

Photosynthetic acclimation to global change: improved understanding for more reliable predictions

Nick Smith

Lizz Waring, Evan Perkowski, Alissar Cheaib, Helen Scott, Zinny Ezekannagha

Isa Beltran, Dinah Borus, Kelly Carroll, Snehanjana Chatterjee, Jeff Chieppa, Rafael Freitas, Eve Gray, Monika Kelley, Risa McNellis, Brad Posch

Texas Tech University

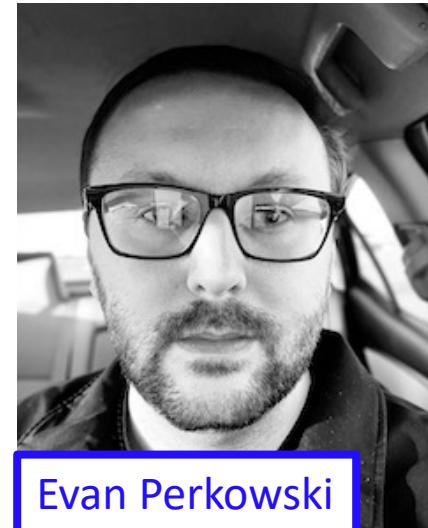
nick.smith@ttu.edu

Thank you

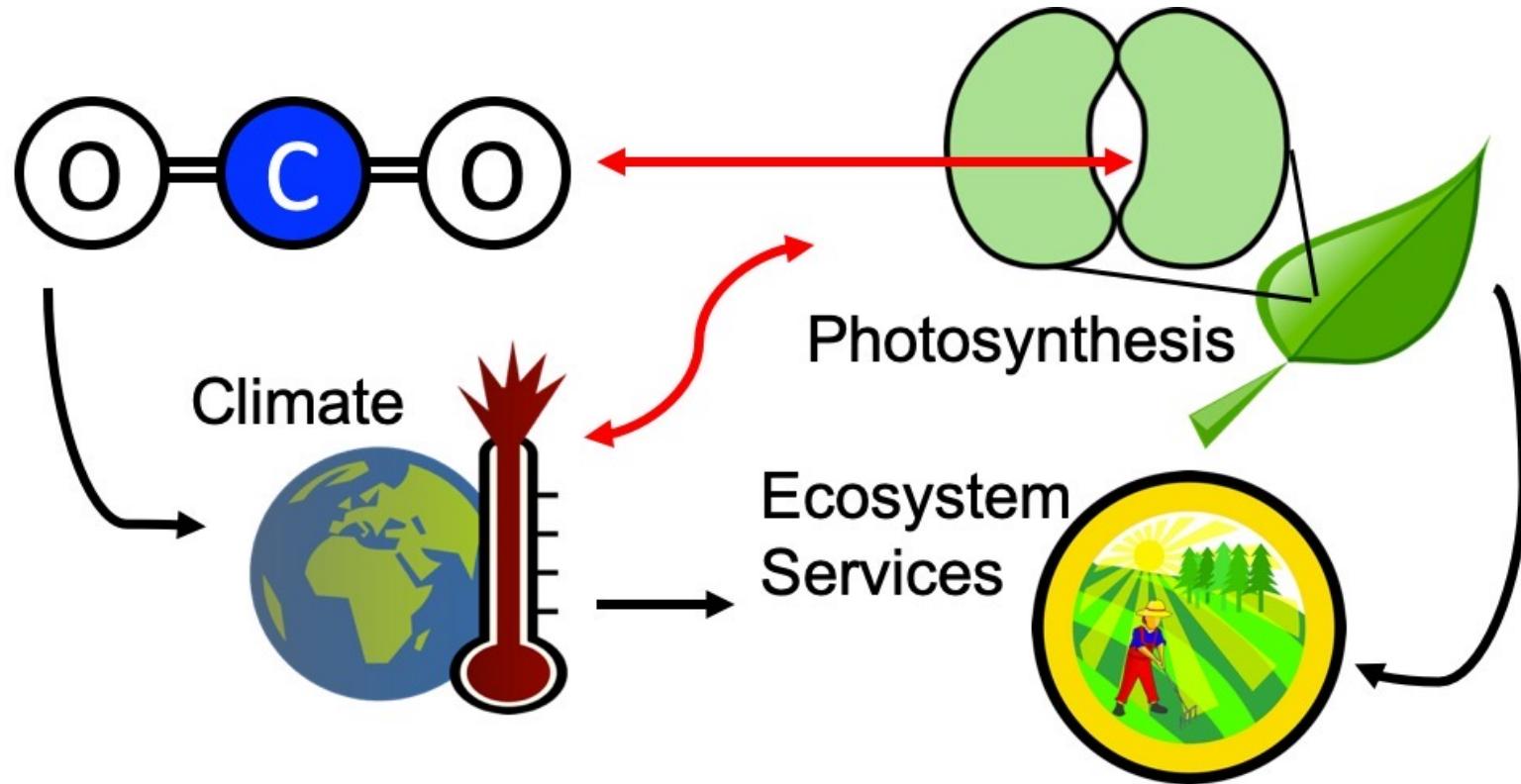
ECOLOGICAL SOCIETY OF AMERICA



- ESA for selecting me as an Early Career Fellow
- Our amazing lab and scientific network
- Lizz Waring, Evan Perkowski, Jeff Chieppa, & Jeff Dukes (ECF nominators)



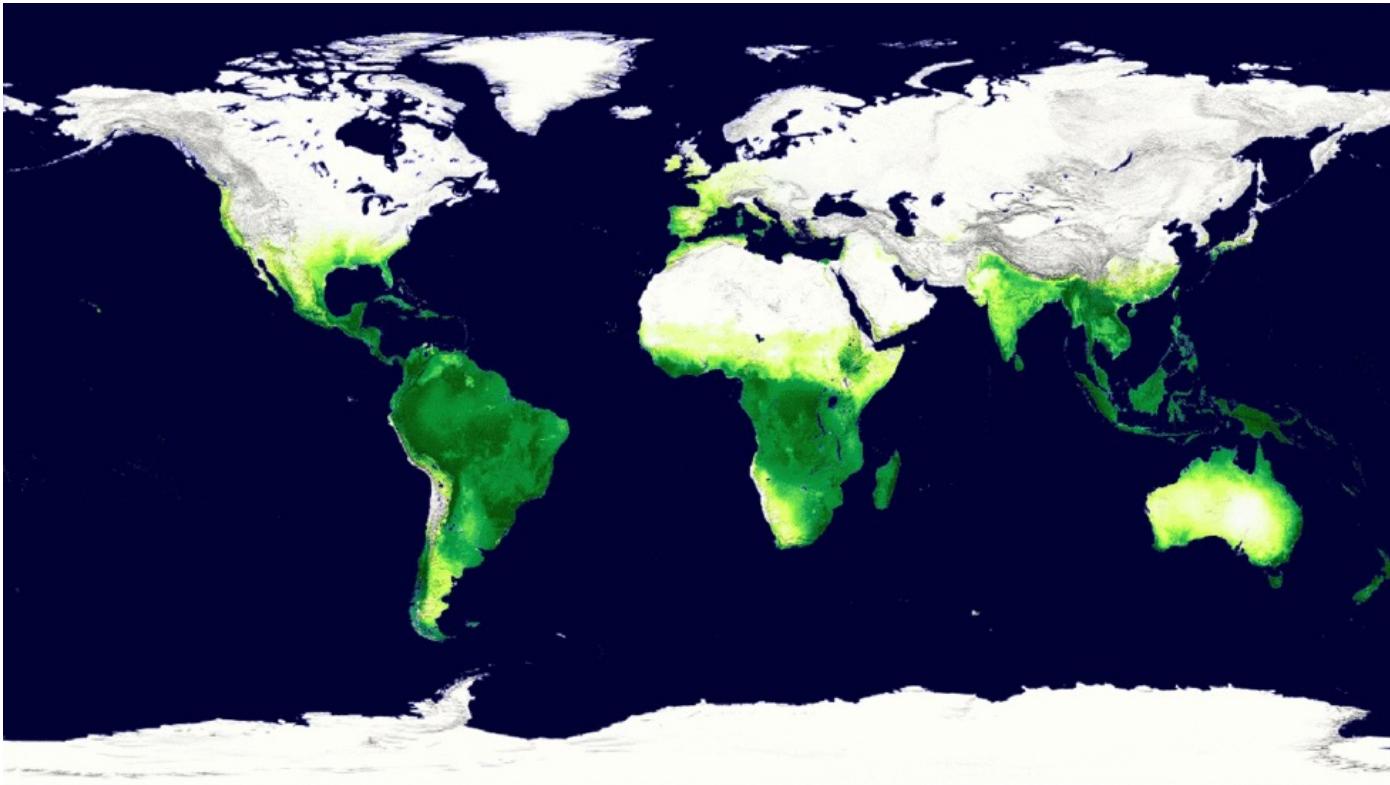
Our lab examines **photosynthesis** as a regulator of global change impacts on ecosystem services



Photosynthesis provides the foundation for other services

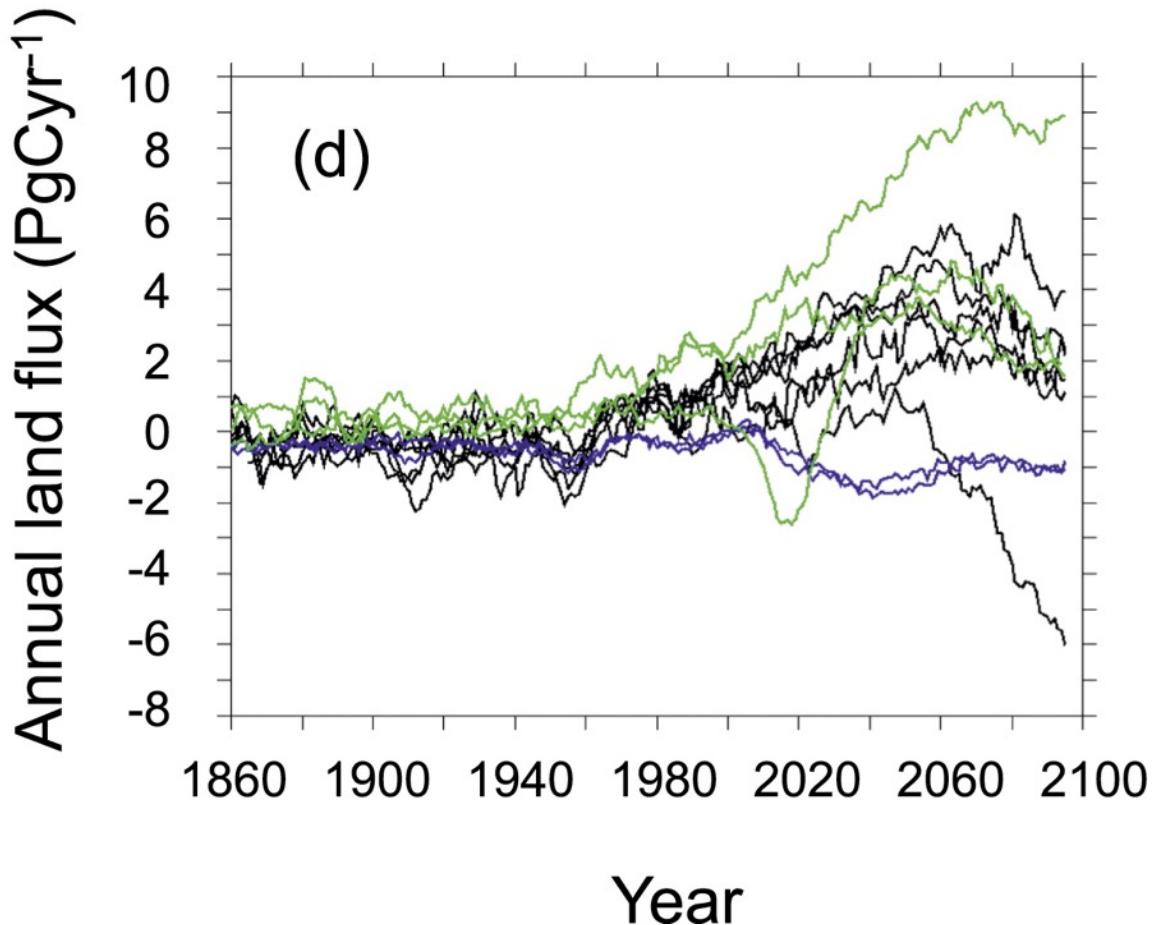


Photosynthesis is a dynamic process that is likely to be impacted by global change

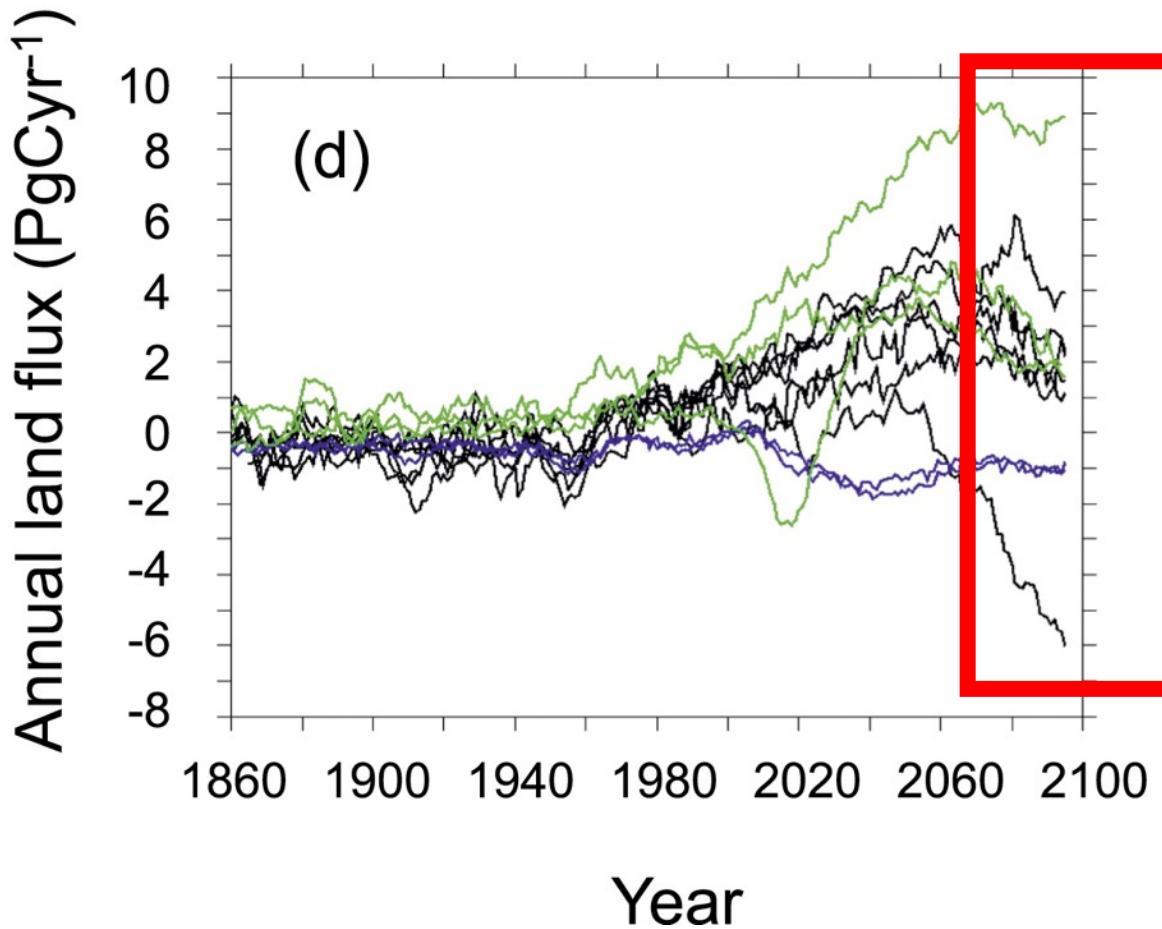


MODIS, NASA

But predictions are uncertain!

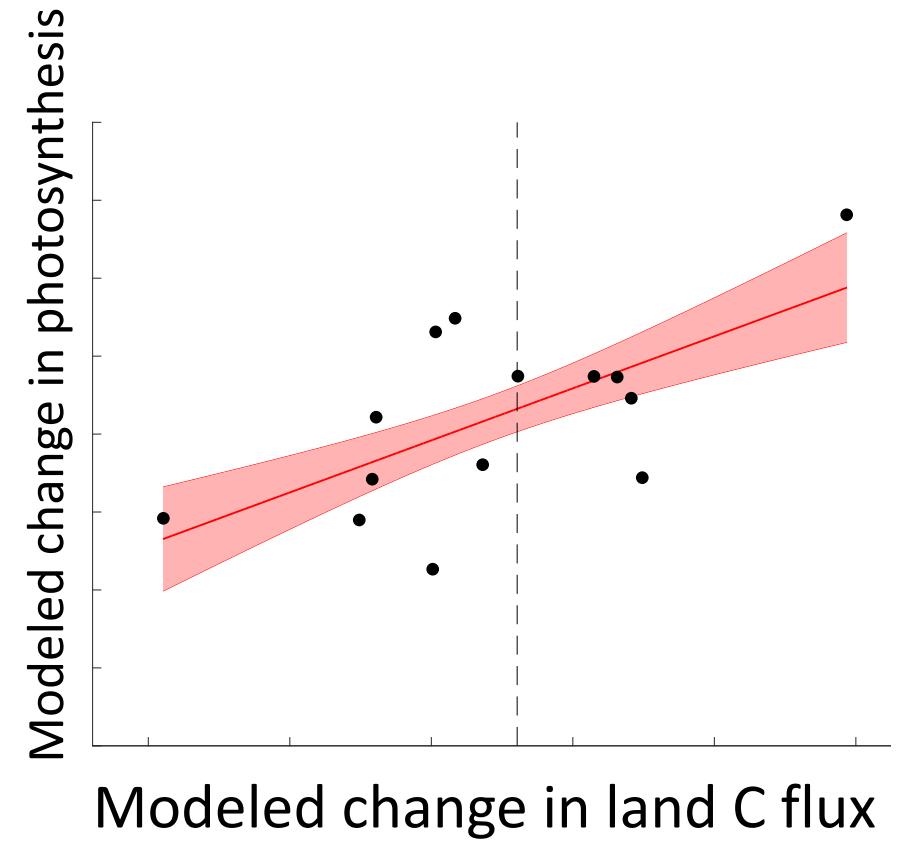
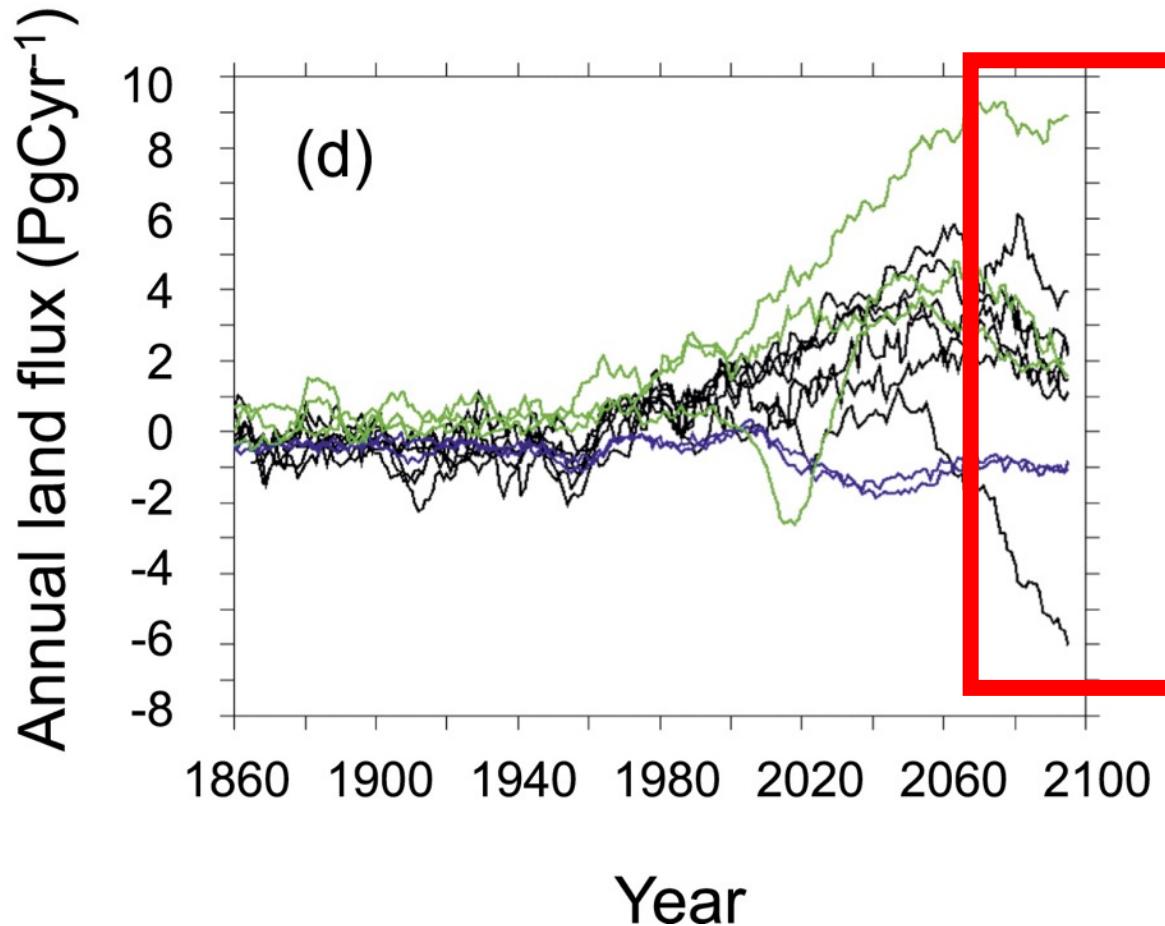


But predictions are uncertain!

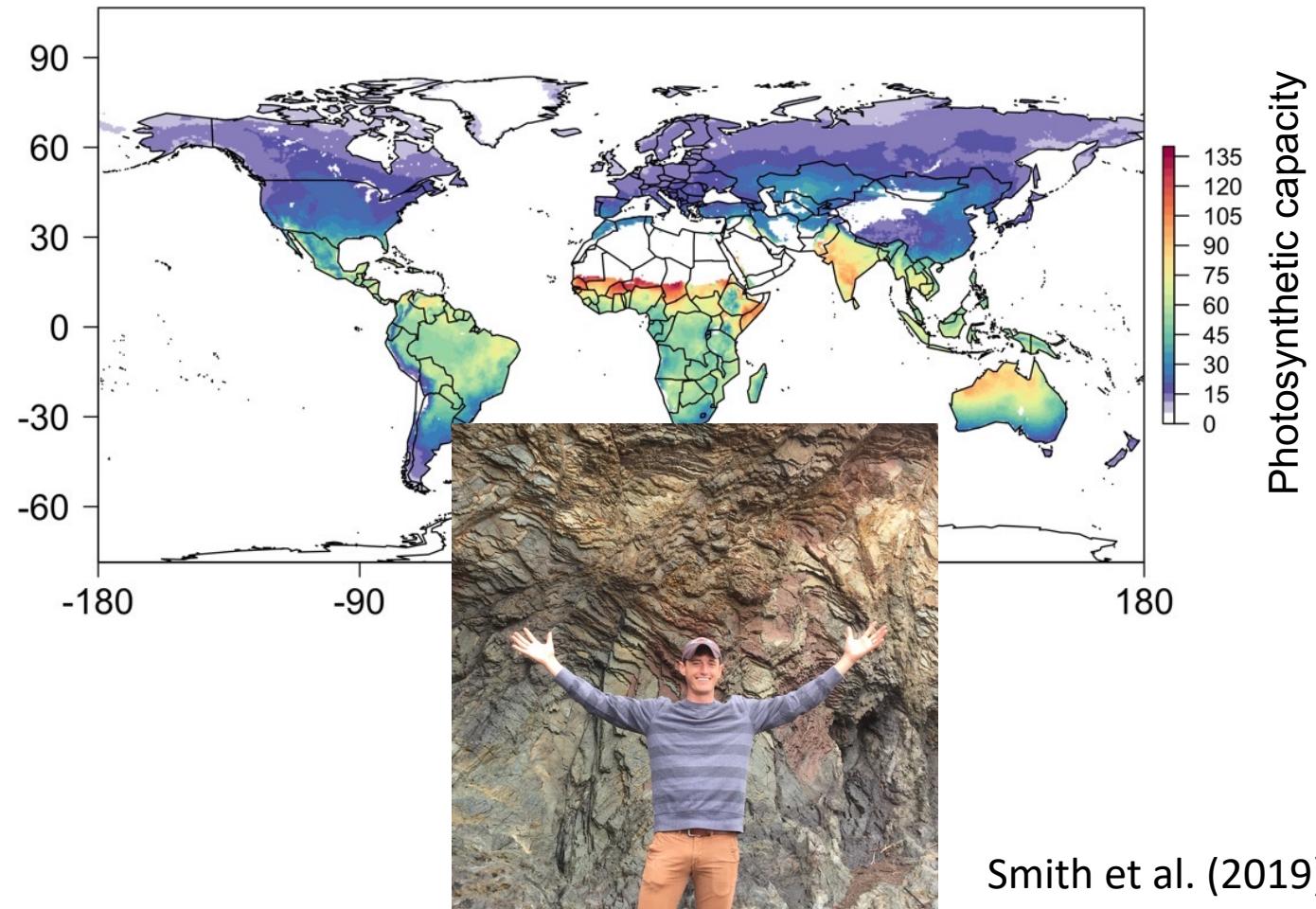
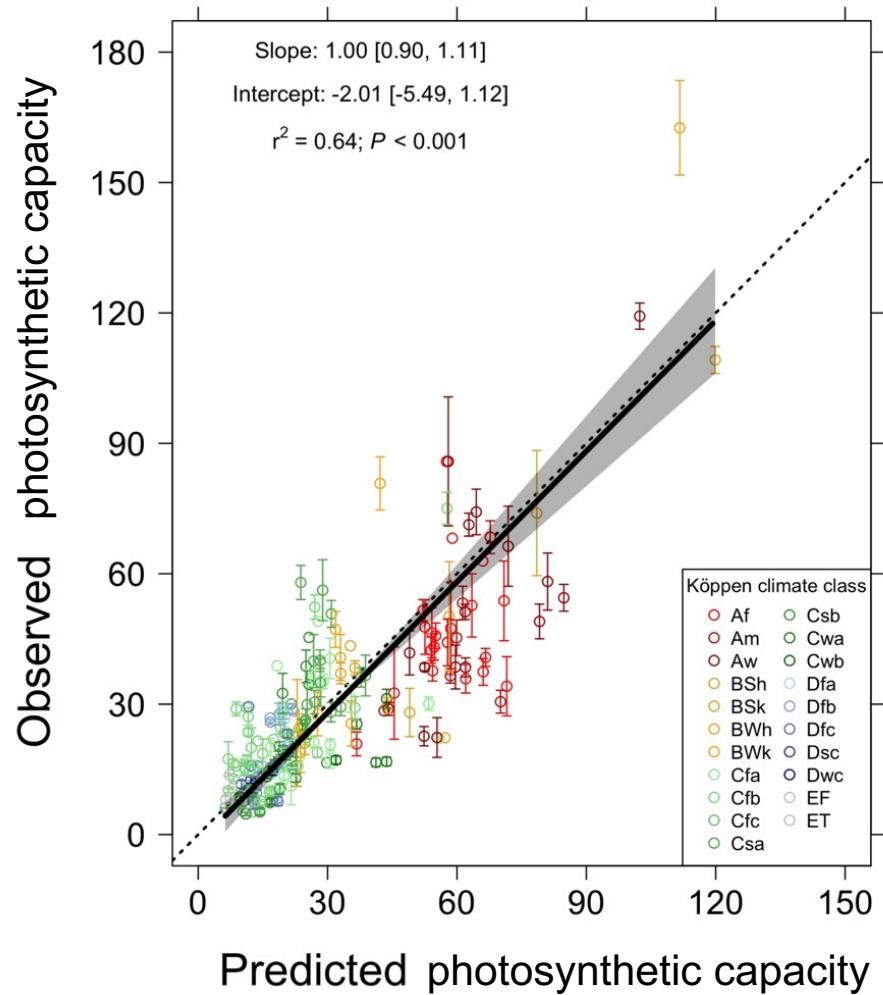


Future model uncertainty (14 Pg) > current fossil fuel emissions (9.5 Pg)

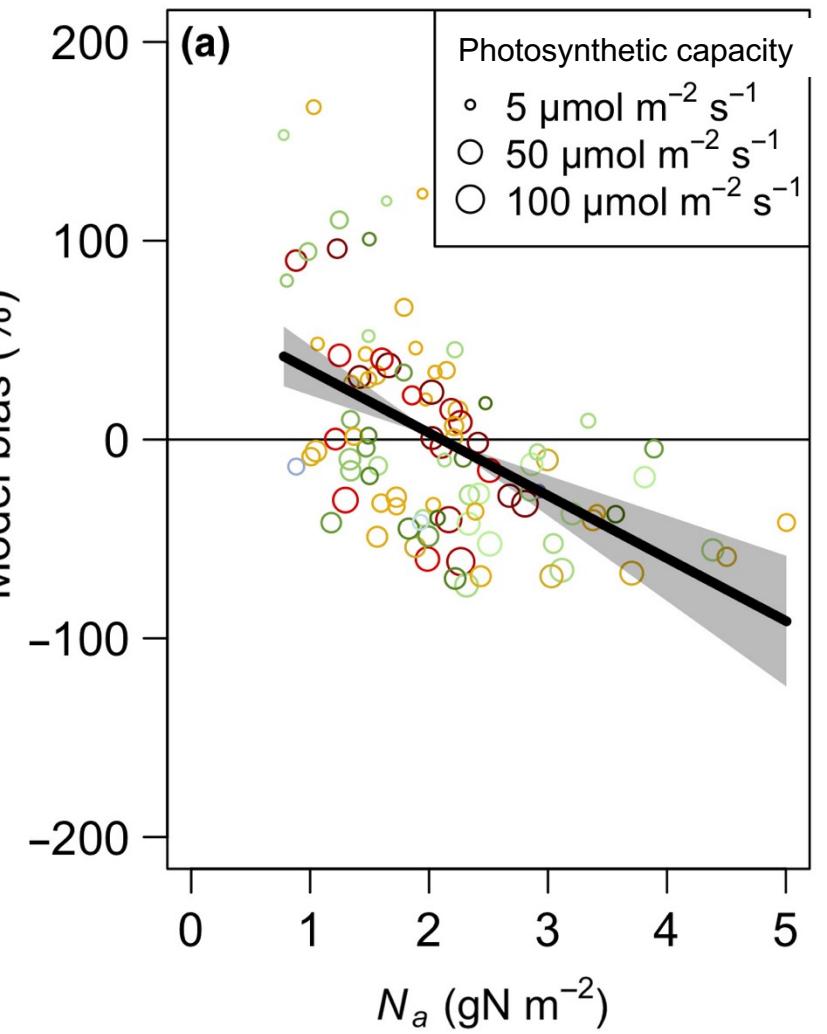
This uncertainty is driven by uncertainty in photosynthesis



When starting the lab in 2017, I “knew” I had the answer!



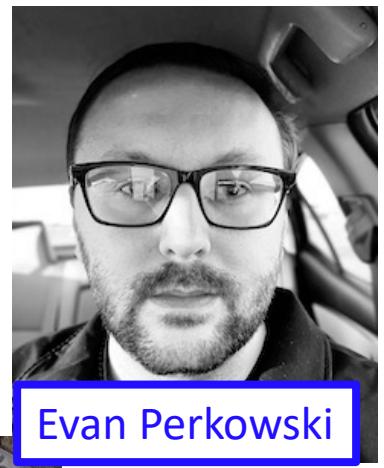
Not everyone agreed



Questioning Nick's worldview



Lizz Waring



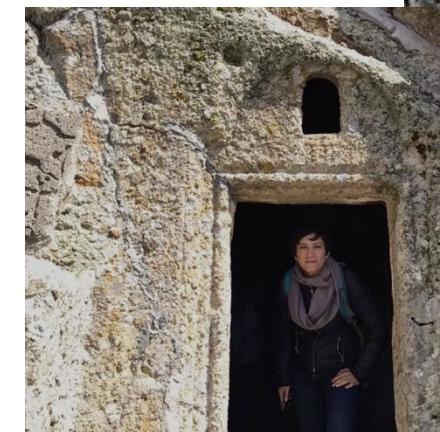
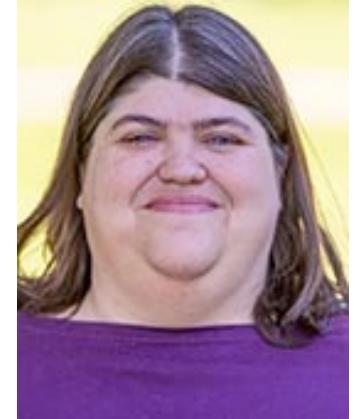
Evan Perkowski



Alissar Cheaib

Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven



Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!



Lizz Waring

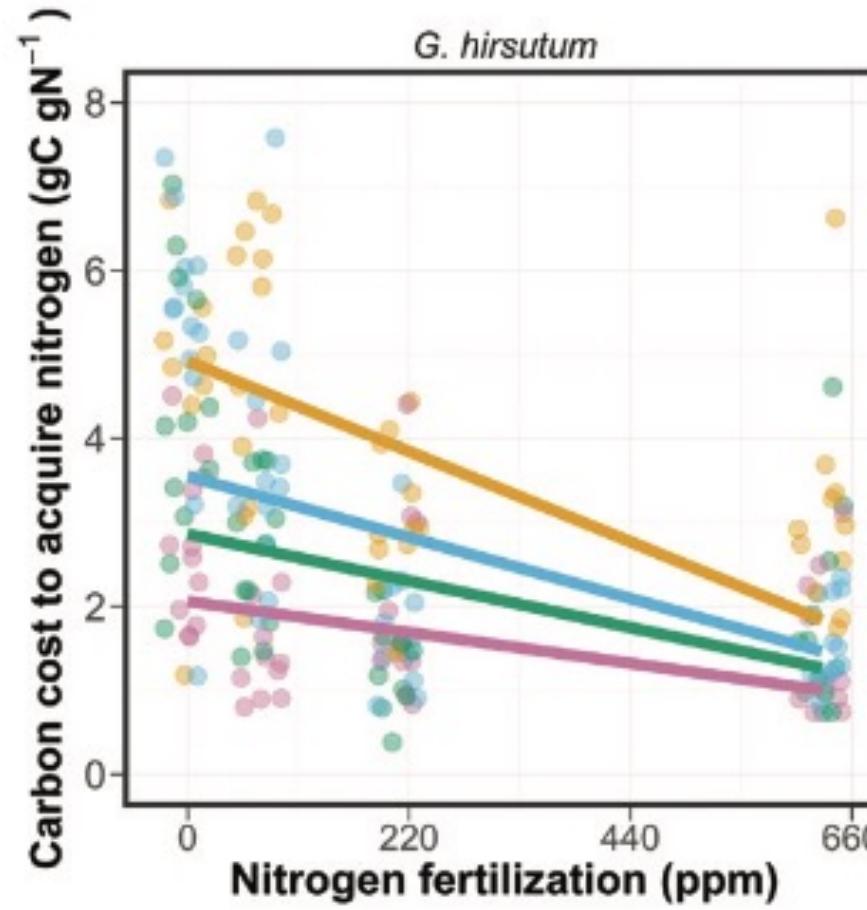


Evan Perkowski



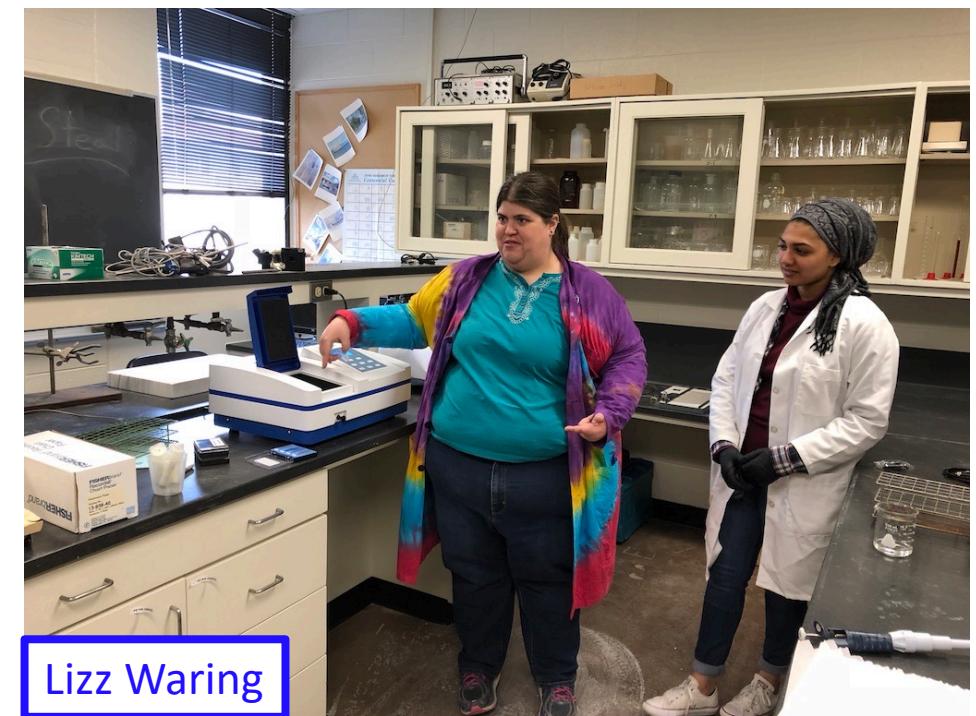
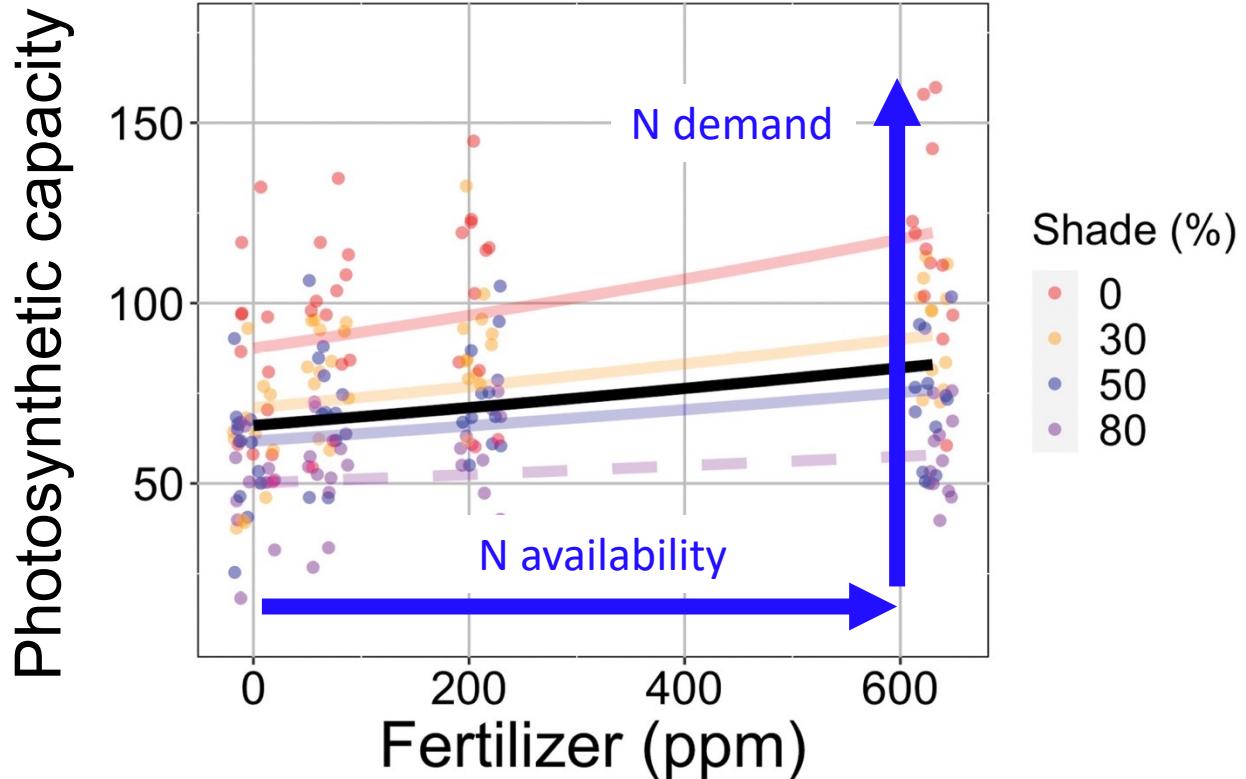
Alissar Cheaib

Scientific lesson: nutrient availability reduces carbon costs to acquire them



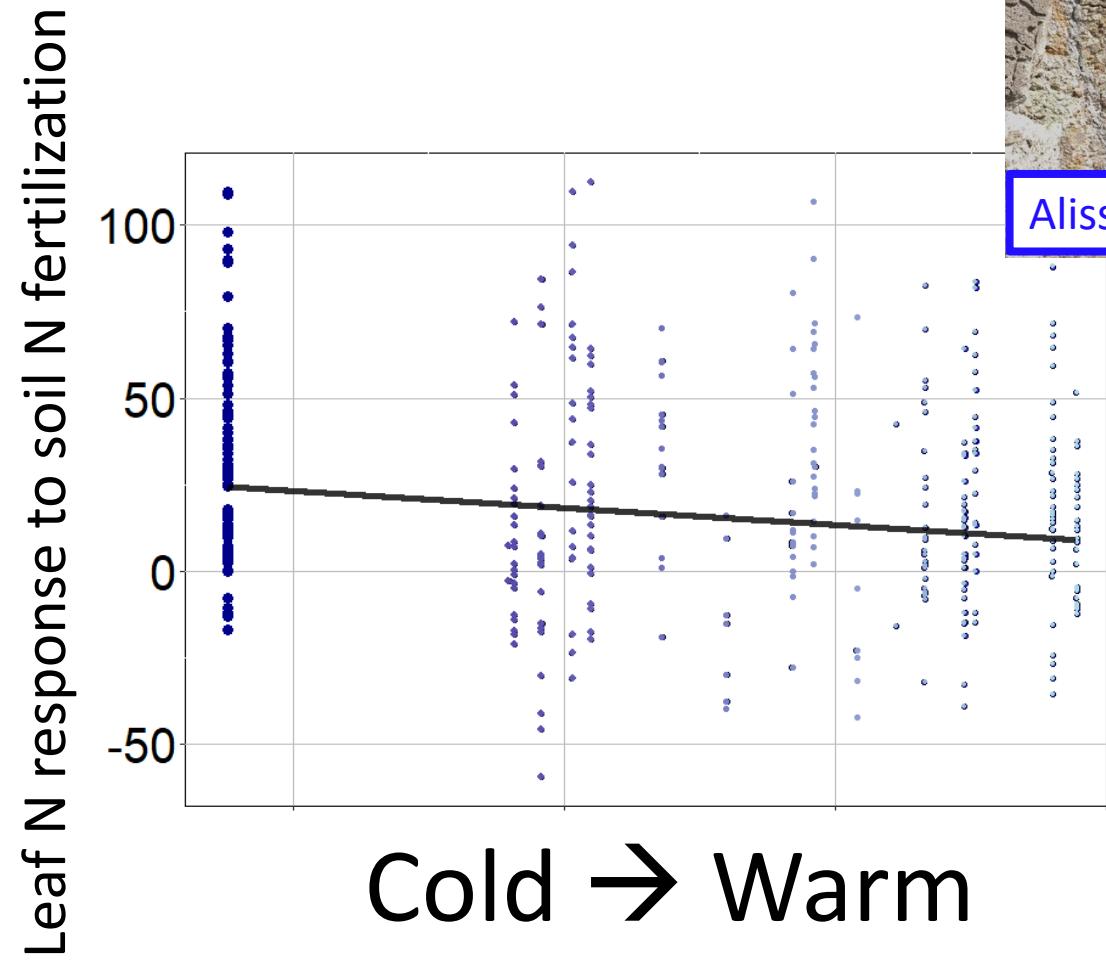
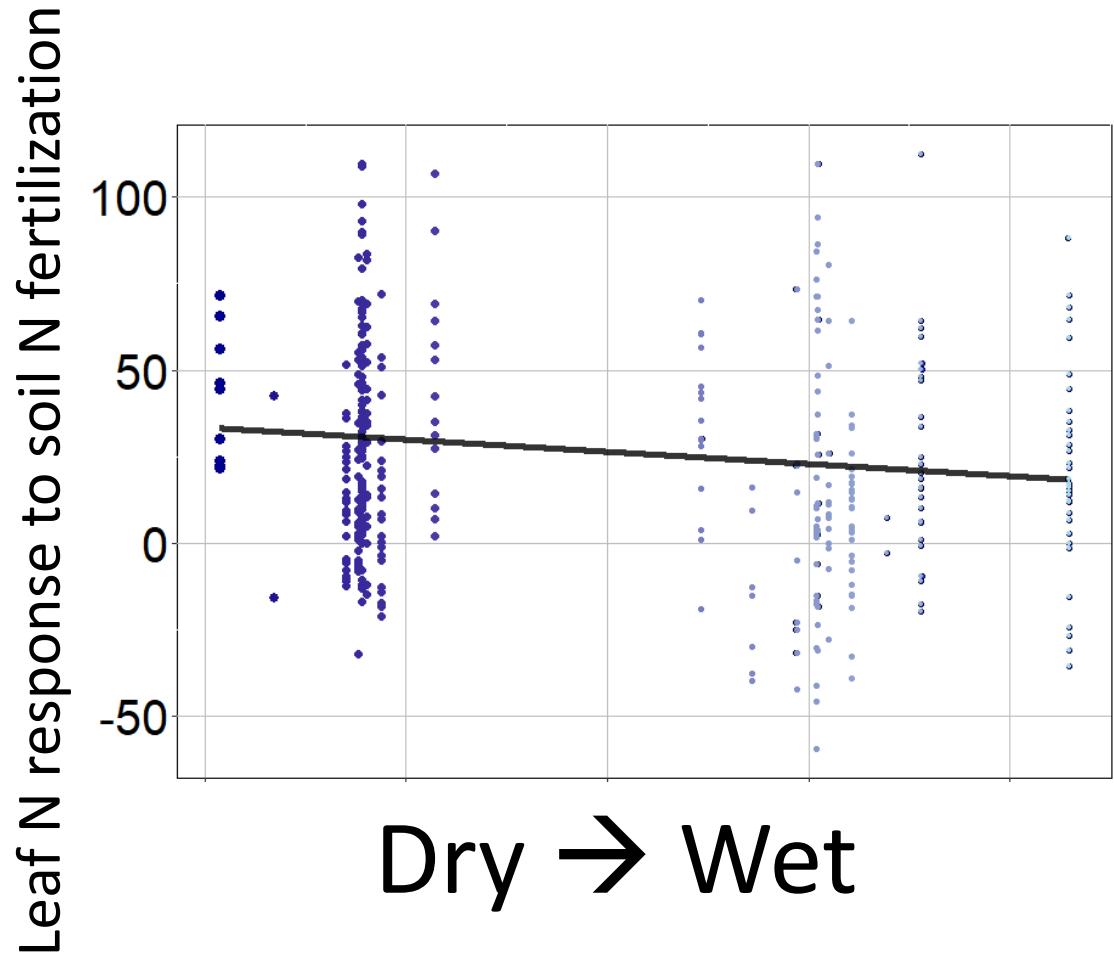
Evan Perkowski

Scientific lesson: nutrient availability and nutrient demand drive photosynthetic capacity



Lizz Waring

Scientific lesson: nutrient demand increases responses to nutrient availability



Scientific lesson: nutrient demand increases responses to nutrient availability



Session: Biogeochemistry (Latebreaking)

LB 5-41 - Integrating data and theory to understand leaf-level nitrogen responses to soil nitrogen

ΔN_{mass}

Thursday, August 10, 2023

5:00 PM – 6:30 PM PDT

Location: ESA Exhibit Hall

Presenting Author(s)

Alissar Cheaib

AC

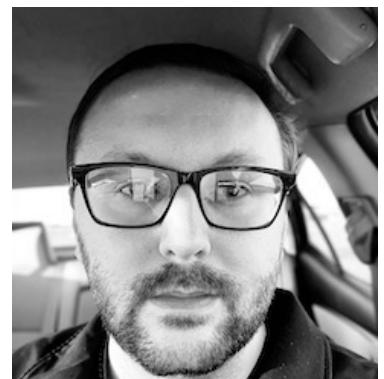
Postdoctoral research associate
Texas Tech University
Lubbock, Texas, United States

Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!
- Nick: plants uptake nutrients to meet photosynthetic demand



Lizz Waring



Evan Perkowski



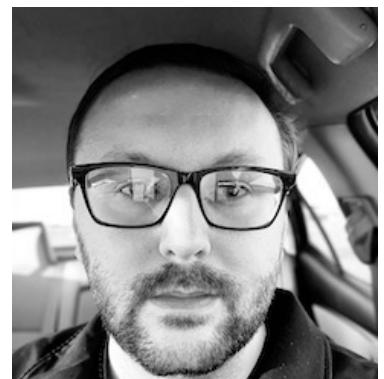
Alissar Cheaib

Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!
- Nick: plants uptake nutrients to meet photosynthetic demand
 - Others: plants uptake nutrients for lots of other things!



Lizz Waring

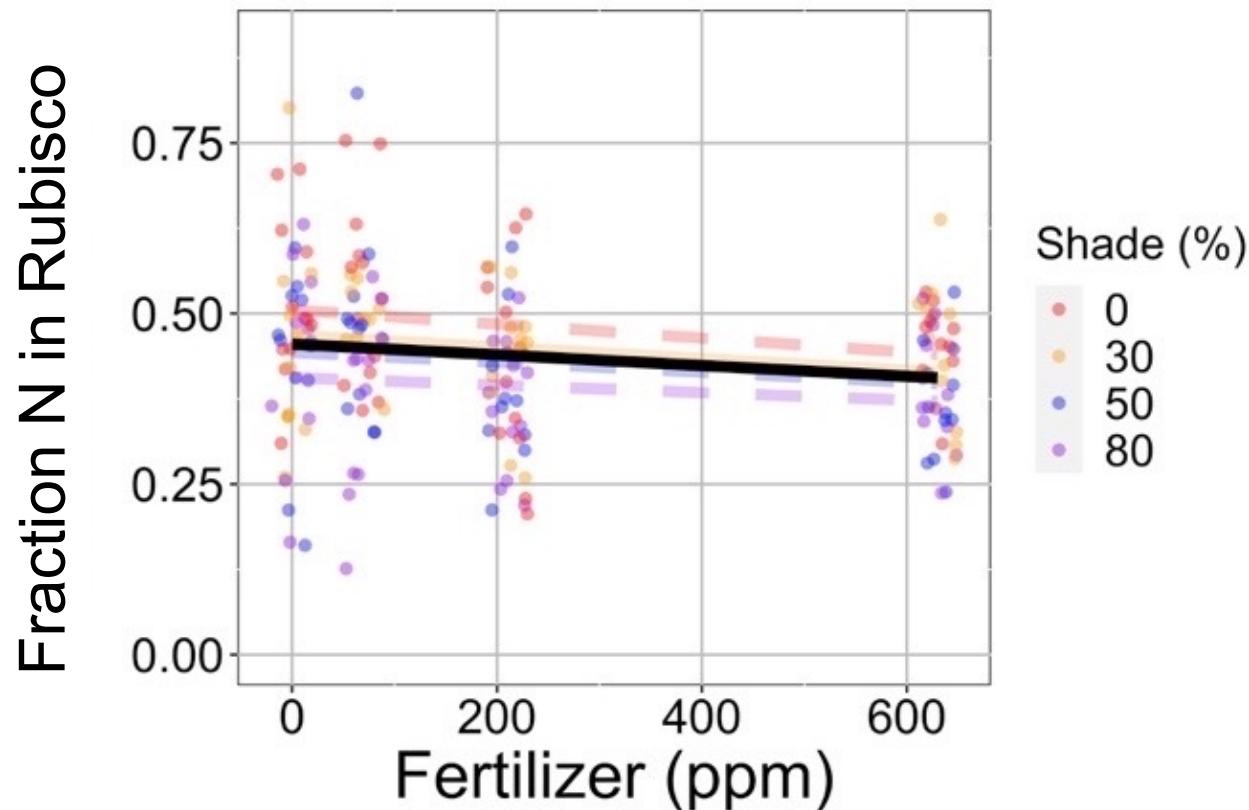


Evan Perkowski



Alissar Cheaib

Scientific lesson: nutrient availability doesn't just influence photosynthesis

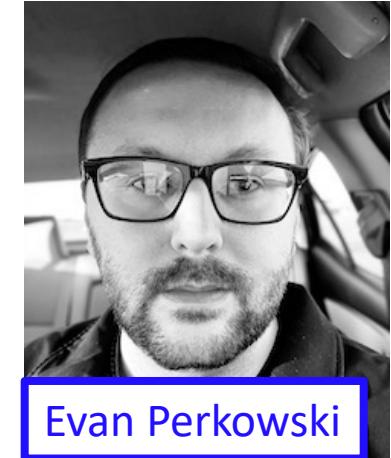


Lizz Waring

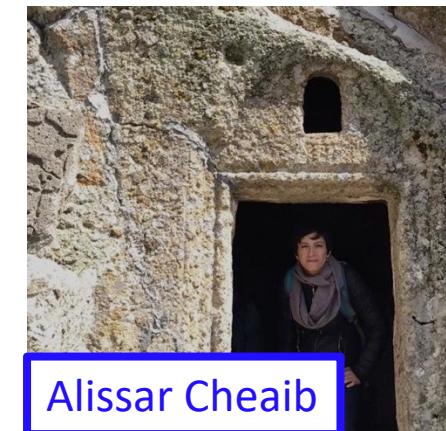
*Consistent across
multiple species,
metrics, and
growth conditions

Questioning Nick's worldview

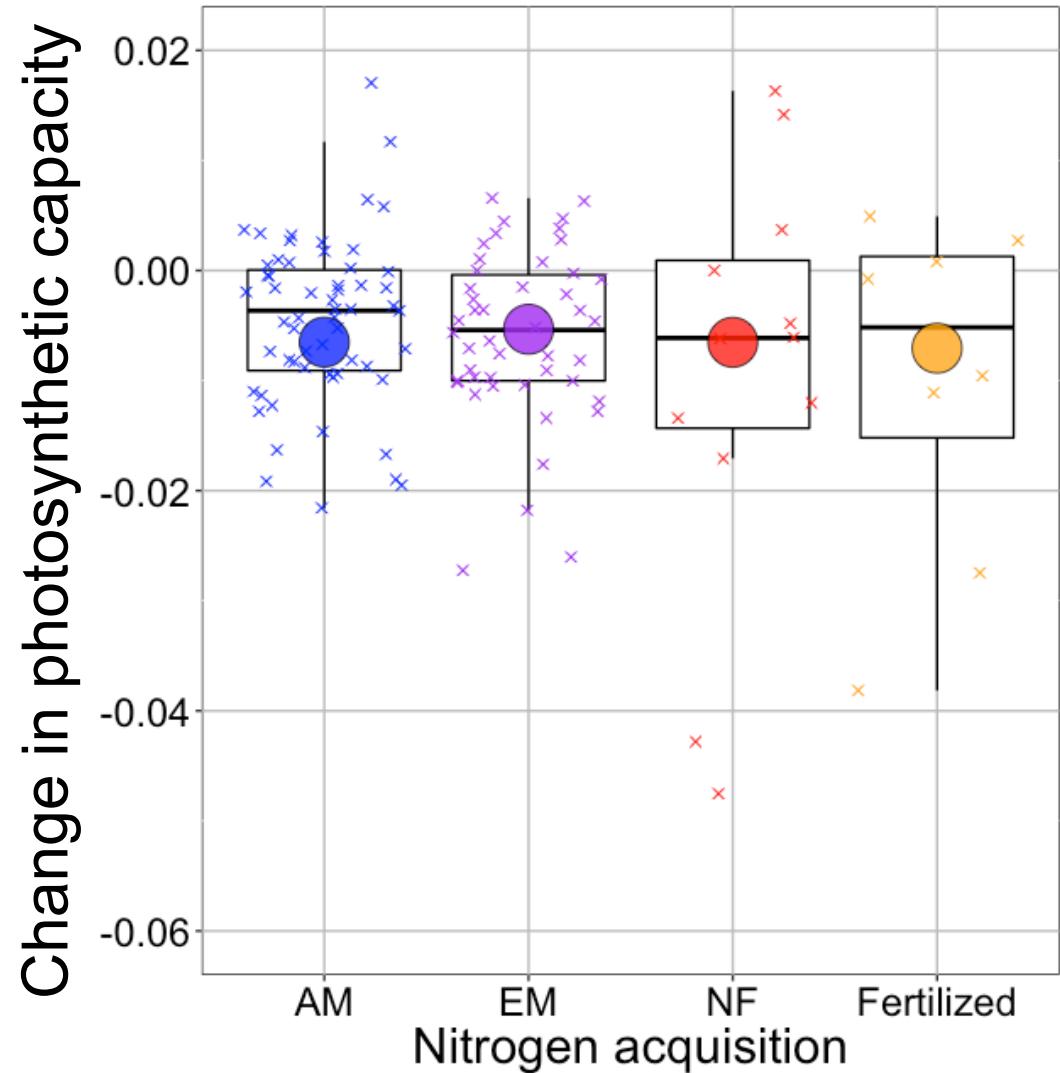
- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!
- Nick: plants uptake nutrients to meet photosynthetic demand
 - Others: plants uptake nutrients for lots of other things!
- Nick: plants downregulate photosynthetic capacity under elevated CO₂ to optimize nutrient use



Evan Perkowski



Alissar Cheaib

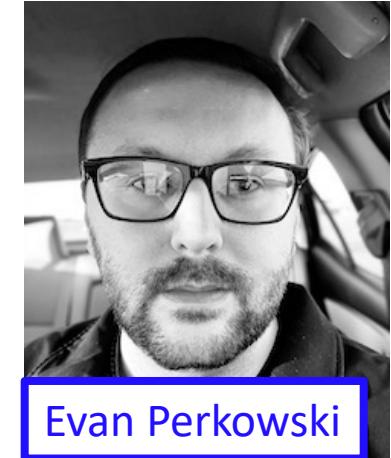


V_{cmax} changes with CO_2 in ways expected from optimization

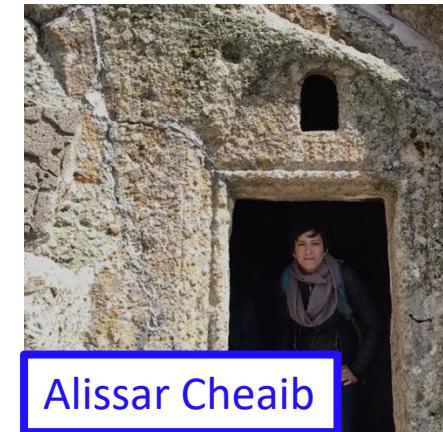
Boxes = data = -0.0063 Pa^{-1}
Circles = predicted = -0.0066 Pa^{-1}

Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!
- Nick: plants uptake nutrients to meet photosynthetic demand
 - Others: plants uptake nutrients for lots of other things!
- Nick: plants downregulate photosynthetic capacity under elevated CO₂ to optimize nutrient use
 - Others: elevated CO₂ responses are the result of interactions between photosynthetic demand, nutrient availability, growth, and allocation

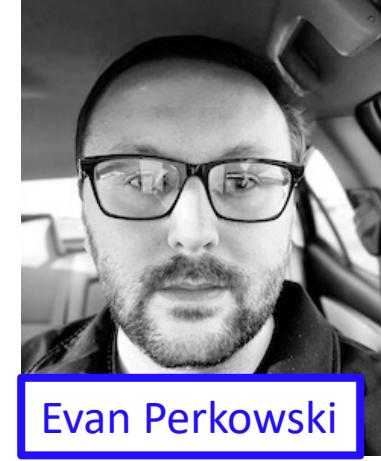
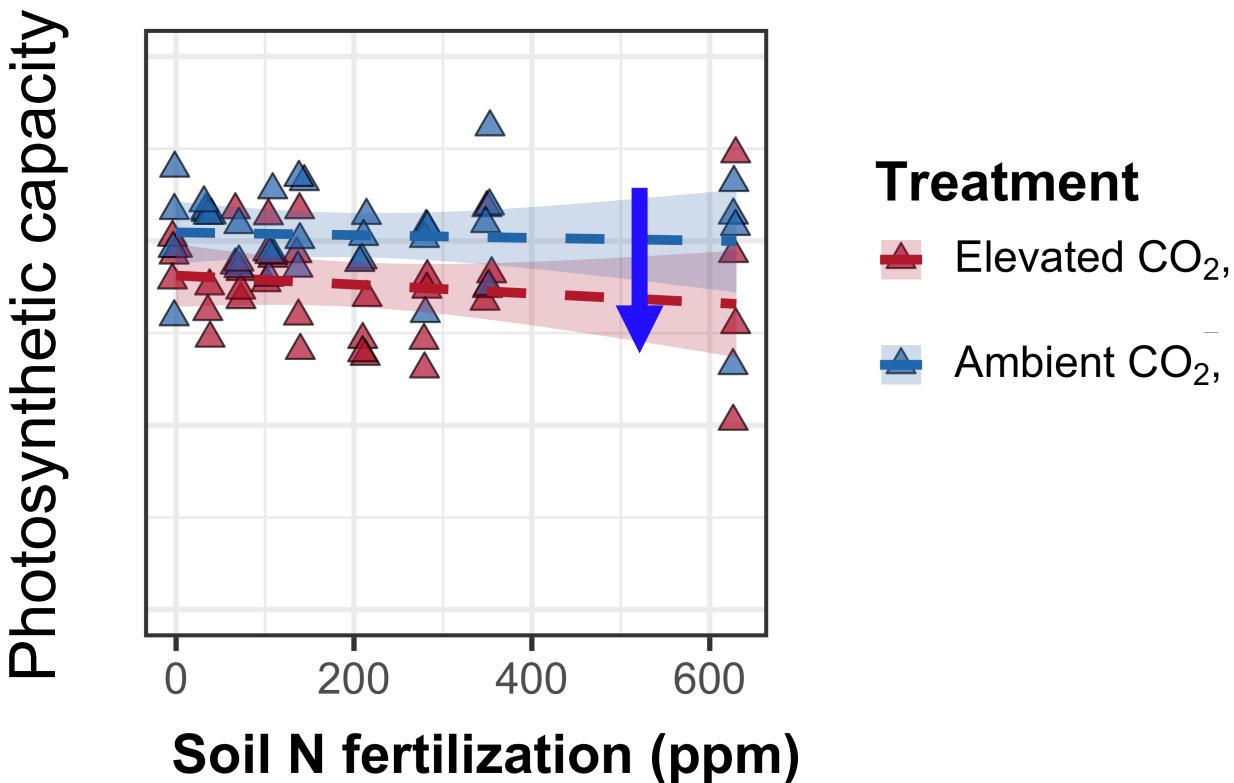


Evan Perkowski



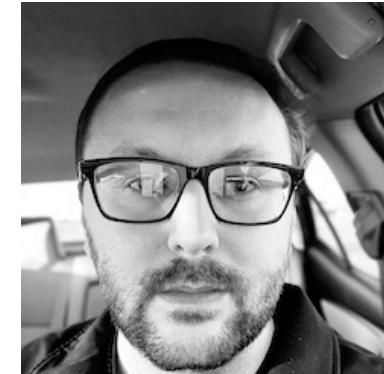
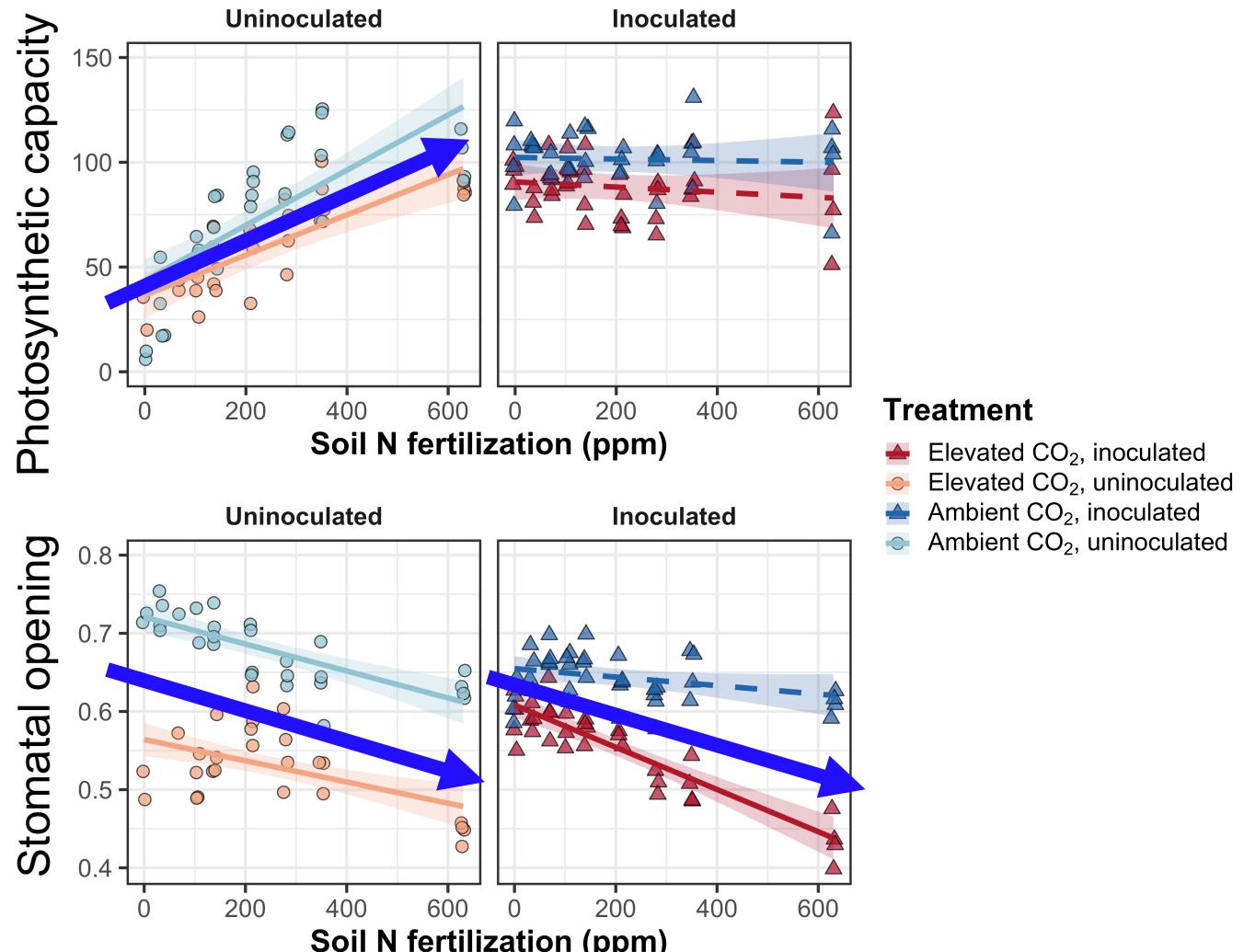
Alissar Cheaib

Scientific lesson: ok, maybe photosynthetic demand decreases regardless of other interactions



Evan Perkowski

Scientific lesson: nitrogen availability still matters independently



Evan Perkowski

Scientific lesson: nitrogen availability still matters independently

Contributed Talk

Session: : Physiological Ecology 3

COS 180-1 - Optimal resource investment to photosynthetic capacity controls leaf and whole plant acclimation responses to elevated CO₂

Wednesday, August 9, 2023

10:00 AM – 10:15 AM PDT

Location: E142

Presenting Author(s)

Evan A A. Perkowski

EP

PhD candidate

Department of Biological Sciences, Texas Tech
University, Lubbock, TX 79409, USA
Lubbock, Texas, United States



Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!
- Nick: plants uptake nutrients to meet photosynthetic demand
 - Others: plants uptake nutrients for lots of other things!
- Nick: plants downregulate photosynthetic capacity under elevated CO₂ to optimize nutrient use
 - Others: elevated CO₂ responses are the result of interactions between photosynthetic demand, nutrient availability, growth, and allocation
- Nick: we only need to worry about modeling C₃ acclimation



Helen Scott



Zinny Ezekannagha

Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!
- Nick: plants uptake nutrients to meet photosynthetic demand
 - Others: plants uptake nutrients for lots of other things!
- Nick: plants downregulate photosynthetic capacity under elevated CO₂ to optimize nutrient use
 - Others: elevated CO₂ responses are the result of interactions between photosynthetic demand, nutrient availability, growth, and allocation
- Nick: we only need to worry about modeling C₃ acclimation
 - Others: C₄ plants are dynamic and important!

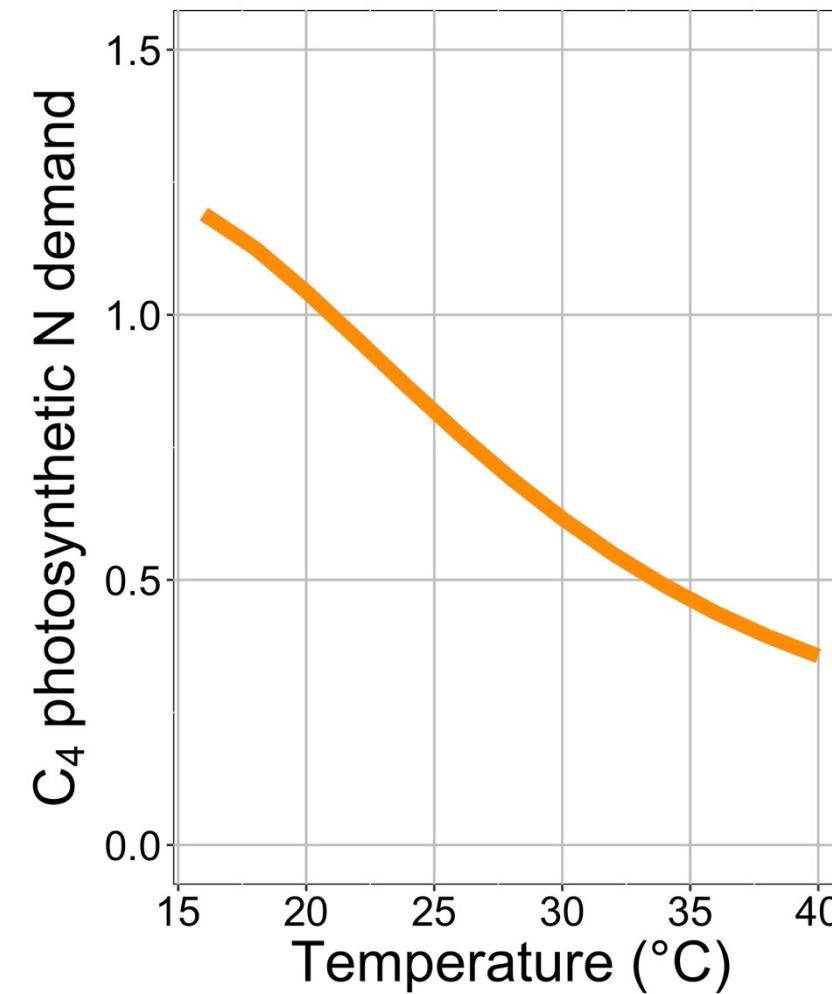
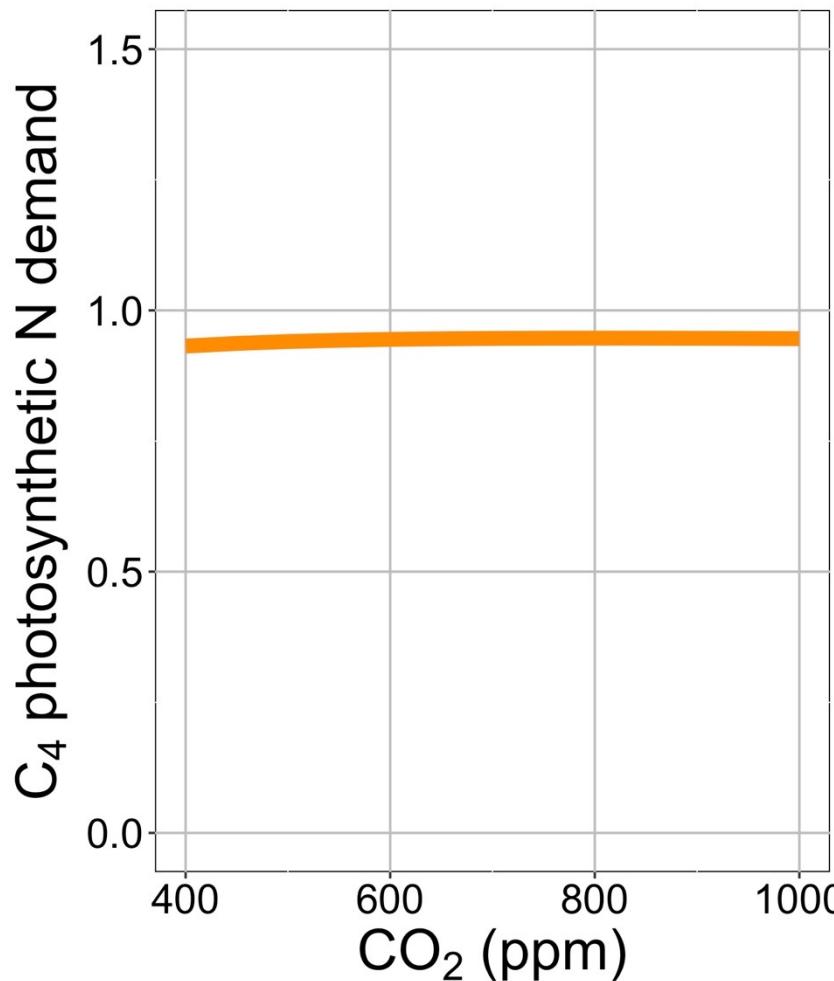


Helen Scott

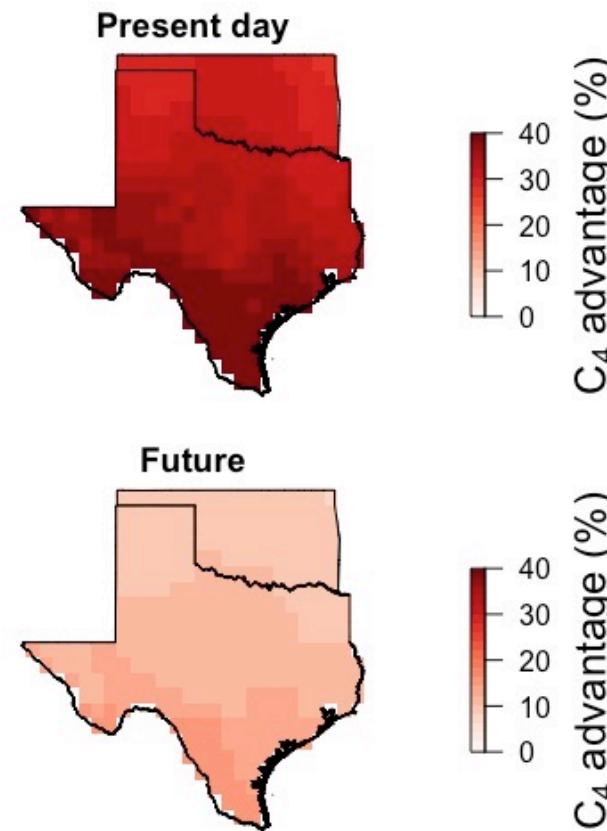


Zinny Ezekannagha

Scientific lesson: C₄ dynamism can be simulated

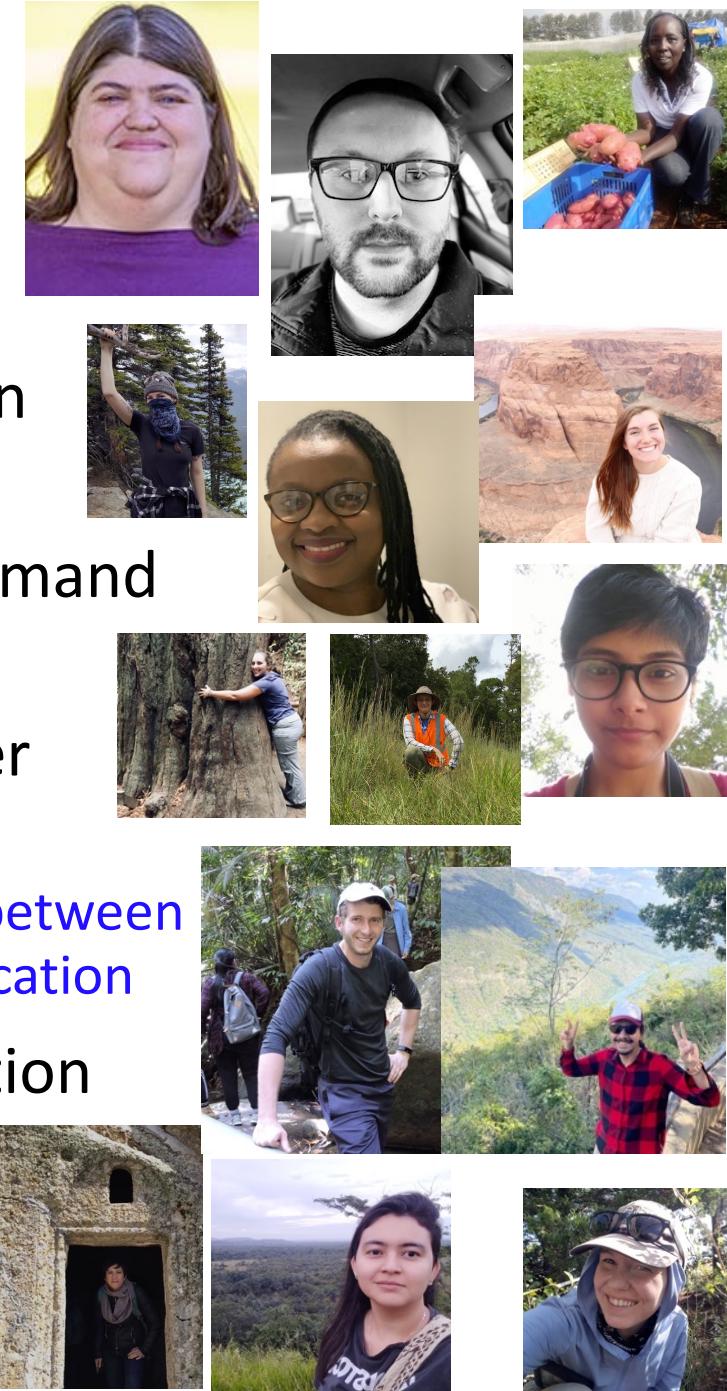


Scientific lesson: C₄ dynamics are likely important for predicting community change



Questioning Nick's worldview

- Nick: photosynthetic capacity is primarily demand-driven
 - Others: nutrient availability matters too!
- Nick: plants uptake nutrients to meet photosynthetic demand
 - Others: plants uptake nutrients for lots of other things!
- Nick: plants downregulate photosynthetic capacity under elevated CO₂ to optimize nutrient use
 - Others: elevated CO₂ responses are the result of interactions between photosynthetic demand, nutrient availability, growth, and allocation
- Nick: we only need to worry about modeling C₃ acclimation
 - Others: C₄ plants are dynamic and important!



Photosynthetic acclimation to global change: improved understanding for more reliable predictions

Nick Smith

Lizz Waring, Evan Perkowski, Alissar Cheaib, Helen Scott, Zinny Ezekannagha
Isa Beltran, Kelly Carroll, Snehanjana Chatterjee, Jeff Chieppa, Rafael Freitas, Eve Gray, Monika Kelley, Risa McNellis,
Brad Posch

Texas Tech University
nick.smith@ttu.edu

Learning from mentees to better understand your science and your self

Nick Smith

Lizz Waring, Evan Perkowski, Alissar Cheaib, Helen Scott, Zinny Ezekannagha
Isa Beltran, Kelly Carroll, Snehanjana Chatterjee, Jeff Chieppa, Rafael Freitas, Eve Gray, Monika Kelley, Risa McNellis,
Brad Posch

Texas Tech University
nick.smith@ttu.edu

Larger lessons learned from mentees about myself and approach to science

Larger lessons learned from mentees about myself and approach to science

- Read, discuss, and debate with mentees

Larger lessons learned from mentees about myself and approach to science

- Read, discuss, and debate with mentees
- Listen to mentees

Larger lessons learned from mentees about myself and approach to science

- Read, discuss, and debate with mentees
- Listen to mentees
- Reserve and prioritize time to teach and train

Larger lessons learned from mentees about myself and approach to science

- Read, discuss, and debate with mentees
- Listen to mentees
- Reserve and prioritize time to teach and train
- Help mentees achieve their goals, not yours

Larger lessons learned from mentees about myself and approach to science

- Read, discuss, and debate with mentees
- Listen to mentees
- Reserve and prioritize time to teach and train
- Help mentees achieve their goals, not yours
- Go slow

Larger lessons learned from mentees about myself and approach to science

- Read, discuss, and debate with mentees
- Listen to mentees
- Reserve and prioritize time to teach and train
- Help mentees achieve their goals, not yours
- Go slow
- Be humble

Presentation available at:

www.github.com/SmithEcophysLab/ESA_2023

Data and code:

www.github.com/SmithEcophysLab

www.smithecophyslab.com/data



Thanks!



SCHMIDT FUTURES

