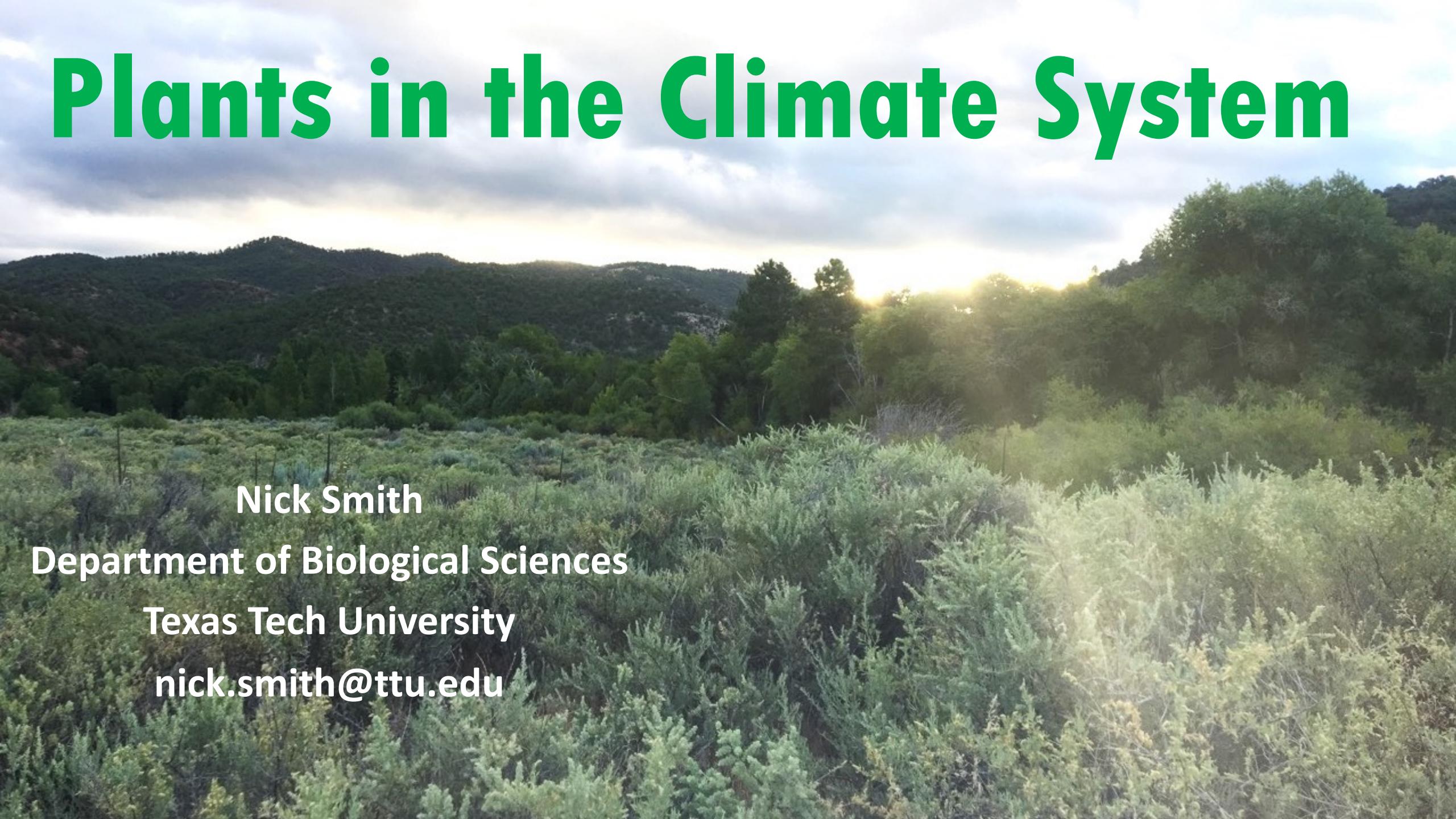


Plants in the Climate System

A scenic landscape featuring rolling hills covered in dense green vegetation, likely shrubs and small trees. The sky is filled with soft, scattered clouds. A bright sun is positioned low on the horizon, casting a warm glow and creating lens flare effects across the scene.

Nick Smith

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Why do people care about plants?

Why do people care about plants?



Why do people care about plants?



Why do people care about plants?



Why do people care about plants?



Why do people care about plants?



Why do people care about plants?



Why do people care about plants?



Why do people care about plants?



But plants also affect climate!

Plant influence on climate

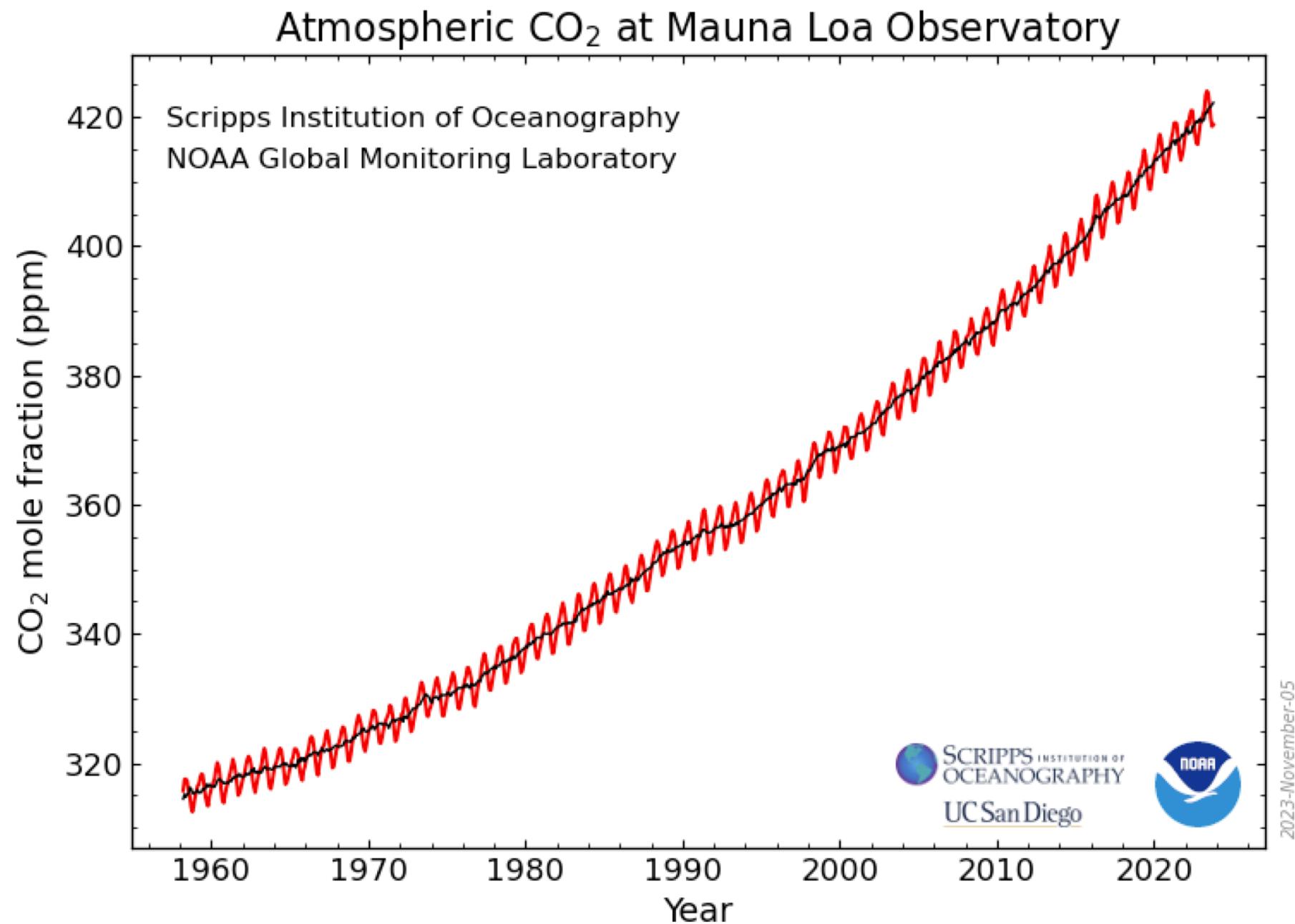
1. Carbon uptake
2. Evapotranspiration (energy transfer)
3. Albedo (surface color)

Plant influence on climate

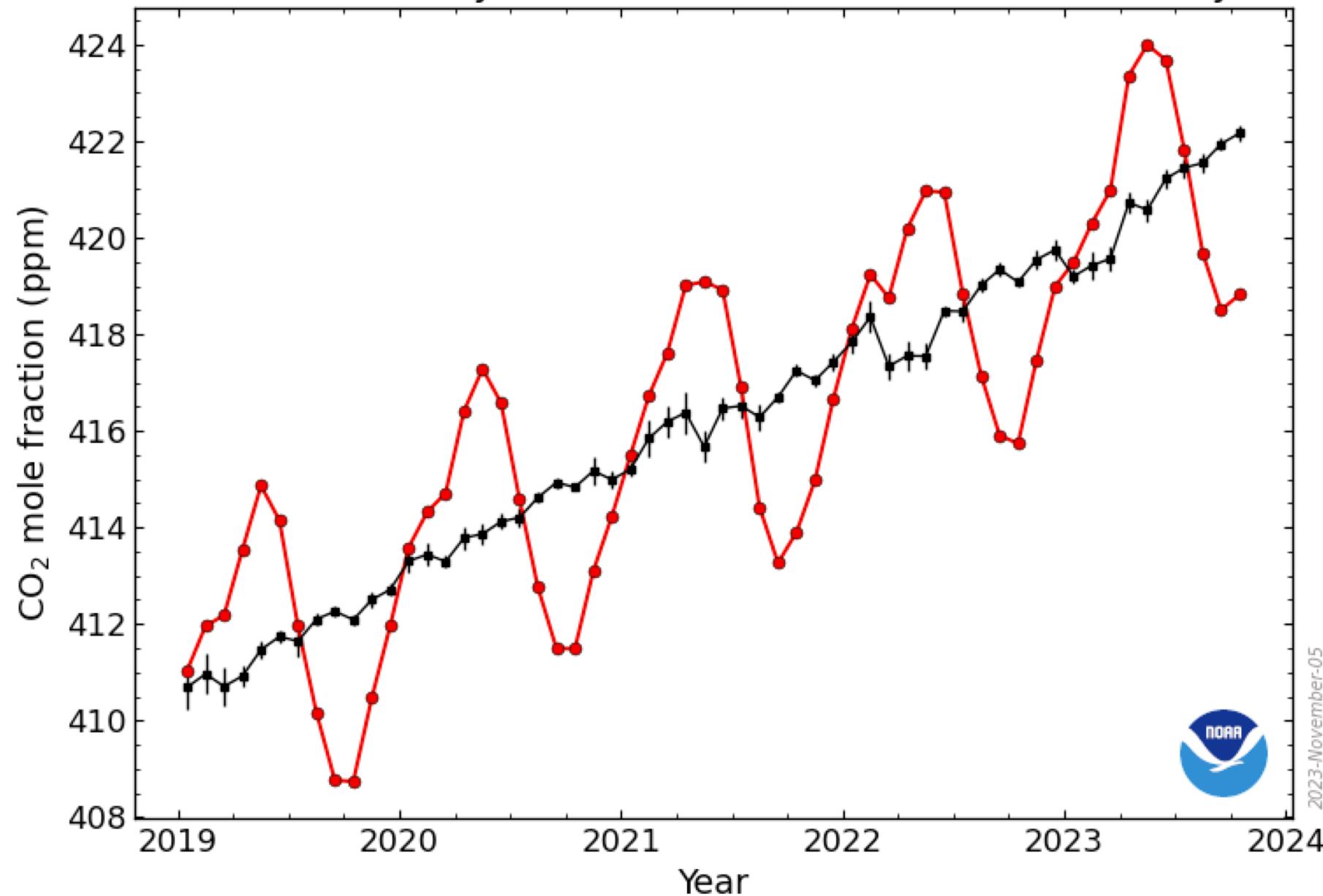
1. Carbon uptake

2. Evapotranspiration (energy transfer)

3. Albedo (surface color)

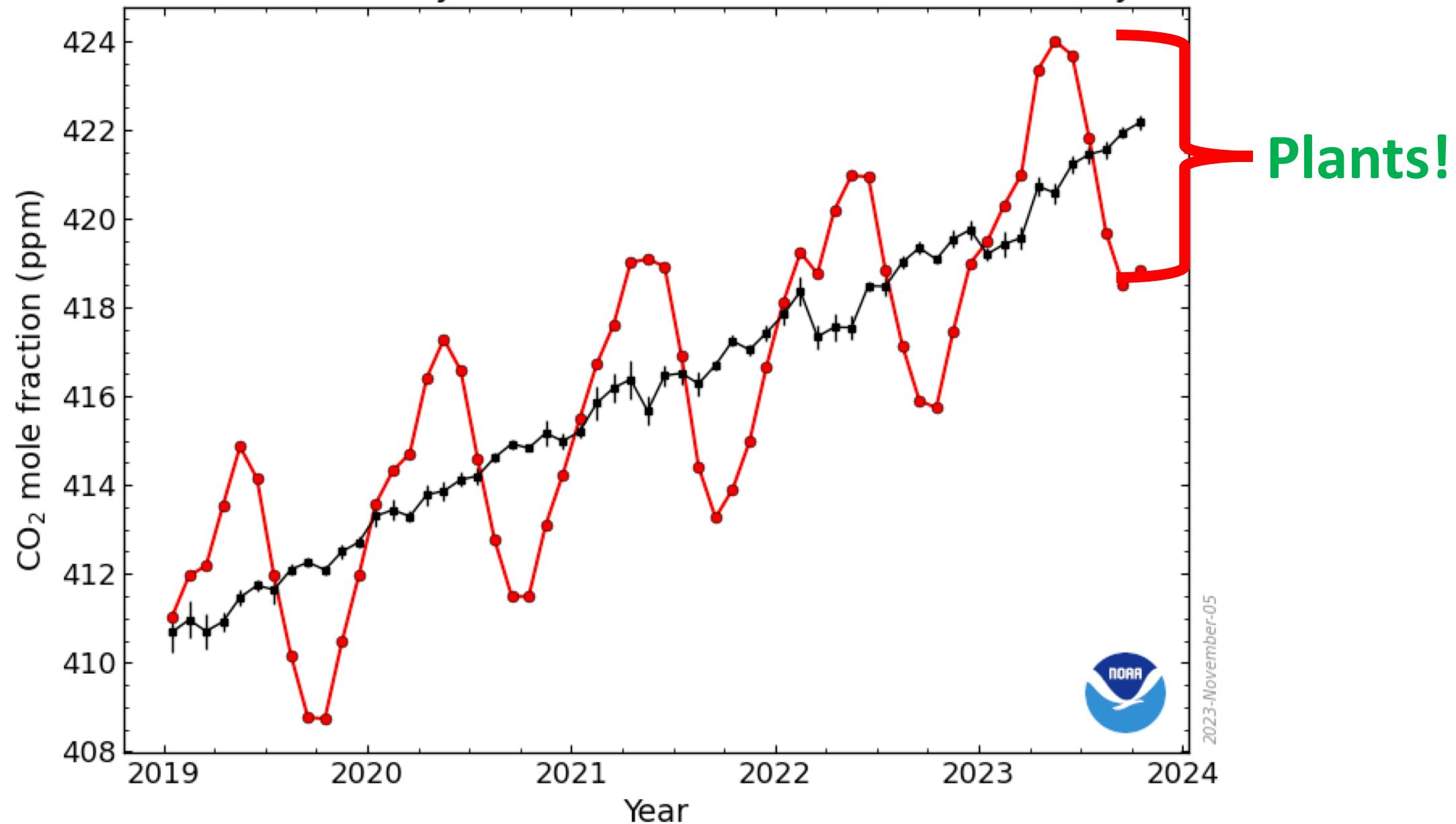


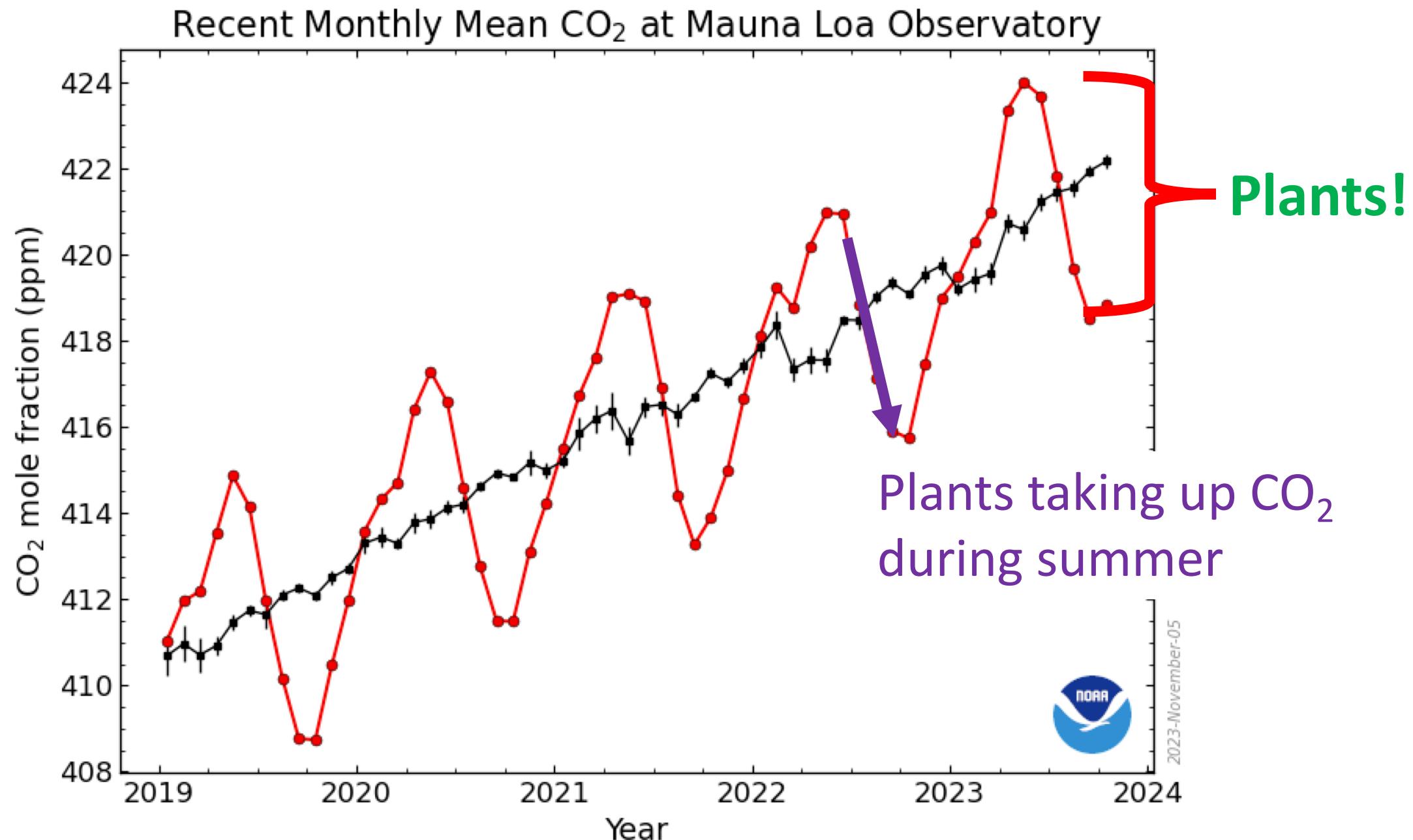
Recent Monthly Mean CO₂ at Mauna Loa Observatory



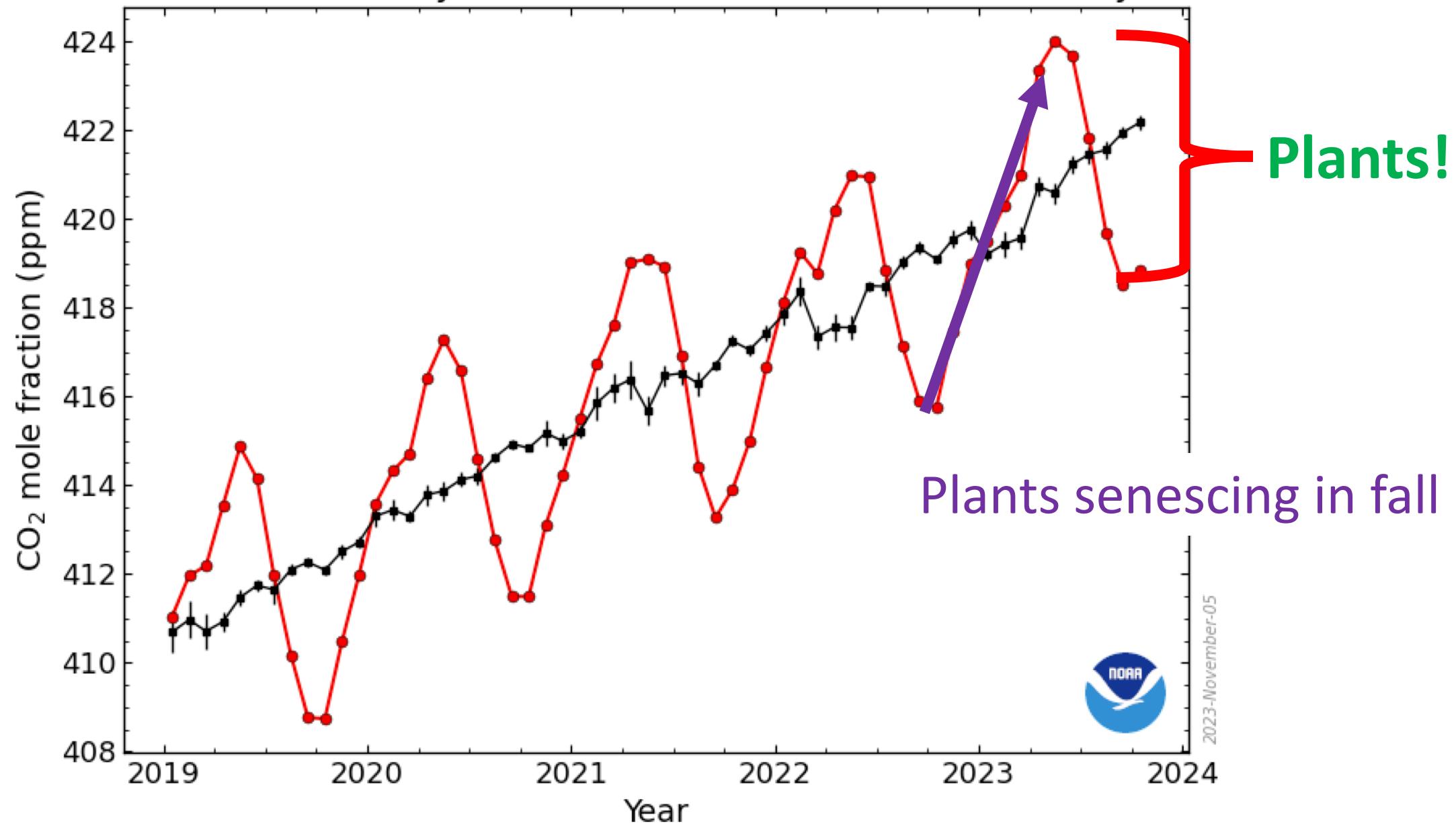
2023-November-05

Recent Monthly Mean CO₂ at Mauna Loa Observatory





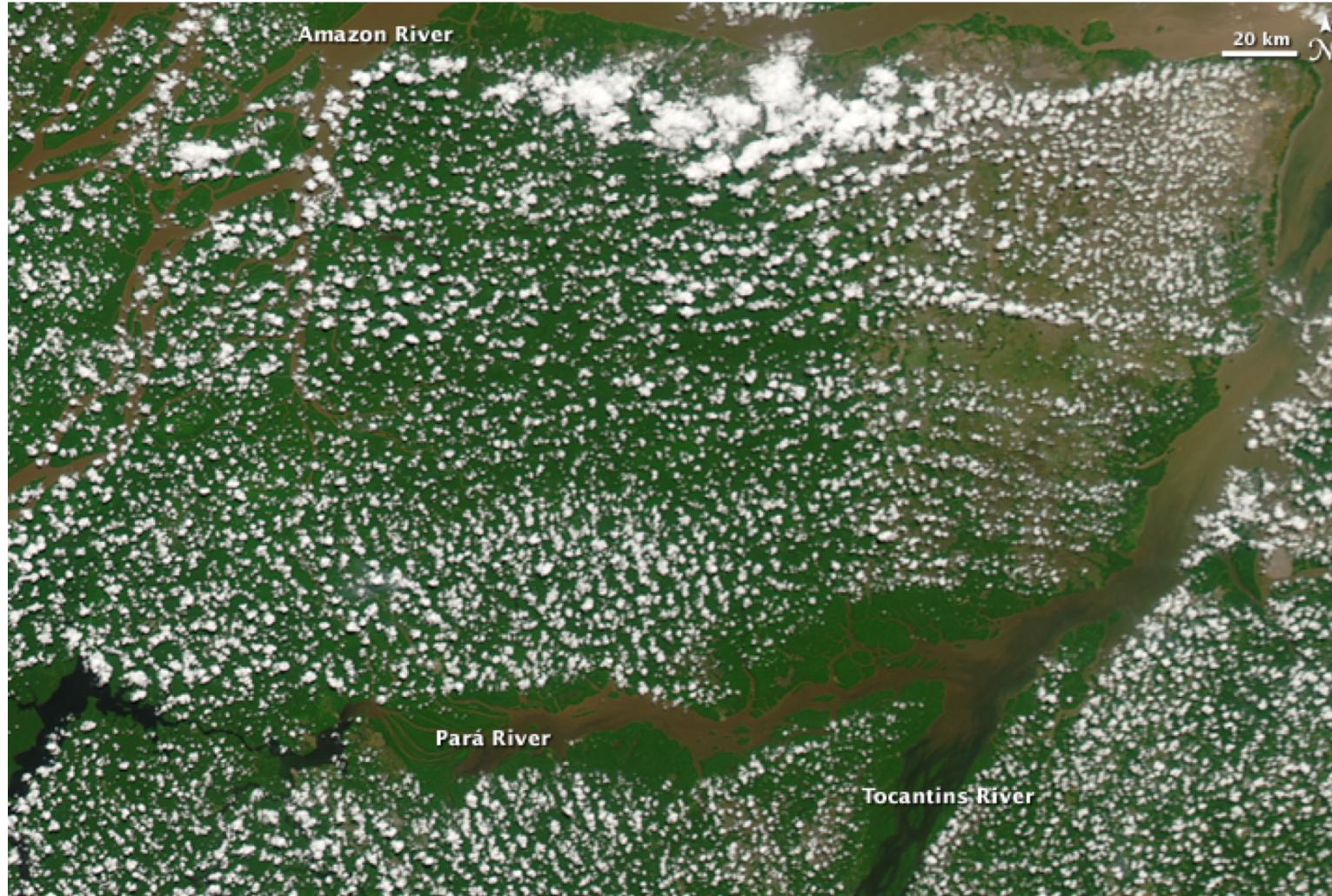
Recent Monthly Mean CO₂ at Mauna Loa Observatory



Plant influence on climate

1. Carbon uptake
2. Evapotranspiration (energy transfer)
3. Albedo (surface color)

Plants influence surface energy fluxes

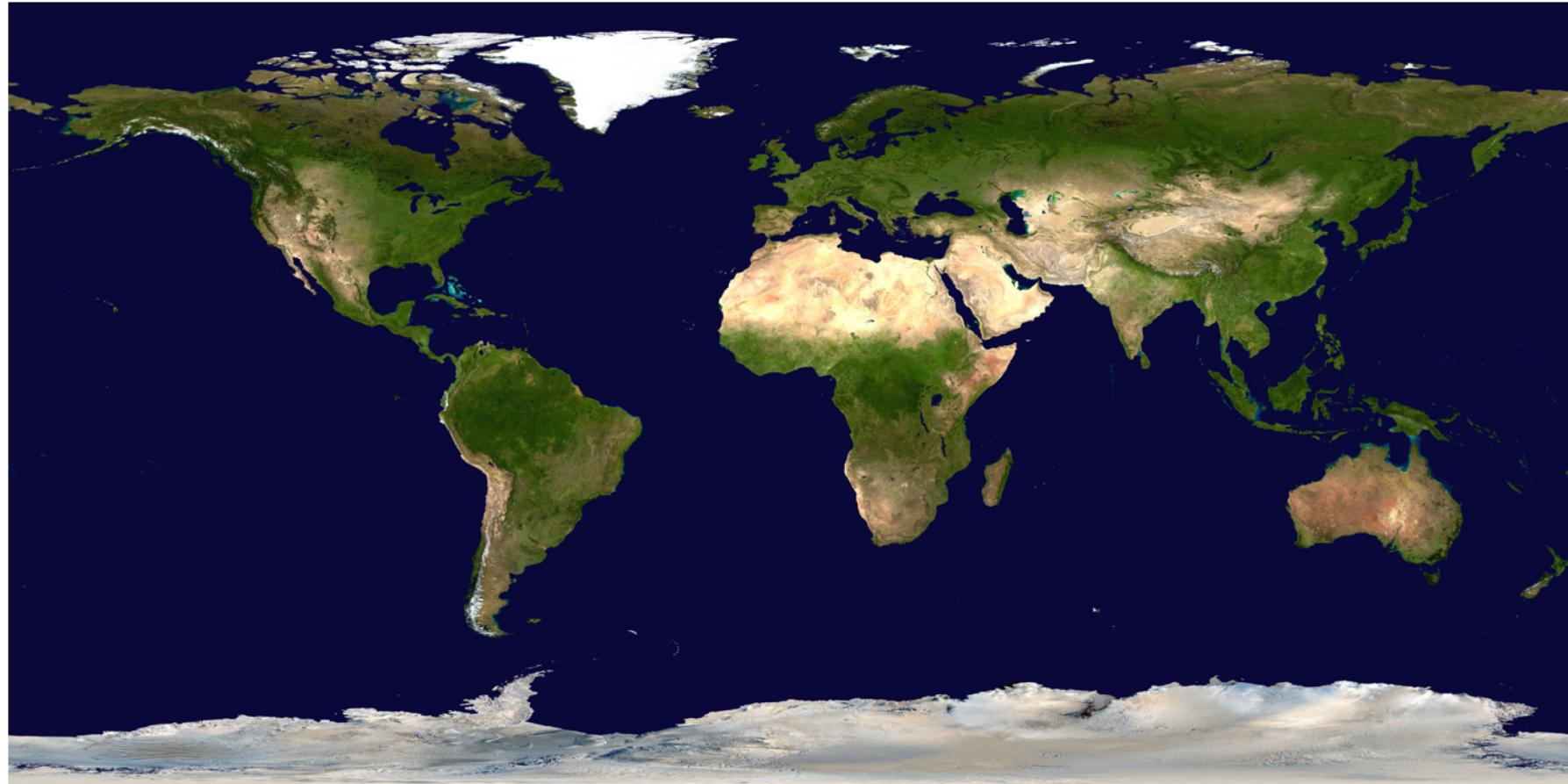


Transpiration cools the
land surface

Plant influence on climate

1. Carbon uptake
2. Evapotranspiration (energy transfer)
- 3. Albedo (surface color)**

Plants influence Earth's color



Darker = more energy absorbed = warmer

So, to know climate, we need to
model plants

So, to know climate, we need to model plants



$$f(X, Y, Z)$$

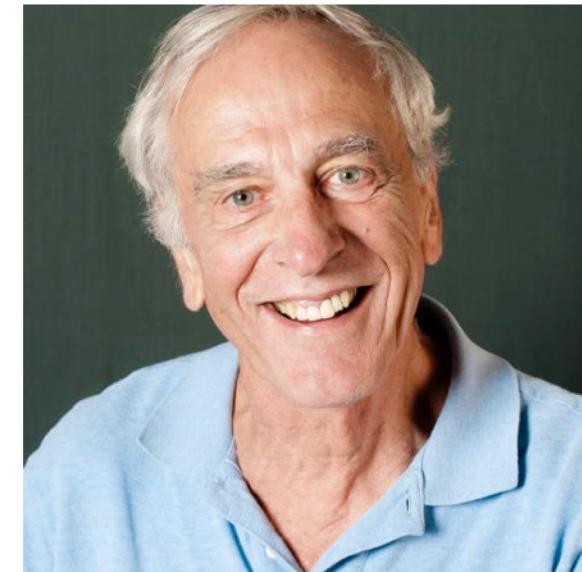
1980's: plant models are developed

A Biochemical Model of Photosynthetic CO₂ Assimilation in Leaves of C₃ Species

G.D. Farquhar¹, S. von Caemmerer¹, and J.A. Berry²

¹ Department of Environmental Biology, Research School of Biological Sciences, Australian National University, P.O. Box 475, Canberra City ACT 2601, Australia and

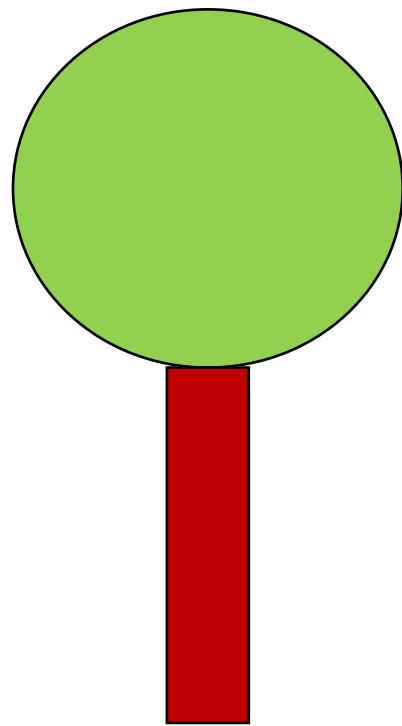
² Carnegie Institution of Washington, Department of Plant Biology, Stanford, Cal. 94305, USA



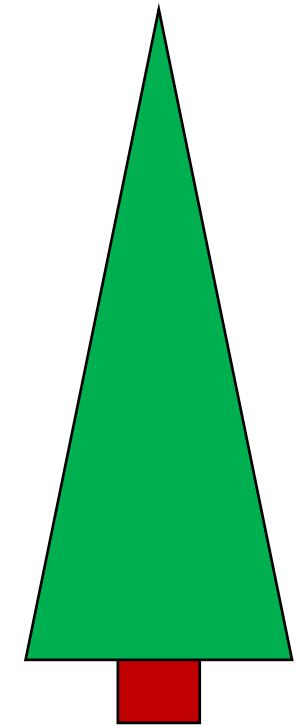
90's to 2000's: spinach world!



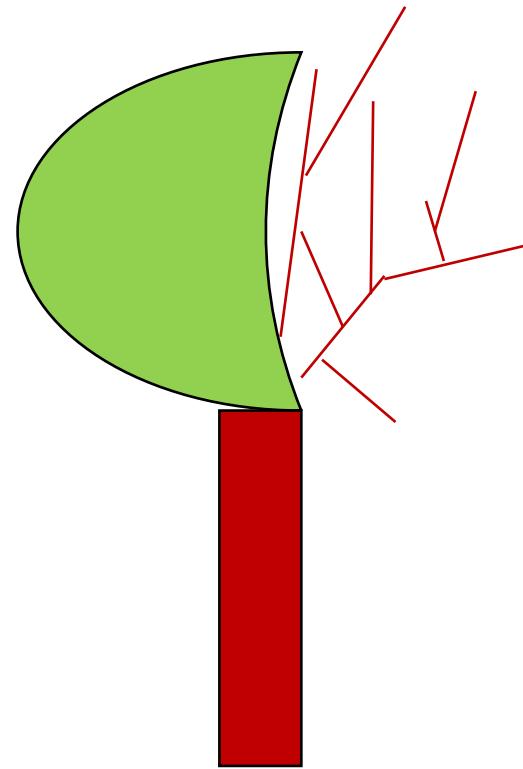
2000's: 5 – 10 plant "types"



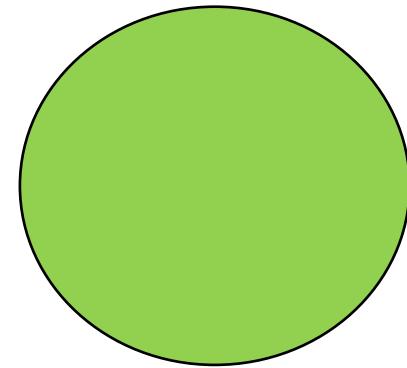
Broadleaf tree



Needleleaf tree



Deciduous tree

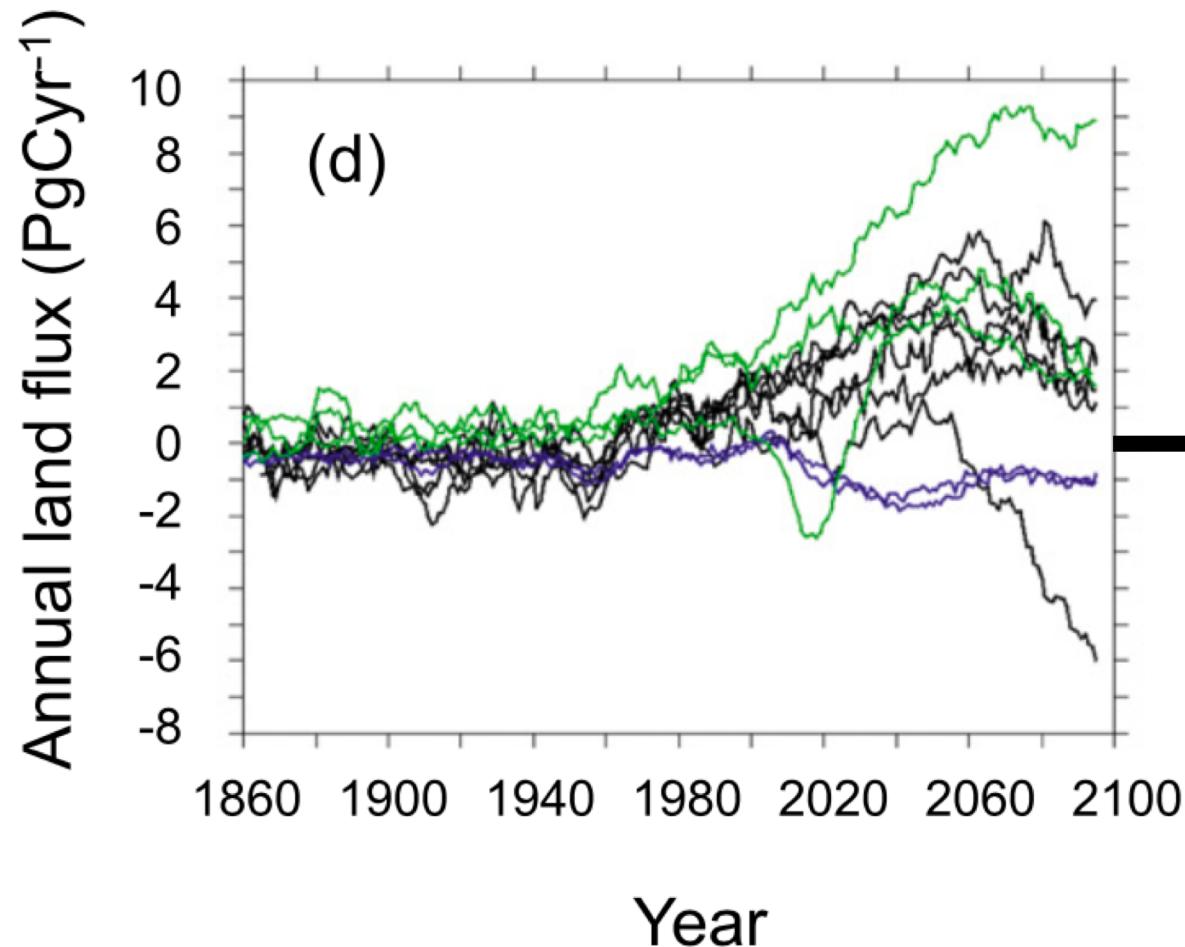


Shrub



Grass

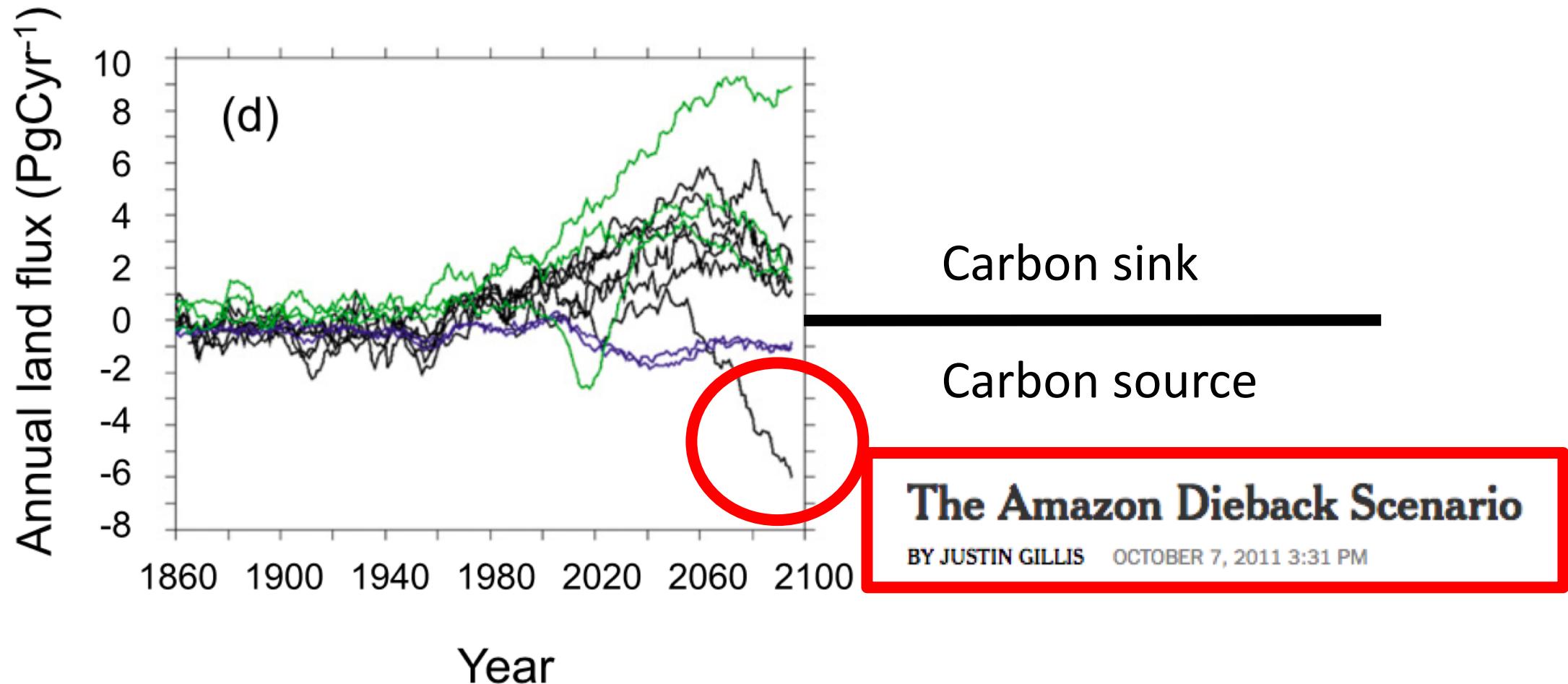
...but the models still vary

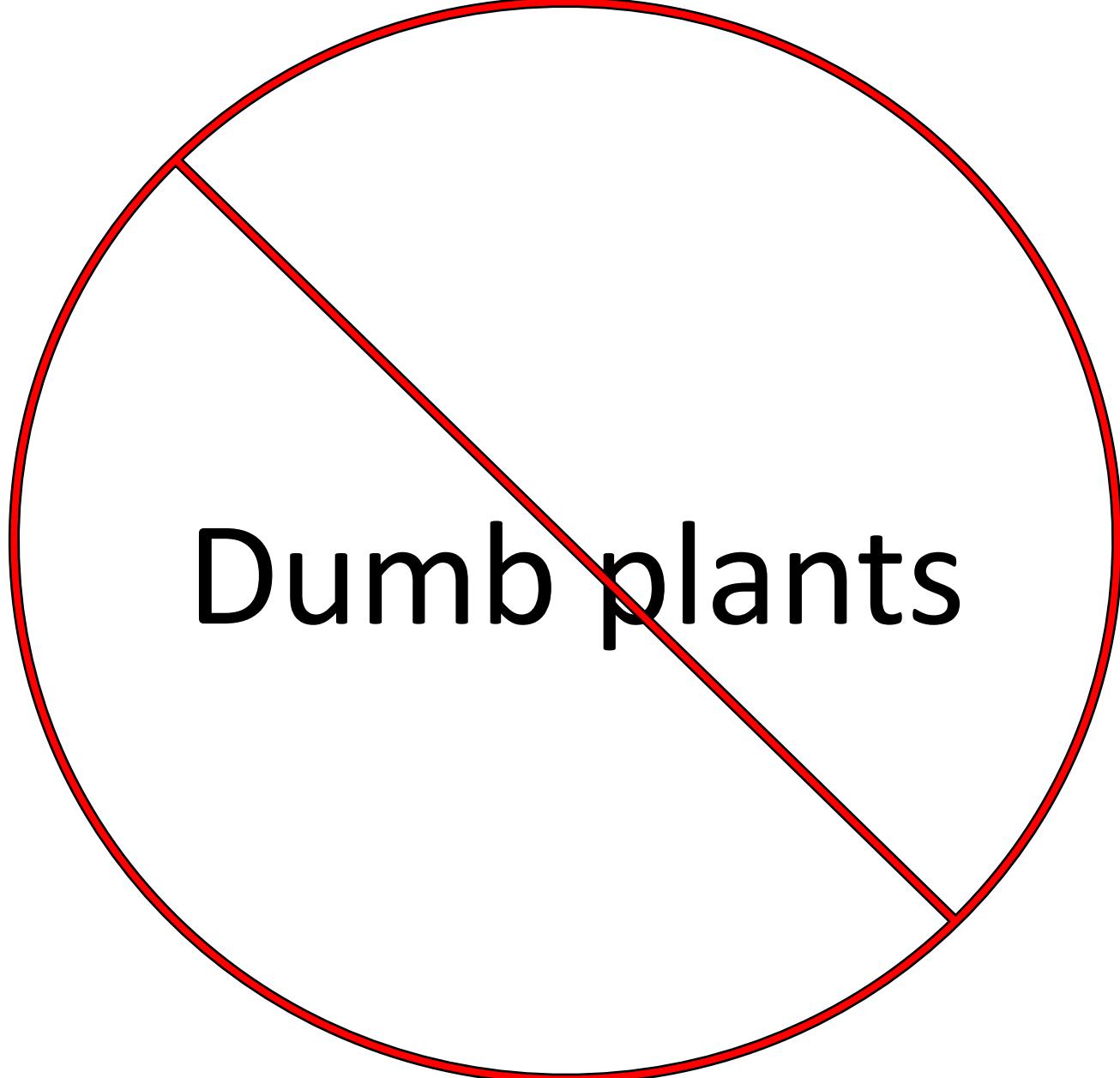


Carbon sink

Carbon source

And some make scary predictions!





Dumb plants

2010's: "Smart" plants

With time, plants will acclimate to environmental perturbations, such as elevated temperature and CO₂.



Global Change Biology (2013) 19, 45–63, doi: 10.1111/j.1365-2486.2012.02797.x

REVIEW

Plant respiration and photosynthesis in global-scale models: incorporating acclimation to temperature and CO₂

NICHOLAS G SMITH* and JEFFREY S DUKES*†

2010's: "Smart" plants

Acclimation reduces plant sensitivity to climate.

nature
climate change

LETTERS

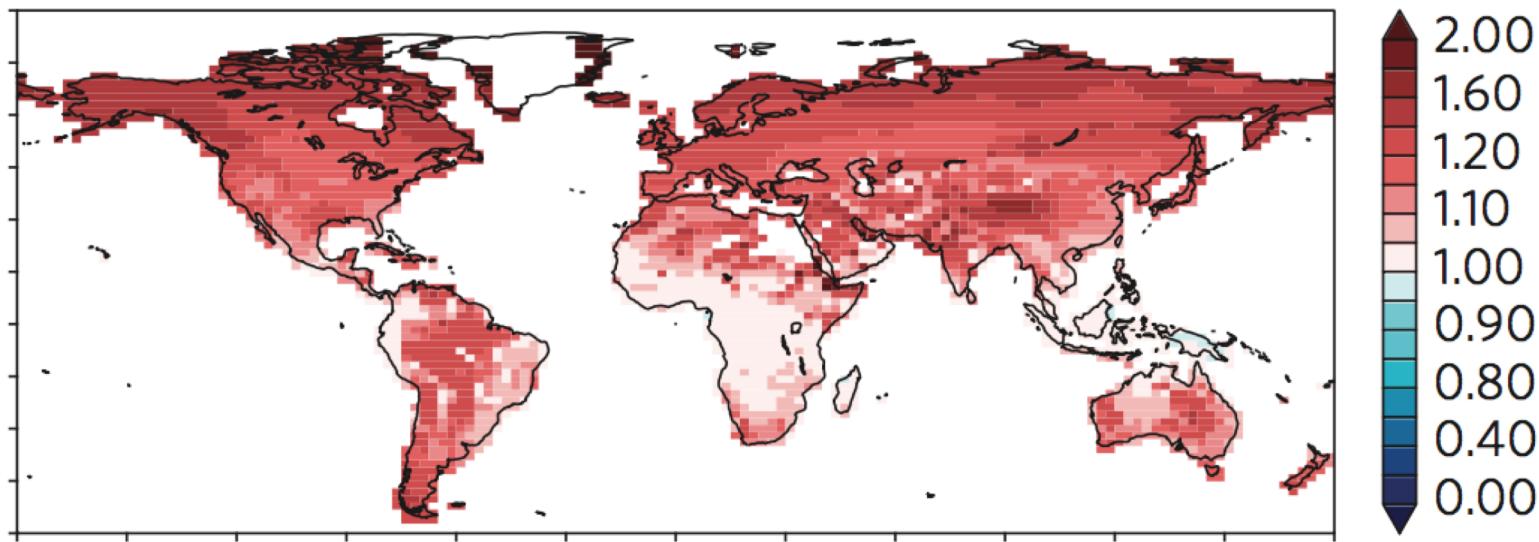
PUBLISHED ONLINE: 7 DECEMBER 2015 | DOI: 10.1038/NCLIMATE2878

Foliar temperature acclimation reduces simulated carbon sensitivity to climate

Nicholas G. Smith^{1*}, Sergey L. Malyshev², Elena Shevliakova², Jens Kattge^{3,4} and Jeffrey S. Dukes^{1,5}

2010's: "Smart" plants

Acclimation reduces plant sensitivity to climate, which increases future carbon uptake (no Amazon dieback).



Effect of acclimation on future photosynthetic capacity ($\mu\text{mol m}^{-2} \text{s}^{-1}$).
Note: 1: no change; >1: increase; <1: decrease

nature
climate change

LETTERS

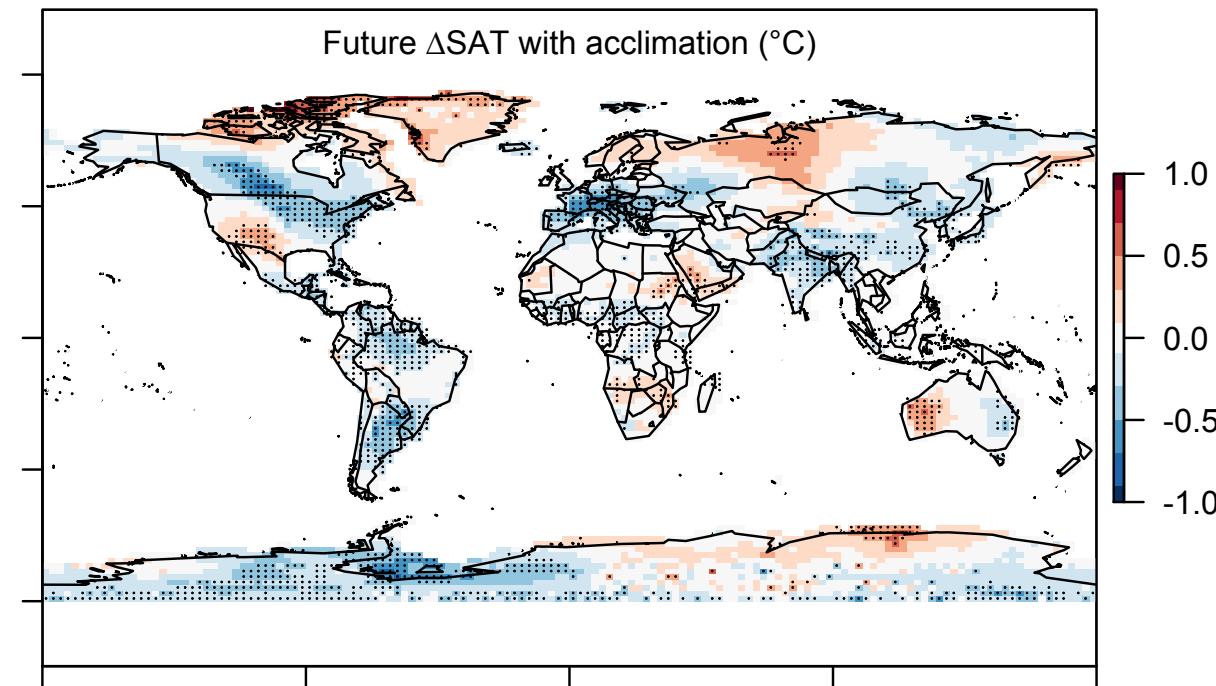
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2010's: "Smart" plants

Acclimation reduces plant sensitivity to climate, which increases future evaporative cooling.



AGU PUBLICATIONS

Journal of Advances in Modeling Earth Systems

RESEARCH ARTICLE

10.1002/2016MS000732

Biophysical consequences of photosynthetic temperature acclimation for climate

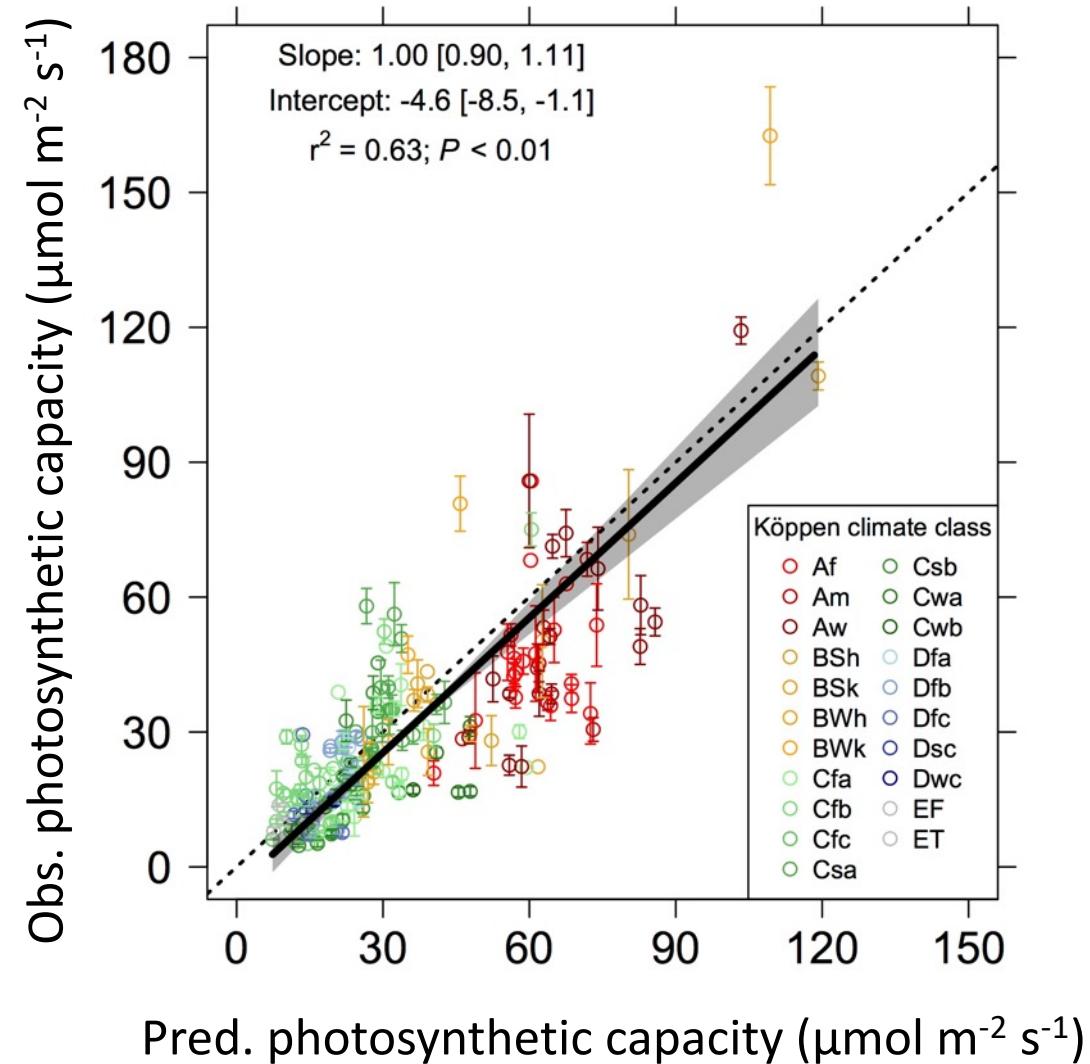
Key Points:
• We assessed the biophysical influence of photosynthetic

Nicholas G. Smith^{1,2,3,4}, Danica Lombardozzi⁵, Ahmed Tawfik³, Gordon Bonan⁵, and Jeffrey S. Dukes^{1,2,3}

2010's: "Smart" plants

A theoretical model of acclimation to everything!

- Temperature
- CO₂
- Light
- Moisture



... but how do humans fit in?

2020's: adding in the human dimension

2020's: adding in the human dimension

Example: What happens when you plant cover crops?

2020's: adding in the human dimension

Example: What happens when you plant cover crops?

1. Increase carbon uptake (cooling)

2020's: adding in the human dimension

Example: What happens when you plant cover crops?

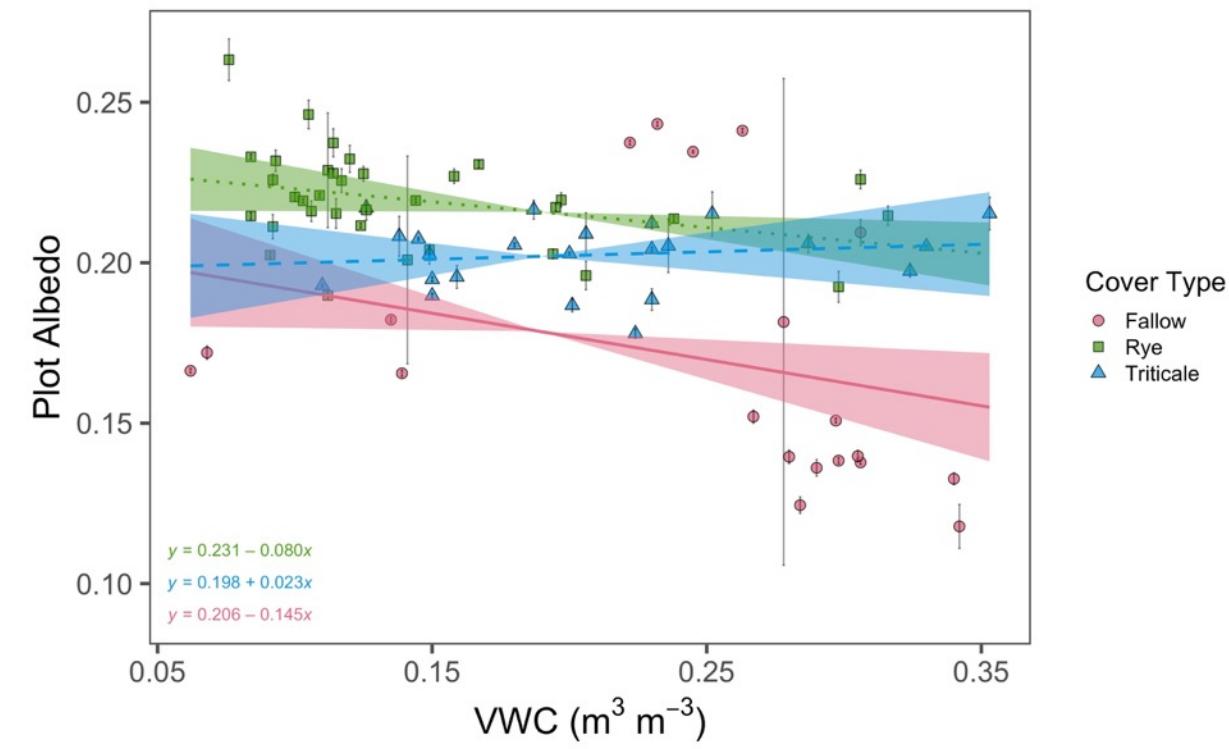
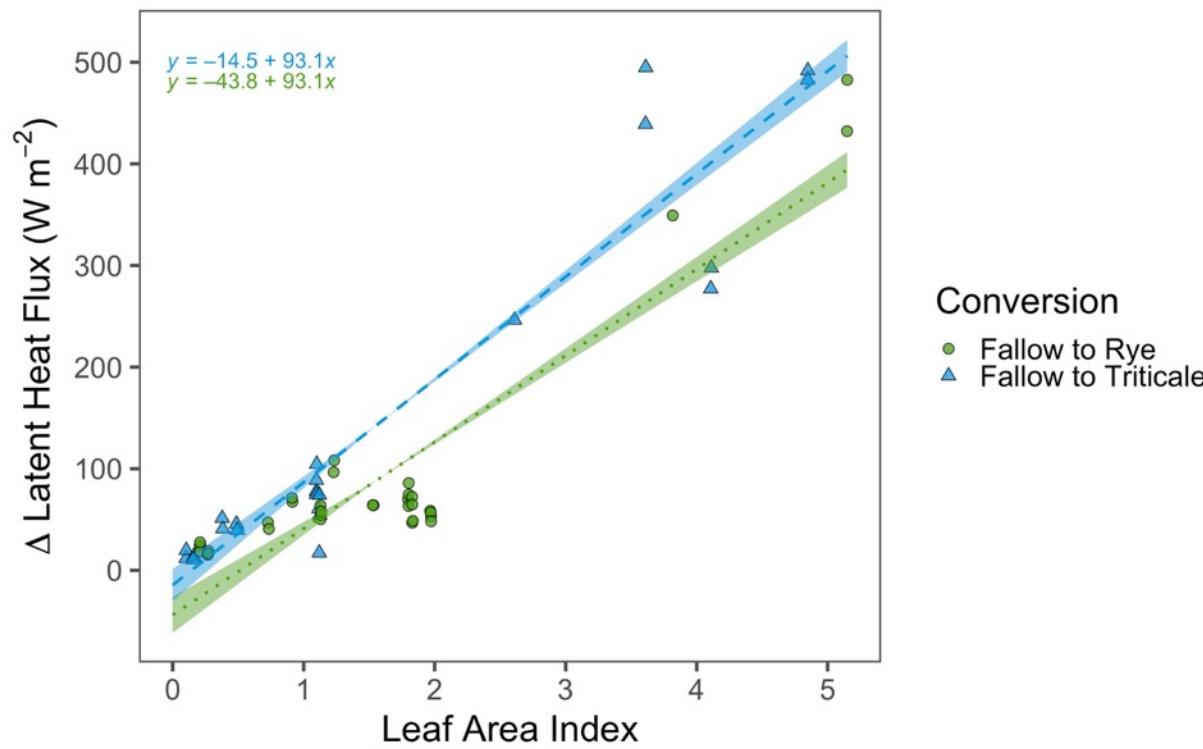
1. Increase carbon uptake (cooling)
2. Increase evapotranspiration (cooling)

2020's: adding in the human dimension

Example: What happens when you plant cover crops?

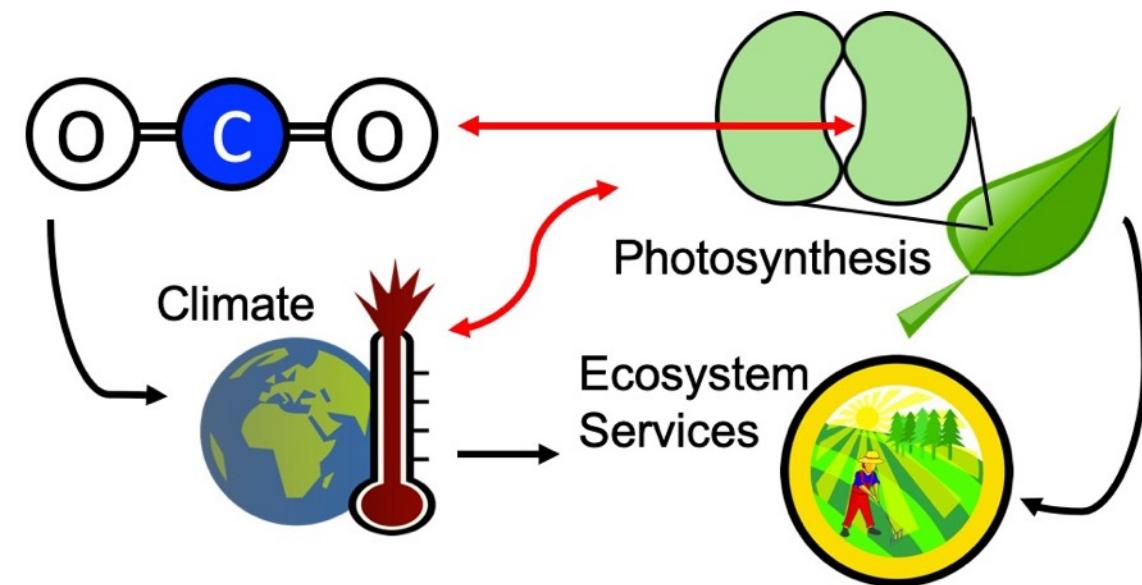
1. Increase carbon uptake (cooling)
2. Increase evapotranspiration (cooling)
3. Change energy reflection/albedo (warming/cooling)

2020's: adding in the human dimension



Smith Ecophysiology Lab at TTU

- How do plants respond and feedback to climate over **large spatial and temporal scales?**
- How is **human activity** modifying plant-climate feedbacks?
- Can we build **robust, reliable models** to represent these responses?



Presentation available at:

www.github.com/SmithEcophysLab/seminar/2023_sbtg

Nick Smith

nick.smith@ttu.edu

