Nutrients, estuaries, and coffee: Memoirs of a GED post-doc

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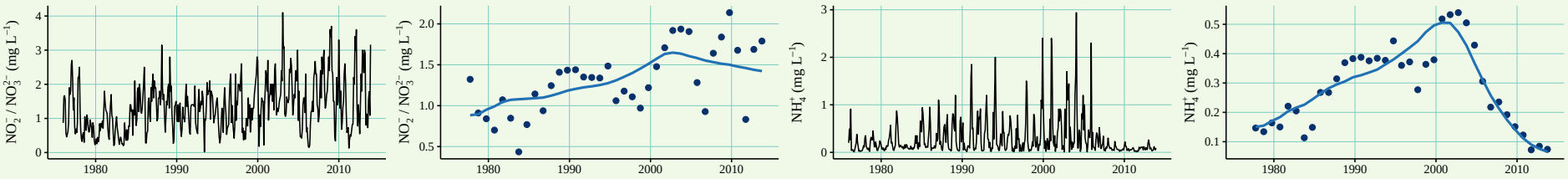
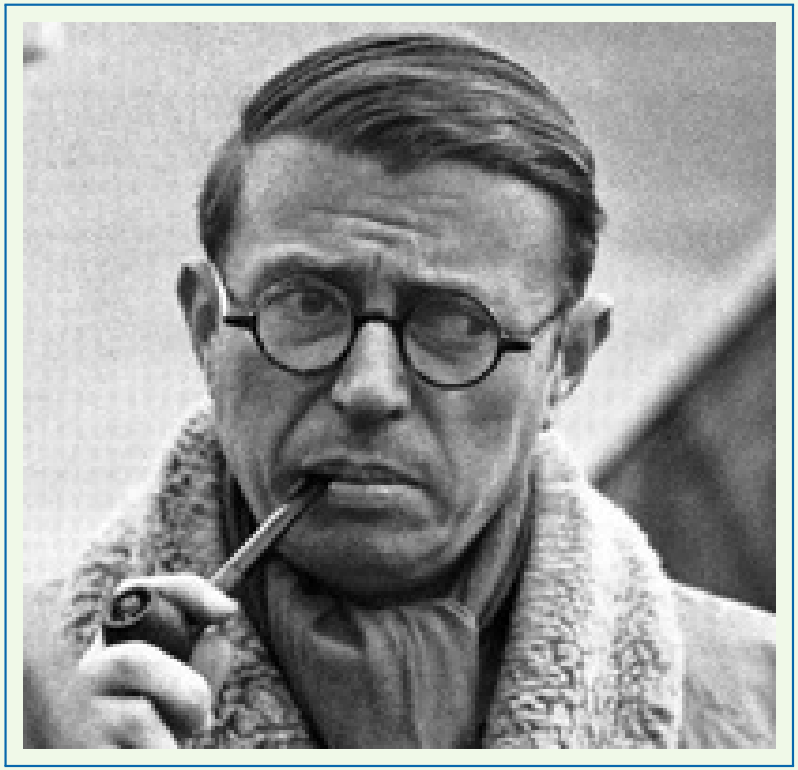
August 28, 2017



Why are we here today?



Freedom is what you do with what's been done to you.

– J. P. Sartre

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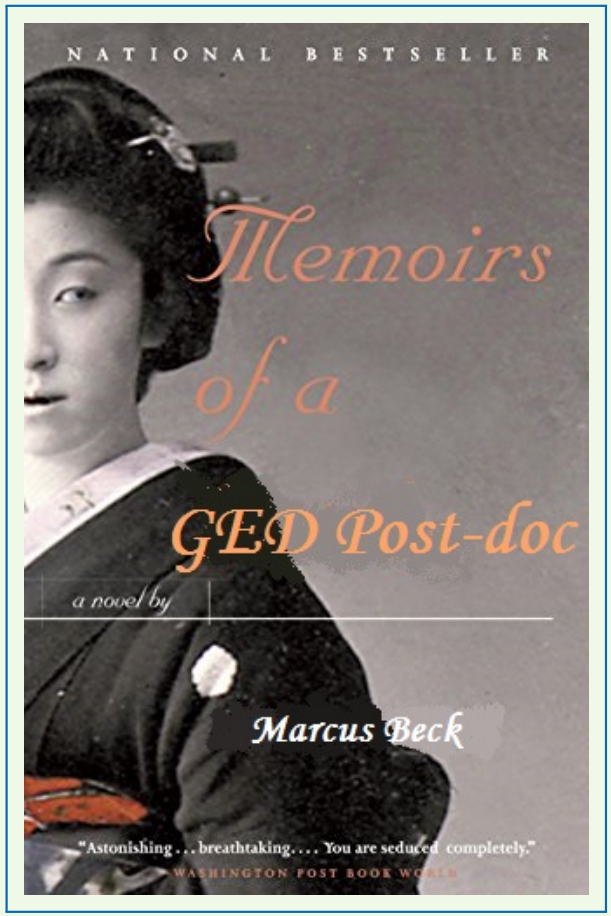

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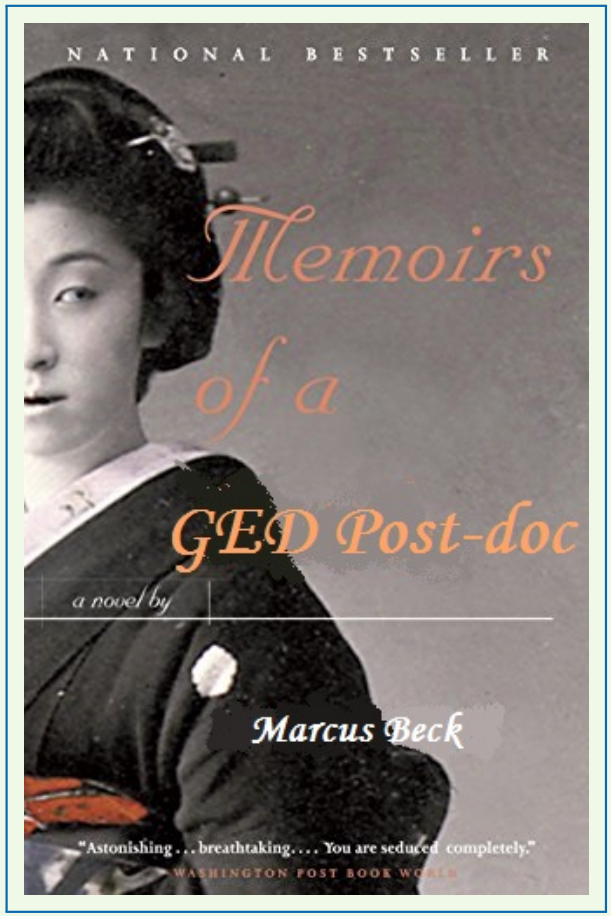

- Where did I come from?

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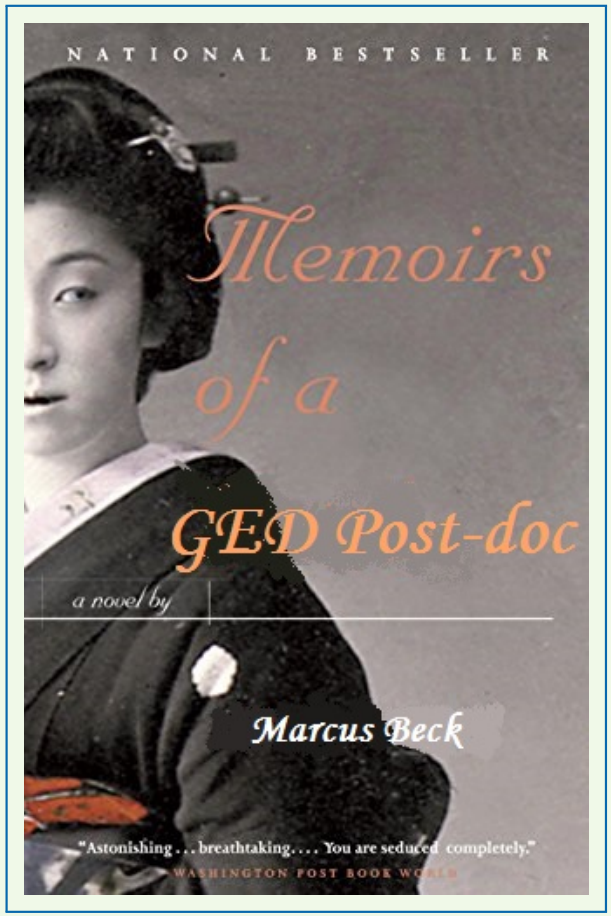
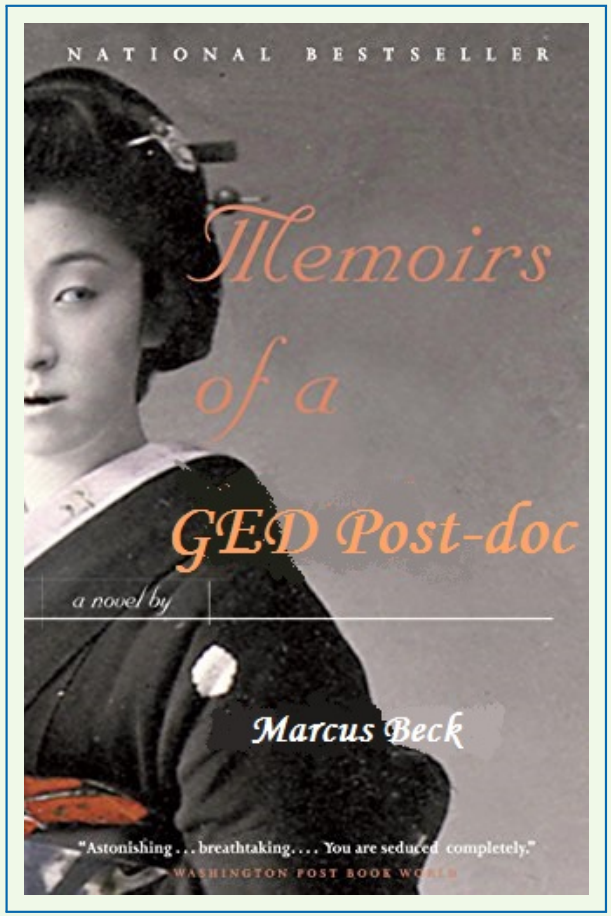


- Where did I come from?
- The ORISE experience

Why are we here today?



- Where did I come from?
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- The EPA experience

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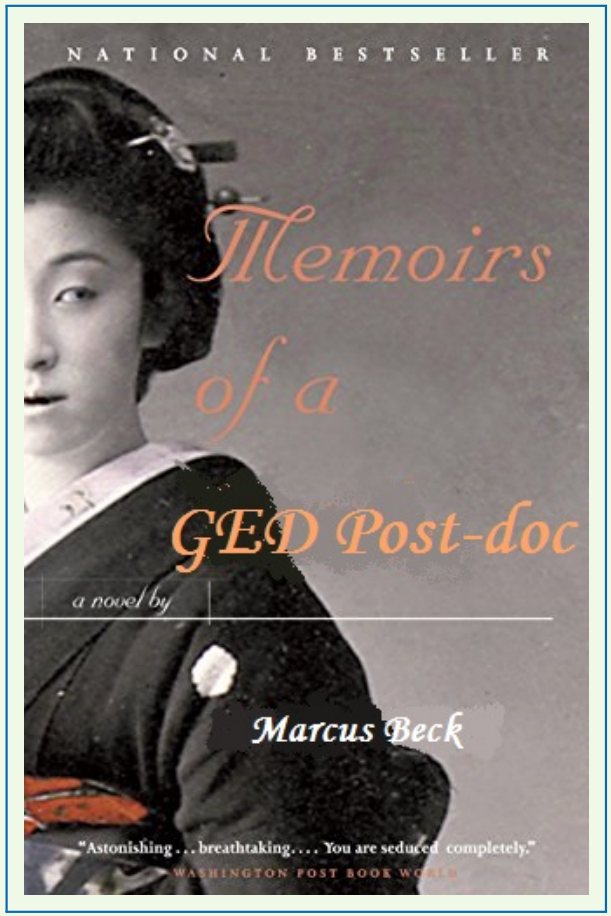

- Where did I come from?
- The ORISE experience
- The EPA experience
- The next chapter

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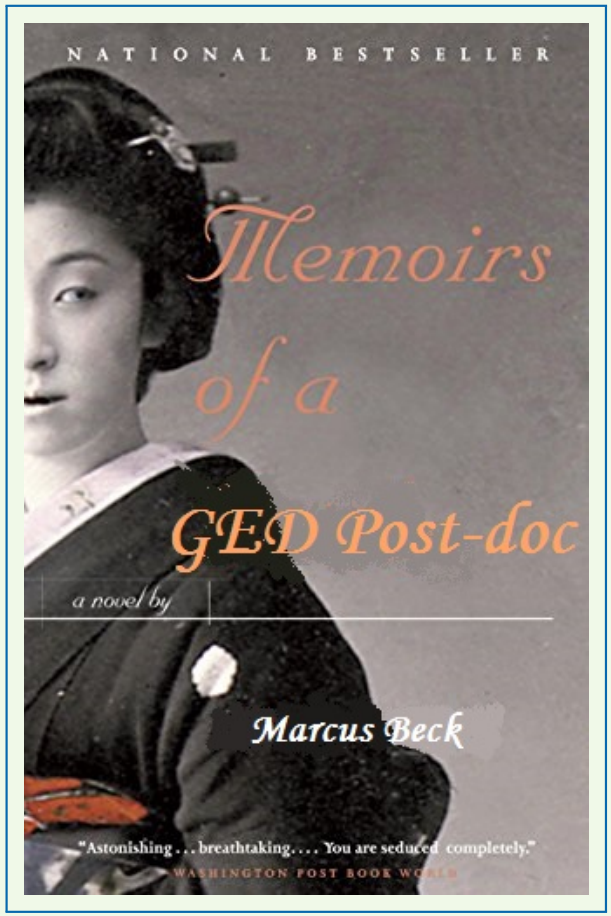
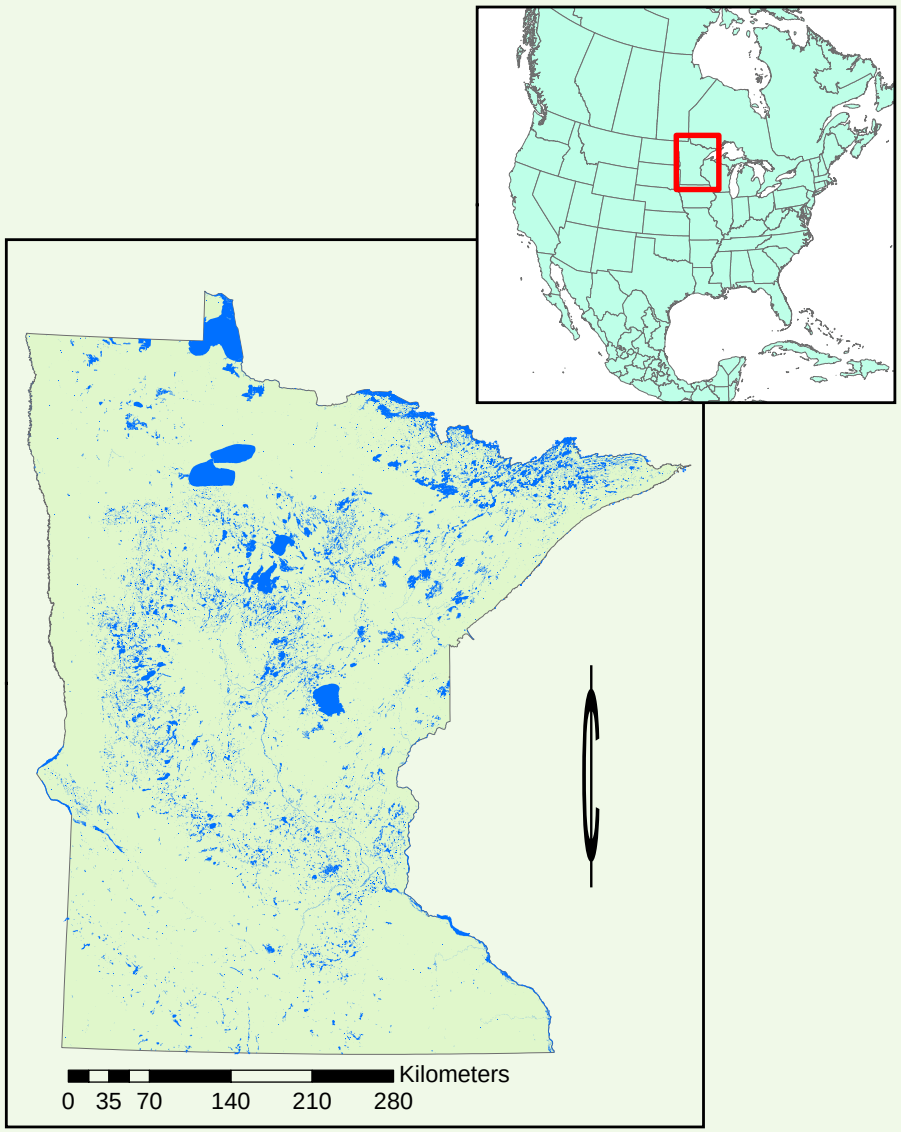
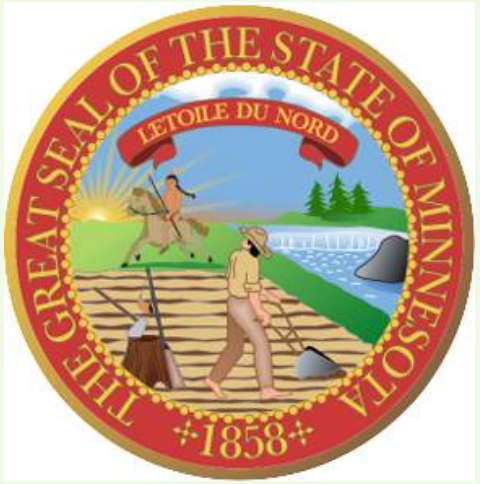


- Where did I come from?
- The ORISE experience
- The EPA experience
- The next chapter
- Final thoughts/ramblings

Where did I come from?

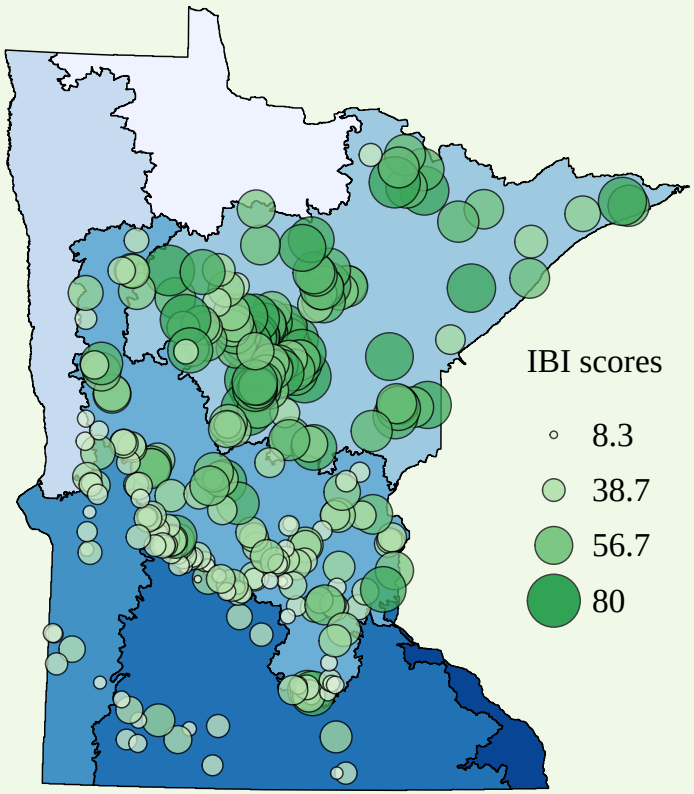
Minnesota, the land of 11,842 lakes





Where did I come from?

- Dataset of 332 vegetation surveys, courtesy of MNDNR [Beck et al., 2014]
- Environmental data describing lake characteristics and anthropogenic stressors



- lake surface area
- maximum lake depth
- trophic state index
- growing degree days
- percent agriculture in wshed
- percent impervious surfaces in wshed
- density of groundwater wells in wshed
- wshed area to lake area
- crop productivity index of wshed
- dock density
- ...

The ORISE experience

July 2013, moved to Pensacola

The ORISE experience

- ORISE is a mysterious entity

The ORISE experience

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- You are not an EPA employee

The ORISE experience

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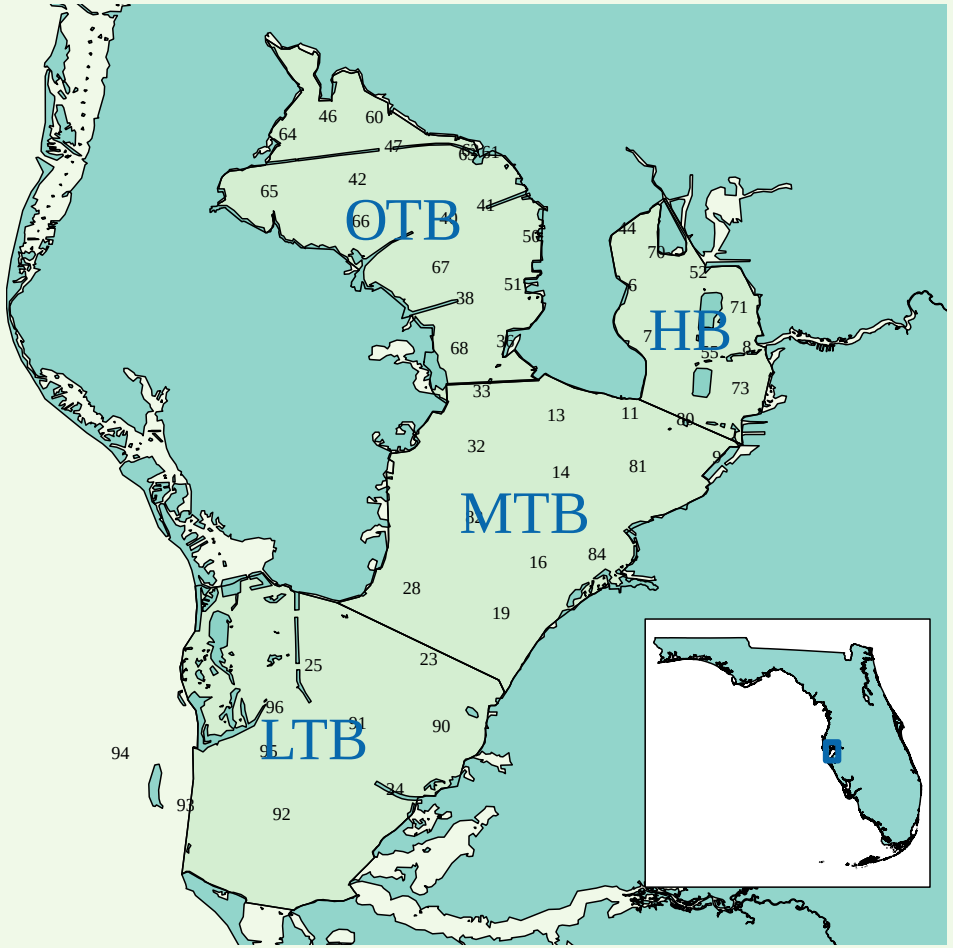
The ORISE experience

- ORISE is a mysterious entity
- You are not an EPA employee
- EPA employees cannot tell you what to do
- You are not responsible for anything

The ORISE experience

Tampa Bay trend analysis

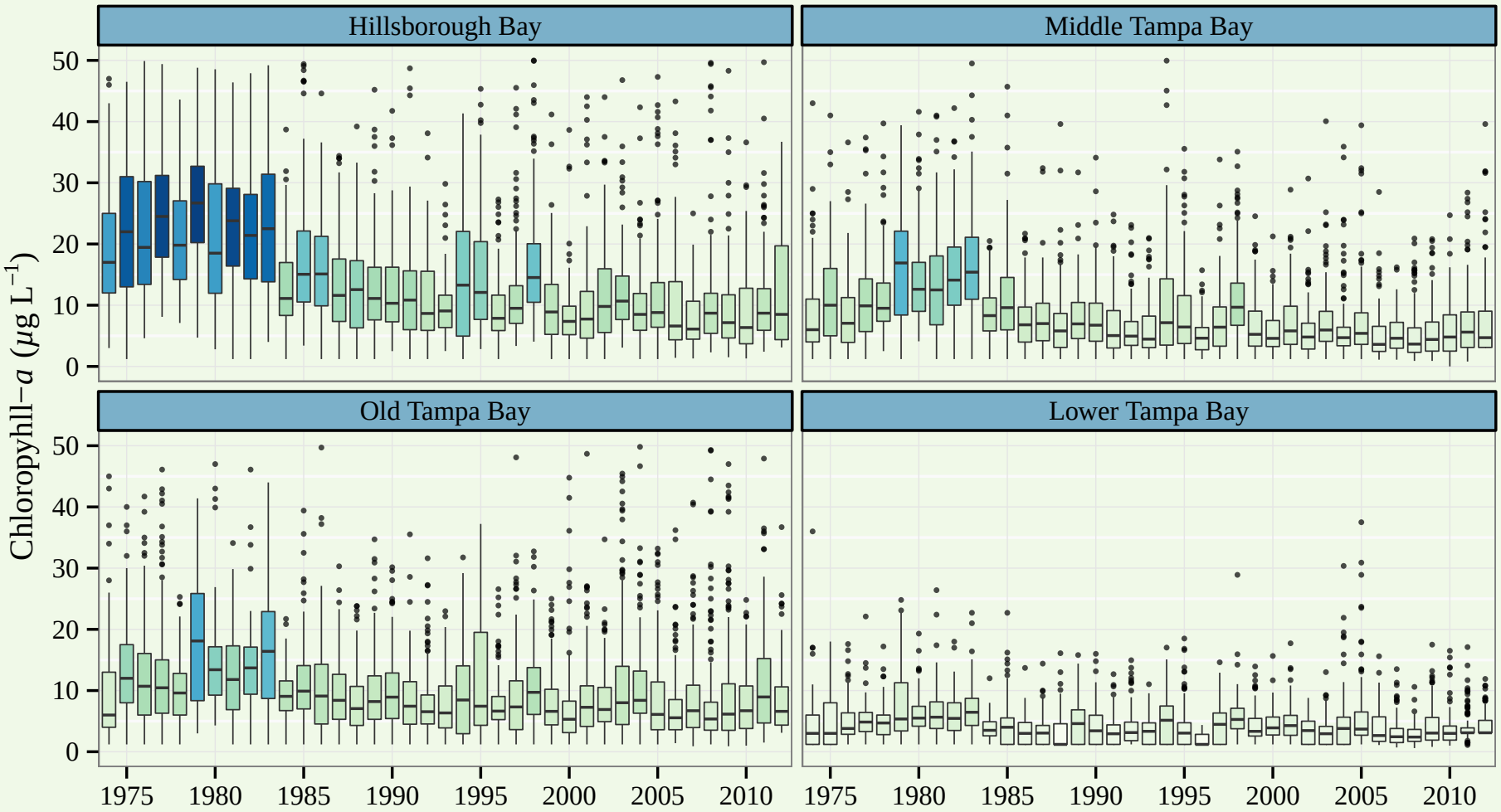
- Four bay segments
- Monthly wq data at 50 stations from 1974 to present
- Longitudinal profile of nutrient load and salinity



Data from [TBEP (Tampa Bay Estuary Program), 2011]

The ORISE experience

Tampa Bay trend analysis



Study objective

Adapt and apply a nutrient response model for estuaries that leverages the descriptive capabilities of large datasets [Beck and Hagy III, 2015]

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Adapt and apply a nutrient response model for estuaries that leverages the descriptive capabilities of large datasets [Beck and Hagy III, 2015]

Questions of concern – Can we...

- ...provide a natural history of water quality that is temporally consistent with drivers of change?

Study objective

Adapt and apply a nutrient response model for estuaries that leverages the descriptive capabilities of large datasets [Beck and Hagy III, 2015]

Questions of concern – Can we...

- ...provide a natural history of water quality that is temporally consistent with drivers of change?
- ...improve our understanding of the nutrient-response paradigm in estuaries?

How does it work?

$$\ln(N) = \beta_0 + \beta_1 t + \beta_2 Sal + \beta_3 \sin(2\pi t) + \beta_4 \cos(2\pi t)$$

N: nitrogen (or other response endpoint)
t: time
Sal: Salinity (or other flow-related variable)

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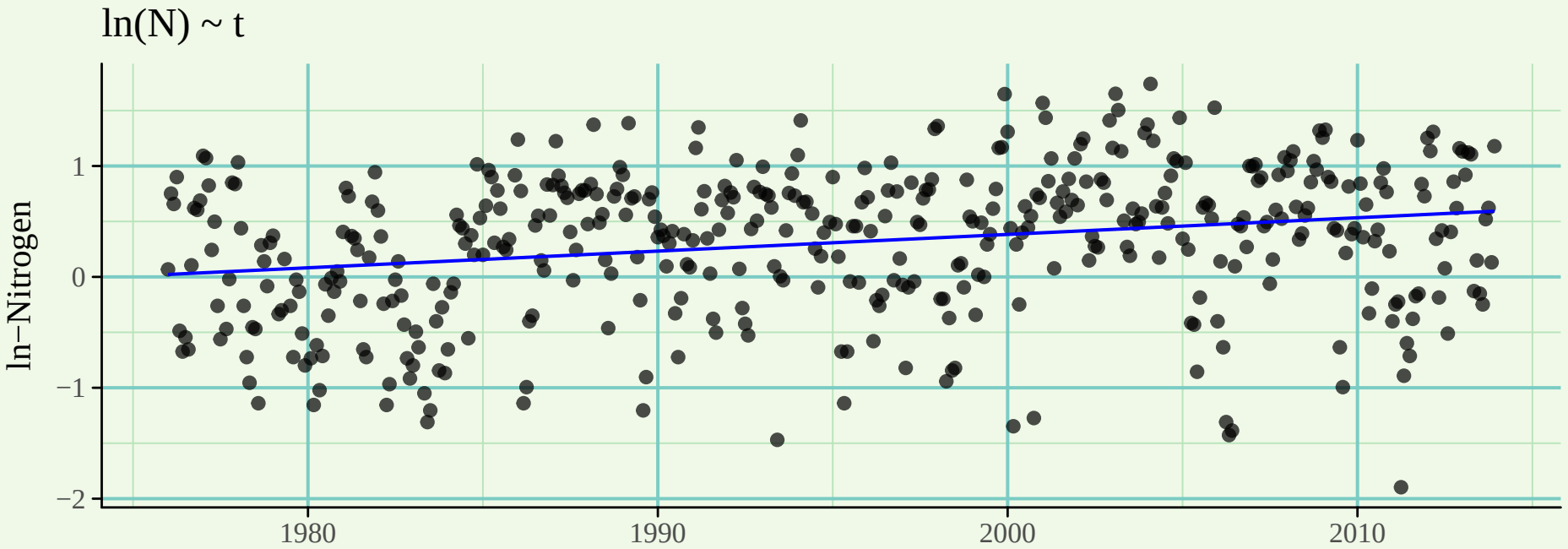

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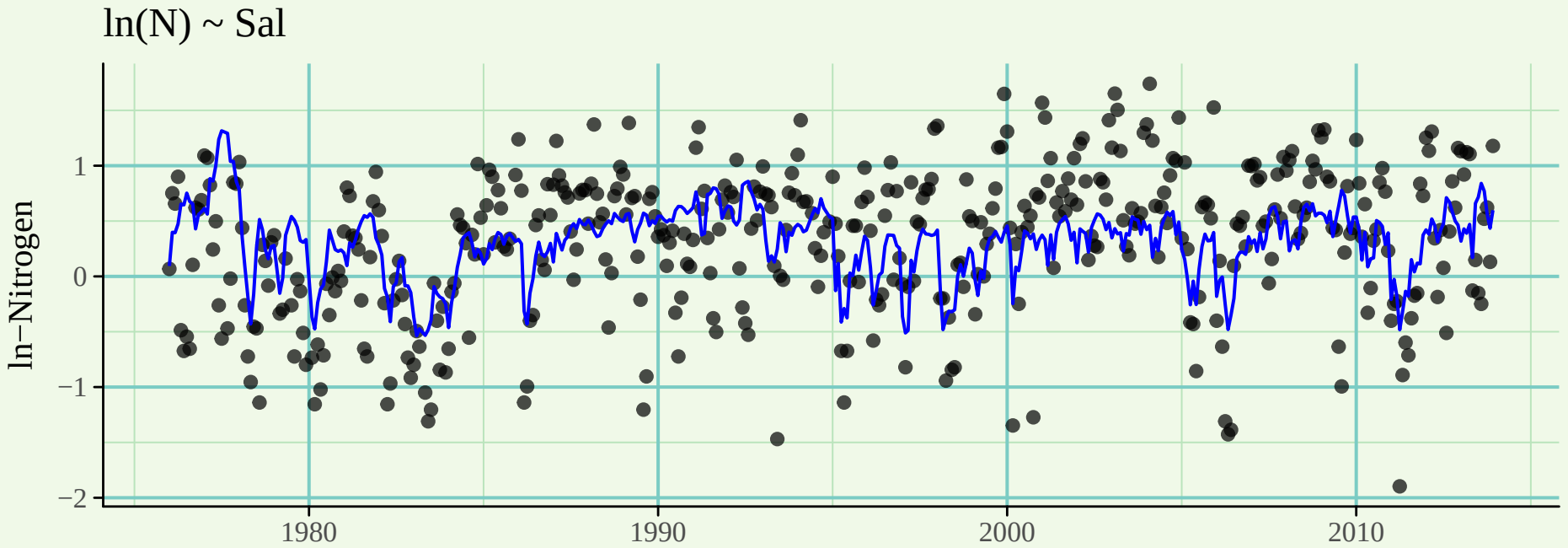

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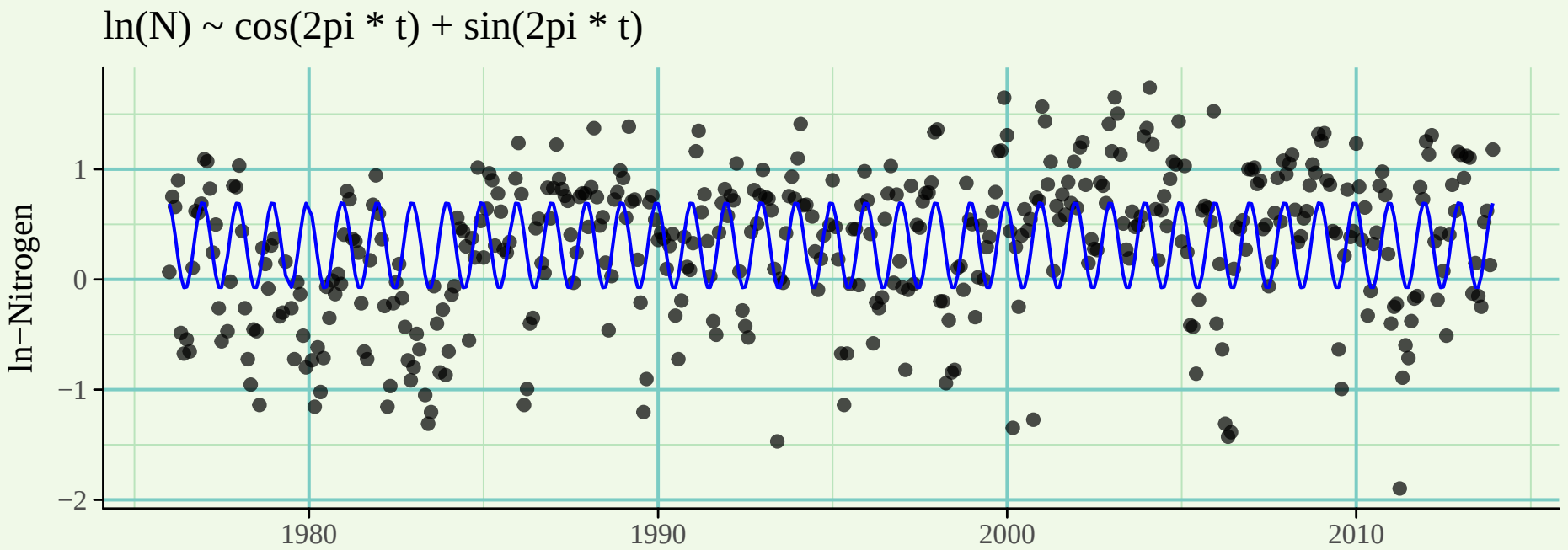

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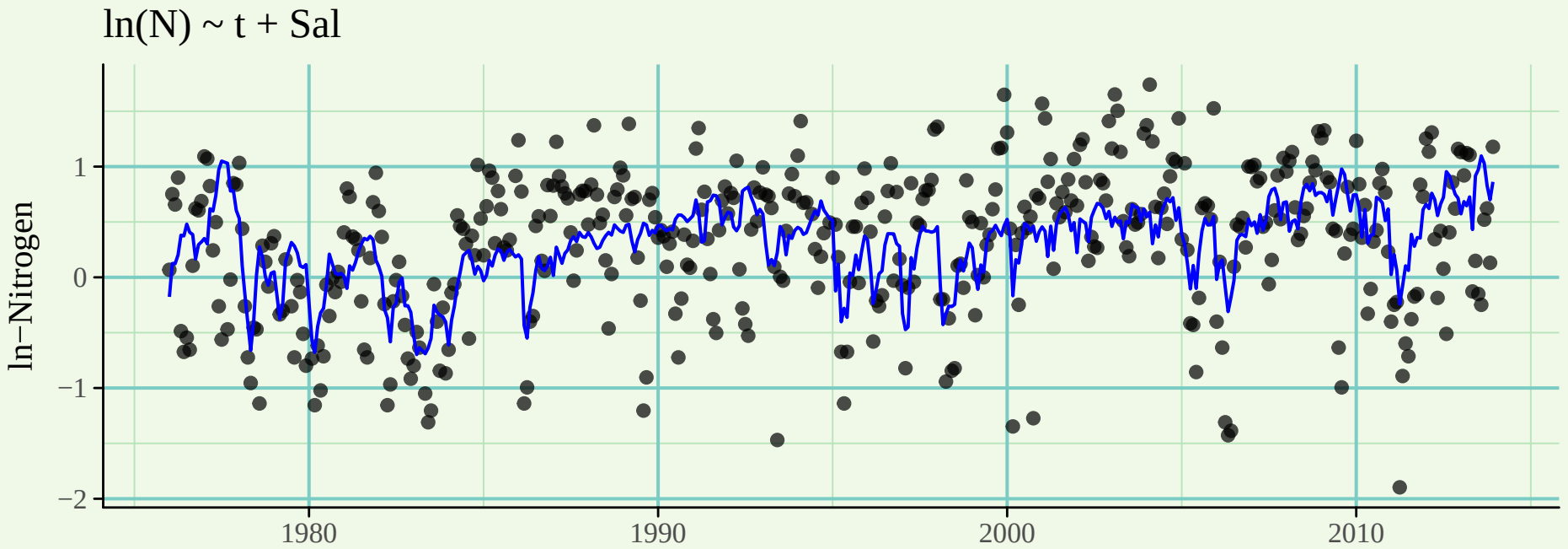

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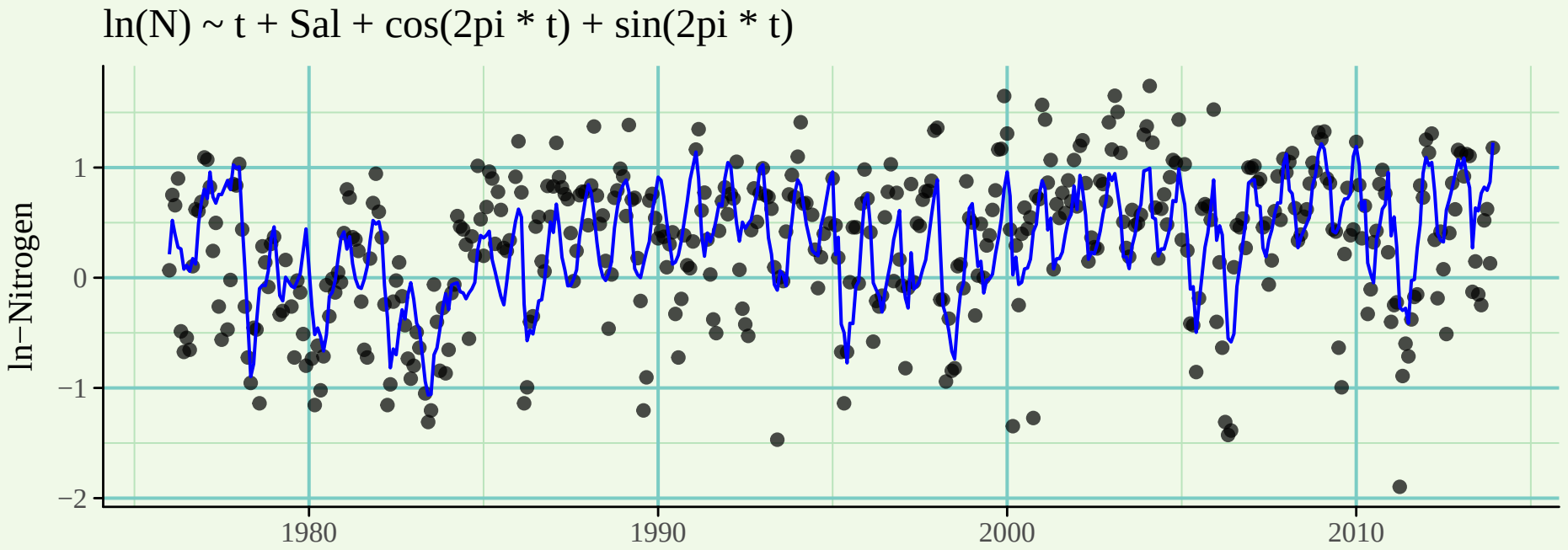
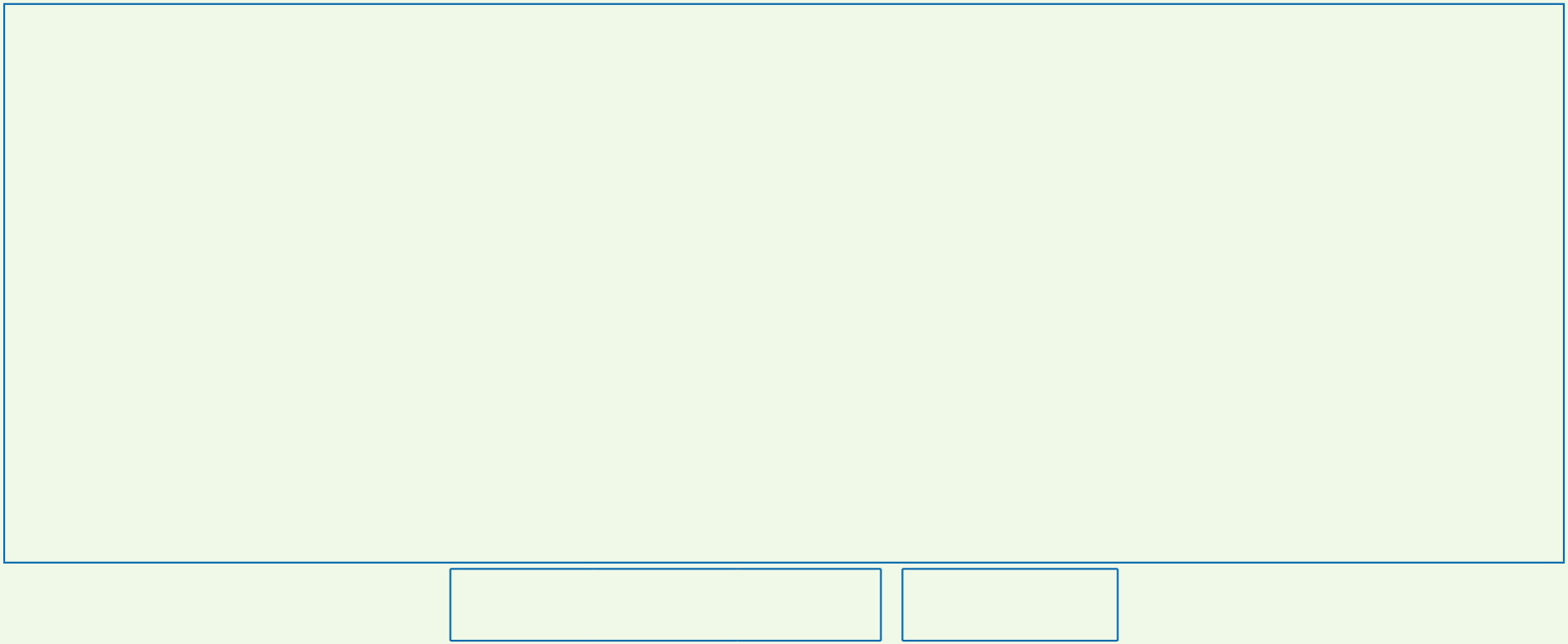


The ORISE experience

Tampa Bay trend analysis

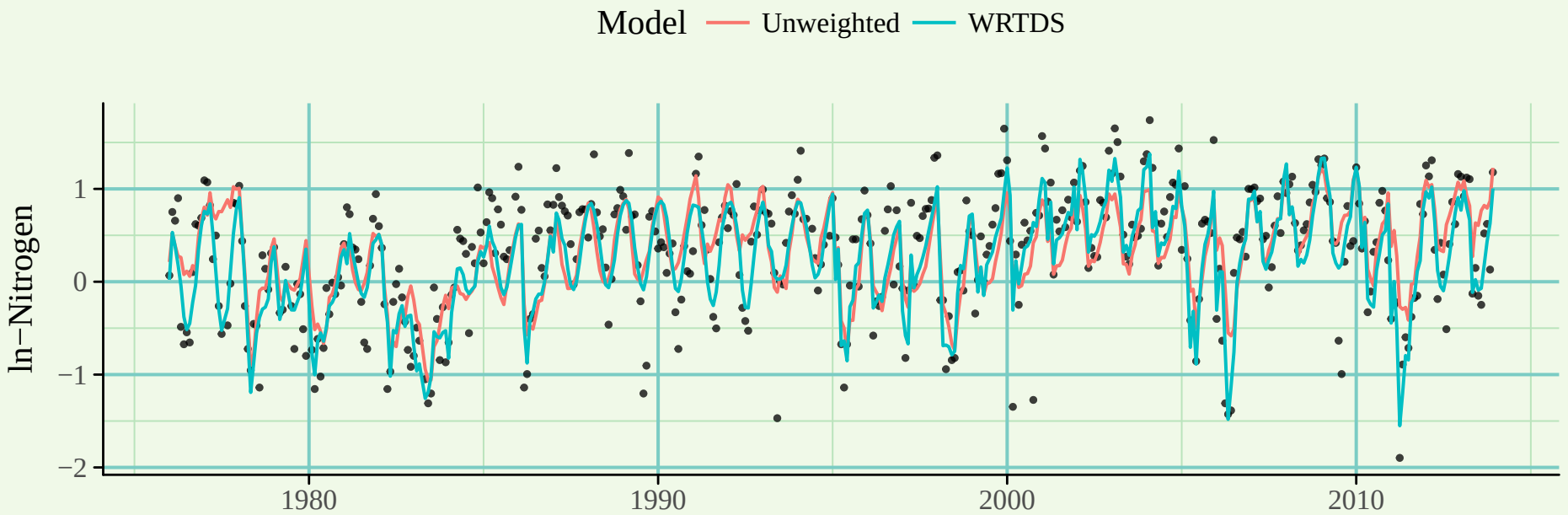
Points: observed time series (black are weighted, grey is zero weight)
Green point: observation at the center of the regression
Blue line: Global model with weights specific to the window
Red line: Accumulated WRTDS model



The ORISE experience

Tampa Bay trend analysis

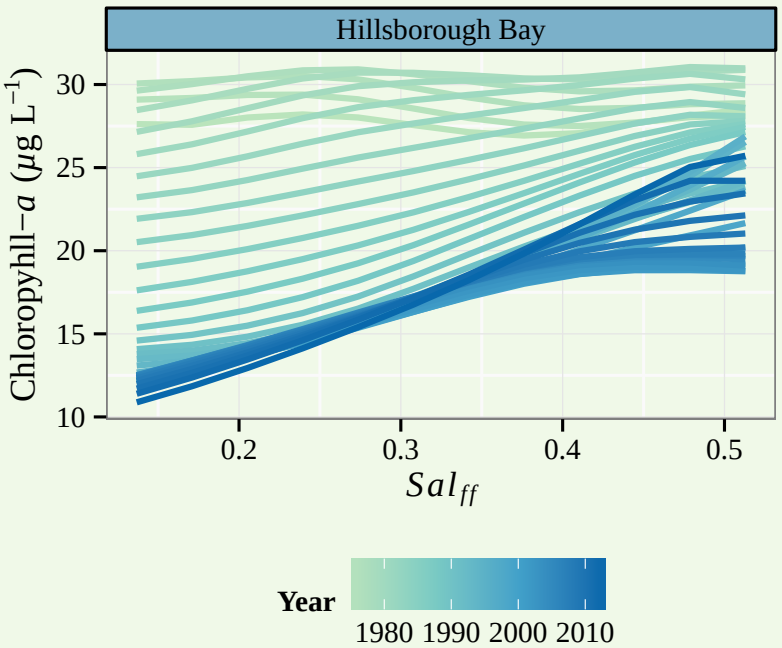
RMSE fit for unweighted = 0.58, WRTDS = 0.36



The ORISE experience

Tampa Bay trend analysis

Because the model is dynamic, we have parameters describing the relationship of chlorophyll with other factors specific to different time periods



- Early period (light blue) - point-sources
- Late period (dark blue) - non-point sources
- Chlorophyll shows increasing response to freshwater input in recent years

The ORISE experience

Tampa Bay trend analysis

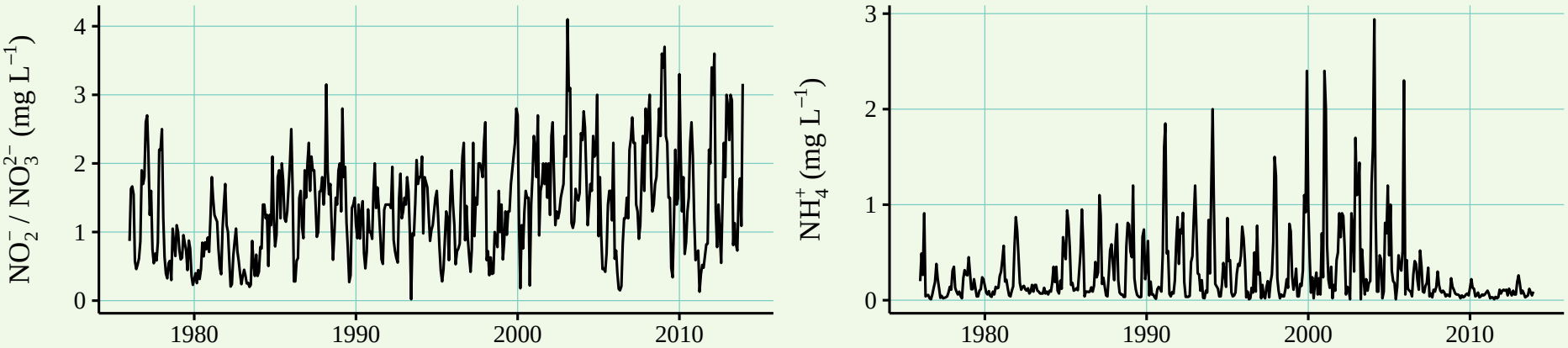
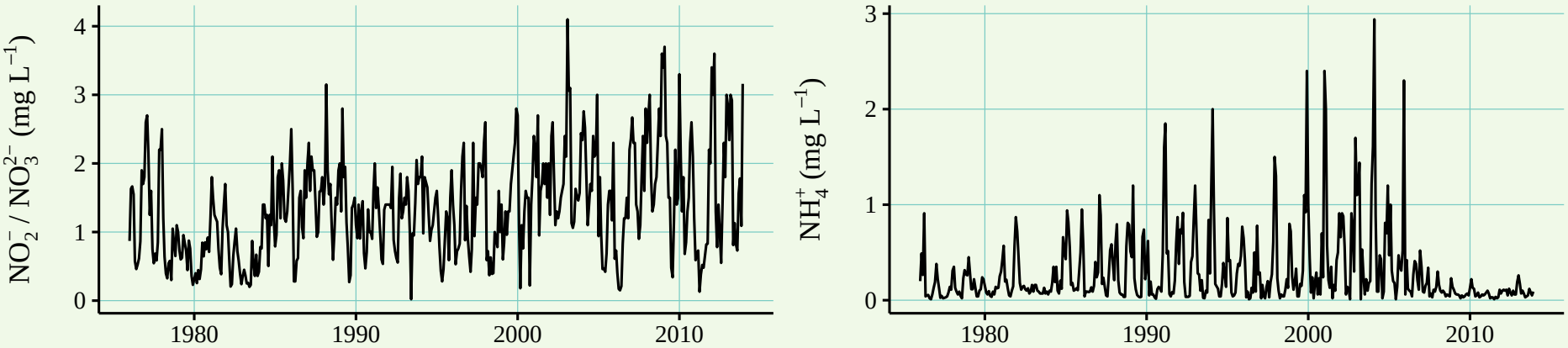


Figure : Observed nitrogen time series at P8 (SF Bay Delta RMP)

The ORISE experience

Tampa Bay trend analysis



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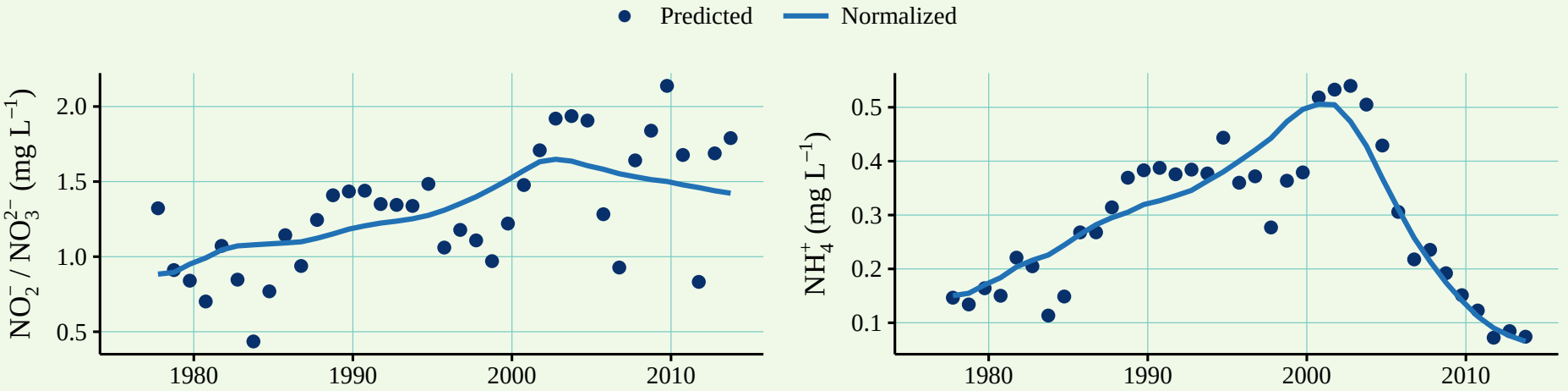


Figure : Annual predicted and flow-normalized nitrogen from WRTDS.

The 'Odum' open-water method has been used for decades to estimate rates of ecosystem metabolism [Odum, 1956]

$$\frac{\delta DO}{\delta t} = P - R + D$$

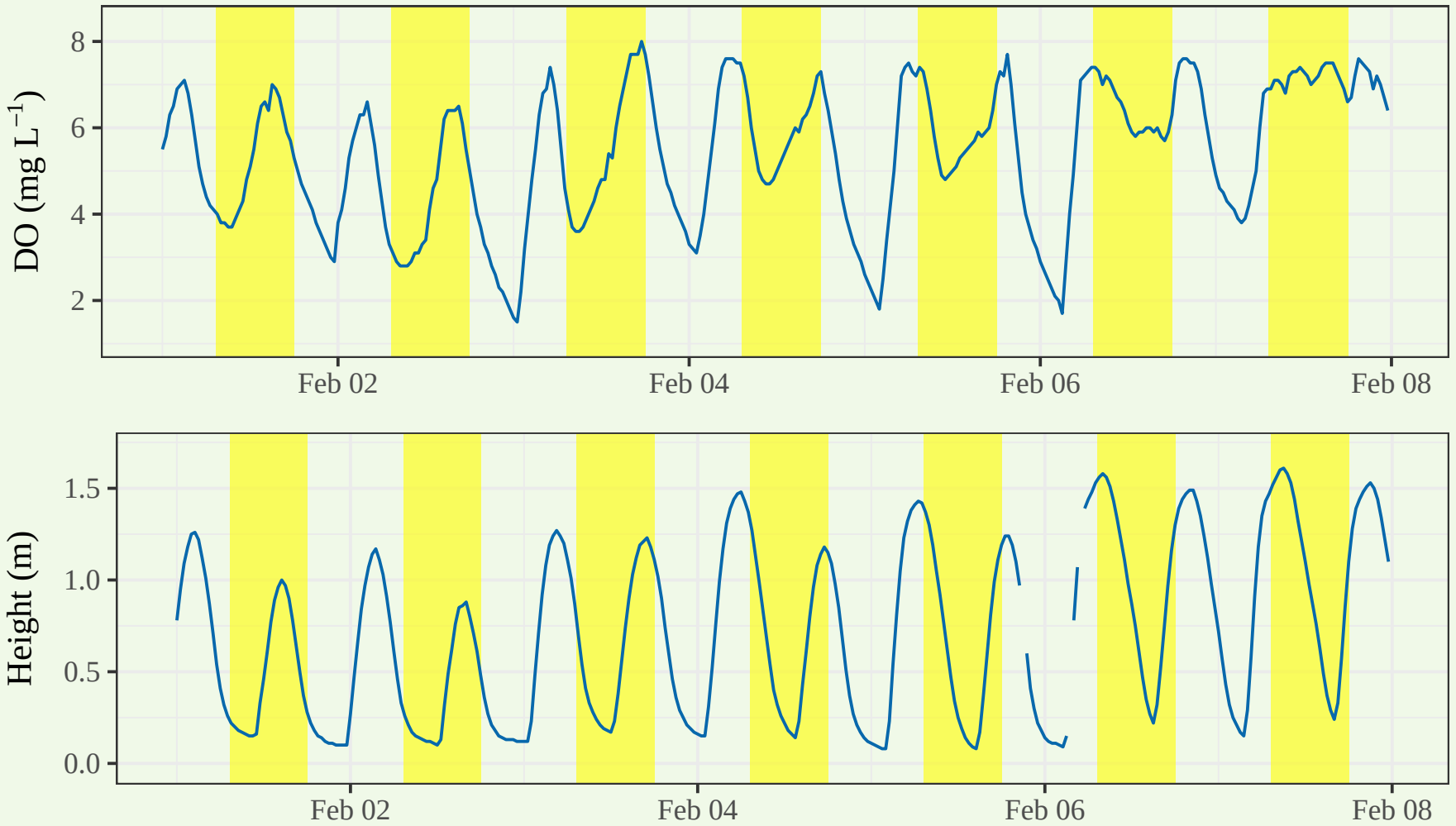
Metabolic rates provide a measure of productivity in a system - are estuaries sources or sinks of organic matter? [Caffrey et al., 2013]

Applications to estuarine monitoring data have been somewhat successful - why??

The ORISE experience

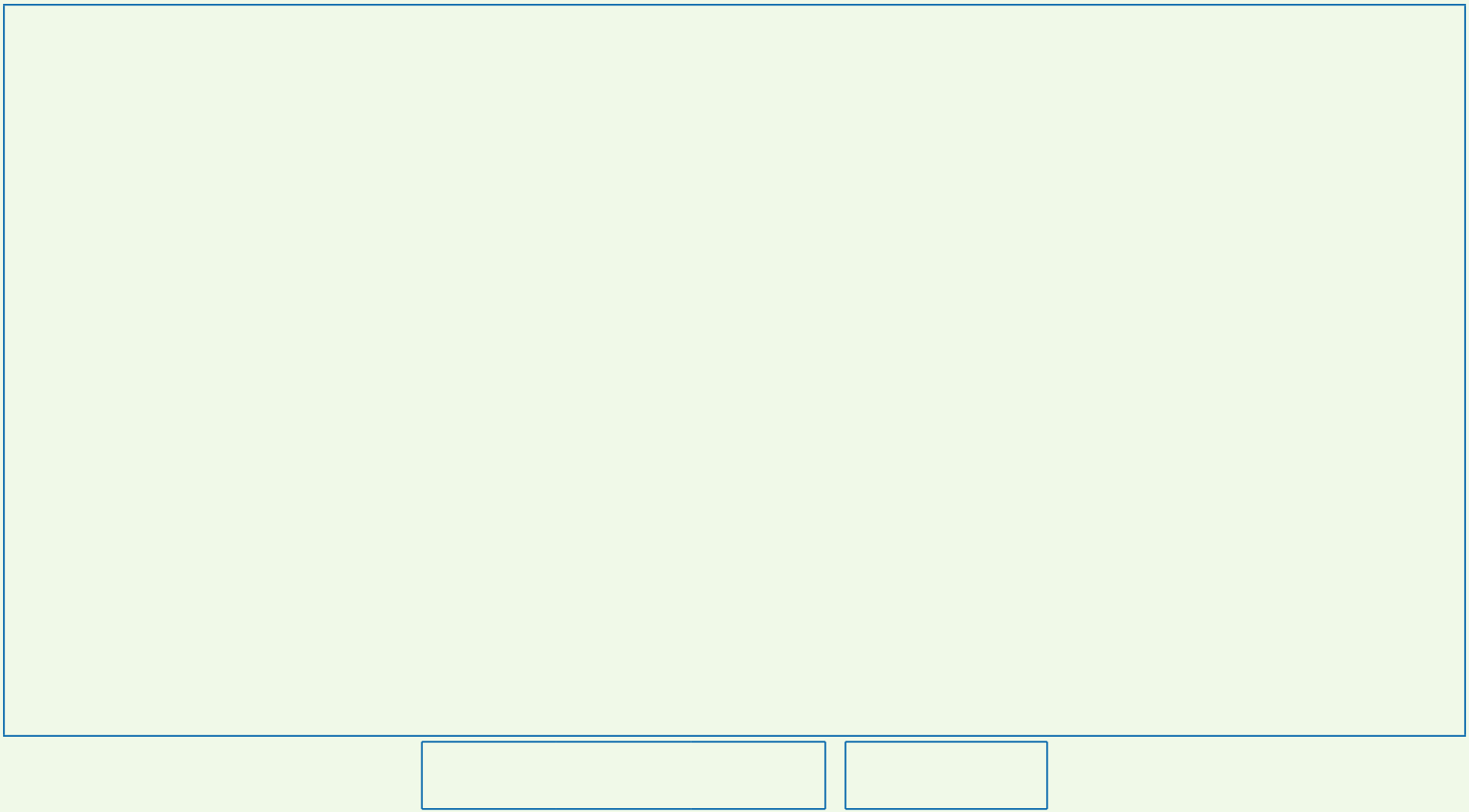
Time series detiding

The 'Odum' method assumes DO represents biological processes...

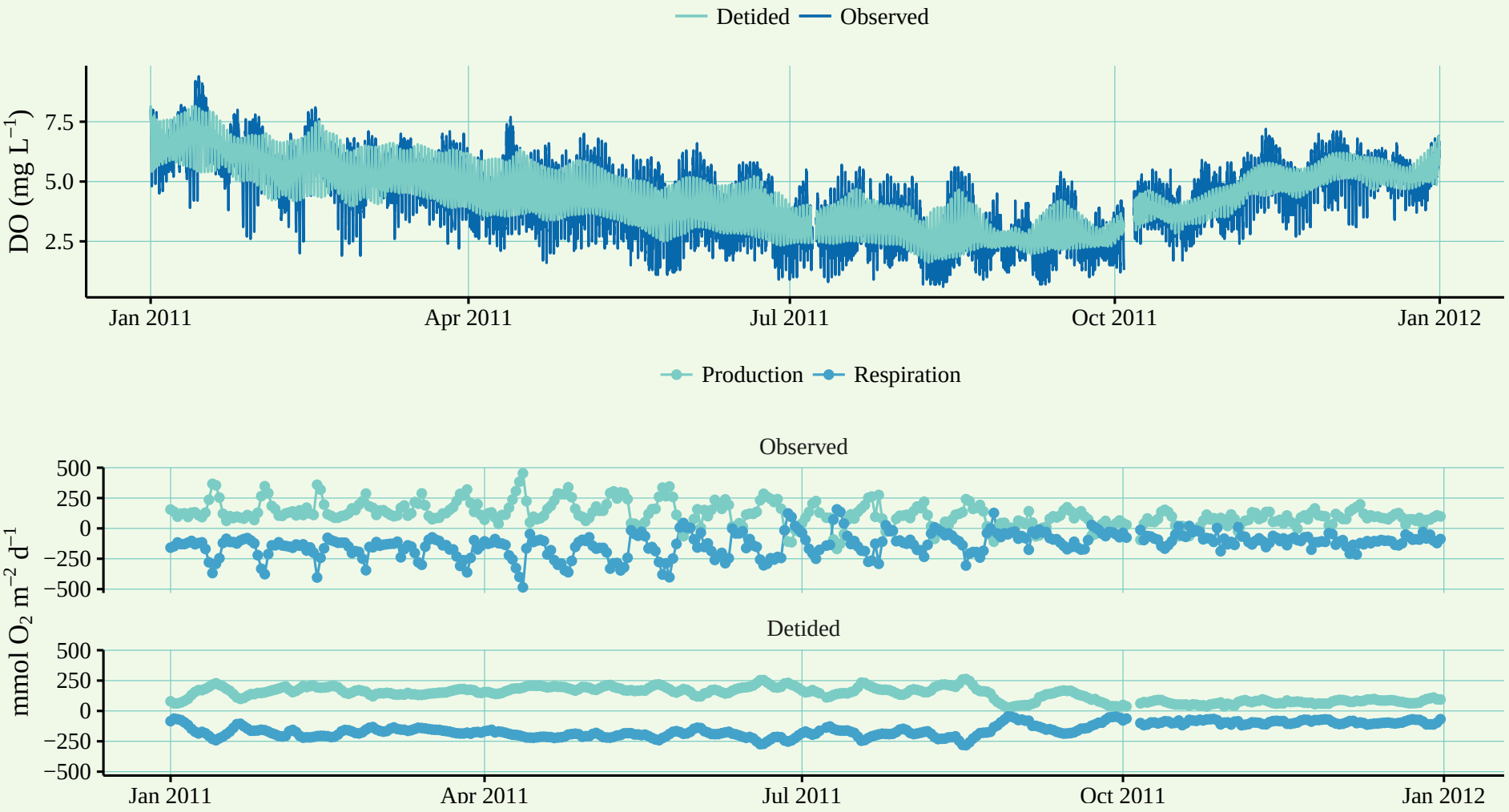


The ORISE experience

Time series detiding

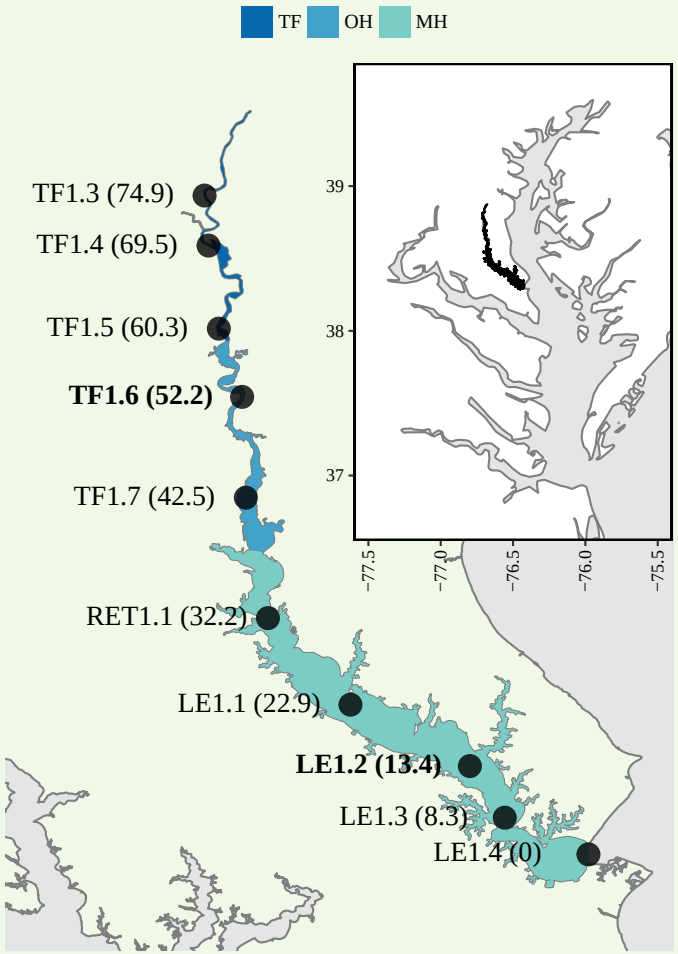


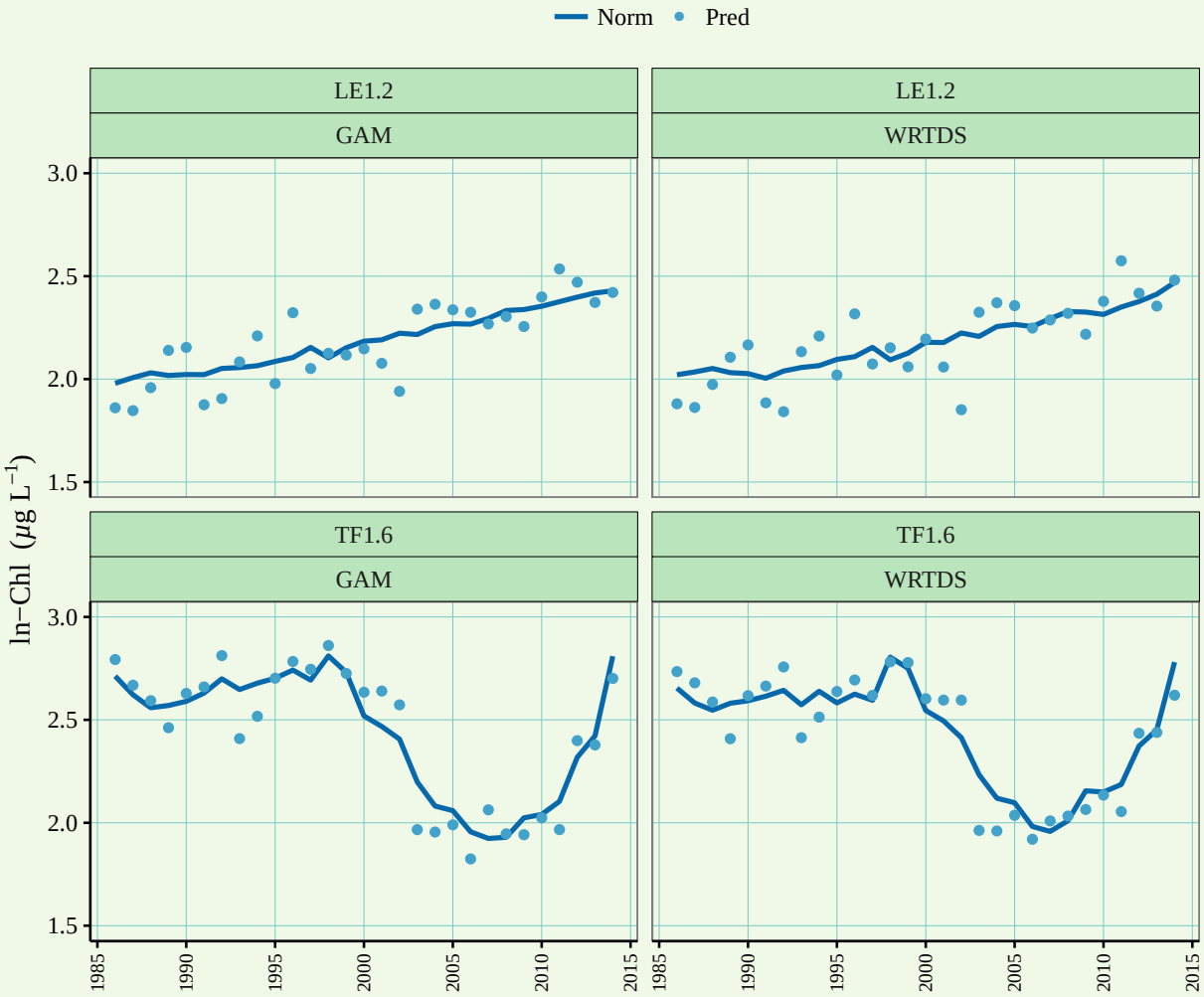
DO time series and ecosystem metabolism [Beck et al., 2015]



Comparing WRTDS and GAMs for trend evaluation

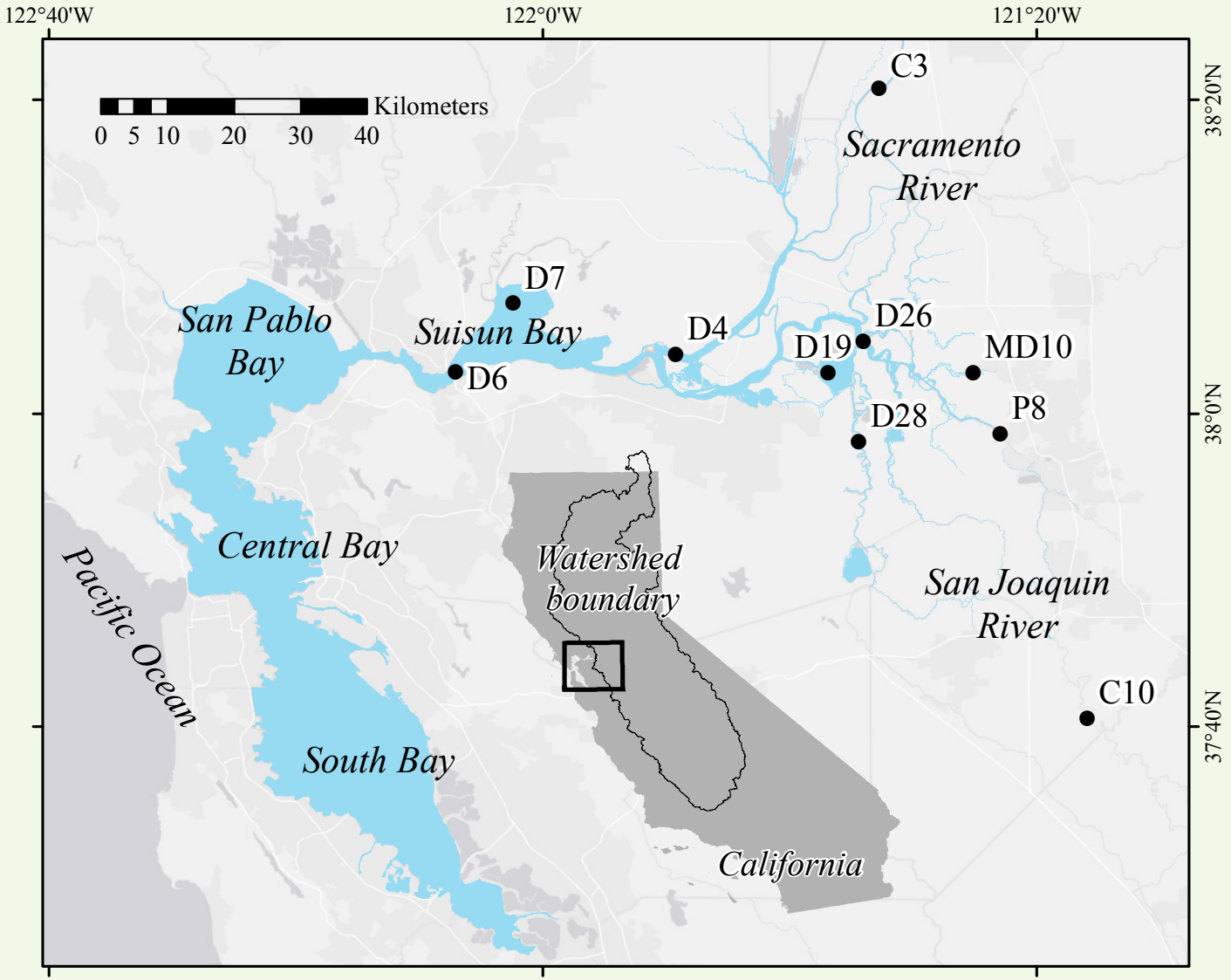
[Beck and Murphy, 2017]



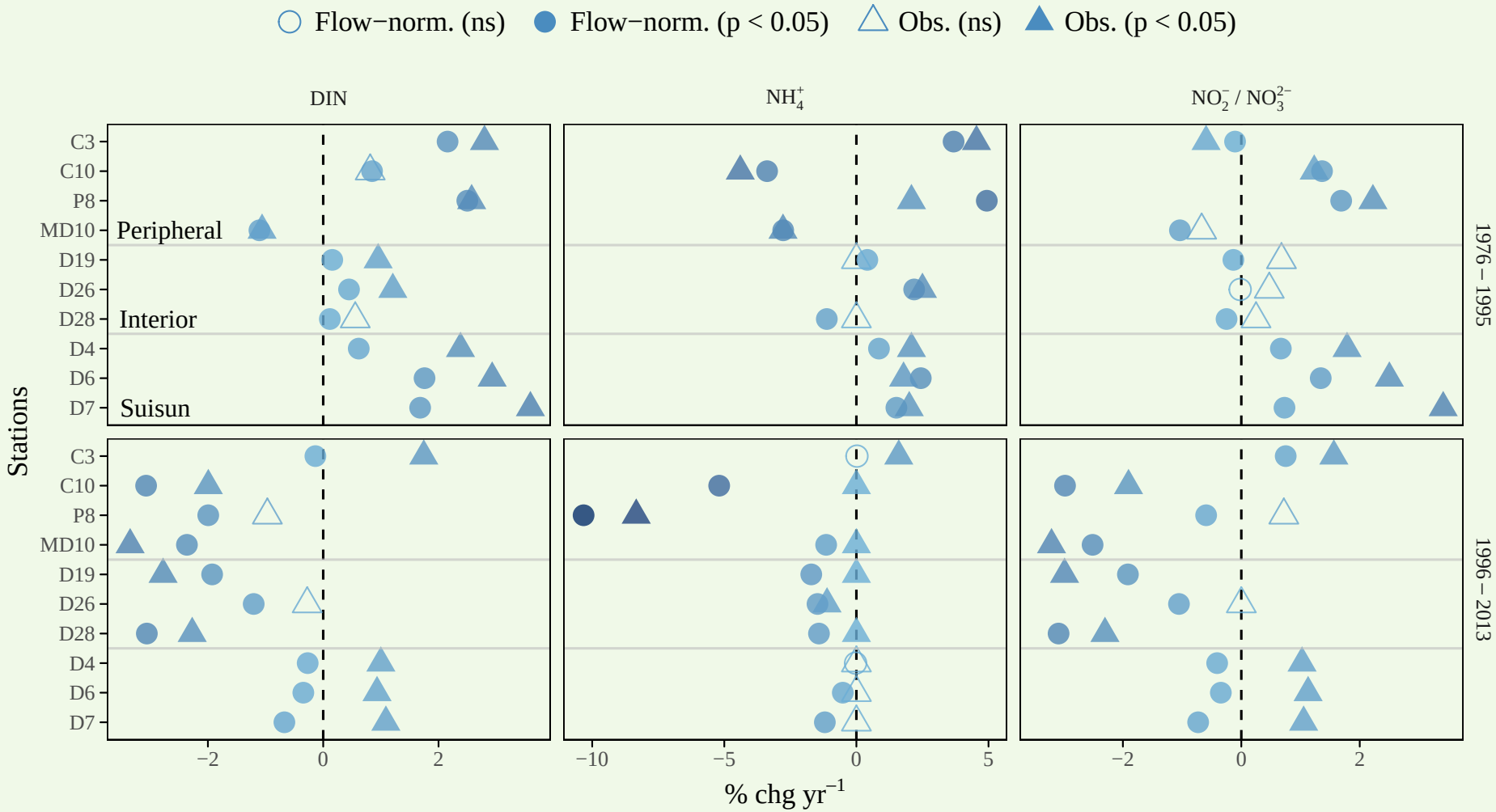


The ORISE experience

Additional WRTDS applications



Better description of nutrient endpoints can change conclusions



The EPA experience

R-term post-doc, Dec. 2015

- You are a federal employee

The EPA experience

R-term post-doc, Dec. 2015

- You are a federal employee
- You are not a permanent federal employee

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The EPA experience

R-term post-doc, Dec. 2015

- You are a federal employee
- You are not a permanent federal employee
- You can't tell contractors what to do
- You move out of cubeland

The EPA experience

4.02B Nutrient Response and Recovery

- Simulation modelling of NGOM hypoxia

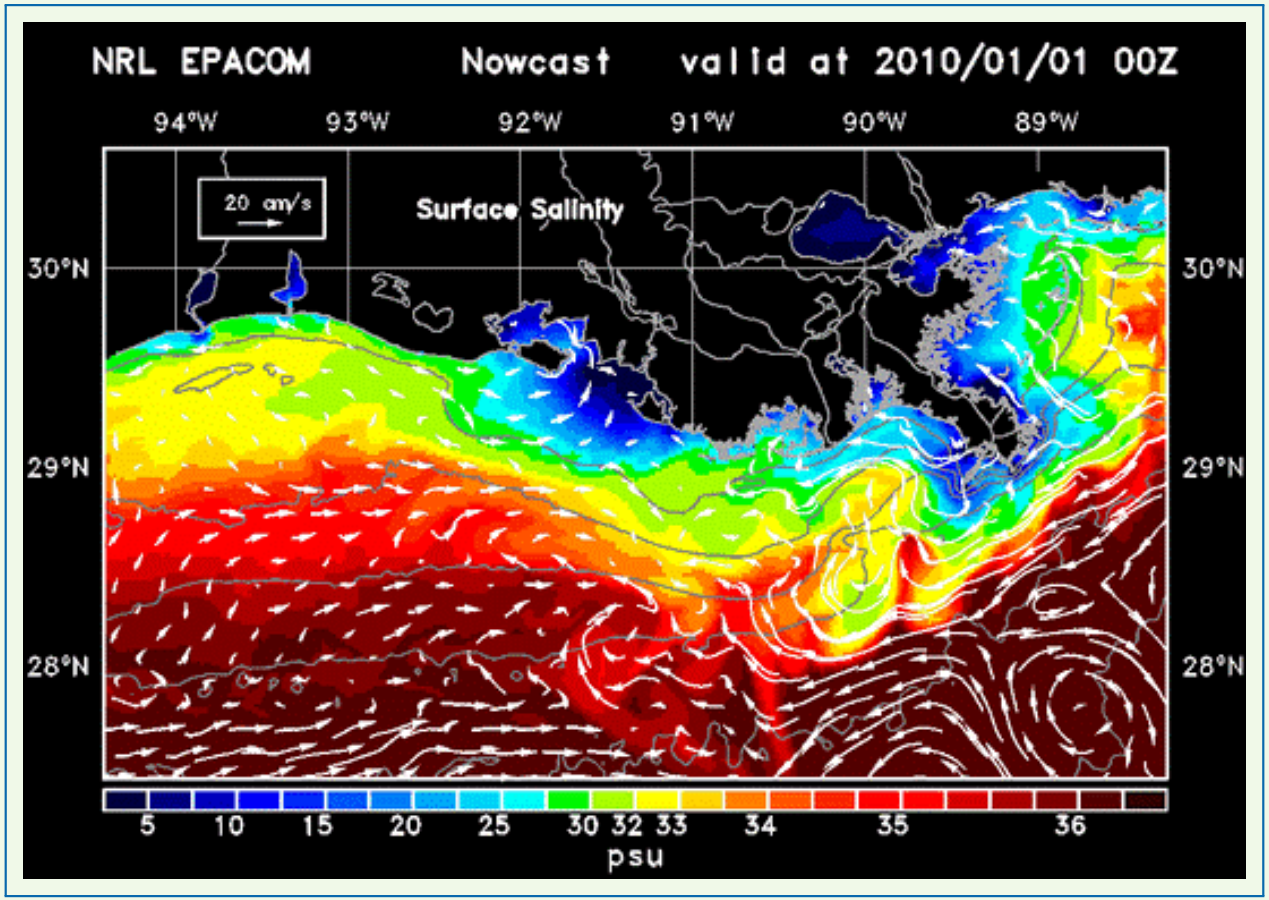
4.02A Microbial Indicators

- Data munging

3.01D Watershed Sustainability

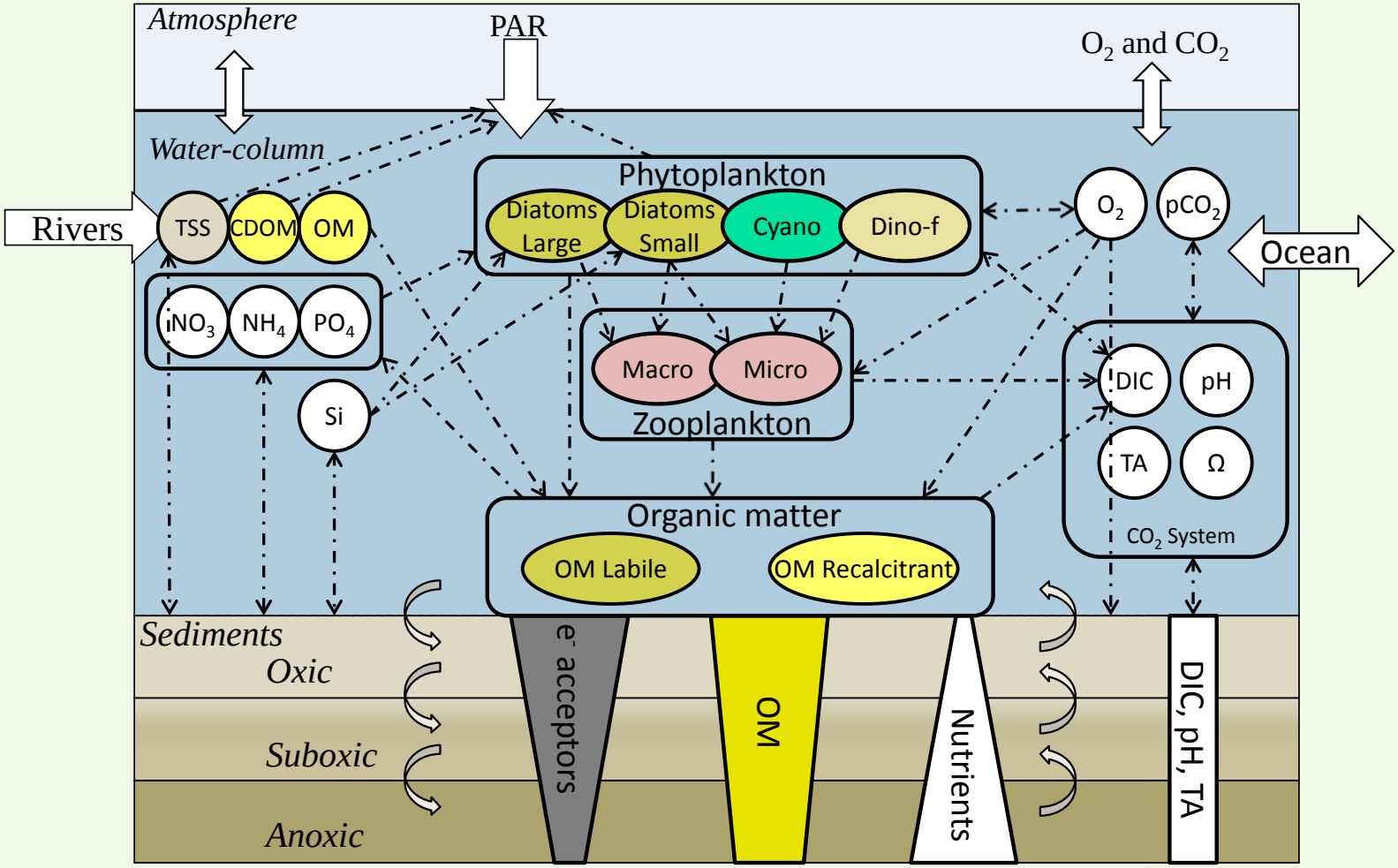
- Coral Biocriteria development

Community General Ecology Model



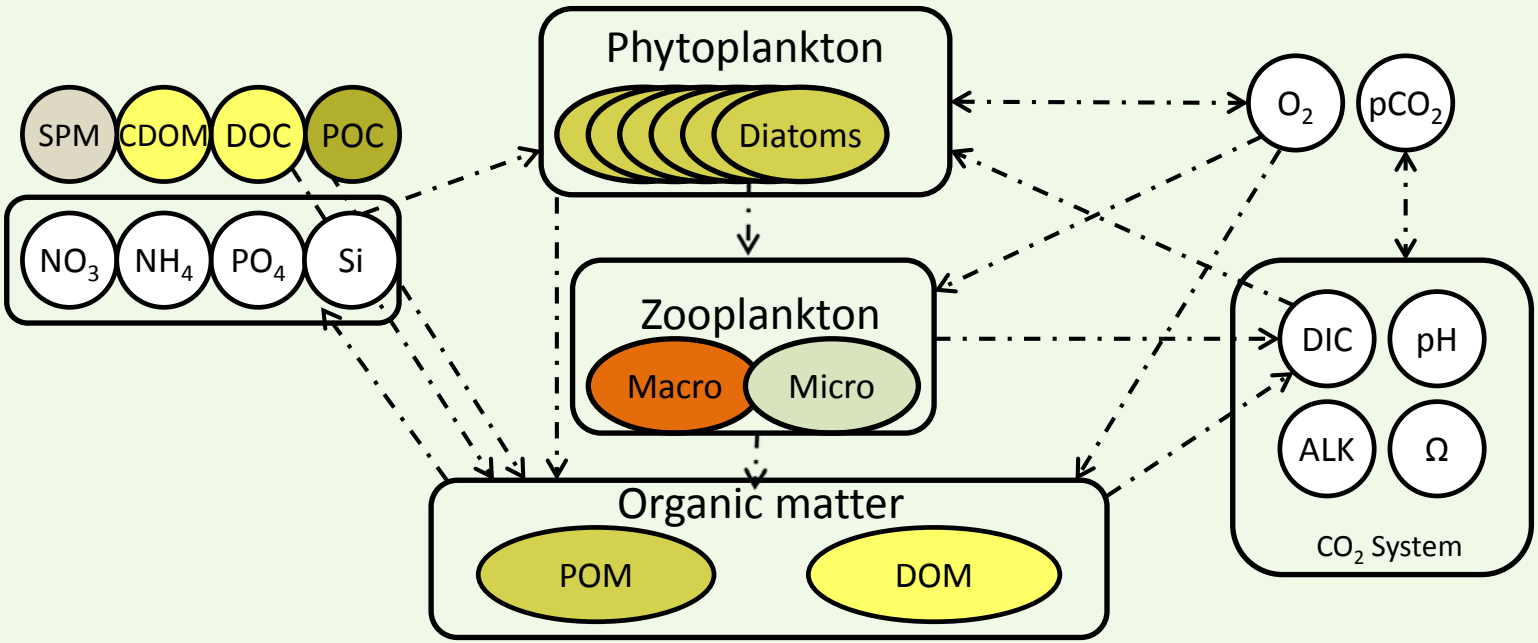
The EPA experience

4.02B Nutrient Response and Recovery



CGEM
ZERO DIMENSION
COMMUNITY GENERAL ECOLOGY MODEL

- 36 state variables
- 108 structural equations
- 251 parameters



Basic concepts:

Models seek to provide generality, precision, realism [Levins, 1966]

We can evaluate model uncertainty to address what a model should provide in this context

Parameter uncertainty - uncertainty in the parameter space that provides bounds on structural equations

Assumptions:

- Parameter values based on field/lab data, literature, expert judgment
- Precision/accuracy limitations due to model domain, reproducibility
- Models are over-parameterized to address all objectives

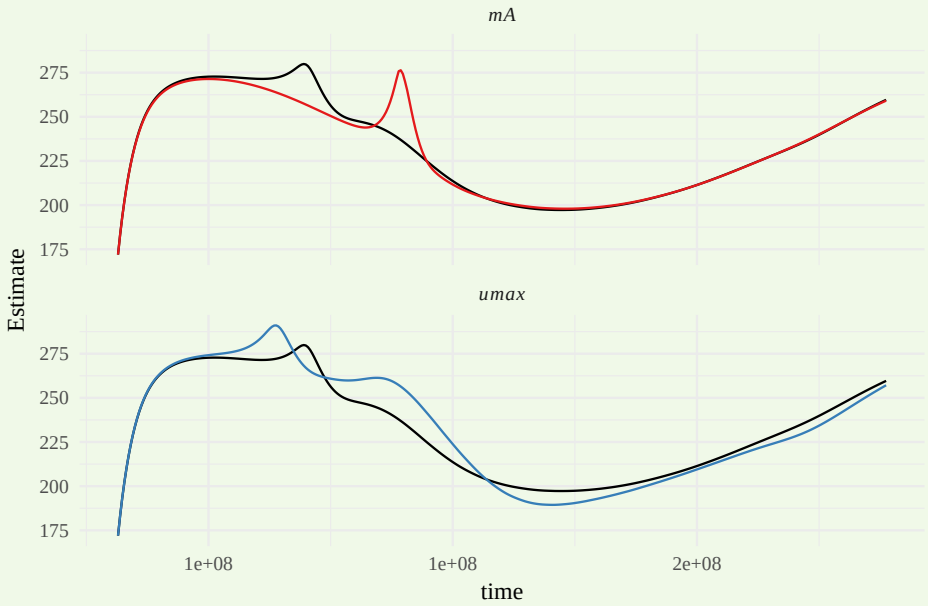
Objective: Evaluate FishTank as 0D unit for larger CGEM model, provide guidance for further refining or application to new environments

- Local sensitivity analysis and identifiability
- Parameter selection heuristics

Method: Local sensitivity analysis, single perturbation of model parameters [Soetaert and Petzoldt, 2010]

$$S_{ij} = \frac{\partial y_i}{\partial \Theta_j} \cdot \frac{w_{\Theta_j}}{w_{y_i}}$$

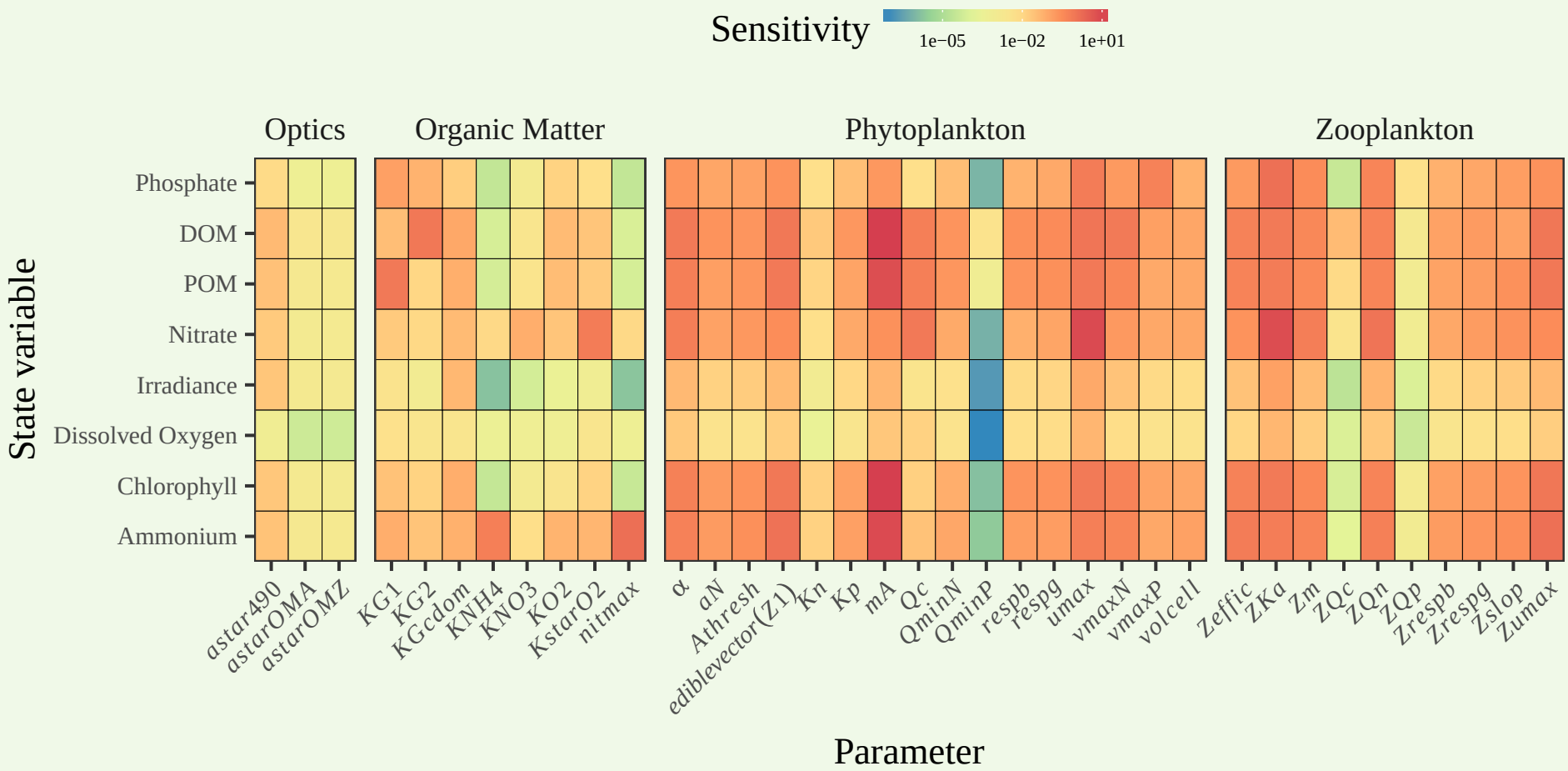
$$L_j = \sum |S_{ij}|/n$$



timestep	default	*umax*	*mA*
1	172.0	172.0	172.0
2	183.3	183.3	183.3
3	193.3	193.3	193.4
4	202.2	202.1	202.2
5	210.0	209.9	210.1
6	217.0	216.9	217.1

The EPA experience

4.02B Nutrient Response and Recovery



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not found
## Error in unit.pmax(pC$widths[2:3], pD$widths[2:3],
pE$widths[2:3]):  could not find function "unit.pmax"
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not found
## Error in eval(expr, envir, enclos):  object 'maxWidth'
not found
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function "textGrob"
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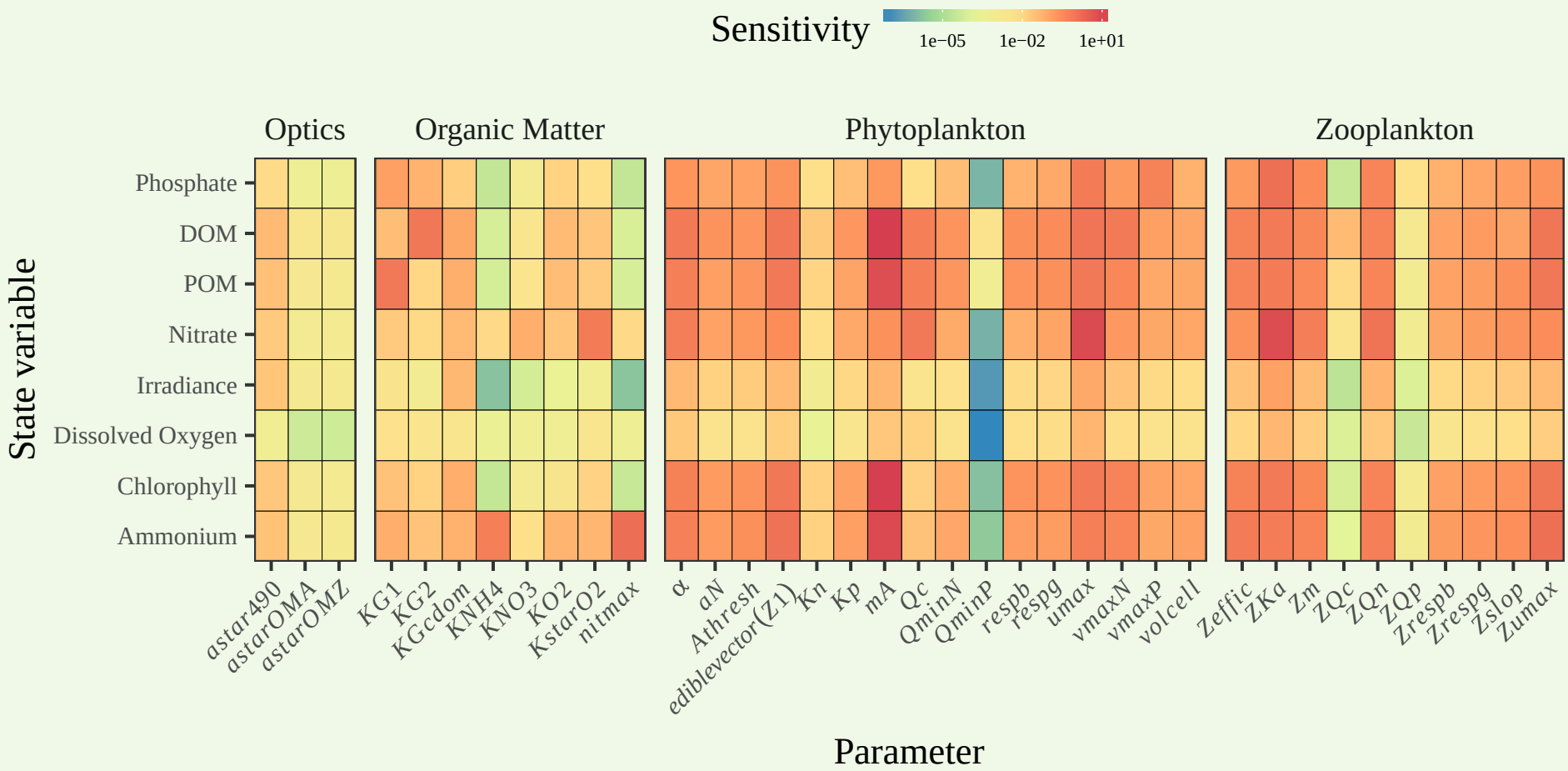
The EPA experience

4.02B Nutrient Response and Recovery



The next chapter

Final thoughts

Sincere thank-yous

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