Using ROMS to assess the effects of nutrient load mitigation strategies in the Mississippi-Atchafalaya river plume

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Circulation Model (ROMS)

**Location:** Northern GoM shelf

**Resolution:** 3-5 km in horizontal
20 vertical layers
Hypoxia effects on fish and fisheries

Kick-off meeting of decision support tool development

Location: Northern GoM shelf

Resolution: 3-5 km in horizontal
20 vertical layers

Forcing: 3-hourly winds (spatially-resolved);
climatological surface heat and freshwater fluxes

River inputs: daily freshwater input (U.S. Army Corps of Engineers);
monthly nutrient and particulate matter loads (USGS)

Boundary conditions: climatology

Simulation period: 2000 - 2016

Output: Daily 3D field of state variables
(T, S, currents + biological variables)
**State variables:**
- Nitrate (NO₃; mmol N m⁻³)
- Ammonium (NH₄; mmol N m⁻³)
- Phosphate (PO₄; mmol P m⁻³)
- Phytoplankton (Phy; mmol N m⁻³)
- Chlorophyll (CHL; mg m⁻³)
- Zooplankton (Zoo; mmol N m⁻³)
- Small detritus (SDet; mmol N m⁻³)
- Large detritus (LDet; mmol N m⁻³)
- River DOM (RDOM; mmol N m⁻³)
- Oxygen (O₂; mmol O₂ m⁻³)

**River input:**
NO₃, NH₄, PO₄ and river DOM

Details available in Fennel et al 2006, GBC; Laurent et al 2012, Biogeosciences; Fennel et al 2013, JGR; Laurent & Fennel 2014, Elementa; Yu et al 2015, Biogeosciences.
### Nutrient load experiments

Simulations: 2000 to 2016 with varying TN and TP loads

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<tr>
<th>Load</th>
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**PHOSPHORUS**
## Nutrient load experiments

### Simulations: 2000 to 2016 with varying TN and TP loads

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**PHOSPHORUS**
Observed total nitrogen load used in the **baseline** simulation
Total nitrogen loads used in the nutrient load reduction experiments
Results for baseline simulation

Chlorophyll (mg m⁻³)

Oxygen (mg L⁻¹)

Depth (m)

Latitude (°N)

Longitude (°W)

Jan.01, 2001

Mississippi

Atchafalaya

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Results for baseline simulation

Chlorophyll (mg m$^{-3}$)

Aug. 18, 2001

Mississippi

Atchafalaya

Latitude (°N)

Longitude (°W)

Depth (m)

Oxygen (mg L$^{-1}$)

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Results for baseline simulation

Mid summer data (Obenour et al 2013)
Results for baseline simulation
Hypoxia effects on fish and fisheries

Effect of nutrient load reduction

$\bar{H} = 921$

$\bar{H} = 261$

$\bar{H} = 344$

$\bar{H}$: time-integrated hypoxic area $(10^3 \, \text{km}^2 \, \text{yr})$
Hypoxia effects on fish and fisheries

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Effect of nutrient load reduction

\[ \bar{C} = 1946 \]

\[ \Delta \text{Chl (mg m}^{-3}\text{)} \]

\[ \bar{C} = 1454 \]

\[ \bar{C} = 1688 \]

\( \bar{C} \): time-integrated average surface chlorophyll (mg m\(^{-3}\) yr)

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Effect of nutrient load reduction

\( \bar{C} = 1946 \)

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\( \bar{C} = 1688 \)

\( \bar{C} \): time-integrated average surface chlorophyll (mg m\(^{-3}\) yr)
Effect of nutrient load reduction

Percent reduction in hypoxic area ($\bar{H}$)

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Percent reduction in surface chlorophyll ($\bar{C}$)

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Overall effect

Hypoxia effects on fish and fisheries

kick-off meeting of decision support tool development
Effect of nutrient load reduction

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