

Photo:
Jane Thomas

Biogeochemical
Modeling in Shallow
Estuarine Ecosystems:
Key Processes and Challenges

seagrass
meadows →

Jeremy Testa

UMCES Chesapeake Biological Laboratory

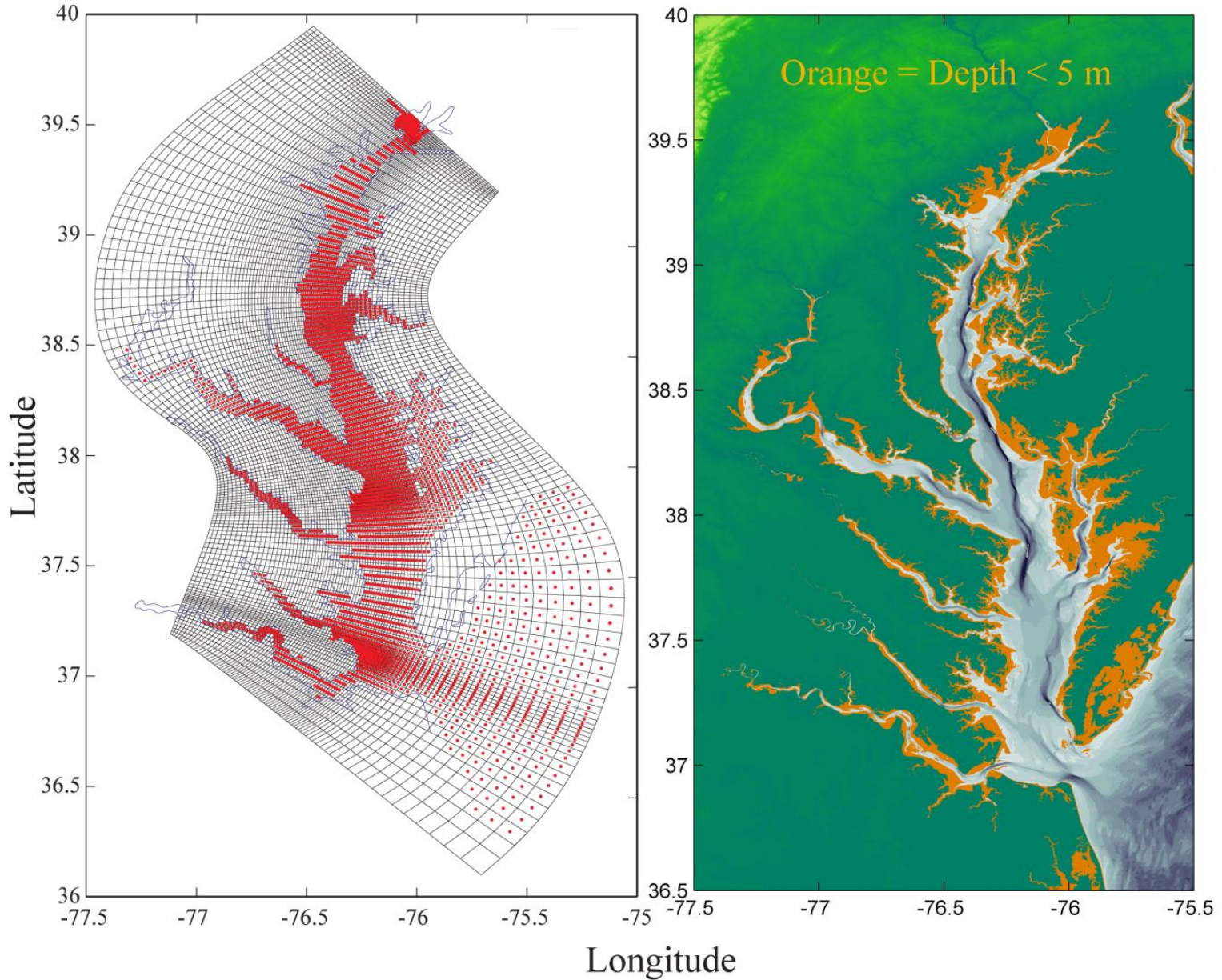
Damian Brady

University of Maine

Ming Li

UMCES Horn Point Laboratory

Shallow Habitat Widespread in Chesapeake Bay



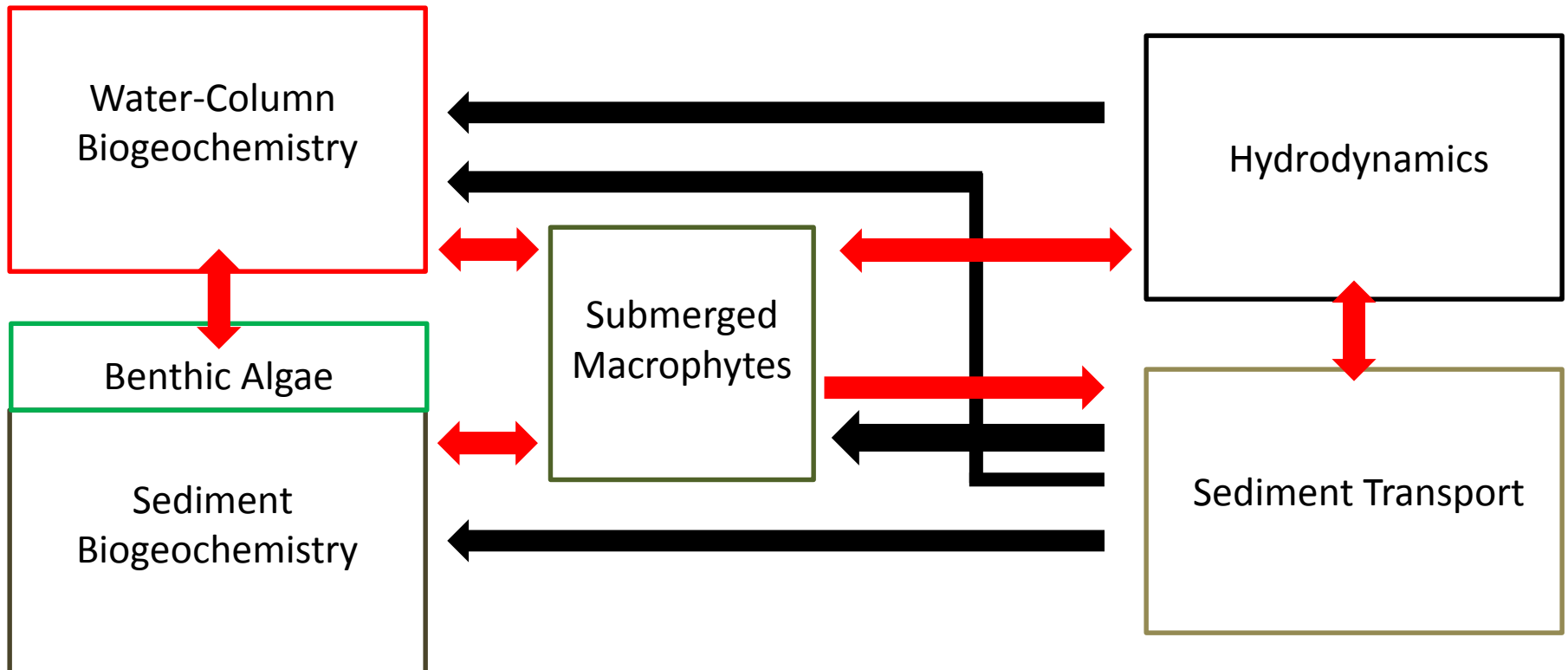
....and big models don't always represent them well

Key Processes in Shallow Waters

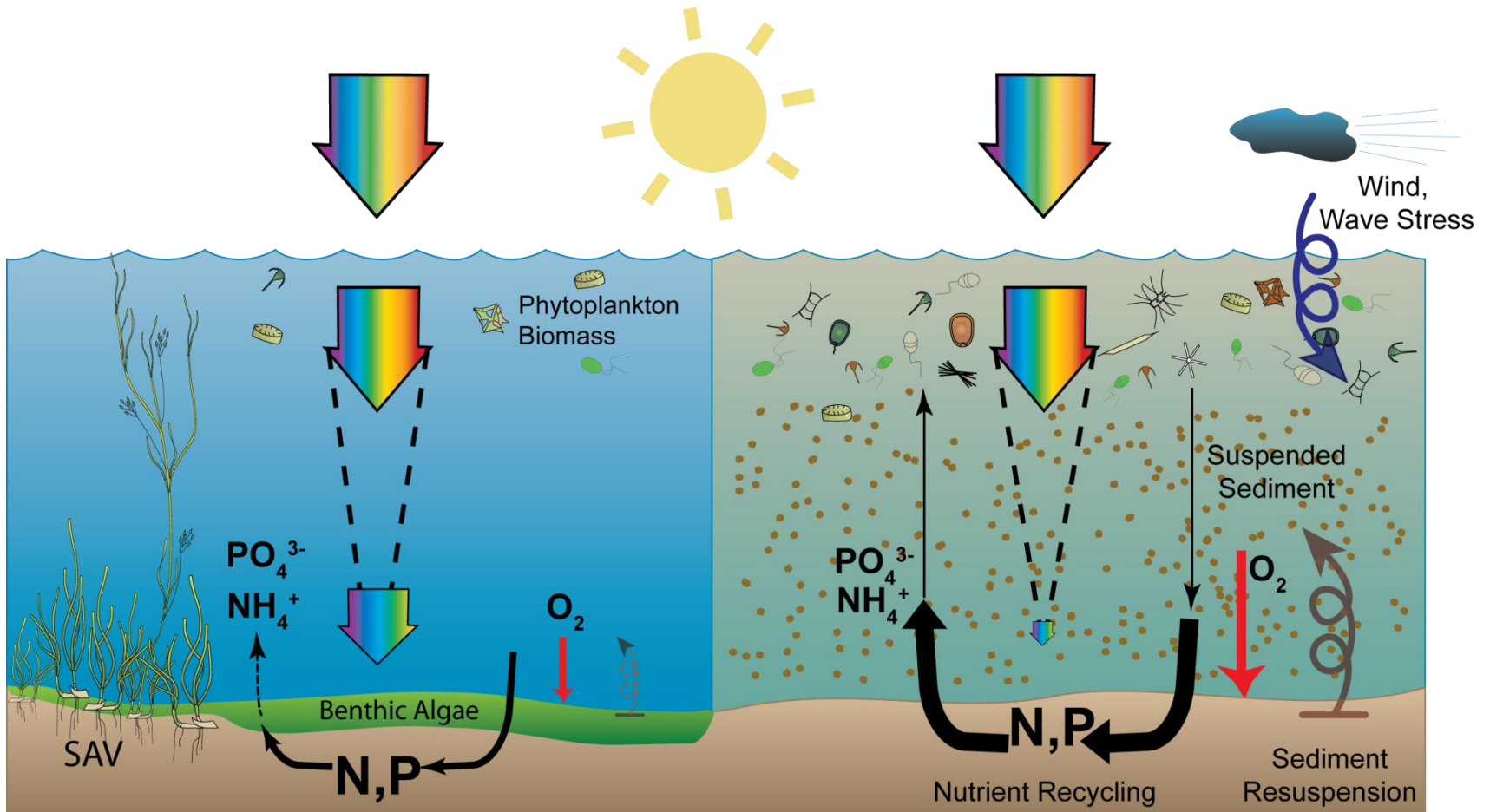
- (1) Sediment-water interactions are important
- (2) Influence of submerged macrophytes
- (3) Sediment resuspension
- (4) Benthic algal growth
- (5) Diel cycling hypoxia

Biogeochemical Processes

Physical Processes



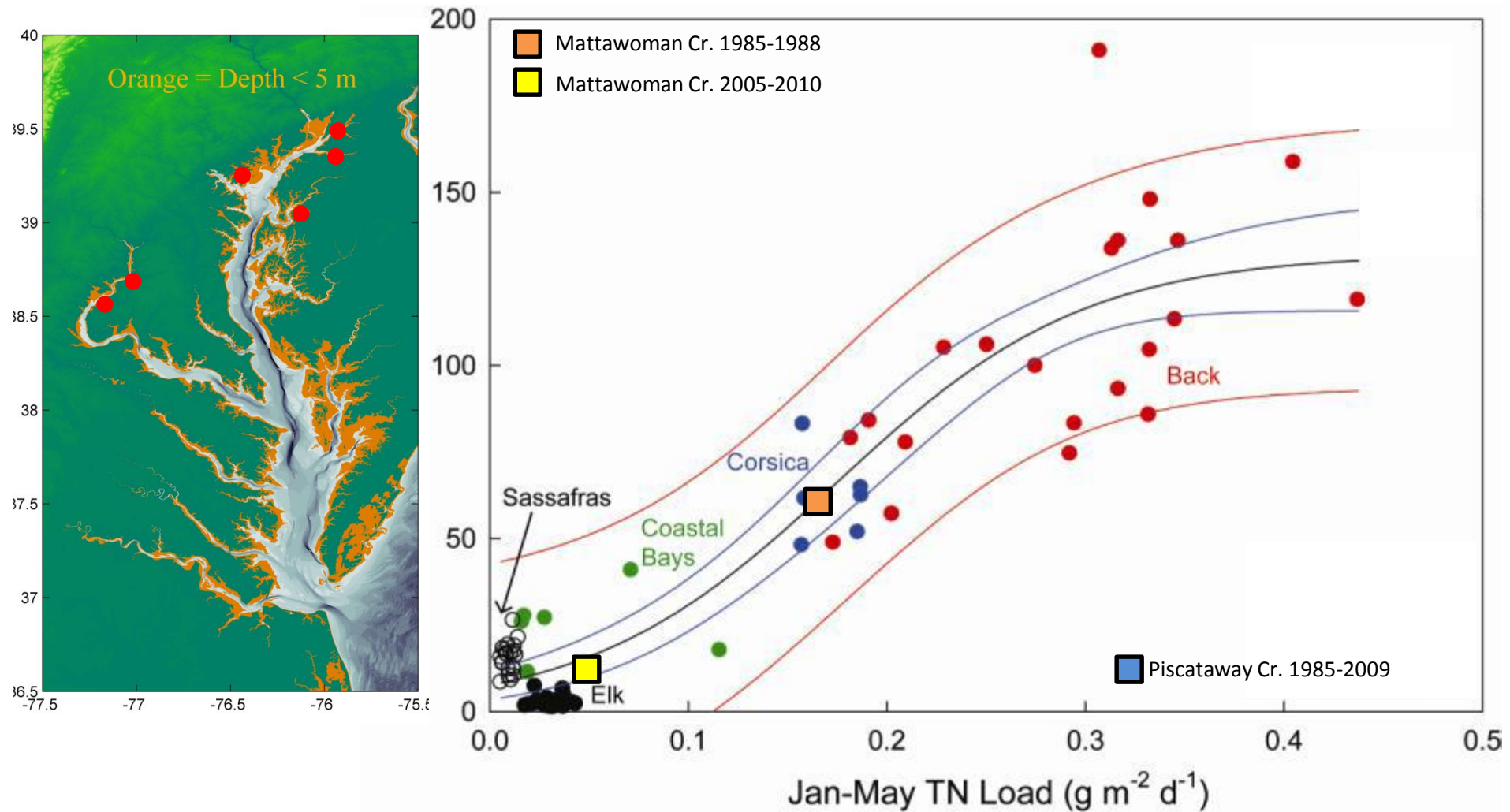
Key Processes and Feedbacks in Shallow Habitats



“Healthy” Ecosystem

Degraded Ecosystem

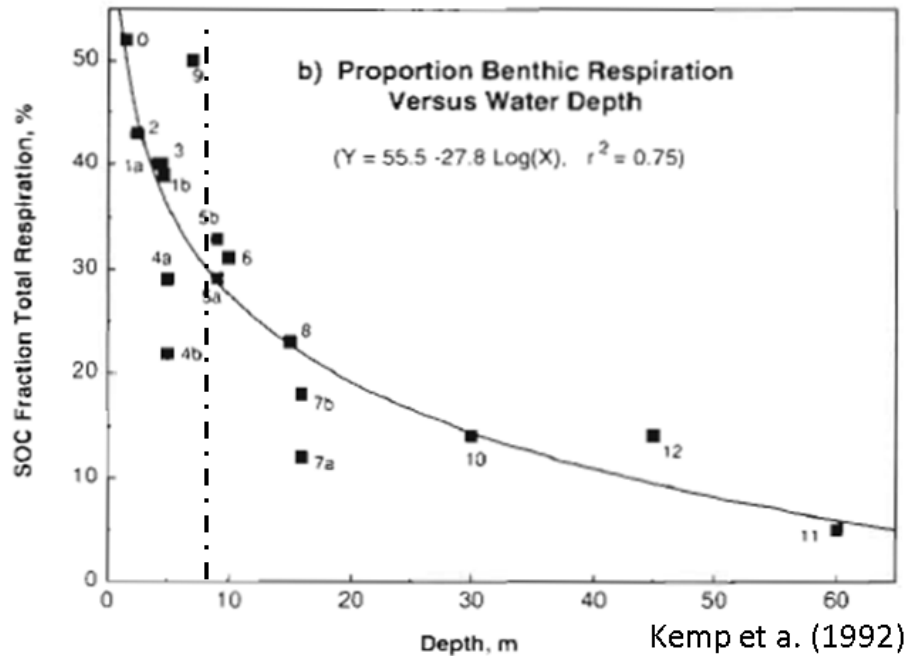
Relationships Between N Load and Chlorophyll



- Will these relationships hold up with the addition of new systems?
- If the relationship is non-linear, what feedback contribute to it?

Sediments as Key Reactors in Shallow Waters

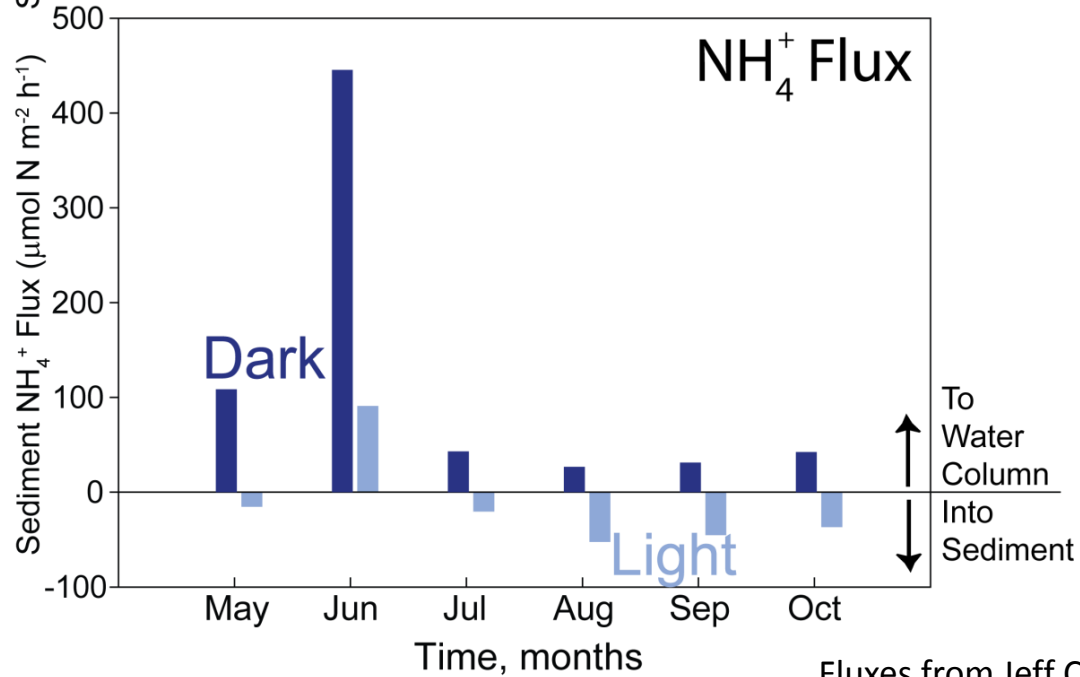
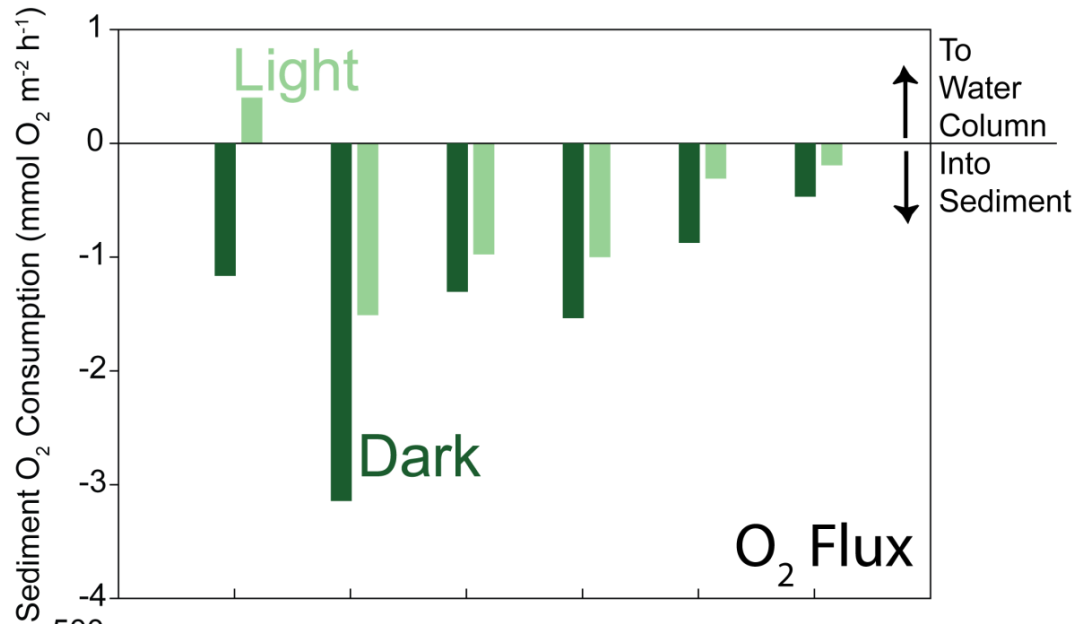
(1) Sediment O₂ demand can be dominated by sediments in shallow systems



(2) Illumination of sediments can shift system

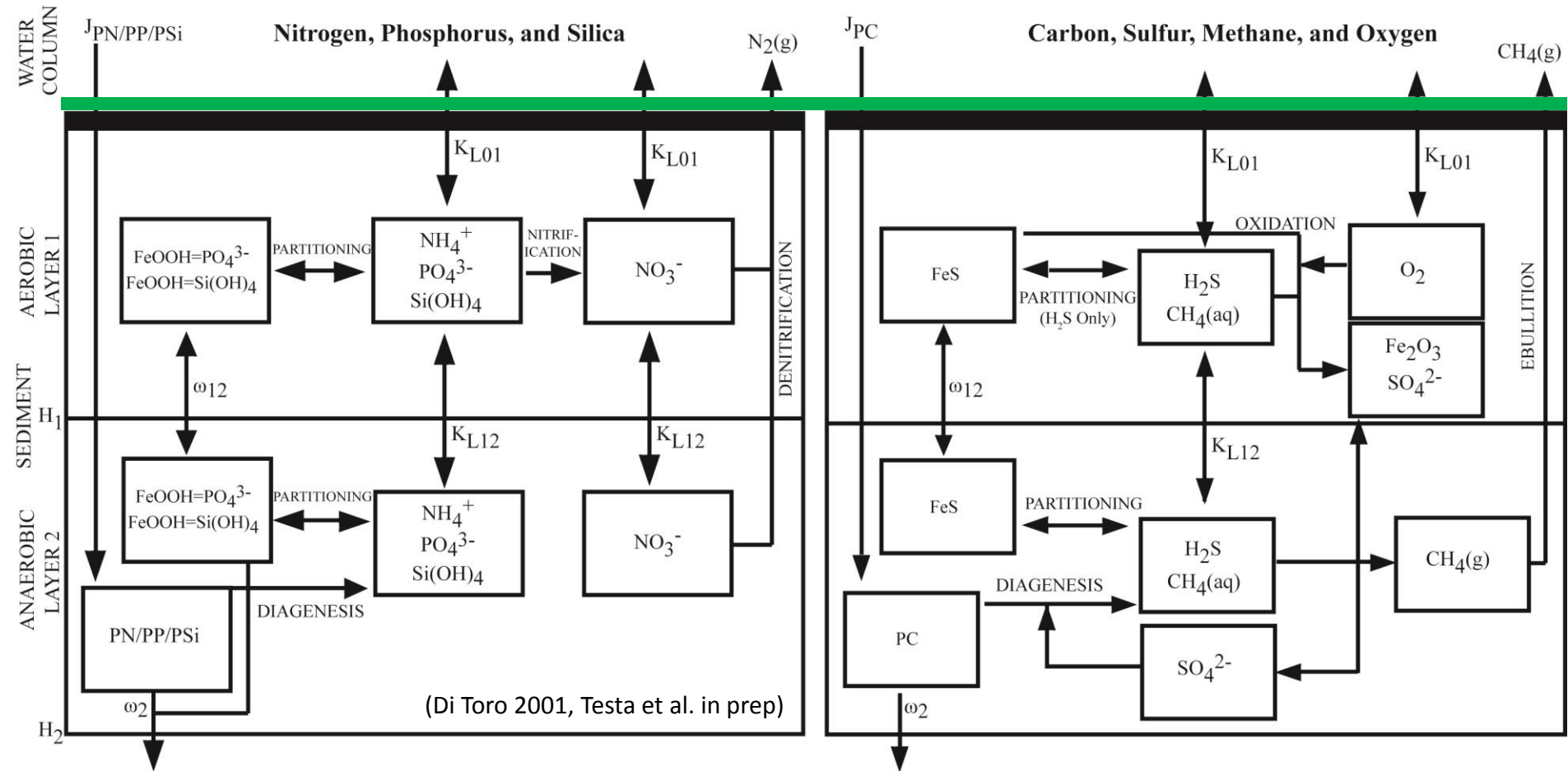


Sediment-Water Fluxes Switch in Dark versus Light



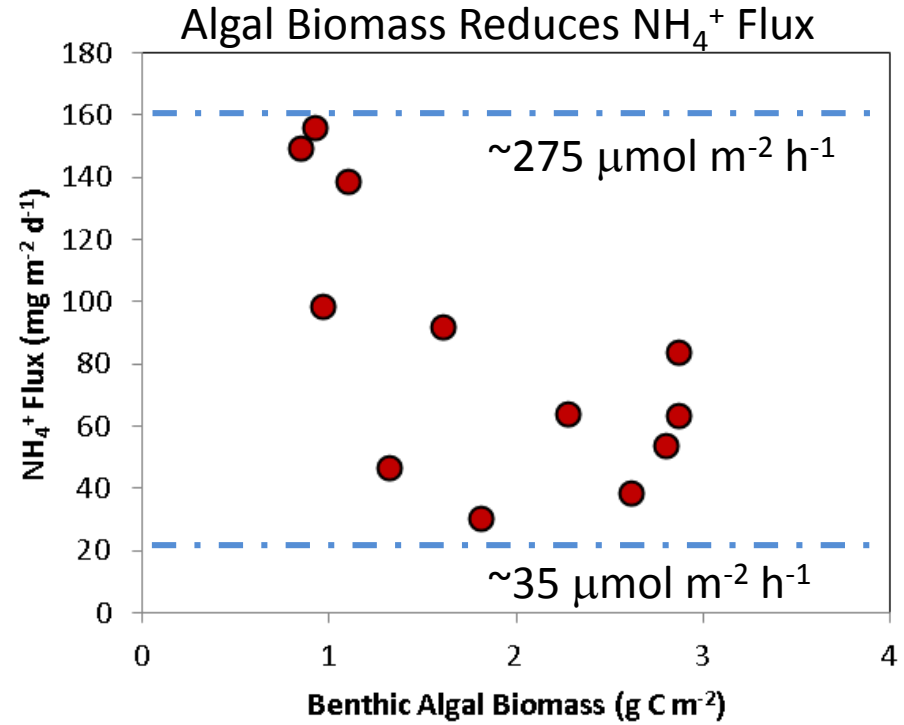
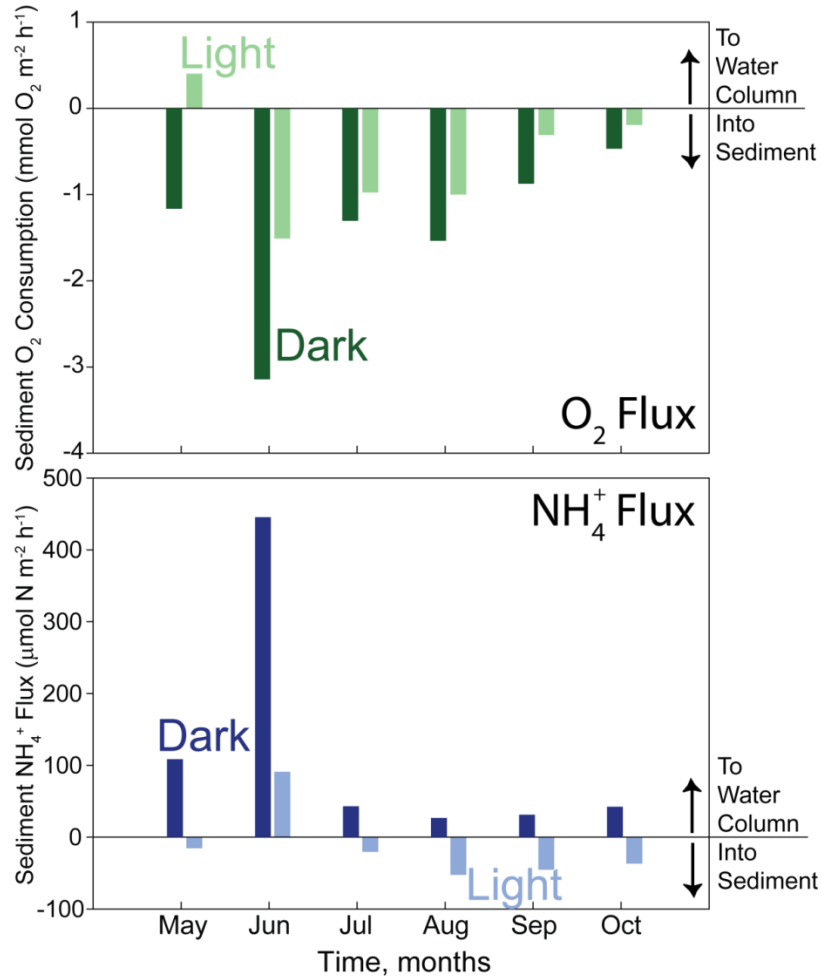
Sediment Biogeochemical Model

...and benthic algae



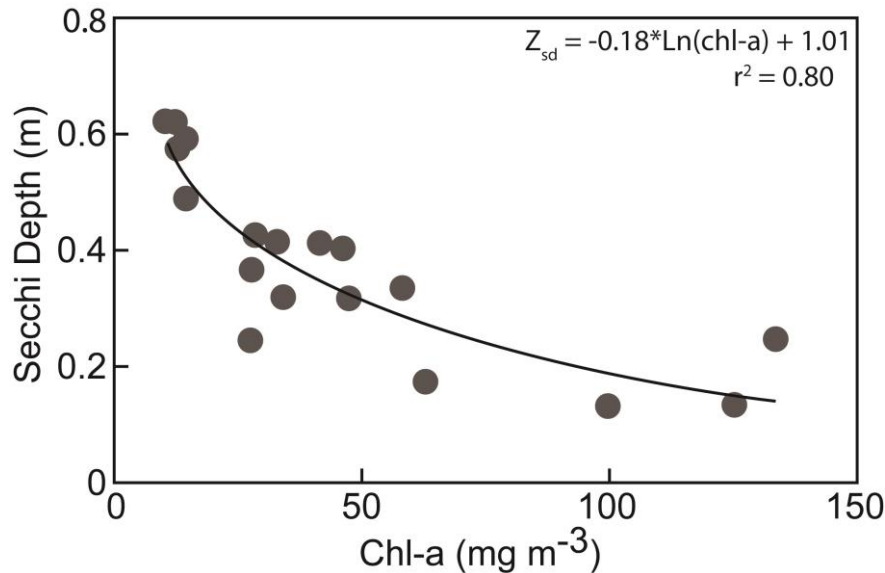
- Improved Silica, Denitrification, phosphorus models
- Benthic algal model added
- Way to model benthic algae not straightforward (algal mat, versus incorporation into sediment)

Incorporating a Benthic Algal Model

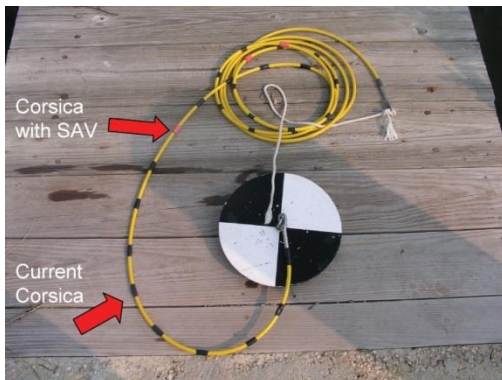
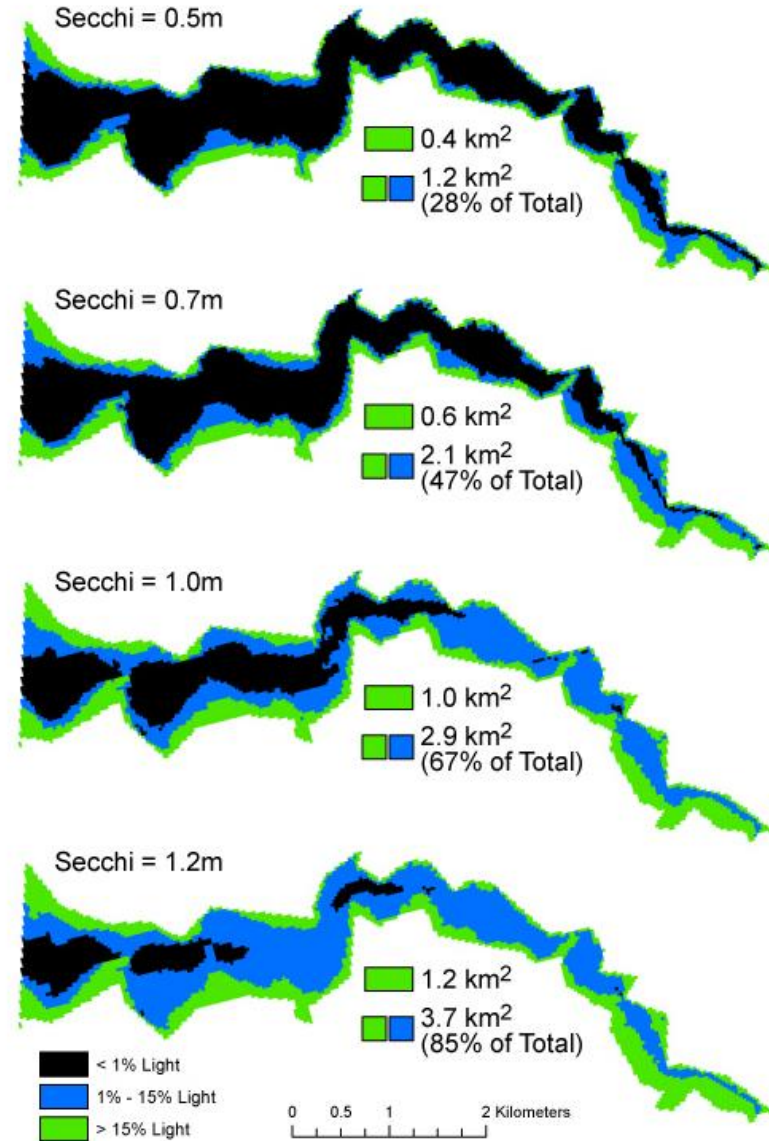


In Shallow Systems, a Little Light Goes a Long Way

Small increase in Secchi (0.7m → 1.0 m) yields large increase in photic bottom (1% surface light) from 41 → >93%



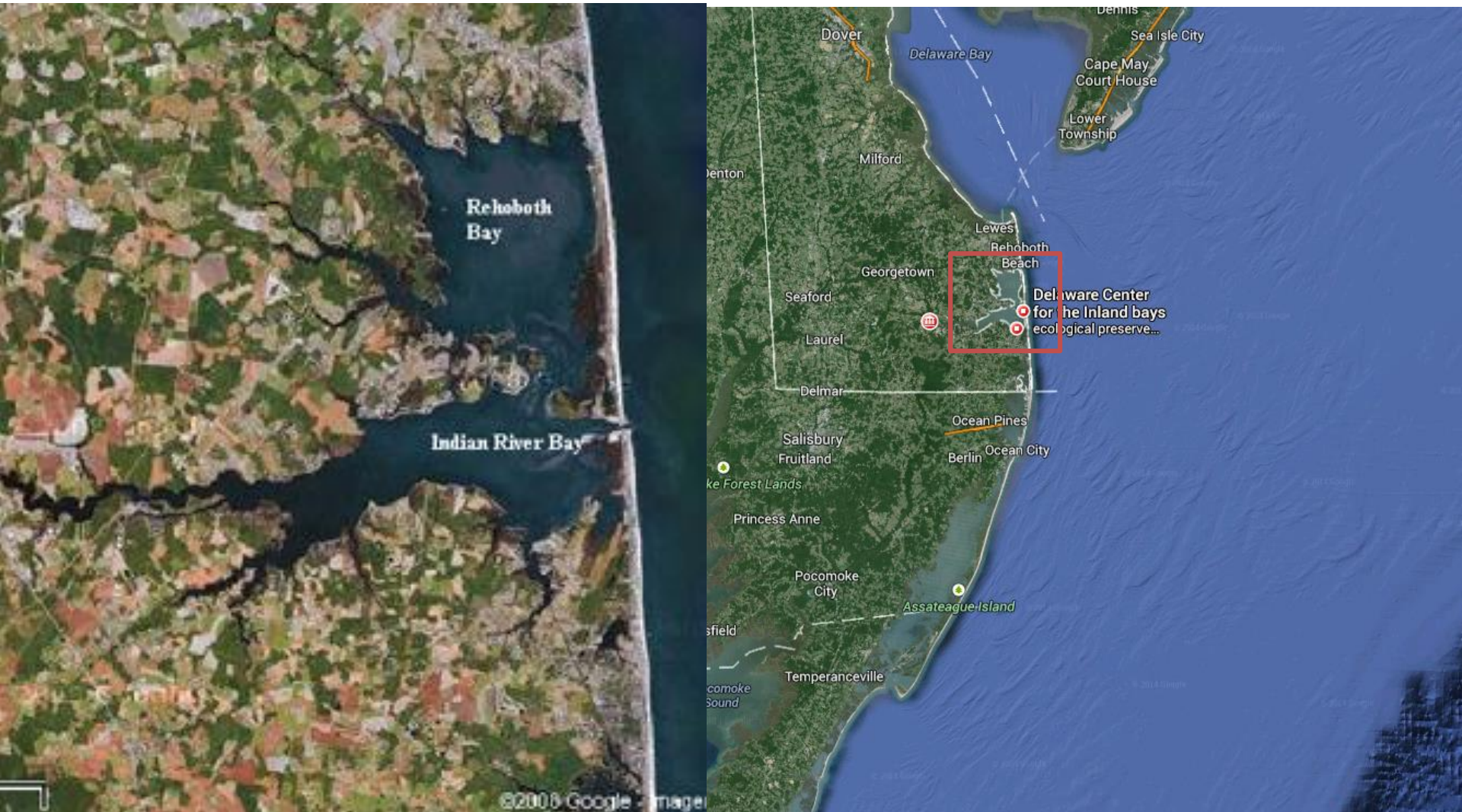
Corsica River (~4.5 km²)



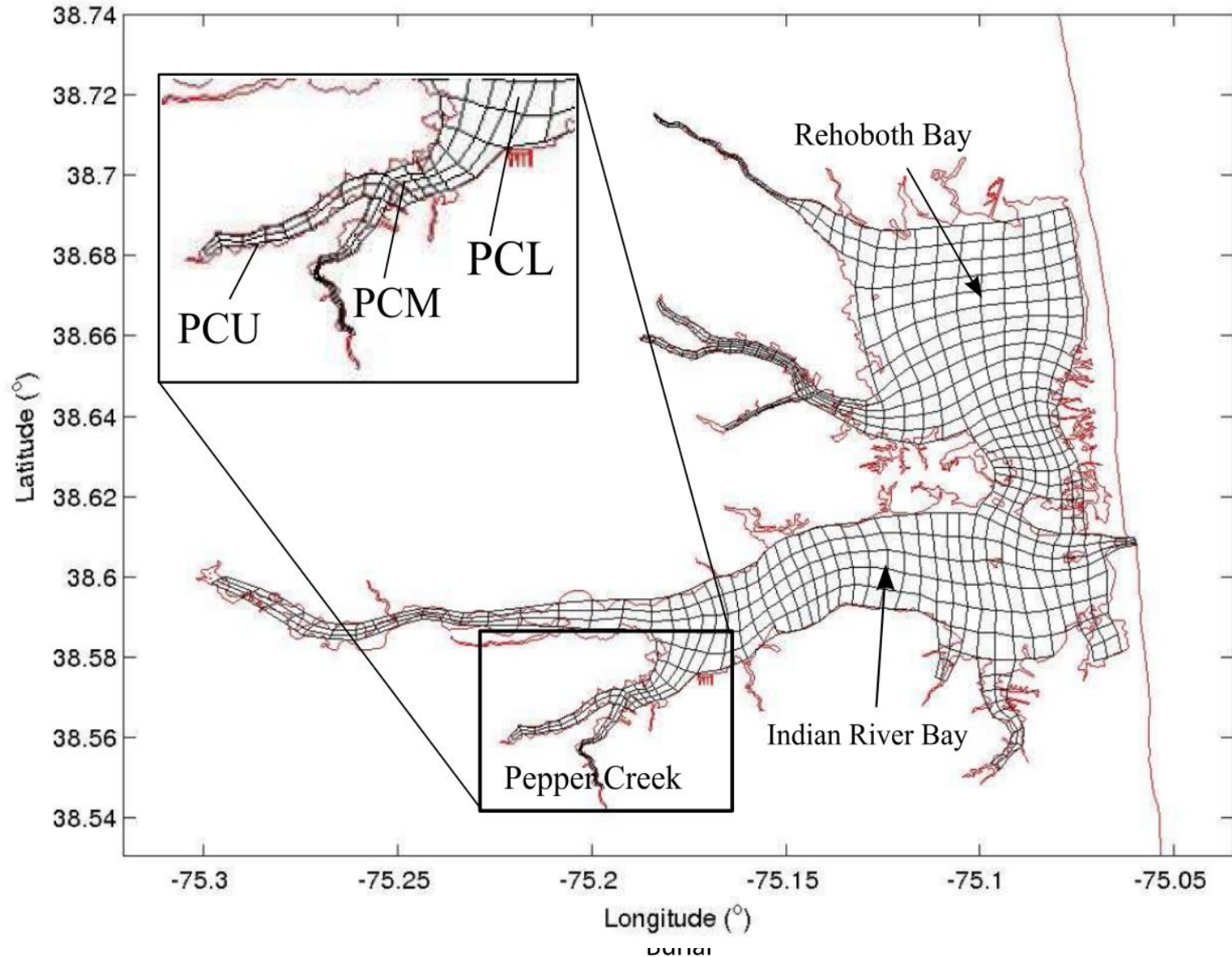
Eva Bailey

(Boynton et al. 2009)

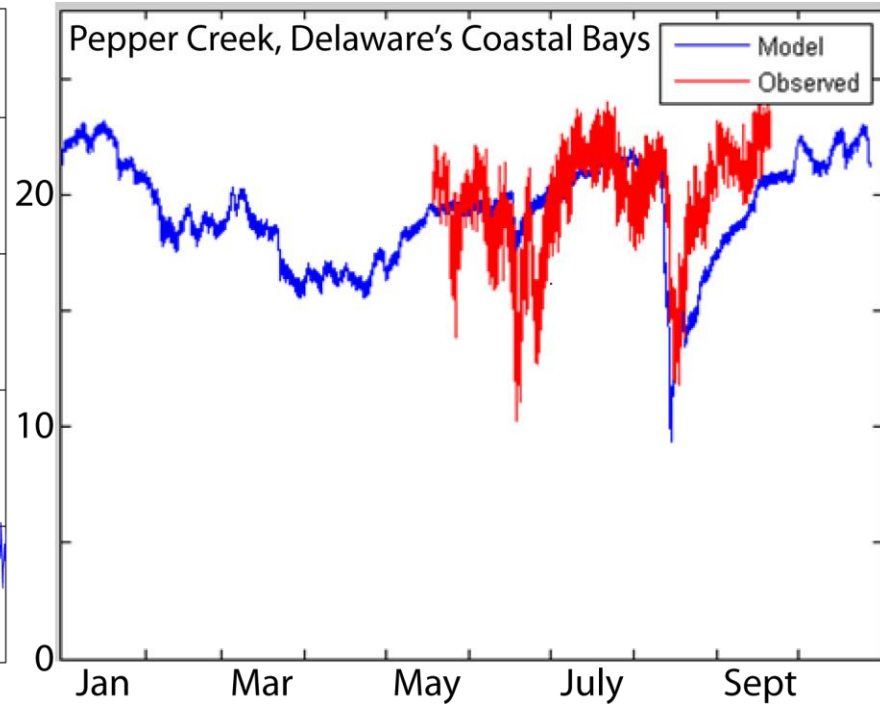
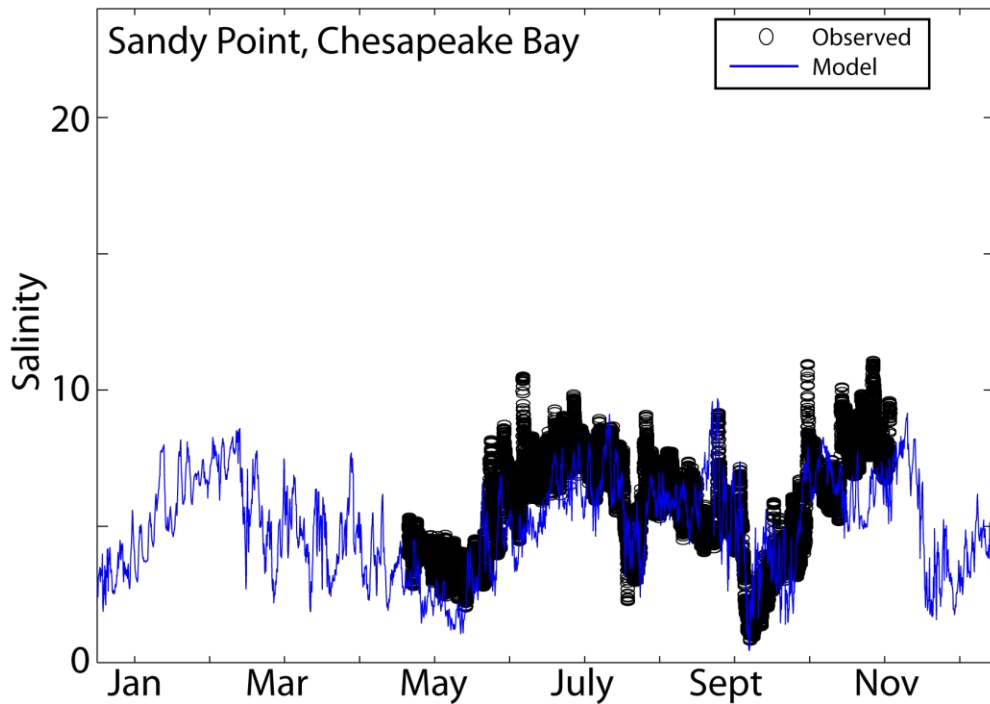
Delaware Inland Bays – Diel Cycling Hypoxia



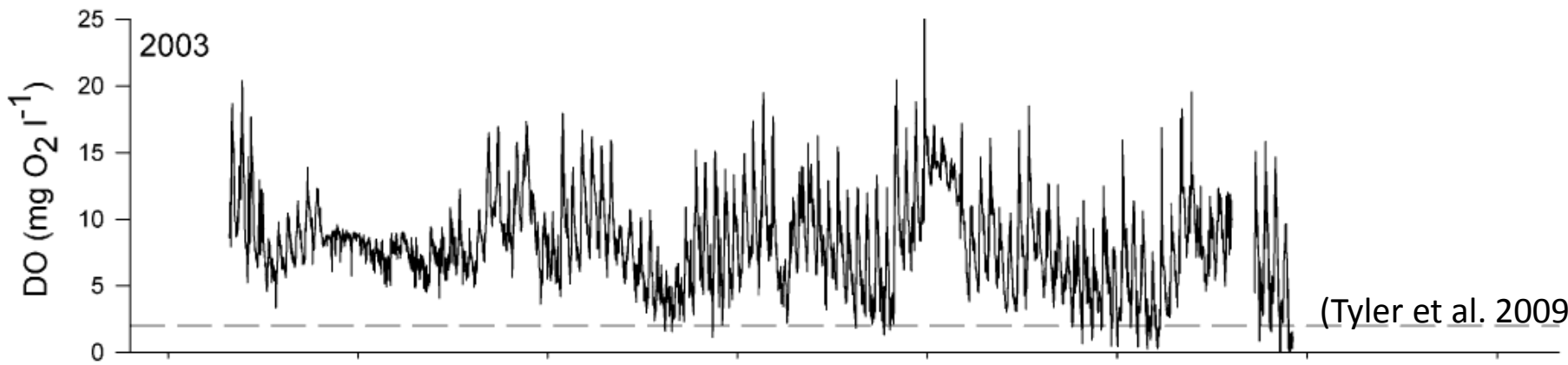
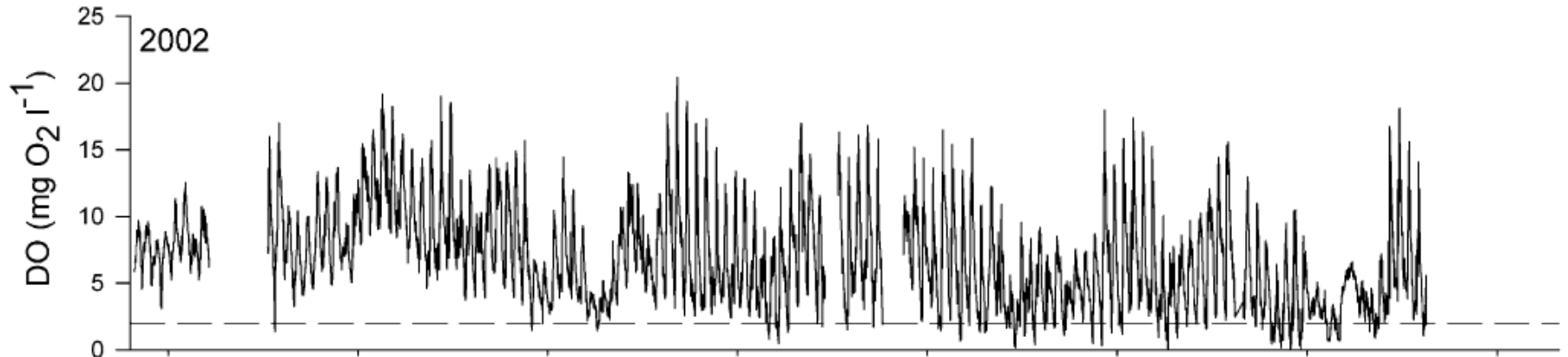
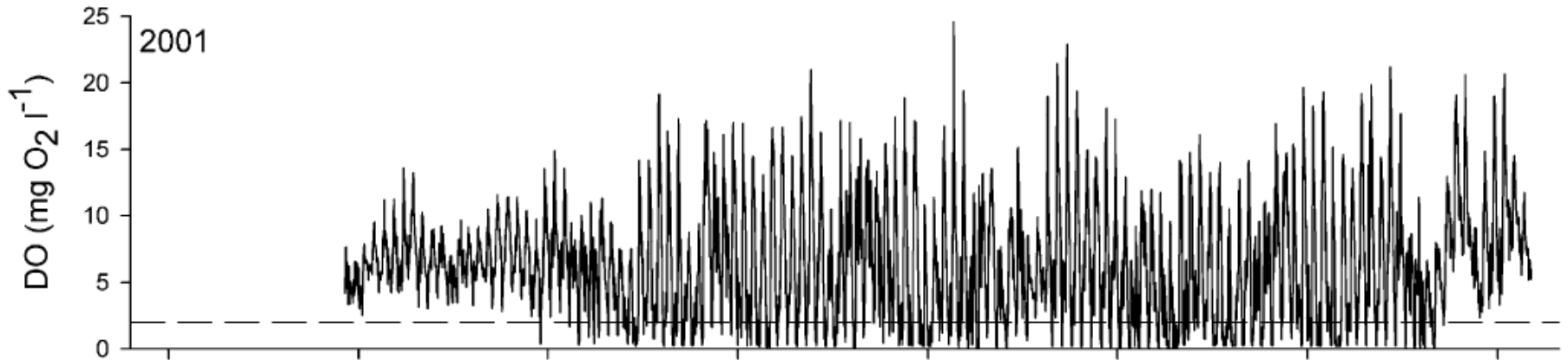
ROMS-RCA in Delaware Inland Bays



ROMS-RCA in Salinity Validation in Delaware Inland Bays and Chesapeake



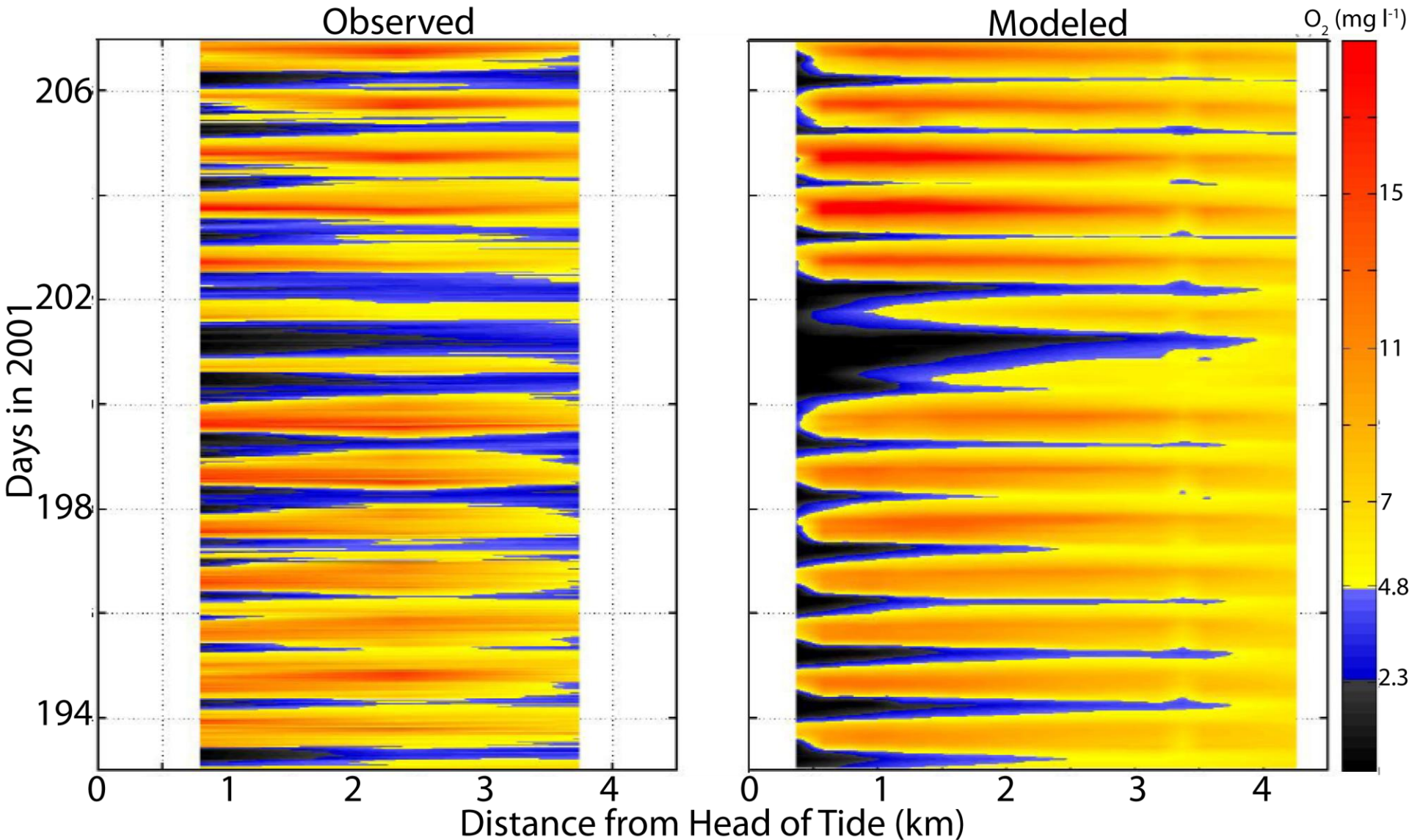
- Salinity captured in both models, but model salinity less variable in DIB



(Tyler et al. 2009)

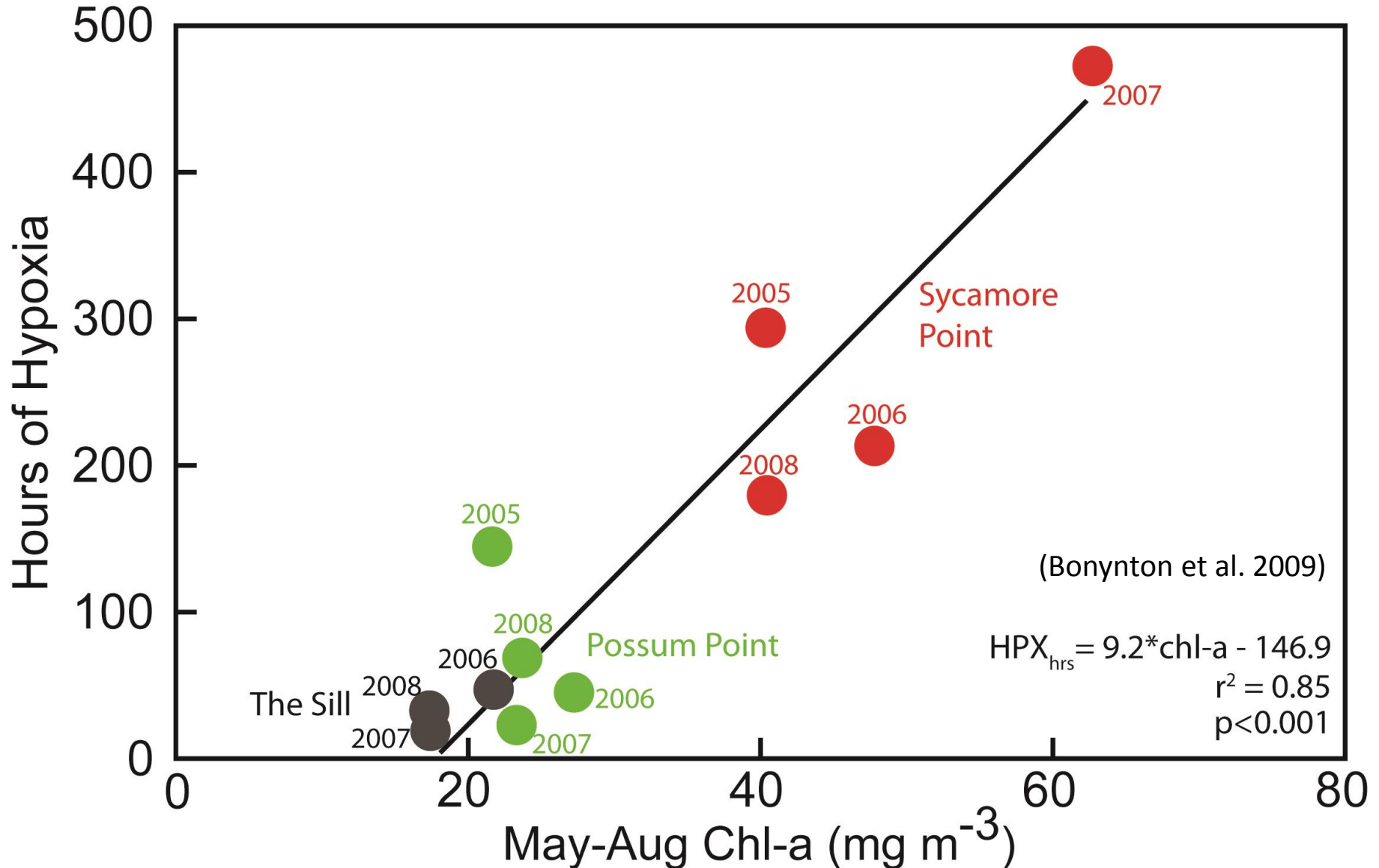
Incredible diel variability but also seasonal and inter-annual variability

Modeling Diel Cycling Hypoxia in DIB



(Brady et al. in prep)

Duration of Diel Cycling Hypoxia and Chlorophyll



Again, both spatial and inter-annual components of this relationship

Chester and Corsica Estuaries

- (1) Diel cycling hypoxia (Corsica)
- (2) Nutrient load reduction scenarios
- (3) Examine Feedbacks with turbidity and benthic processes

