



Implementing Plant Hydraulic Stress in CLM

Daniel Kennedy, Pierre Gentine
Columbia University

Outline

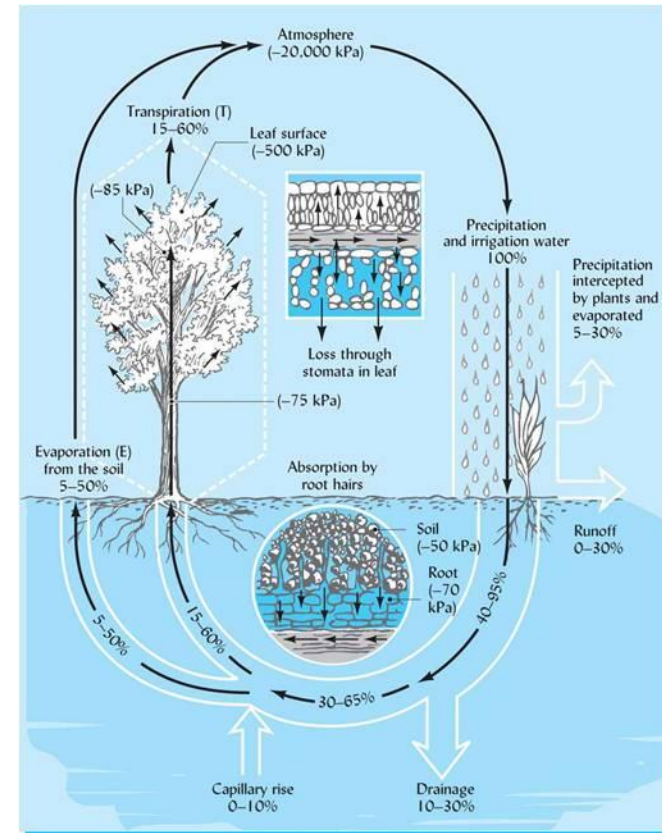
2

- Motivation
- PHS Model in CLM
- Parameterization
- Preliminary flux tower results from the model
- Next steps

Plant Water Dynamics

3

- How does water move within the SPAC?
- Vegetation plays a key role
- Plants operate at the intersection of the carbon, water, and energy cycles
- Drought, VPD expected to increase



Model Drought Response

4

Research

New
Phytologist 

Confronting model predictions of carbon fluxes with measurements of Amazon forests subjected to experimental drought

Thomas L. Powell¹, David R. Galbraith^{2,3}, Bradley O. Christoffersen⁴, Anna Harper^{5,6}, Hewlley M. A. Imbuzeiro⁷, Lucy Rowland⁸, Samuel Almeida⁹, Paulo M. Brando¹⁰, Antonio Carlos Lola da Costa¹¹, Marcos Heil Costa⁷, Naomi M. Levine¹, Yadvinder Malhi³, Scott R. Saleska⁴, Eleneide Sotta¹², Mathew Williams⁸, Patrick Meir⁸ and Paul R. Moorcroft¹

¹Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, MA 02138, USA; ²School of Geography, University of Leeds, Leeds, LS2 9JT, UK; ³Environmental Change Institute, School of Geography and the Environment, University of Leeds, Leeds, LS2 9JT, UK; ⁴Department of Earth and Atmospheric Sciences, University of Colorado Boulder, Boulder, CO 80502, USA; ⁵College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter, EX4 4QF, UK; ⁶Department of Biological Sciences, University of Colorado Boulder, Boulder, CO 80502, USA; ⁷Grupo de Pesquisas em Ecologia, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil; ⁸Centre for Ecology and Hydrology, Edinburgh, EH8 9XP, UK; ⁹Department of Geography, University of Edinburgh, Edinburgh, EH8 9XP, UK; ¹⁰Centro de Geociências, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil; ¹¹Centro de Geociências, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil; ¹²Centro de Geociências, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil

Author for correspondence:

Paul R. Moorcroft

Tel: +1 617 496 6744

Email: paul_moorcroft@harvard.edu

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“Model predictions ... poorly replicated the response to drought treatment”

change.

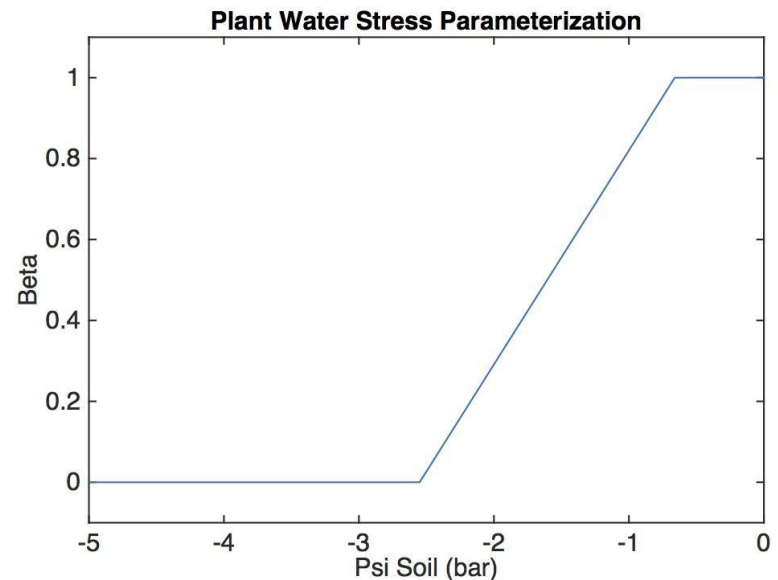
- Here, carbon (C) flux predictions of five terrestrial biosphere models (Community Land Model version 3.5 (CLM3.5), Ecosystem Demography model version 2.1 (ED2), Integrated Biosphere Simulator version 2.6.4 (IBIS), Joint UK Land Environment Simulator version 2.1 (JULES), and the Ecosystem Model for the Tropics (EMT)) were compared to measurements of carbon fluxes in Amazon forests subjected to experimental drought.

Plant Water Stress - Btran

5

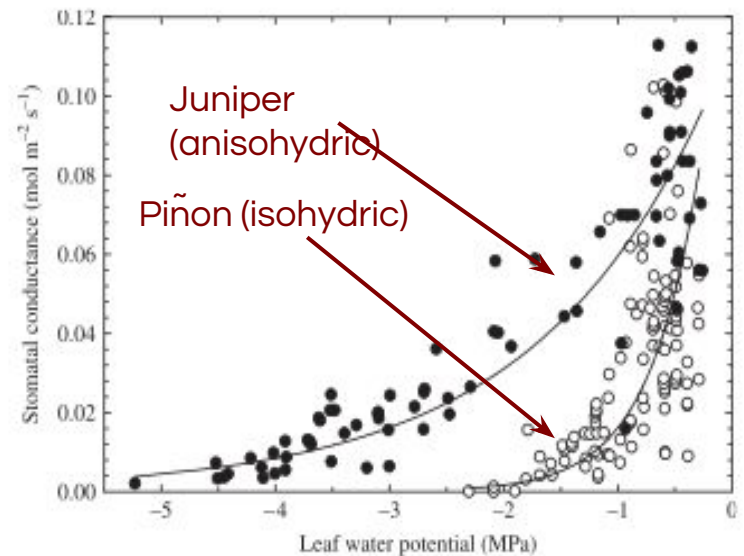
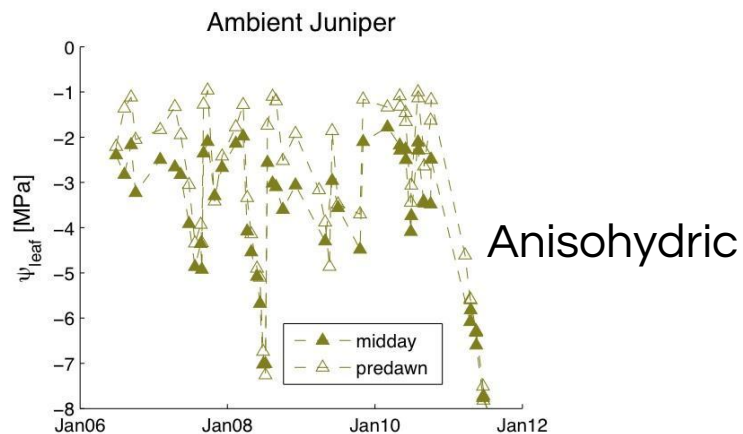
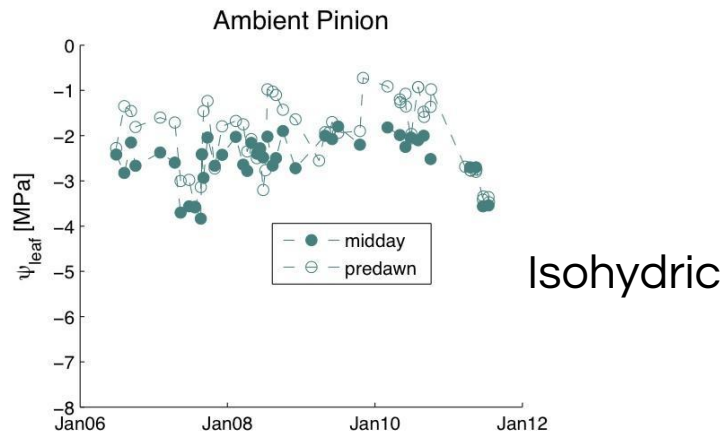
- Applied as attenuating factor for stomatal conductance, photosynthesis, and respiration calculations
- Not in line with typical field measurements
- Lacks flexibility to reproduce observed plant water use strategies

$$\beta = f(\Psi_{soil})$$



Isohydric vs. Anisohydric species

6

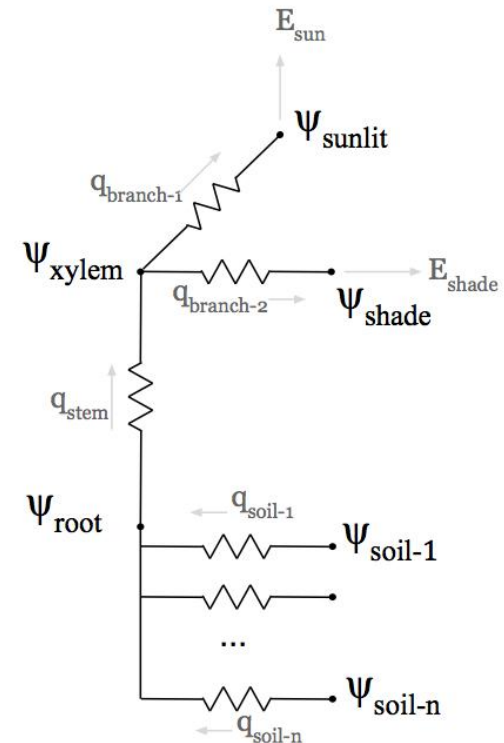


Model Development

Text

7

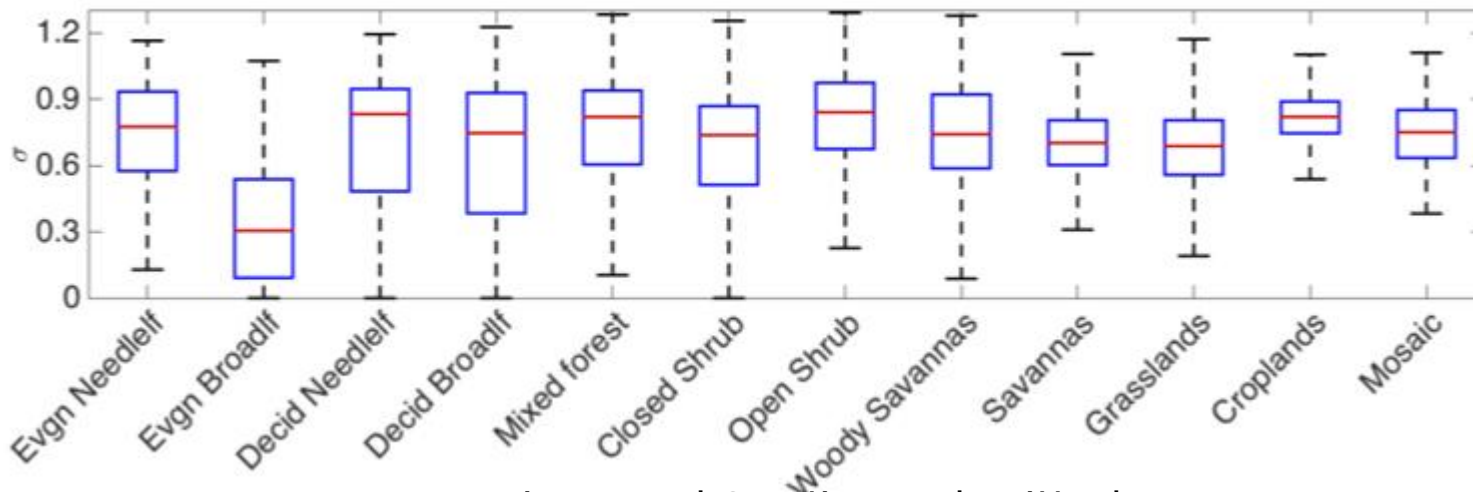
- Simple model to resolve water transport through the SPAC
- Water supply modeled via simple hydraulic framework
- Loss relative to unstressed transpiration modeled based on leaf-level water potential
- Water stress function used to calculate conductance, photosynthesis, and respiration



Parameterization

8

- Are PFTs right for plant hydraulics?
- Below, ecosystem-scale isohydricity by PFT derived from VOD dynamics
- Lower values are more isohydric



Konings and Gentine, submitted

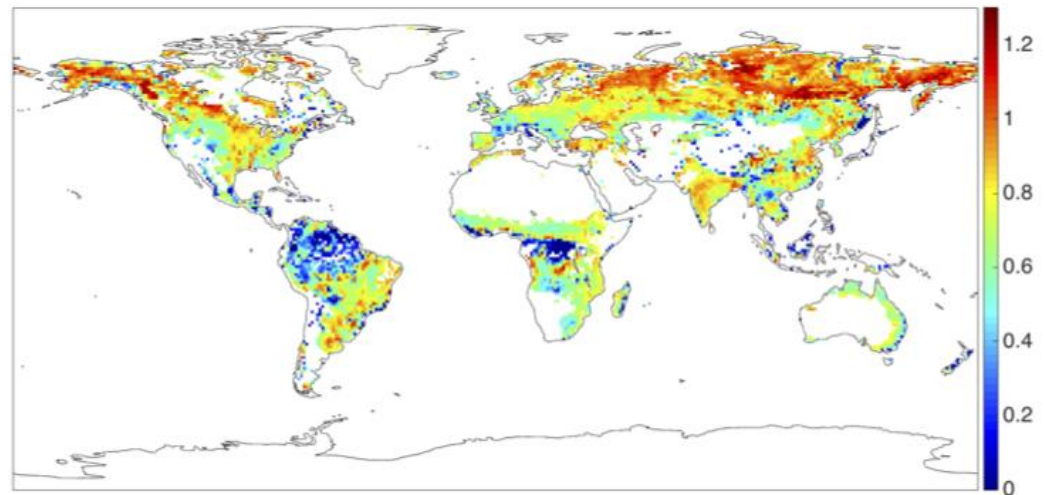
Vegetation Optical Depth

9

- PHS models vegetation water status
- Allows interface with new stream of observations for model evaluation and parameterization

Global Variations in isohydricity slope. Lower values are more isohydric.

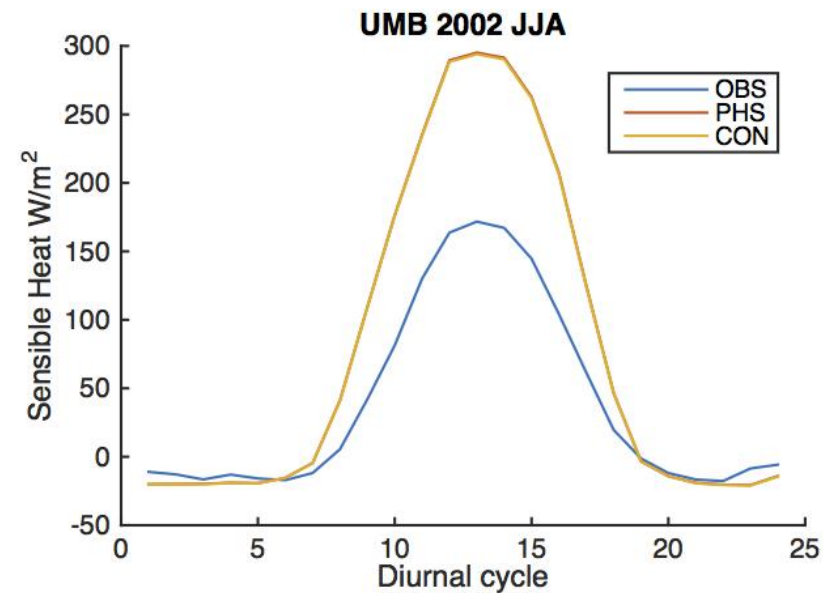
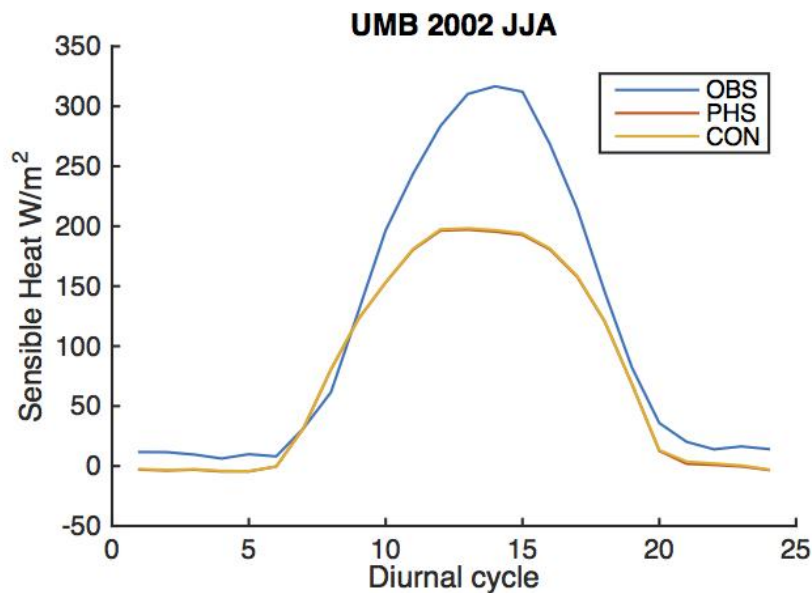
Konings and Gentine, submitted



Flux tower results: well-watered

10

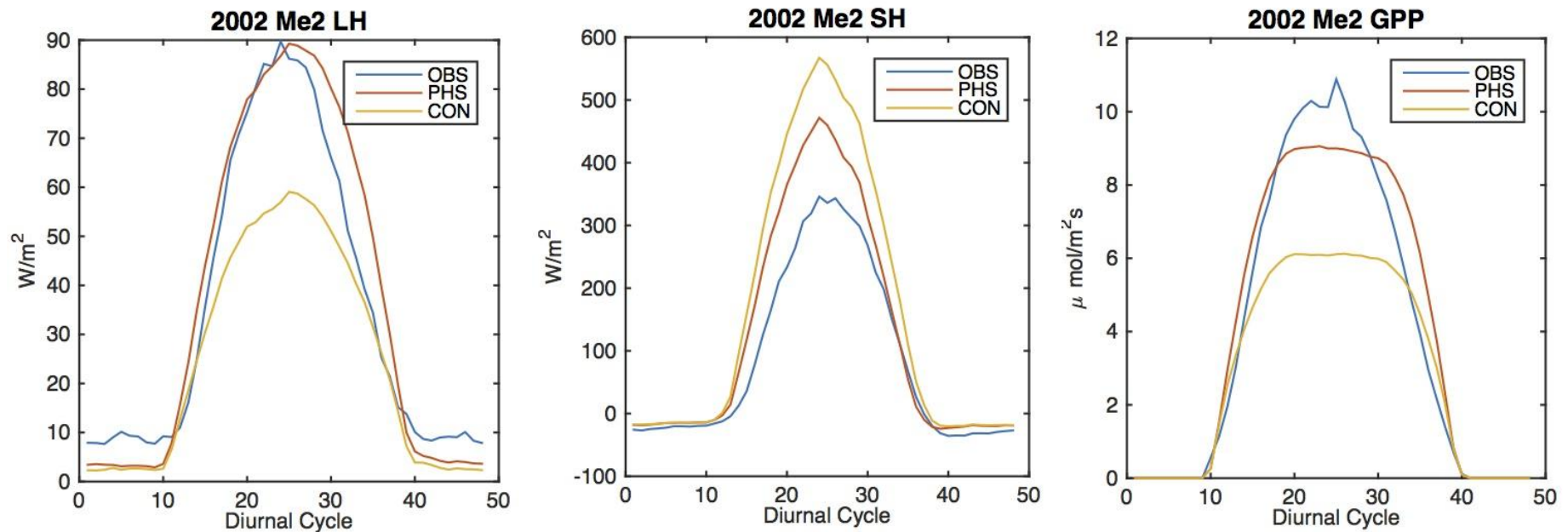
University of Michigan Biological Station



Flux tower results: Semi-arid

11

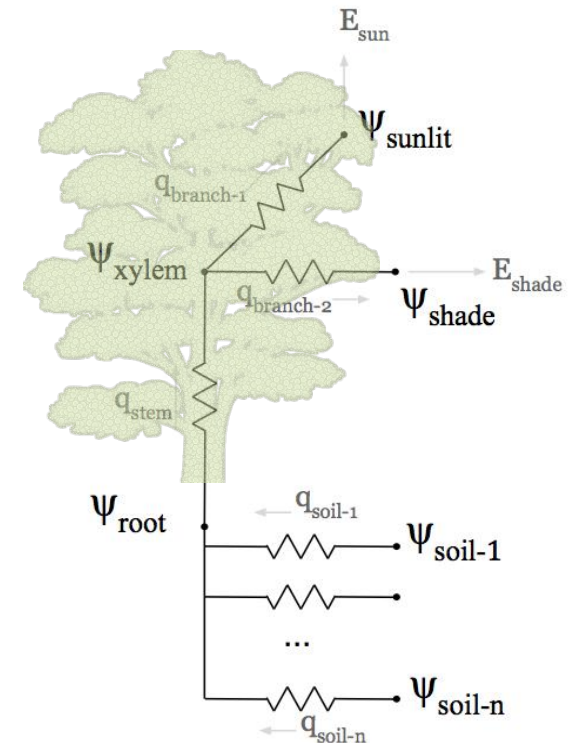
Metolius Intermediate Pine: Central Oregon



Next steps

12

- Global parameterization
- Model evaluation relative to Btran and available obs
- Drought response case studies
- Future simulations



Questions?

13

