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

- 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)

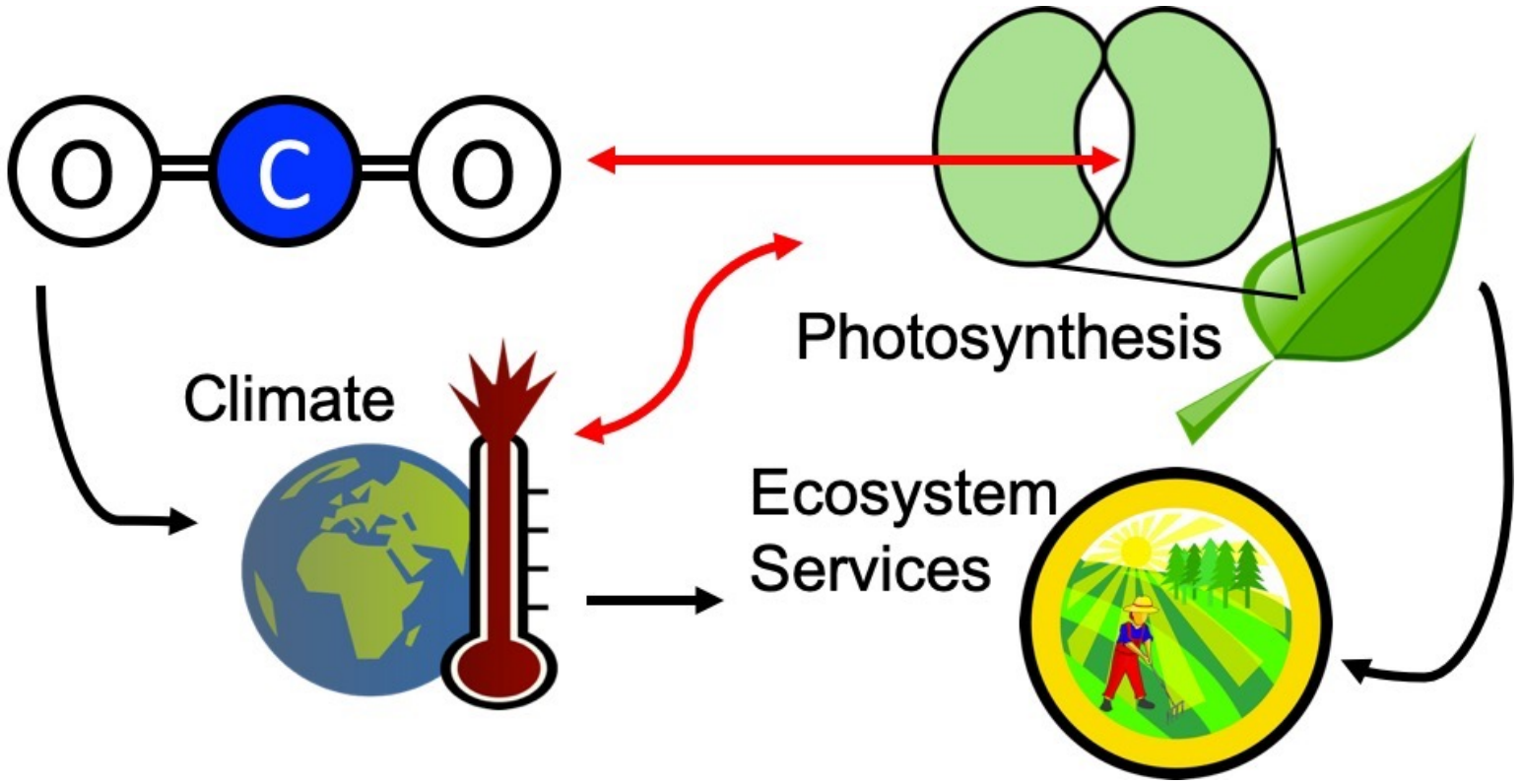

Lizz Waring


Evan Perkowski

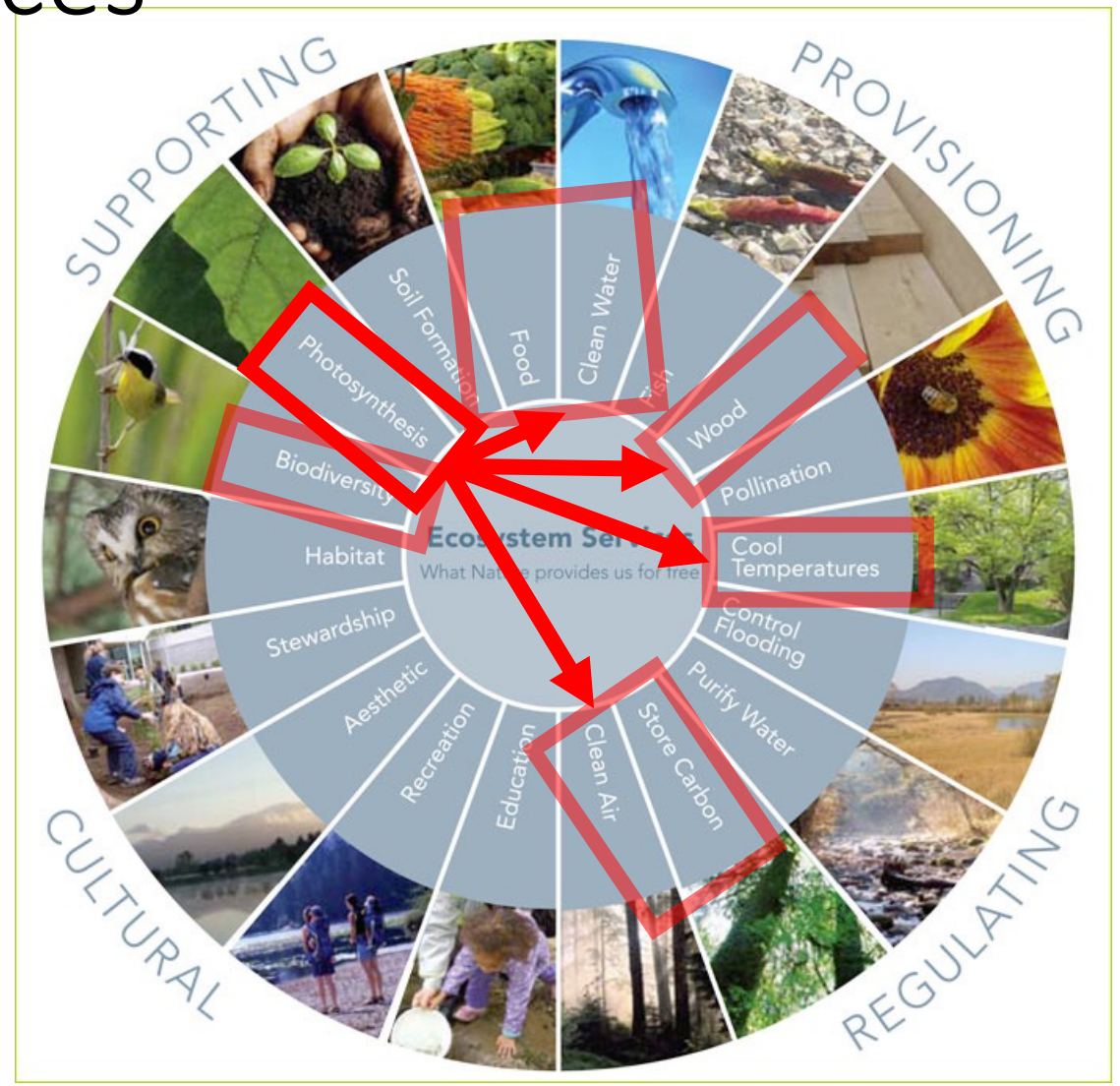

Jeff Chieppa


Jeff Dukes

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

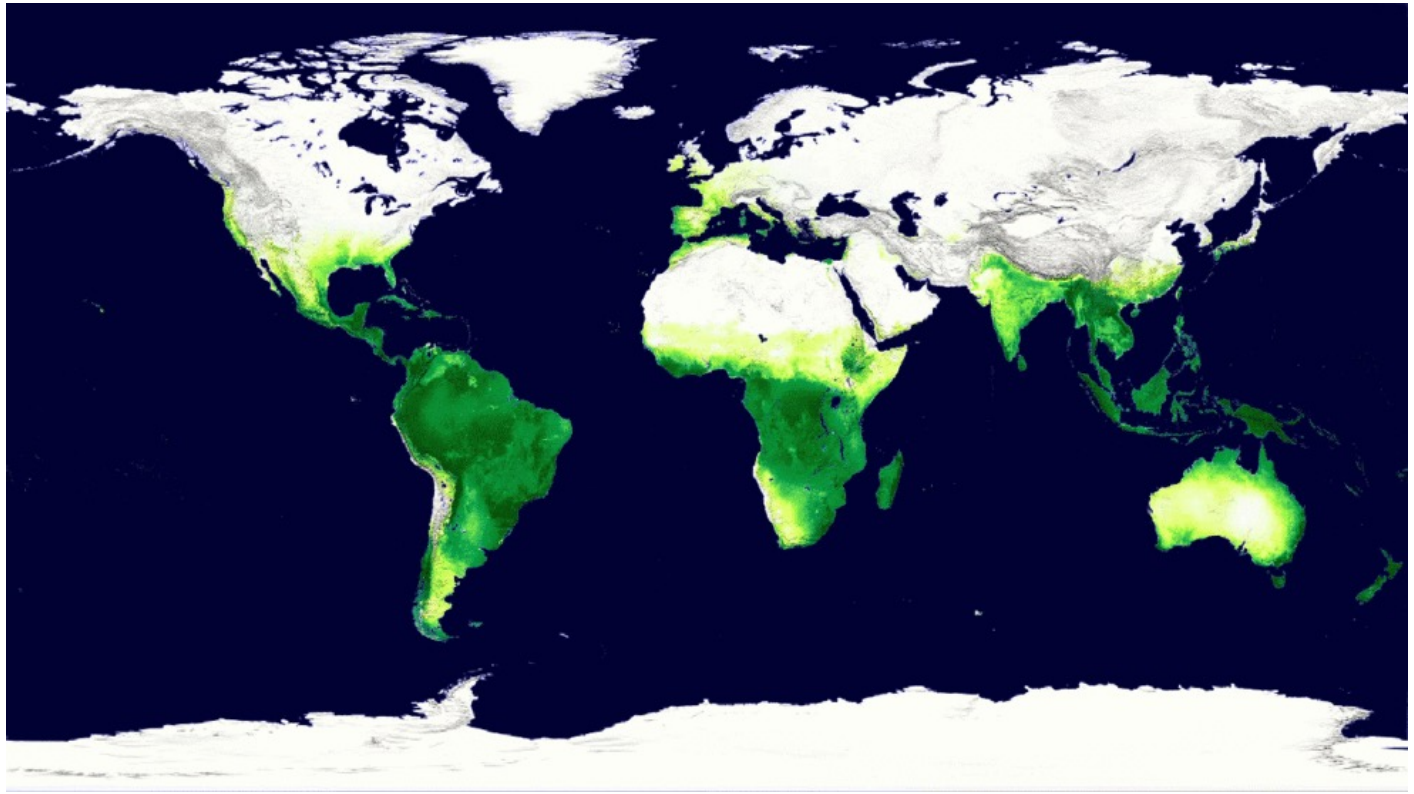


Photosynthesis provides the foundation for other services



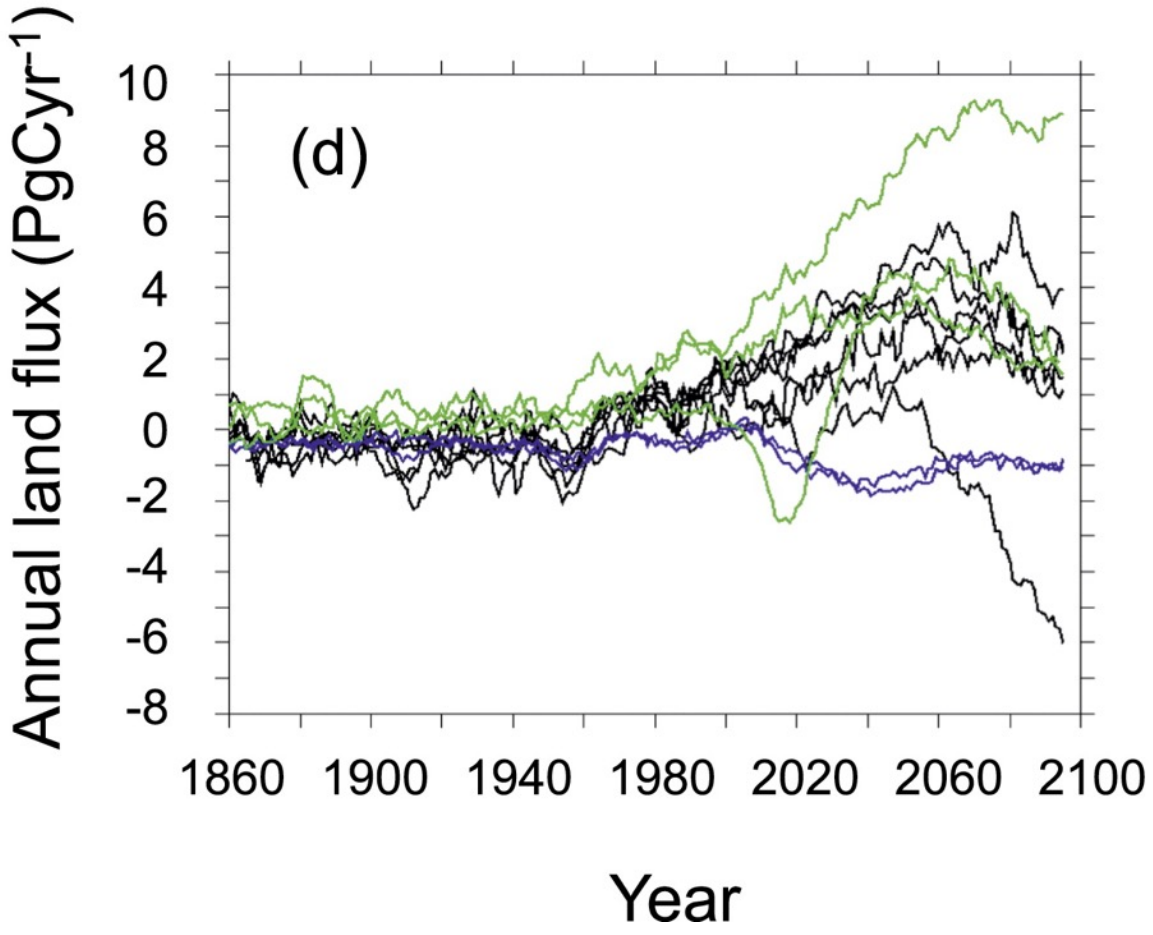
FNAL

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



MODIS, NASA

But predictions are uncertain!



Friedlingstein et al. (2014)

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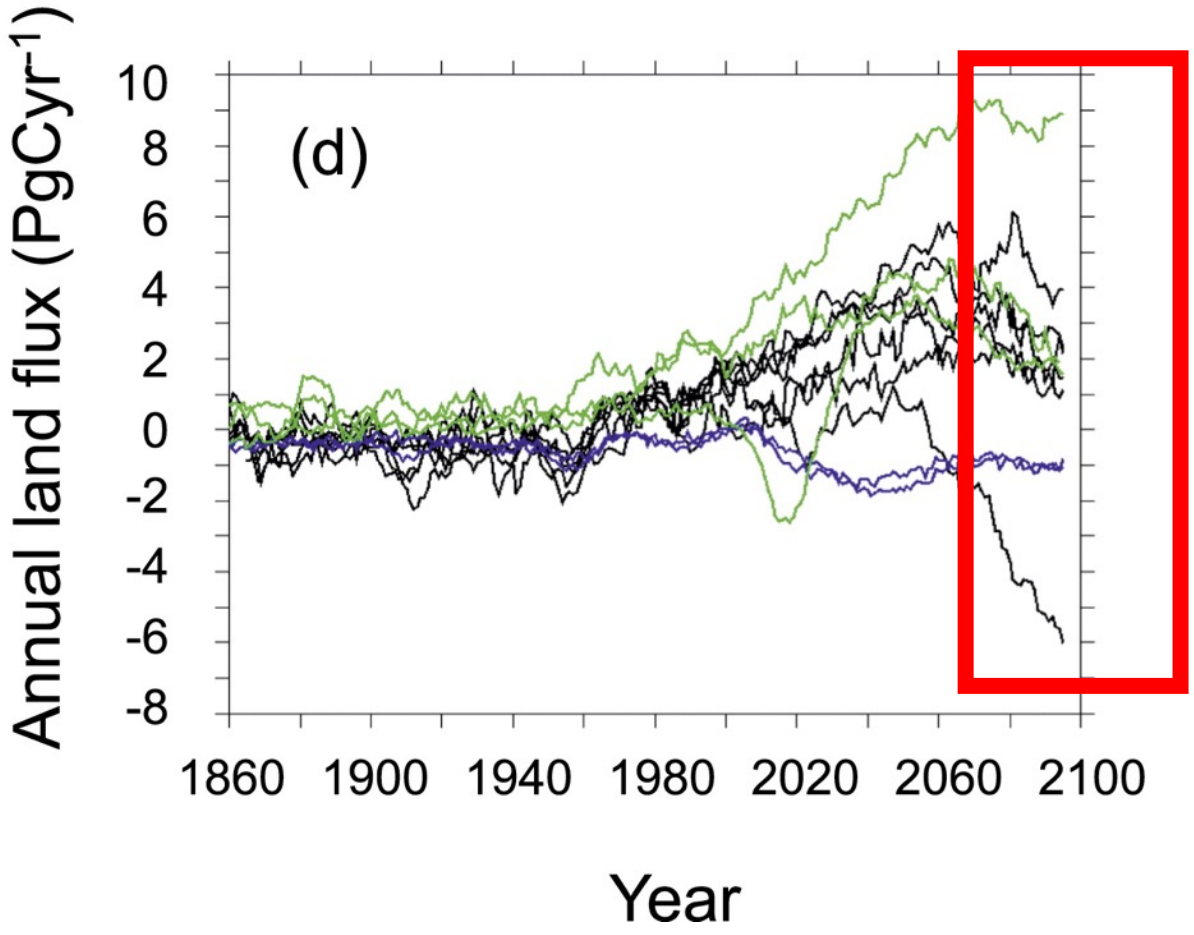
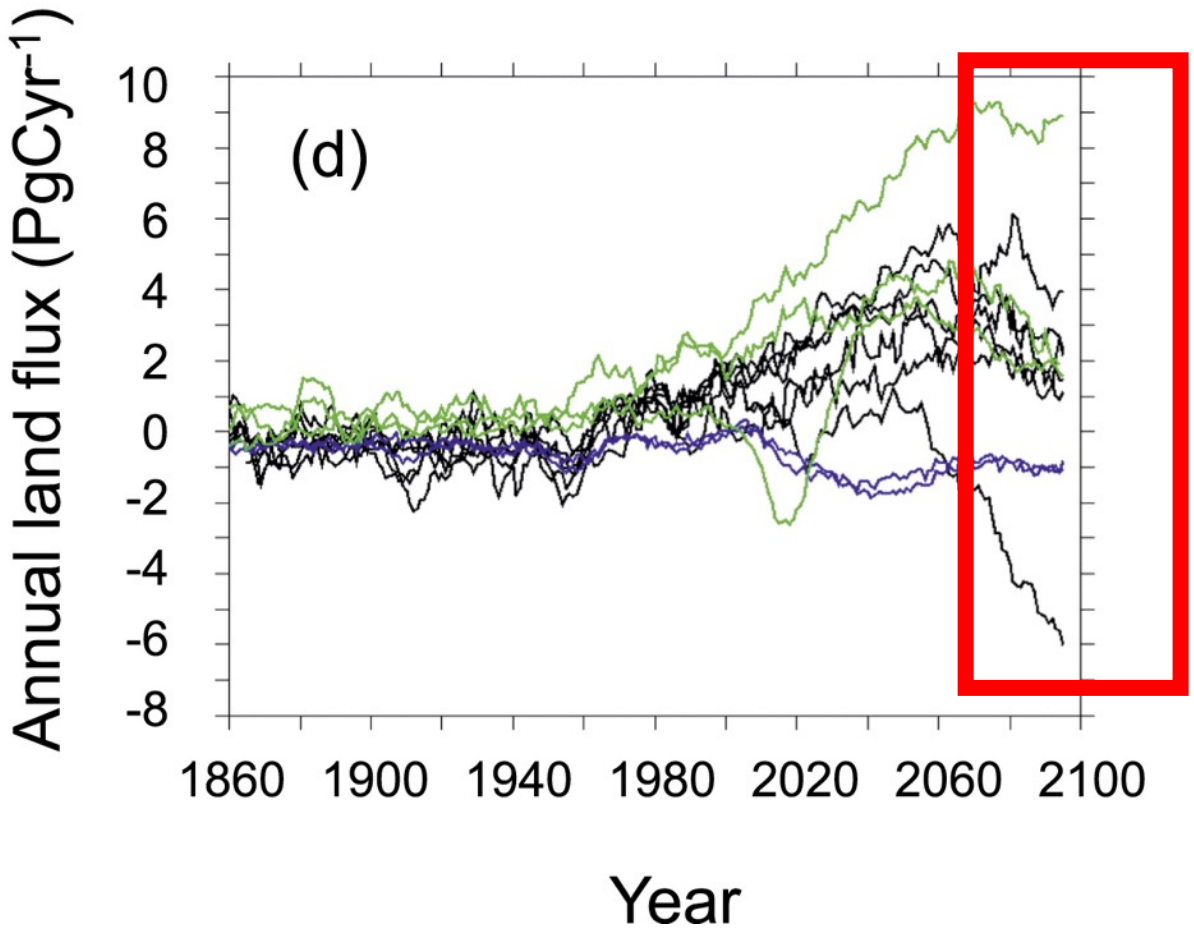
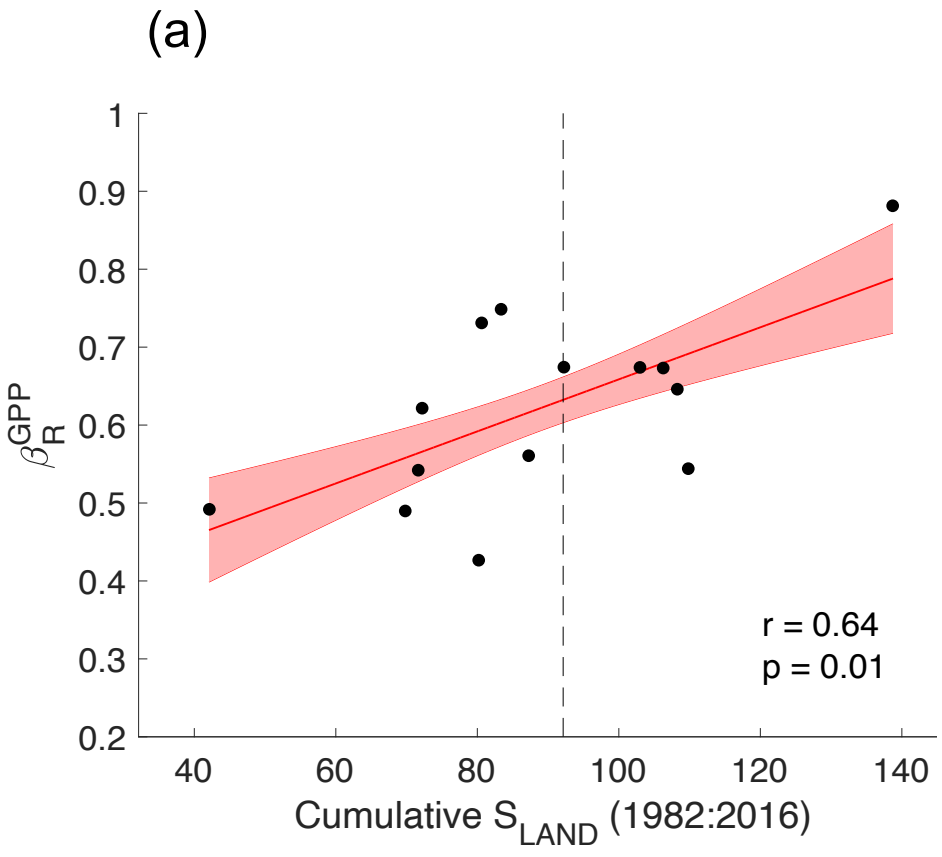


Future model uncertainty (14 Pg) > current fossil fuel emissions (9.5 Pg)

Friedlingstein et al. (2014)

This uncertainty is driven by uncertainty in photosynthesis

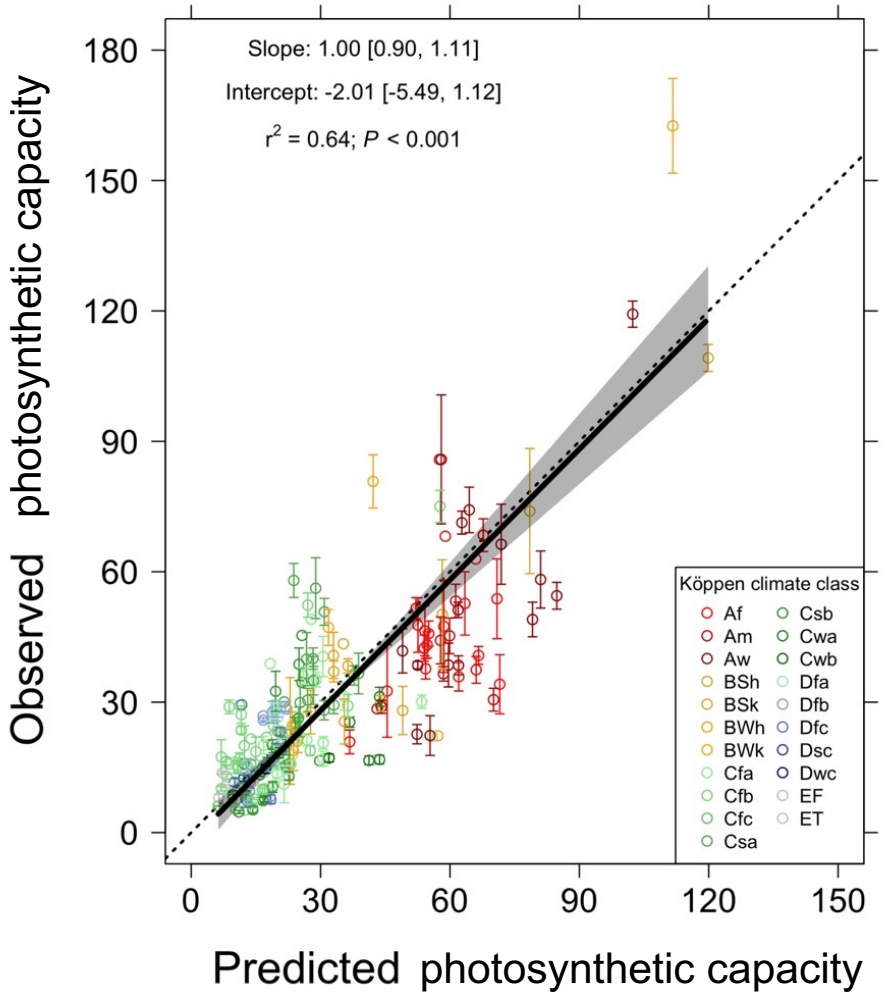


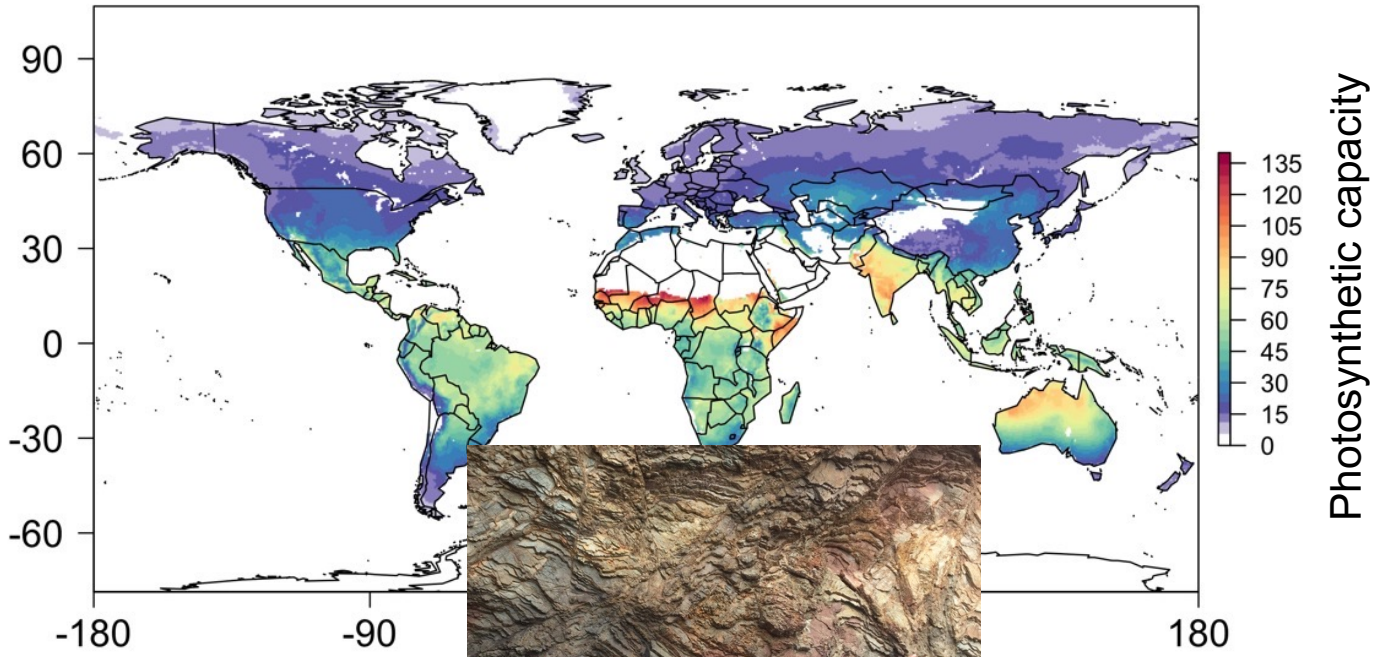


Friedlingstein et al. (2014)

Keenan et al. (in review)

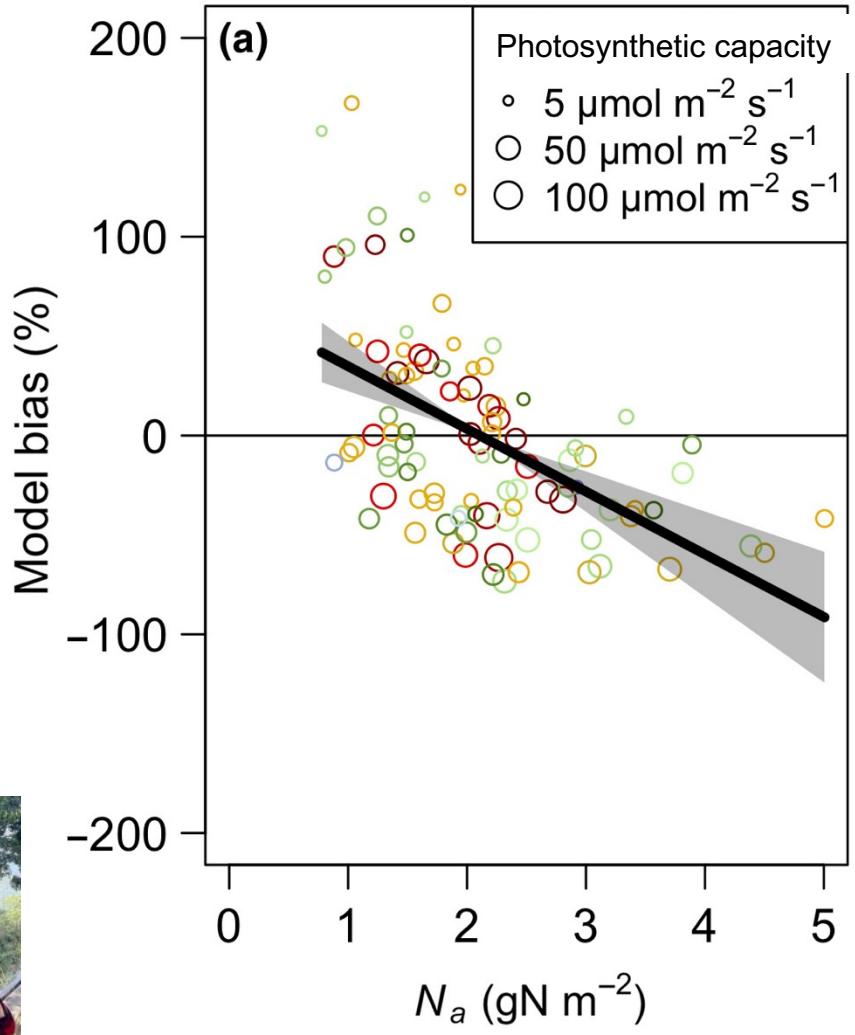
When starting the lab in 2017, I “knew” I had the answer!





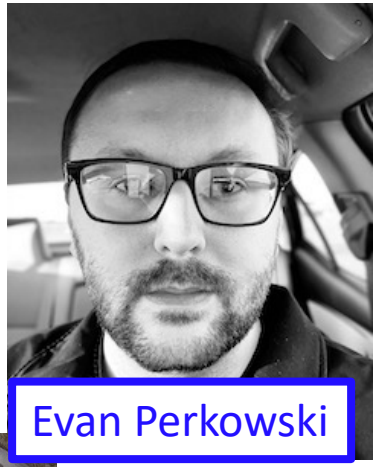
Smith et al. (2019)

Not everyone agreed



Questioning Nick’s worldview


Lizz Waring


Evan Perkowski


Alissar Cheaib

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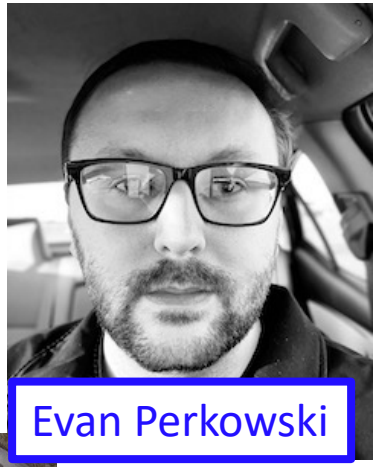
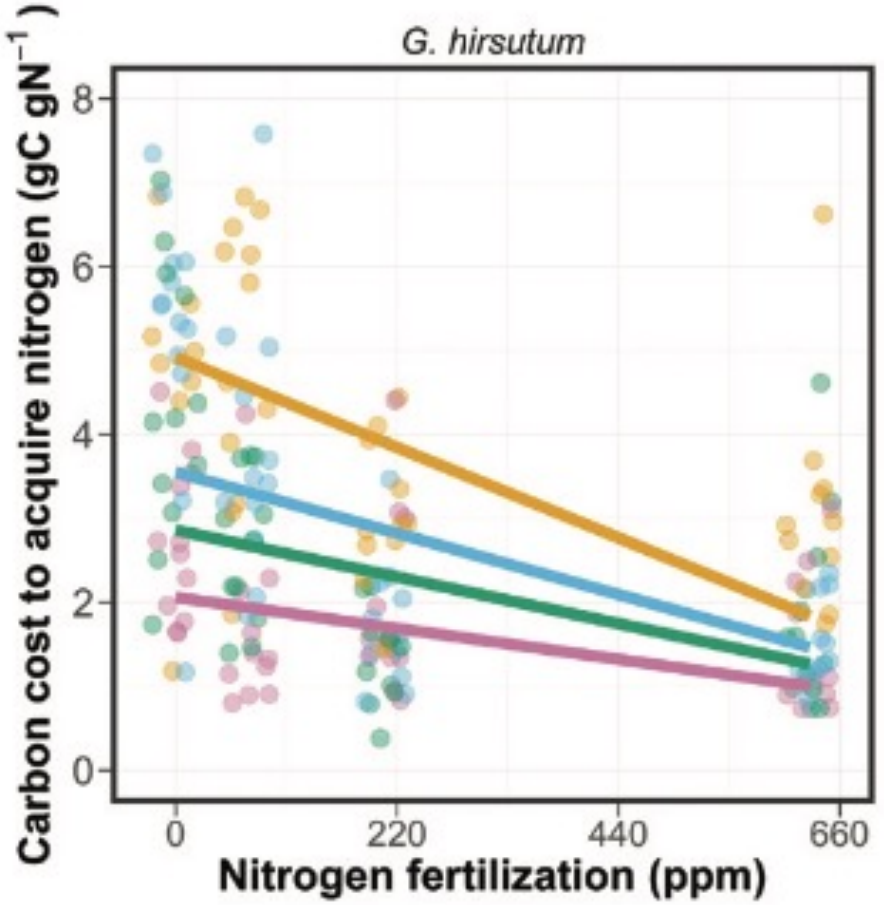

Evan Perkowski


Alissar Cheaib

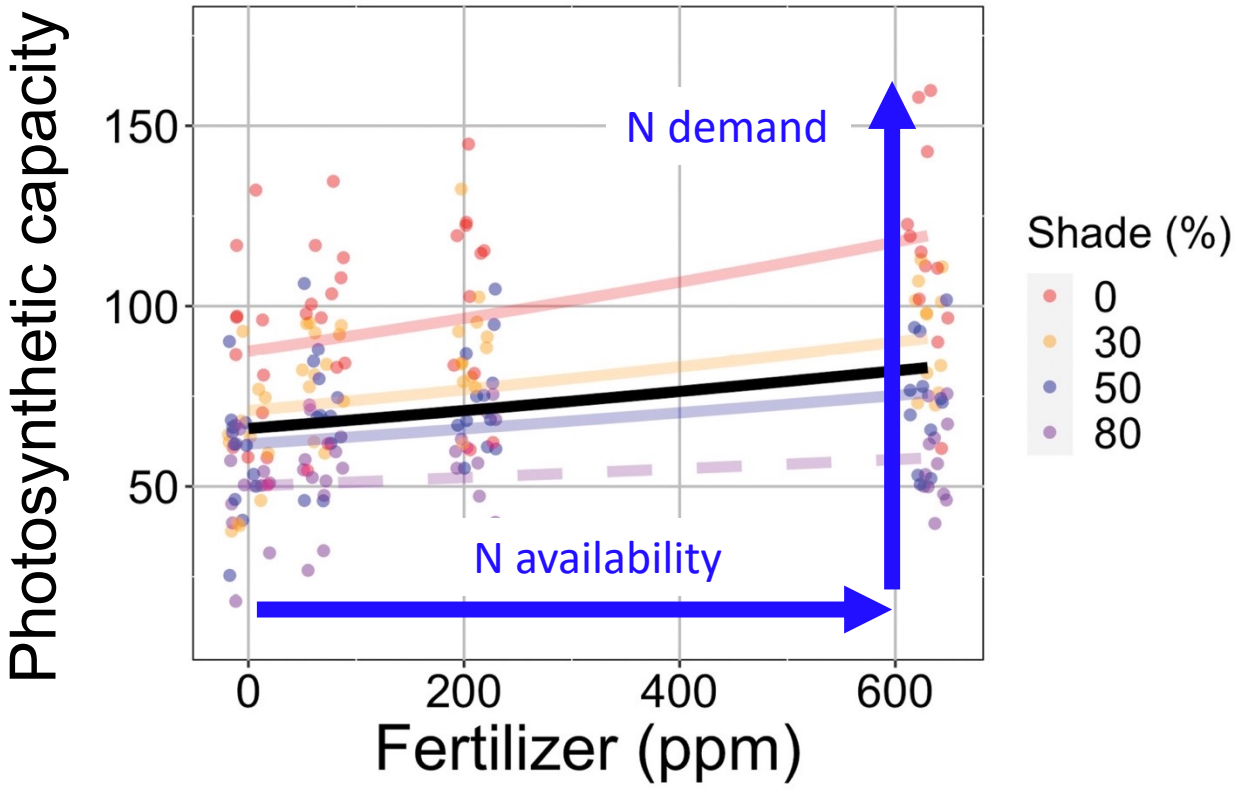
Scientific lesson: nutrient availability reduces carbon costs to acquire them

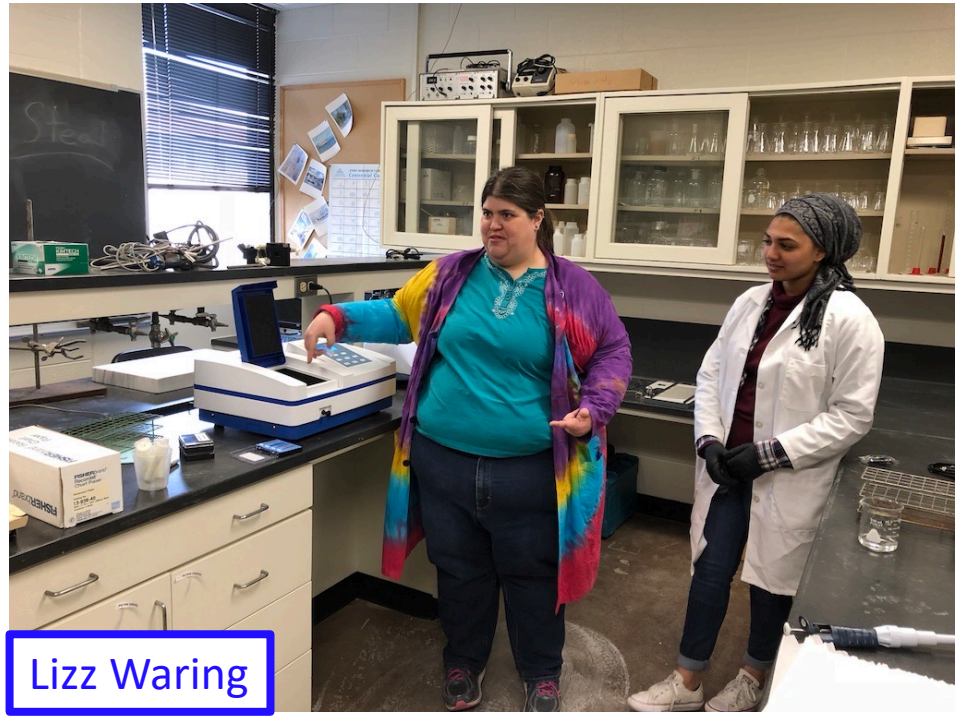
Evan Perkowski



Perkowski et al. (2021)

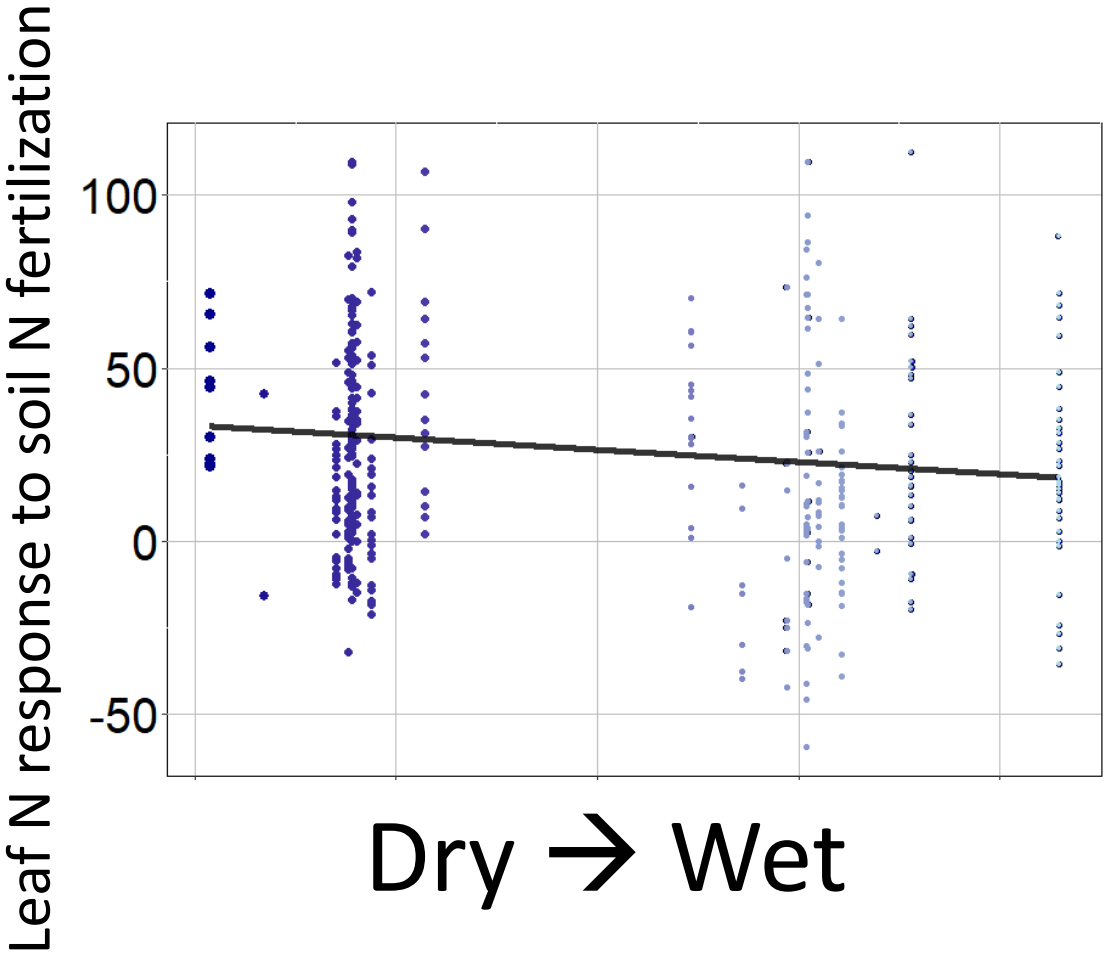
Scientific lesson: nutrient availability and nutrient demand drive photosynthetic capacity

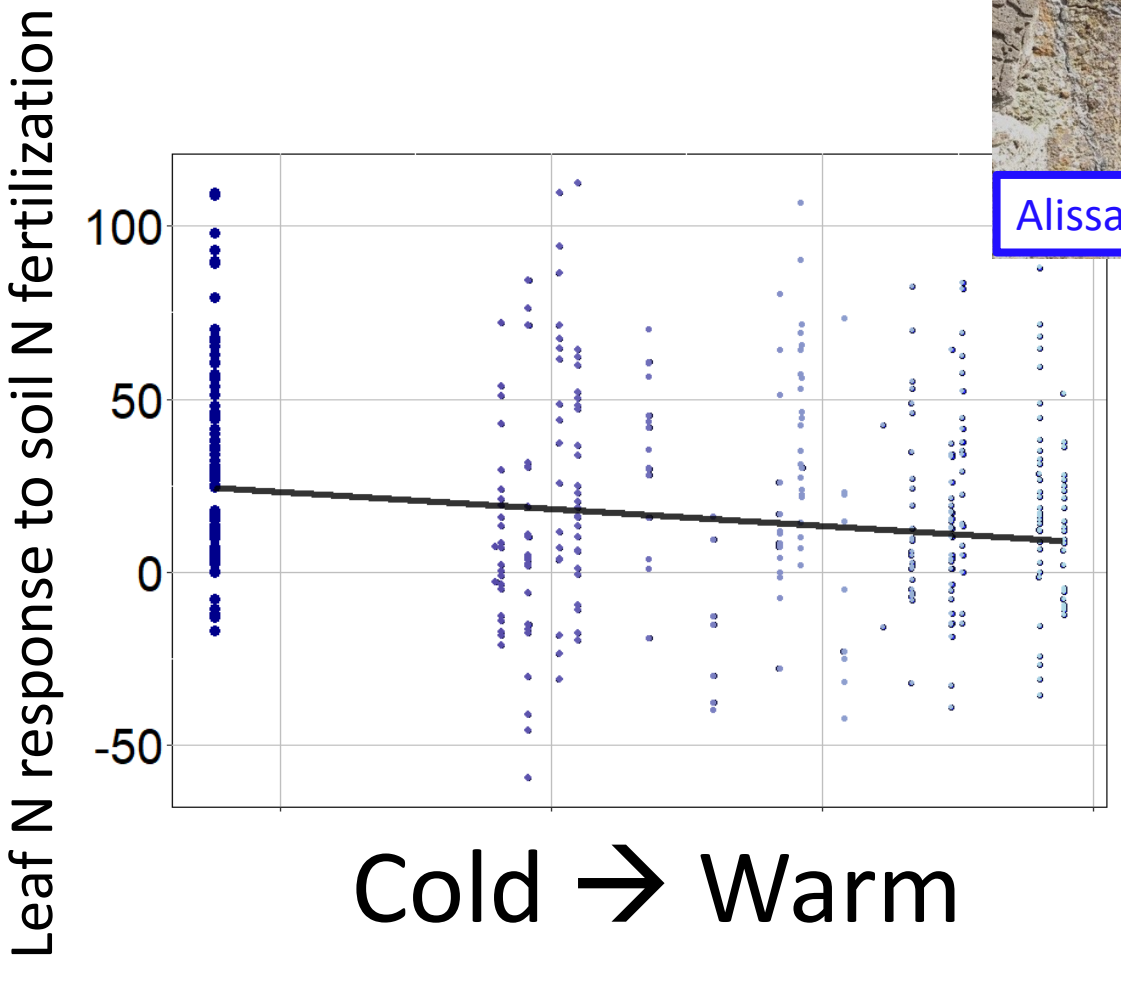




Waring et al. (2023)

Scientific lesson: nutrient demand increases responses to nutrient availability





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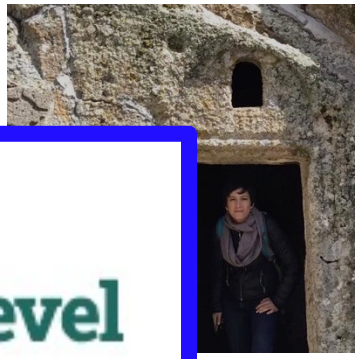


Session: Biogeochemistry (Latebreaking)

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

Thursday, August 10, 2023 5:00 PM – 6:30 PM PDT Location: ESA Exhibit Hall

Presenting Author(s)

AC

Alissar Cheaib

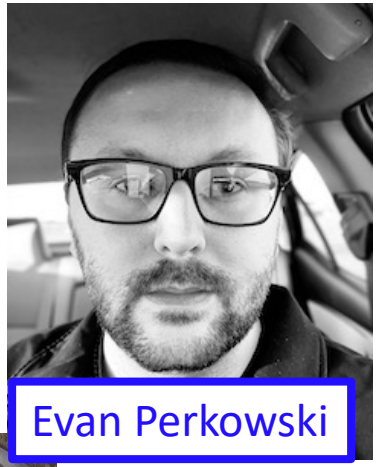
Postdoctoral research associate
Texas Tech University
Lubbock, Texas, United States

ΔN_{mass}

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

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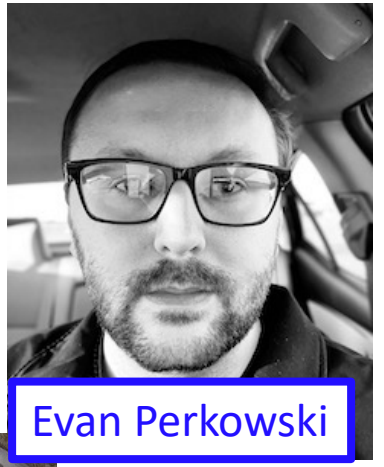
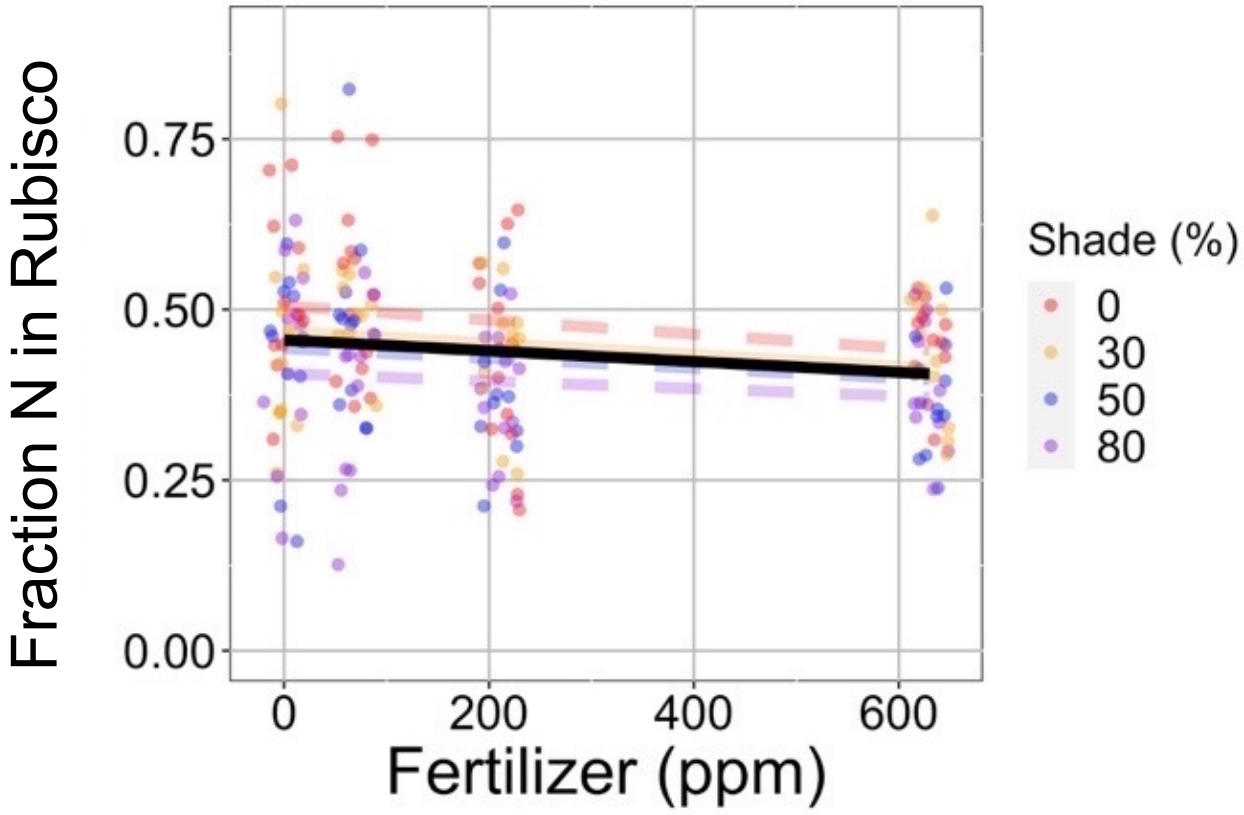
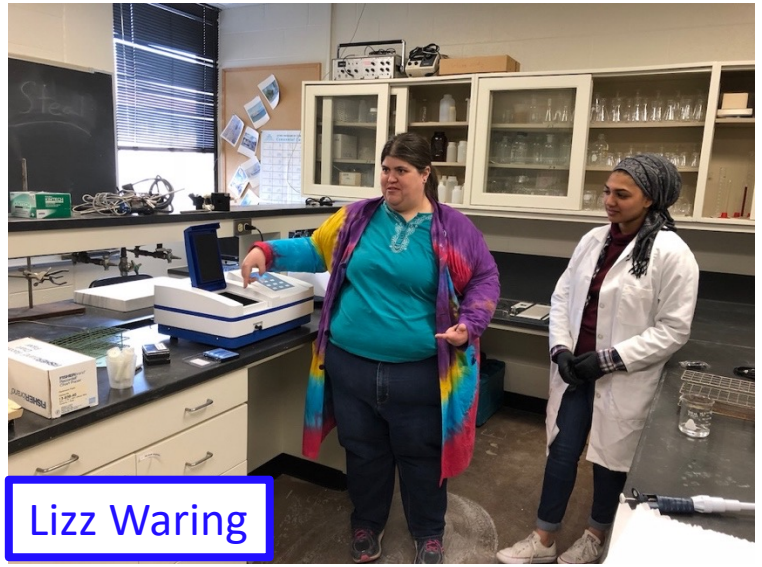

Evan Perkowski


Alissar Cheaib

Scientific lesson: nutrient availability doesn't just influence photosynthesis





*Consistent across multiple species, metrics, and growth conditions

Waring et al. (2023)

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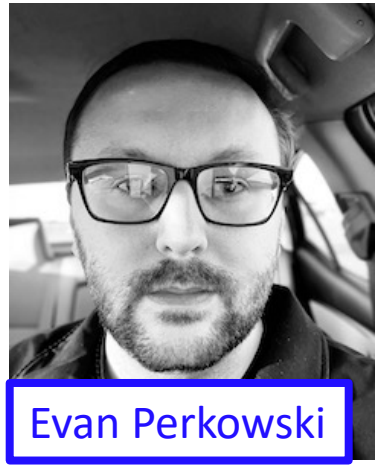
Evan Perkowski


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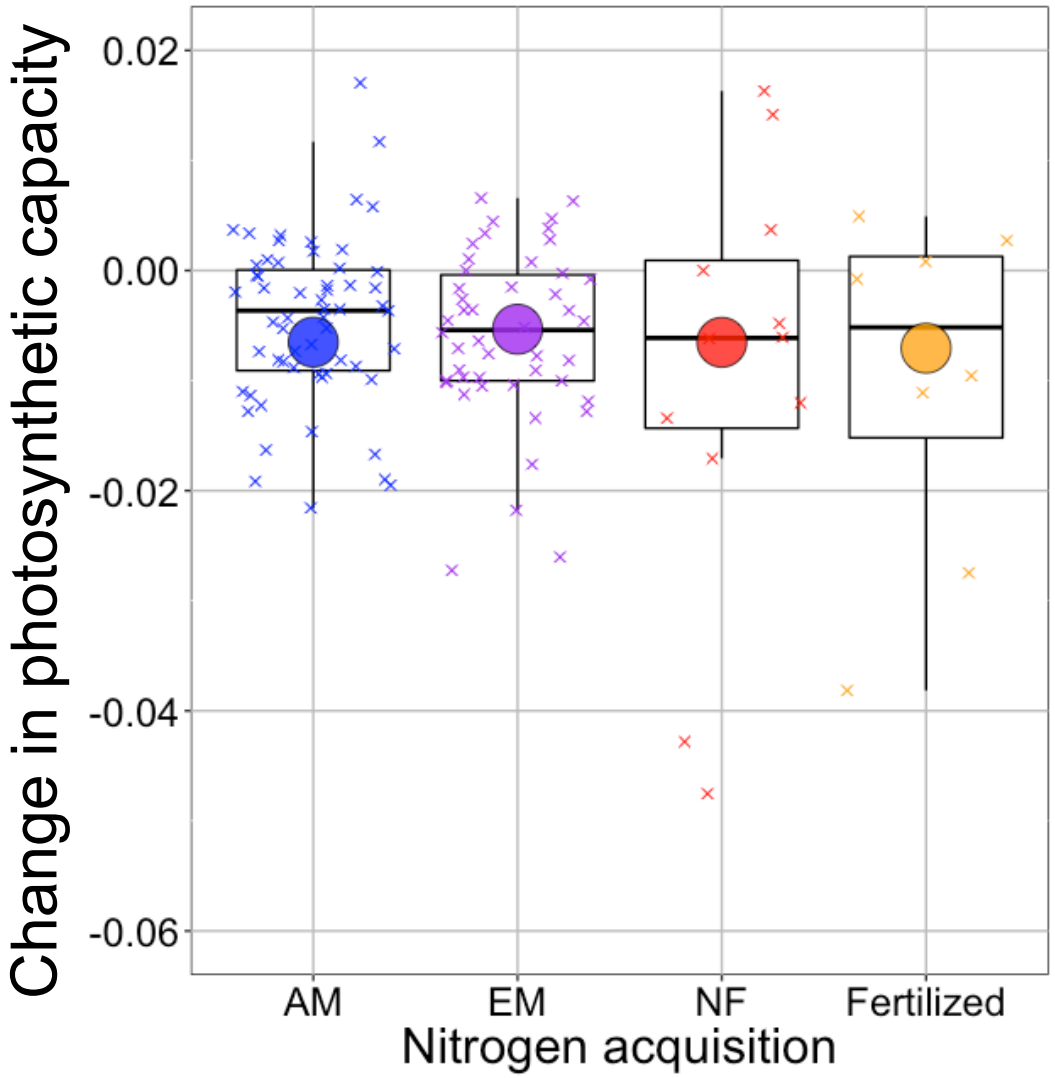

V_{cmax} changes with CO_2 in ways expected from optimization

Boxes = data = -0.0063 Pa^{-1}

Circles = predicted = -0.0066 Pa^{-1}

Smith and Keenan (2020)

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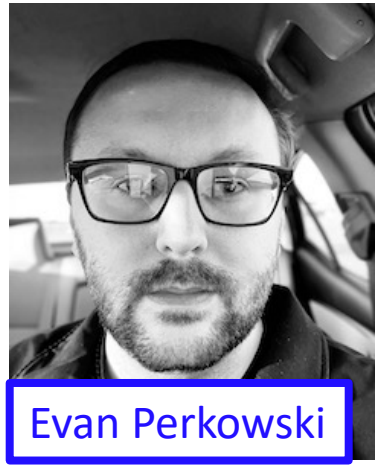
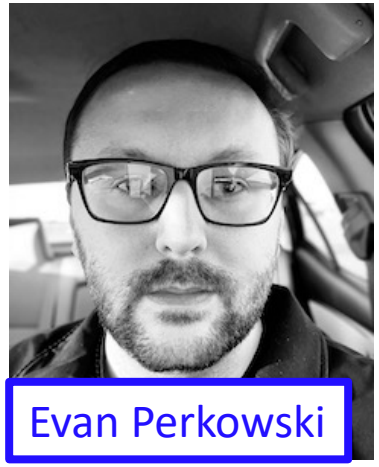
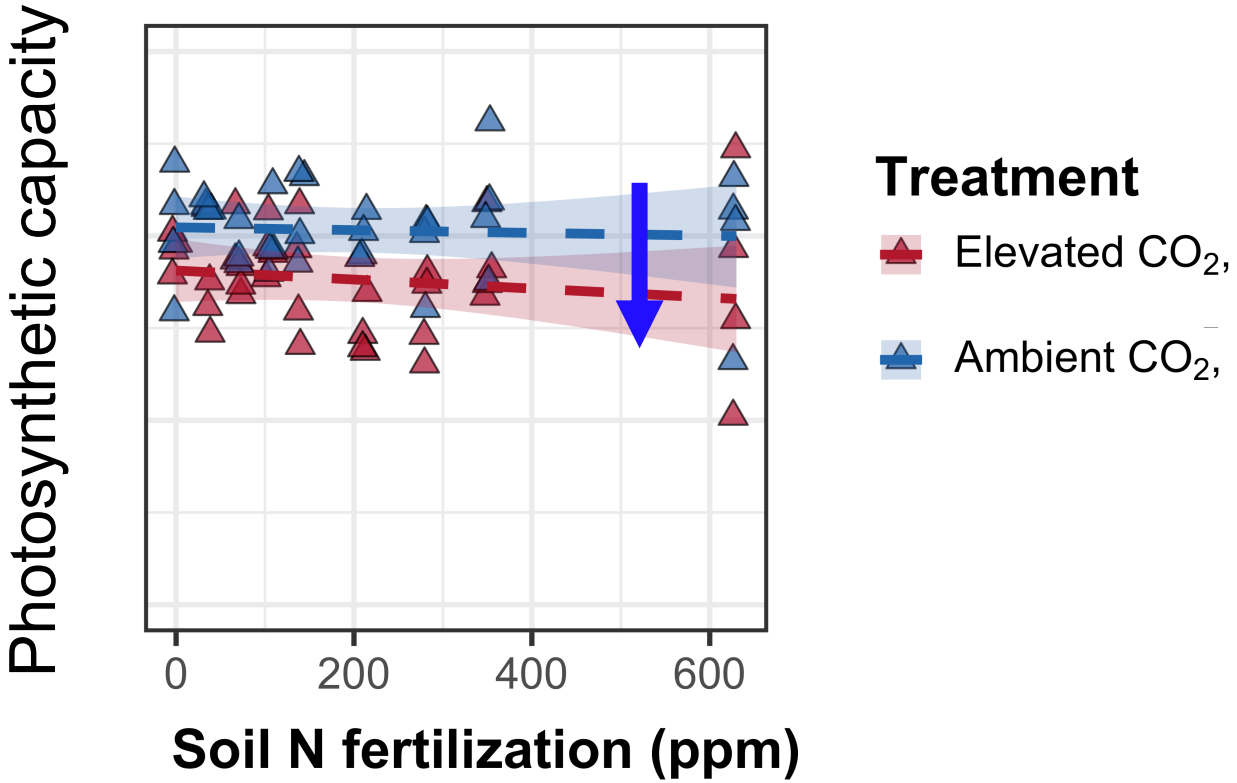

Evan Perkowski


Alissar Cheaib

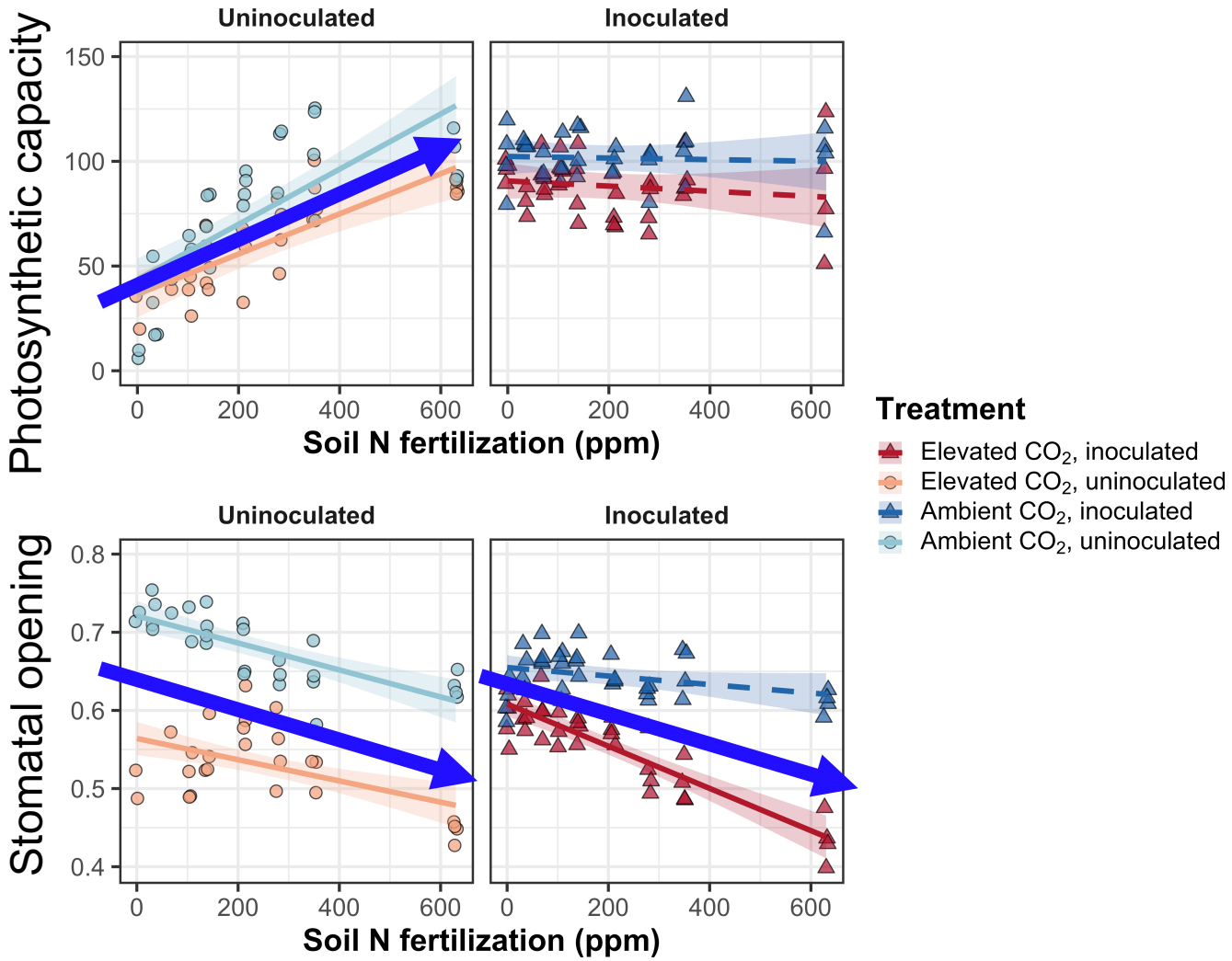
Scientific lesson: ok, maybe photosynthetic demand decreases regardless of other interactions

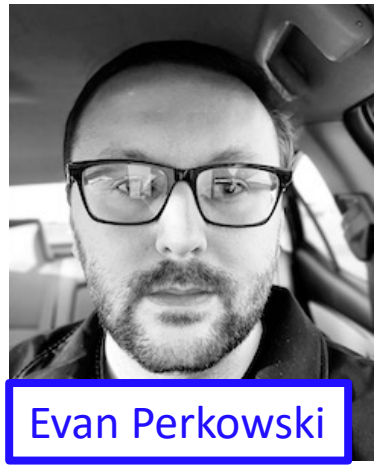


Evan Perkowski



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)

EP

Evan A A. Perkowski

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

0 200 400 600

Soil N fertilization (ppm)

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- Nick: we only need to worry about modeling C_3 acclimation


Helen Scott


Zinny Ezekannagha

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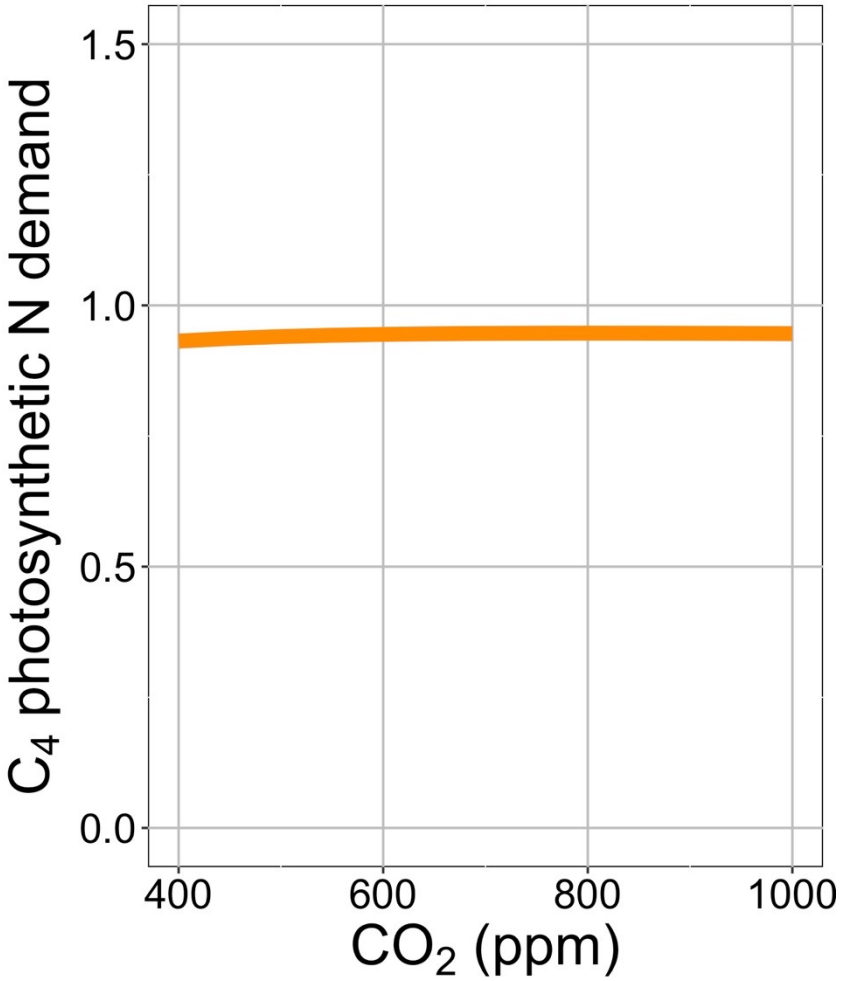
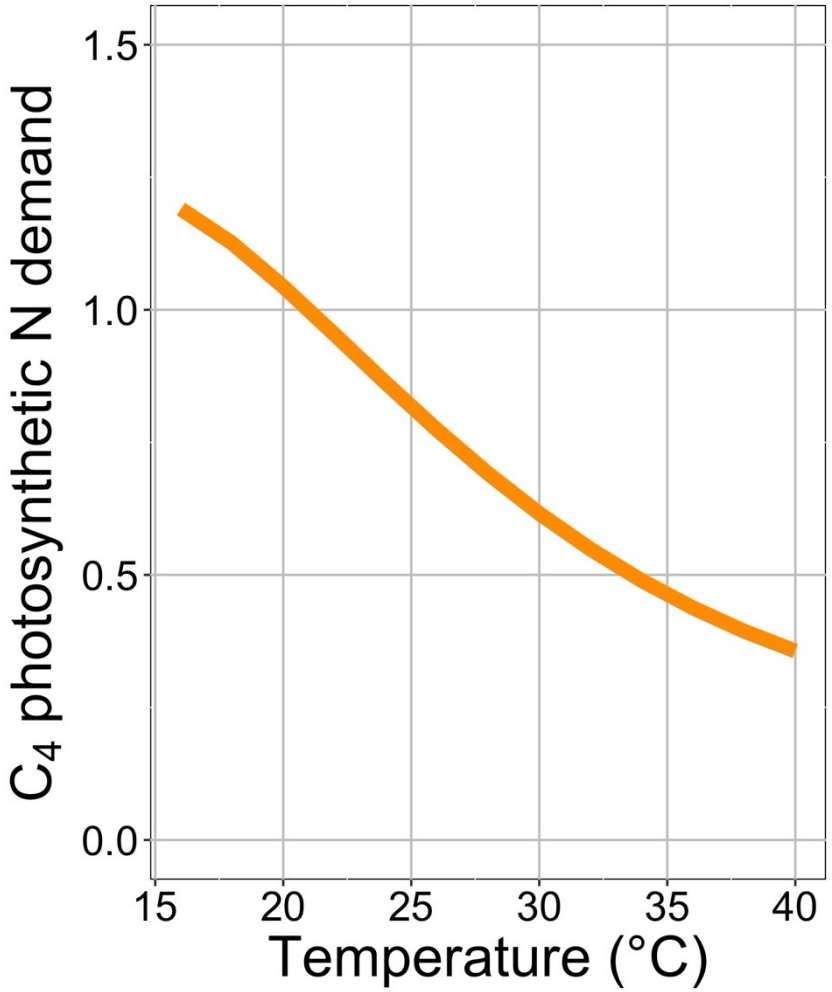
  - Others: C_4 plants are dynamic and important!


Helen Scott

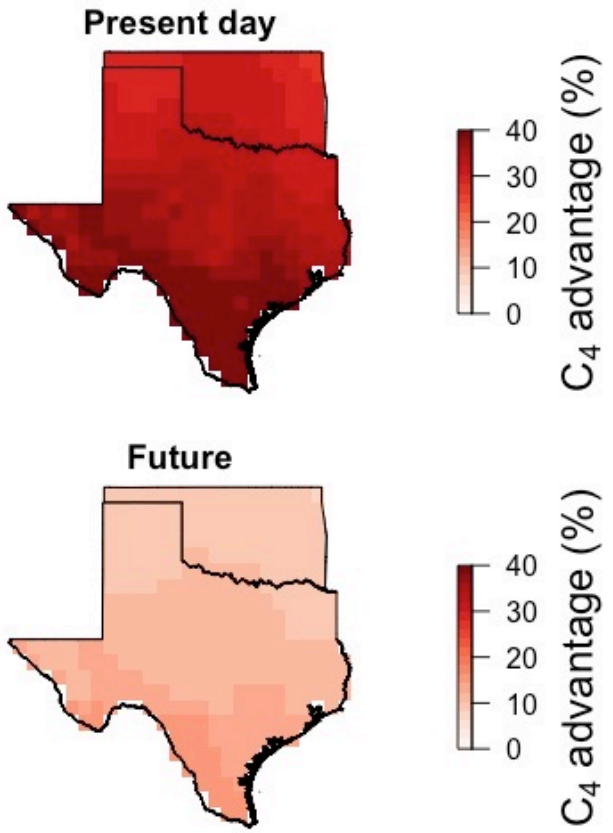

Zinny Ezekannagha

Scientific lesson: C_4 dynamism can be simulated





Scientific lesson: C_4 dynamics are likely important for predicting community change

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Ansley et al. (2023)

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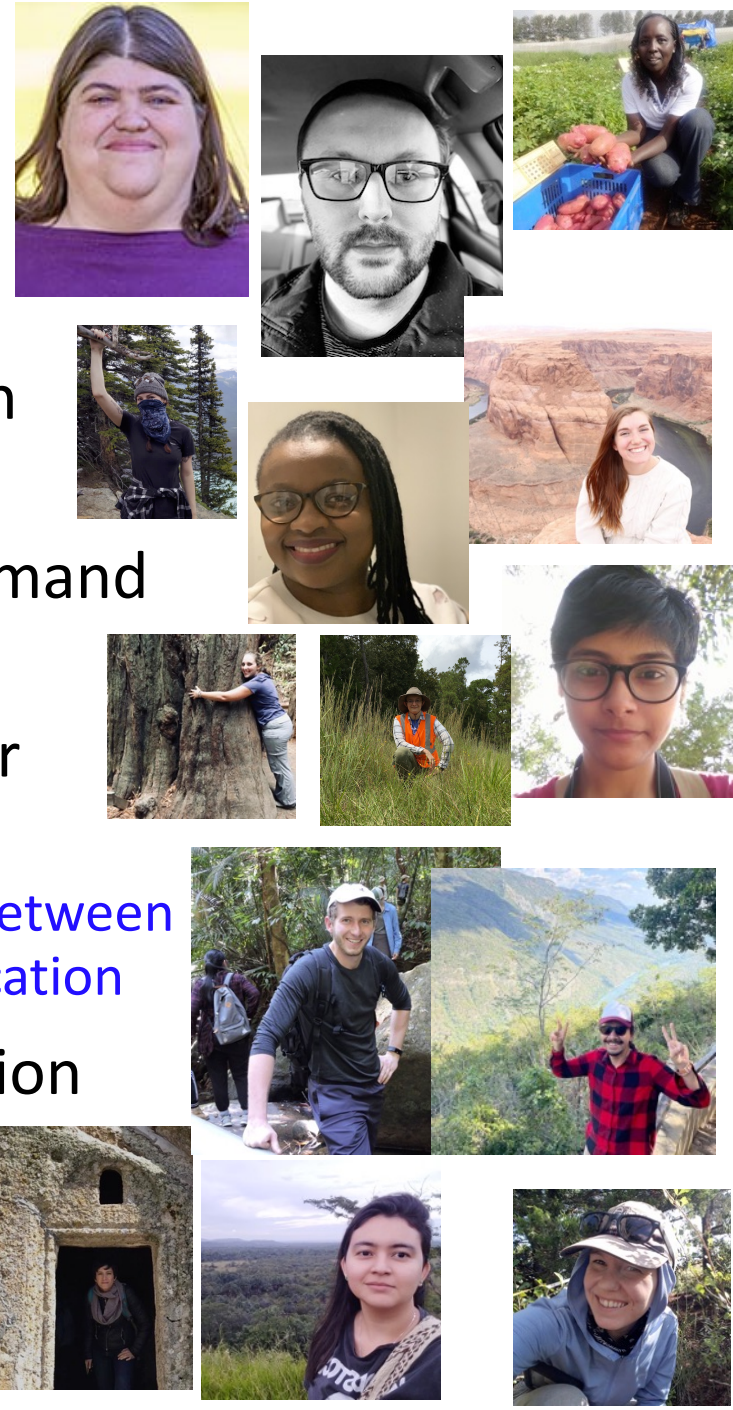

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Learning from mentees to better understand your science and your self

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Larger lessons learned from mentees about myself and approach to science

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- Listen to mentees

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- 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!