



# MetaBIO IDS

## A holistic approach to space-based terrestrial ecosystem science

*Award Number: NNH17AE86I*

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*Trevor F. Keenan*  
*Assistant Professor, UC Berkeley*  
*Faculty Scientist, Lawrence Berkeley National Lab.*



MetaBIO IDS:

Merging Top-Down and Bottom-Up Approaches to Partition Carbon and Water Fluxes between the Atmosphere and Biosphere

Trevor Keenan



Anna Michalak



Josh Fisher



Remi Luo



Yao Zhang

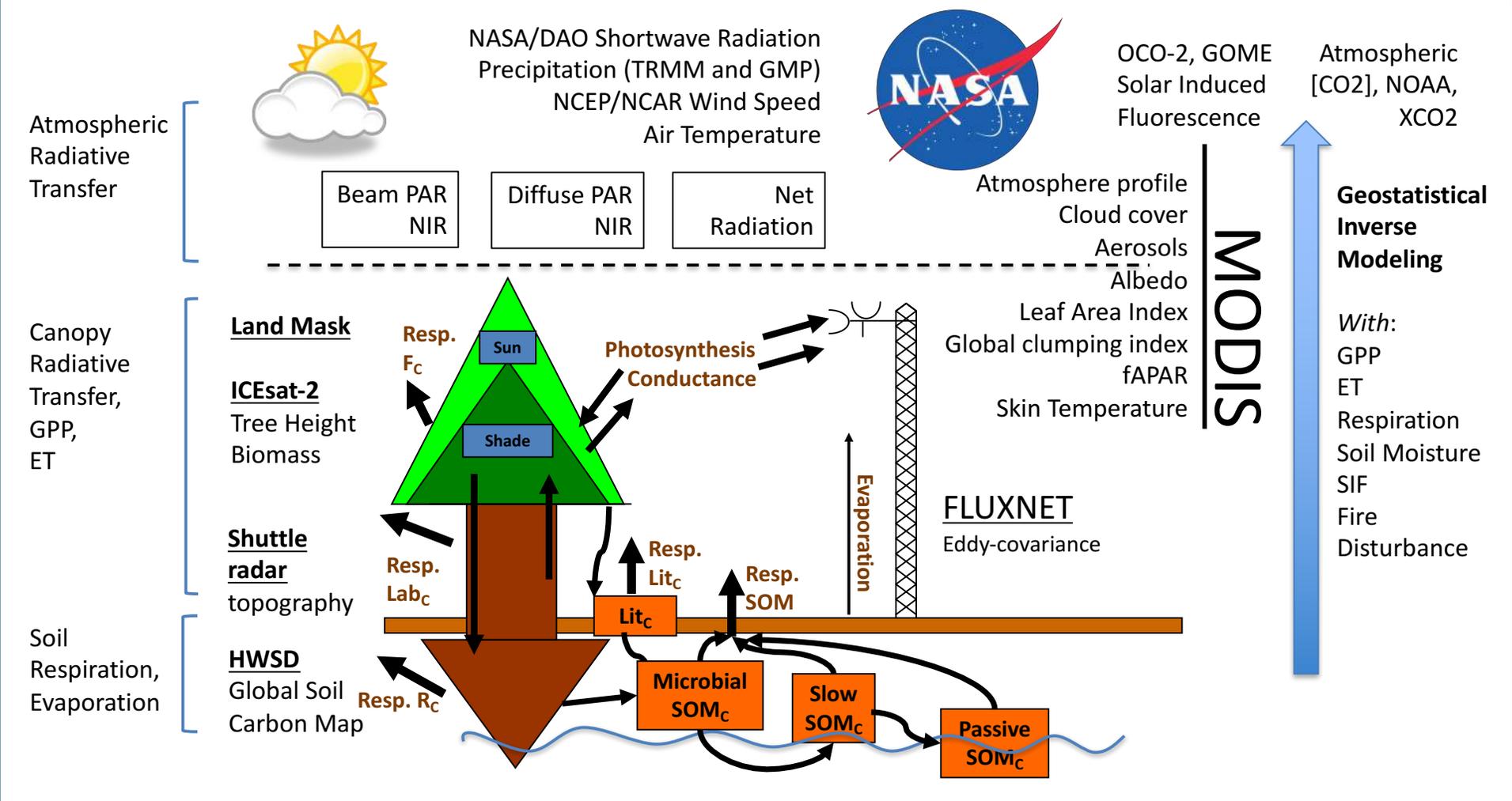


Wu Sun



Yuanyuan Fang

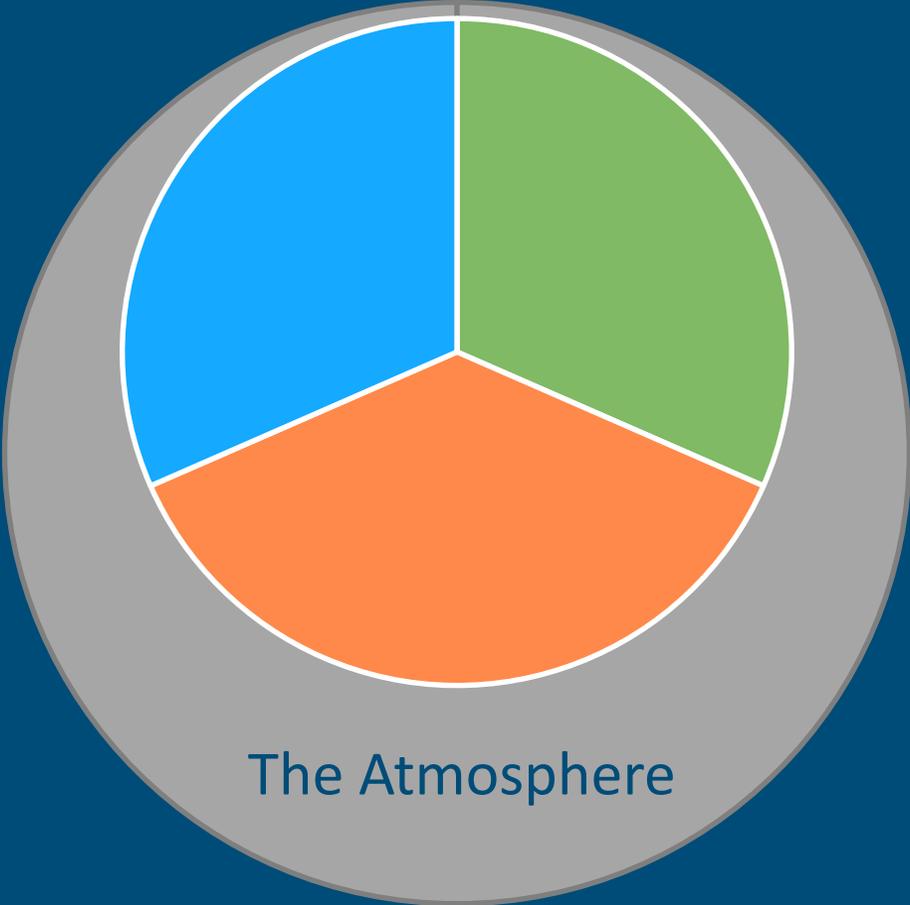


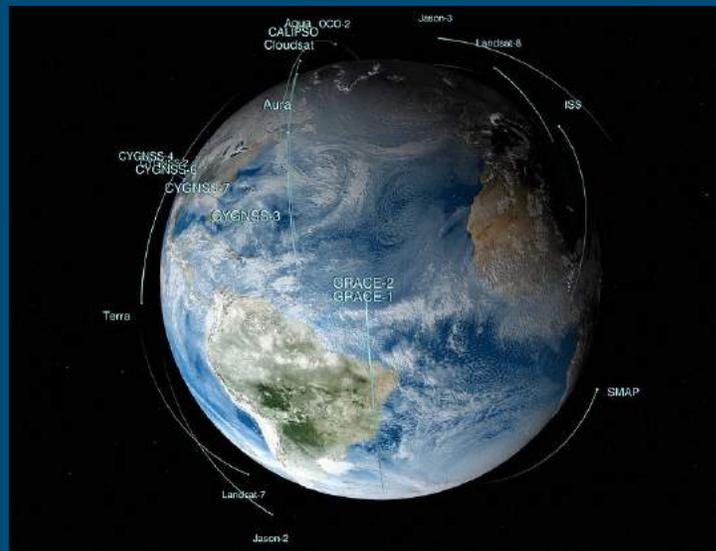


States Traits Rates



States Traits Rates





- States: Environmental controls of biomass and vegetation cover
- Traits: Photosynthetic potential
- Rates: Global photosynthesis

> 35 papers (published or in press)



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## Greening of the Earth and its drivers

Zaichun Zhu<sup>1,2</sup>, Shilong Piao<sup>1,2\*</sup>, Ranga B. Myneni<sup>3</sup>, Mengtian Huang<sup>2</sup>, Zhenzhong Zeng<sup>2</sup>,

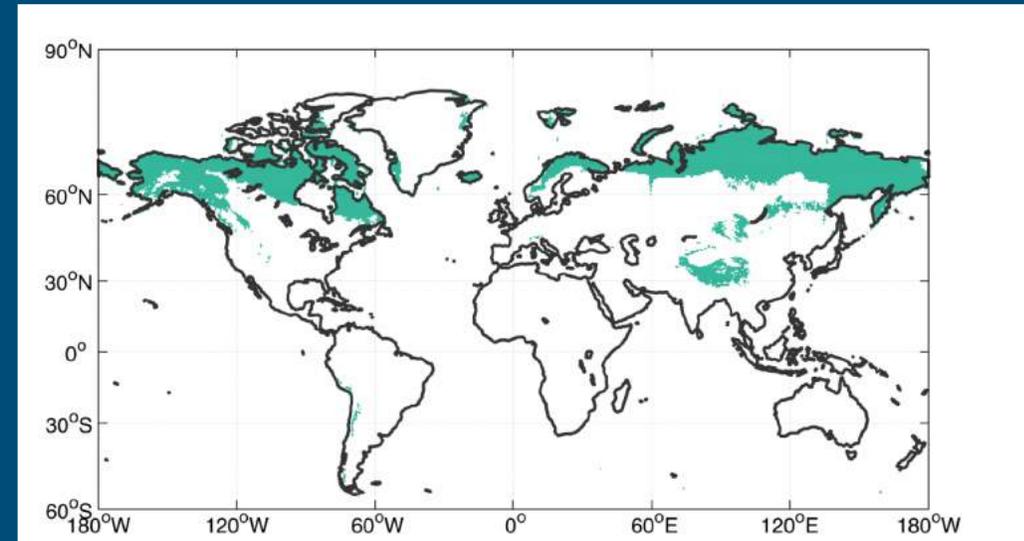
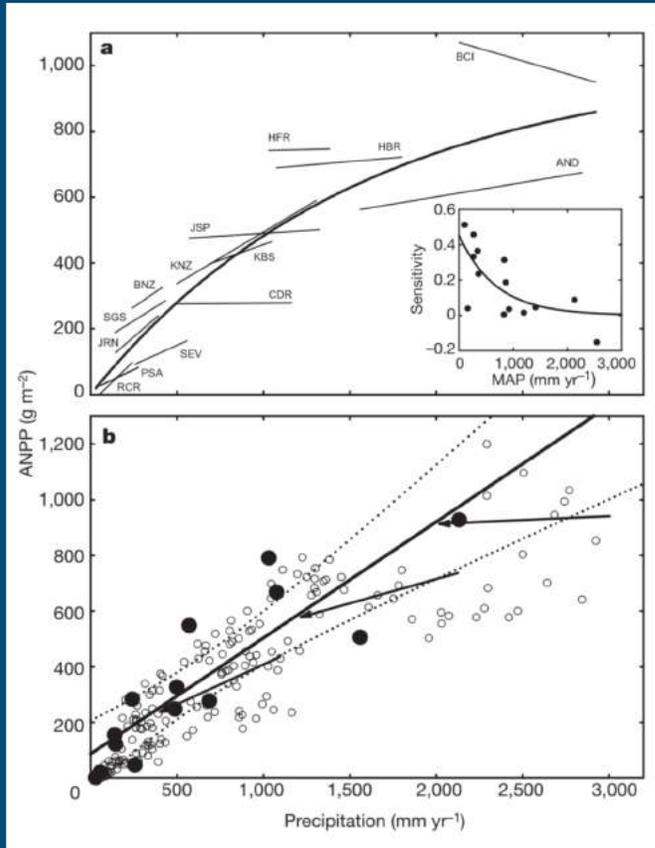
## Human-induced greening of the northern extratropical land surface

Jiafu Mao<sup>1\*</sup>, Aurélien Ribes<sup>2</sup>, Binyan Yan<sup>3</sup>, Xiaoying Shi<sup>1</sup>, Peter E. Thornton<sup>1</sup>, Roland Séférian<sup>2</sup>,

**Analysis of trends in fused AVHRR and MODIS NDVI data for 1982–2006: Indication for a CO<sub>2</sub> fertilization effect in global vegetation**

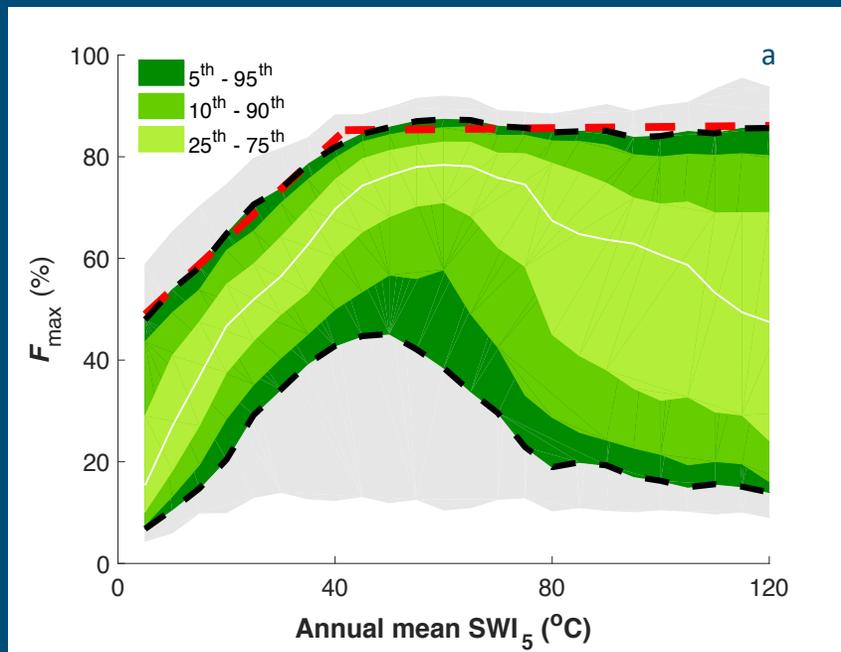
S. O. Los<sup>1</sup>

# Ecosystem States: constraints on vegetation cover



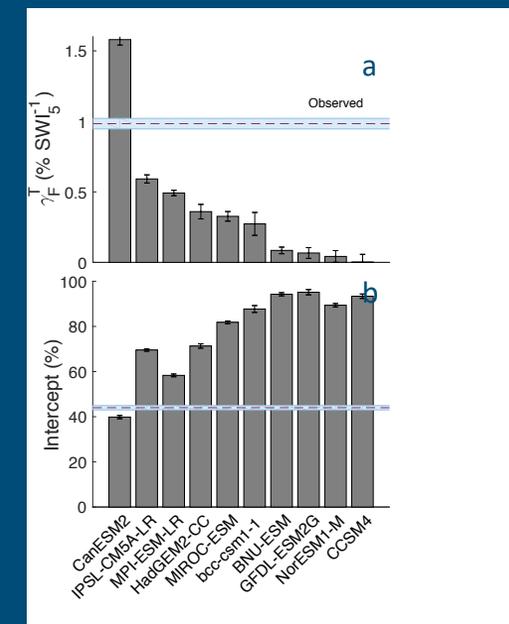
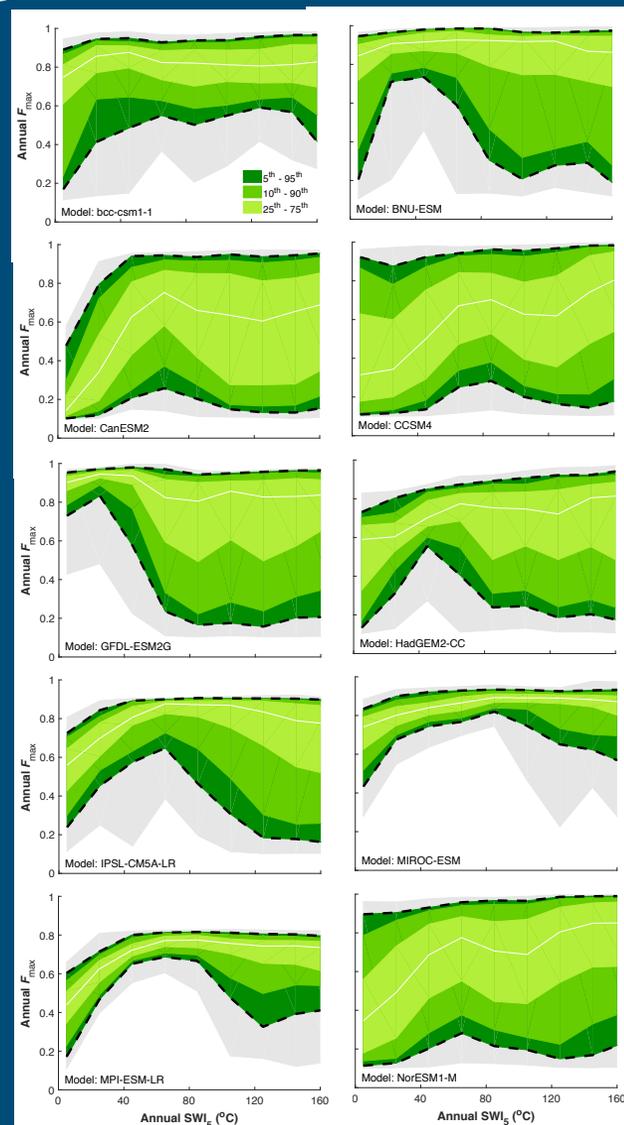
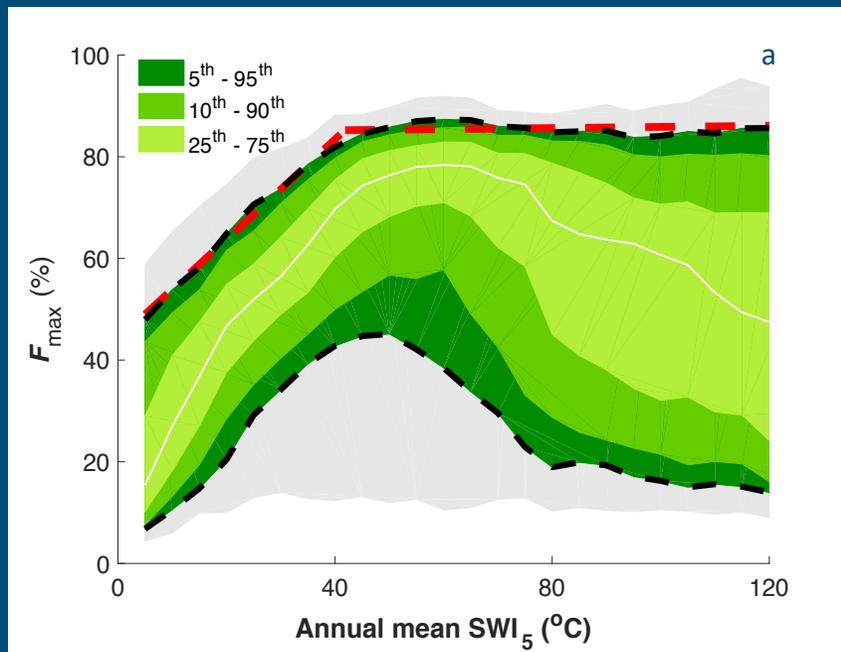
Huxman et al., 2004

# Ecosystem States: constraints on vegetation cover



Keenan and Riley (2019)  
Nature Climate Change

# Ecosystem States: constraints on vegetation cover



Keenan and Riley (2019)  
Nature Climate Change

# Ecosystem States: responses of biomass and LAI to CO<sub>2</sub>



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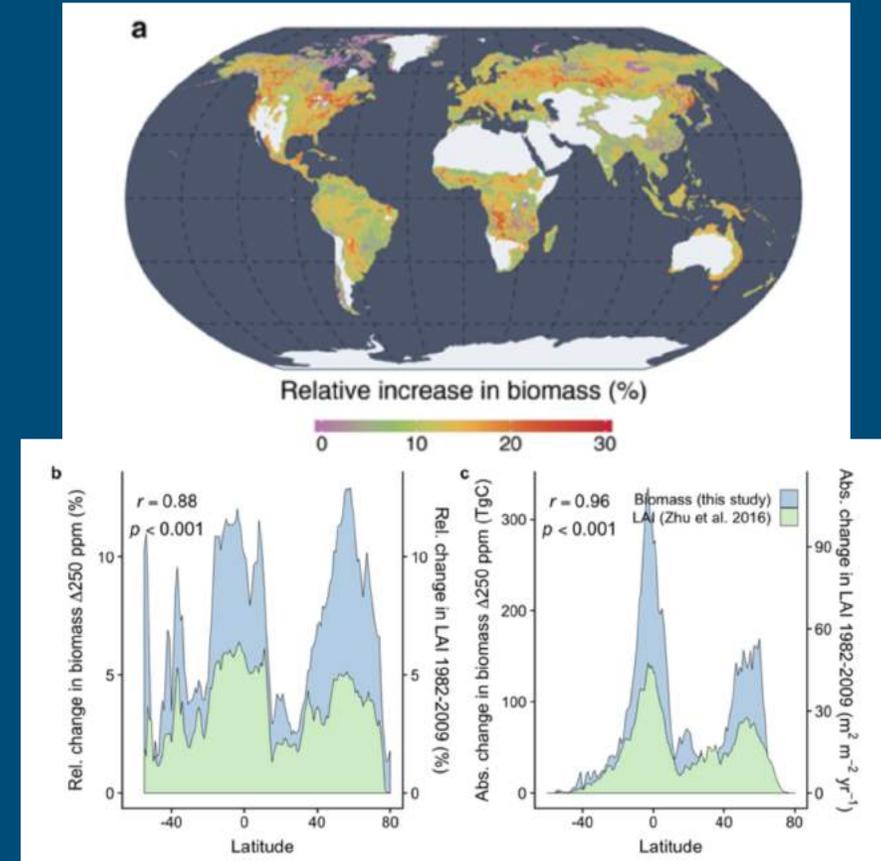


nature  
climate change

Letter | Published: 12 August 2019

Nitrogen and phosphorus constrain the CO<sub>2</sub> fertilization of global plant biomass

- We used FACE observations to estimate the effect of CO<sub>2</sub> on biomass
- And related the projected response with observed historic changes in biomass and LAI



Terrer et al. (2019) Nature Climate Change

# Physiological Traits



# Physiological Traits: Vcmax

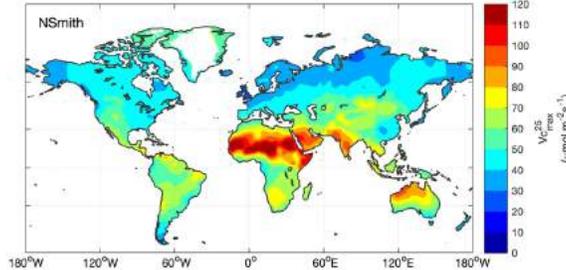
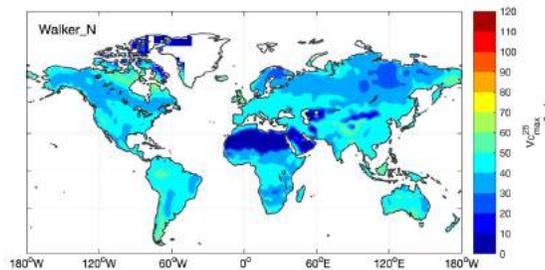
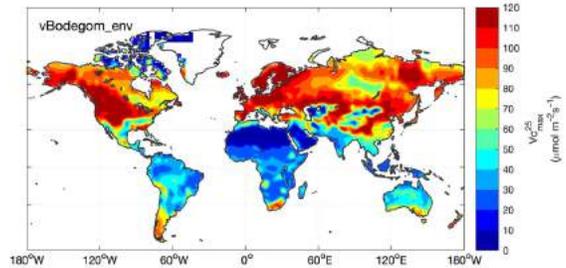
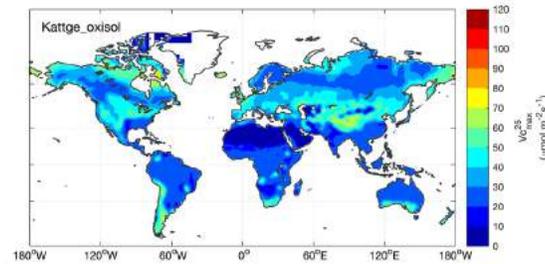
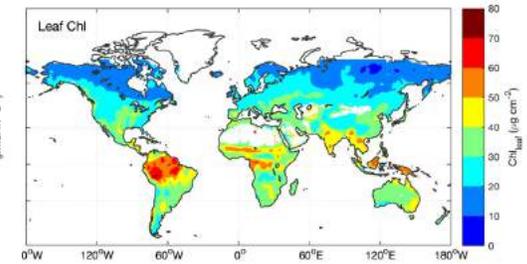
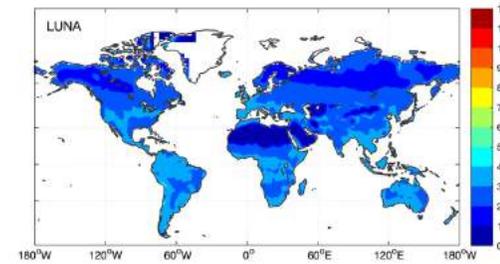
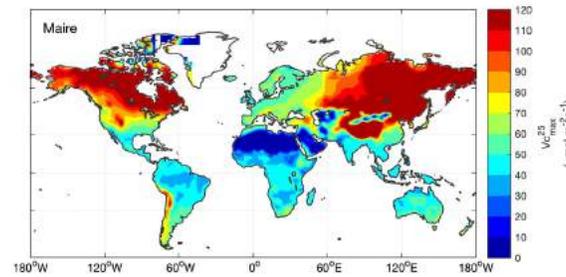
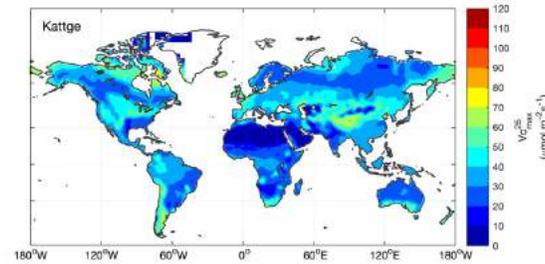


Nutrient limitation

Climate

Climate & Nutrient limitation

Leaf Chl



Luo et al. (in prep)

# Photosynthetic Rates:



Drought and CO<sub>2</sub>

# Photosynthetic Rates: the effect of drought

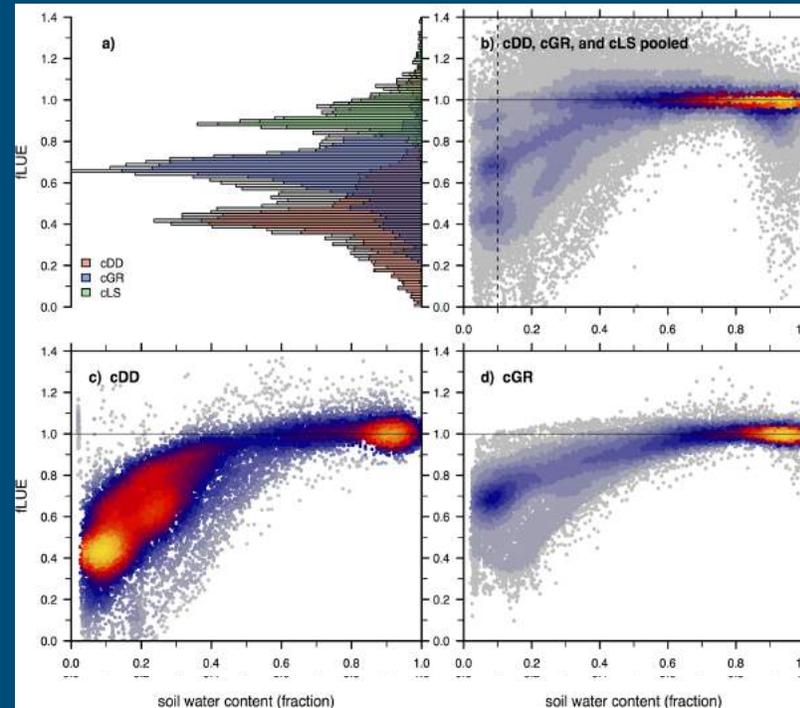


nature  
geoscience

Article | Published: 11 March 2019

Drought impacts on terrestrial primary production underestimated by satellite monitoring

Detecting and accounting for a drought related bias in satellite-based estimates of photosynthesis



Stocker et al. 2019

# Photosynthetic Rates: the effect of CO<sub>2</sub>



↑ CO<sub>2</sub>

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↑ CO<sub>2</sub>

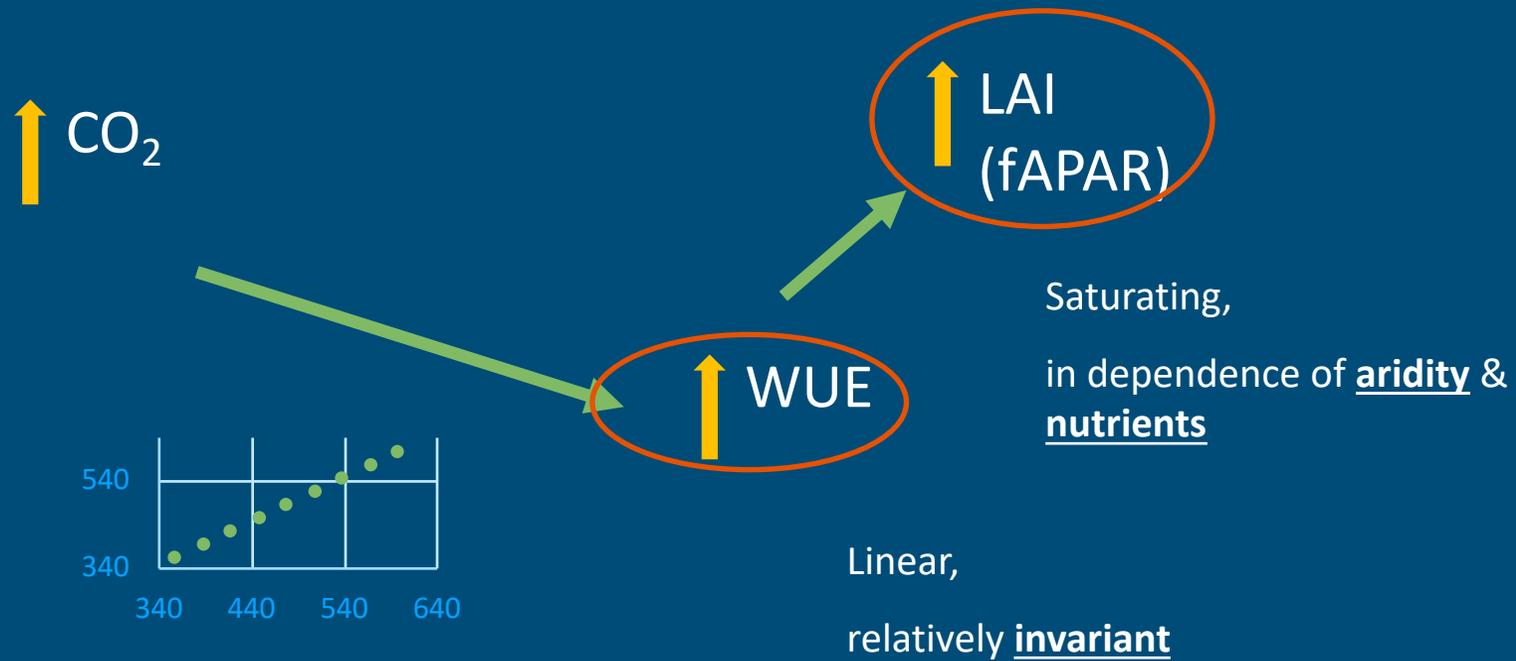


↑ WUE

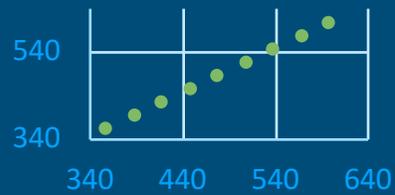
# Photosynthetic Rates: the effect of CO<sub>2</sub>



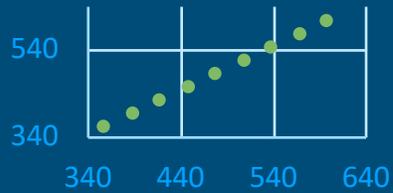
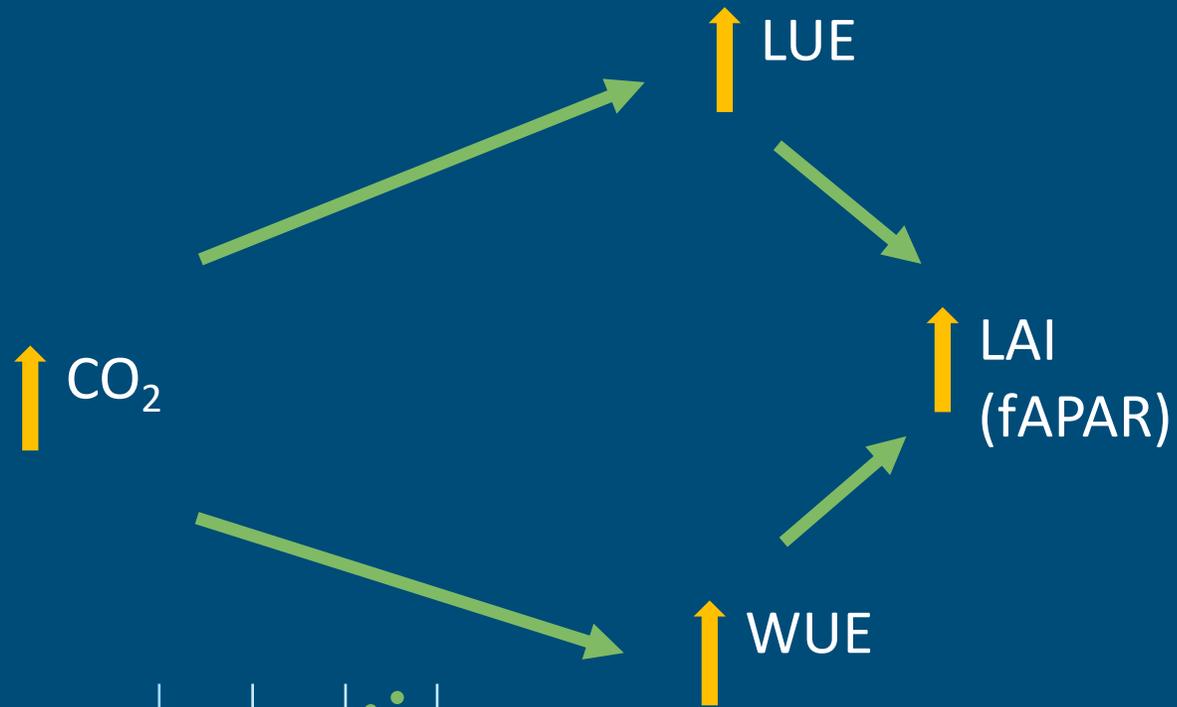
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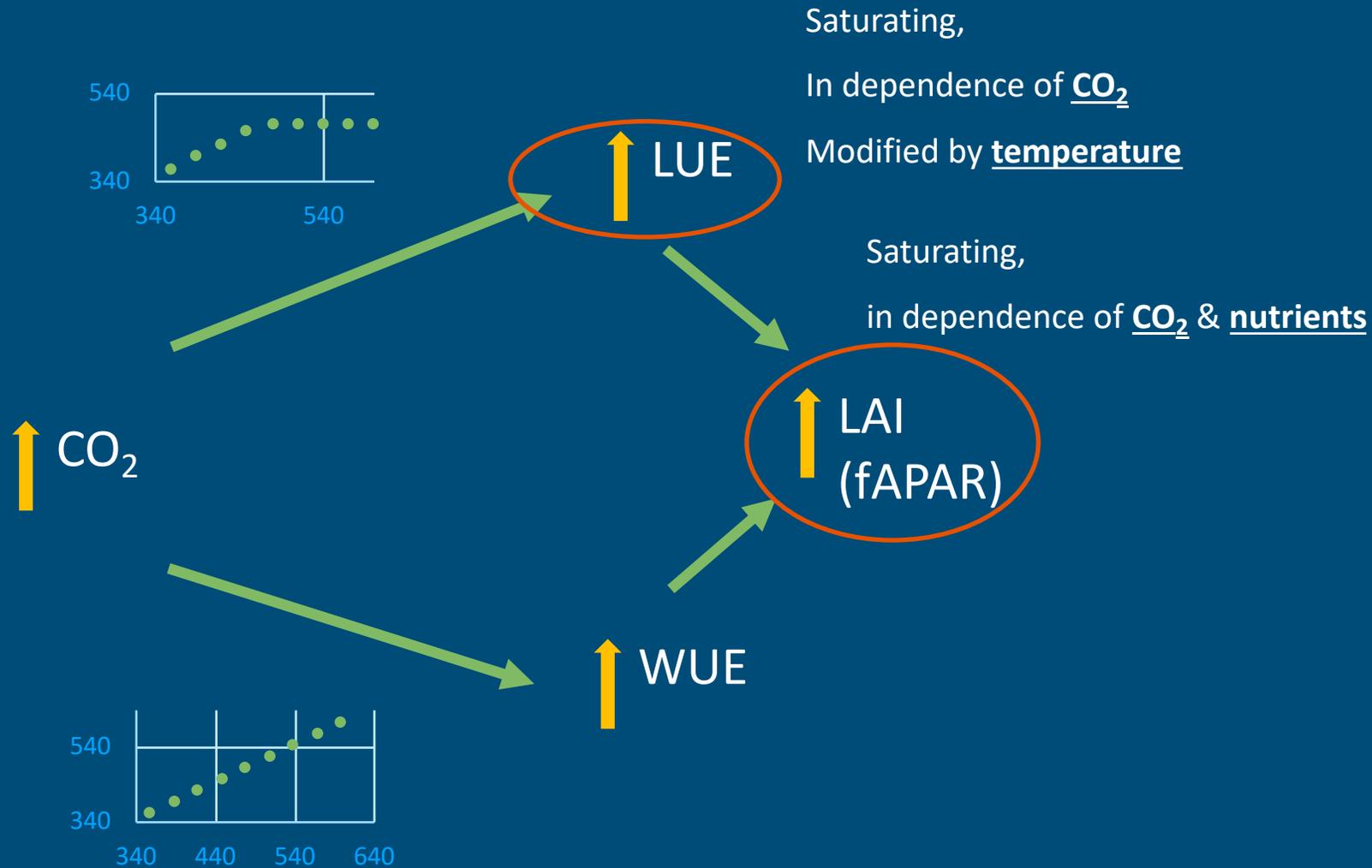
# Photosynthetic Rates: the effect of CO<sub>2</sub>



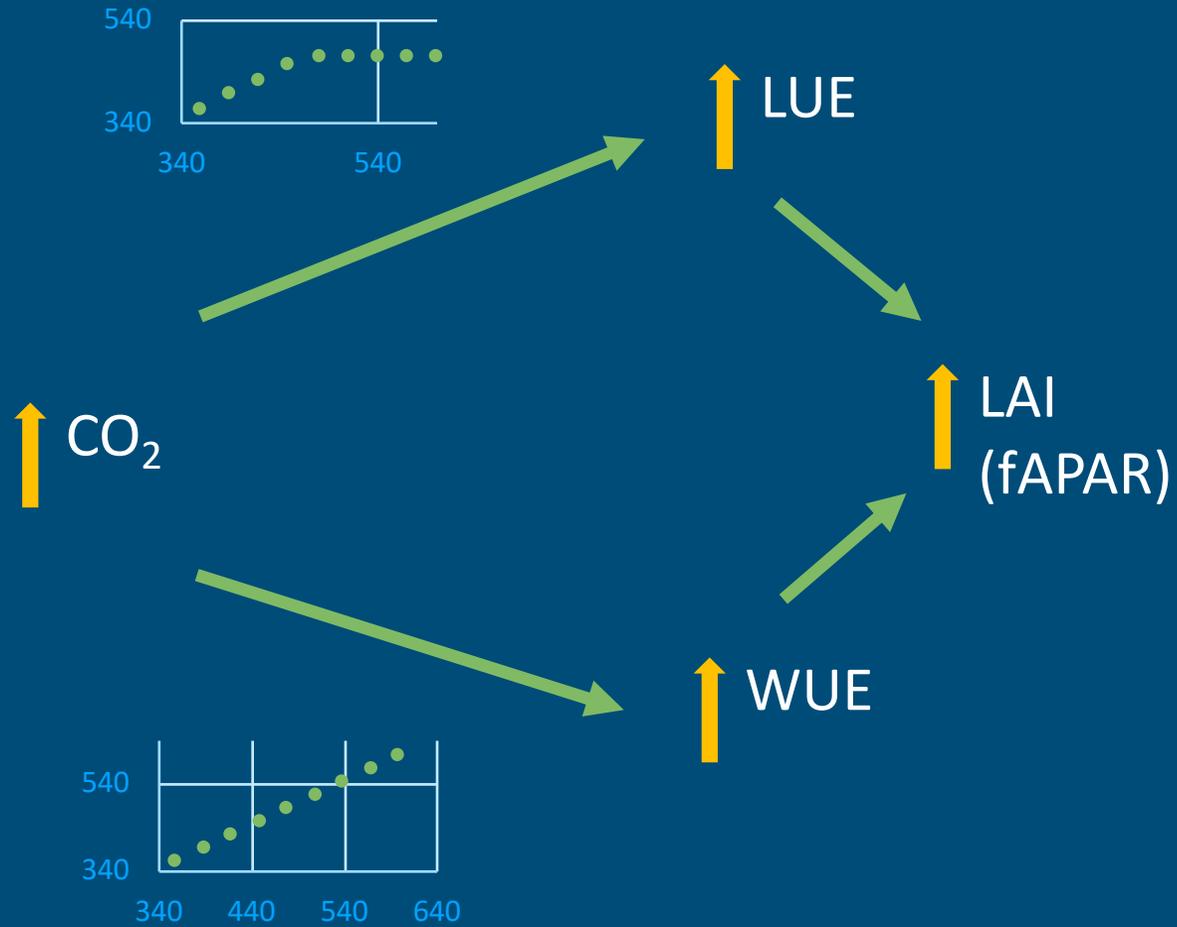
# Photosynthetic Rates: the effect of CO<sub>2</sub>



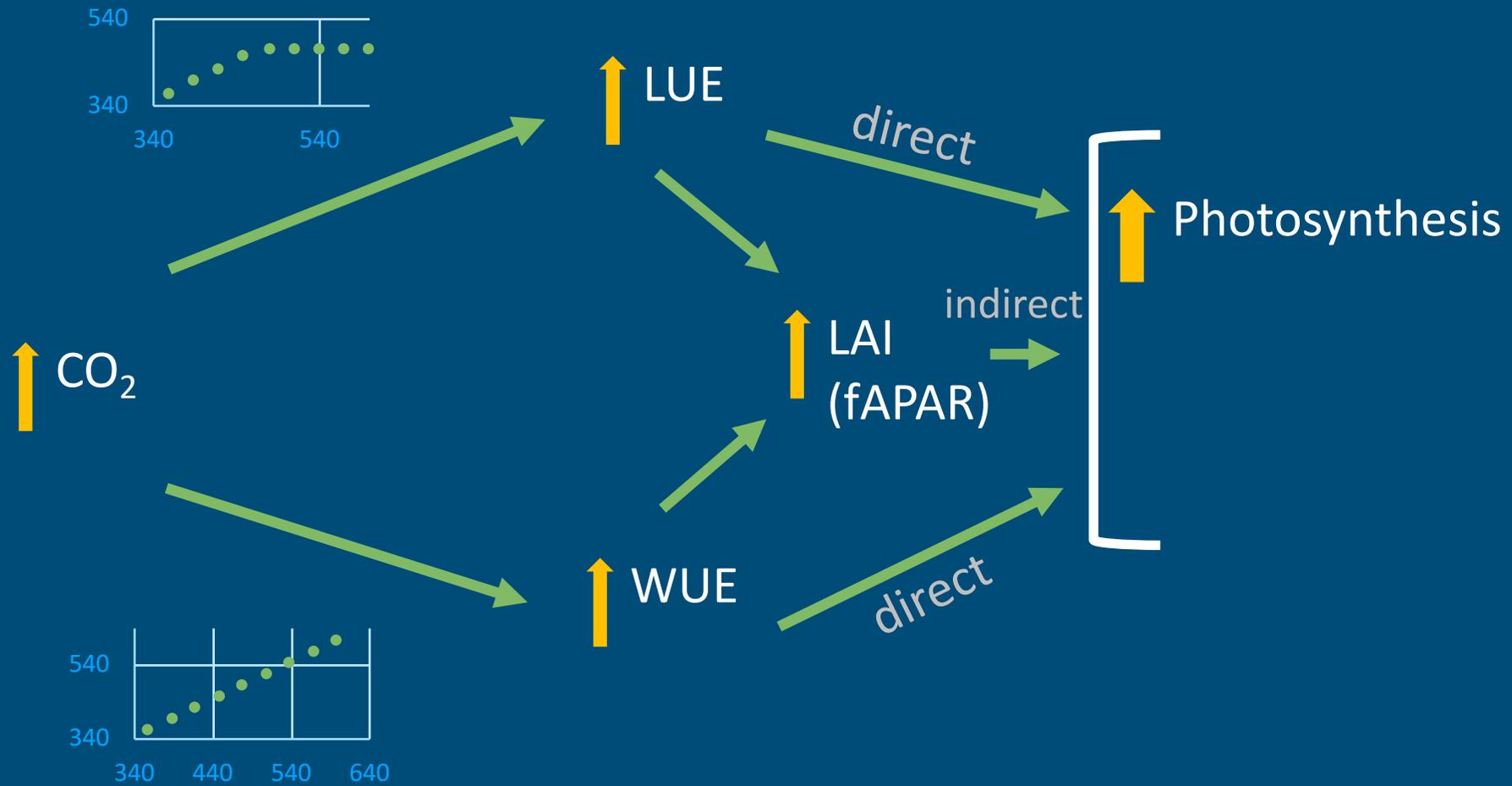
# Photosynthetic Rates: the effect of CO<sub>2</sub>



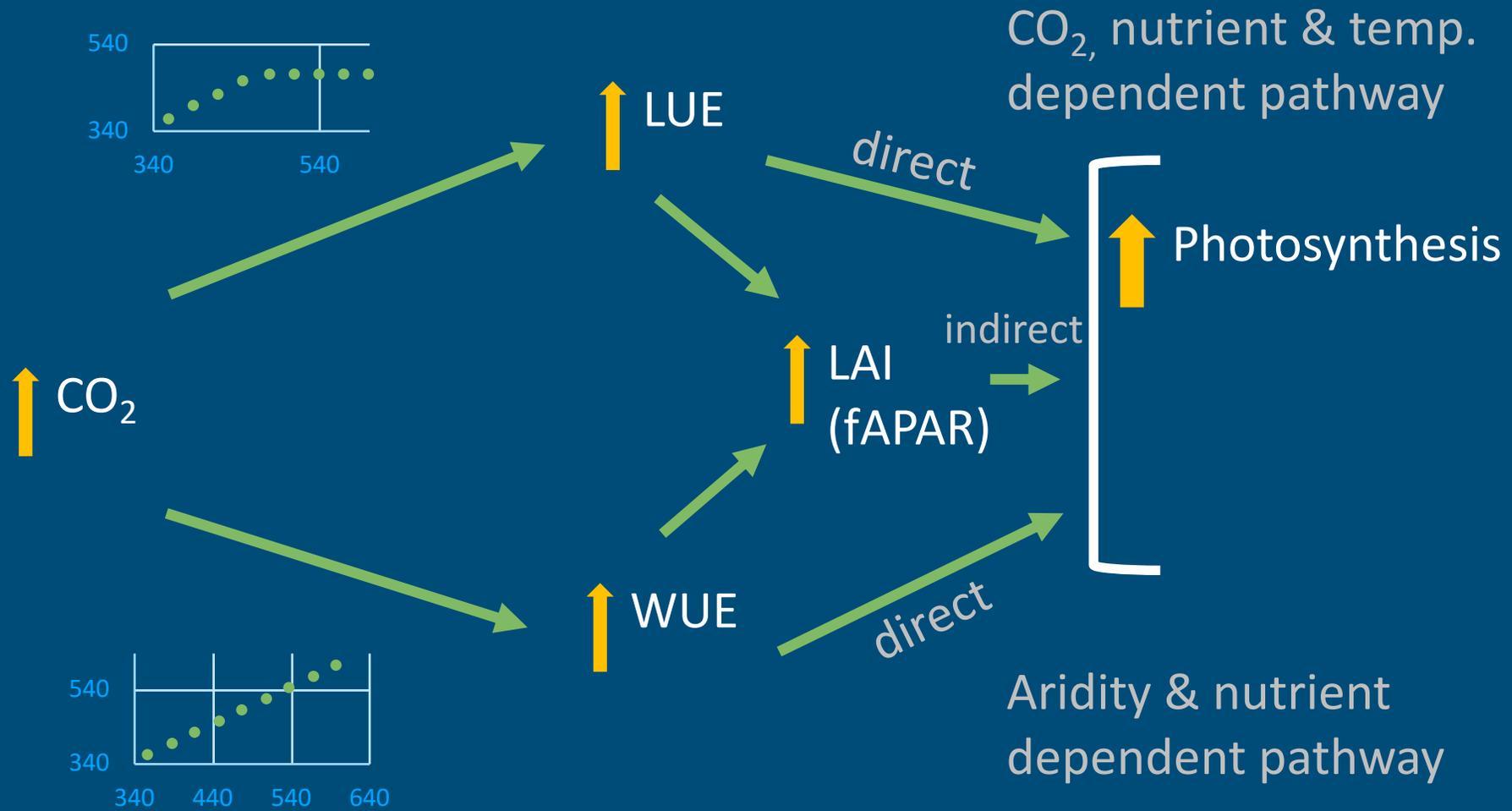
# Photosynthetic Rates: the effect of CO<sub>2</sub>



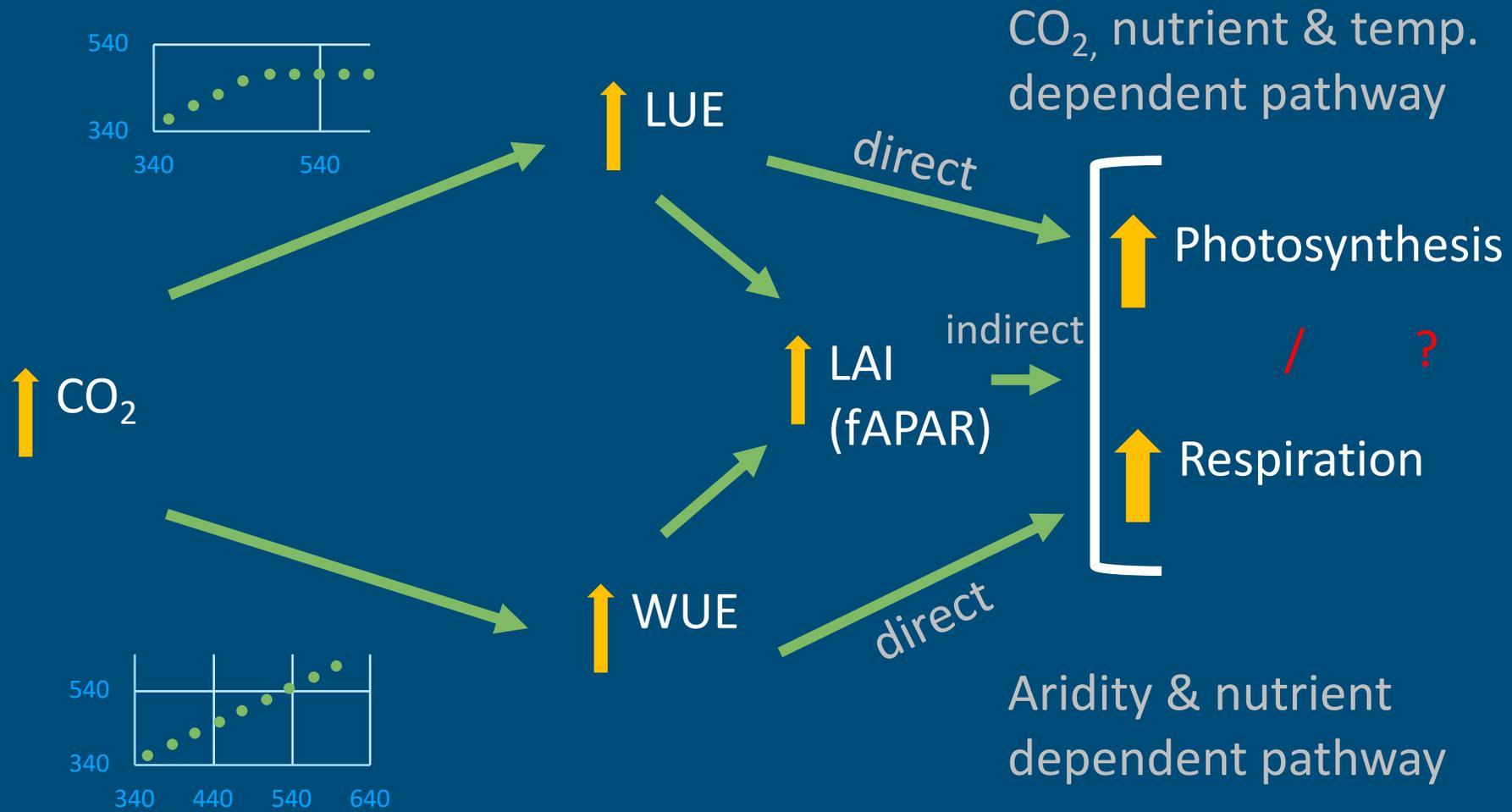
# Photosynthetic Rates: the effect of CO<sub>2</sub>



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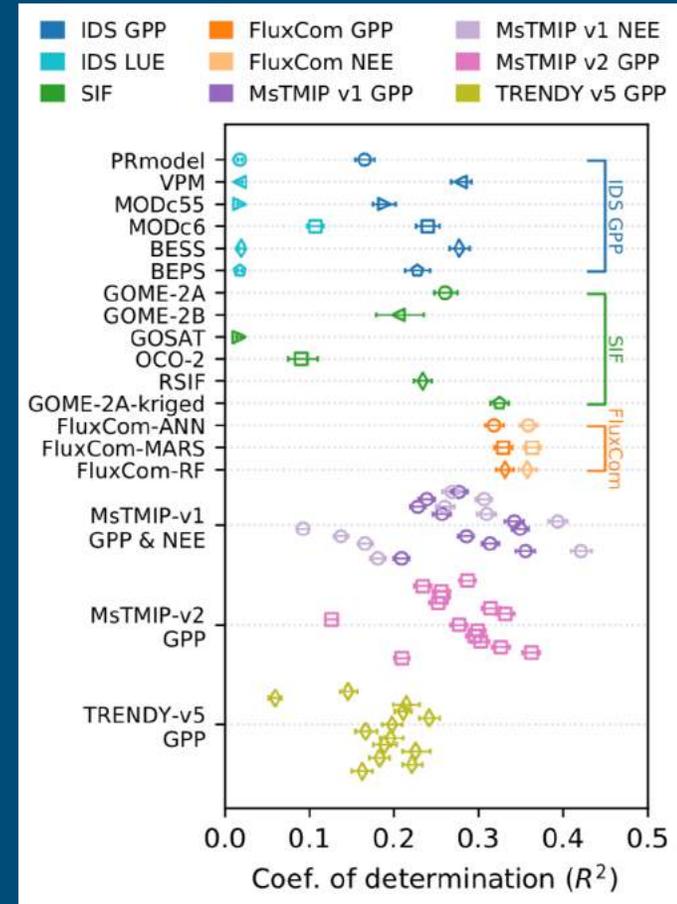
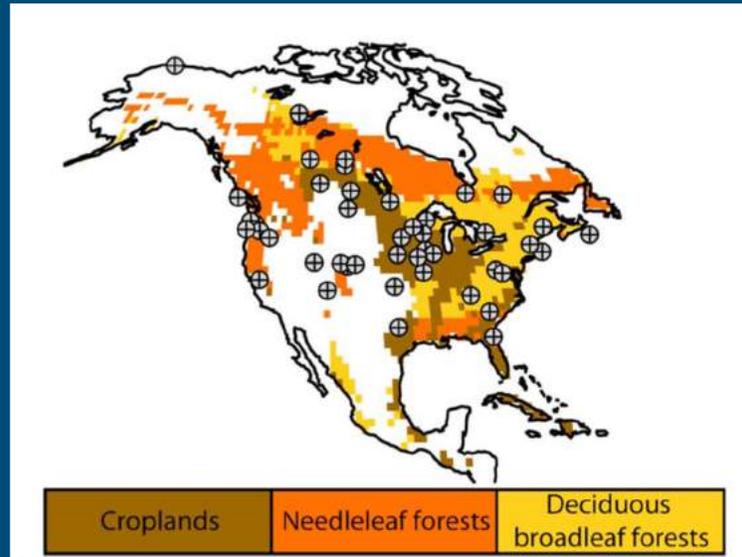
Can we integrate photosynthetic theory into long-term estimates of photosynthesis from space?



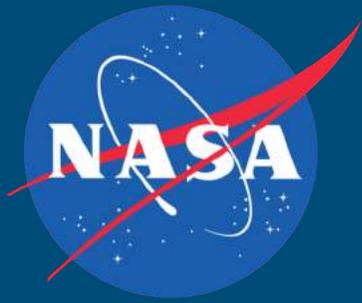
# The atmosphere as a filter – geostatistical inverse modeling



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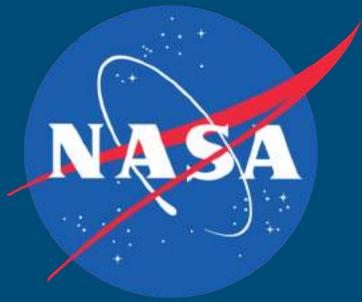
Sun et al. (in prep)



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*I'm looking for a postdoc!*  
*Flash drought/machine learning/remote sensing.*





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*fin*

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Thank you!

