REPRESENTING ISOHYDRICITY AND ANISOHYDRICITY IN CLM: A PROTOTYPE STUDY

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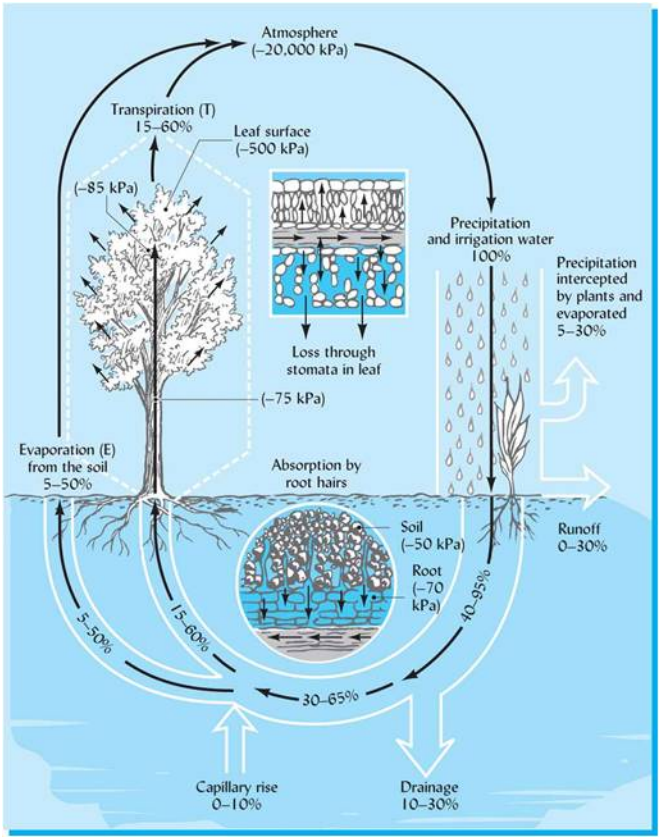
Outline

- Background on plant water dynamics
- Isohydric versus Anisohydric species
- Simplified soil-plant-atmosphere-continuum model
- Preliminary results from the model

Plant Water Dynamics

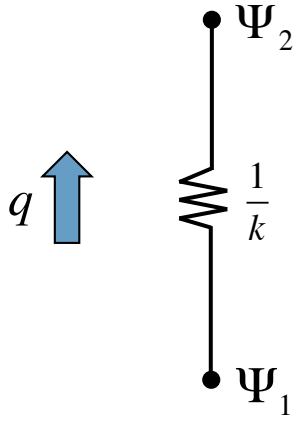
- How does water move within the SPAC?
- Important for:
  - Soil Moisture
  - Boundary Layer
  - Carbon Cycle
  - …



Plant Water Dynamics

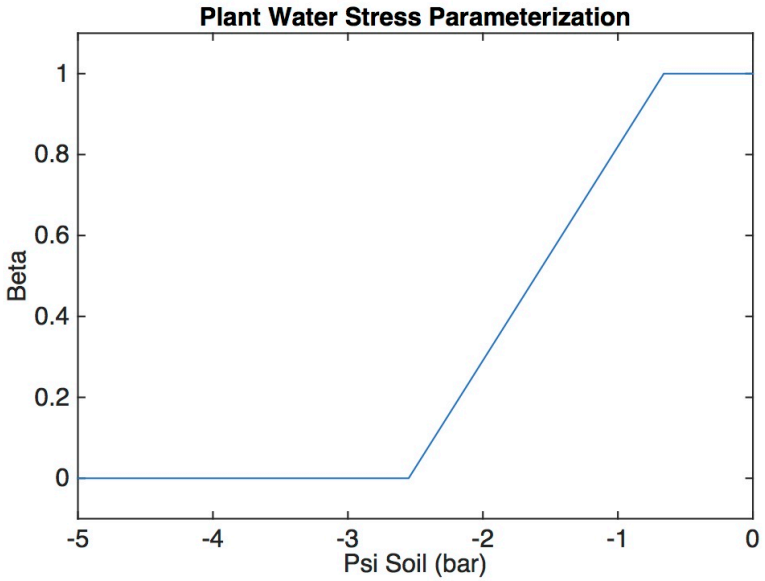
- How does water move in the SPAC?
- Water fluxes are driven by gradients in water potential
- Water fluxes modeled by

$$q = k(\Psi_1 - \Psi_2)$$

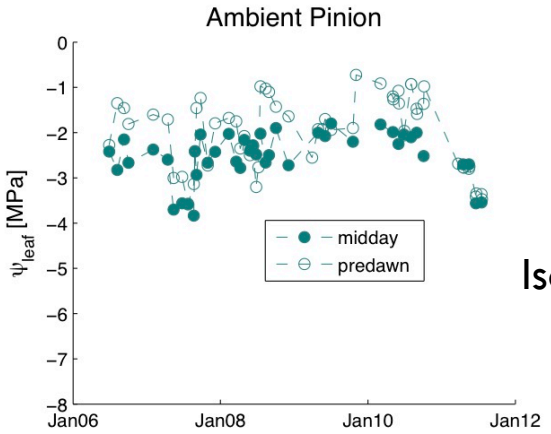


Plant Water Stress, β ~f(Ψsoil)

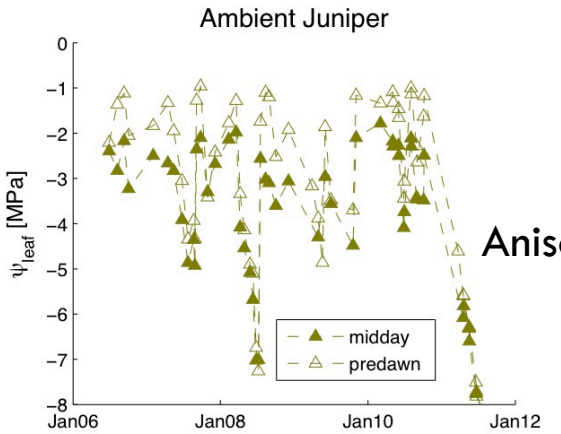
- Interest in plant water stress, which is applied through β
- $\beta = \frac{E_{actual}}{E_{potential}}$
- In CLM $\beta = f(\Psi_{soil})$
- $\beta < 1$ with stomatal closure or cavitation



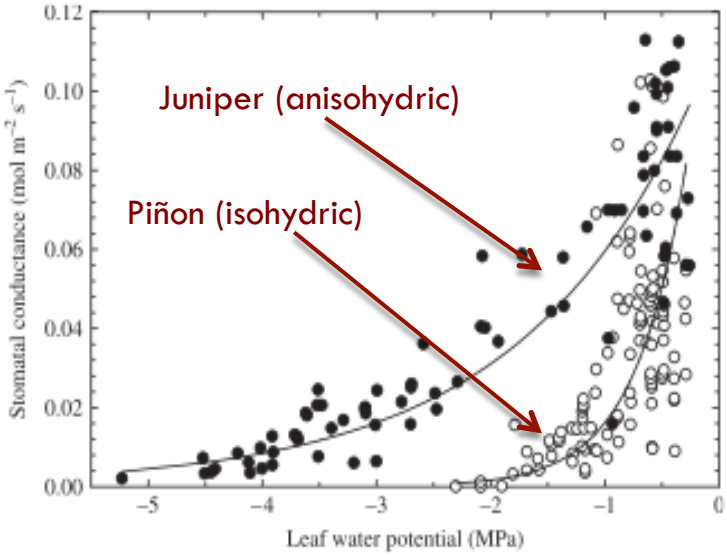
Isohydric vs. Anisohydric species



Isohydric



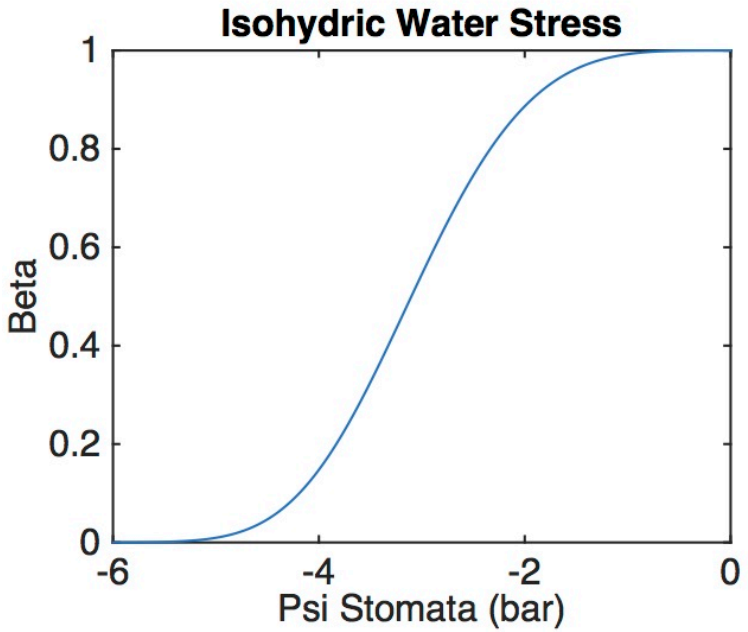
Anisohydric

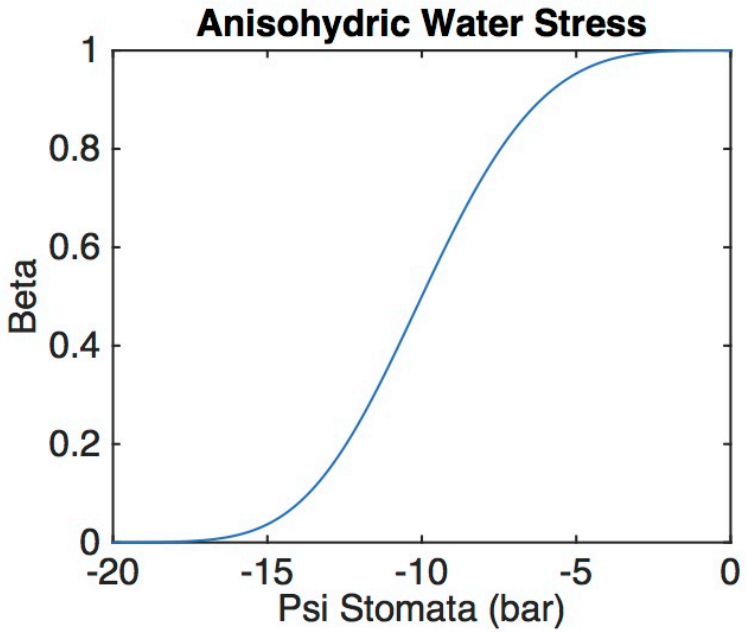


Plant Water Stress, β ~f(Ψ stomata)

- We change beta dependence to

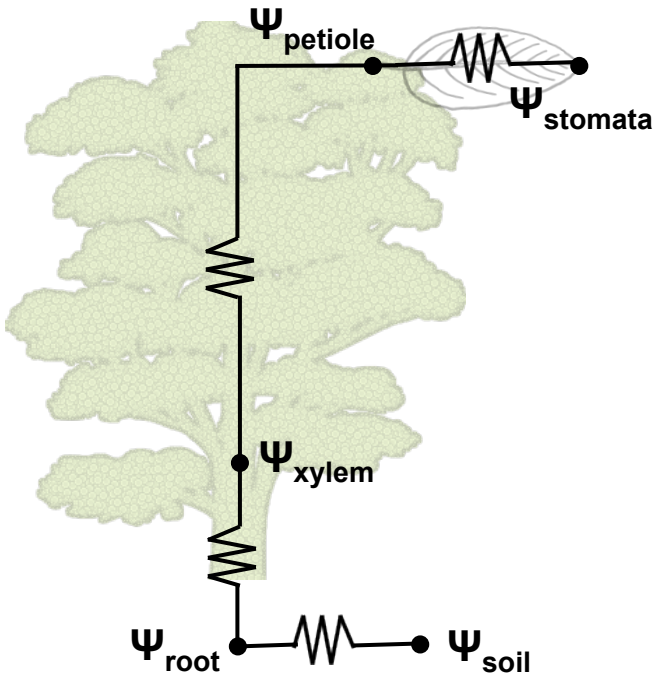
$$\beta = f(\Psi_{stomata})$$



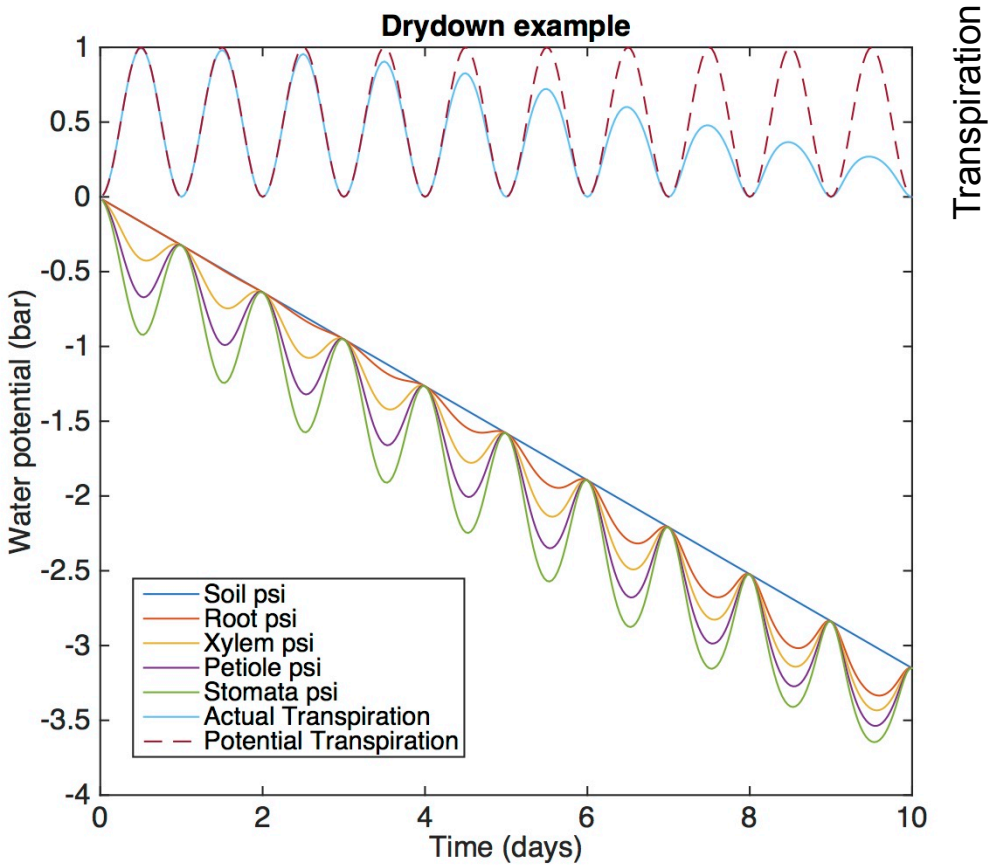


Model Development

- Simple model to resolve Ψ along the SPAC
- Forced by Ψ_{soil} and $E_{potential}$
- Water stress imposed by β, as a function of $\Psi_{stomata}$

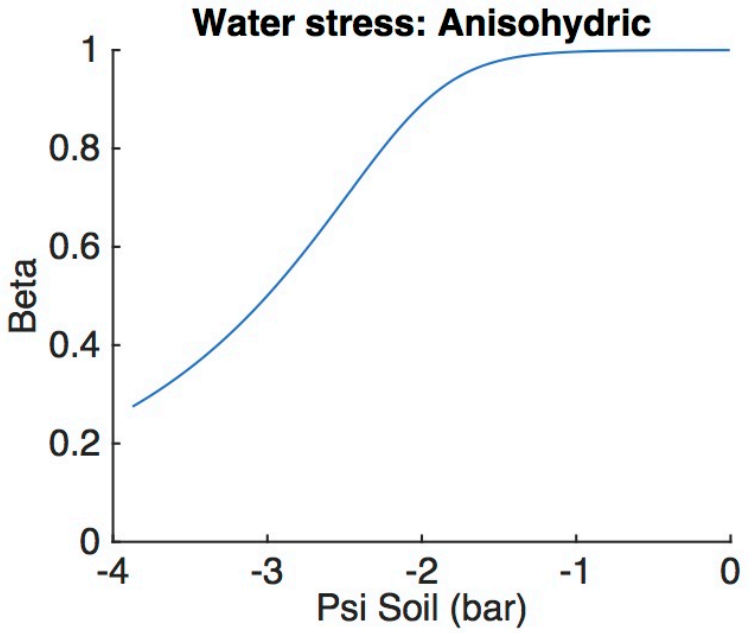


Model results: Example Drydown



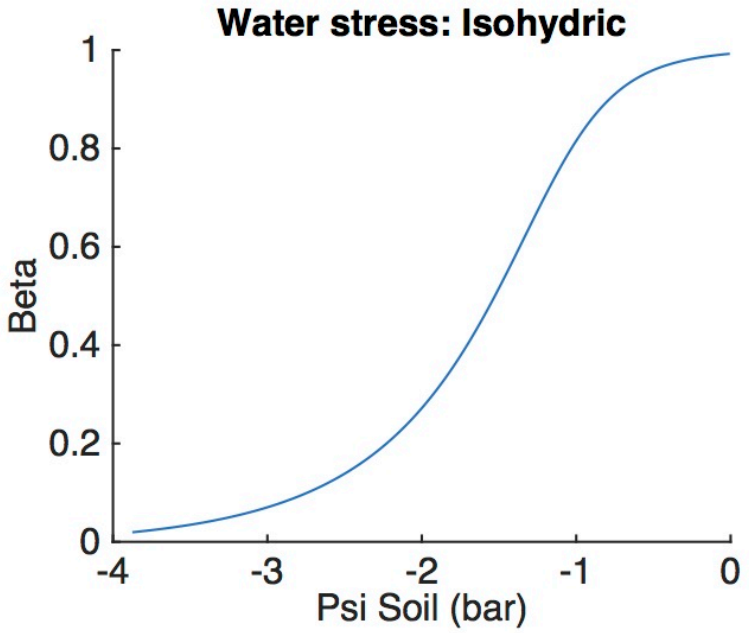
Anisohydric, $\beta \sim f(\Psi soil)$

- How does β (plant water stress) depend on Ψ_{soil} ?
- How do our model's findings compared to CLM?
- Beta>0 beyond typical parameterization



Model results: Isohydric

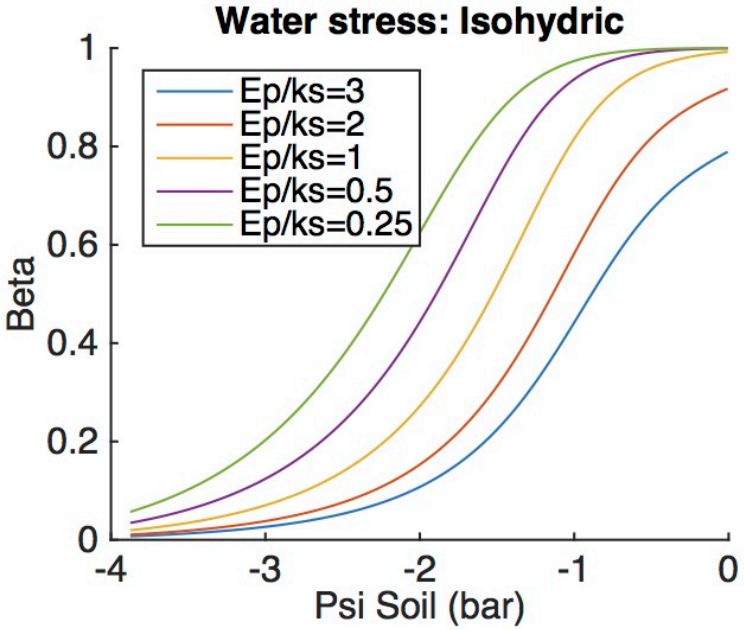
- How does β (plant water stress) depend on Ψ_{soil} ?
- How do our model's findings compared to CLM?
- Very similar to CLM



Model results: Isohydric

- How does β (plant water stress) depend on Ψ_{soil} ?
- What happens when we vary potential transpiration?
- Can a well-watered plant have water stress?

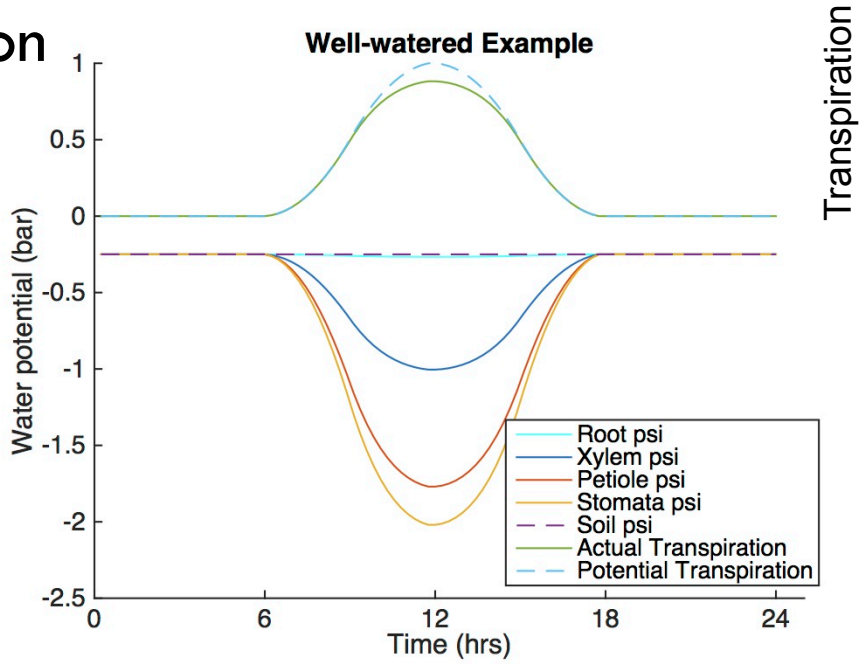
$$E \propto k_s(\Psi_{soil} - \Psi_{stomata})$$



Is this realistic?

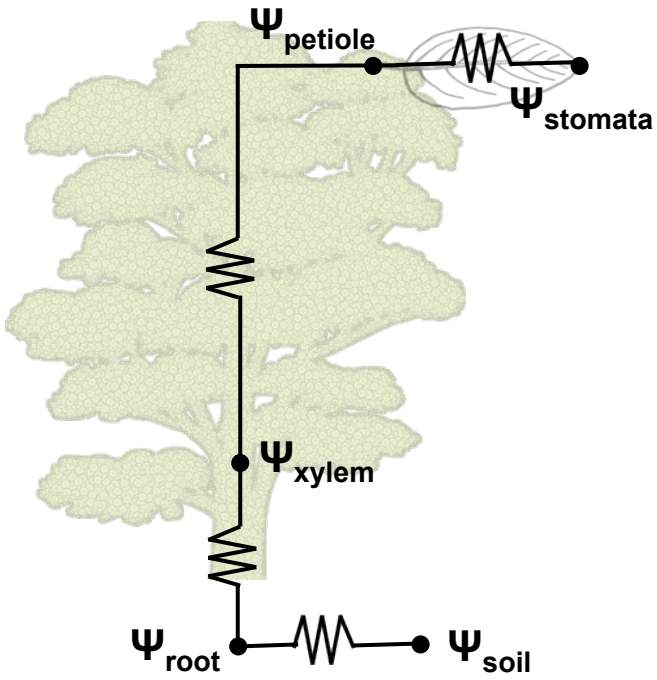
- Can a well-watered plant have water stress?
- Midday potential transpiration high relative to conductance
- Here β =0.88 at the peak of potential transpiration

$$E \propto k_s(\Psi_{soil} - \Psi_{stomata})$$



Conclusions and further work

- Informative to resolve water transport through the plant due to variable plant water strategies
- Plants liable to water stress both from soil and from atmosphere
- Next steps
  - Further model development
  - Couple to boundary layer model



Questions?