Forecasting Gulf of Mexico Hypoxia under Scenarios of Watershed and River Management

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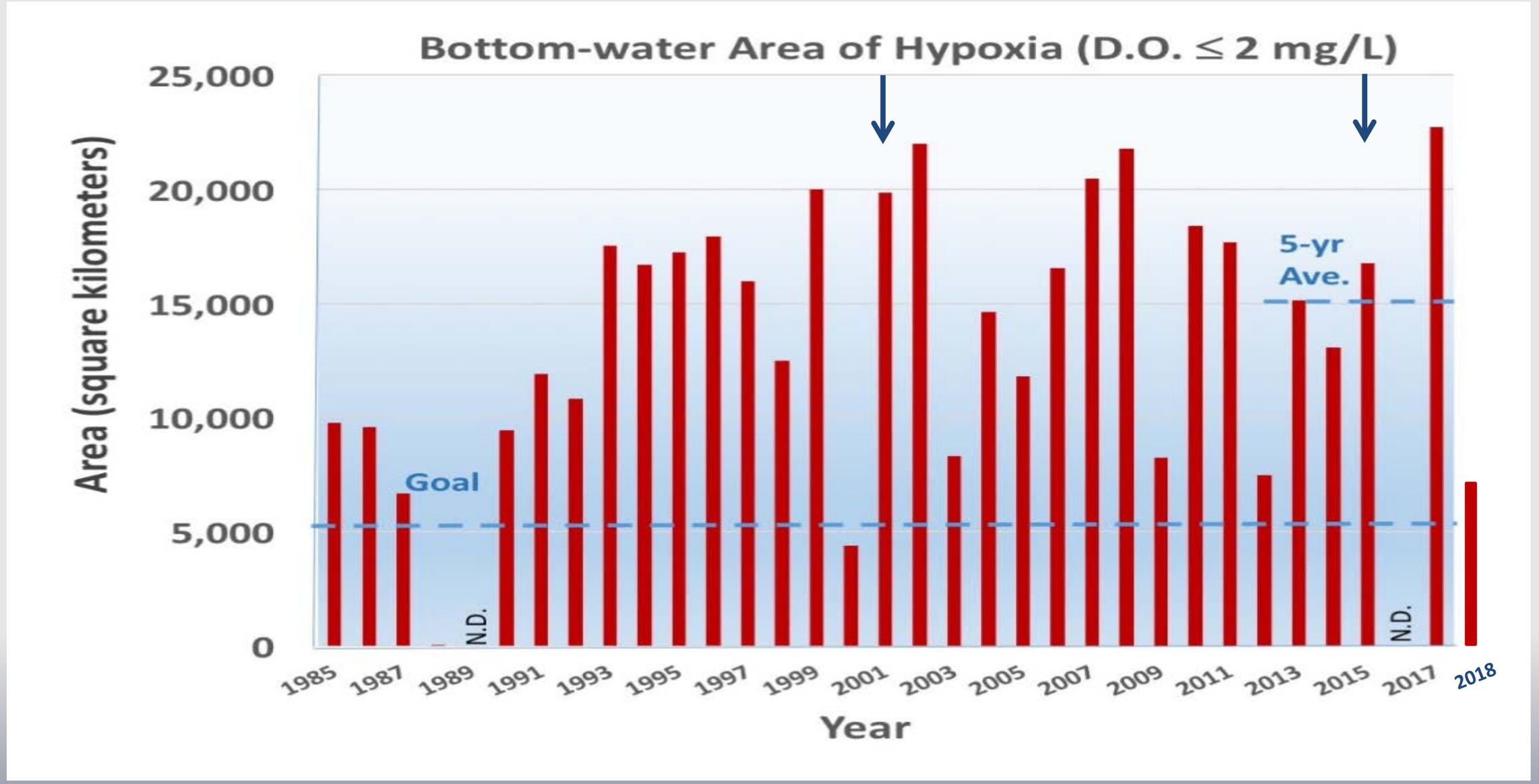
COASTAL WATERS CONSORTIUM

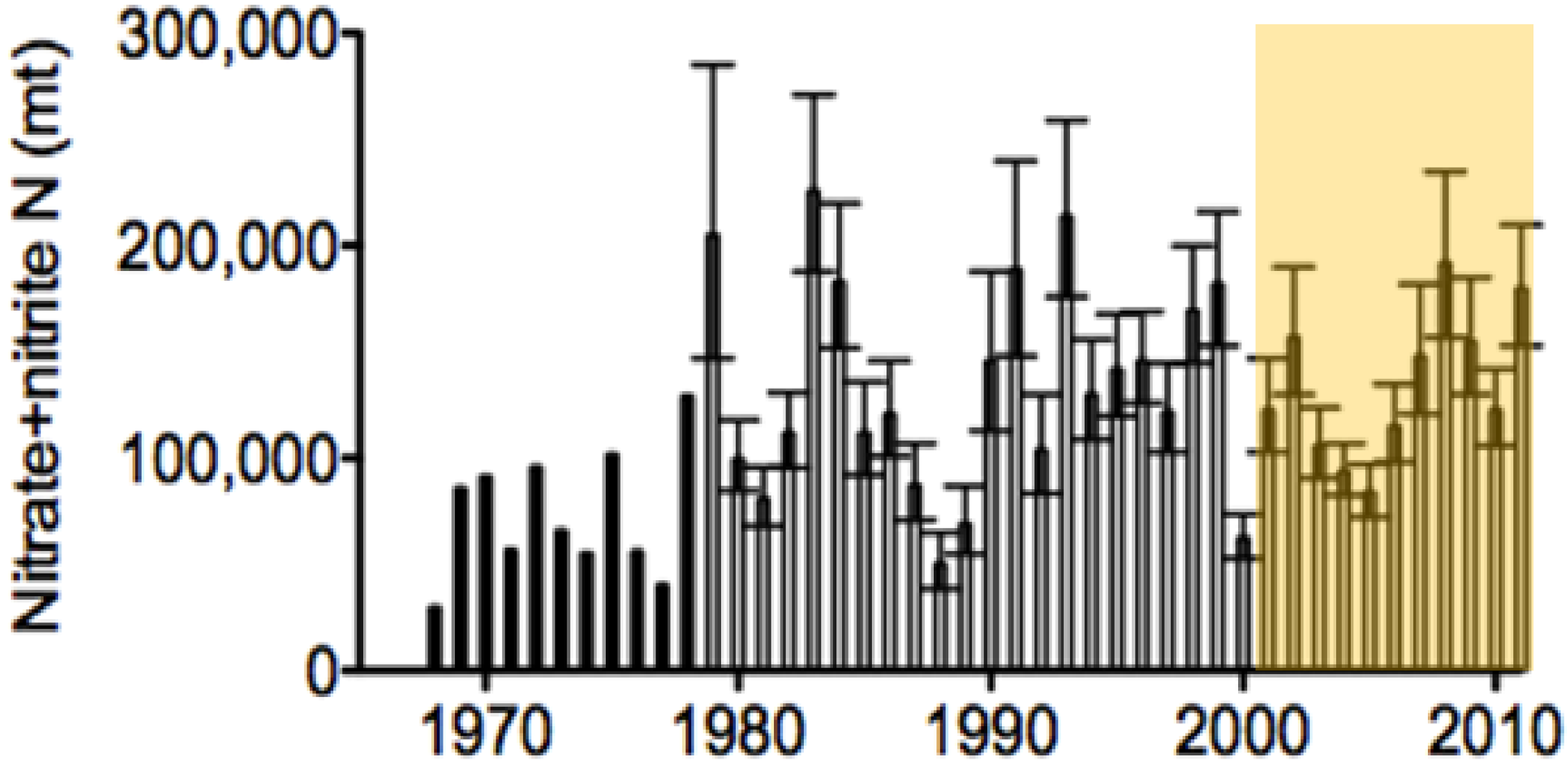
Extent of Gulf Hypoxia 1985 - 2018



www.gulfhypoxia.net

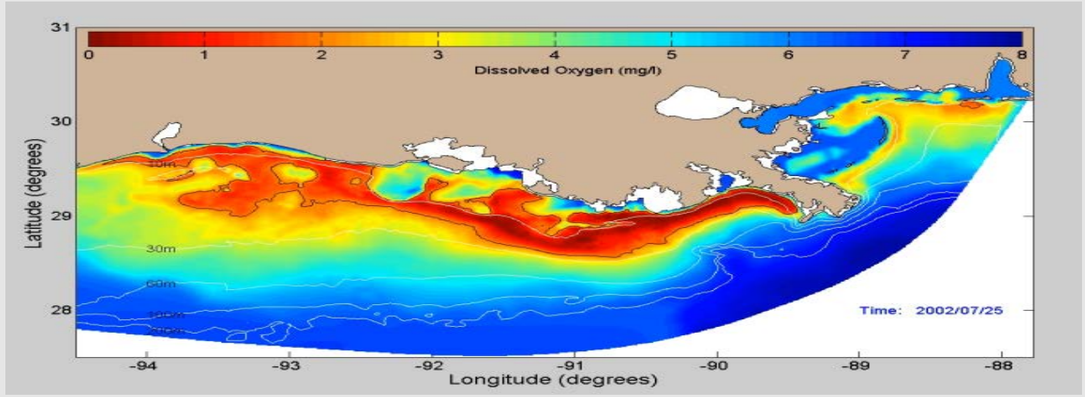
Annual Nitrogen Loading

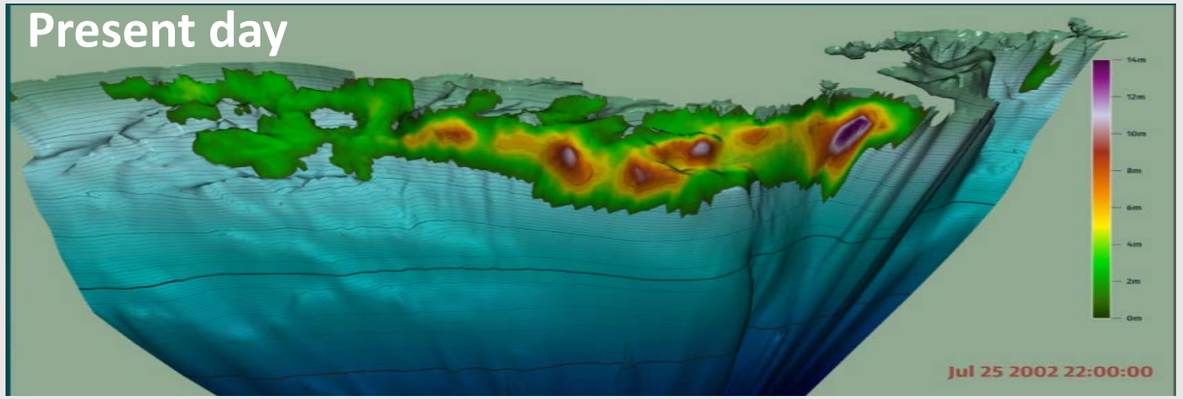
Mainstem and Atchafalaya Channels

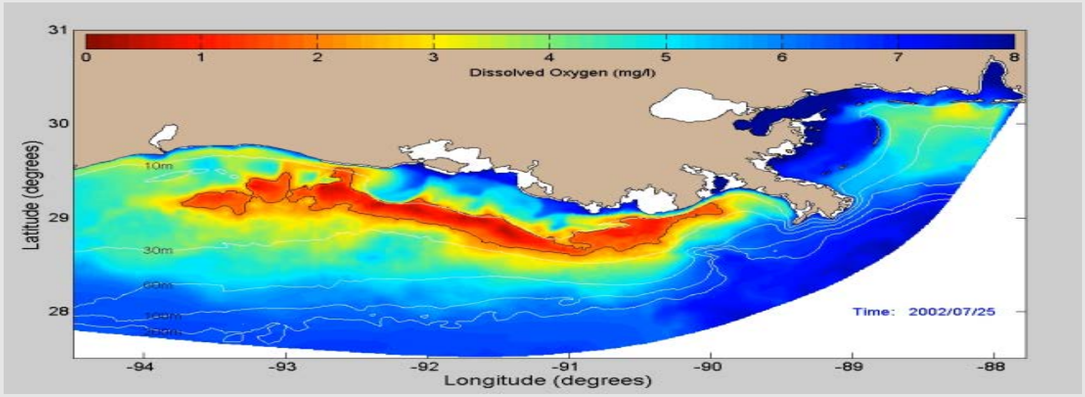


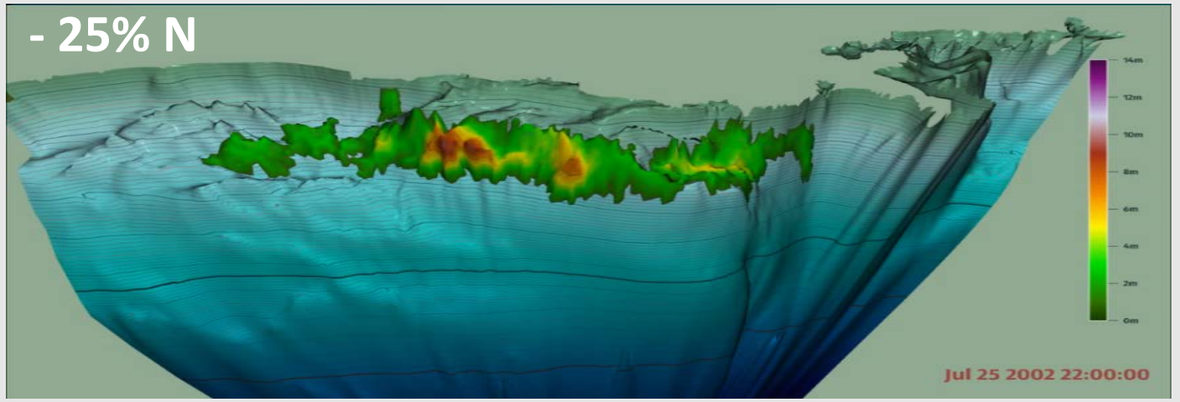
Turner et al. (2012)

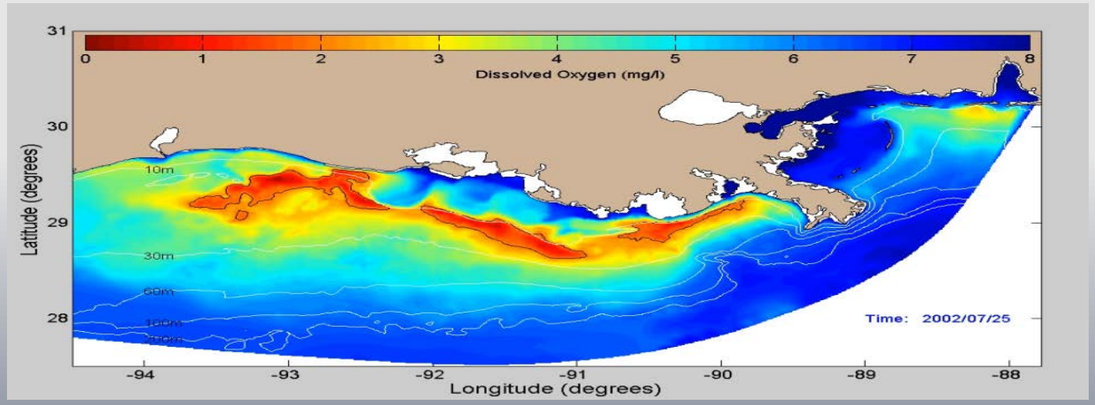
Simulated Gulf Hypoxic Area and Volume

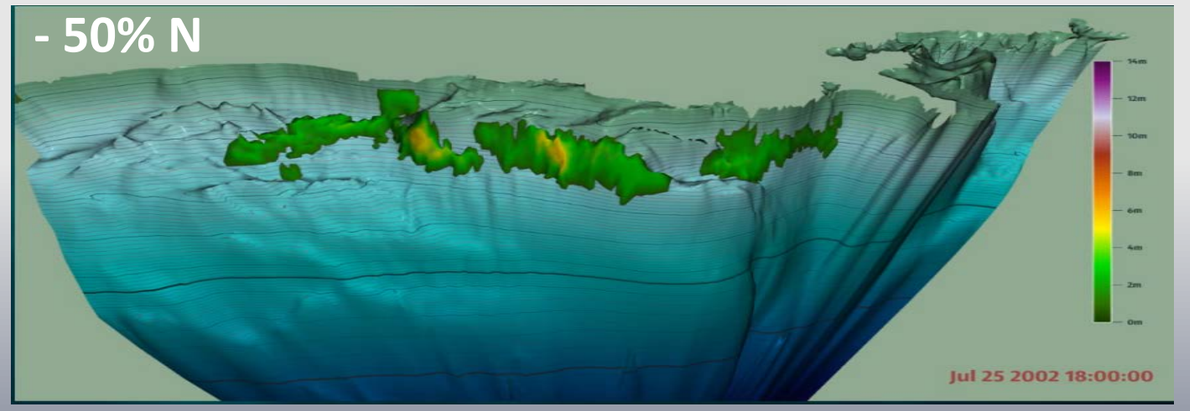












Justic et al. (in preparation)

Annual Nitrogen Loading

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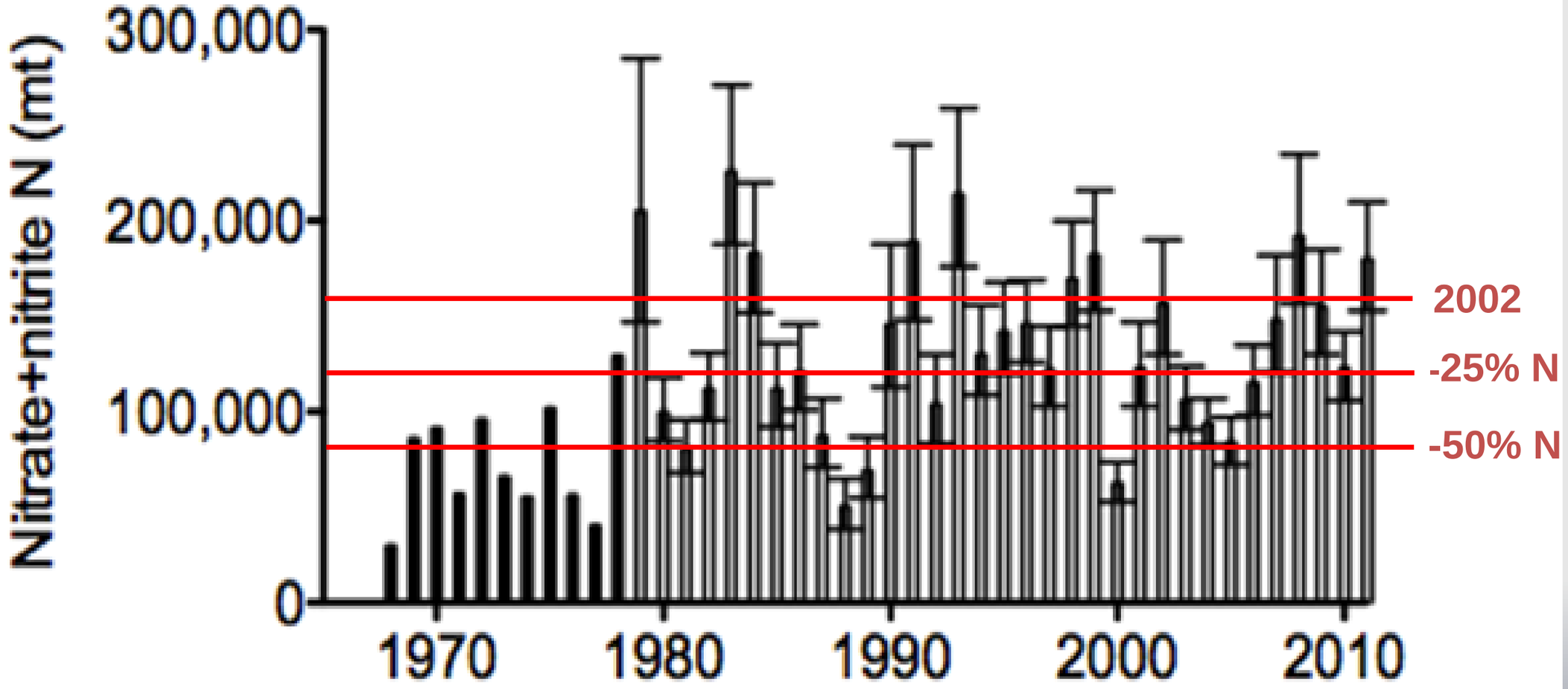


Turner et al. (2012)

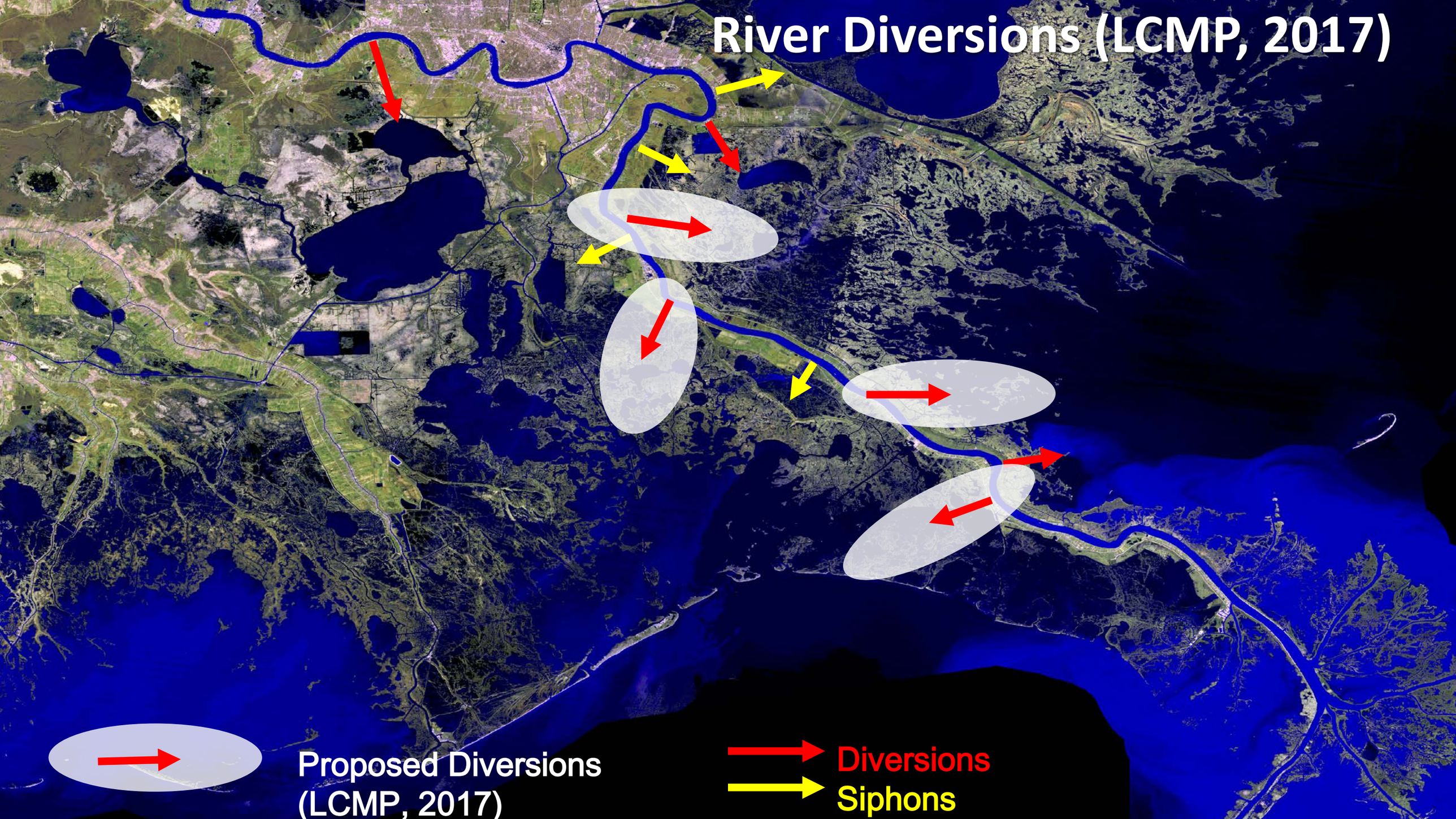
River Diversions

Caernarvon Diversion
Source: USACE

Proposed Sediment Diversions (LCMP, 2017)

- Mid-Barataria (75,000 cfs; 2,124 $m^3 s^{-1}$)
- Lower-Barataria (50,000 cfs; 1,416 $m^3 s^{-1}$)
- Mid-Breton Sound (35,000 cfs; 991 $m^3 s^{-1}$)
- Lower Breton Sound (50,000 cfs; 1,416 $m^3 s^{-1}$)

Total diversion discharge (210,000 cfs; 5,947 $m^3 s^{-1}$)

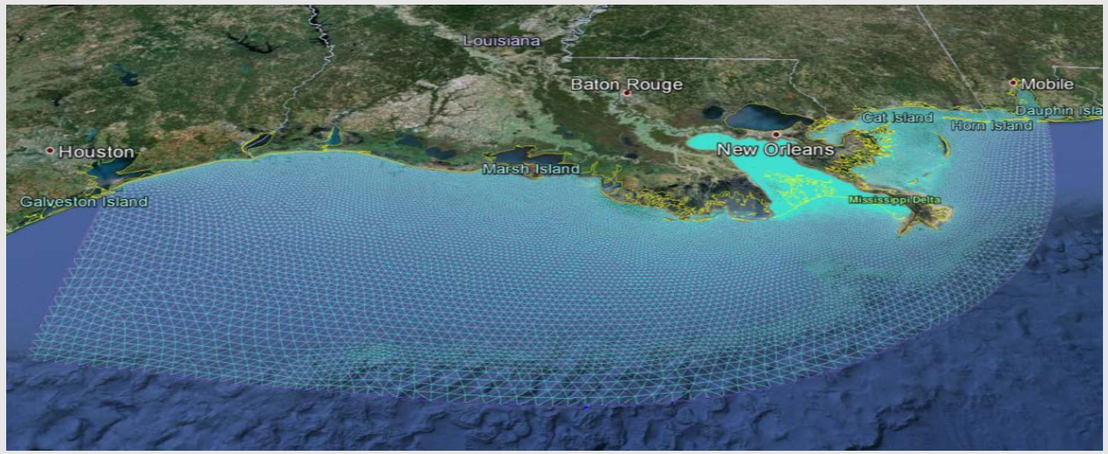

River Diversions (LCMP, 2017)
Proposed Diversions
(LCMP, 2017)
Diversions
Siphons

Research Questions

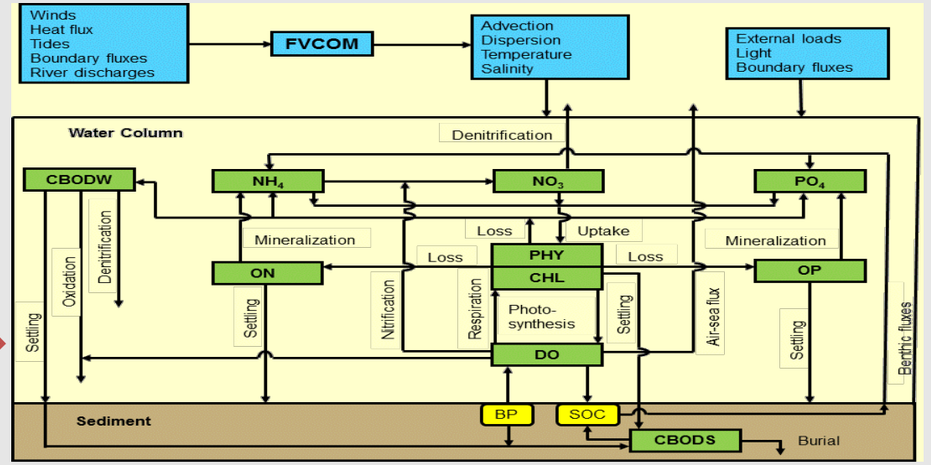
- How could estuarine and coastal hydrodynamics and salinity regimes change under the proposed large-scale river diversions?
- How could nutrient transport pathways and dynamics of hypoxia be affected?

FVCOM LATEX Model

FVCOM



WASP

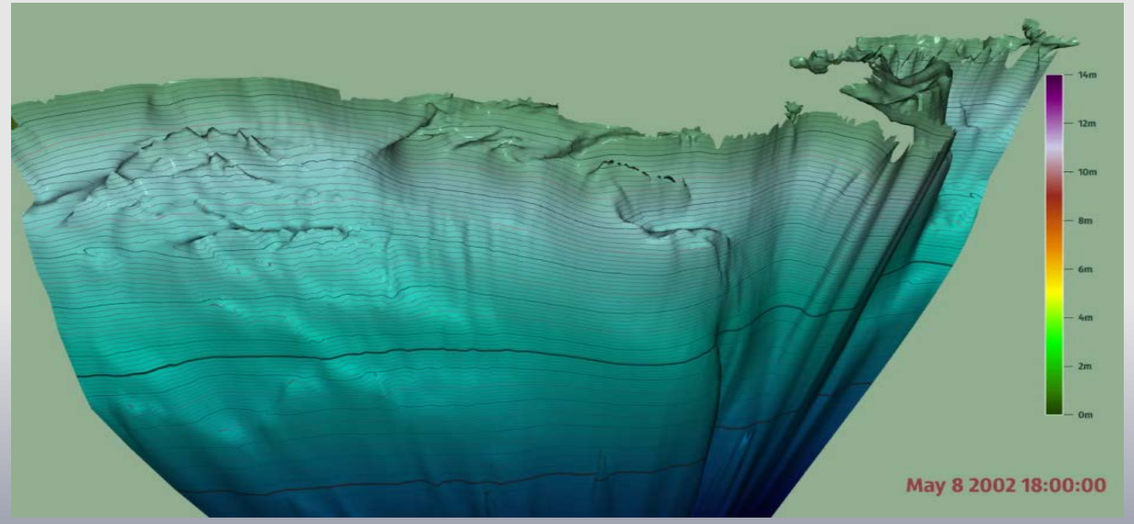


IBM

Individual Processes
- Movement
- Growth
- Mortality
- Spawning

Conditions
- Dissolved O_2
- Temperature
- Salinity
- Food density
- Predator Density
- Individual Size

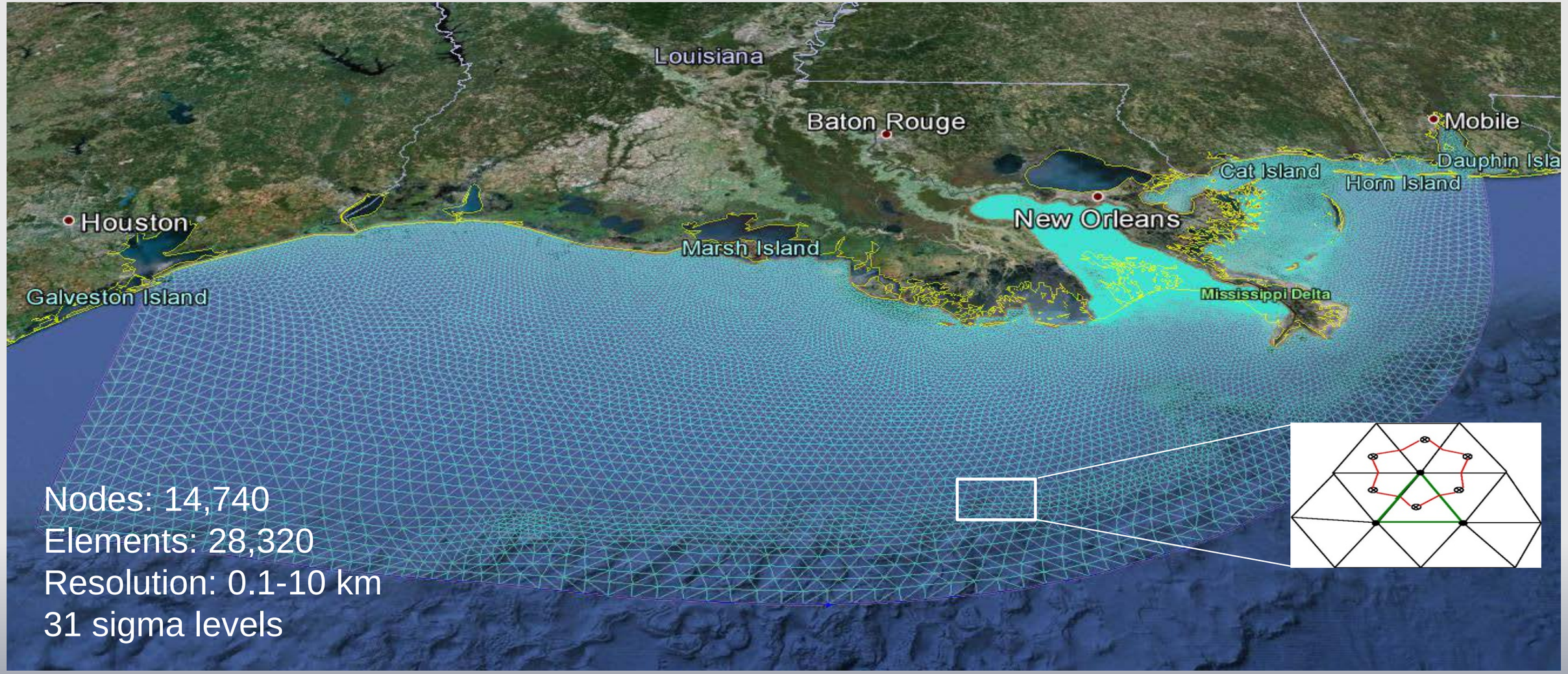
VISH



Wang and Justic (2009), Justic and Wang (2014), Rose et al. (2014)

FVCOM LATEX Model

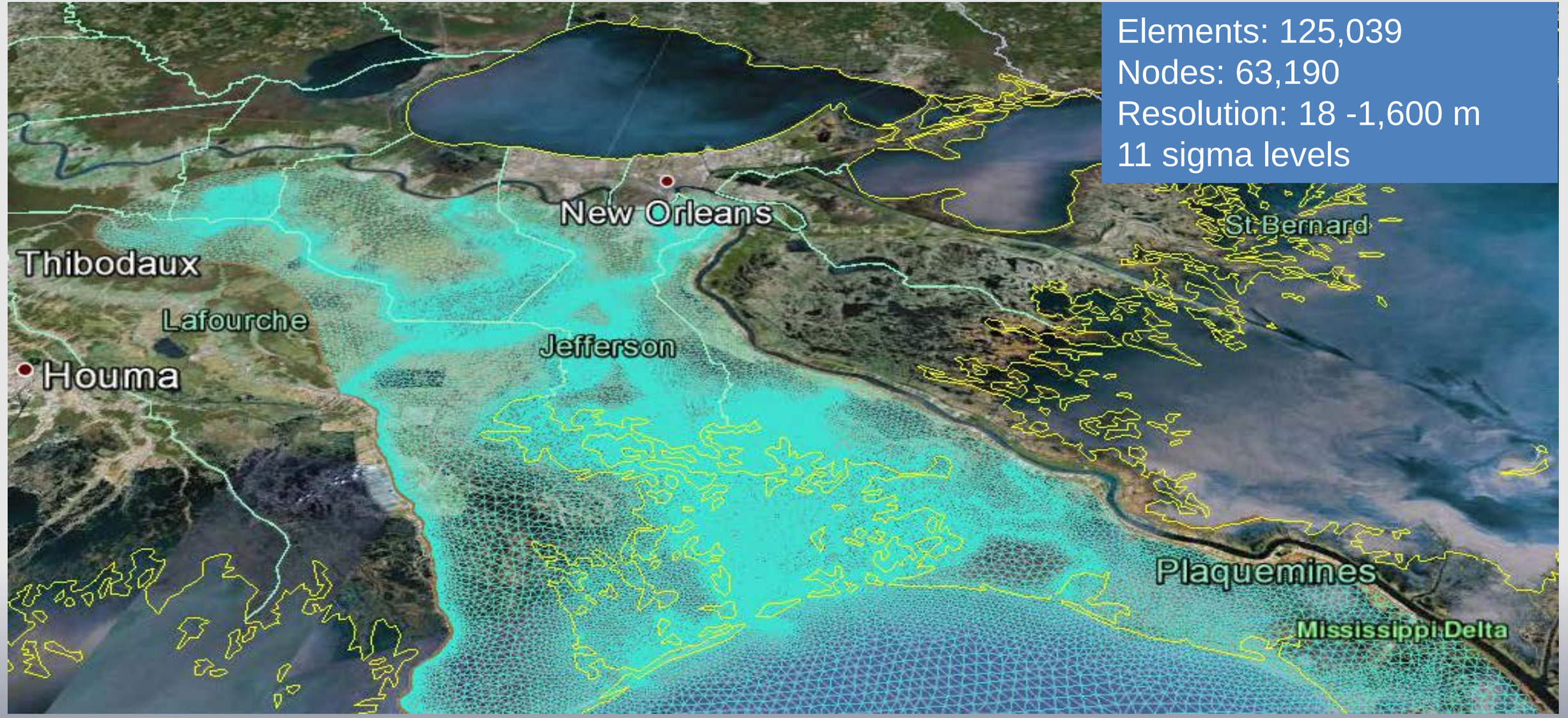
Computational Domain and Grid



Wang and Justic (2009), Justic and Wang (2014)

FVCOM Barataria Bay Model

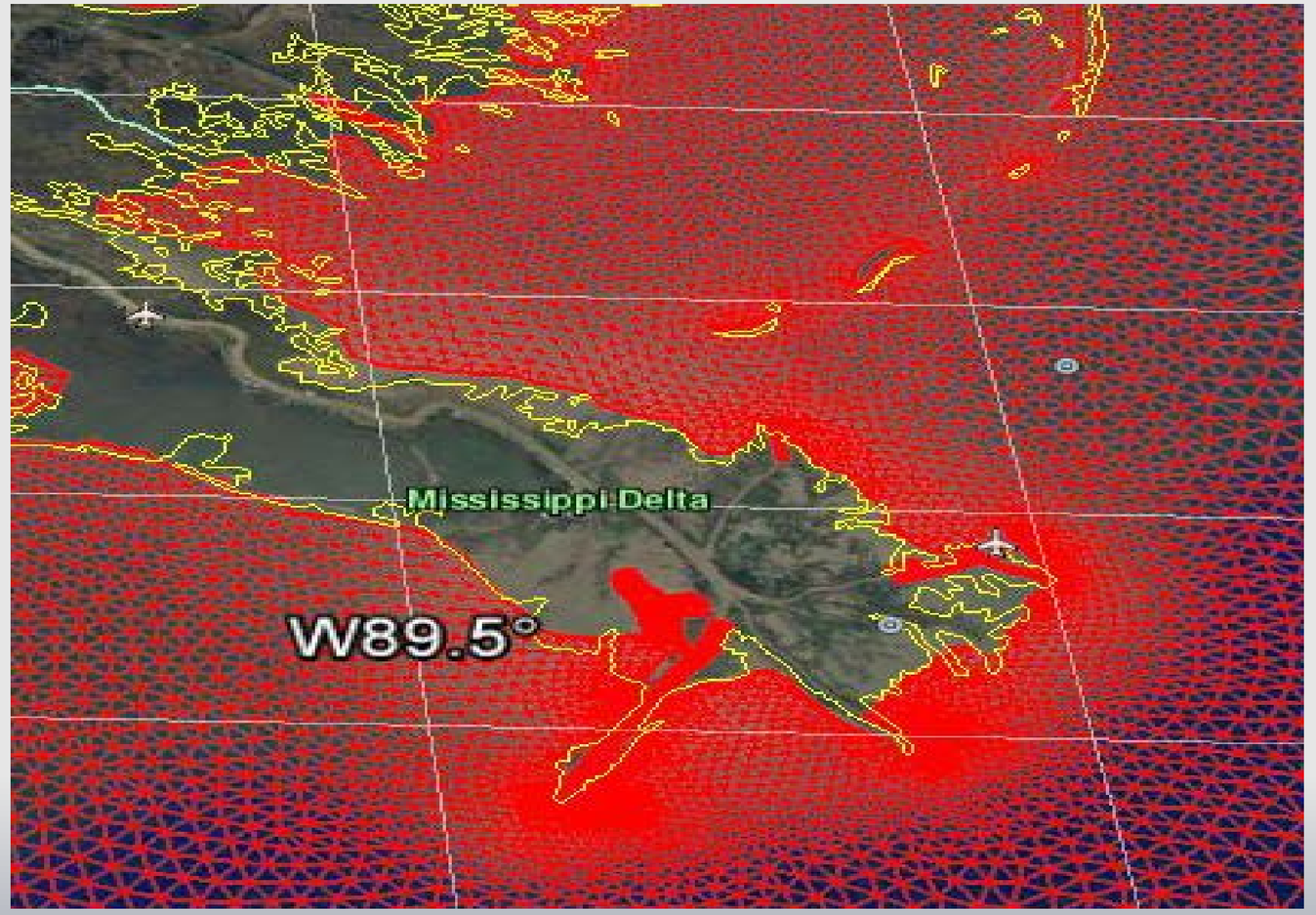
Computational Domain and Grid



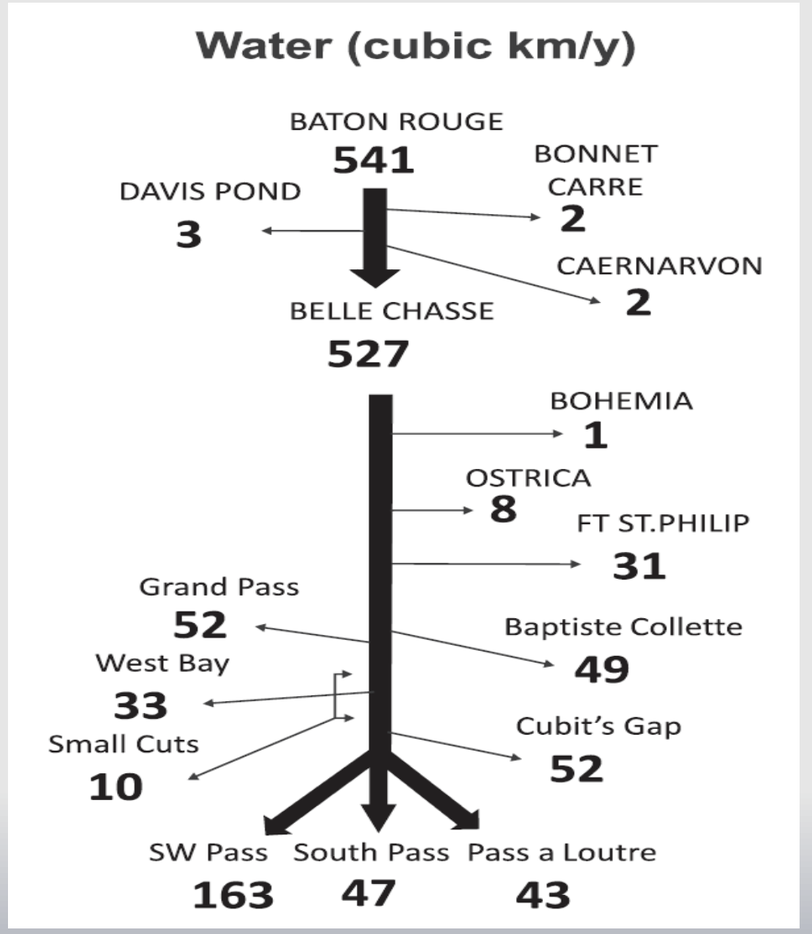
Justic et al. (in preparation)

FVCOM LATEX Model

Partitioning of the Lower Mississippi River Discharge

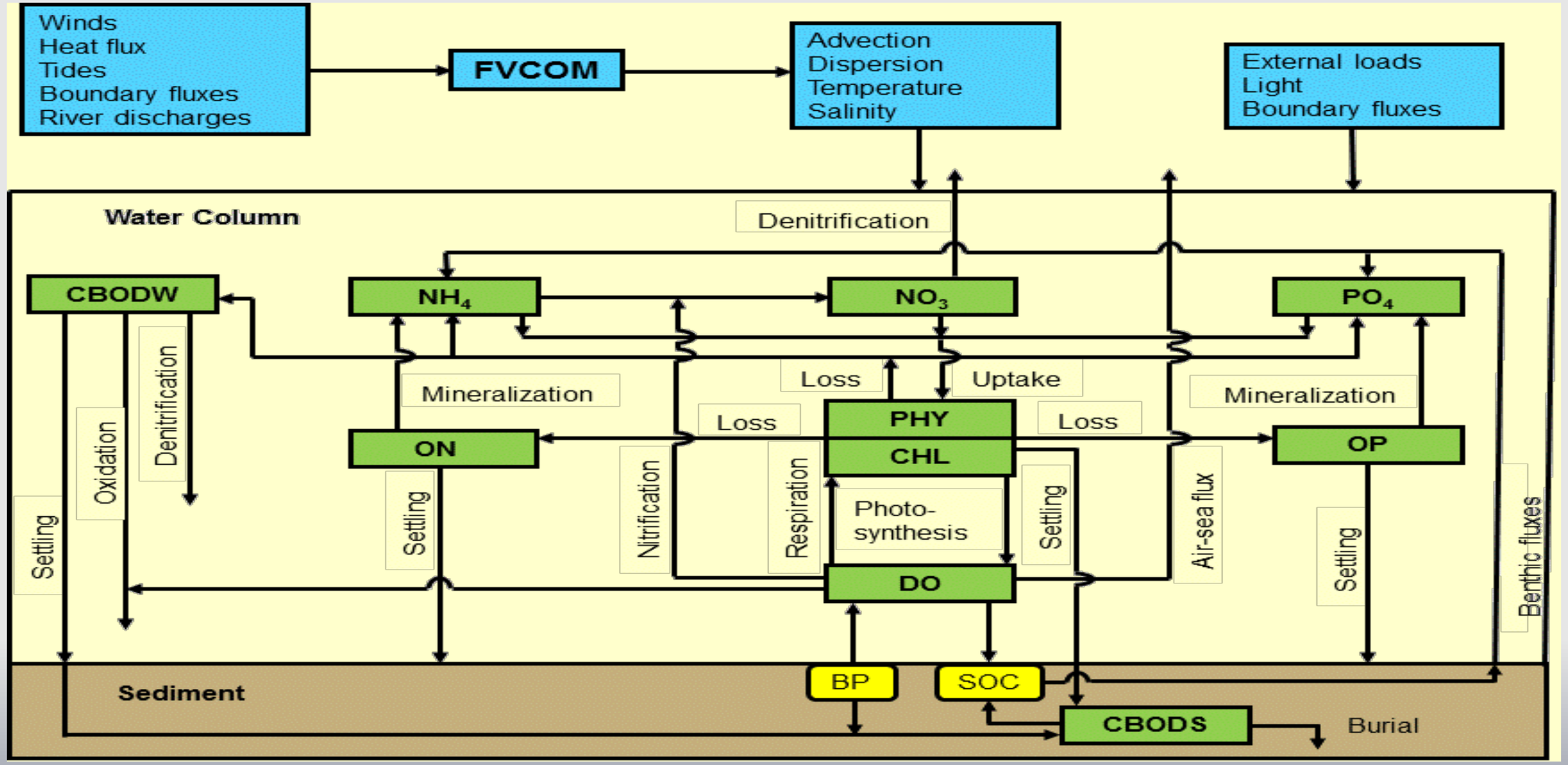


Justic and Wang (in preparation)



Allison et al. (2012)

FVCOM LATEX Water Quality Model



Justic and Wang (2014)

Model Scenarios

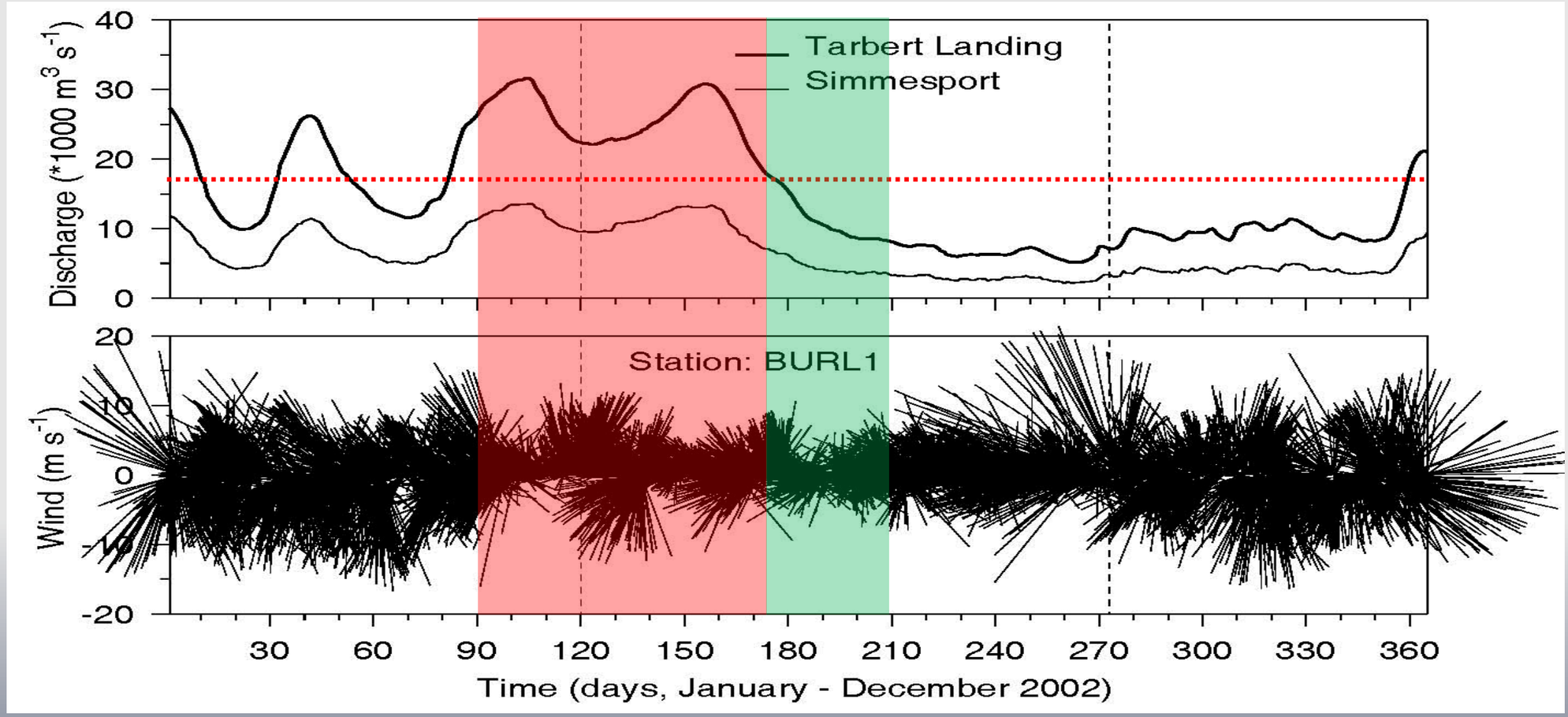
- Hypothetical diversion scenarios – 4 sediment diversions (210,000 cfs/5,947 $m^3 s^{-1}$; LCMP, 2017)
- Sediment diversion operation schedule - February 20 - July 5
- MR at Belle Chase >16,990 $m^3 s^{-1}$ (600,000 cfs; LCMP, 2012)

Model Forcing

- Mississippi River discharge – USACE
- Mississippi River nutrient concentrations – USGS
- Wind – NOGAPS
- Heat flux – COAMPS
- Boundary forcing – IASNFS

Simulation Period

- January 1 – December 31, 2002
- High flow year, increased frontal activity, large hypoxic zone (22,000 km^2)

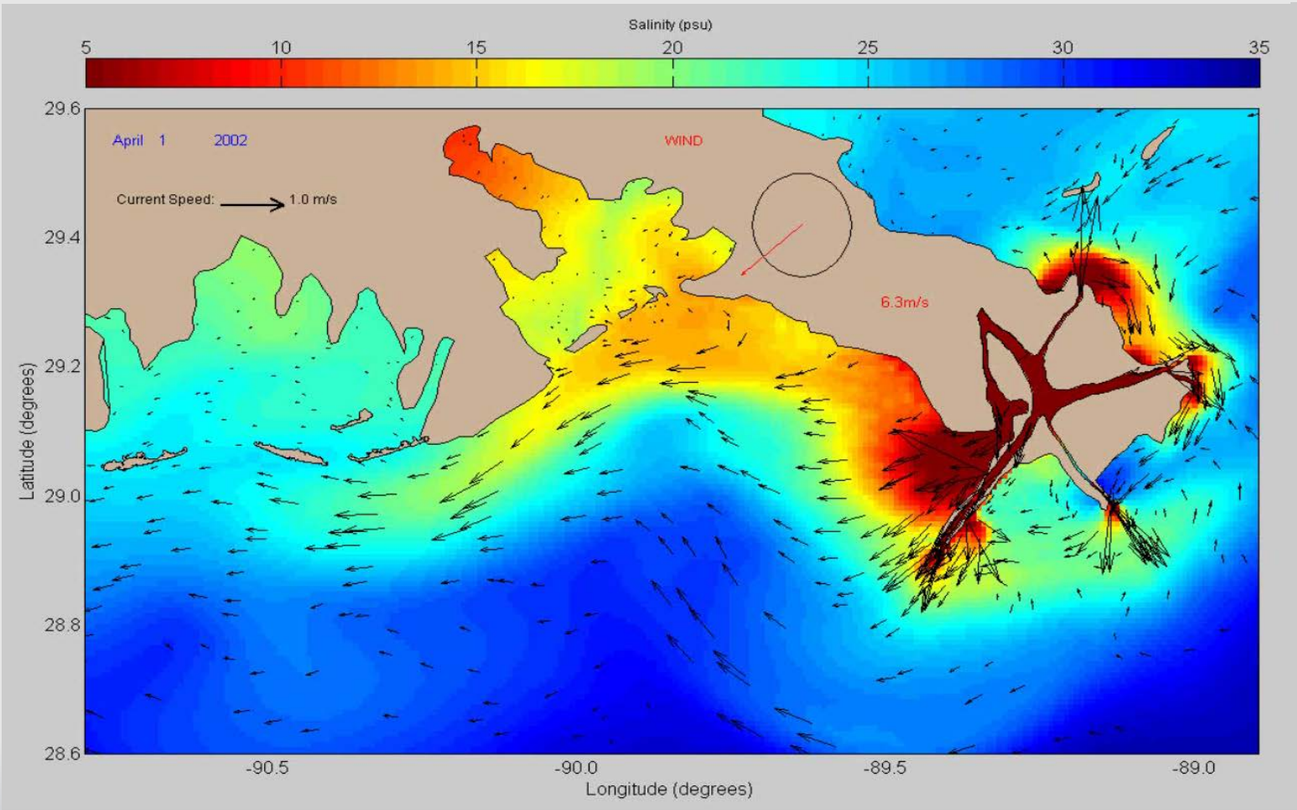


Wang and Justic (2009)

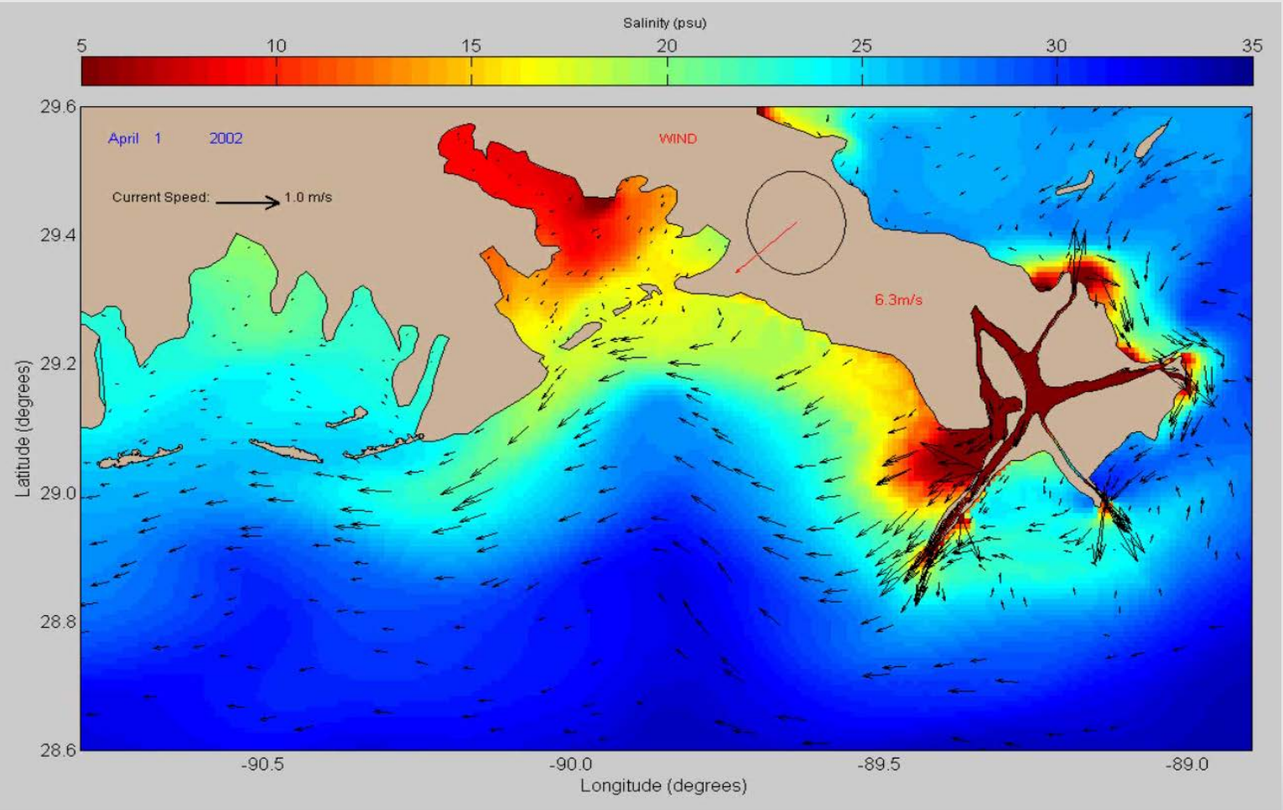
FVCOM LATEX Model

Simulated Surface Currents and Salinity (4/1 – 7/31/2002)

w/o Sediment Diversions

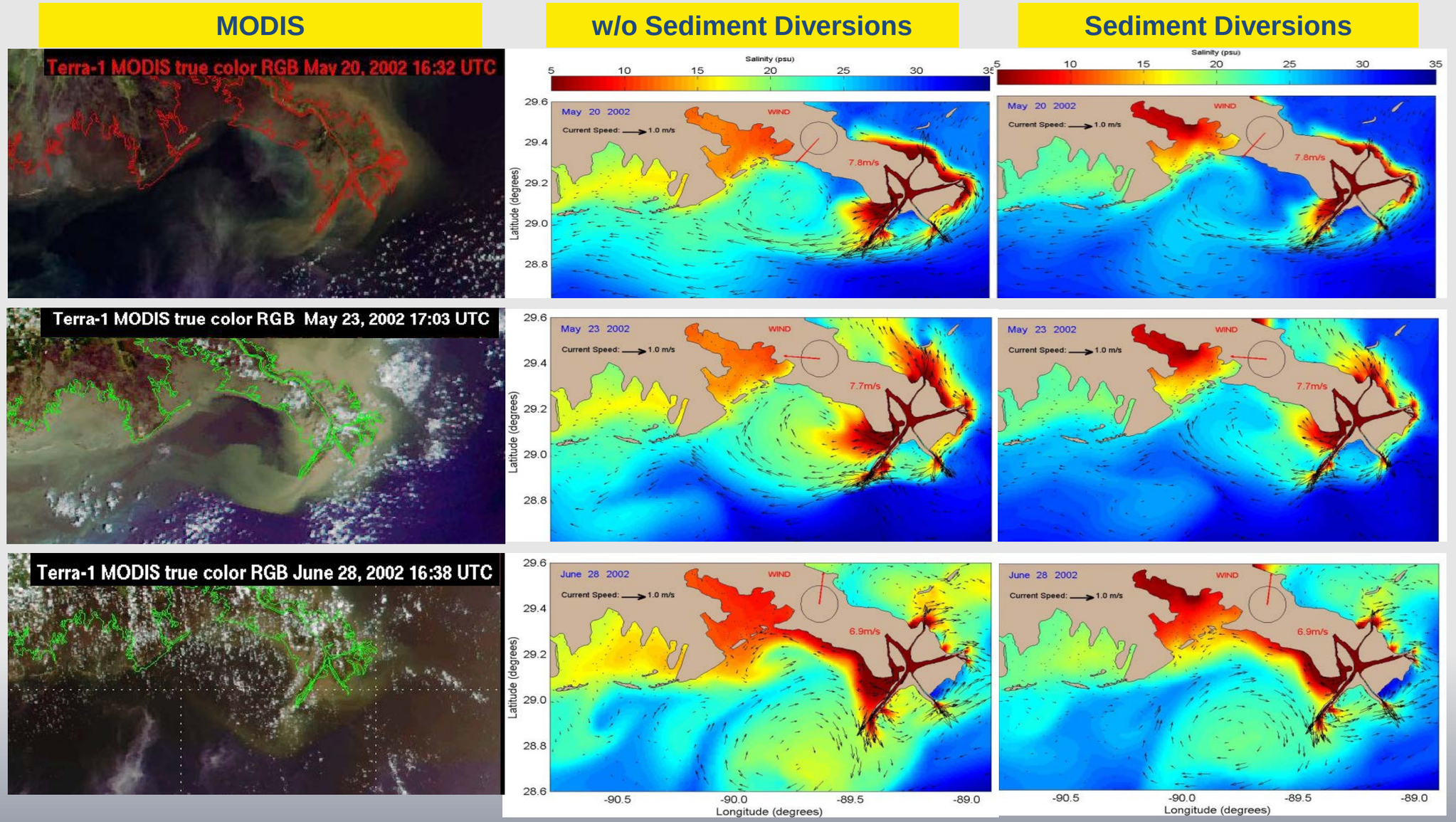


Four Operational Sediment Diversions



Justic and Wang (in preparation)

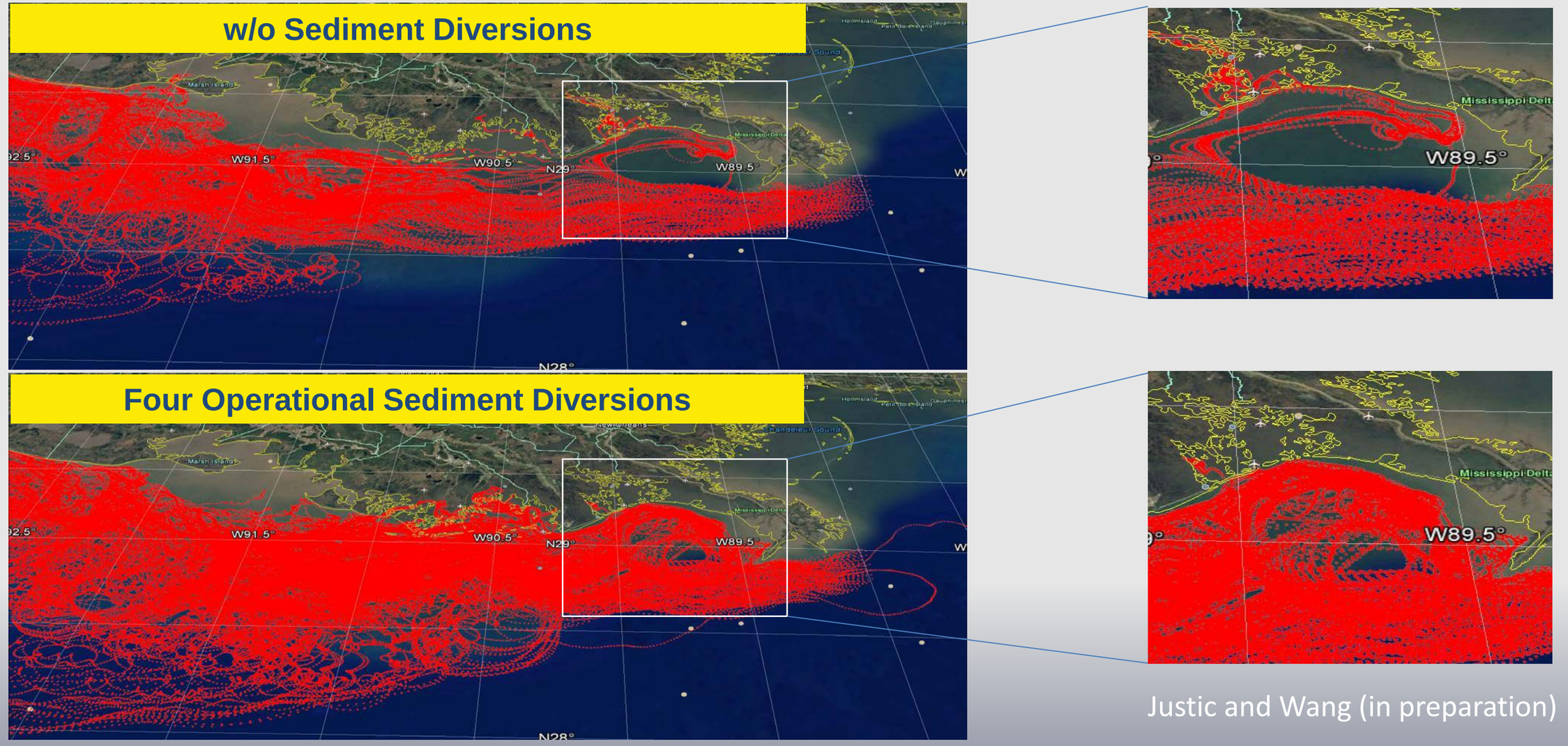
FVCOM - MODIS Comparison



Justic and Wang (in preparation)

FVCOM LATEX Model

Simulated Particle Trajectories (5/19 – 7/31/2002)

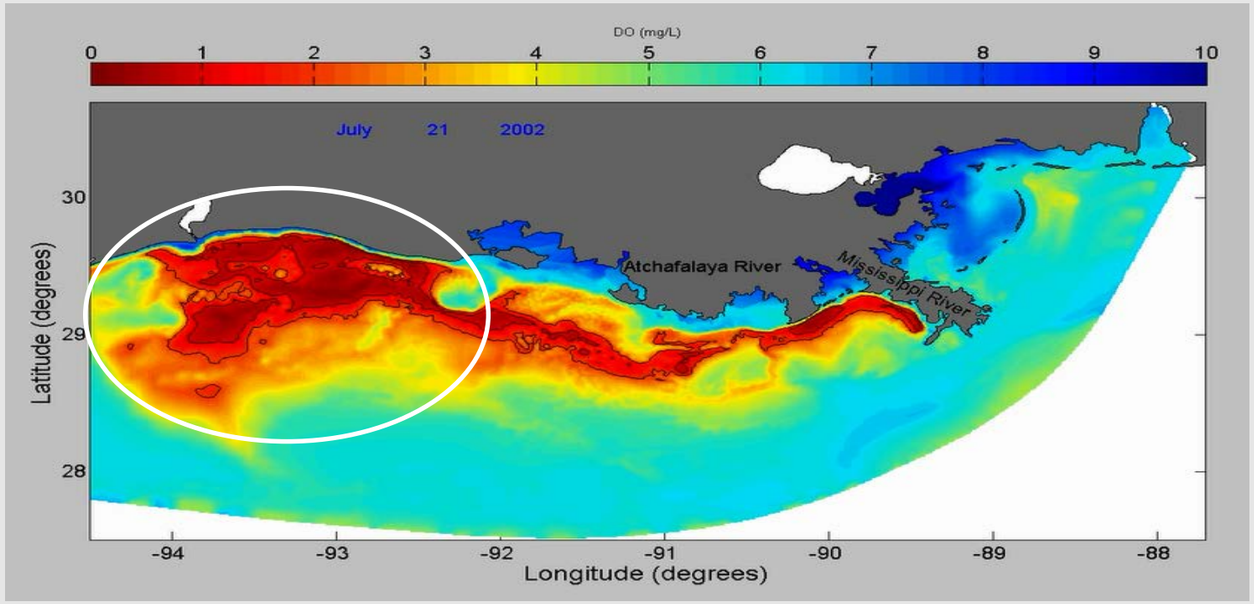


Justic and Wang (in preparation)

FVCOM LATEX Model

Simulated Hypoxic Area (July 21, 2002)

w/o Sediment Diversions



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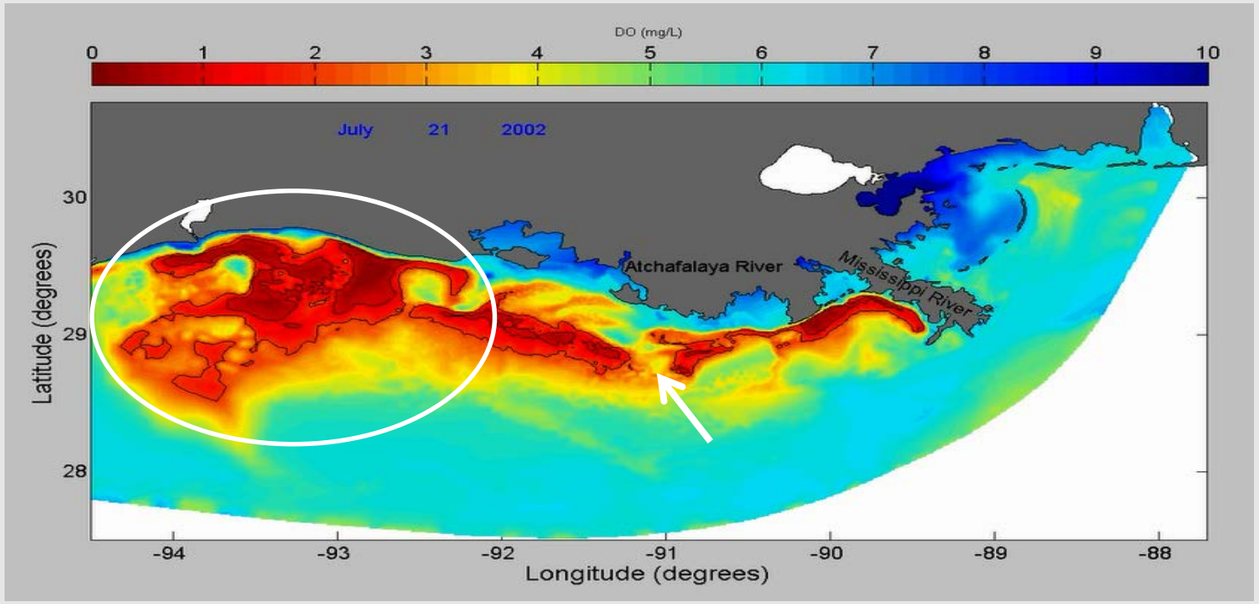

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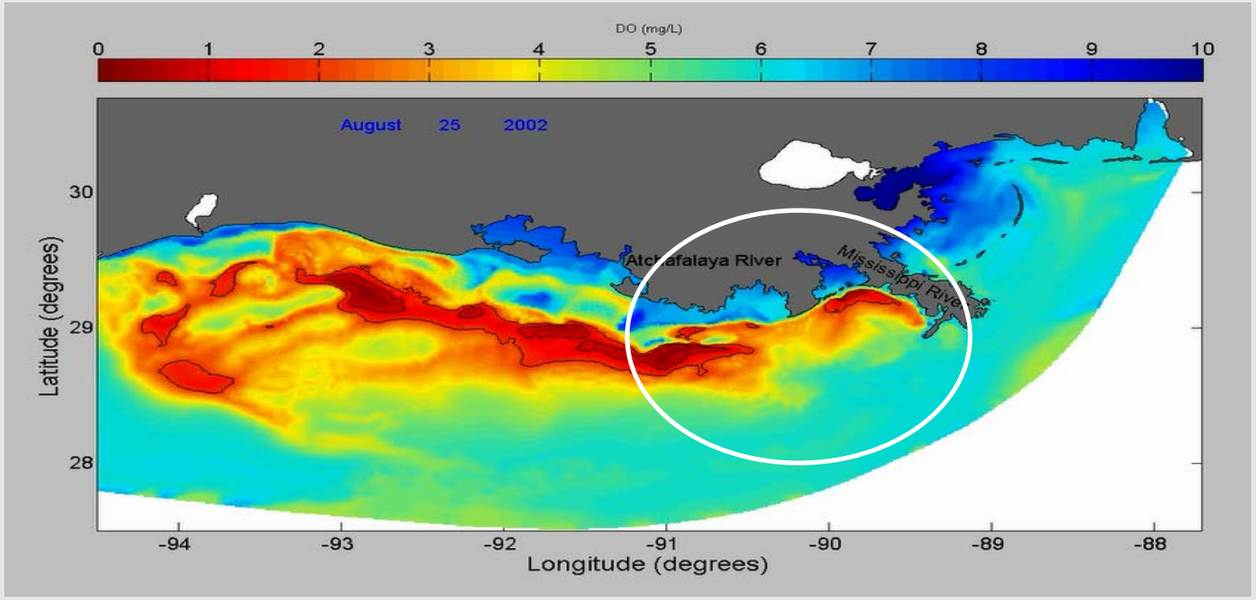
FVCOM LATEX Model

Simulated Hypoxic Area (August 25, 2002)

w/o Sediment Diversions



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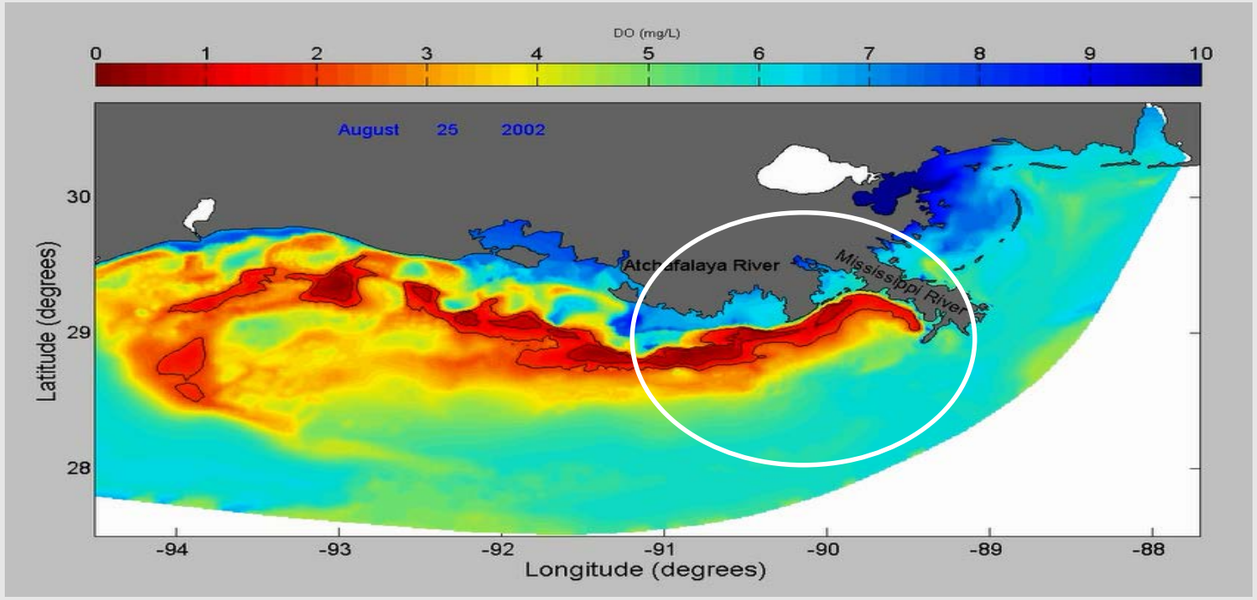

Justic and Wang (in preparation)

Conclusions

- Proposed large-scale sediment diversions could potentially strongly affect hypoxia dynamics in the NGOM.
- Large decreases (up to 25%) in midsummer hypoxic area in the western NGOM region.
- Small increases (up to 10%) in late summer hypoxic area in the eastern NGOM region.
- Decreased velocities in the channels of the MR Birdfoot Delta.
- Weakening of the anticyclonic gyre in the Louisiana Bight.

Acknowledgements

- NOAA CSCOR (NGOMEX)
- BP/GoMRI (Coastal Waters Consortium)
- LSU high performance computing
- Dong Ko (NRL)