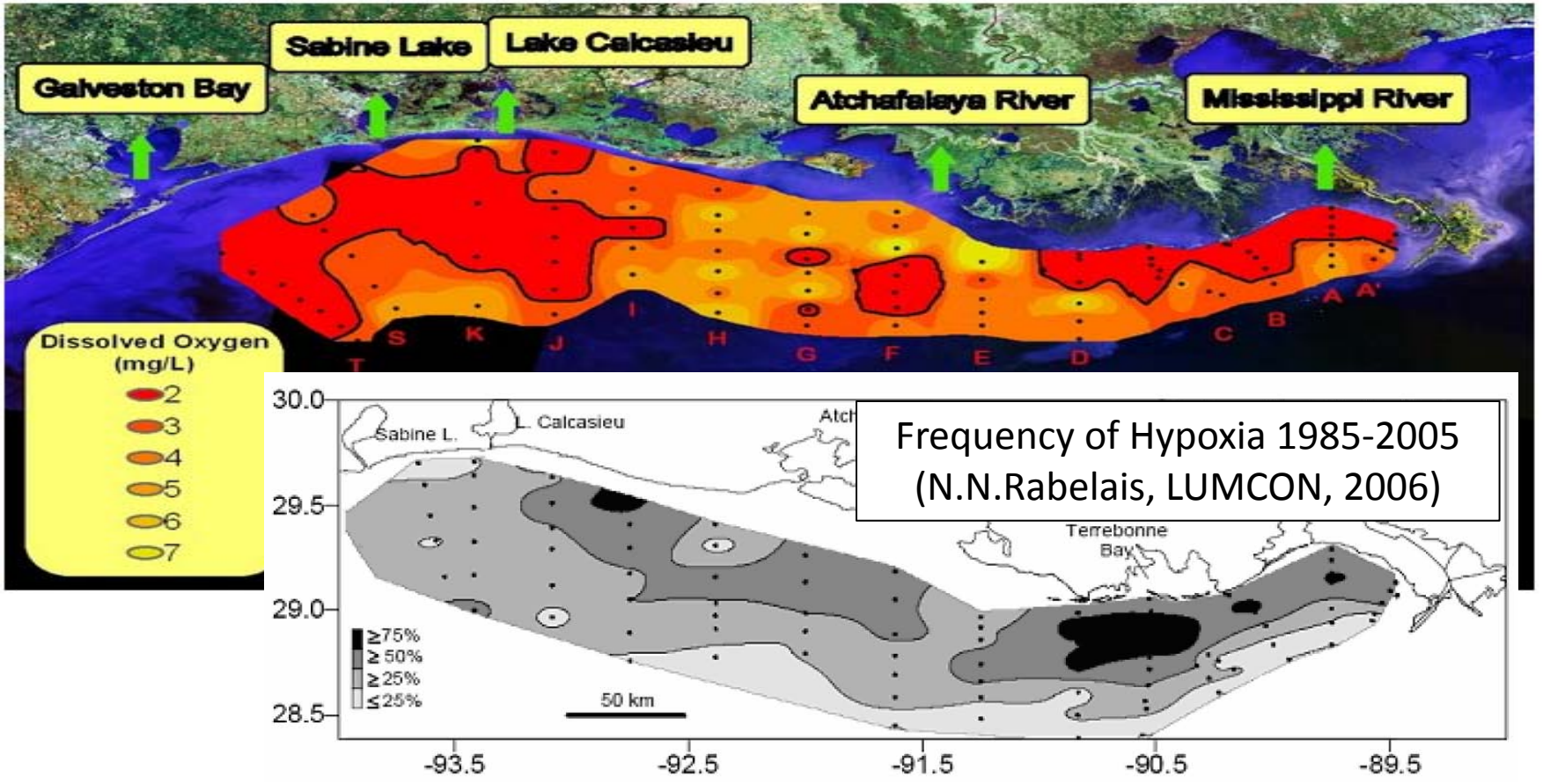
Hypoxia in the Northern Gulf of Mexico
Definition

- Concentration of dissolved oxygen
  - < 2 mg/L (2 ppm)
- Observation Based
  - fish and shrimp species normally present not captured in bottom-dragging trawls at oxygen levels < 2mg/L.

http://www.gulfhypoxia.net/Overview/

The Problem: The Dead Zone

LUMCON Annual Shelfwide Cruise Data – 24-31 July 2010



Top image courtesy of LUMCON: http://www.gulfhypoxia.net/Overview/

Source of the Problem: Nutrient Rich Fresh Water

41% of Lower 48 Drainage
90% of Gulf Fresh Water
1.6M MT annual Nitrogen

Image courtesy of LUMCON: http://www.gulfhypoxia.net/Overview/

Dead Zone Dynamics

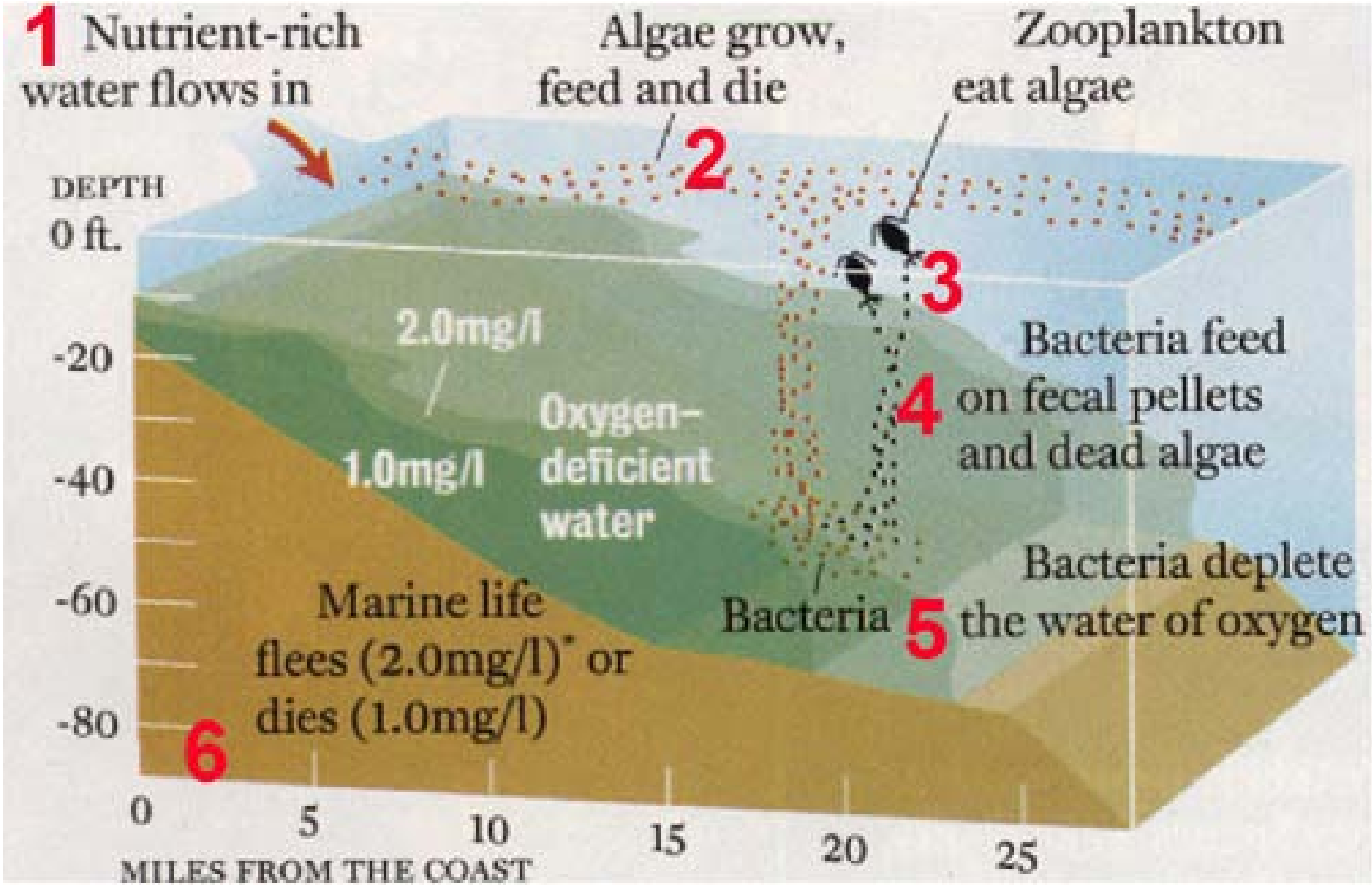
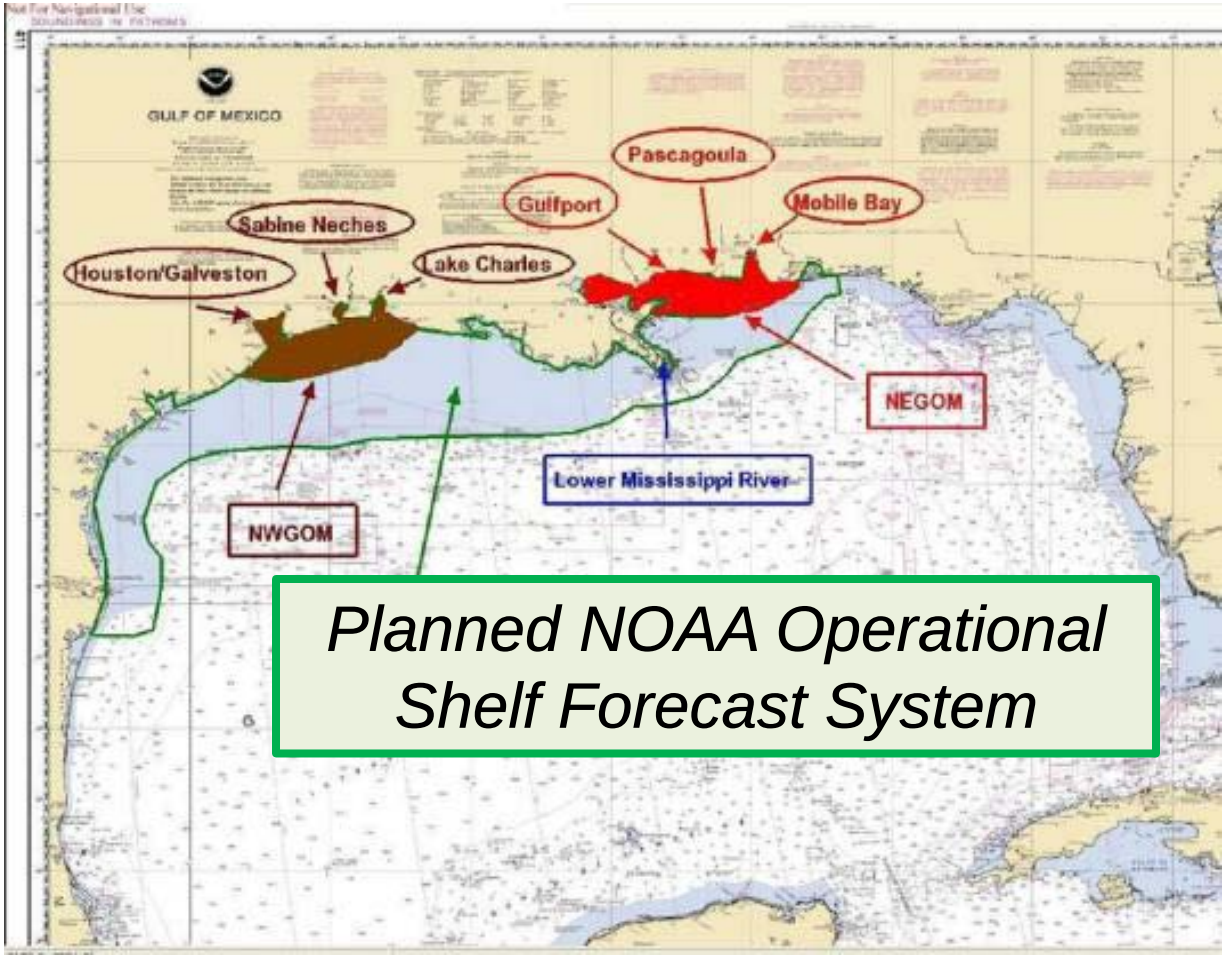


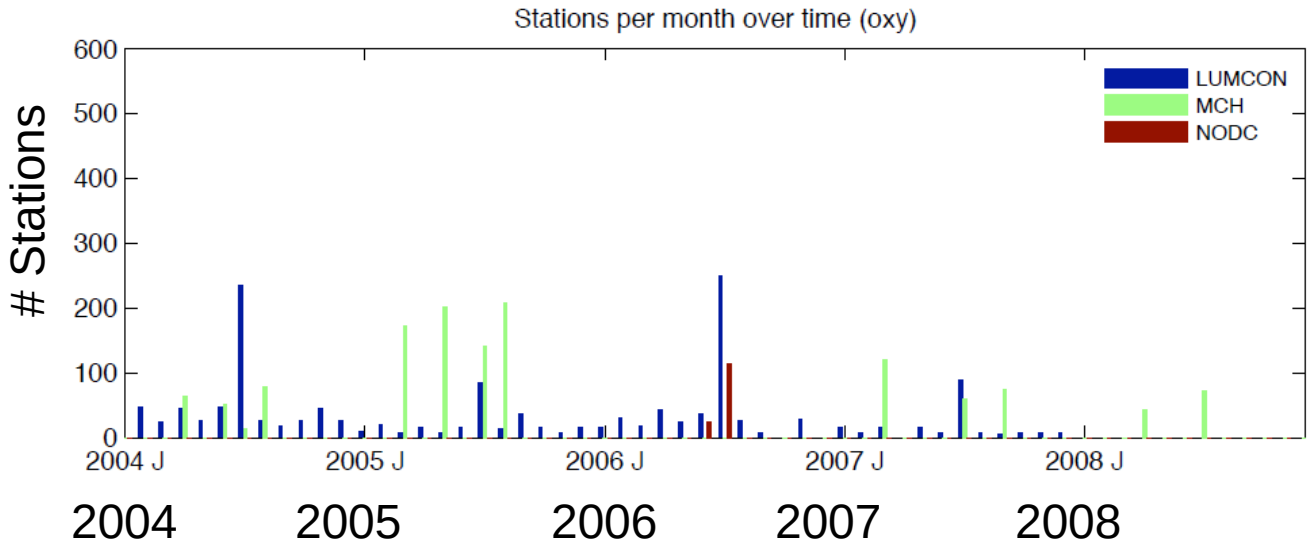
Image courtesy of LUMCON: http://www.gulfhypoxia.net/Overview/

Shelf Hypoxia Testbed Approach

- Collaboration
  - R2R
  - R2O (Transition)
- Data
  - In Situ
  - Forecast System
- Models
  - Development
  - Evaluation



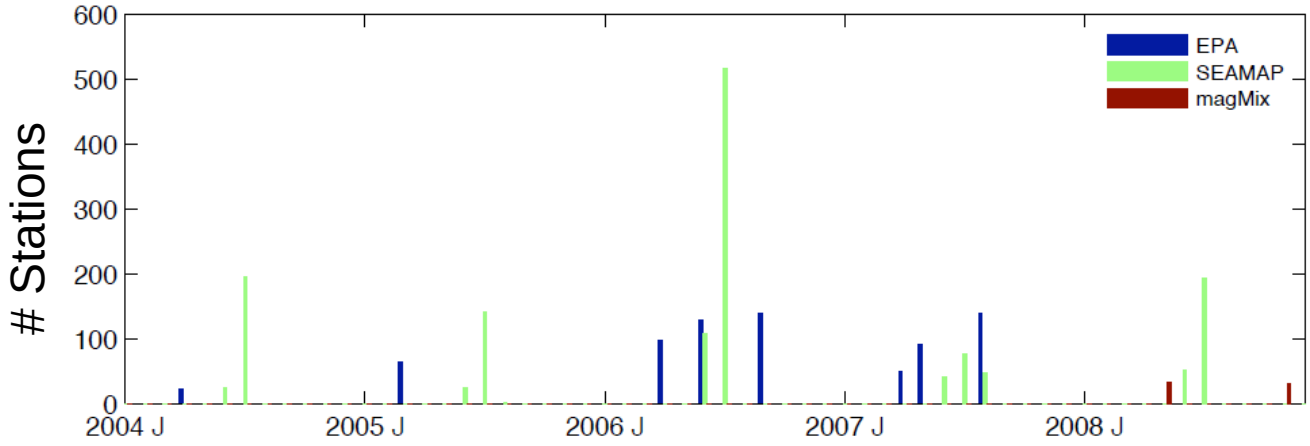
Hypoxia Data: Compile, Edit & Store



LUMCON

MCH - TAMU

NODC - NOAA



EPA

SEAMAP - NOAA

MAGMIX - USM

Data to:
SURA Site (R2R)
& NOAA NODC (R2O)

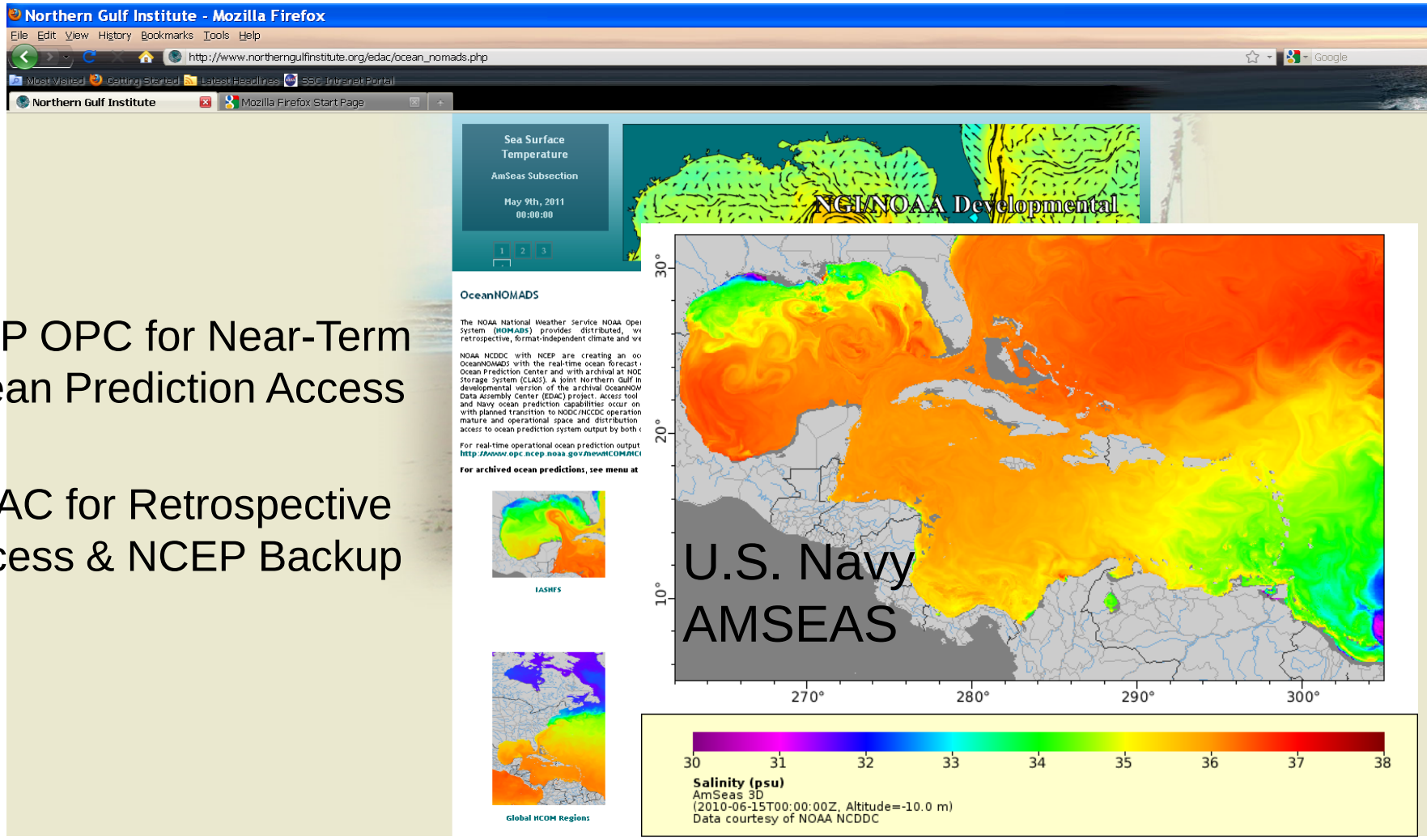
U.S. IOOS Coastal Ocean Modeling Testbed

Access to Gulf Forecasts

NGI/NCDDC EDAC/OceanNOMADS

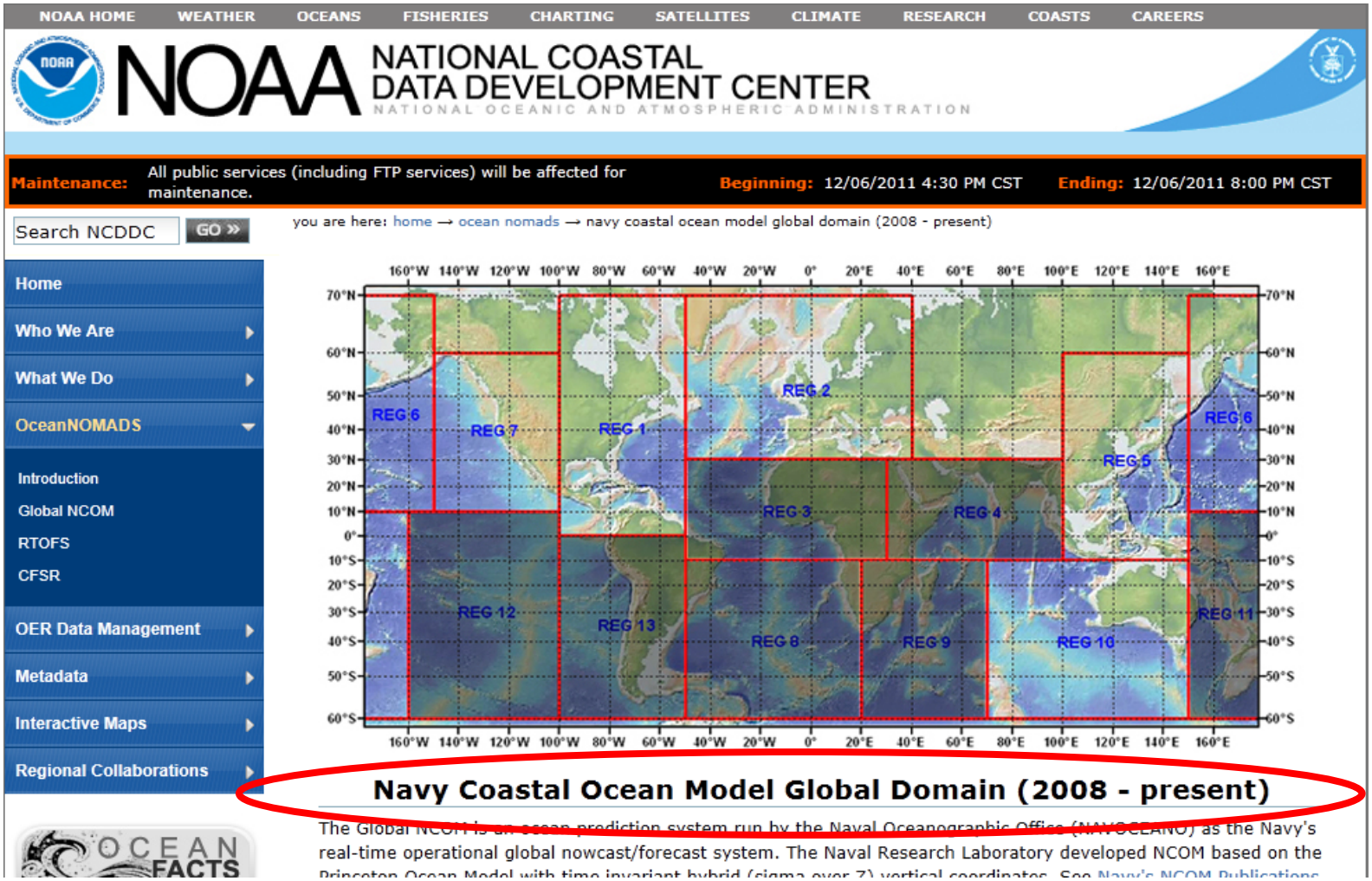
NCEP OPC for Near-Term Ocean Prediction Access

EDAC for Retrospective Access & NCEP Backup



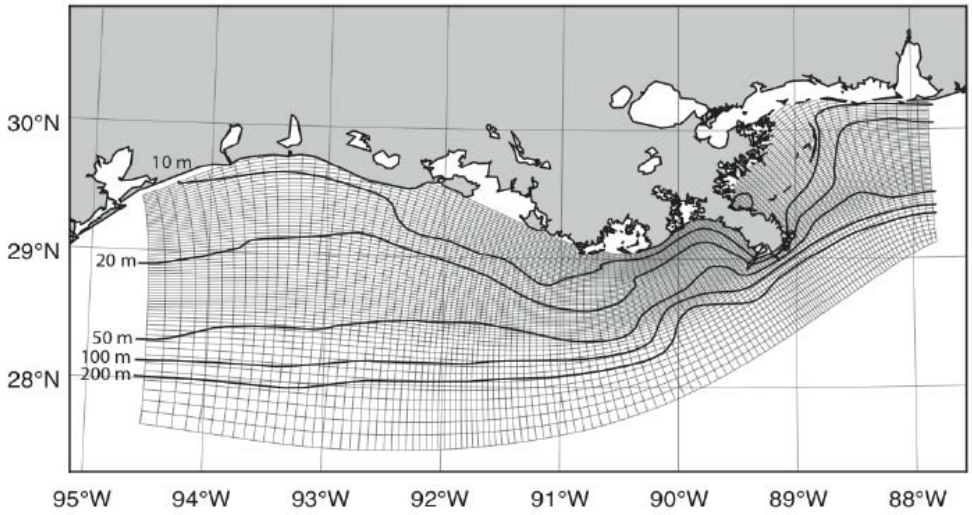
http://www.northerngulfinstitute.org/edac/ocean_nomads.php

NCDDC OceanNOMADS Production Site – R2O

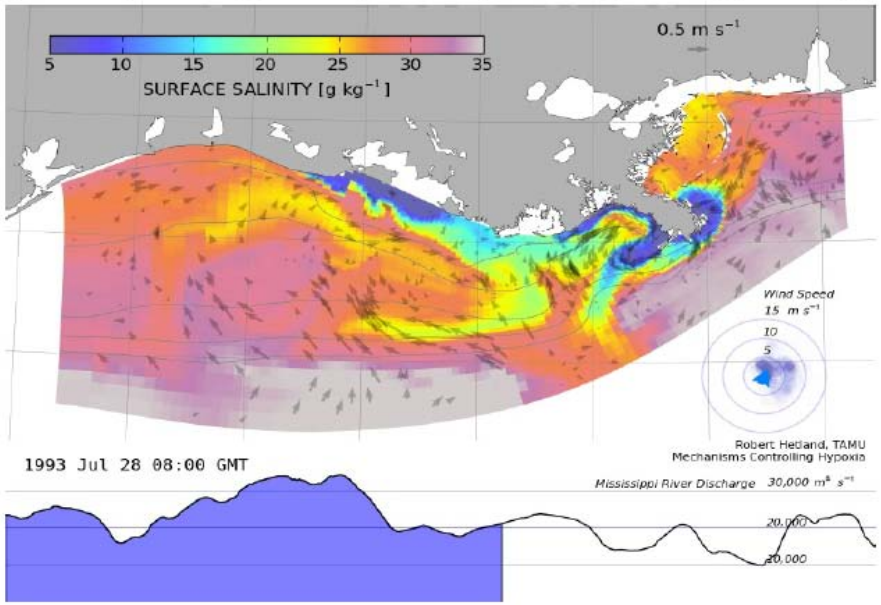


http://www.ncddc.noaa.gov/ocean-nomads

Model Development & Evaluation



Fennel/ ROMS Model Grid, Bathymetry & Sample Salinity Snapshot for 28 Jul 93



What is impact of not having offshore forcing?

Model Development & Evaluation

ROMS Salinity Skill Scores (Nested in Gulf Models):

HYCOM	0.54	
IASNFS (NCOM)	0.56	*AMSEAS Surrogate*
IASNFS 6h	0.55	
NGOM (POM)	0.51	
NGOM 3h	0.52	
CLIM (unnested)	0.38	

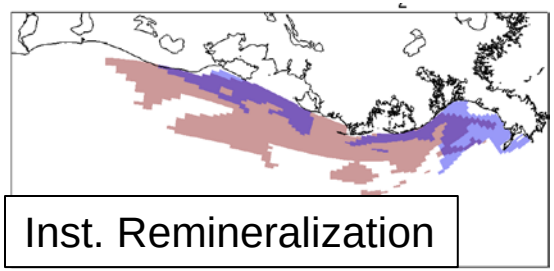
skill score = 1-sum(obs. - model) ^{2} / sum(obs.-climatology) ^{2}

(salinity data from MCH program profiles for 2004-8, from surface to 50 m)

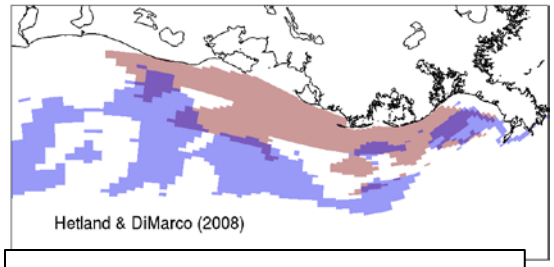
Model Development & Evaluation

Impact of Nesting on Hypoxic Area less obvious

July 2004 - unnested

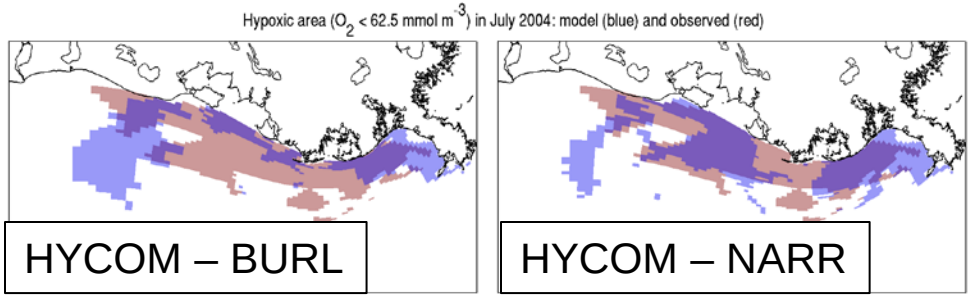


Inst. Remineralization



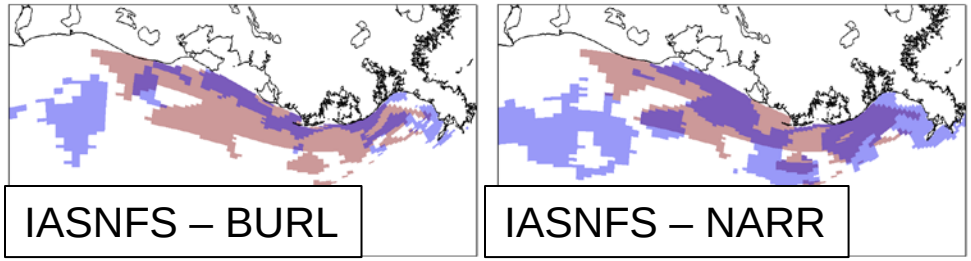
Hetland & DiMarco, 2008

July 2004 - nested



HYCOM – BURL

HYCOM – NARR

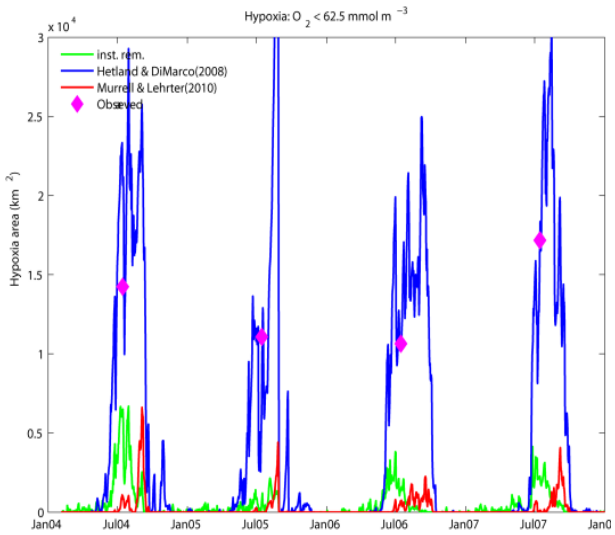


IASNFS – BURL

IASNFS – NARR

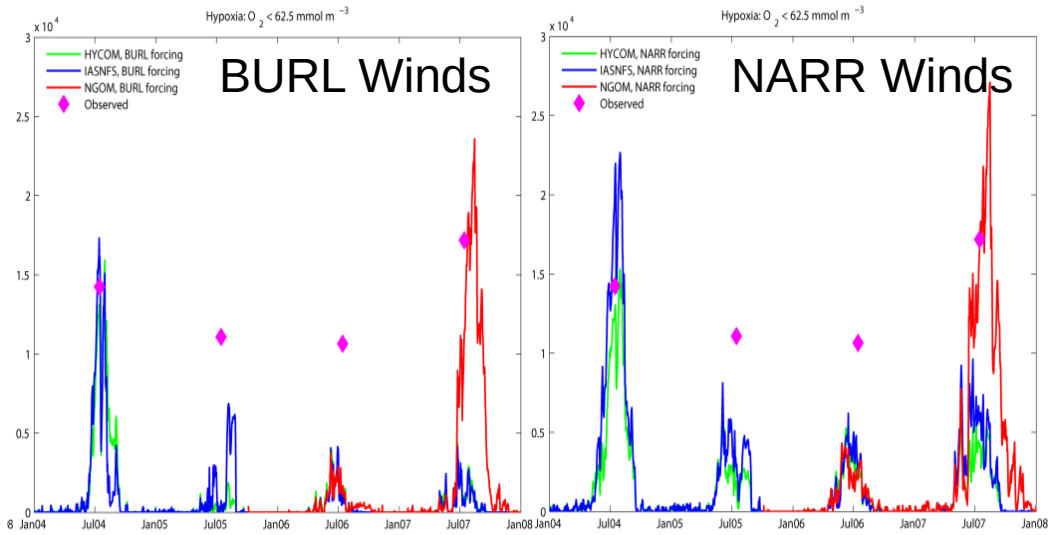
Model Development & Evaluation

unnested



nested

Hypoxic Area



Inst. Remineralization
green

Hetland & DiMarco, 2008
blue

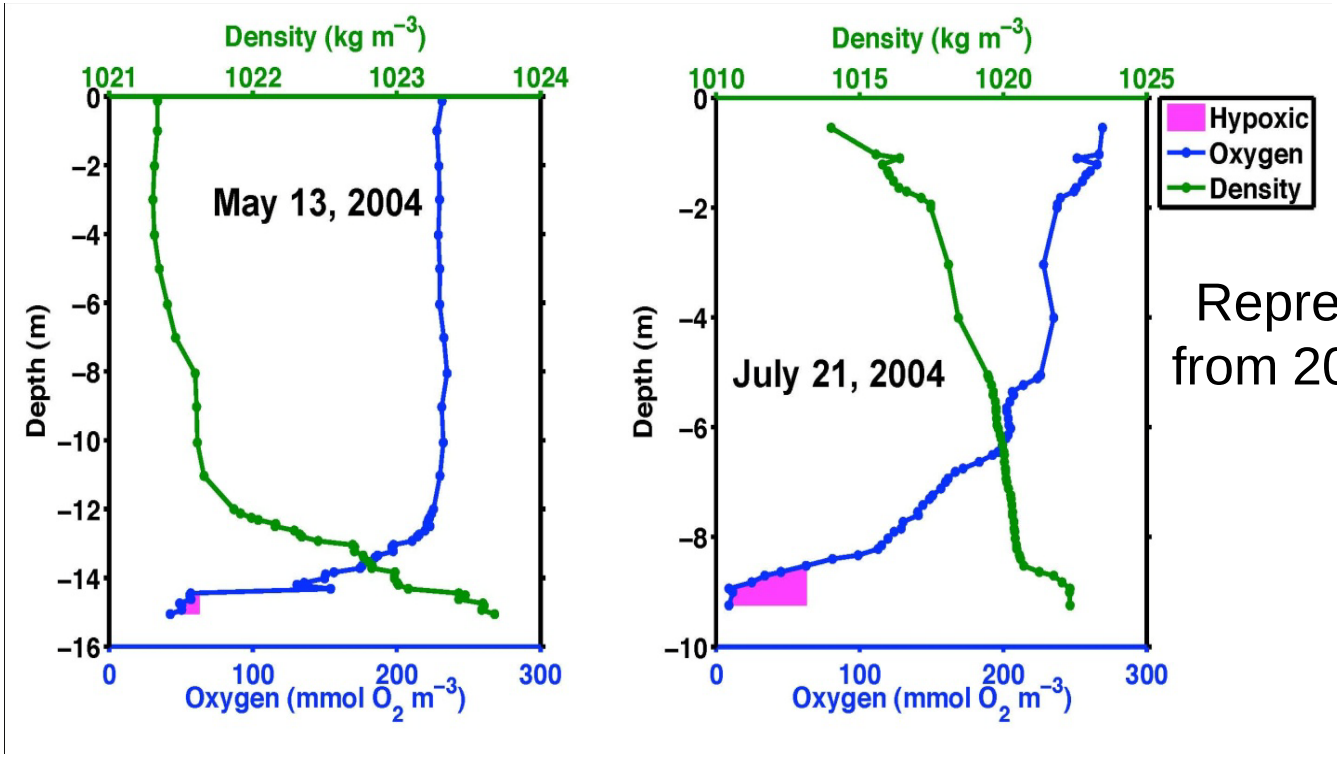
HYCOM
green

IASNFS
blue

NGOM
red

LUMCON Cruise Data
magenta diamonds

Model Development & Evaluation

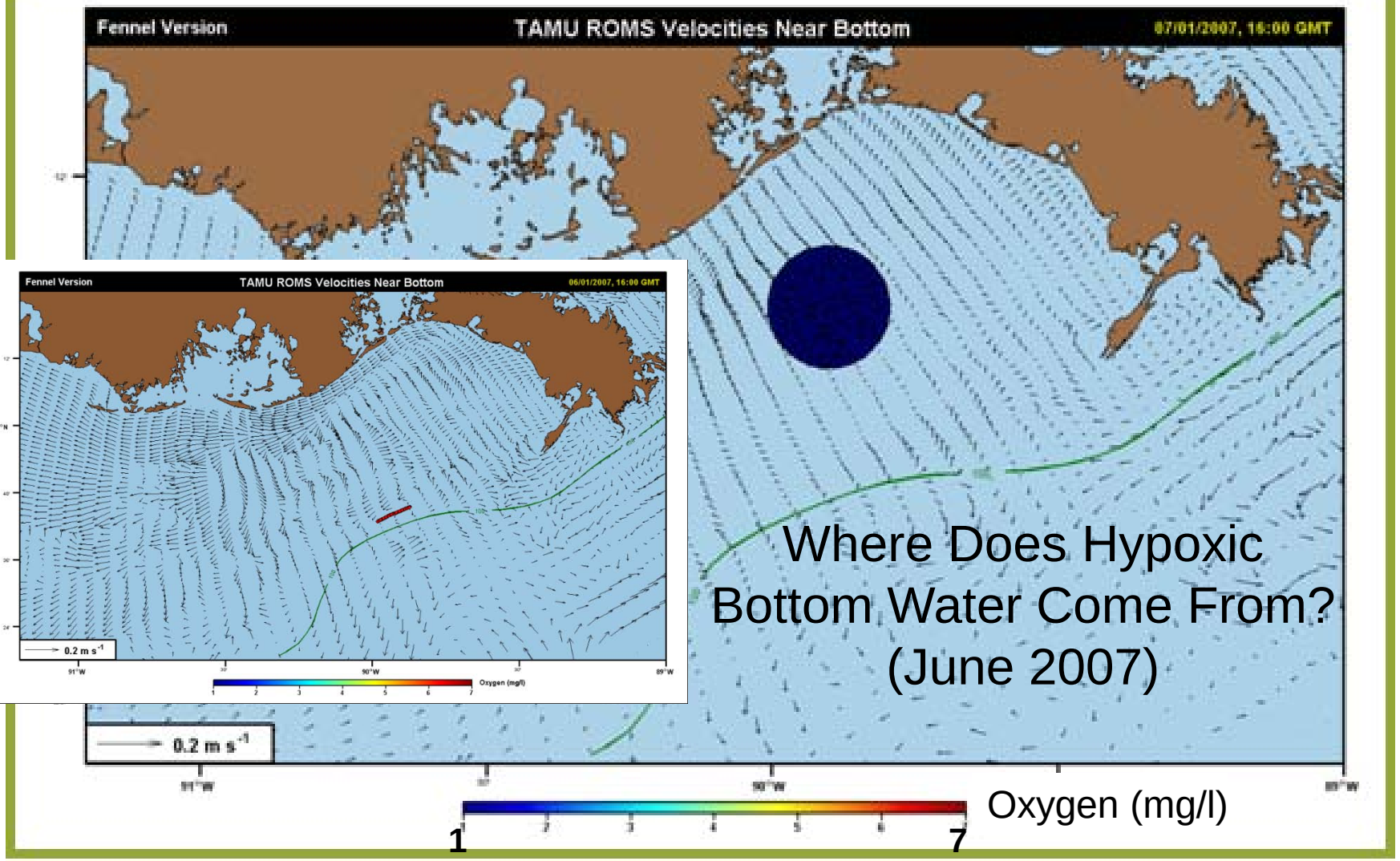


Representative O_2 profiles from 2004 LUMCON Cruises

Indefinite impact of nesting likely due to biogeochemistry being more important than horizontal boundaries in this present generation of biogeochemical models

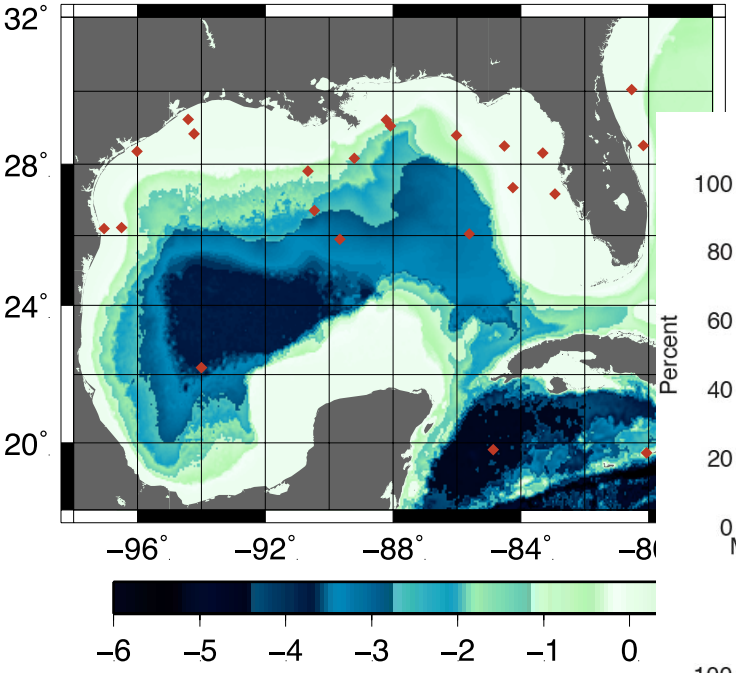
Biogeochemical models need attention on vertical resolution of bottom boundary layer, treatment of vertical diffusion & sediment interface biogeochemistry

Model Development & Evaluation



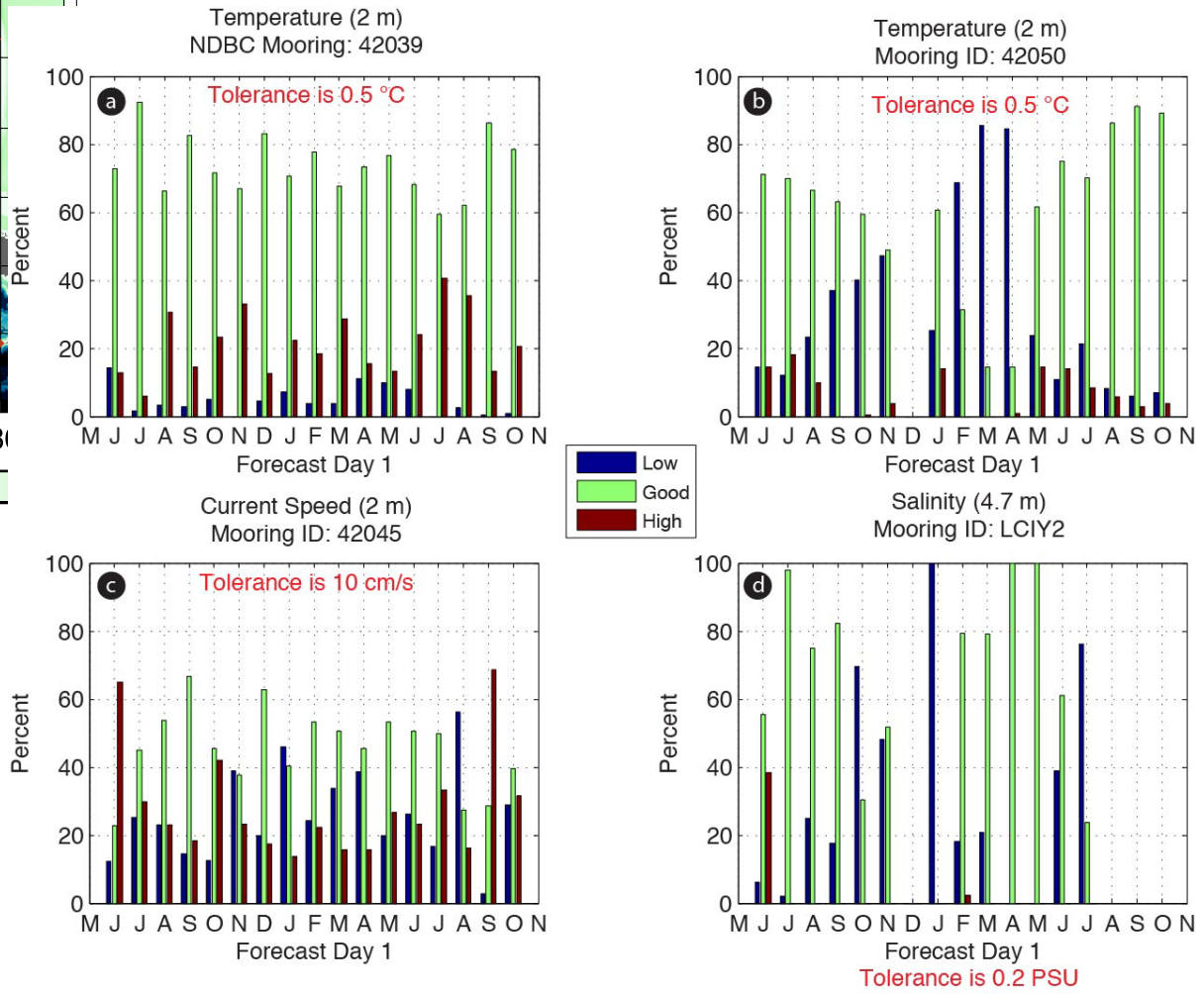
Courtesy Bruce Lipphardt, U. Delaware

Model Evaluation - R2O

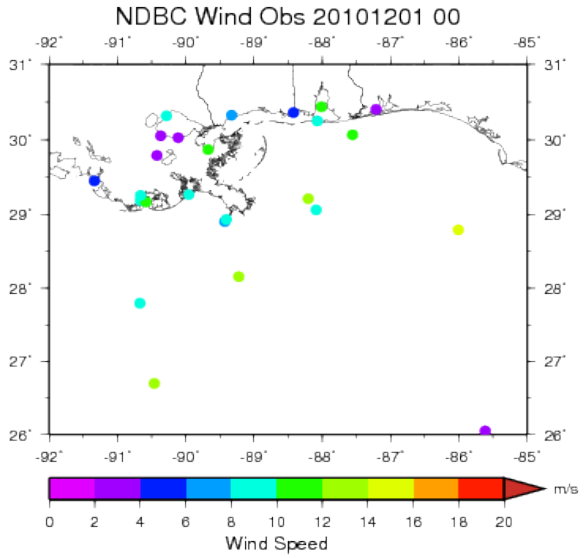


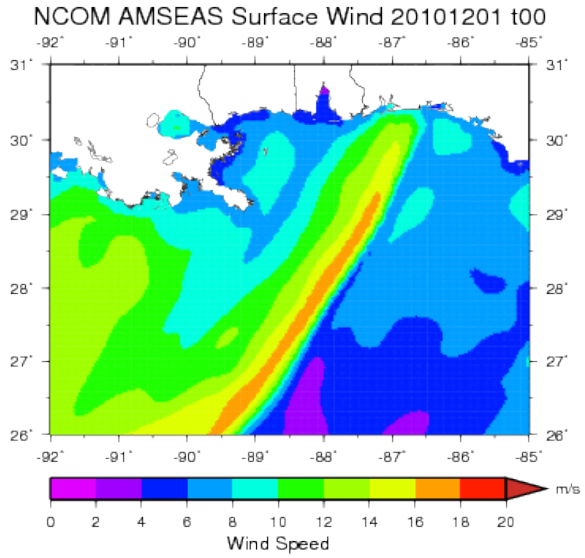
Mooring Sites used in AMSEAS evaluations (from NOAA NDBC)

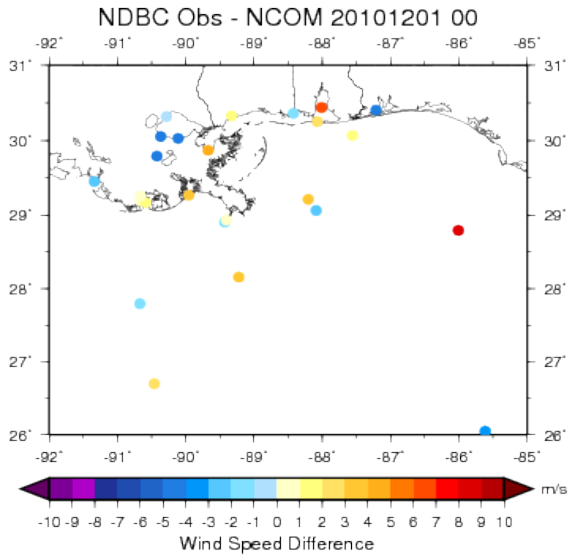
Sample evaluation plots – 4 Different Stations Temperature, Currents and Salinity

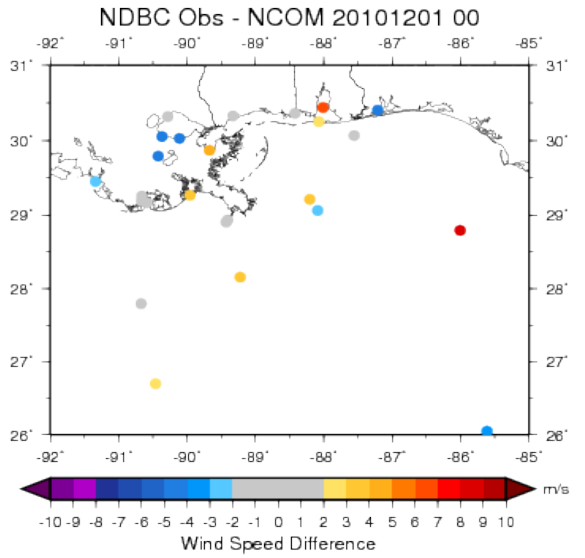


Model Evaluation - R2O







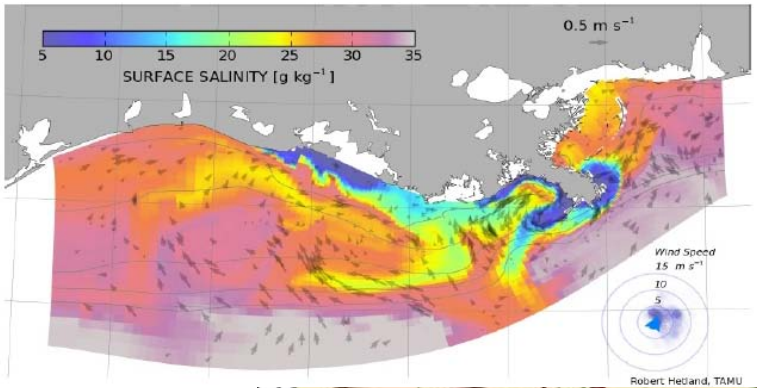


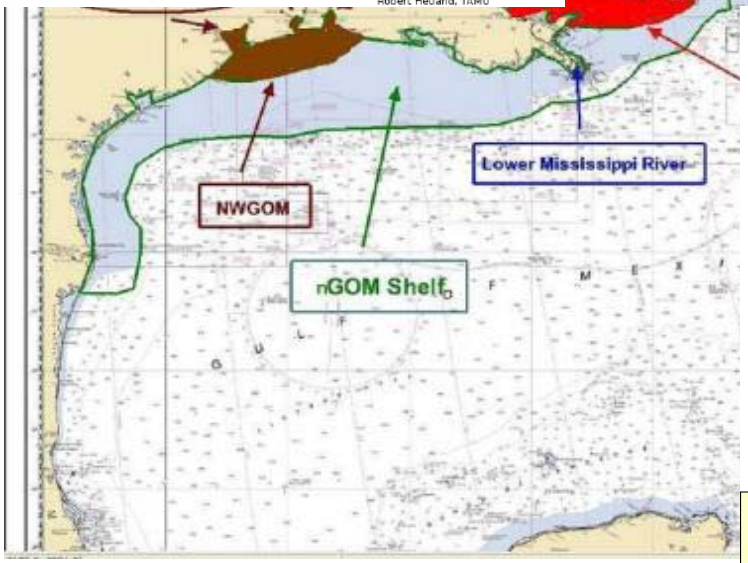
AMSEAS COAMPS Wind Comparisons (speed: m/s)

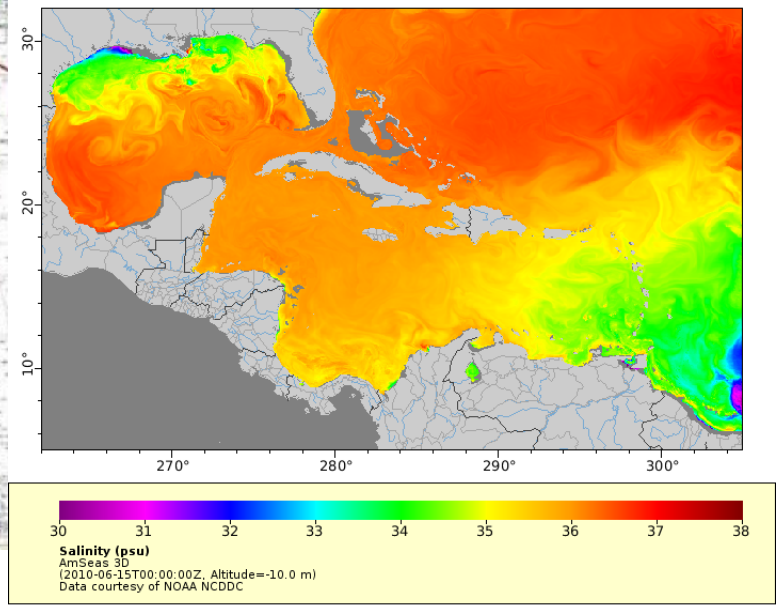
Images courtesy Pat Fitzpatrick & Yee Lau (MSU)

Technical Report @ http://testbed.sura.org/

QUESTIONS?







Final Report @ http://testbed.sura.org/