3-D Hypoxia Models for the Northern Gulf of Mexico

D. Justic

Department of Oceanography and Coastal Sciences
College of the Coast and Environment
Louisiana State University, USA
(djusti1@lsu.edu)

2016 Hypoxia Monitoring Workshop
Stennis Space Center, September 12-13, 2016

Outline

- Capturing the dynamics of hypoxia: Why 3D time-variable hypoxia models are needed?

- Examples of 3D hypoxia models for the northern Gulf of Mexico

- 3D hypoxia models as management tools

- Model data requirements and monitoring needs

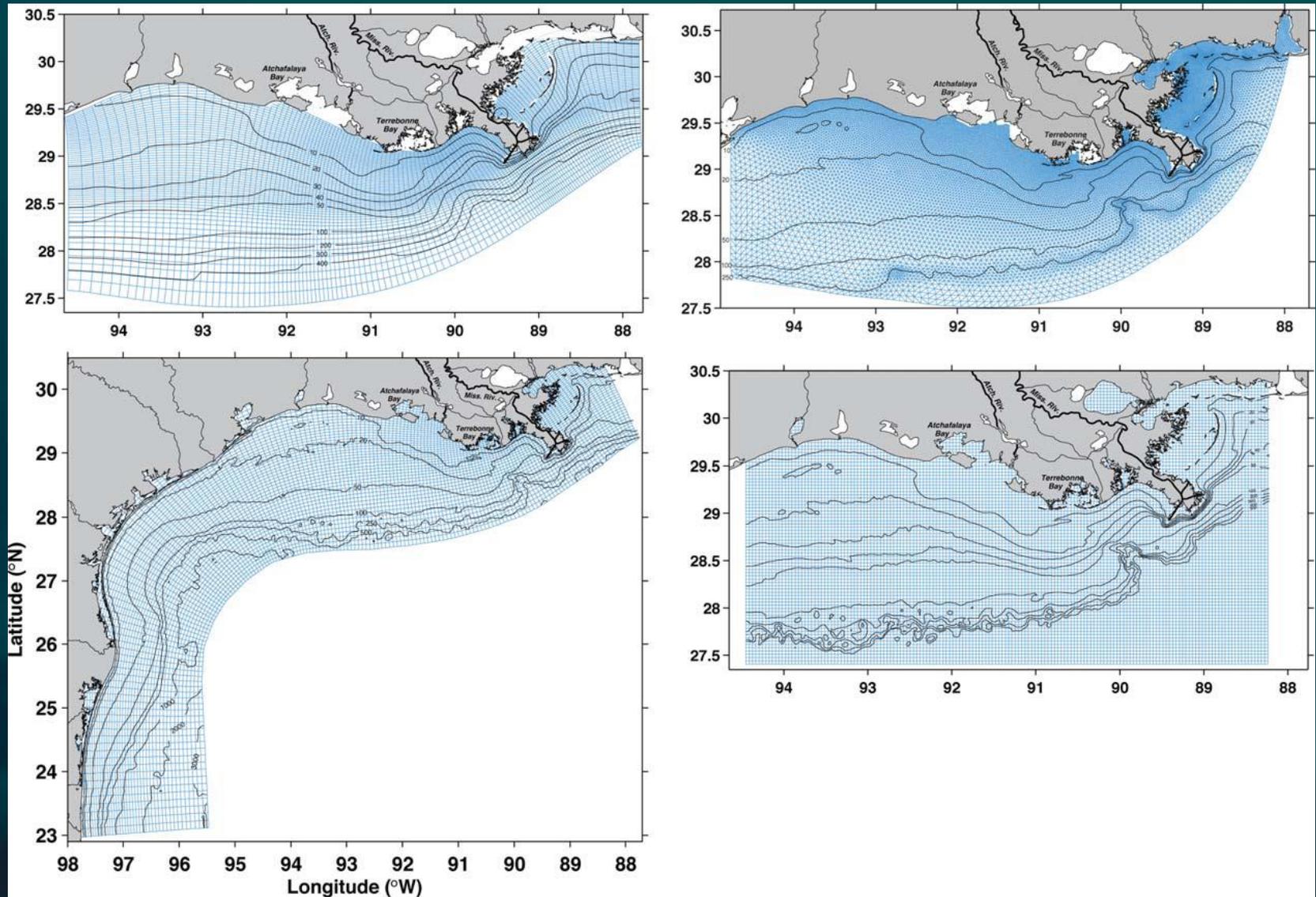# Why 3D time-variable hypoxia models are needed?

	Statistical	Box	3D
Temporal resolution	Single point in time	Days	Seconds to hours
Spatial resolution	Entire self	100km	1km
Functional relationships	Empirical	Semi-mechanistic	Mechanistic
Hardware requirements	PC	PC	HPC
Computing time (annual run)	Seconds	Minutes	Days
Data requirements	Low	Intermediate	High

Examples of NGOM 3D Hypoxia Models
(high-resolution coupled hydrodynamic-biological models)

- **ROMS** (TAMU/Dalhousie) - Hetland et al. (2008); Fennel et al. (2011); Laurent et al. (2013)

- **NCOM** (NRL/US EPA) - Ko et al. (2008); Lehrter et al. (2013)

- **FVCOM LATEX** (LSU) - Wang et al. (2009); Justic et al. (2014)
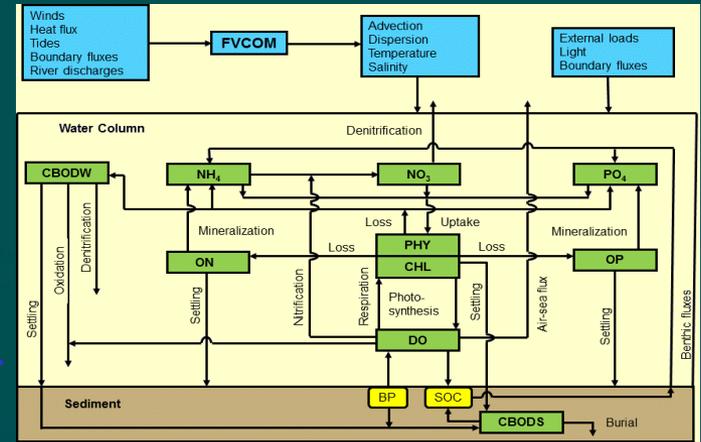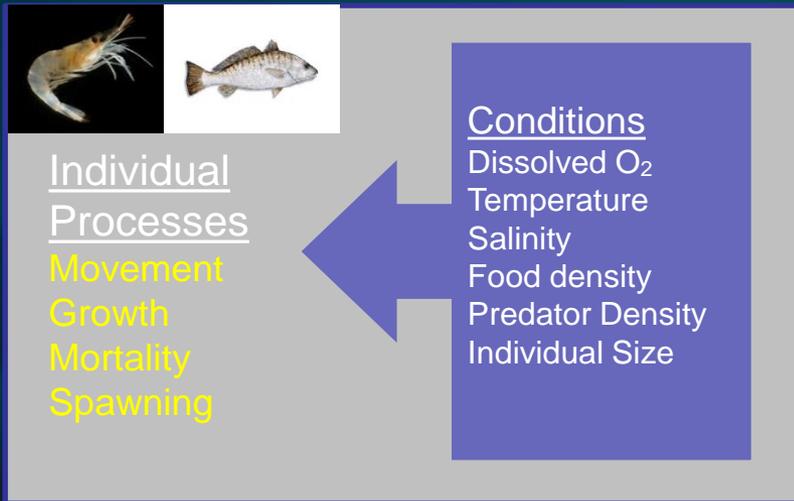
NGOM 3D Hypoxia Models

Fennel et al. (2016)
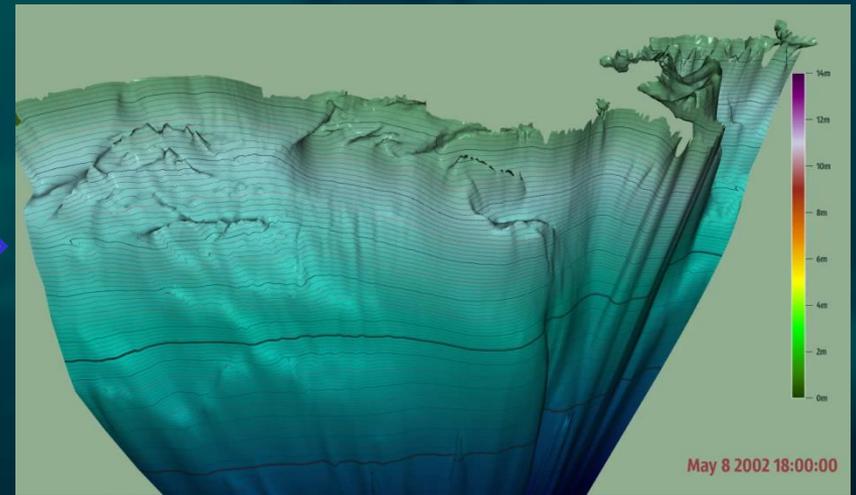
FVCOM LATEX

FVCOM

WASP

IBM

VISH

Individual
Processes
Movement
Growth
Mortality
Spawning

Conditions
Dissolved O$_2$
Temperature
Salinity
Food density
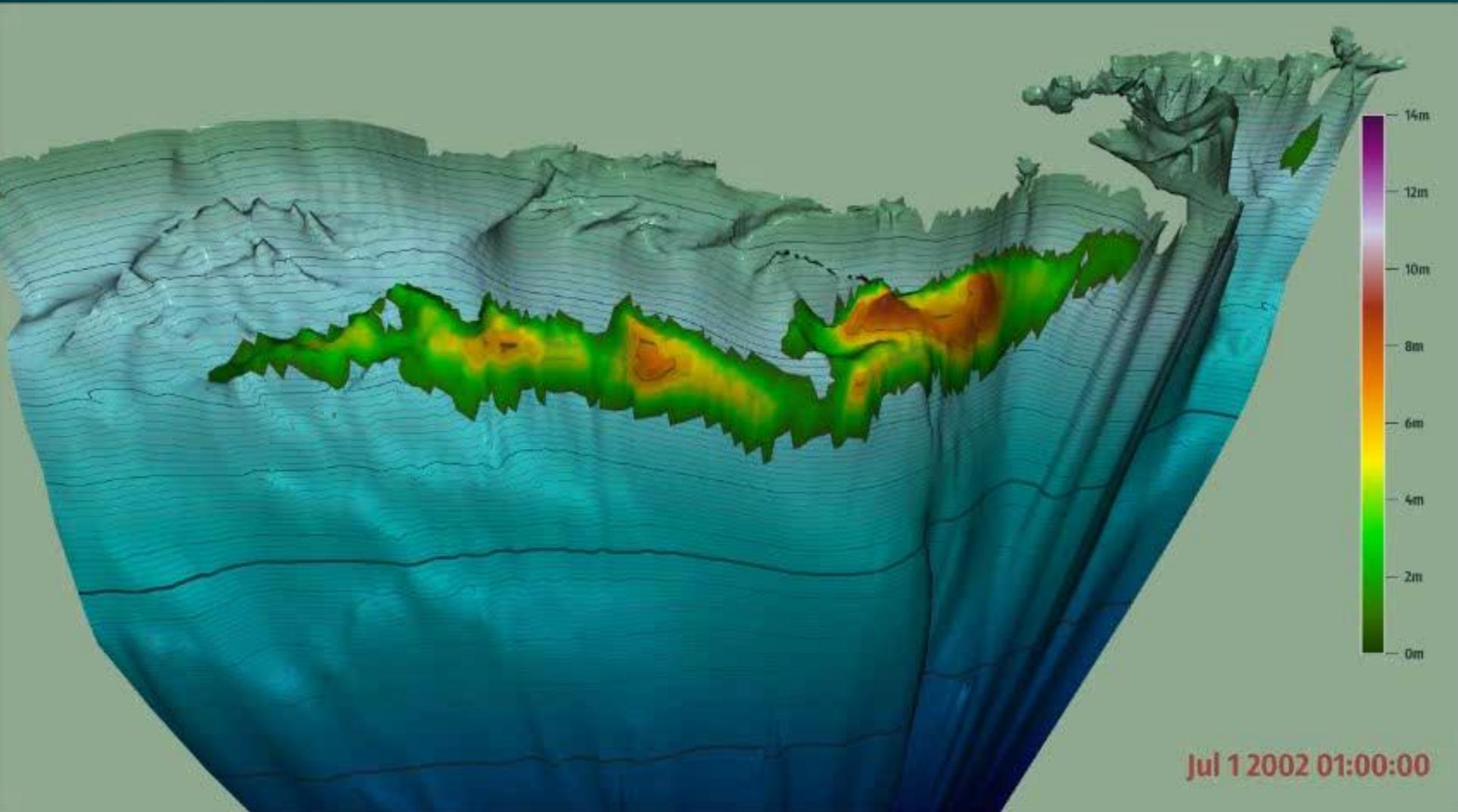Predator Density
Individual Size

May 8 2002 18:00:00

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

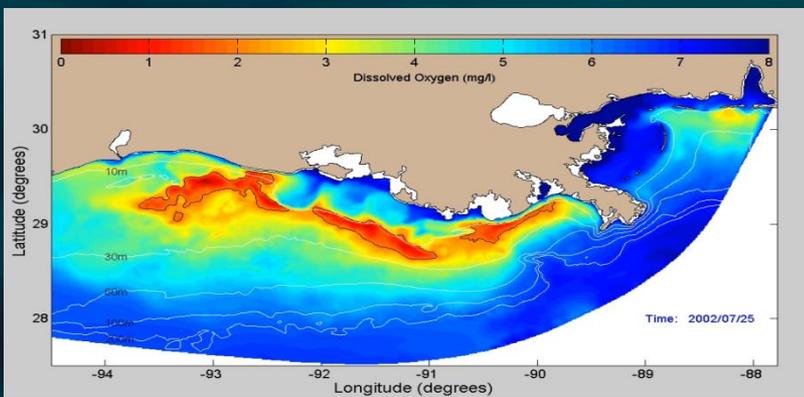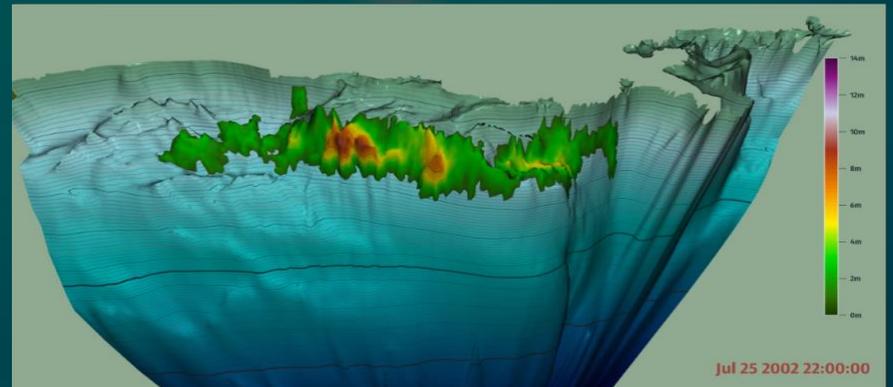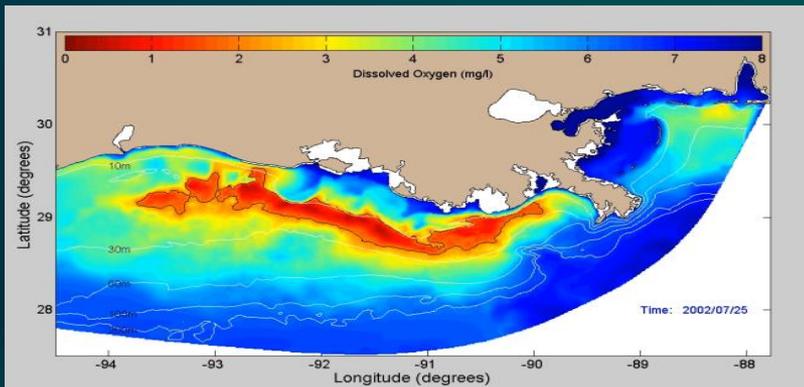# 3D Hypoxia Models as Management Tools

FVCOM LATEX (July 2002)

Jul 1 2002 01:00:00

Justic and Wang (2014)
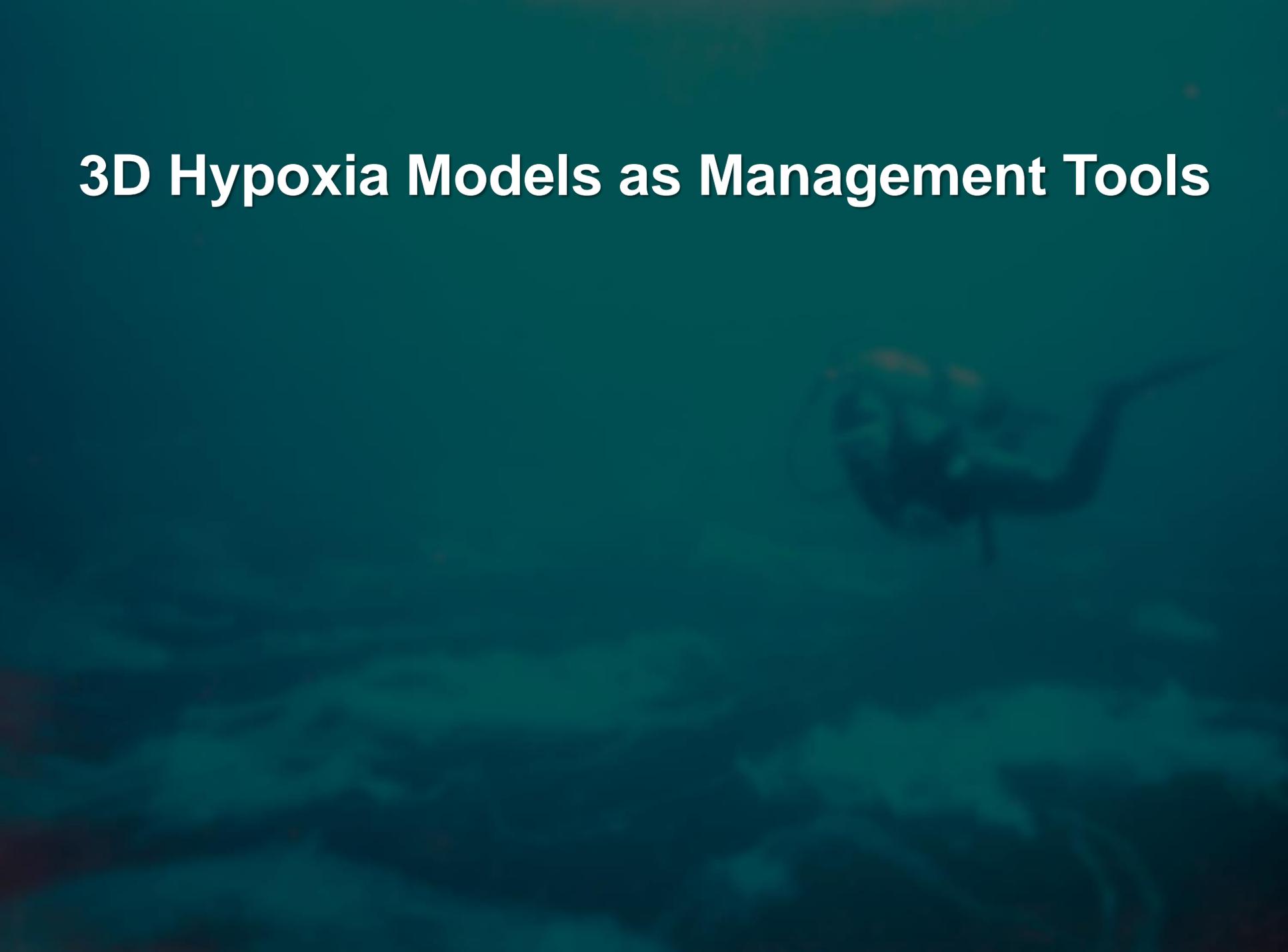
Effects of Nutrient Reduction Strategies on Hypoxia
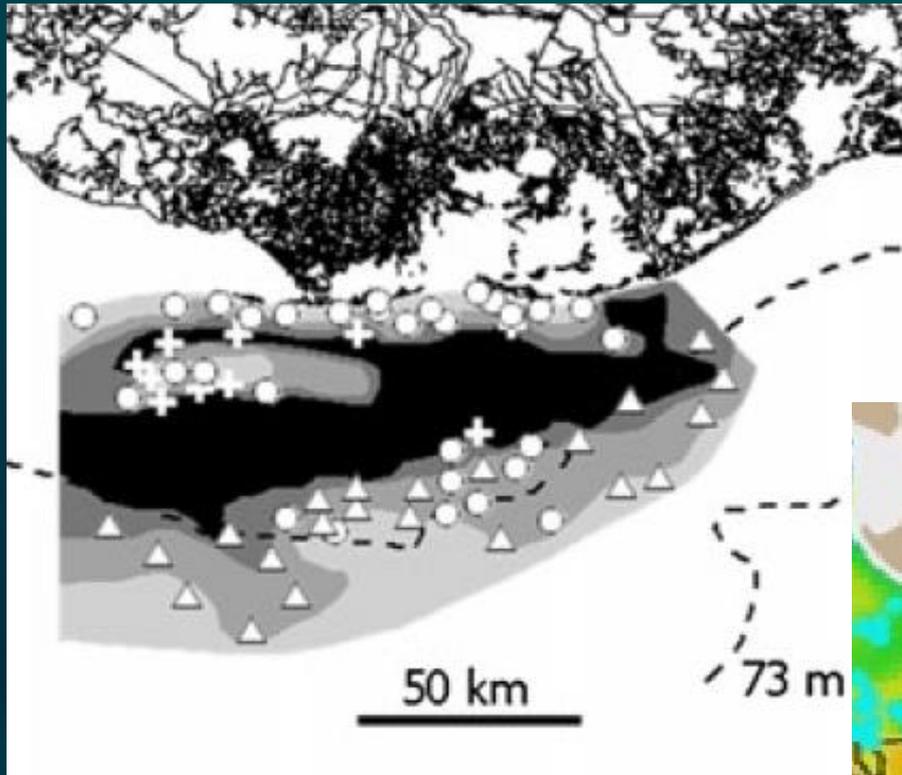

Justic et al. (in preparation)
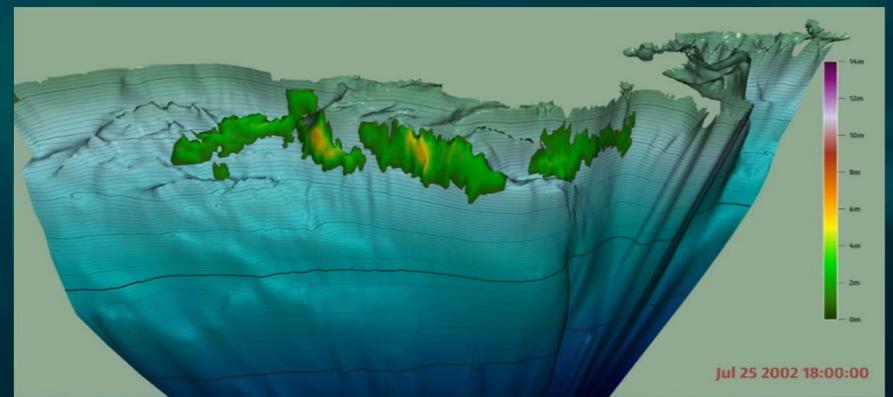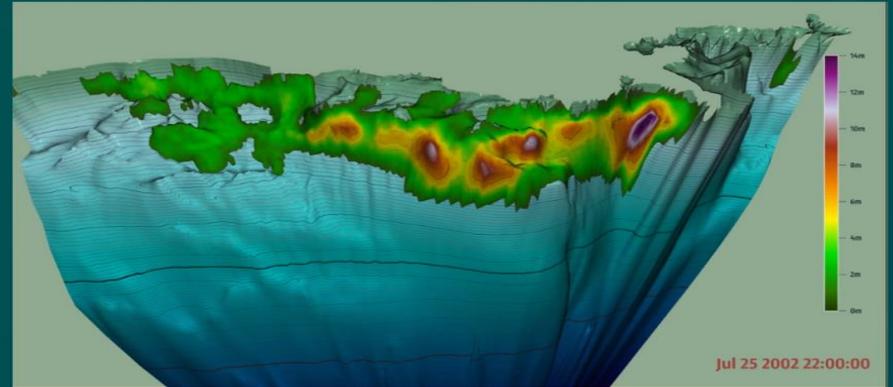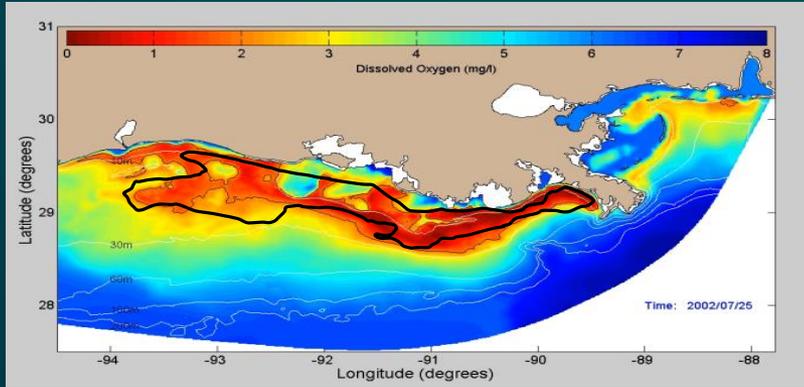
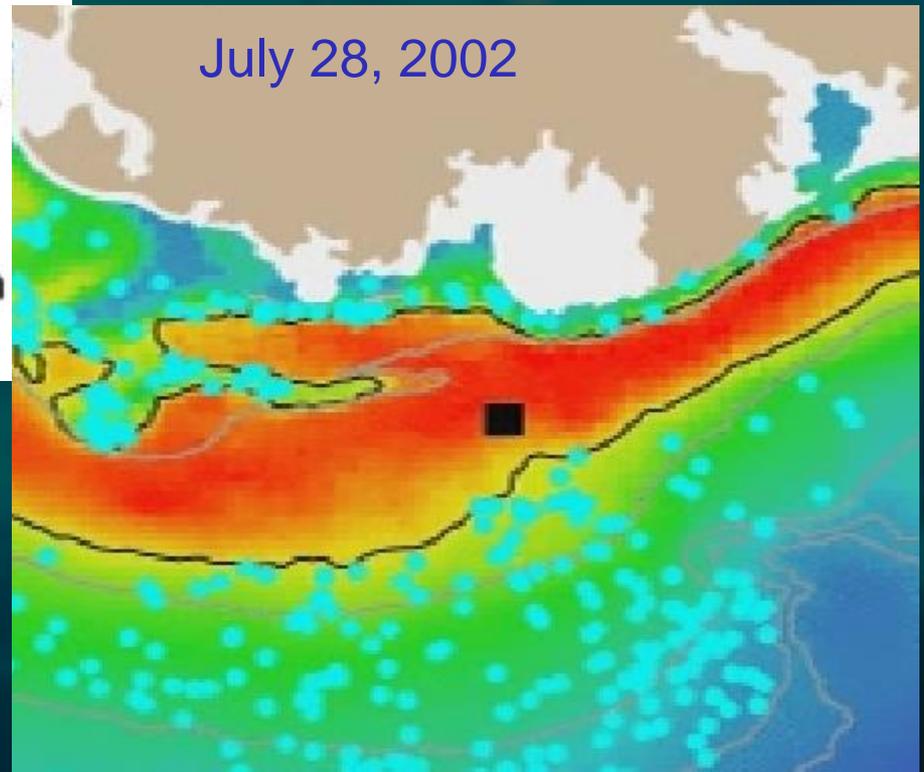# Effects of Future Climate Change on Hypoxia
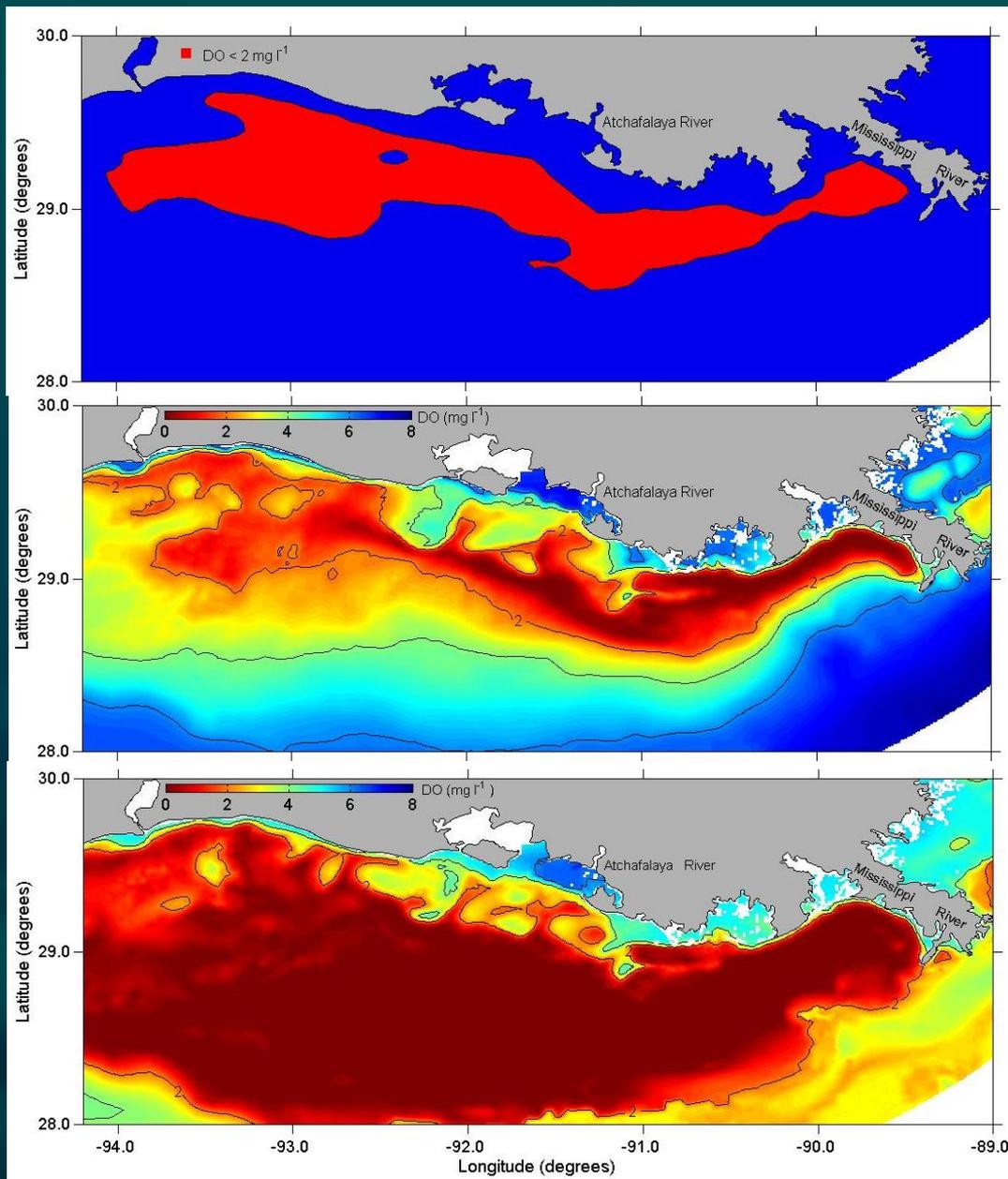
Justic et al.
(2016, in press)

Effects of Hypoxia on Living Resources

July 20-28, 2002
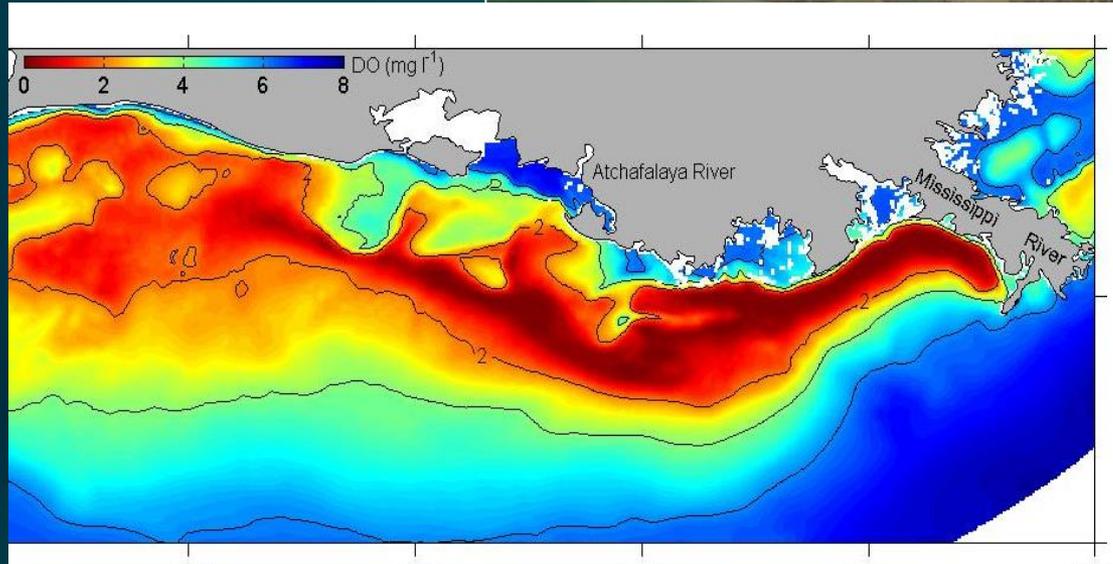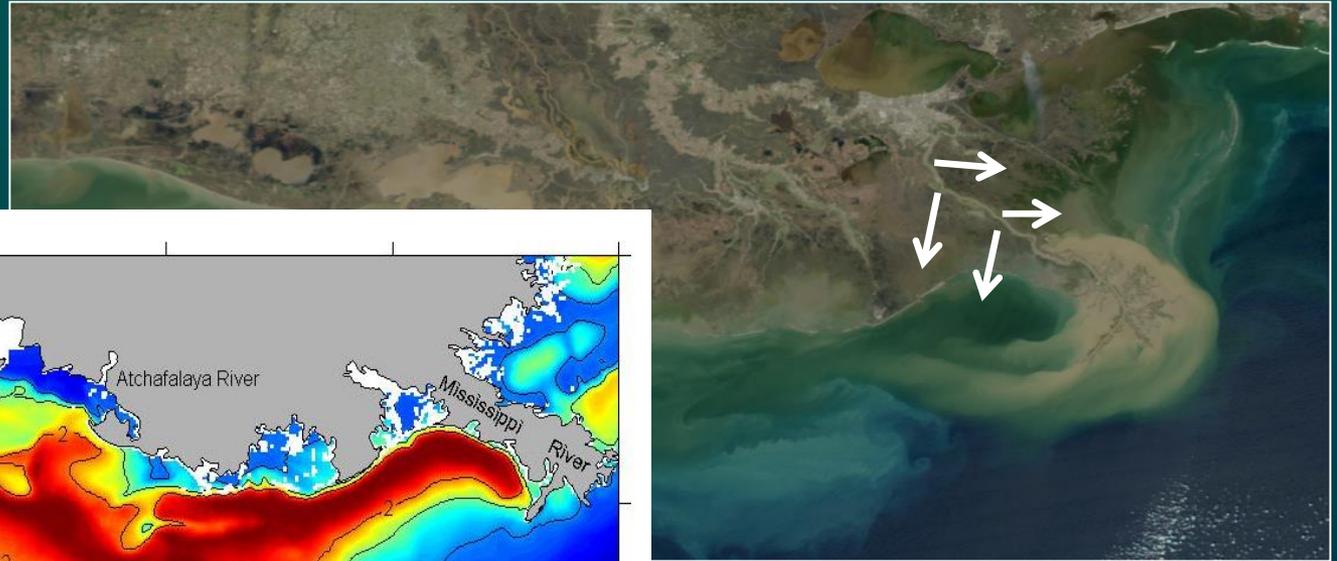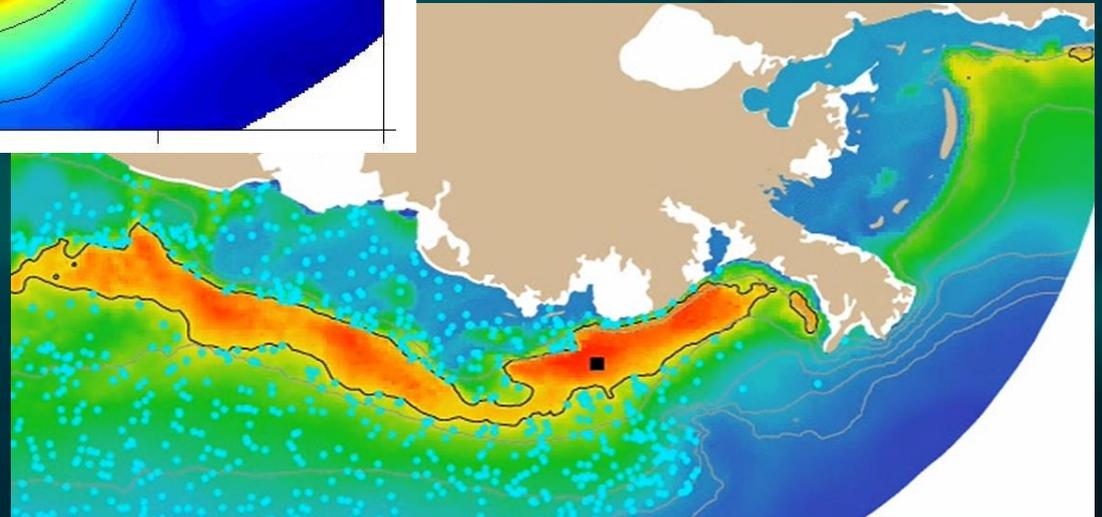Craig and Bosman (2012)

July 28, 2002

LaBone et al. (in review)

Effects of Proposed Sediment Diversions on Hypoxia and Livings Resources

Justic et al. (in preparation)

3D Model Data Requirements

Hydrodynamic model forcing

- heat flux
- winds
- tides
- river discharge
- boundary fluxes

Biogeochemical model forcing

- light (e.g., incident solar radiation, PAR)
- temperature
- external loads (e.g., riverine nutrients, carbon, TSS, CDOM)
- boundary fluxes (e.g., nutrients, carbon, chlorophyll, DO)

Model Data Requirements (cont.)

Initial conditions

Model parameters

Calibration/verification/skill assessment

- Satellite imagery (e.g., chlorophyll a)

- Continuous temperature, salinity and DO time-series

- Shipboard measurements of temperature, salinity, DO, nutrients, chlorophyll a, etc.

- Maps of hypoxic areas and volumes, DO, nutrient and chlorophyll a concentrations, etc.
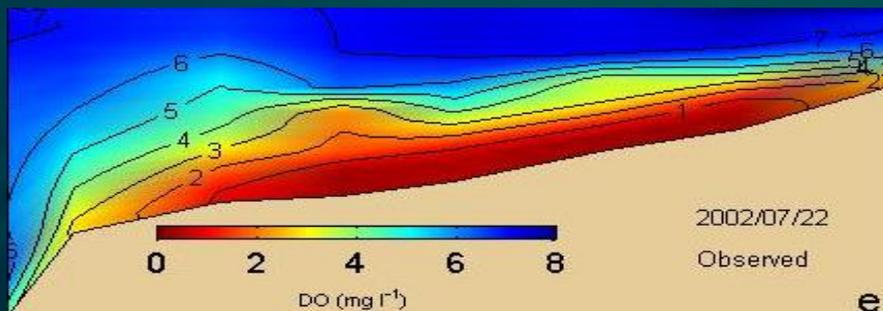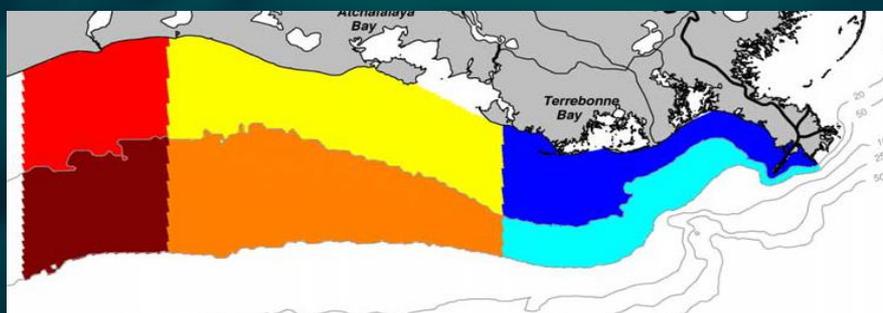
Examples of Data 3D Models Could Use
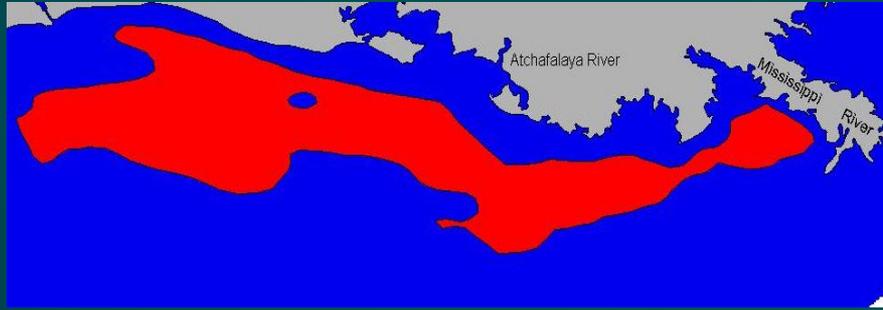
Shelfwide cruises
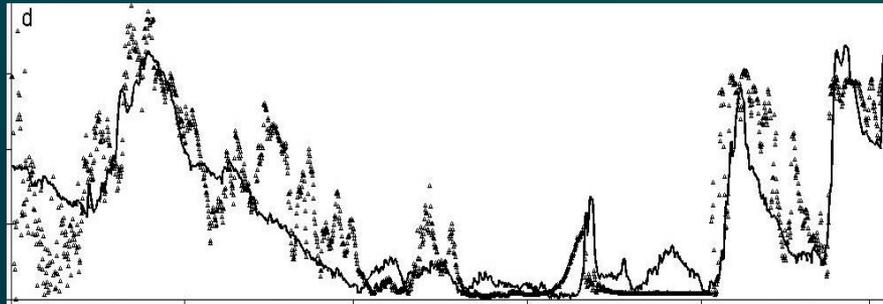
Continuous
(fixed locations)

Transects
(shipboard or glider)

Aggregated by regions
(multiple sources)