

# R:

# New Theory for Nutrient Competition, Plant Traits, and Improved Advection Improves ALM

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## Objective

- N and P are important controllers of terrestrial C-climate feedbacks
- Current representations in ALM are poorly tested and numerically problematic
- Here, we synthesize results from three recently submitted ACME-supported publications:
  - Using a new method to represent multi-nutrient and multi-consumer interactions (ECA)
  - Prognostic leaf traits that control photosynthesis
  - Plant root nutrient uptake traits
  - Improved advective flux calculations
- These advances lead to improved estimates of global carbon exchanges,  $\text{NO}_3^-$  leaching, and  $\text{N}_2\text{O}$  gas emissions.

## Approach

- Equilibrium Chemistry Approximation application for nutrient constraints (Tang and Riley 2013)
- Comparison with experimental manipulations and global observations using ILAMB
- Improved advective transport calculation



Figure. ECA accurately predicts N and P fertilization responses in tropical systems (Zhu et al. 2015, *Biogeosciences D*)

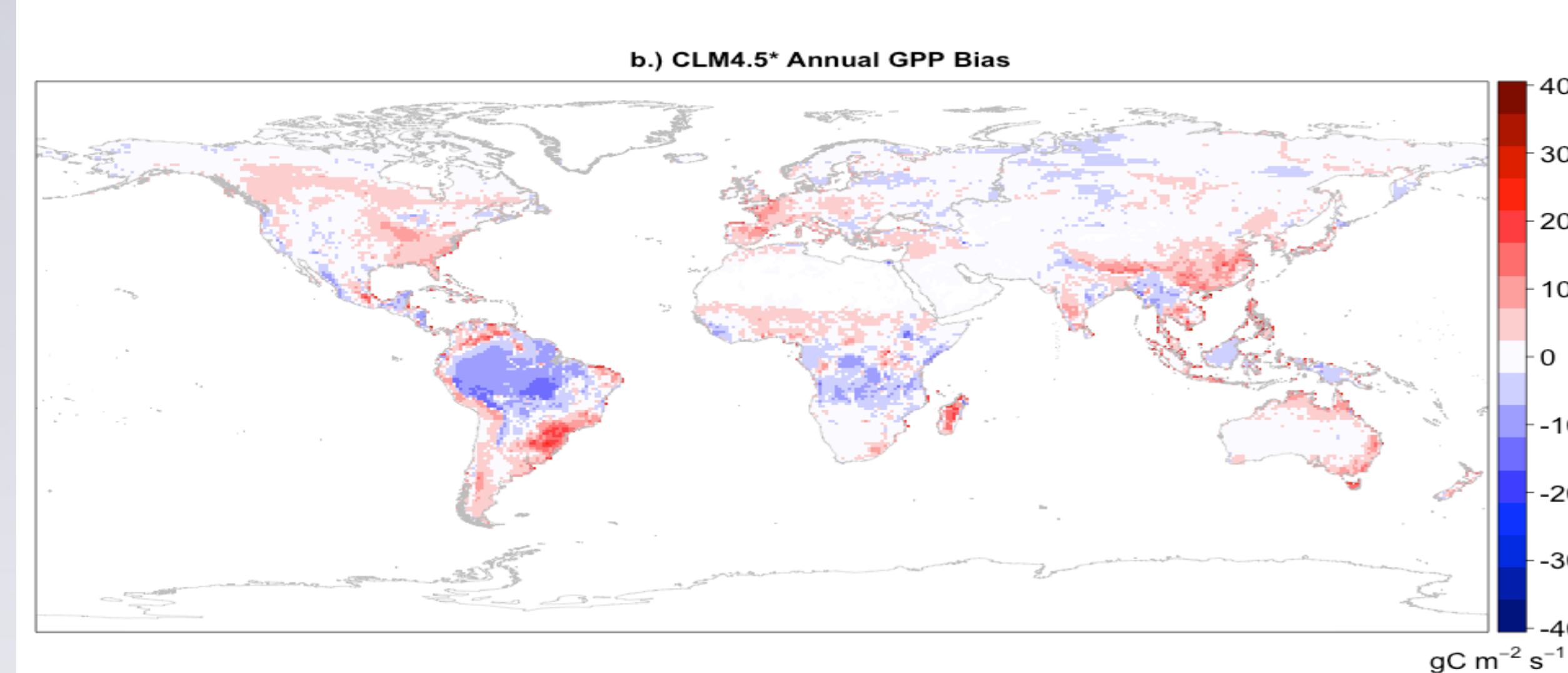
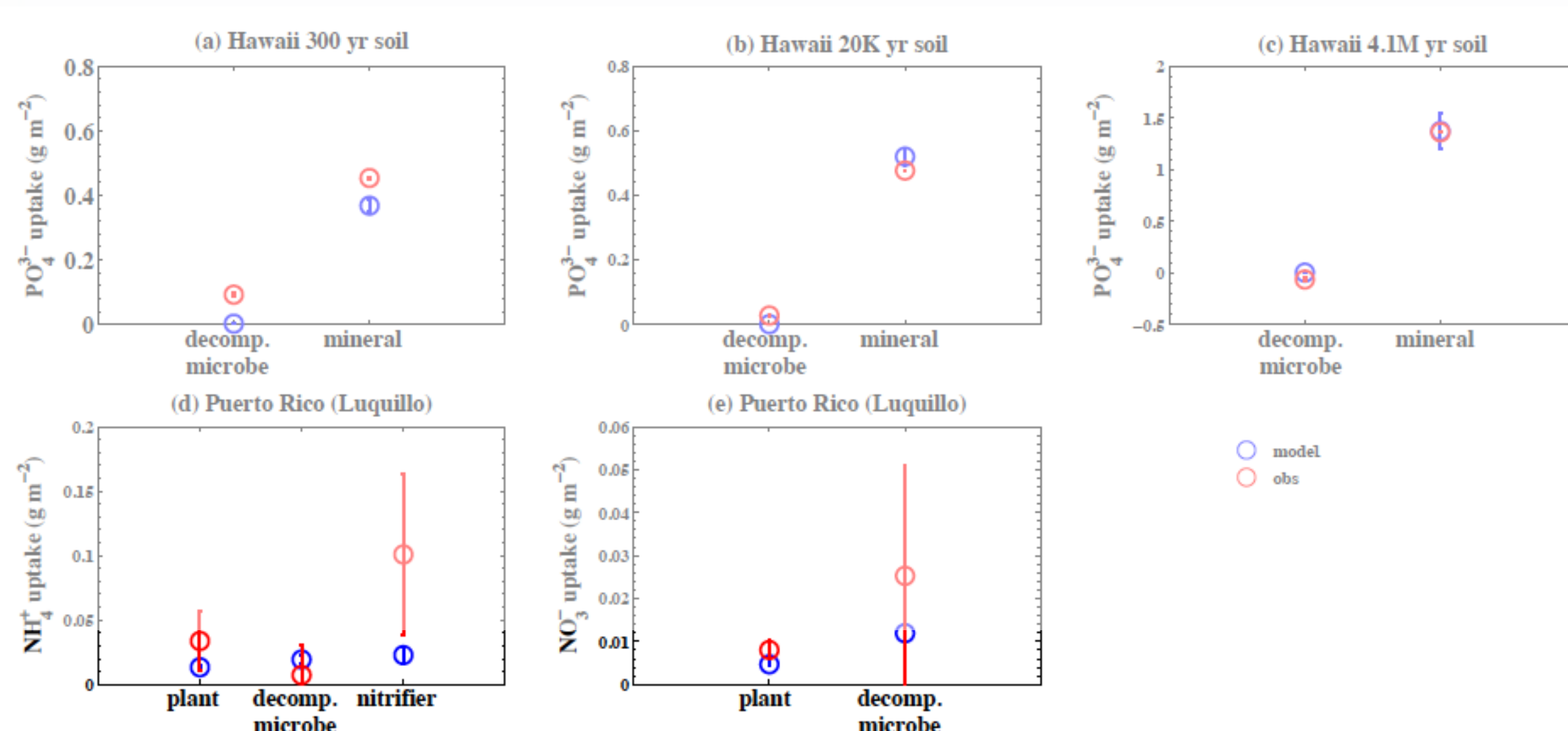
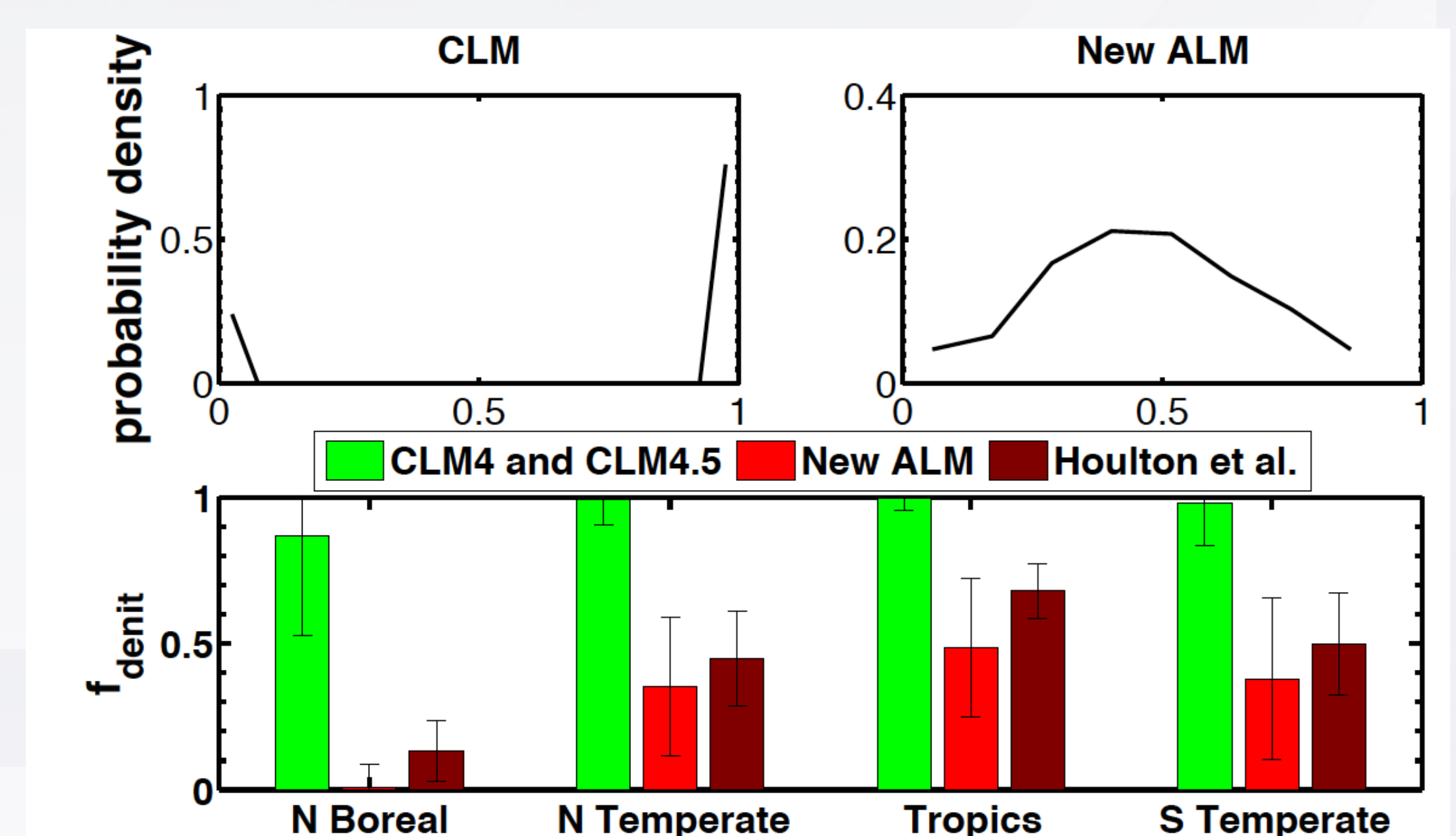


Figure. Global GPP bias reduced by 65%. Energy and water variables also improved (Ghimire et al., submitted *Biogeosciences*).

Figure. N losses in CLM4 and CLM4.5 shown to be poorly predicted by Houlton et al. (2015). Improved competition and advection dramatically improves N loss predictions (Zhu and Riley, submitted *Nature Climate Change*).



## Impact

- Global GPP biases reduced by 65%
- Improved ALM captures N and P addition experiments
- The partitioning of ecosystem N losses to  $\text{N}_2\text{O}$  and  $\text{NO}_3^-$  has been dramatically improved
- Improvements depend on improved representations of nutrient competition and advective fluxes

Ghimire, B., W. J. Riley, and C. D. Koven (2015a), submitted *Biogeosciences*.

Zhu, Q., and W. J. Riley (2015), submitted *Nature Climate Change*.

Zhu, Q., W. J. Riley, J. Y. Tang, and C. D. Koven (2015), *Biogeosciences Discussion*, 12, 4057-4106.