GRAPLEr, GLEON, and gateways: Updates from the PRAGMA lake expedition

Renato, Cayelan, and Paul

Outline

- History of lake expedition
- Recent GRAPLE updates
  - Development of IPOP for sensor gateways at FCR
  - SmartReservoir project
  - GRAPLEr applications to improve our understanding of lake water quality
  - GRAPLEr in undergraduate classrooms
  - Computer science-ecology collaboration lessons learned
- Future steps for GRAPLE

GLEON+PRAGMA Lake expedition

PRAGMA-26 (Taiwan, 2014)

Gainesville, USA, 2017

Chuncheon,
South Korea, 2015

GLEON-16 (Canada, 2014)

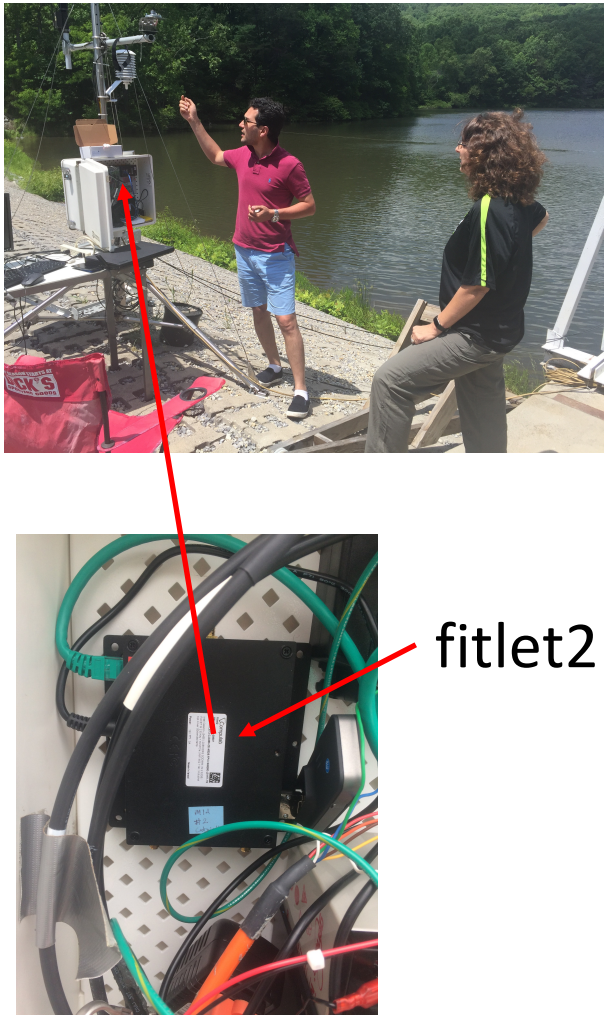
Nara, Japan, 2015

Blacksburg, USA, 2015

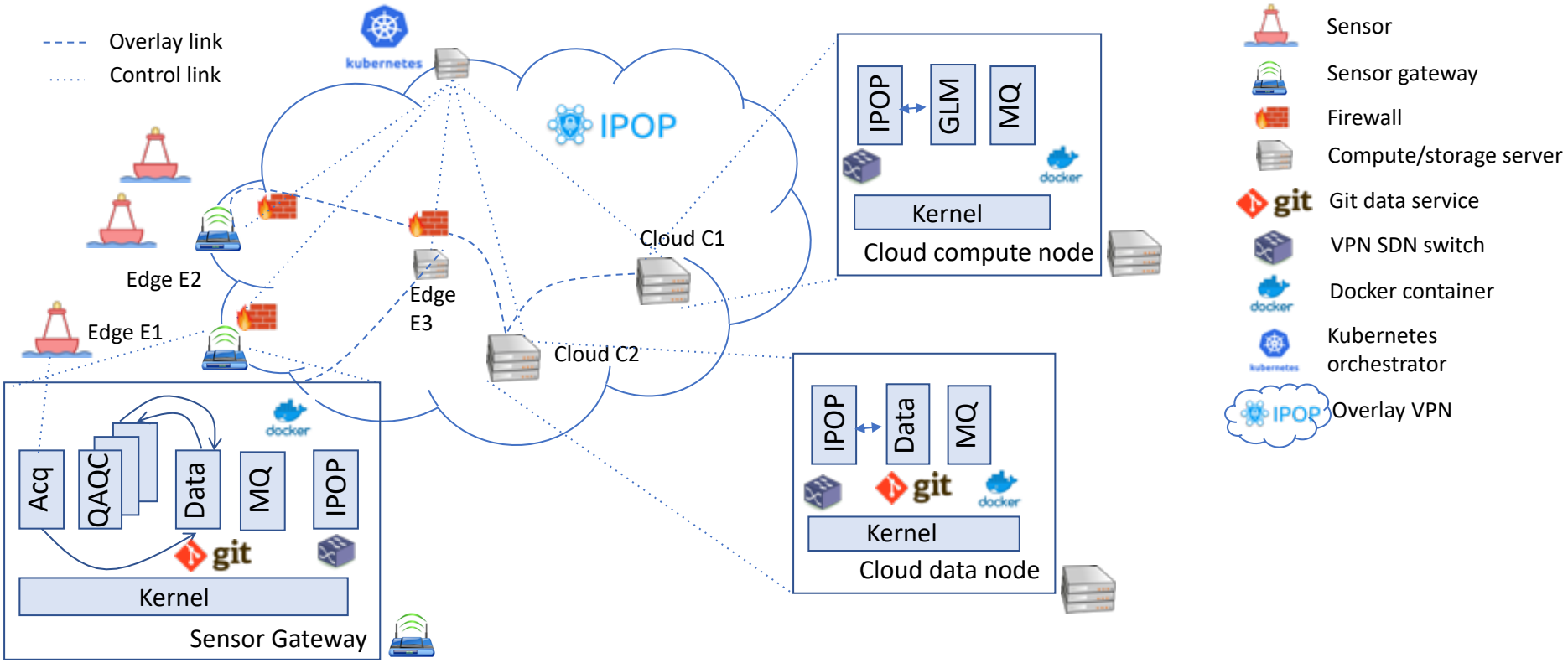
PRAGMA 34, Jeju

Sensor Gateway Design

- Fanless mini-PC, open-source software
- Reads/stores data from logger (Campbell)
- Security, NAT traversal:
  - Connects to IPOP overlay VPN via 4G cellular link
  - Data publishing, remote maintenance
- Pushes data updates (diffs) to private and/or public repository using git



Towards Event-driven Edge Computing Platform



Figueiredo et al., in prep.

Can we use Renato's CI "glue" to generate real-time forecasts for drinking water managers?

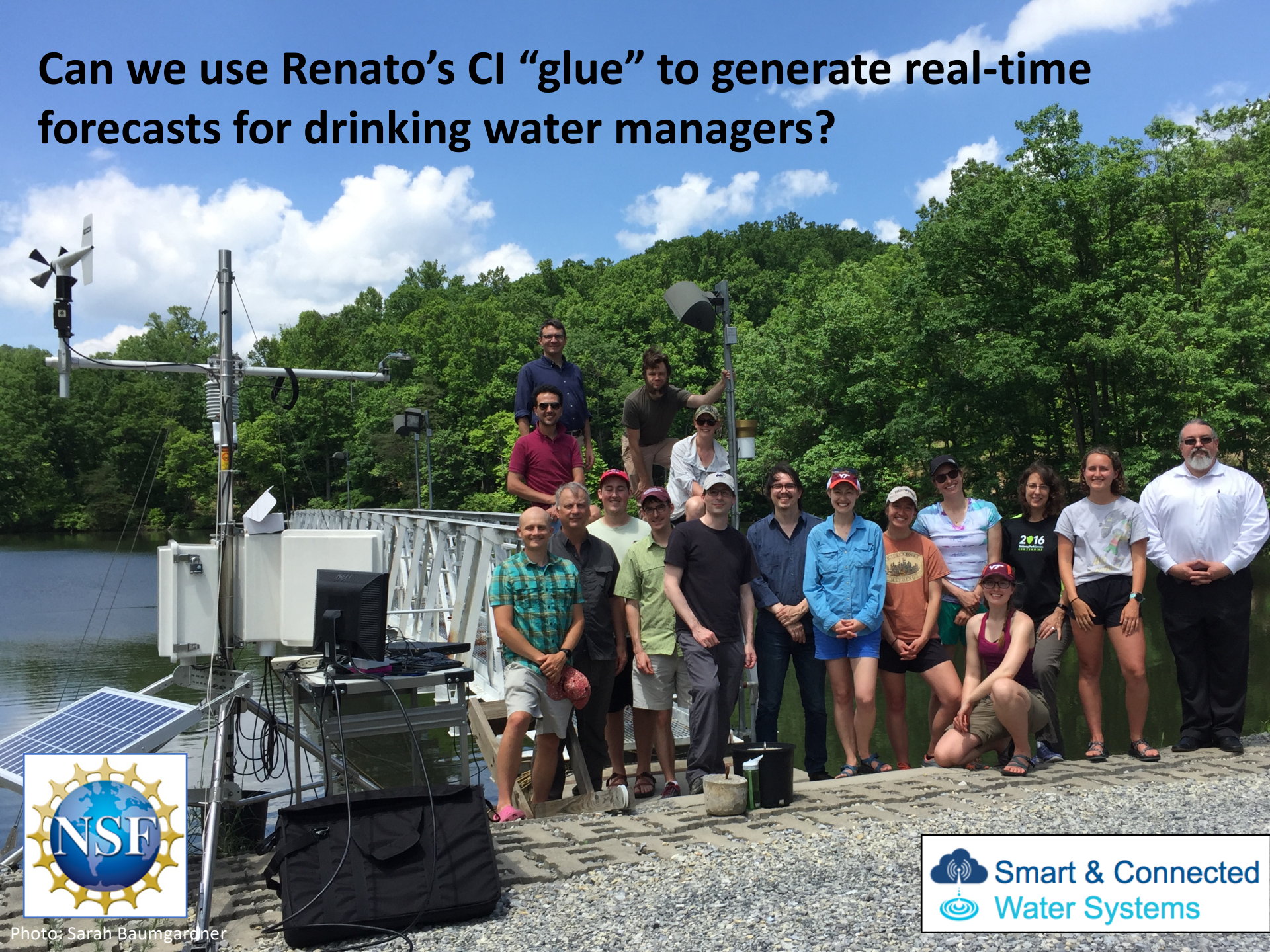
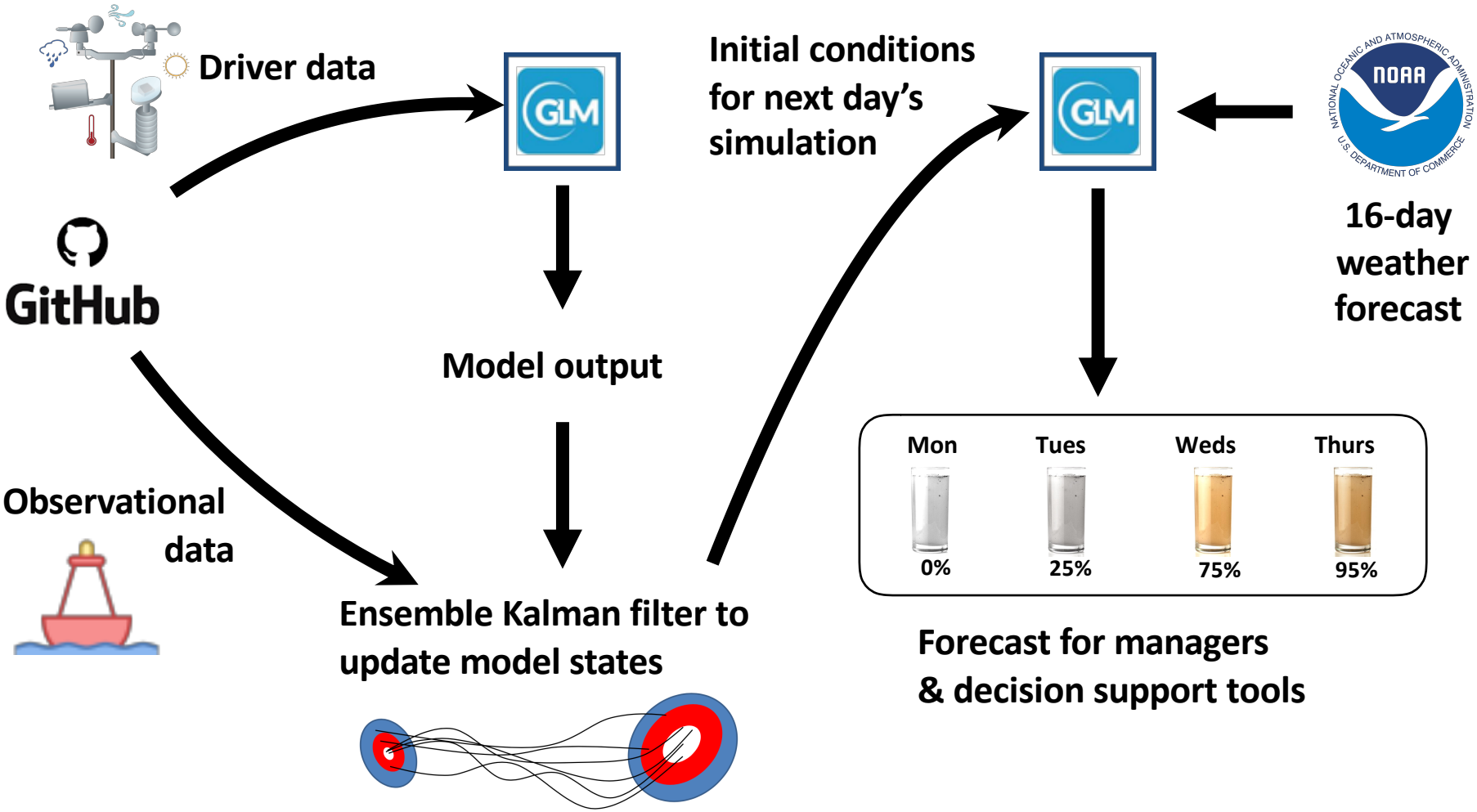


Photo: Sarah Baumgardner

Smart & Connected Water Systems

Smart Reservoir forecasting workflow



Adaptation: Thomas et al., in prep.; Images: A Fowler, Wellograph

High iron water quality impairment event predicted 8 days in advance in October 2018

Photo Credit: Bethany Bookout

Search or jump to... / Pull requests Issues Marketplace Explore

CareyLabVT / SCCData

Unwatch 2 Star 0 Fork 0

Code Issues 0 Pull requests 0 Projects 0 Wiki Insights Settings

Sensor data for SCC project

Edit

Manage topics

121 commits 14 branches 0 releases 3 contributors

Branch: diana-data New pull request Create new file Upload files Find File Clone or download

This branch is 12 commits ahead of master. Pull request Compare

vahid-dan 04/25/19 06:37:38 EST -0500: Git Backup Latest commit c41150f 13 hours ago

FCRweir.csv	04/25/19 06:37:38 EST -0500: Git Backup	13 hours ago
README.md	Initialize Branch	22 days ago

README.md

SCCData/diana-data

SmartReservoir.org

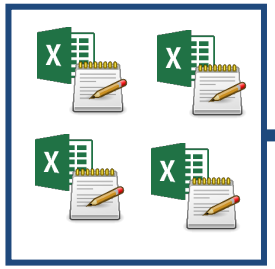
Data for SCC

GRAPLEr in action

Get response variables from 1000s of simulations, visualize output, and repeat

R + GRAPLEr

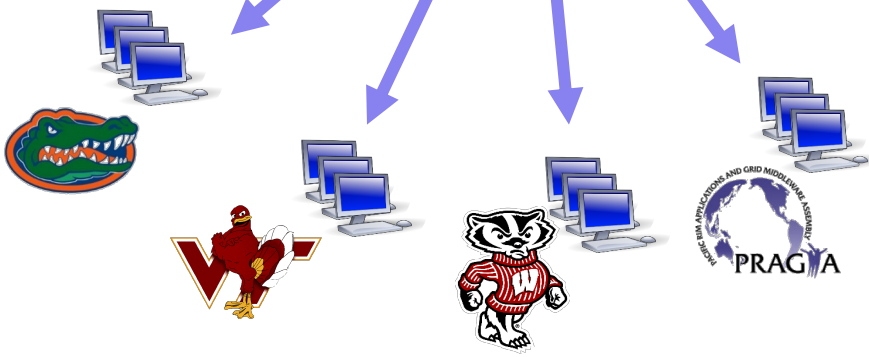
Specify range of GLM simulations



GRAPLEr creates new driver files for each simulation…

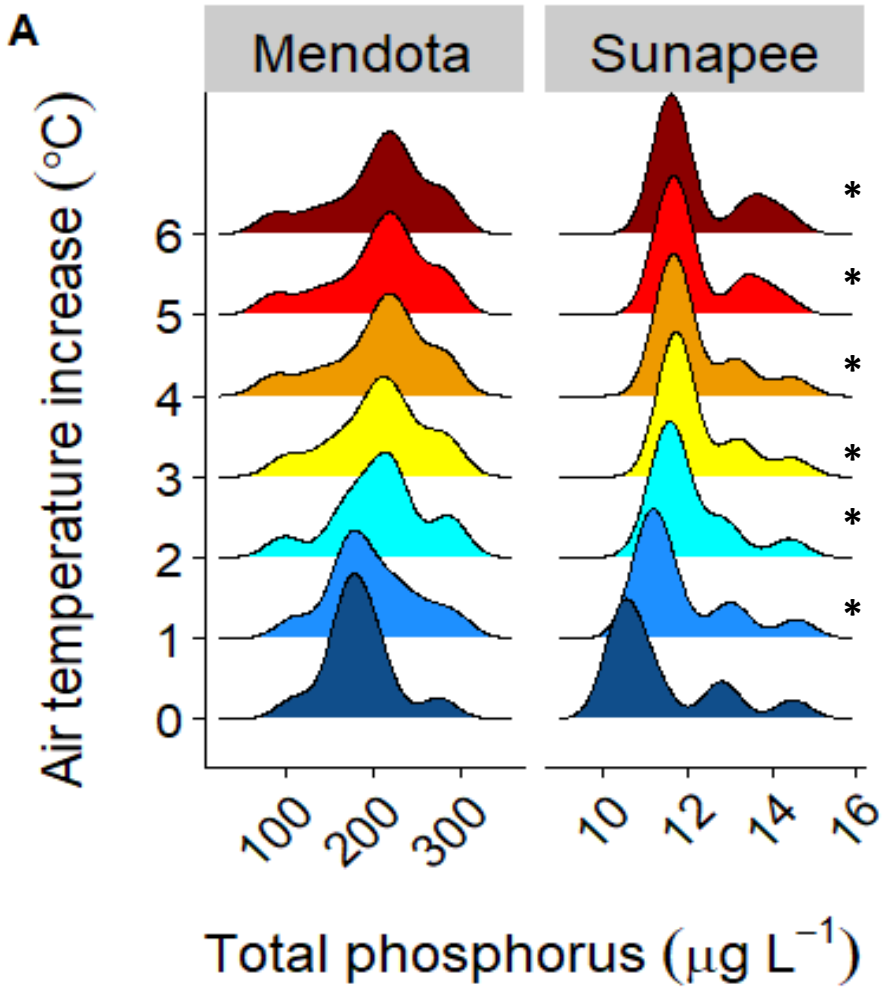
…then uses the cloud to distribute simulations to many computers

You + a computer



Subratie et al. 2017

Increasing air temperatures differentially alter nitrogen and phosphorus cycling in a eutrophic and an oligotrophic lake

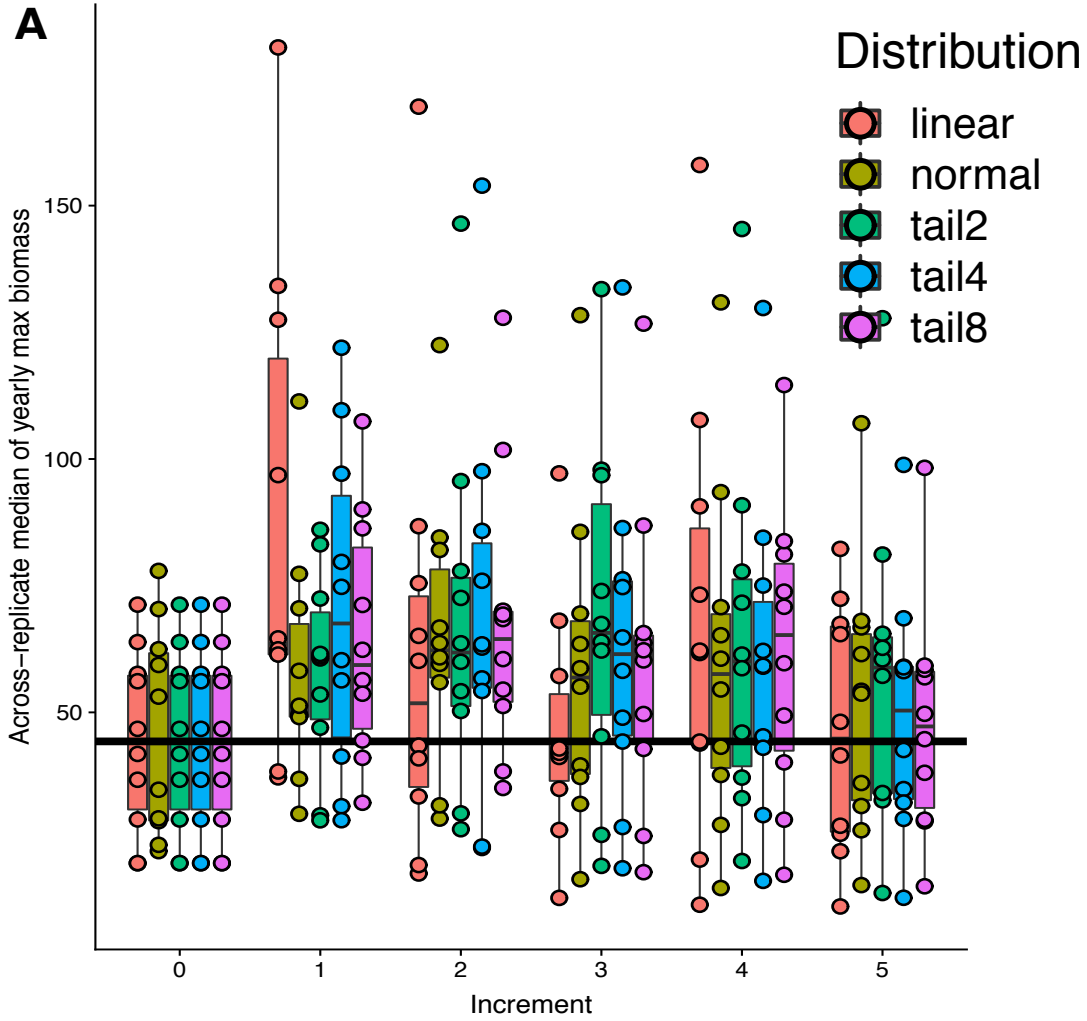


Lake Mendota

Lake Sunapee

Farrell et al., in prep.

Using different temperature distributions for climate scenario modeling alters predictions of future algal biomass



Krinos et al., in prep.

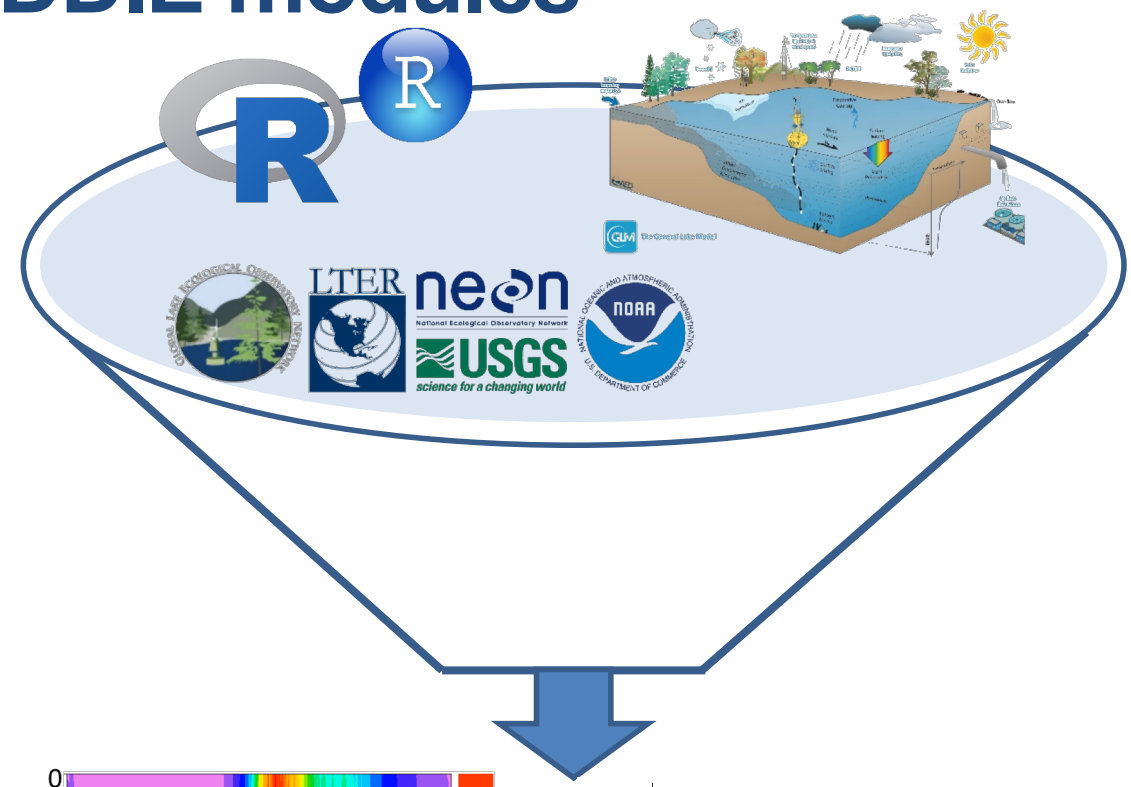
Teaching IPOP in ecology classrooms via Macrosystems EDDIE modules

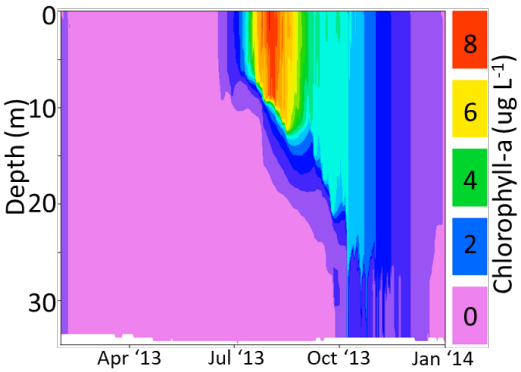
Flexible & adaptable

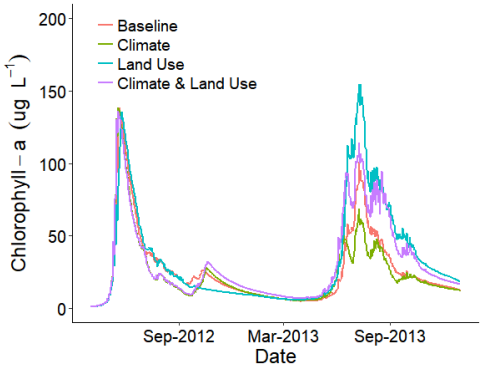
- A-B-C structure
- Plug and play

Tools we use

- R + RStudio
- GLEON sensor data
- Lake simulation models (GLM)
- Distributed computing via GRAPLEr

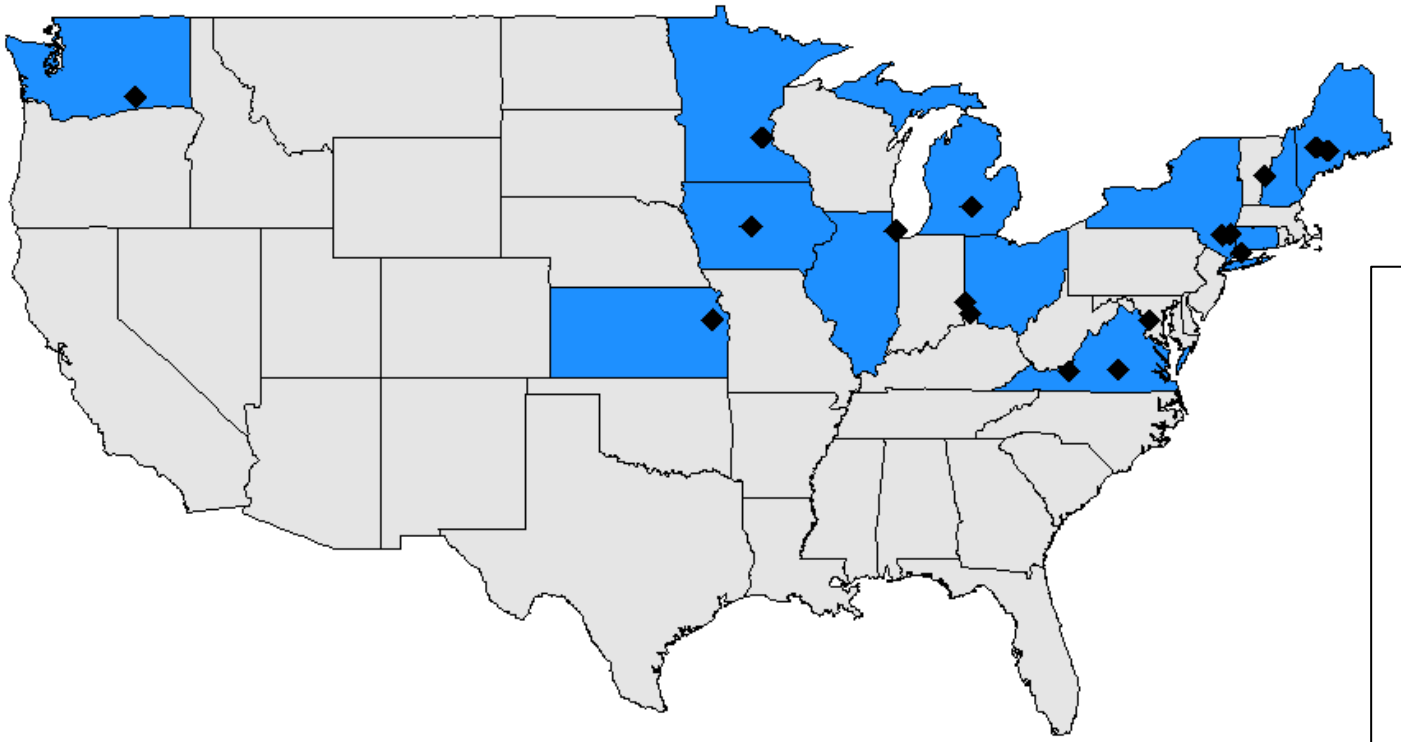


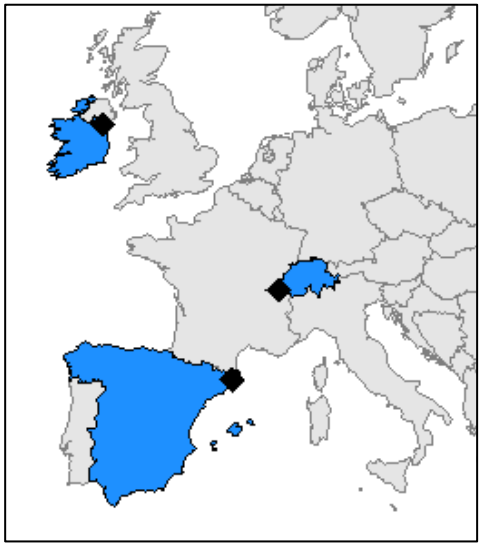




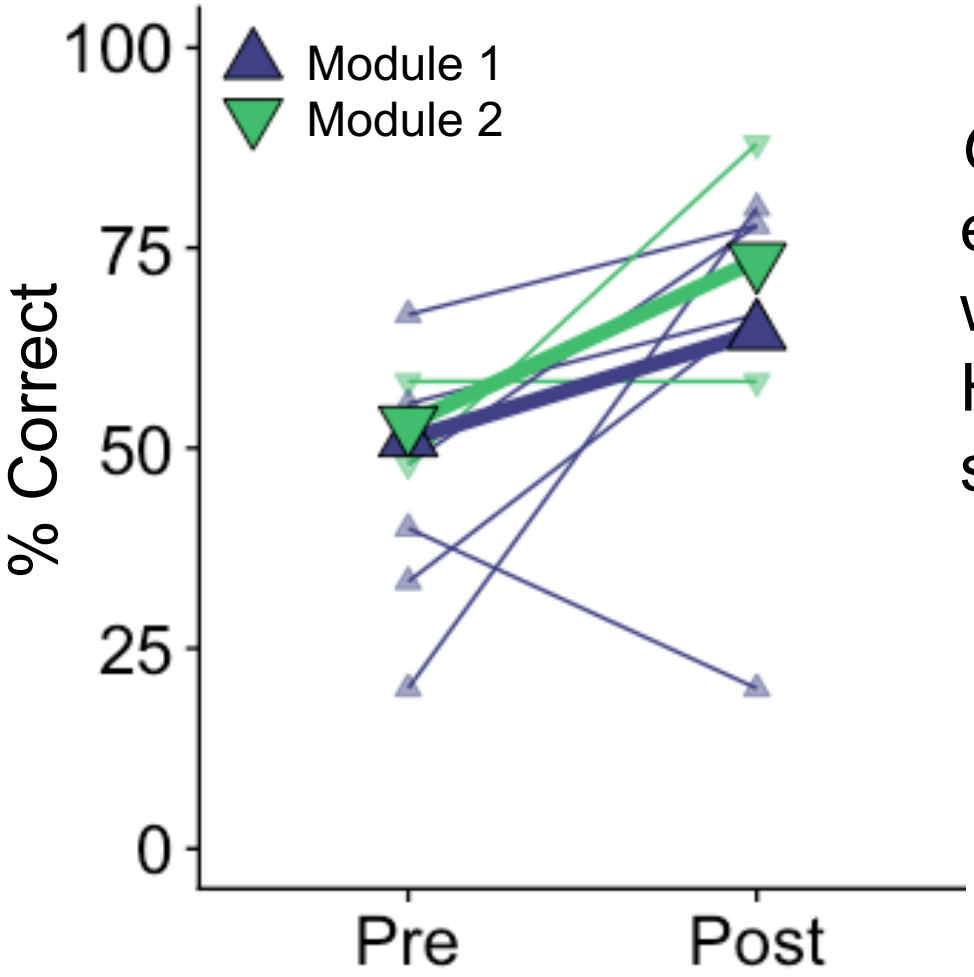
Module student participants: 2017-2018

- >1000 students in total; first-year undergraduates to master's students
- 24 institutions; associate's colleges to R1 universities





GRAPLEr modules enable significant student gains in understanding climate change

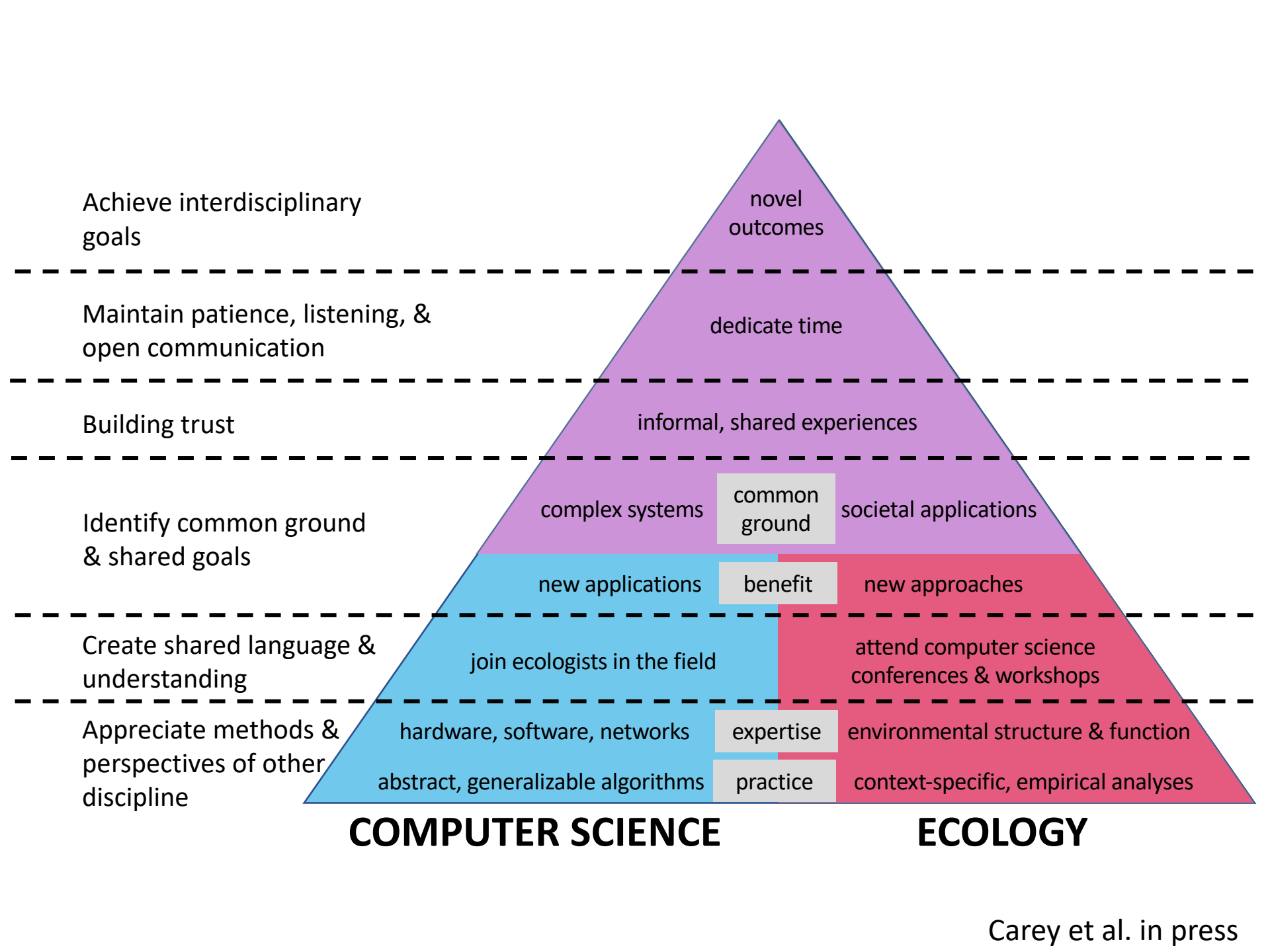


Question: You force a lake ecosystem model with +3°C warmer air temperatures. How will lake thermal stratification respond?

Enhancing collaboration between ecologists and computer scientists: lessons learned and recommendations for a path forward

Cayelan C. Carey[1]†, Nicole K. Ward[1], Kaitlin J. Farrell[1], Mary E. Lofton[1], Arianna I. Krinos[1], Ryan P. McClure[1], Kensworth C. Subratie[2], Renato J. Figueiredo[2], Jonathan P. Doubek[1], Paul C. Hanson[3], Philip Papadopoulos[4], Peter Arzberger[5]

IN PRESS!



Carey et al. in press

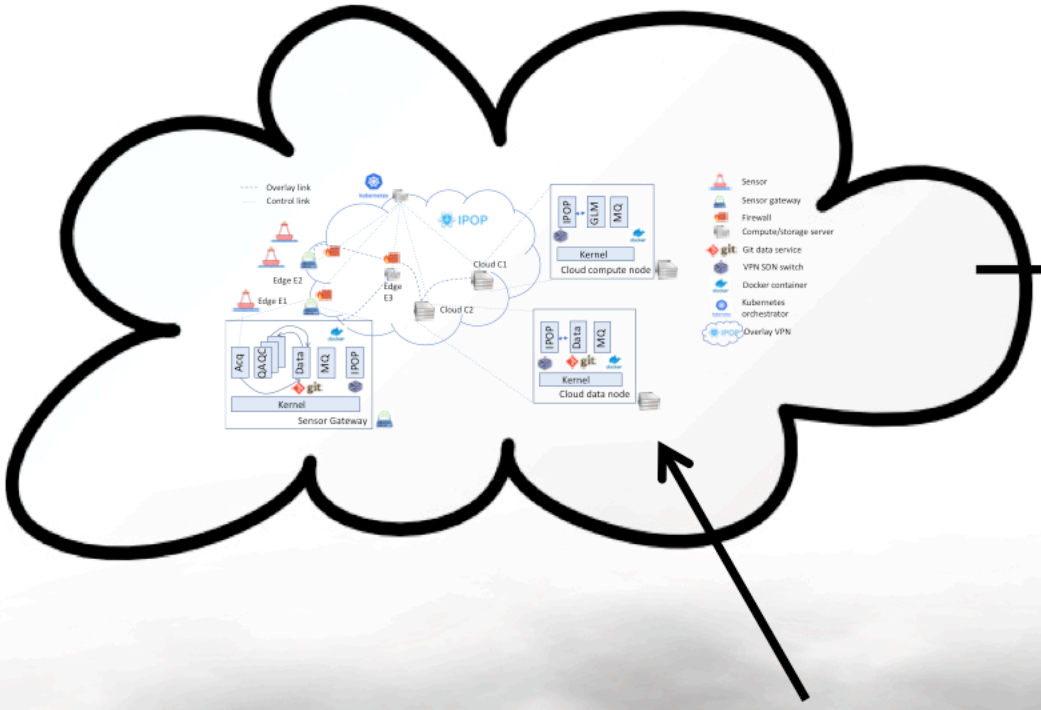
Ways in which the PRAGMA Lake expedition has enabled novel freshwater ecology

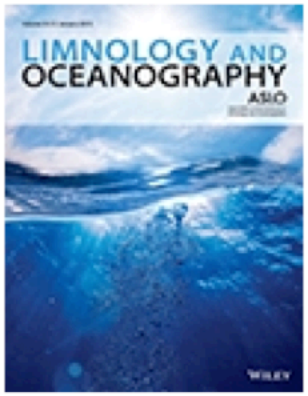
- Science:
  - Addressing new research questions because of new approaches
- Training:
  - 1000s of ecology undergrads have learned how to program in R, use GRAPLEr, and apply new computational tools
  - 11 PhD & MS students have used cyber-enabled tools developed in this project for their research
- Developing the framework for future CS-ecology collaborations!

Next steps in GRAPLE-land

- Interdisciplinary training at the intersection of computer science, freshwater ecology, and data science
  - Engaging UGs, grads, and postdocs in diverse GRAPLE collaborative environment
  - Expanding to students who don't have access to cyberinfrastructure and associated expertise
- Interdisciplinary research tackling multiple projects
  - Scaling existing cyberinfrastructure to new GLEON sites
  - Simulating water quality dynamics in a broad range of lakes at large spatial scales
  - Expand capacity of GRAPLEr to facilitate running a suite of different models in the R environment

GRAPLE - Global Artificial Intelligence and forecasting data assimilation using an IPOP overlay network in a distributed cloud computing cyber-infrastructure (GAIFDAiPOPoNDCCC, (pronounced, 'GRAPLE Gayf di pop on da kuh kuh kuh'))





Thank you!

GRAPLEr team & PRAGMA Lake Expedition contributors:
Ken Subratie, Saumitra Aditya, Srinivas Mahesula, Jaikrishna Sukumar, Hari Sundararaman, Phil Papadopoulos, Peter Arzberger, Kait Farrell, Jon Doubek, Mary Lofton, Ryan McClure, Arianna Krinos

Data Providers: Lake Sunapee Protective Association, GLEON, North Temperate Lakes LTER, USGS

Funding: Supplement to NSF ACI-1234983