Implementing Plant Hydraulic Stress in CLM

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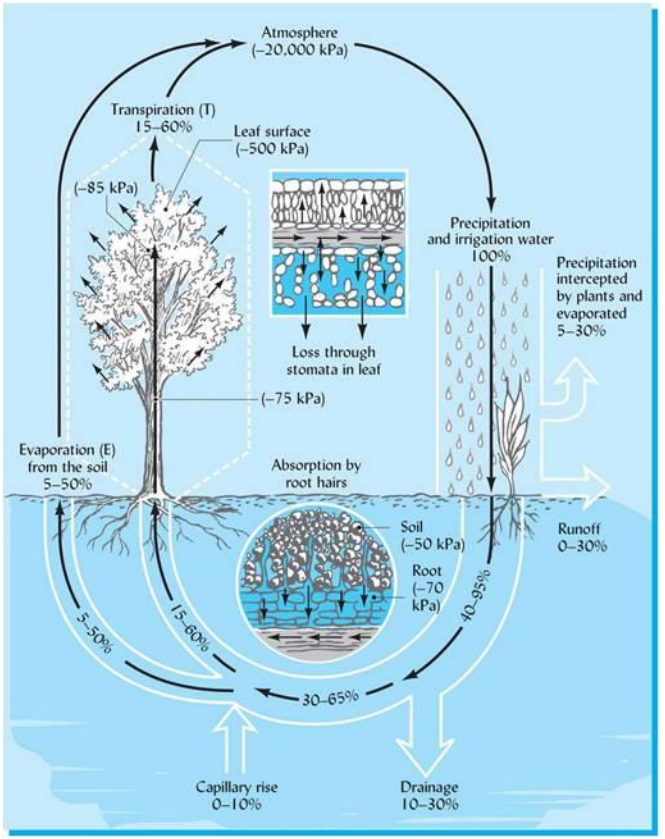
Outline

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

Plant Water Dynamics

- 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

Research

New Phytologist

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

Thomas L. Powell[1], David R. Galbraith[2,3], Bradley O. Christoffersen[4], Anna Harper[5,6], Hewlley M. A. Imbuzeiro[7], Lucy Rowland[8], Samuel Almeida[9], Paulo M. Brando[10], Antonio Carlos Lola da Costa[11], Marcos Heil Costa[7], Naomi M. Levine[1], Yadvinder Malhi[3], Scott R. Saleska[4], Eleneide Sotta[12], Mathew Williams[8], Patrick Meir[8] and Paul R. Moorcroft[1]

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"Model predictions … poorly replicated the response to drought treatment"

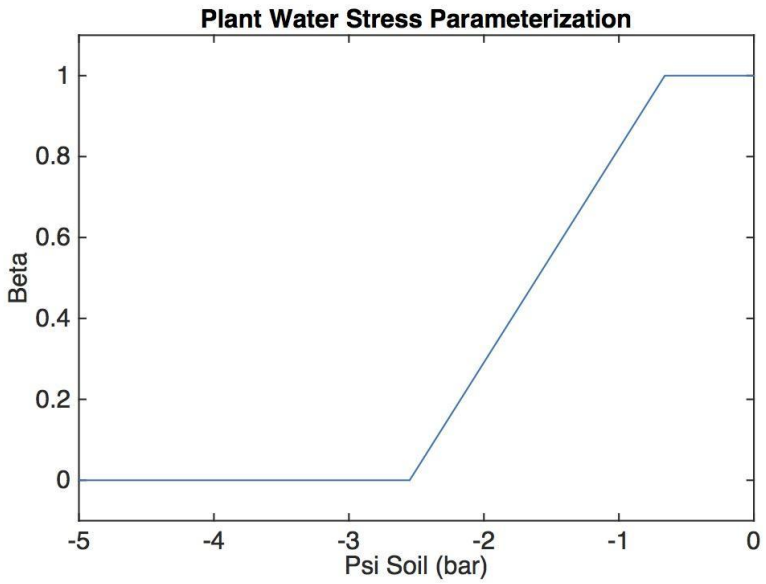
change.

• 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

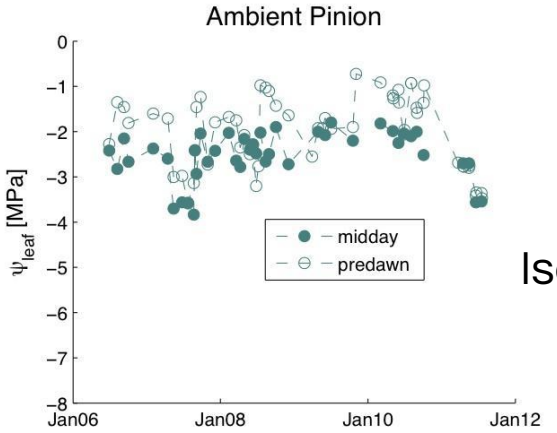
Plant Water Stress - Btran

- 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

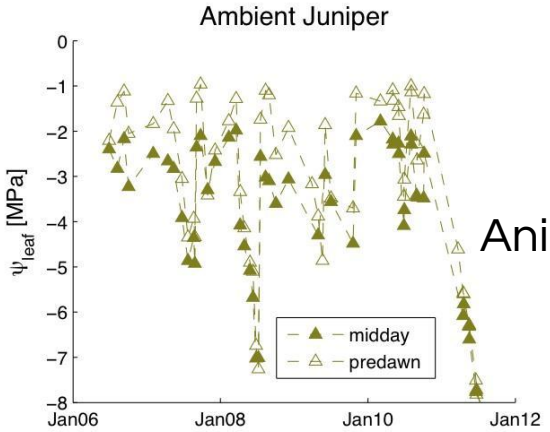
$$\beta = f(\Psi_{soil})$$



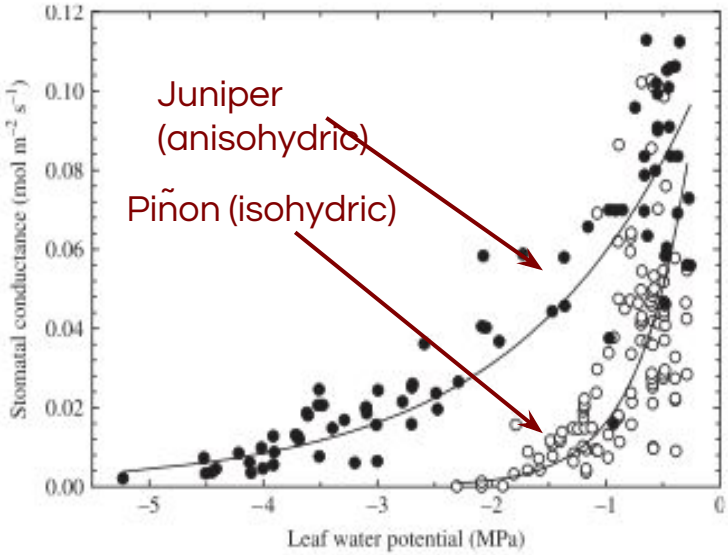
Isohydric vs. Anisohydric species



Isohydric



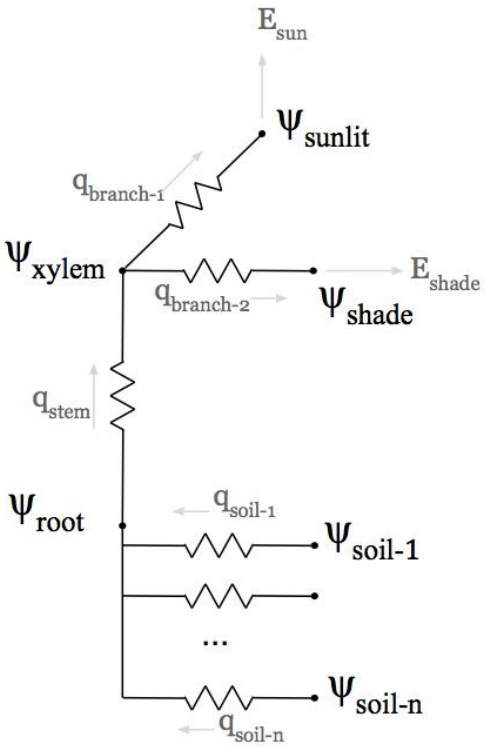
Anisohydric



Model Development

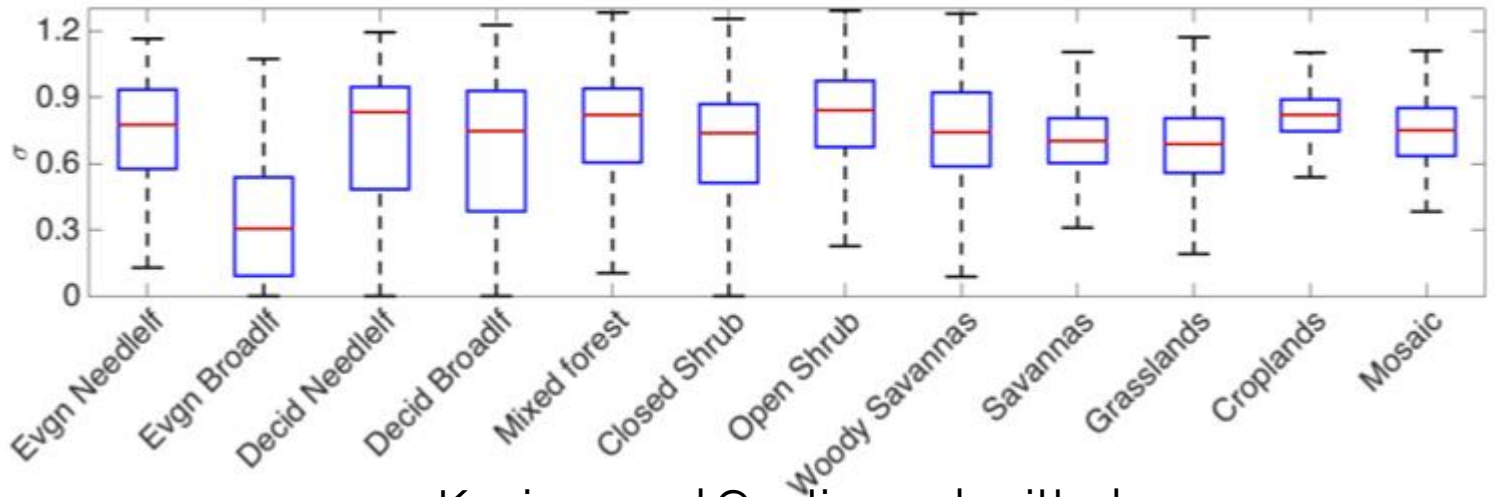
Text

- 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

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



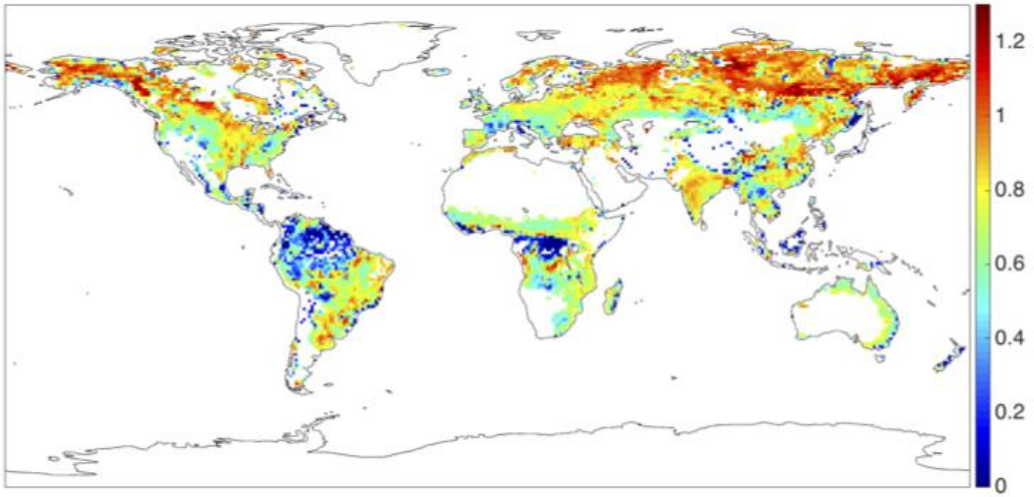
Konings and Gentine, submitted

Vegetation Optical Depth

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

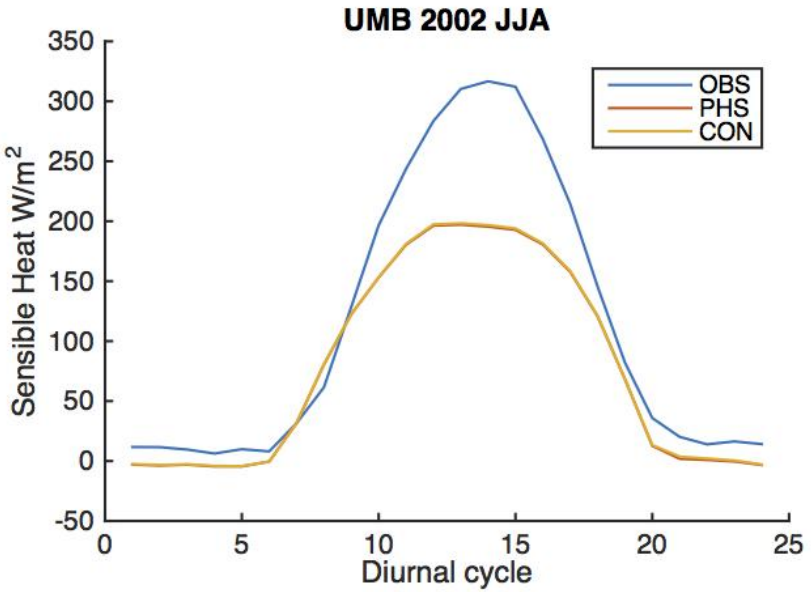
Global Variations in isohydricity slope. Lower values are more isohydric.

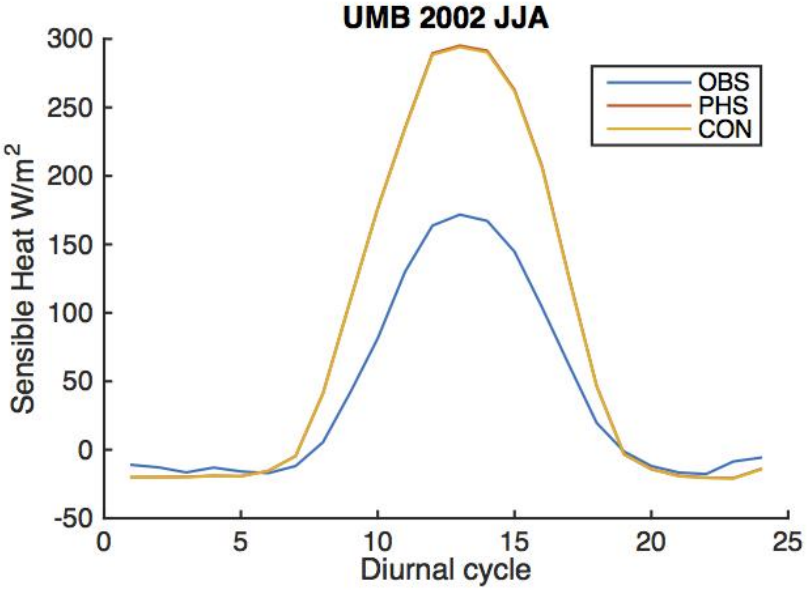
Konings and Gentine, submitted



Flux tower results: well-watered

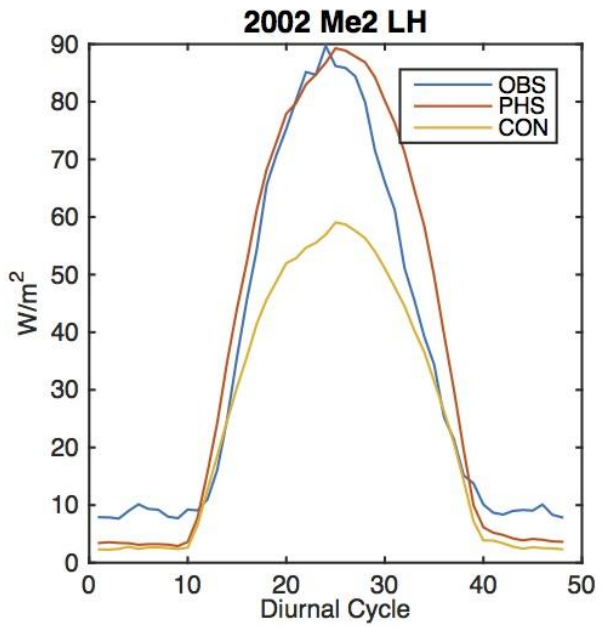
University of Michigan Biological Station

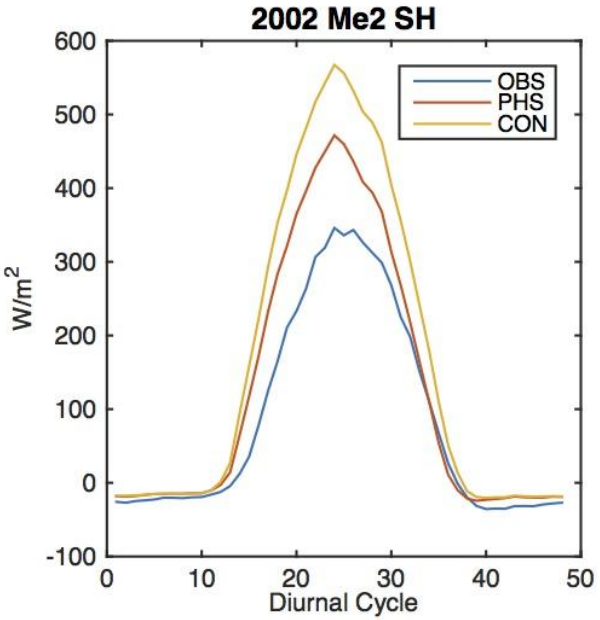


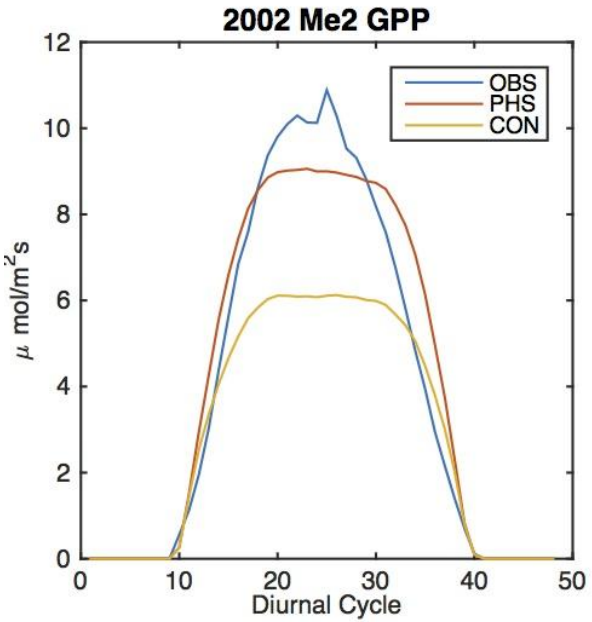


Flux tower results: Semi-arid

Metolius Intermediate Pine: Central Oregon

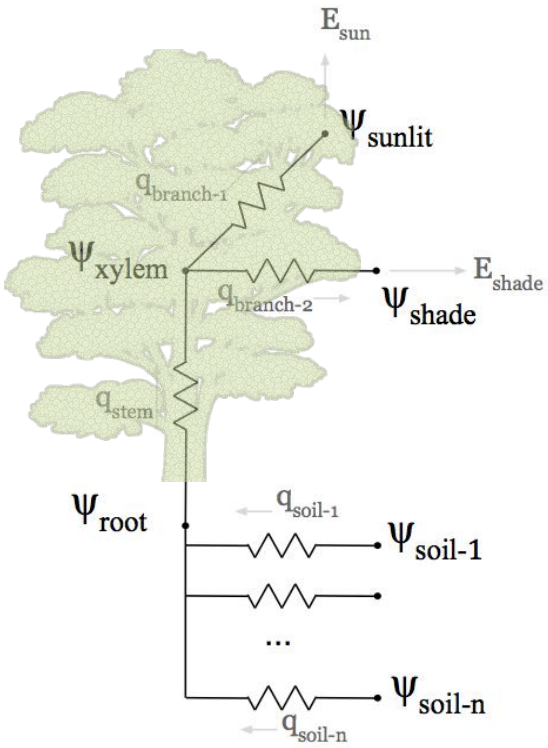






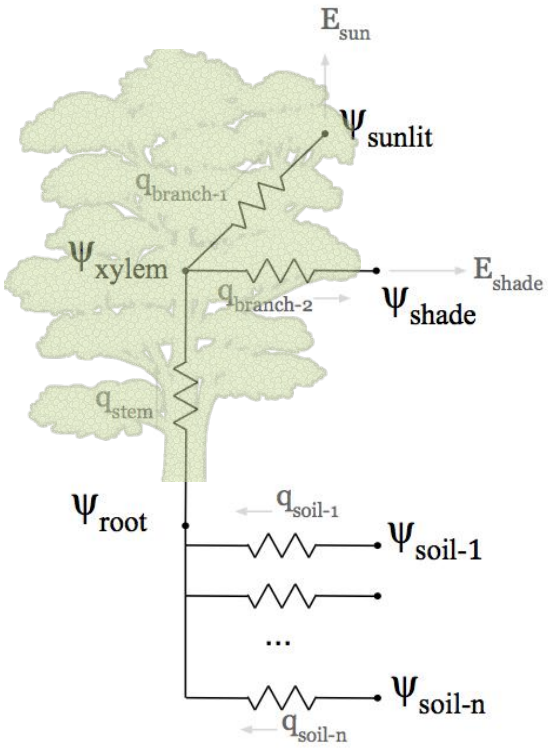
Next steps

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



Questions?


Thank
You!


E sun
Ψ sunlit
q branch-1
Ψ xylem
E shade
q branch-2
Ψ shade
q stem
Ψ root
q soil-1
Ψ soil-1
...
Ψ soil-n
q soil-n