Vermont EPSCoR

Experimental Program to Stimulate Competitive Research

Summary of Lake Modeling Progress

Andrew Schroth and Peter Isles

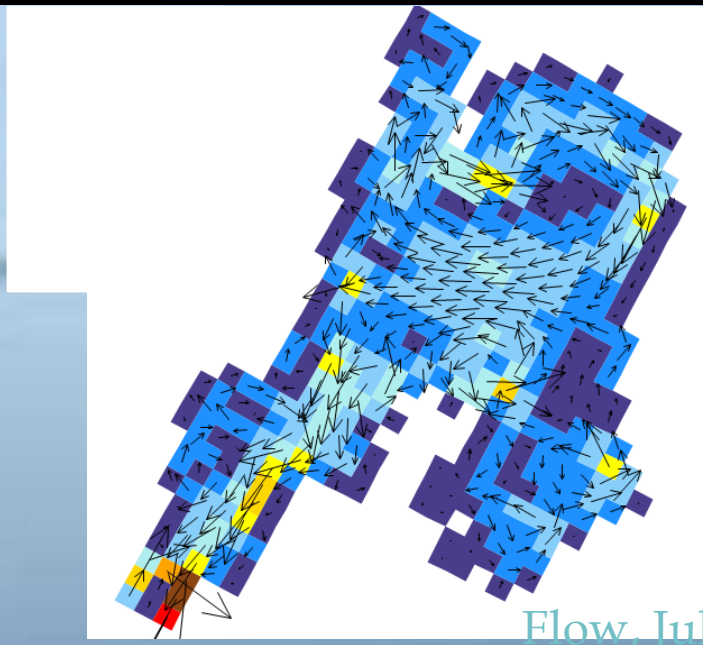
Lake Modeling Framework

Environmental Fluid Dynamics Code (EFDC)

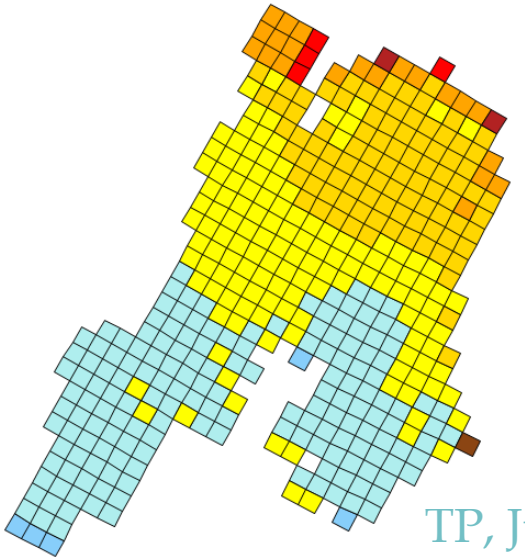
- 3-D hydrodynamic model
- Water temperature, flow patterns

Row-Column AESOP (RCA)

- Water Quality Model
- Sediment diagenesis

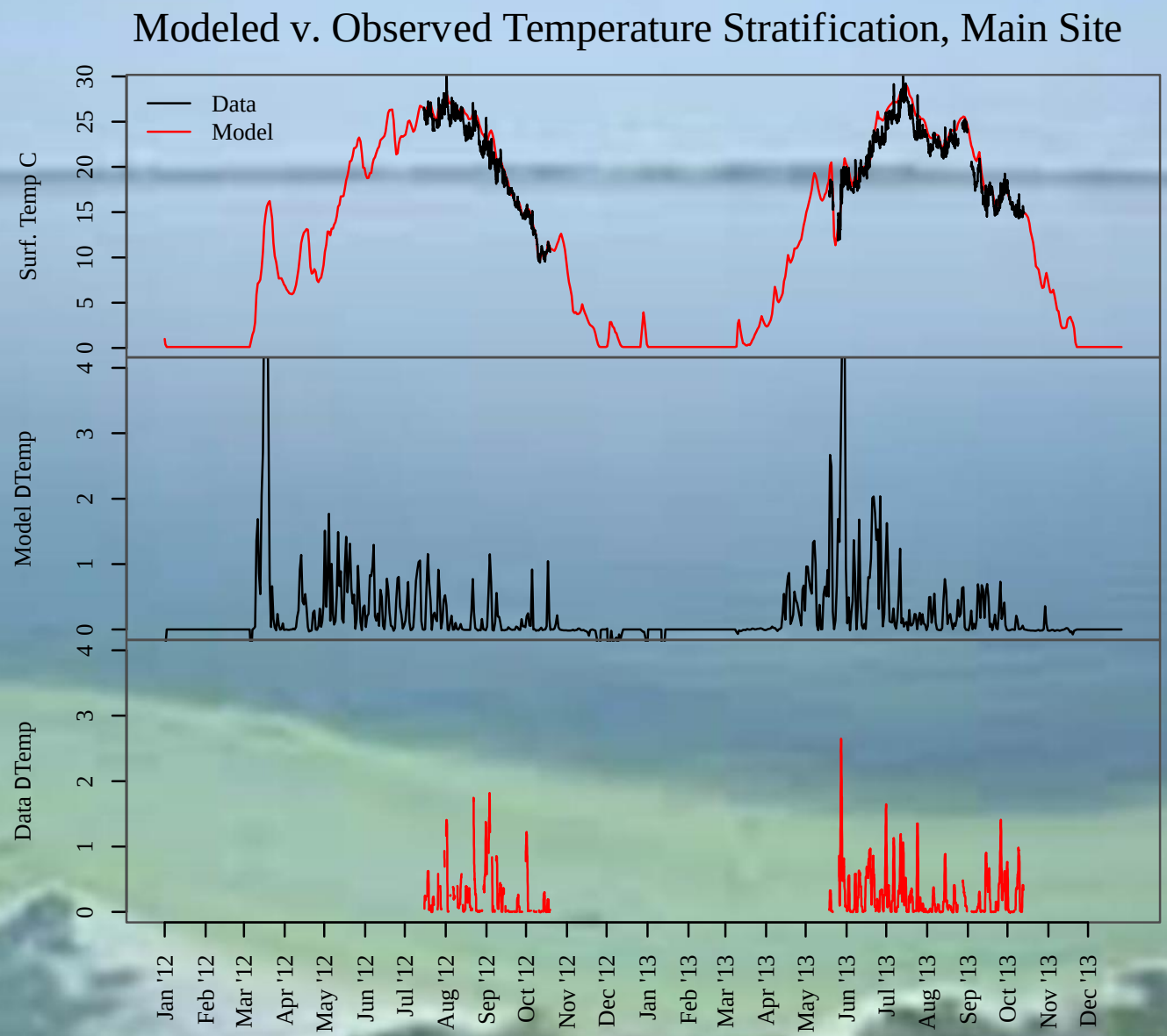


Flow, July 2012

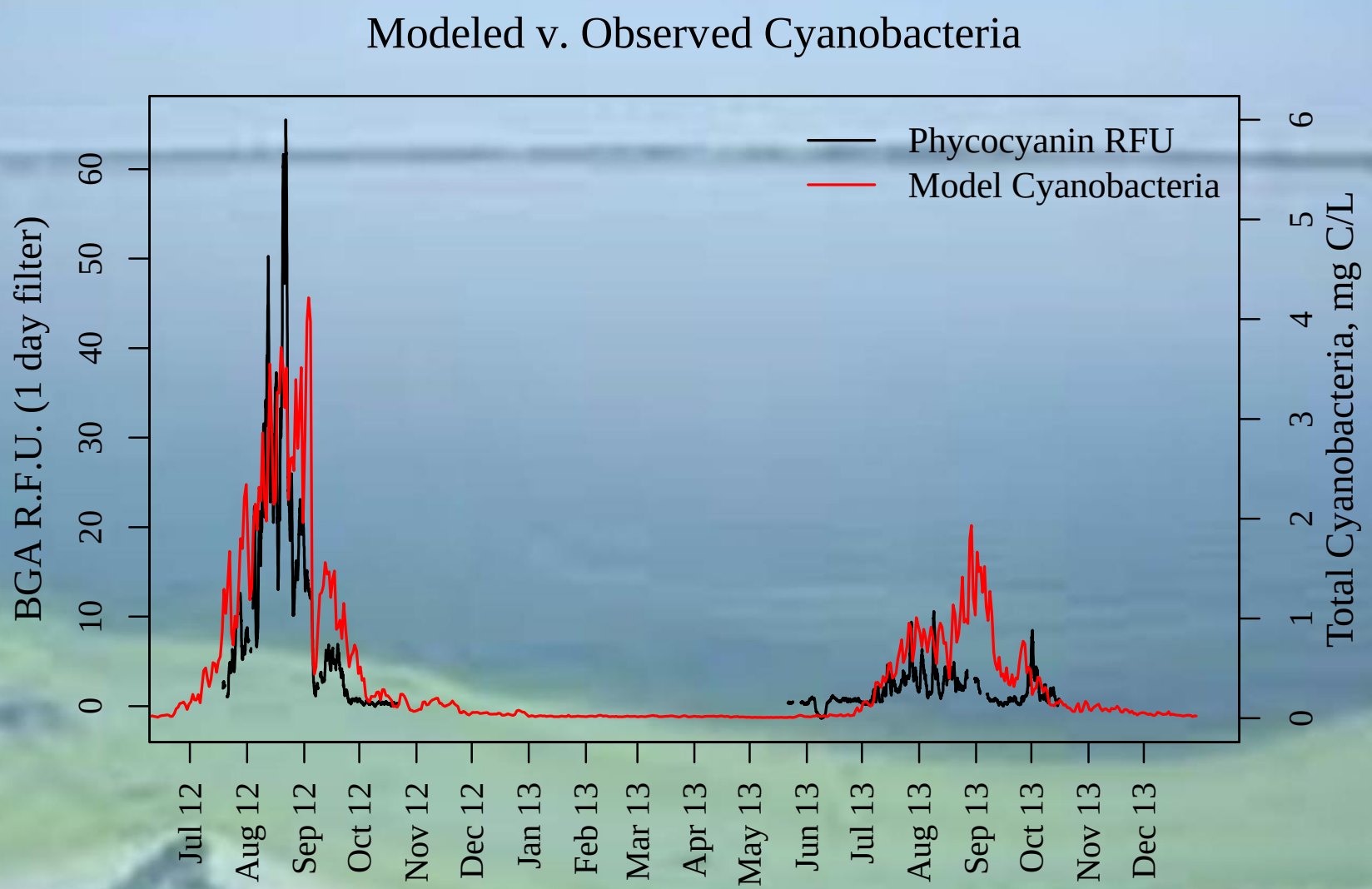


TP, July 2012

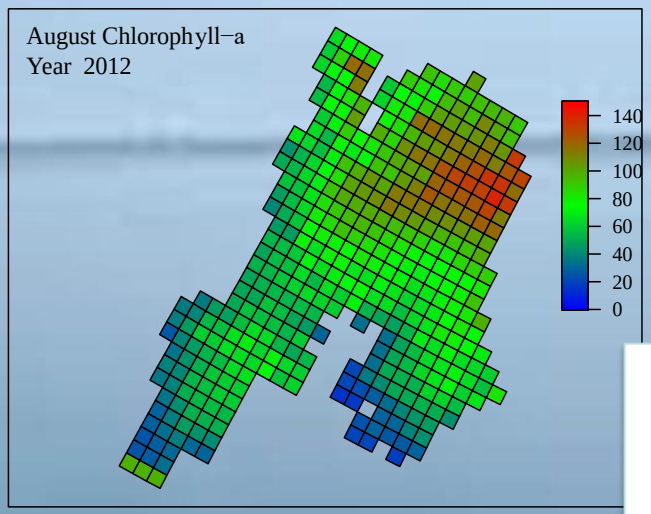
High-frequency calibration

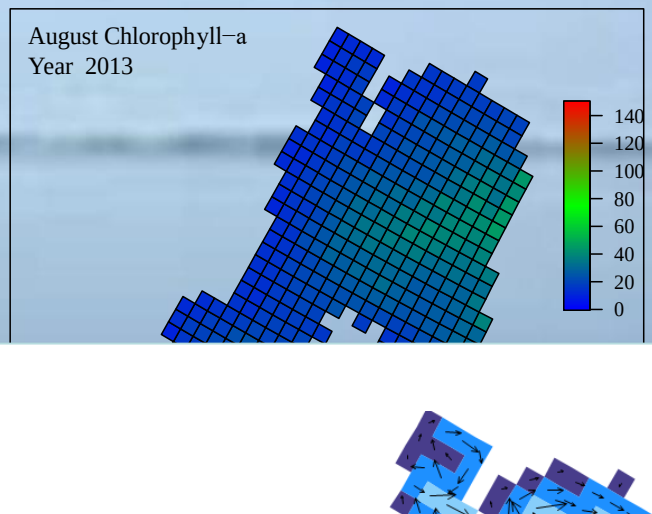


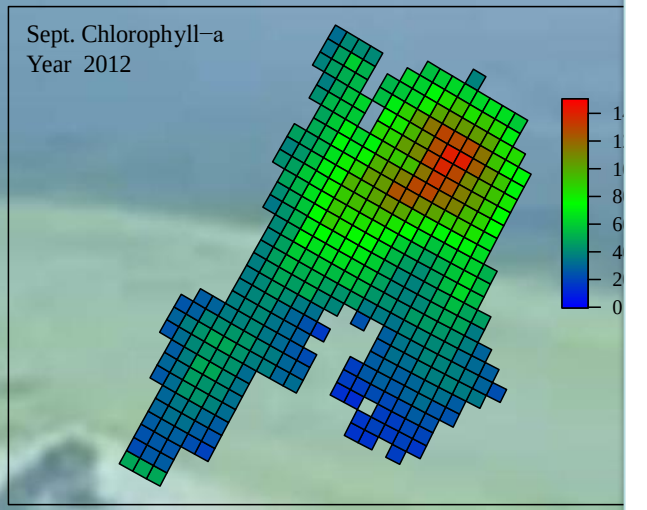
Chapter 6: High-frequency calibration

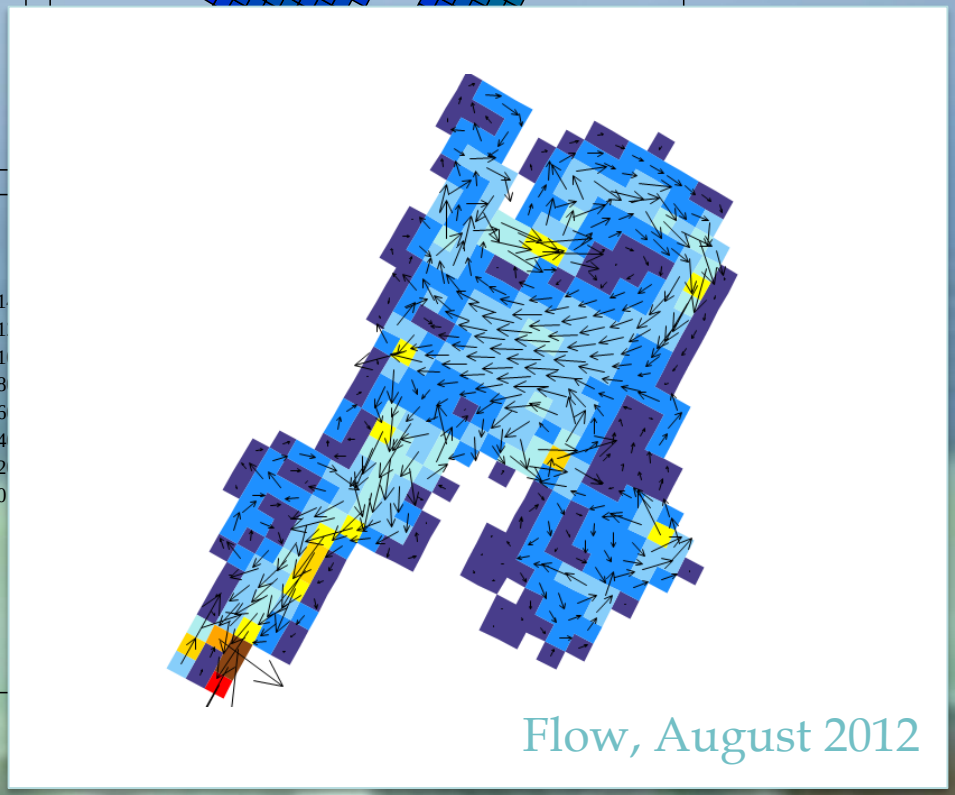


High-frequency calibration

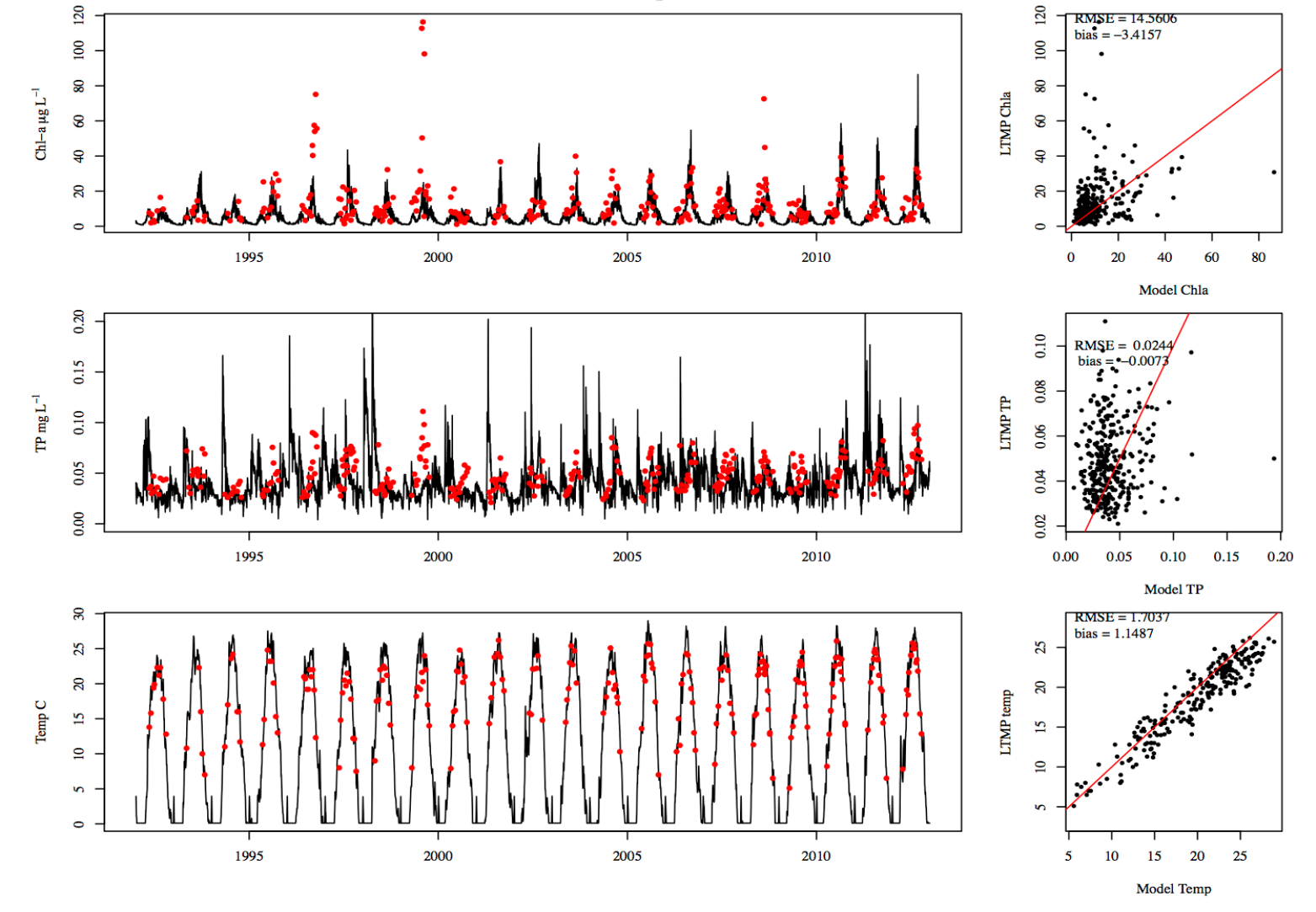






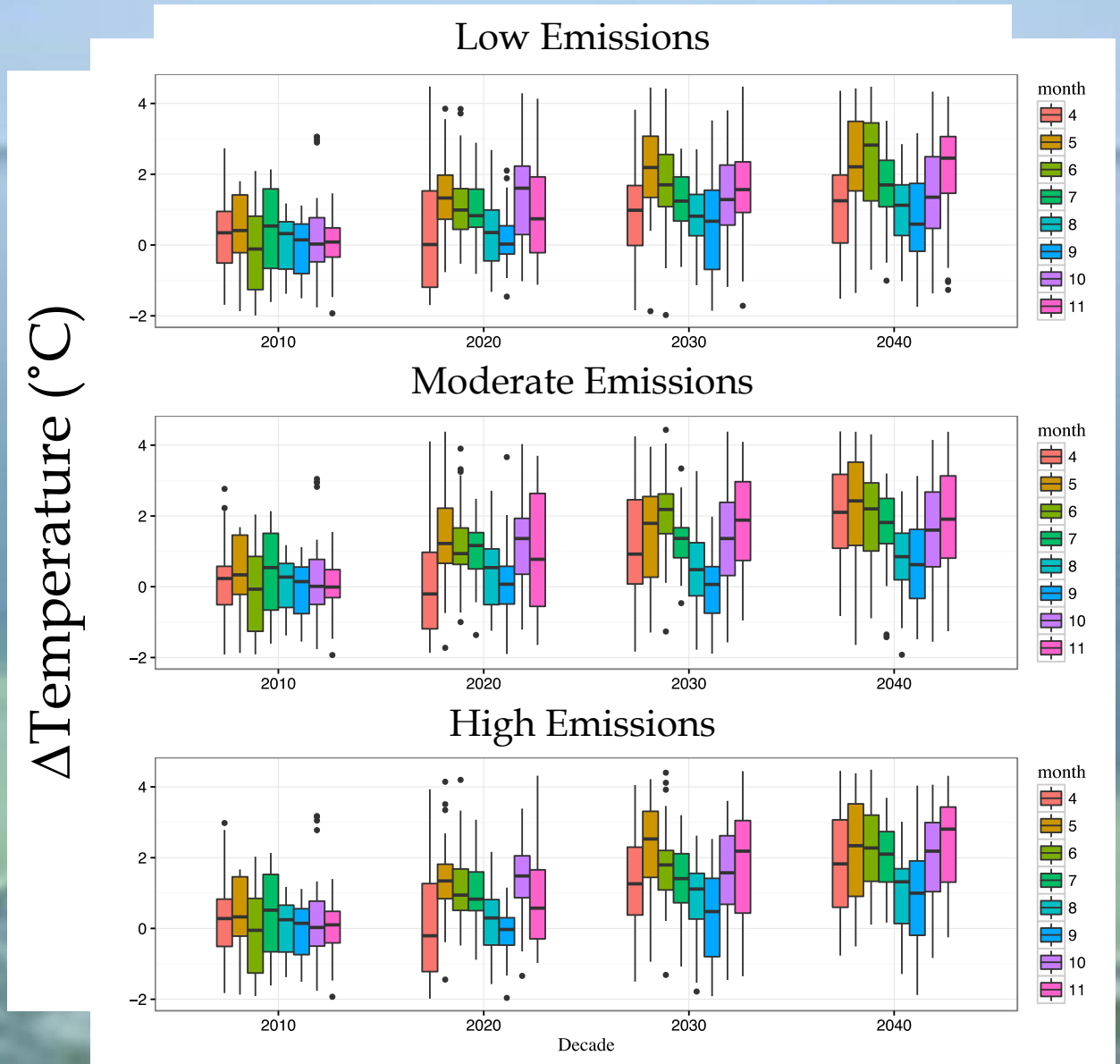


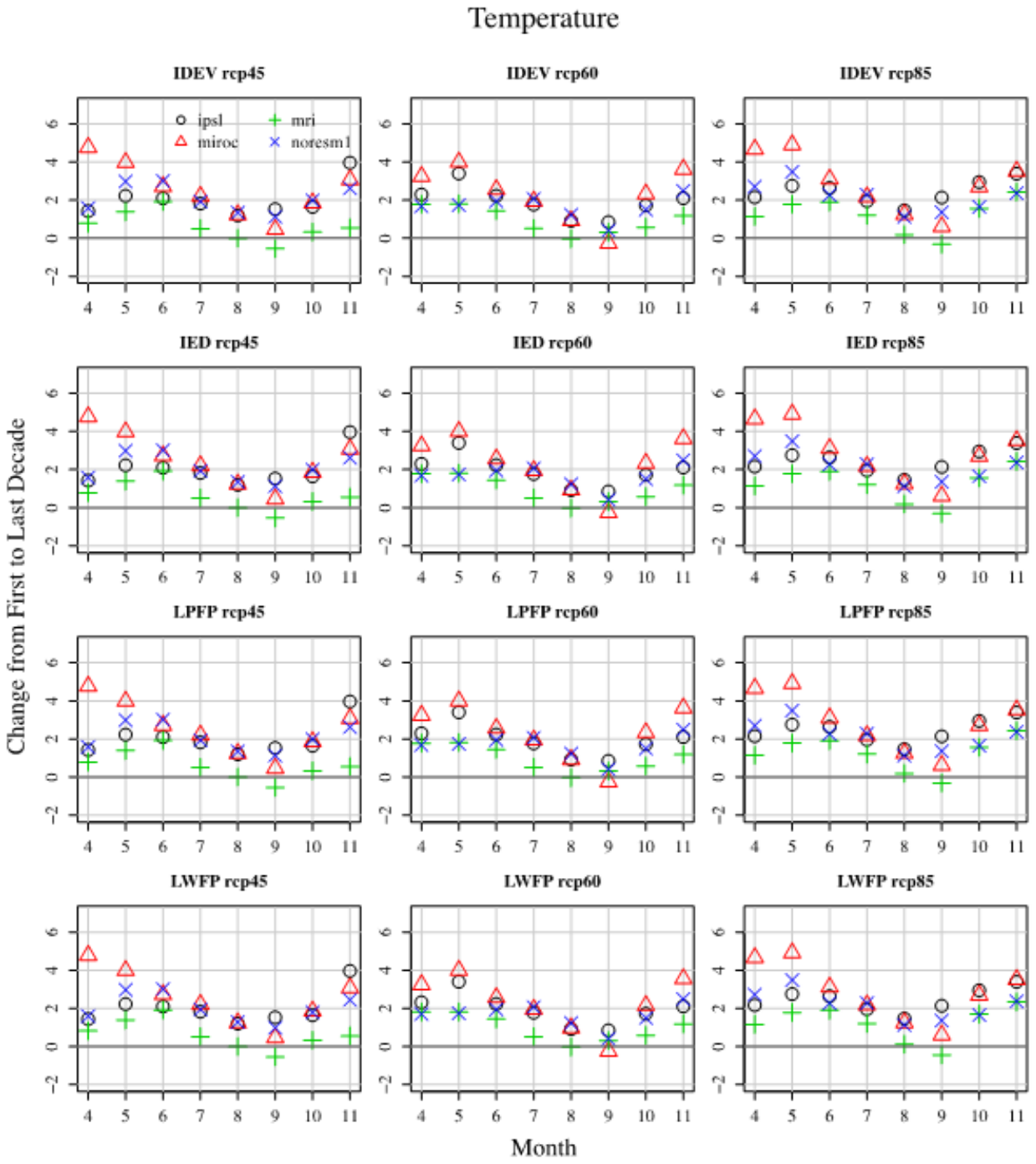
Long-term calibration

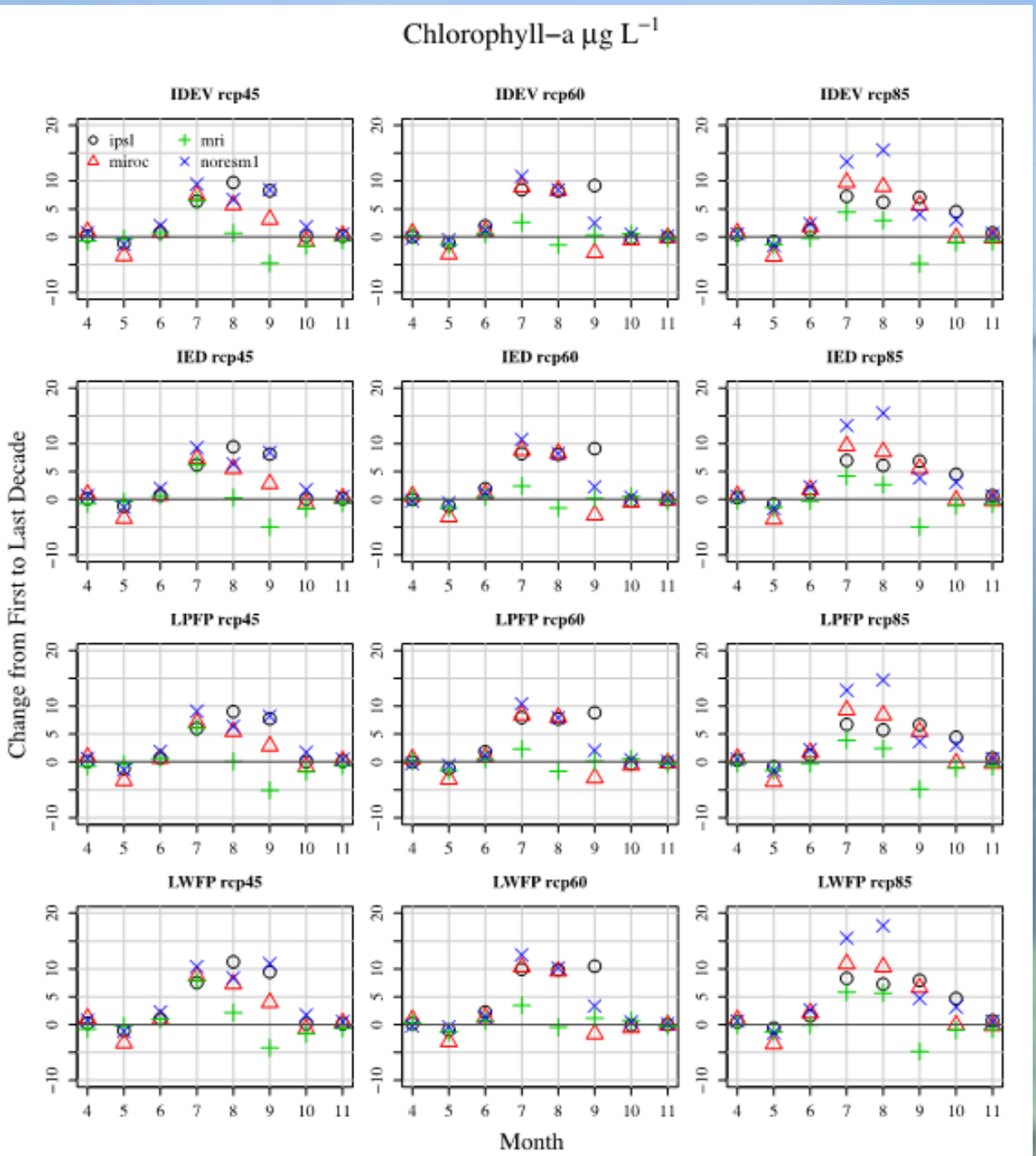


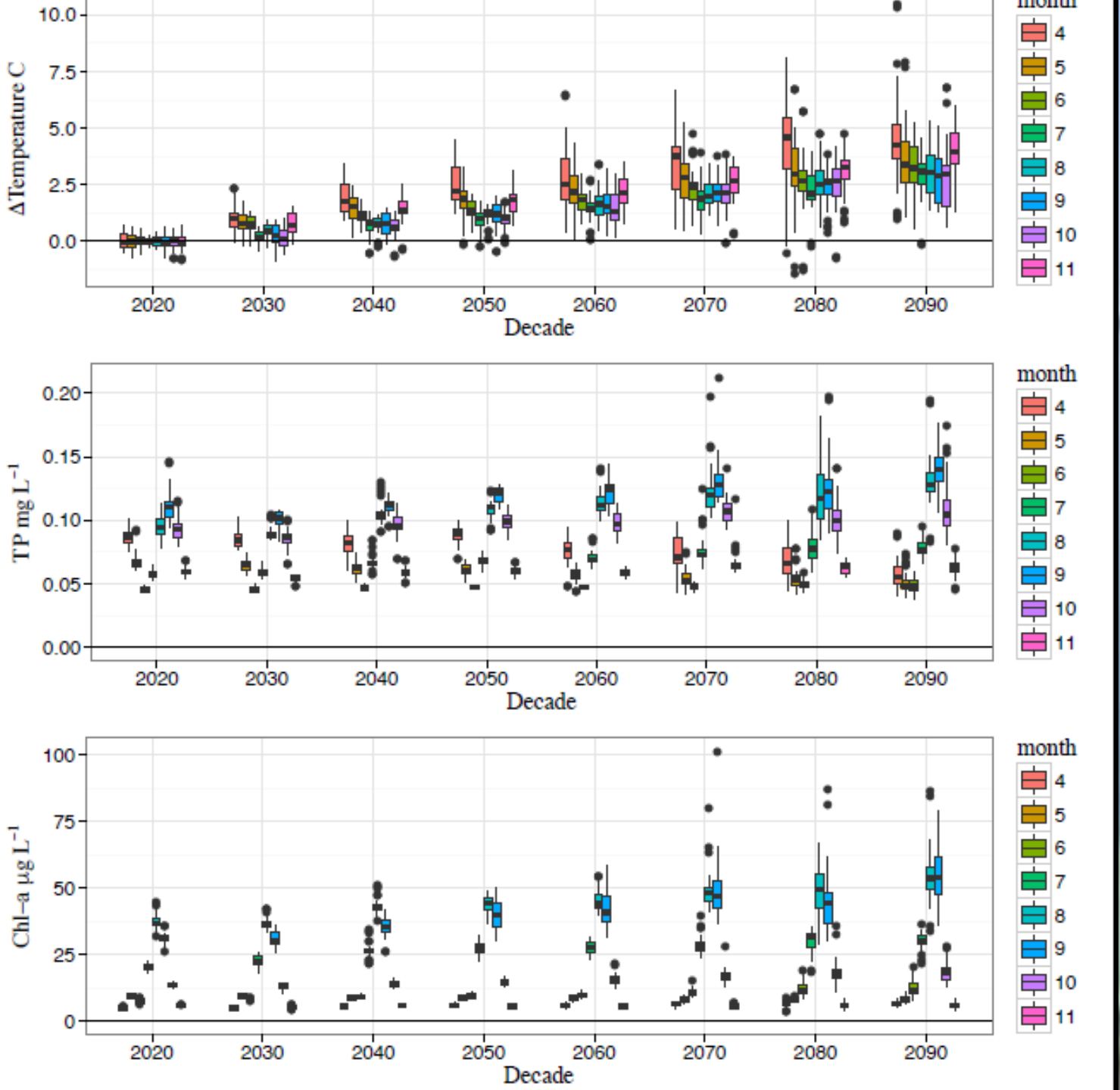
Future Climate Scenarios

Monthly Changes in Water Temperature



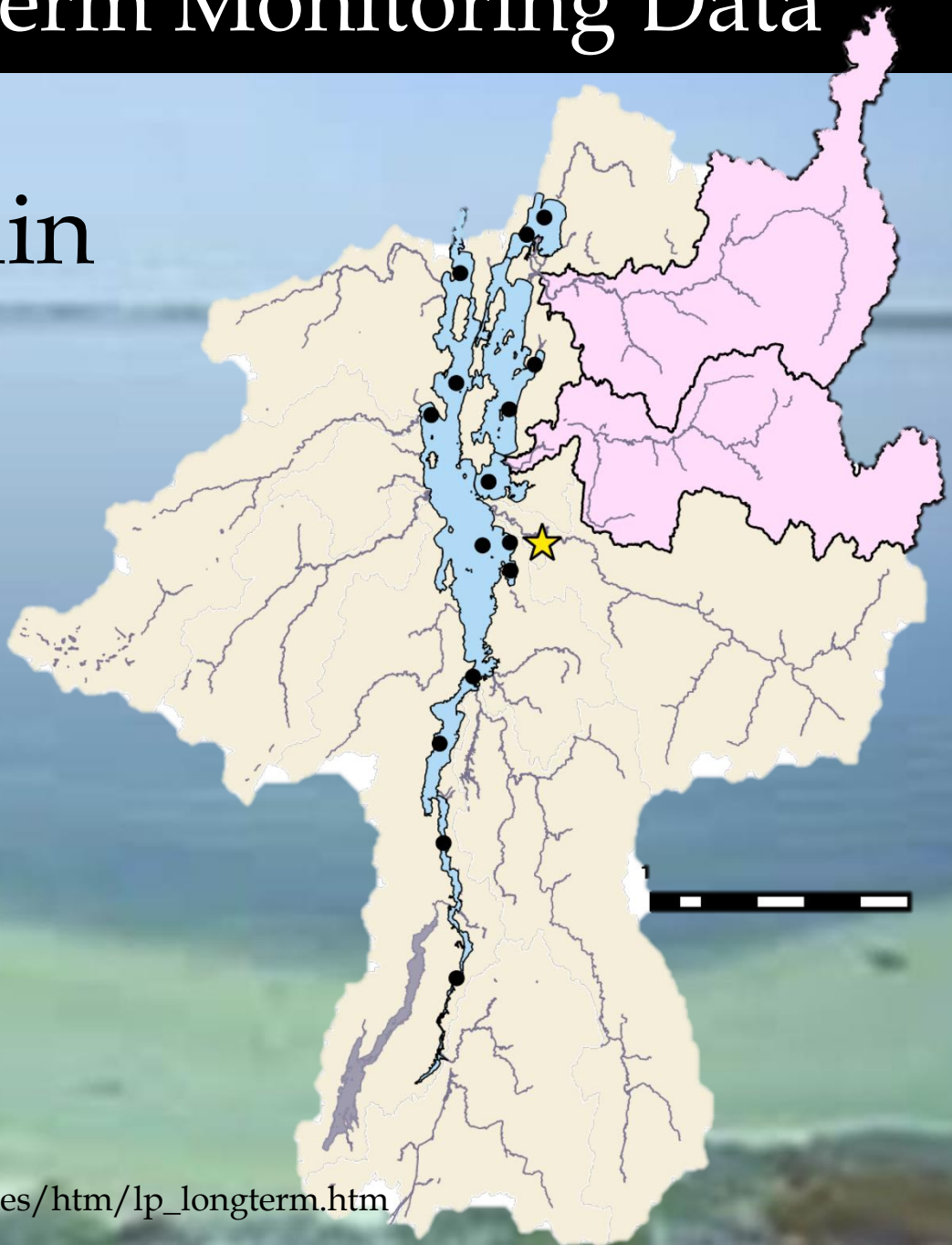

Temperature
IDEV rcp45
IDEV rcp60
IDEV rcp85
IED rcp45
IED rcp60
IED rcp85
LPFP rcp45
LPFP rcp60
LPFP rcp85
LWFP rcp45
LWFP rcp60
LWFP rcp85
ipsl
miroc
mri
noresm1
Change from First to Last Decade
Month


Chlorophyll–a µg L^{-1}
IDEV rcp45
IDEV rcp60
IDEV rcp85
IED rcp45
IED rcp60
IED rcp85
LPFP rcp45
LPFP rcp60
LPFP rcp85
LWFP rcp45
LWFP rcp60
LWFP rcp85
ipsl
miroc
mri
noresm1
Change from First to Last Decade
Month


ΔTemperature C
10.0
7.5
5.0
2.5
0.0
2020
2030
2040
2050
2060
2070
2080
2090
Decade
month
4
5
6
7
8
9
10
11
TP mg L⁻¹
0.20
0.15
0.10
0.05
0.00
Chl–a µg L⁻¹
100
75
50
25
0

Lake-wide Long-Term Monitoring Data

Lake Champlain LTMP



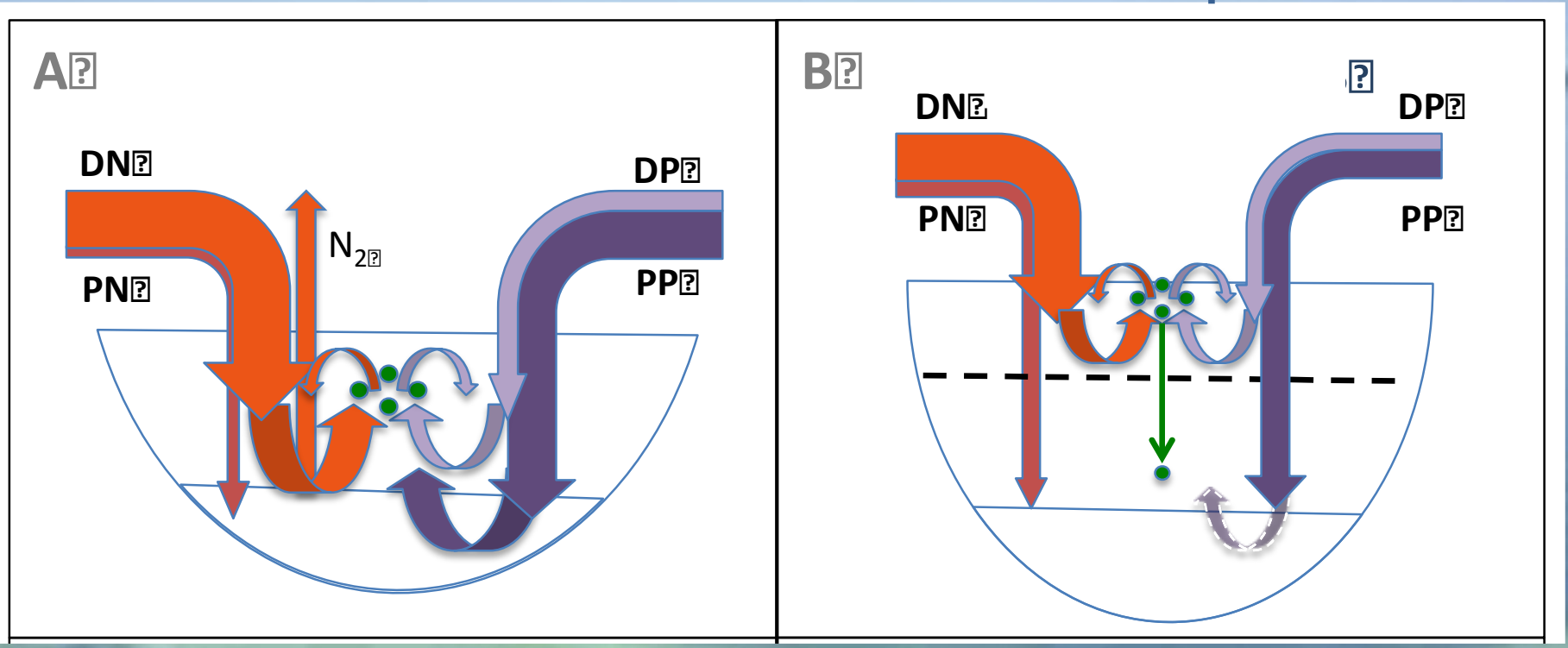
- **15 Sites**
- **1992-present**
- **Tributaries**

http://www.watershedmanagement.vt.gov/lakes/htm/lp_longterm.htm

Conceptual Model: TN:TP

Shallow

Deep



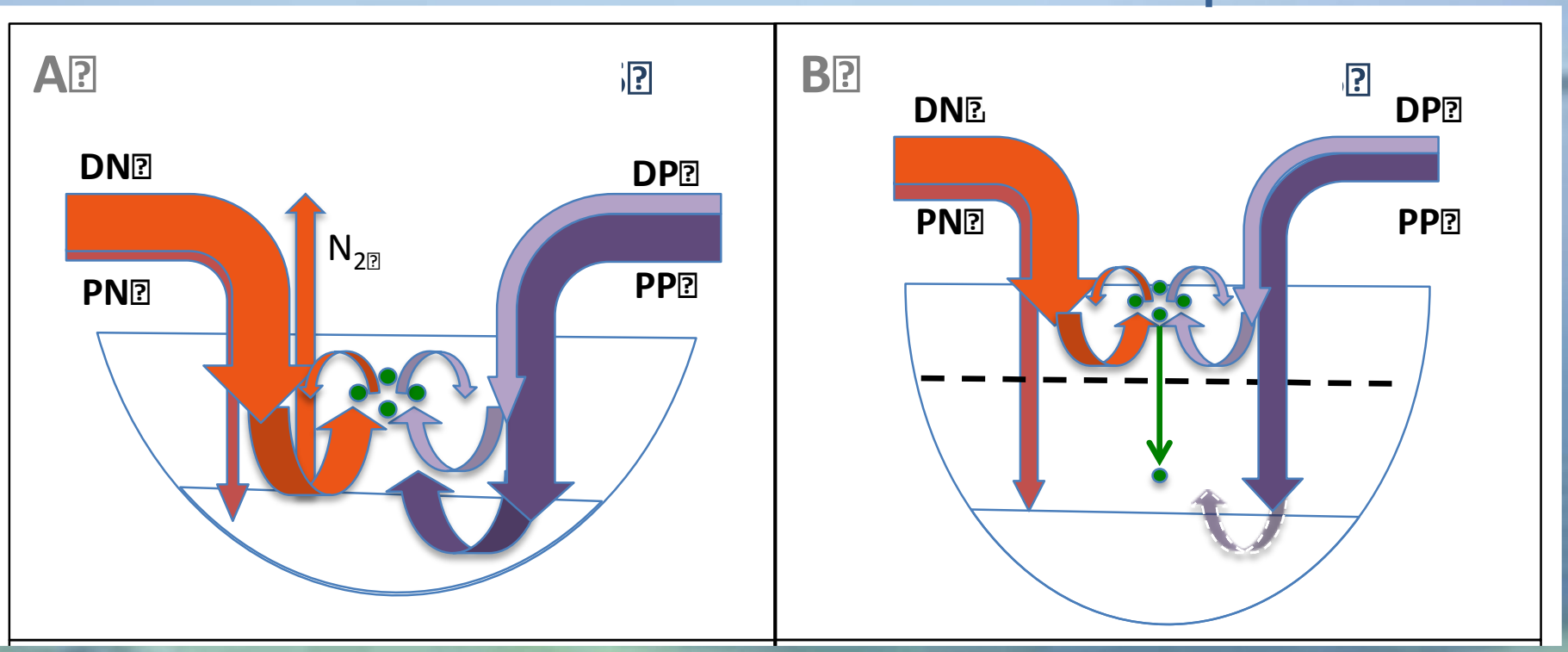
- Dissolved nutrients available immediately (in spring)
- Particulate nutrients available when Temp, O2 conditions allow

- Dissolved nutrients efficiently recycled
- Particulate nutrients mostly lost to the sediments

Conceptual Model: TN:TP Sensitivity

Shallow

Deep



Take Home Point: Climate change will promote cyanobacteria dominance across LC via multiple mechanisms, but potentially fruitful targeted management interventions exist

as changes in timing of nutrient delivery

lead to increased role of late season internal loading

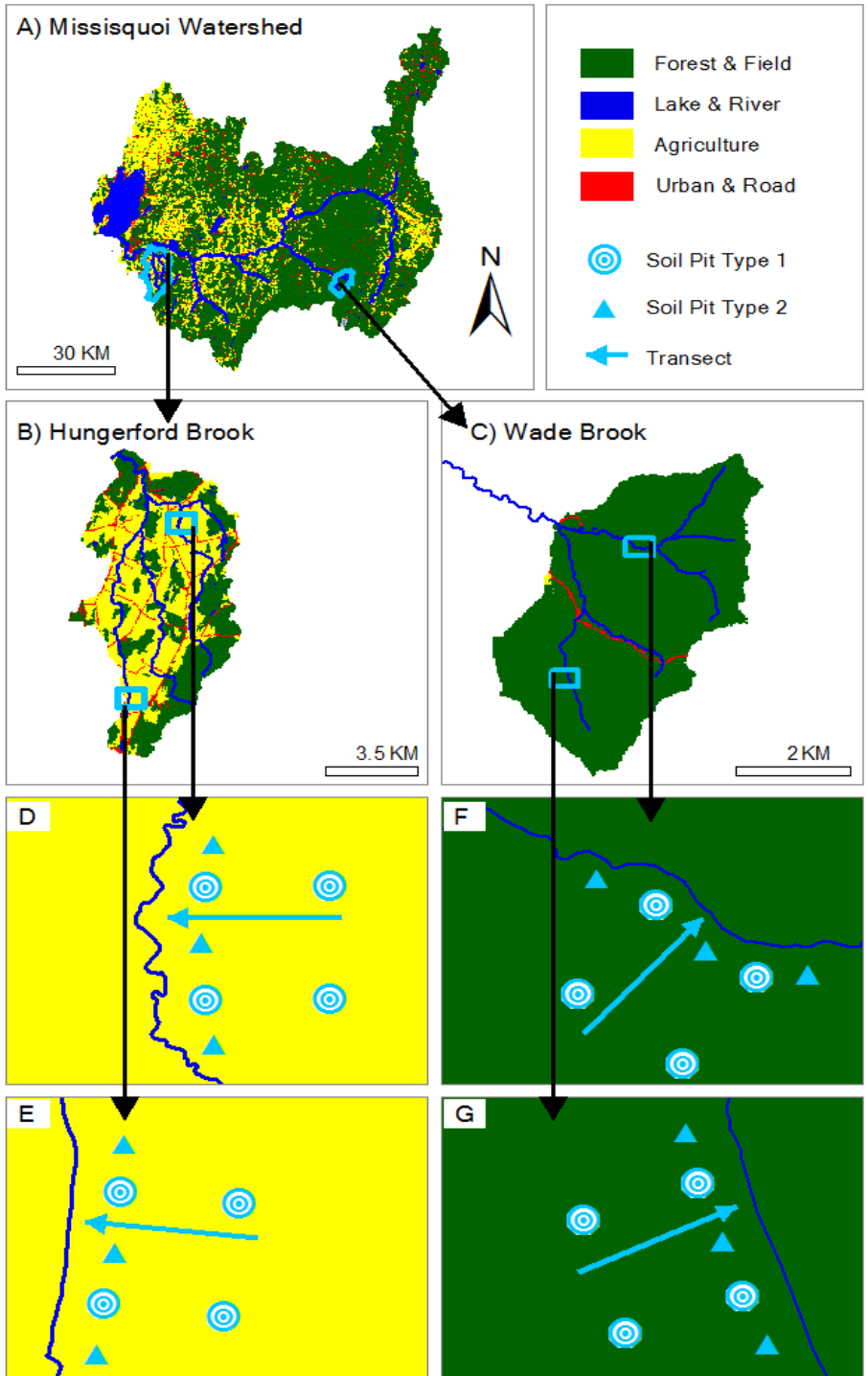
New Project BREE (Basin Resilience to Extreme Events)

Expand RACC and NEWRnet watershed and lake monitoring

Soil transects and additional in-stream sensor assets

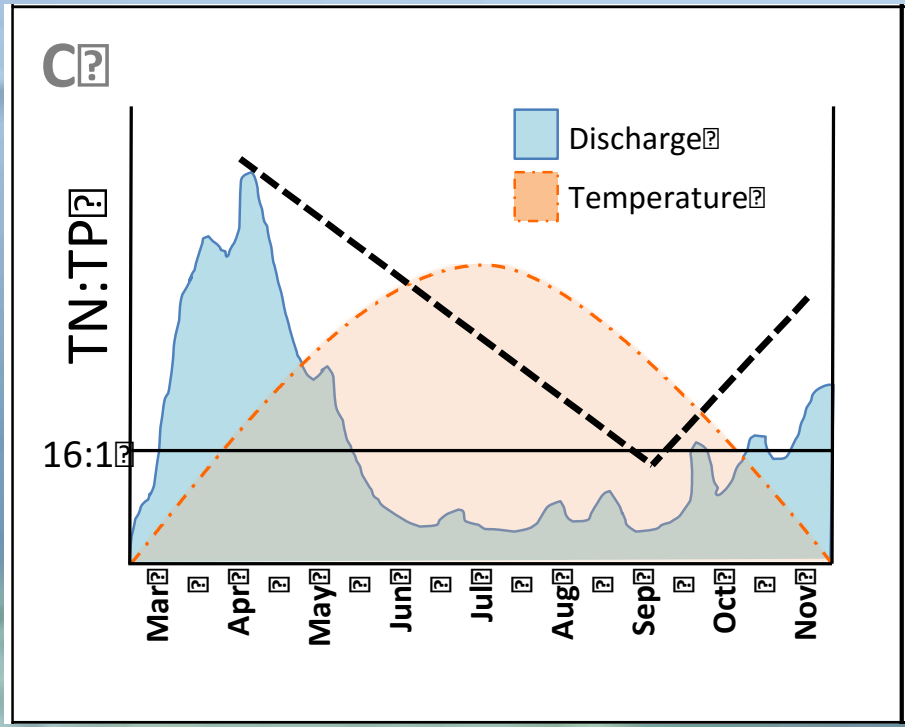
Additional lake monitoring sites

Hire Lake Modeling Faculty Member



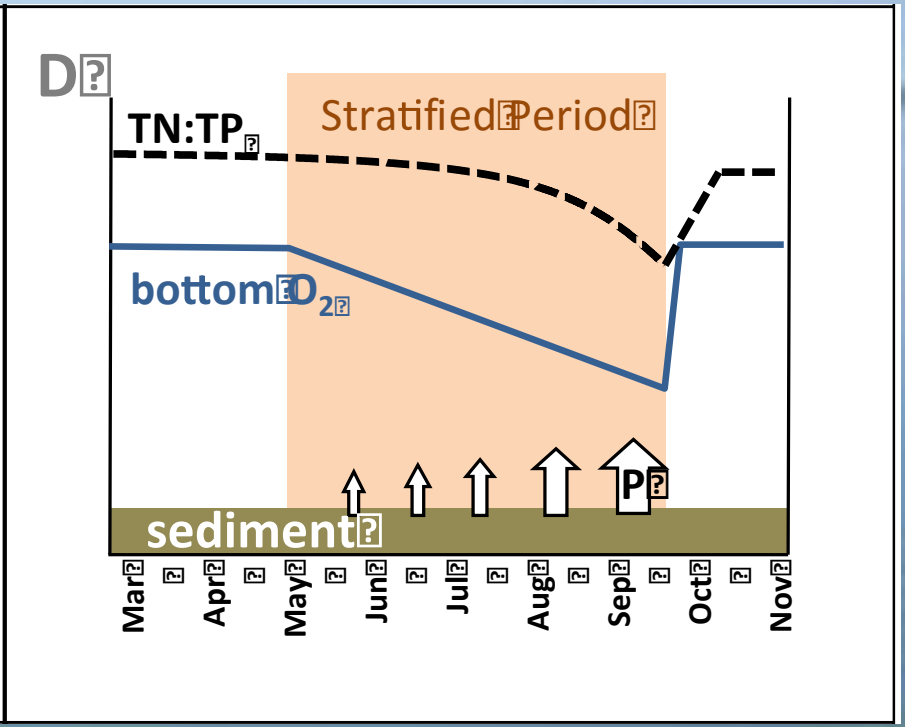
Conceptual Model

Shallow



- TN:TP drops following decreasing N inputs and increasing temperatures during the summer
- TN:TP usually approaches Redfield ratio in late summer (Missisquoi)

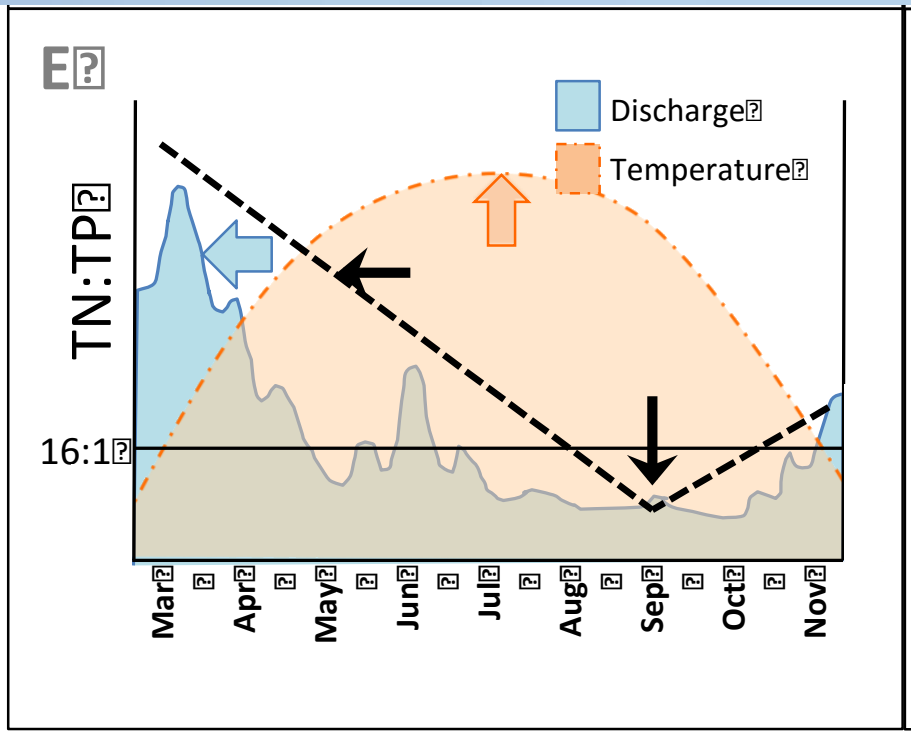
Deep



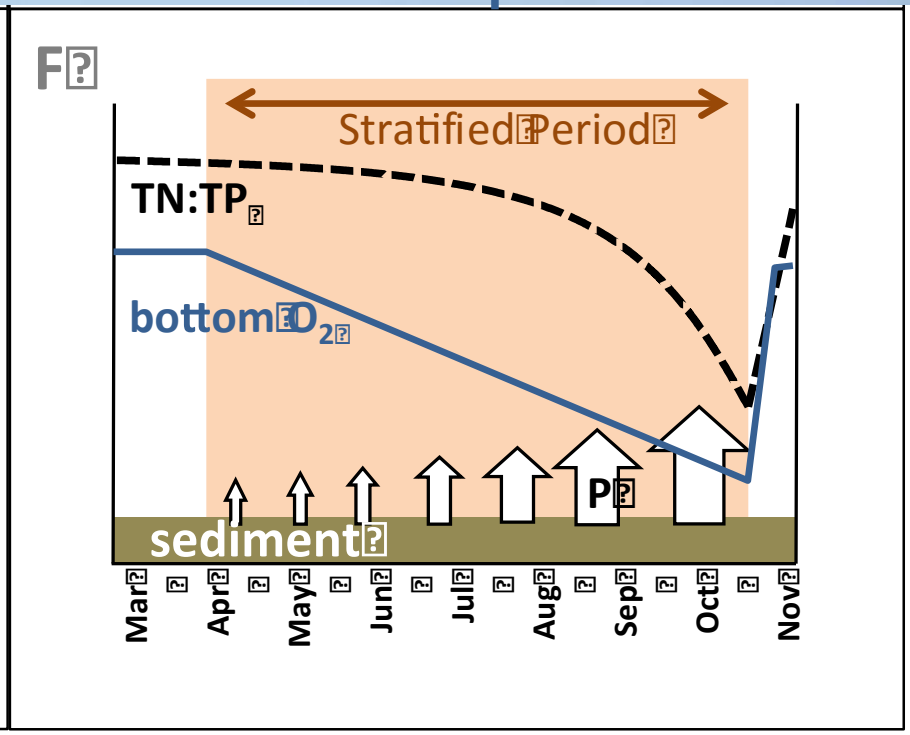
- Bottom water O2 gradually declines during summer stratification due to sedimentation OM from epilimnion
- If O2 falls enough, pulse of P

Conceptual Model

Shallow



Deep



- With climate change, peak discharge is earlier, and warm temps start earlier and last longer
- This leads to prolonged period of declining N:P

- Longer stratified period leads to more bottom O2 depletion and consequent P release in late summer (also more denitrification).