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

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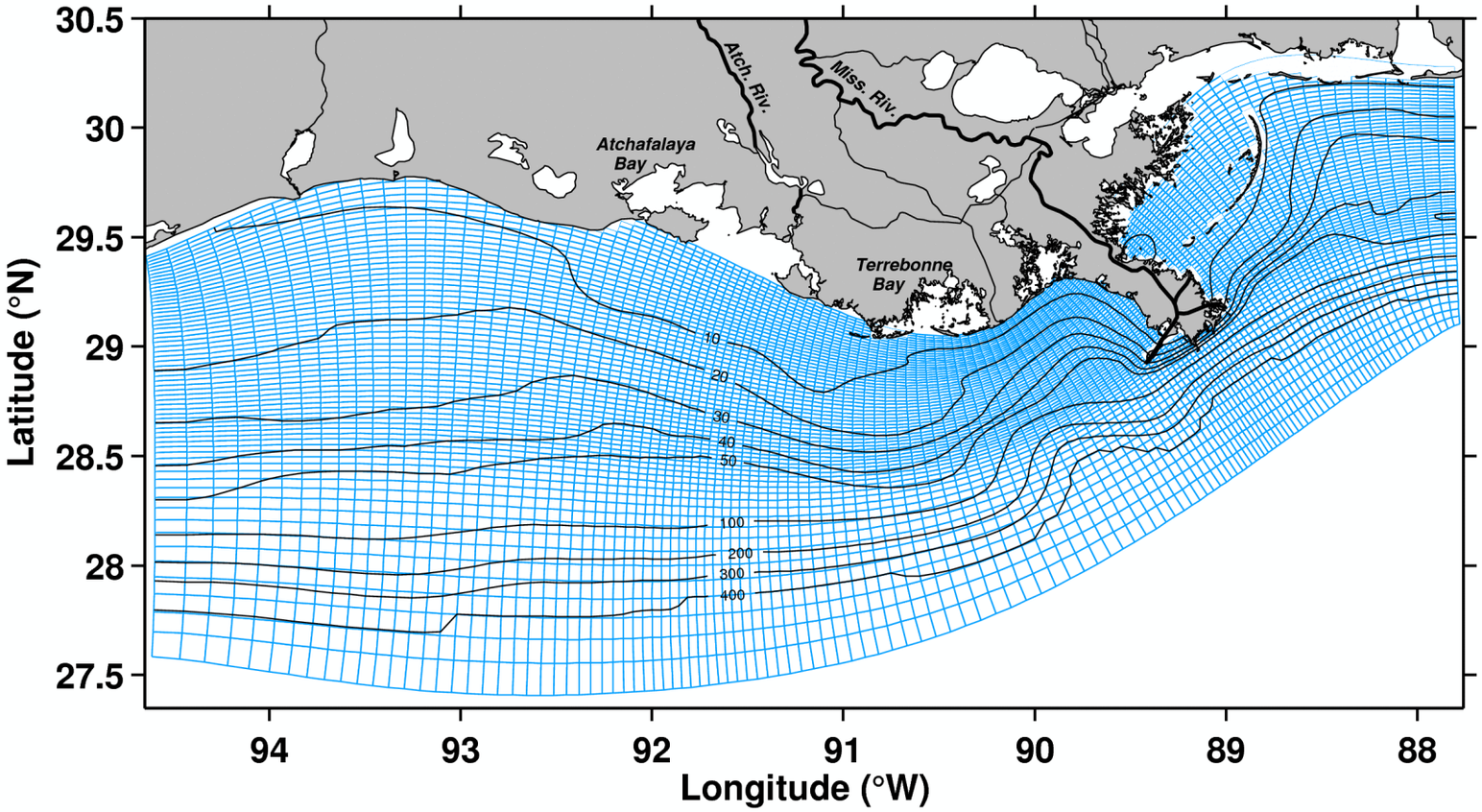
Circulation Model (ROMS)



Location: Northern GoM shelf

Resolution: 3-5 km in horizontal
20 vertical layers

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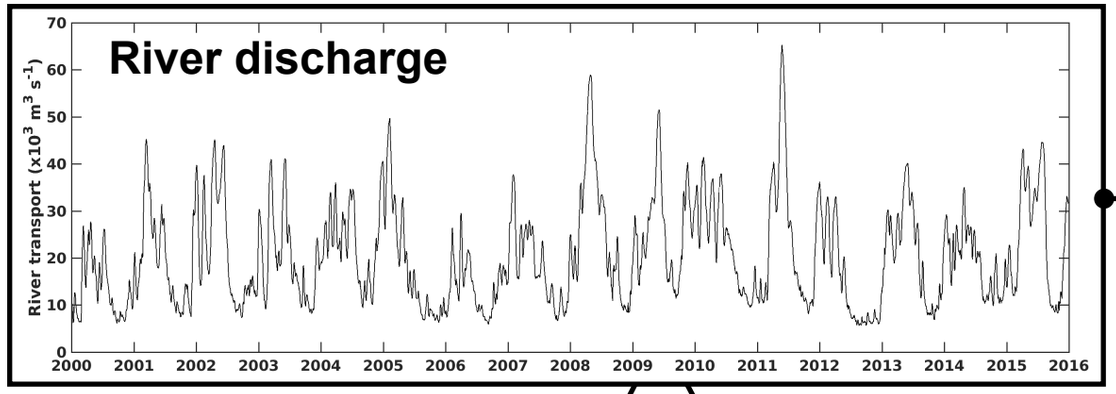
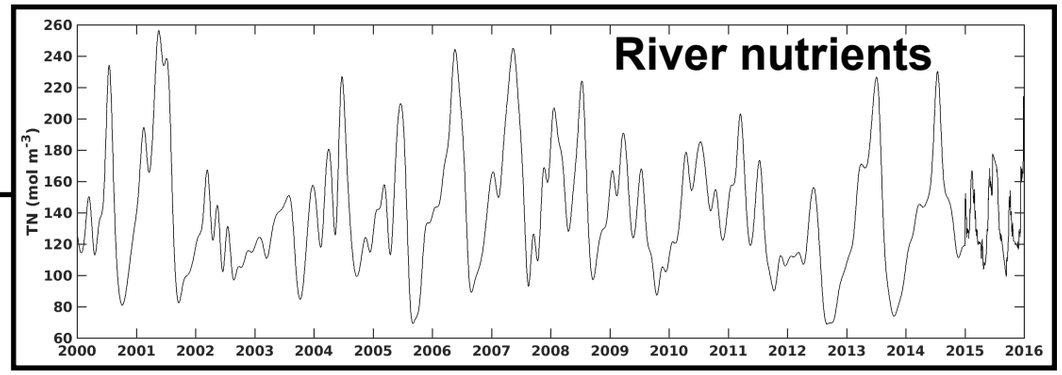
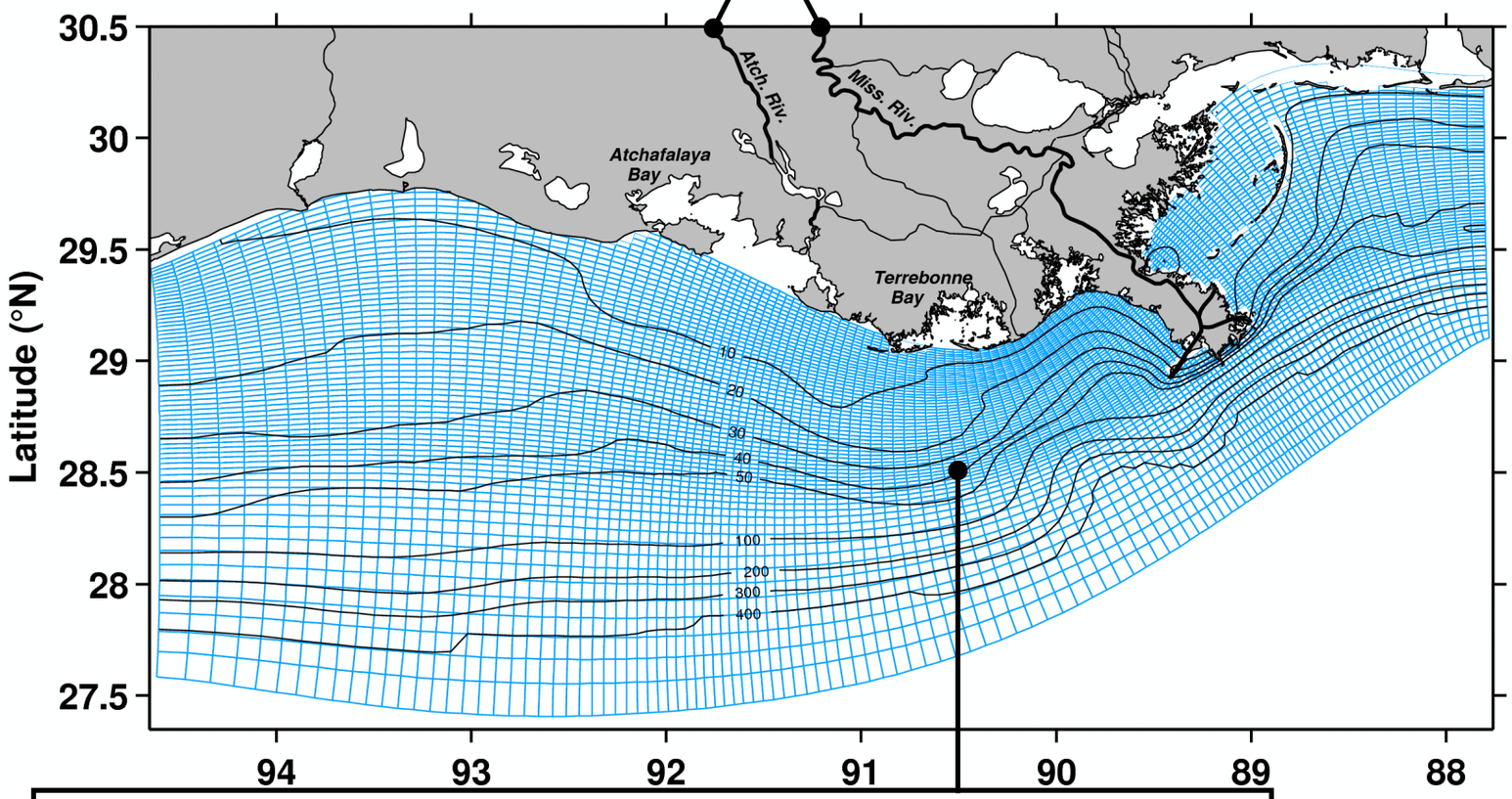
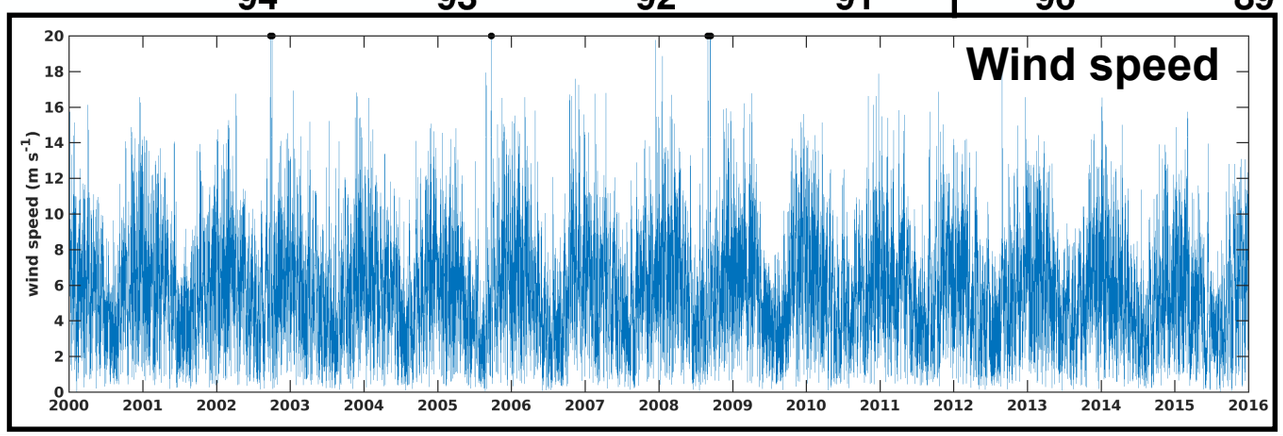








Location: Northern GoM shelf

Resolution: 3-5 km in horizontal
20 vertical layers

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

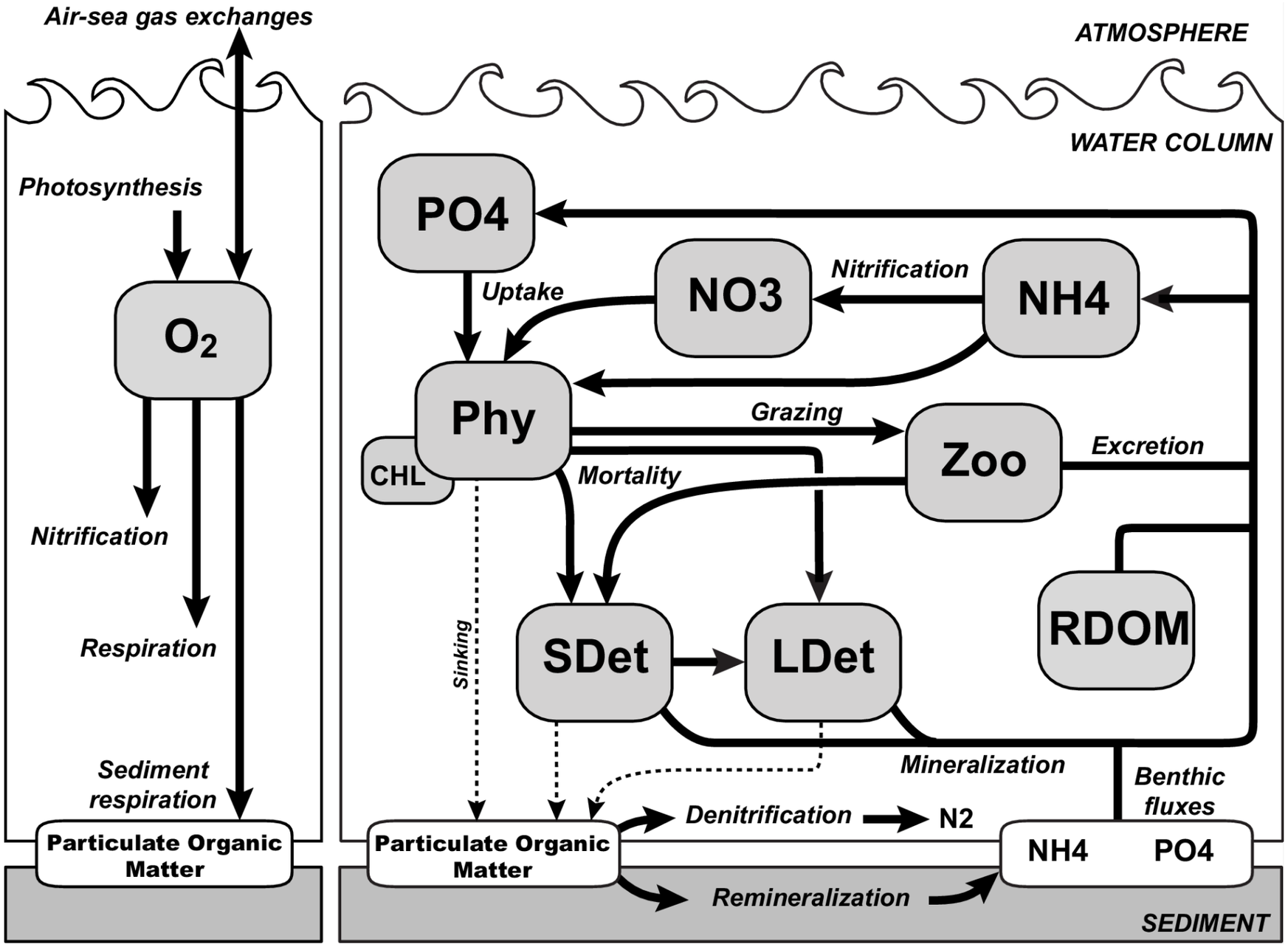
River inputs: daily freshwater input (U.S. Army Corps of Engineers); monthly nutrient and particulate matter loads (USGS)

Boundary conditions: climatology

Simulation period: 2000 - 2016

Output: Daily 3D field of state variables (T, S, currents + biological variables)

Biogeochemical Model



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

Load		NITROGEN						
		100%	90%	80%	60%	50%	40%	20%
PHOSPHORUS	100%							
	90%							
	80%							
	60%							
	50%							
	40%							
	20%							

Nutrient load experiments

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Load		NITROGEN						
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PHOSPHORUS	100%	Baseline						
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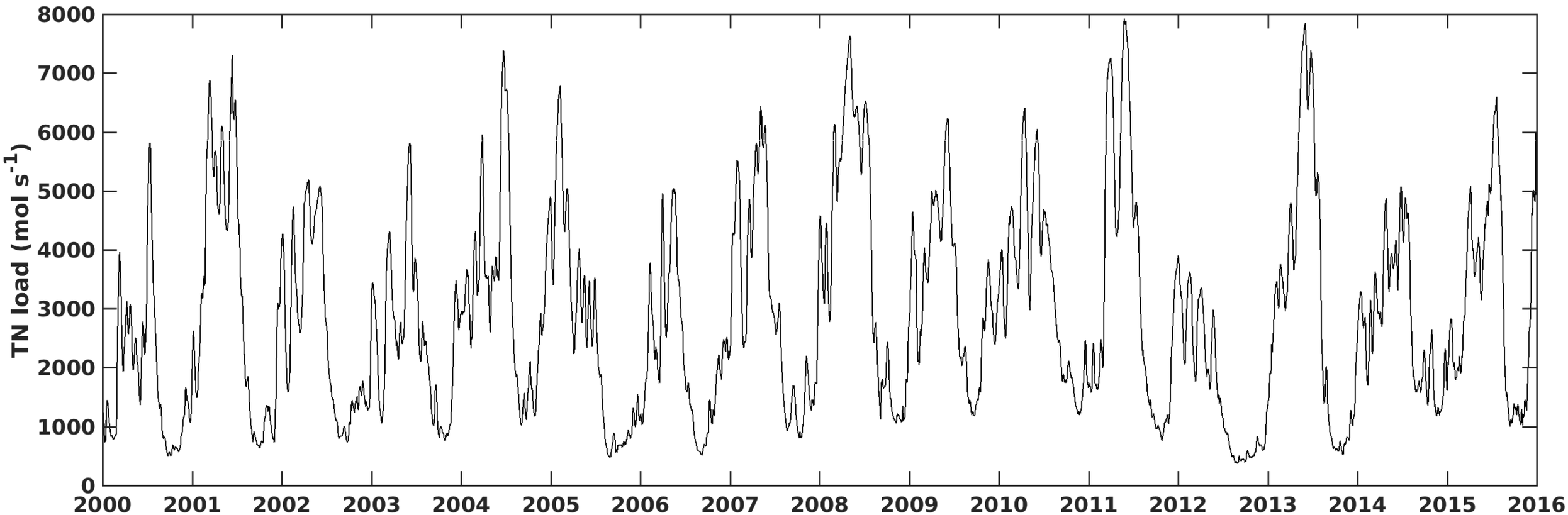
	80%							
	60%							
	50%							
	40%							
	20%							

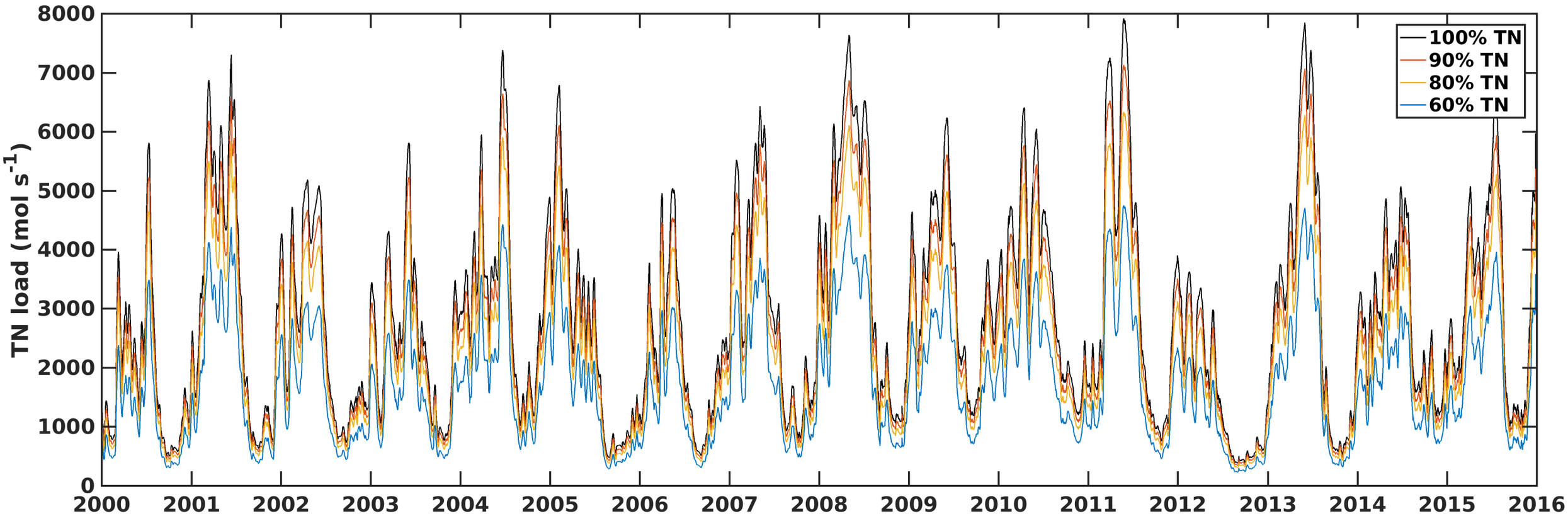
Nutrient load experiments

Observed total nitrogen load used in the <u>baseline</u> simulation

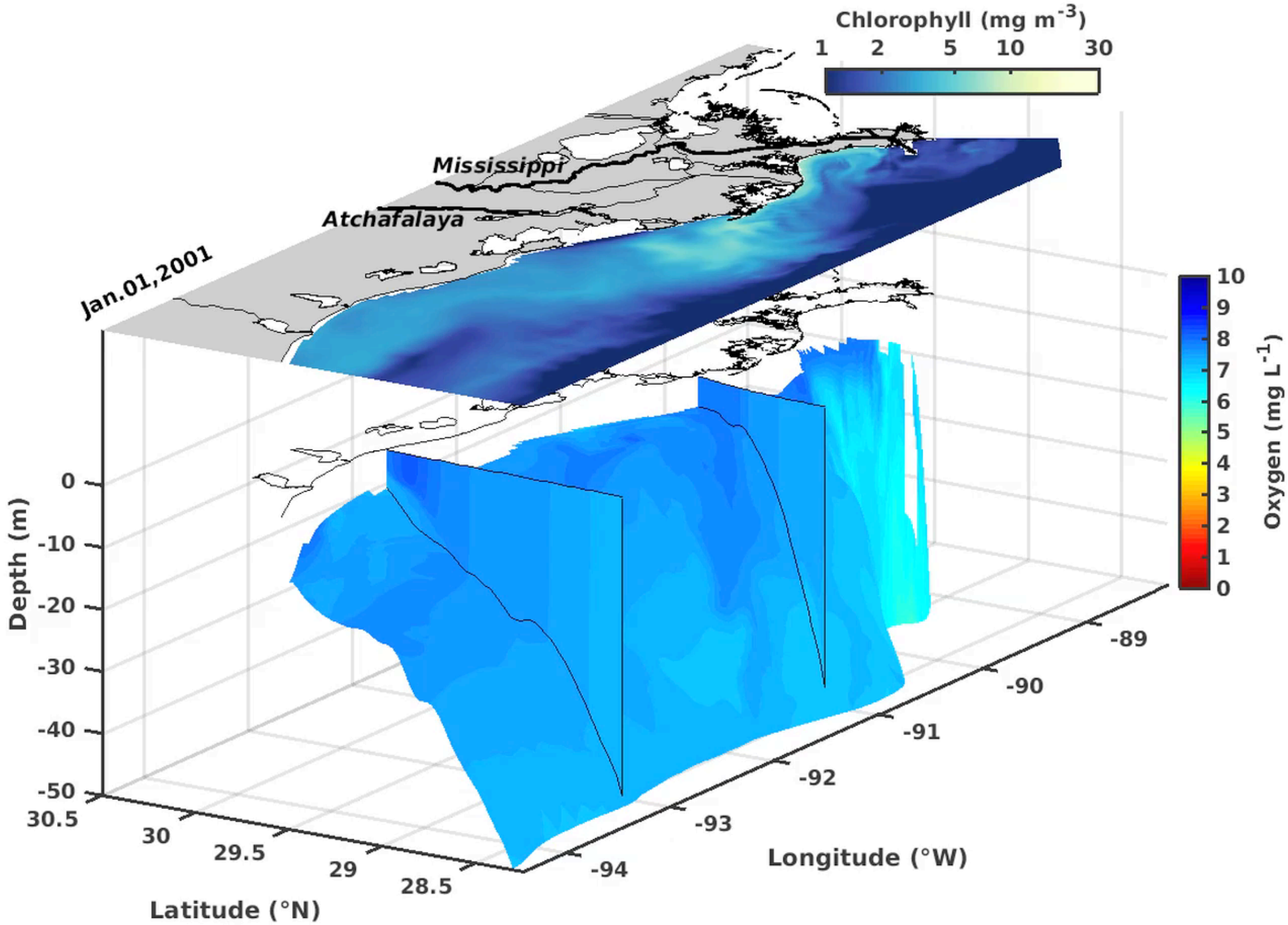


Nutrient load experiments

Total nitrogen loads used in the nutrient load reduction experiments



Results for baseline simulation



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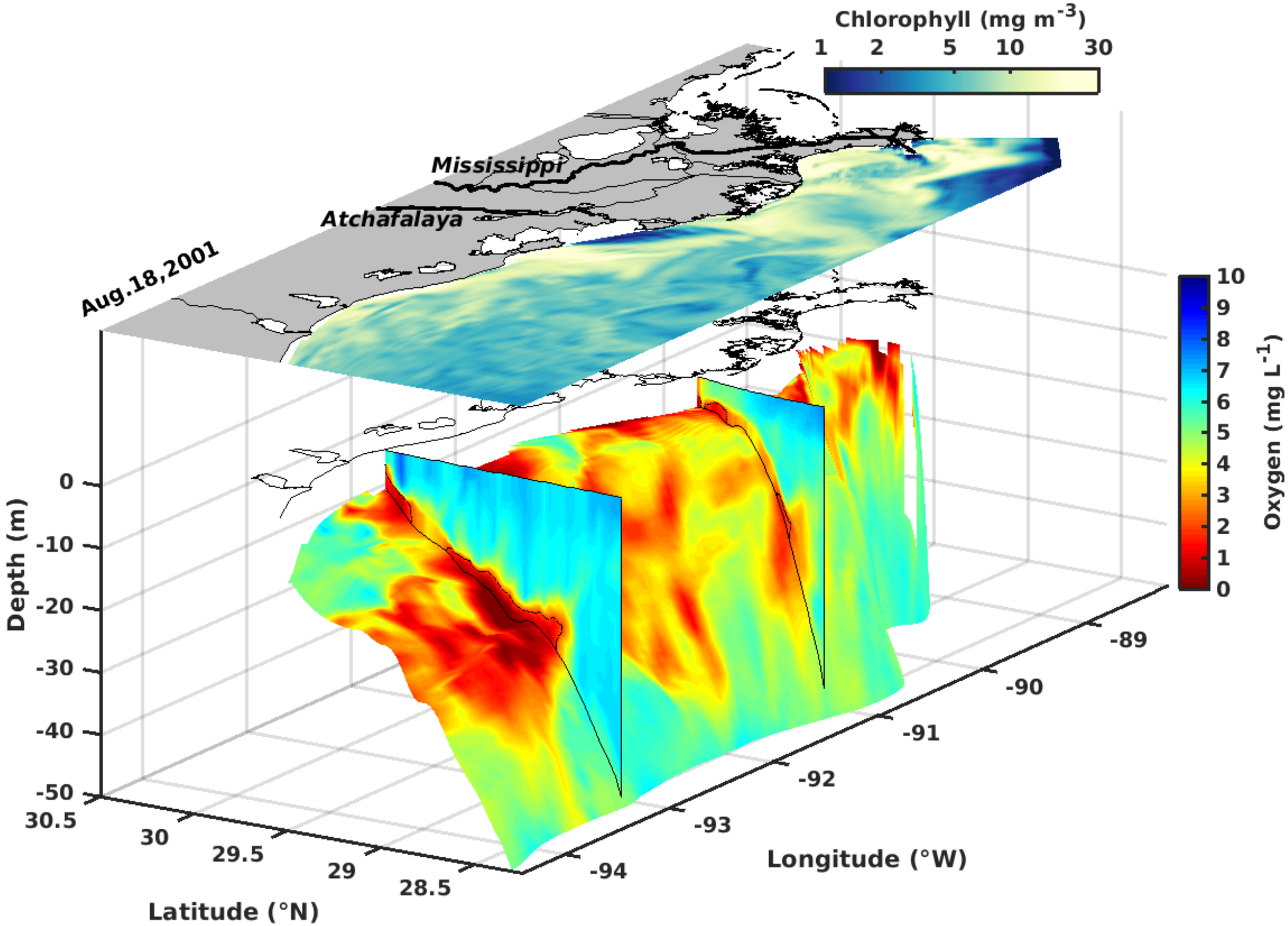

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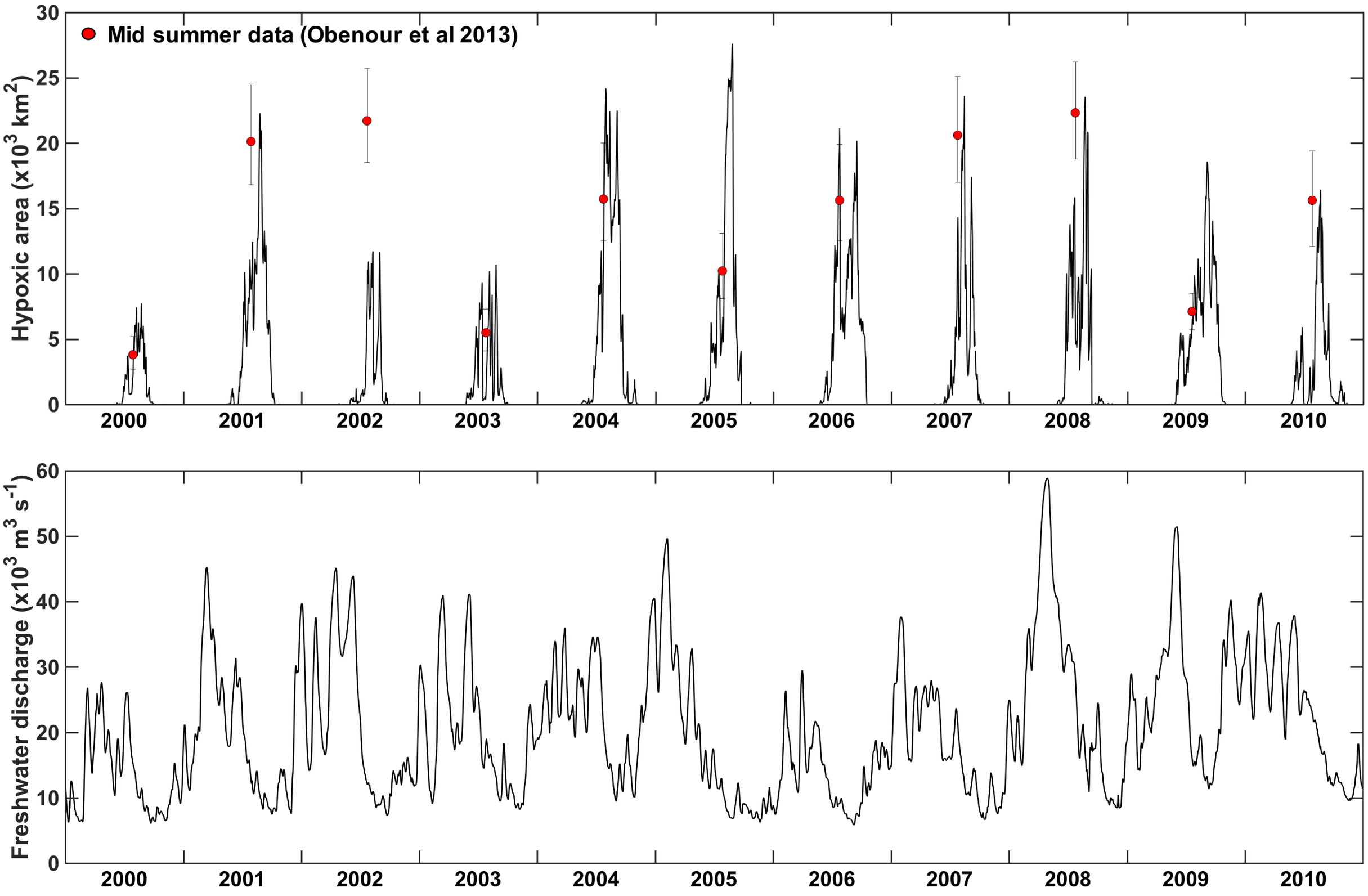

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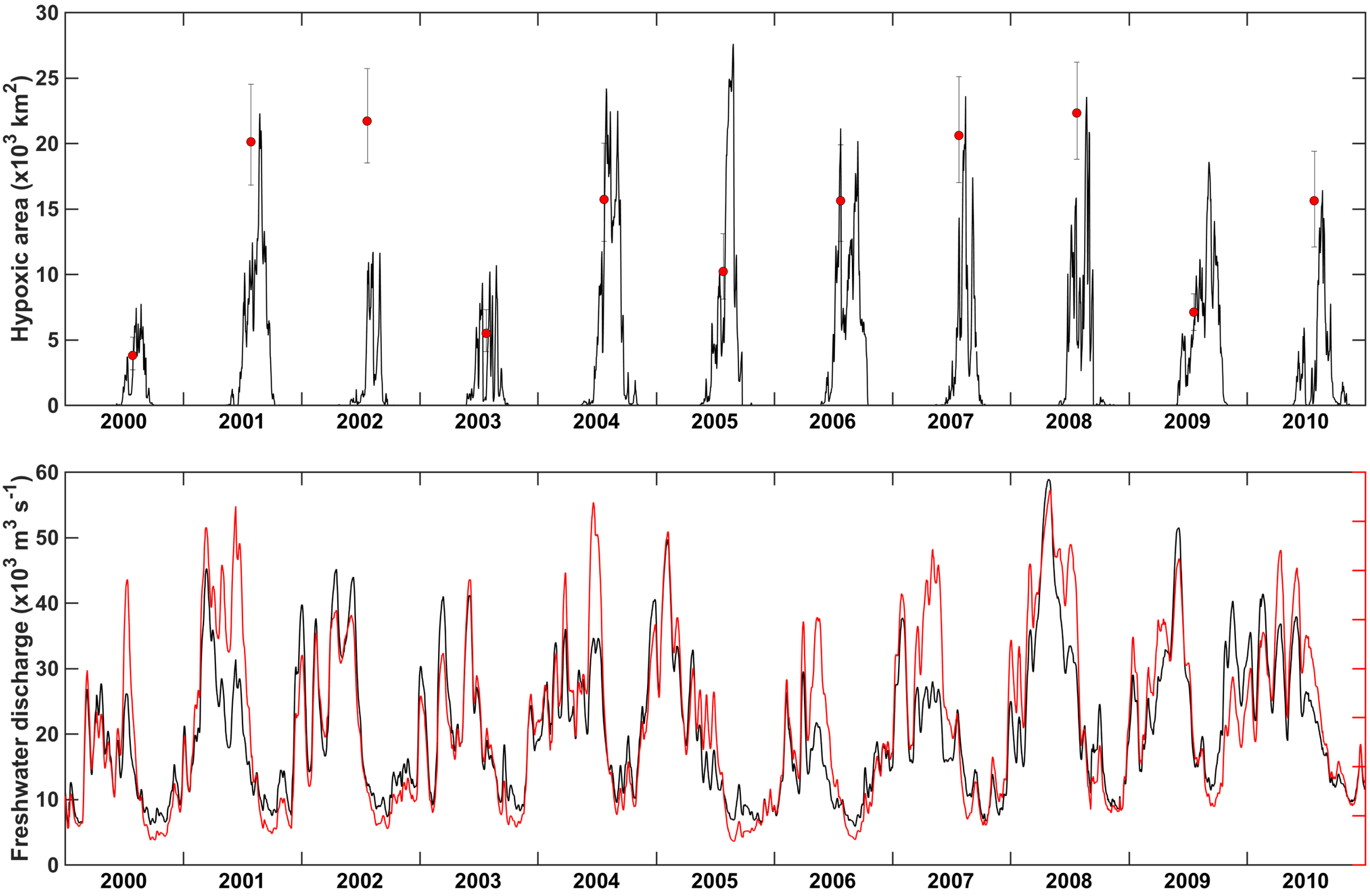
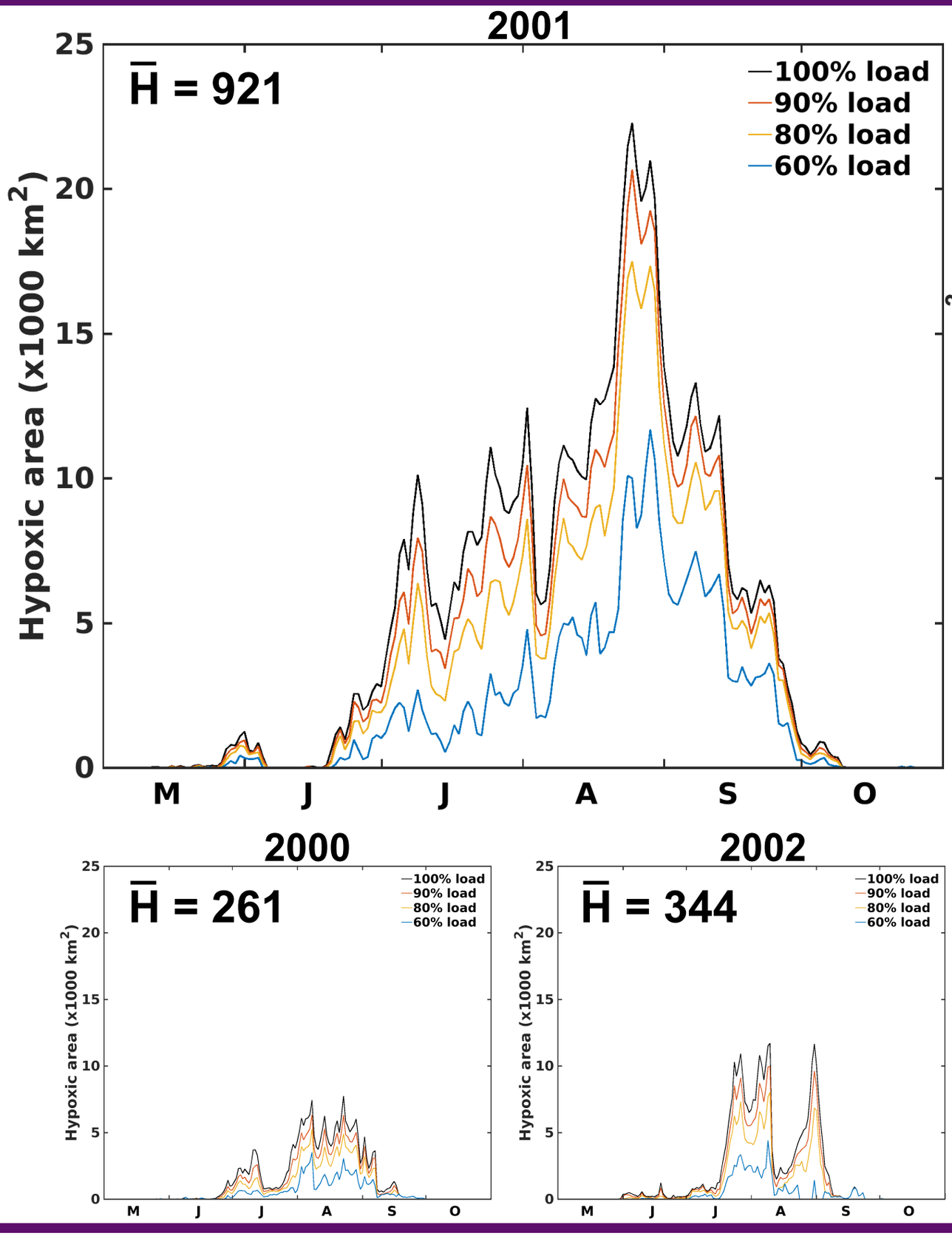
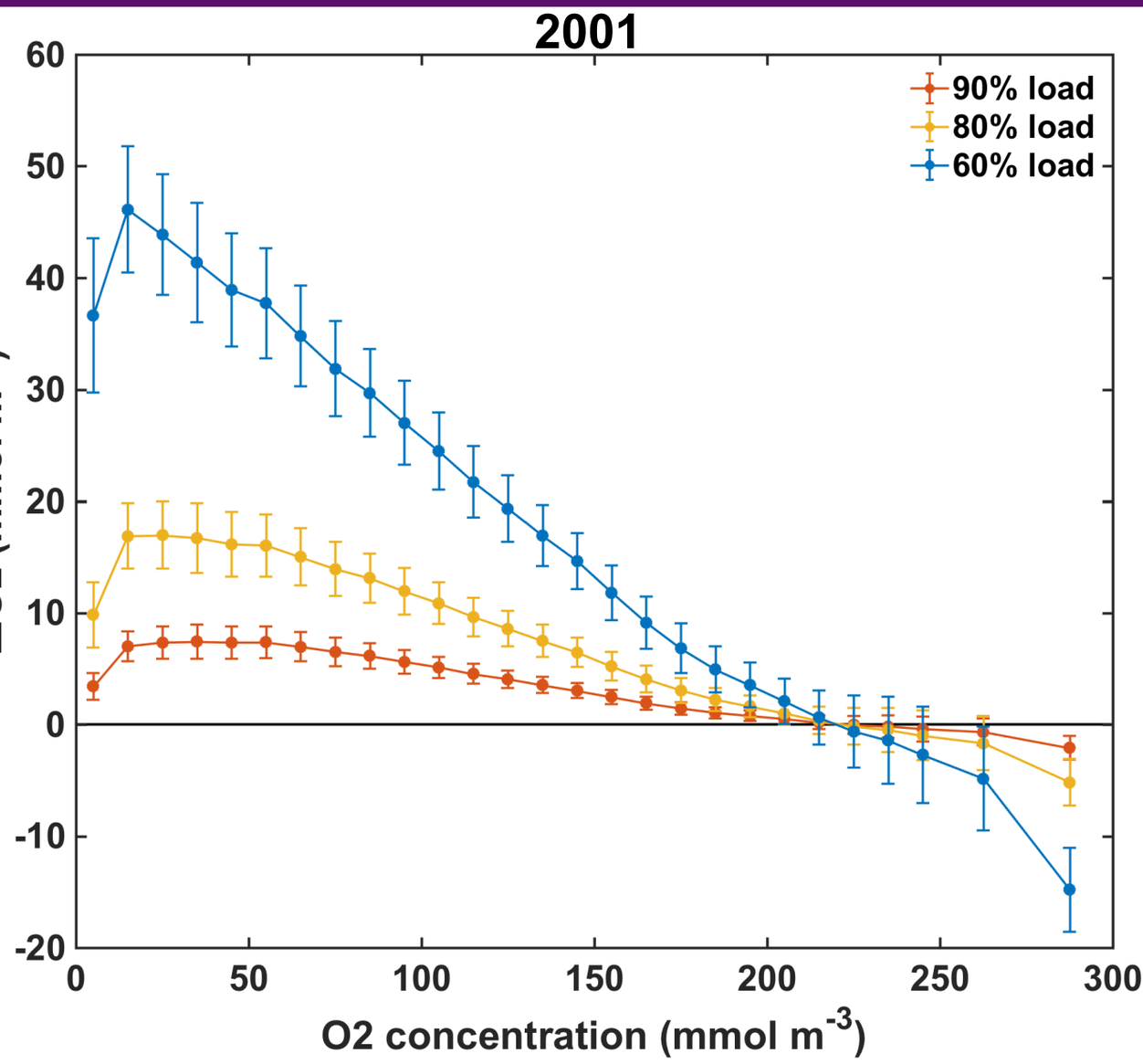


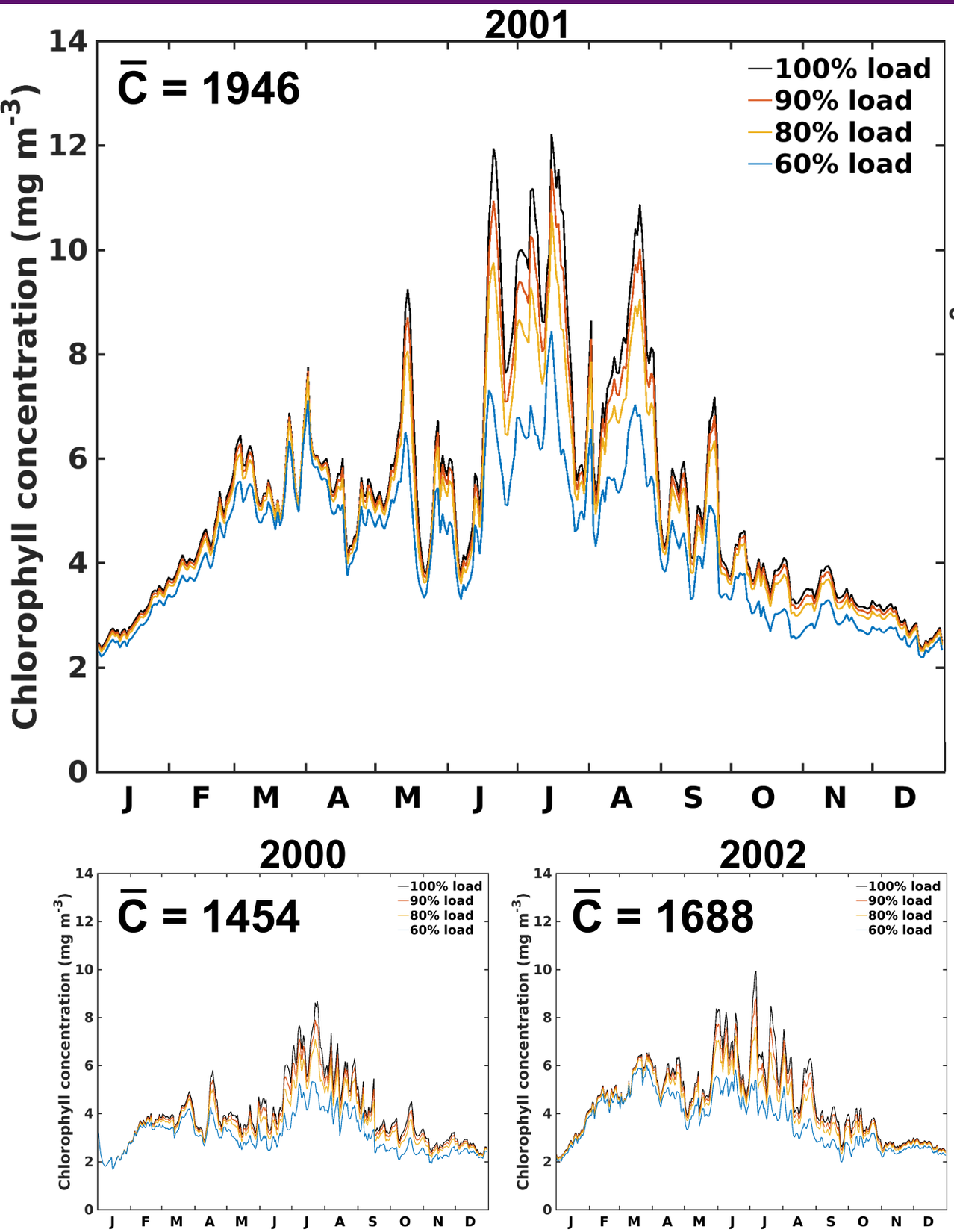
Effect of nutrient load reduction

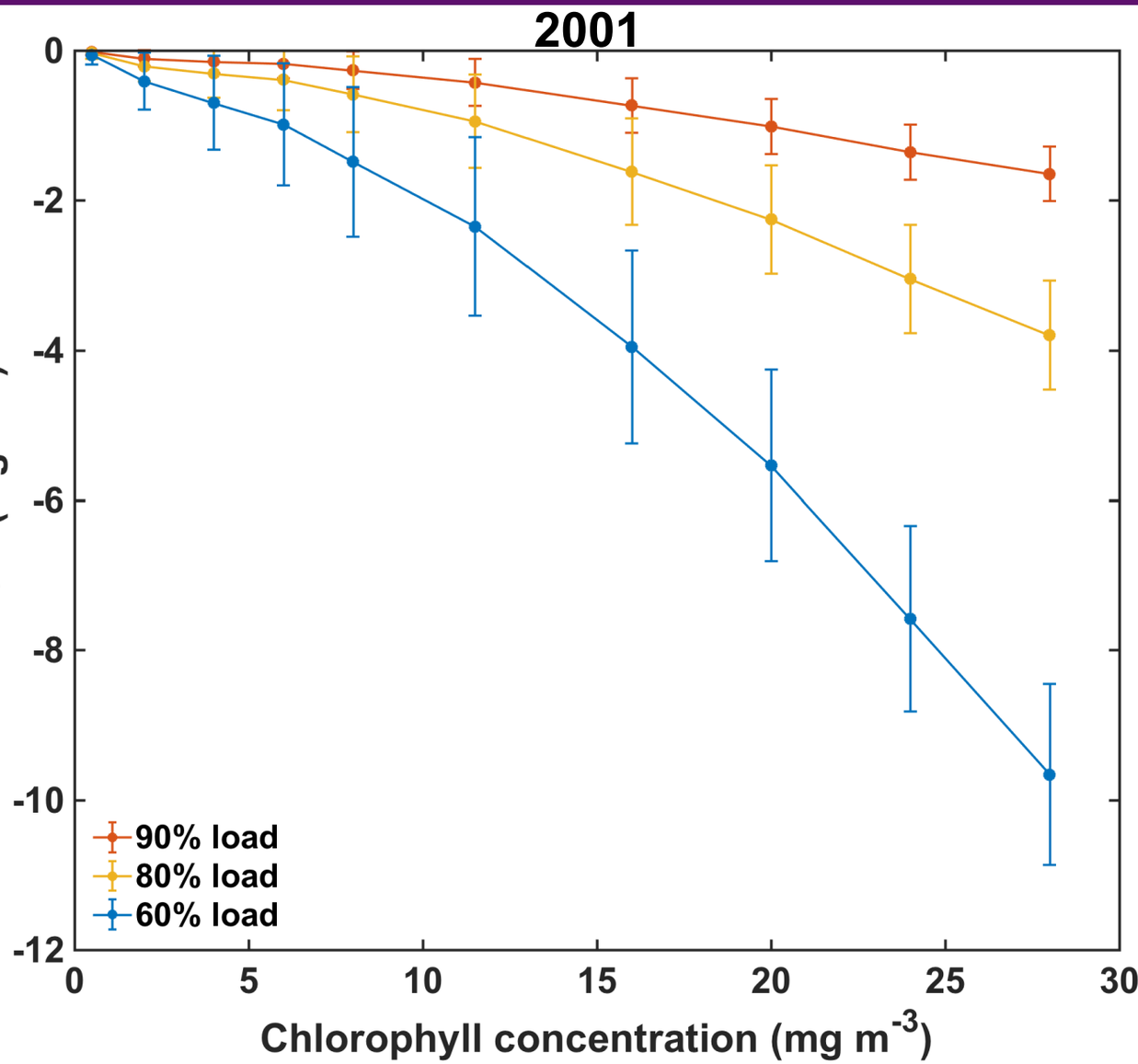




$\bar{H}$: time-integrated hypoxic area (10^3 km^2 yr)

Effect of nutrient load reduction





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

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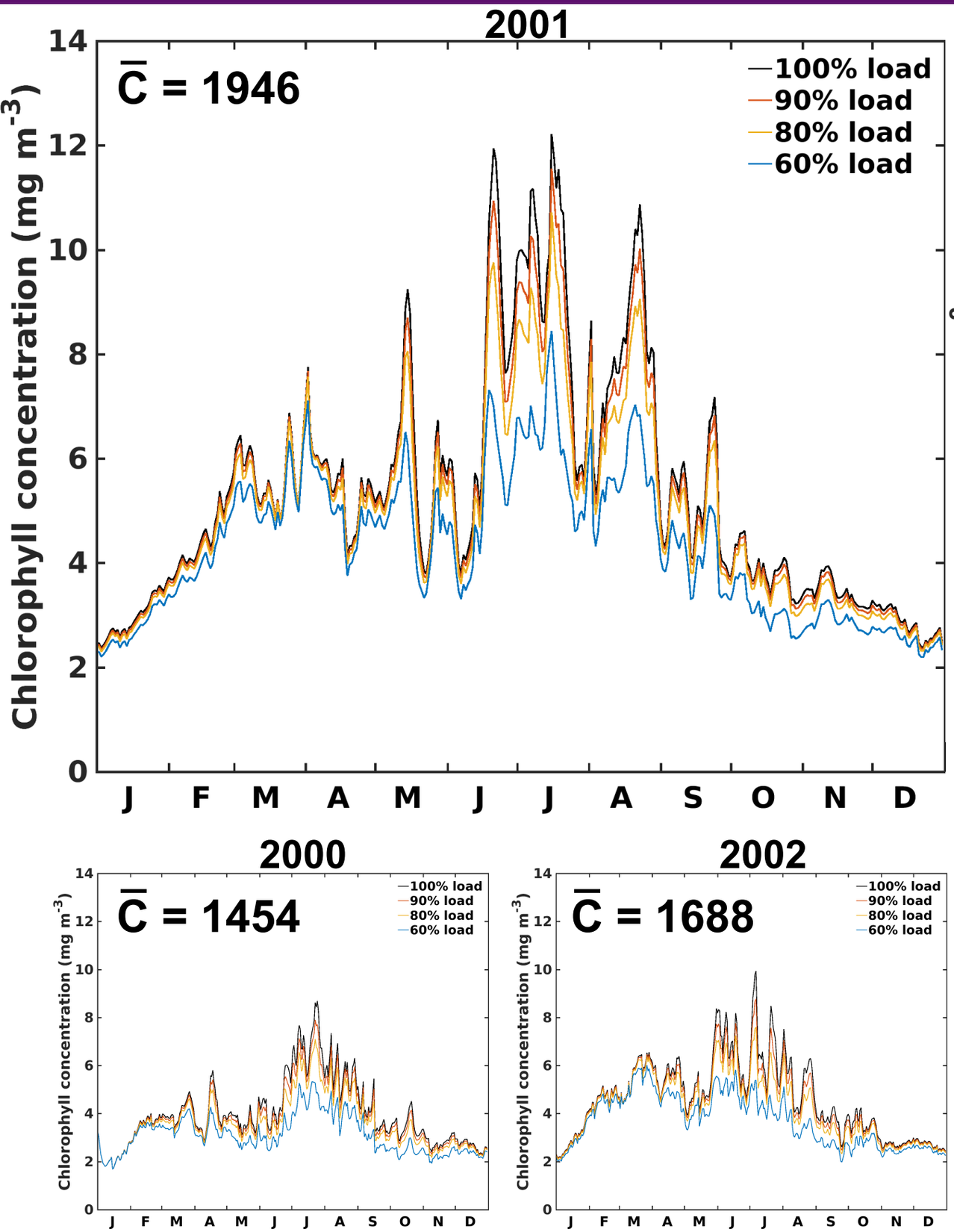

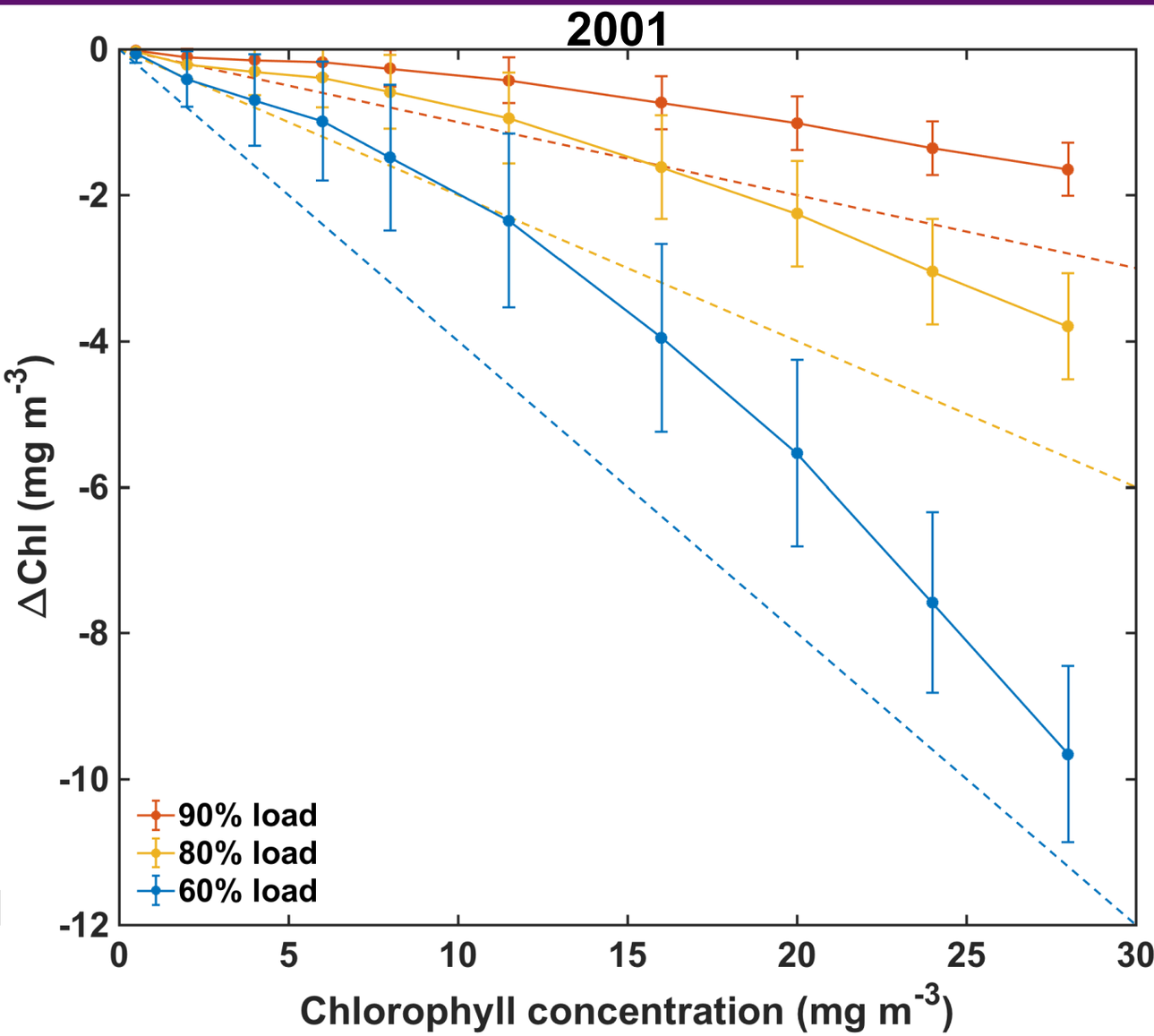

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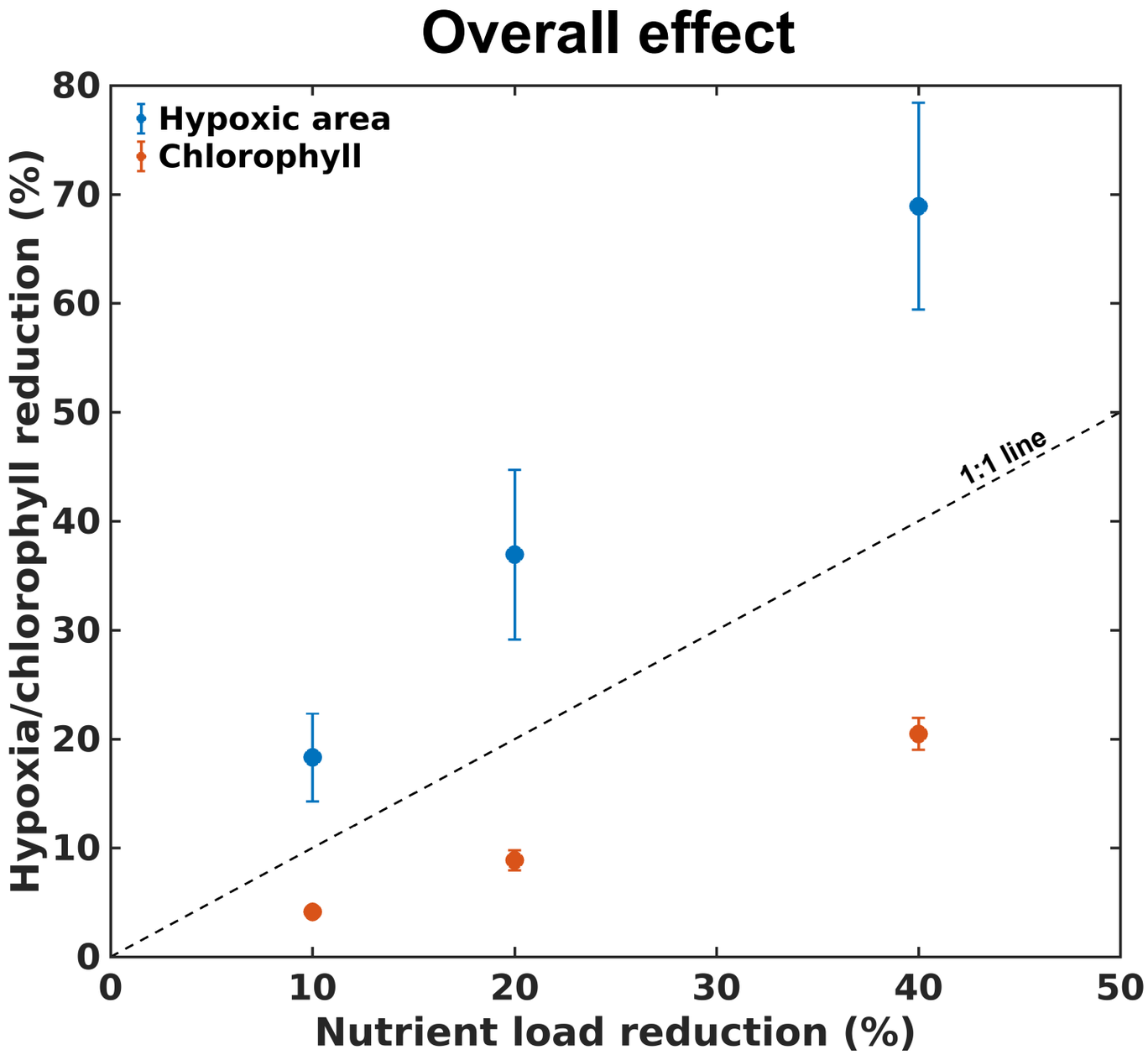
Effect of nutrient load reduction

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

	2000	2001	2002
$\bar{H}_{90}$:	21%	14%	21%
$\bar{H}_{80}$:	40%	28%	43%
$\bar{H}_{60}$:	68%	60%	79%

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

	2000	2001	2002
$\bar{C}_{90}$:	5%	4%	4%
$\bar{C}_{80}$:	10%	8%	9%
$\bar{C}_{60}$:	22%	19%	20%



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Overall effect