Tree Water Storage as a Diagnostic Metric of Forest Response to Drought

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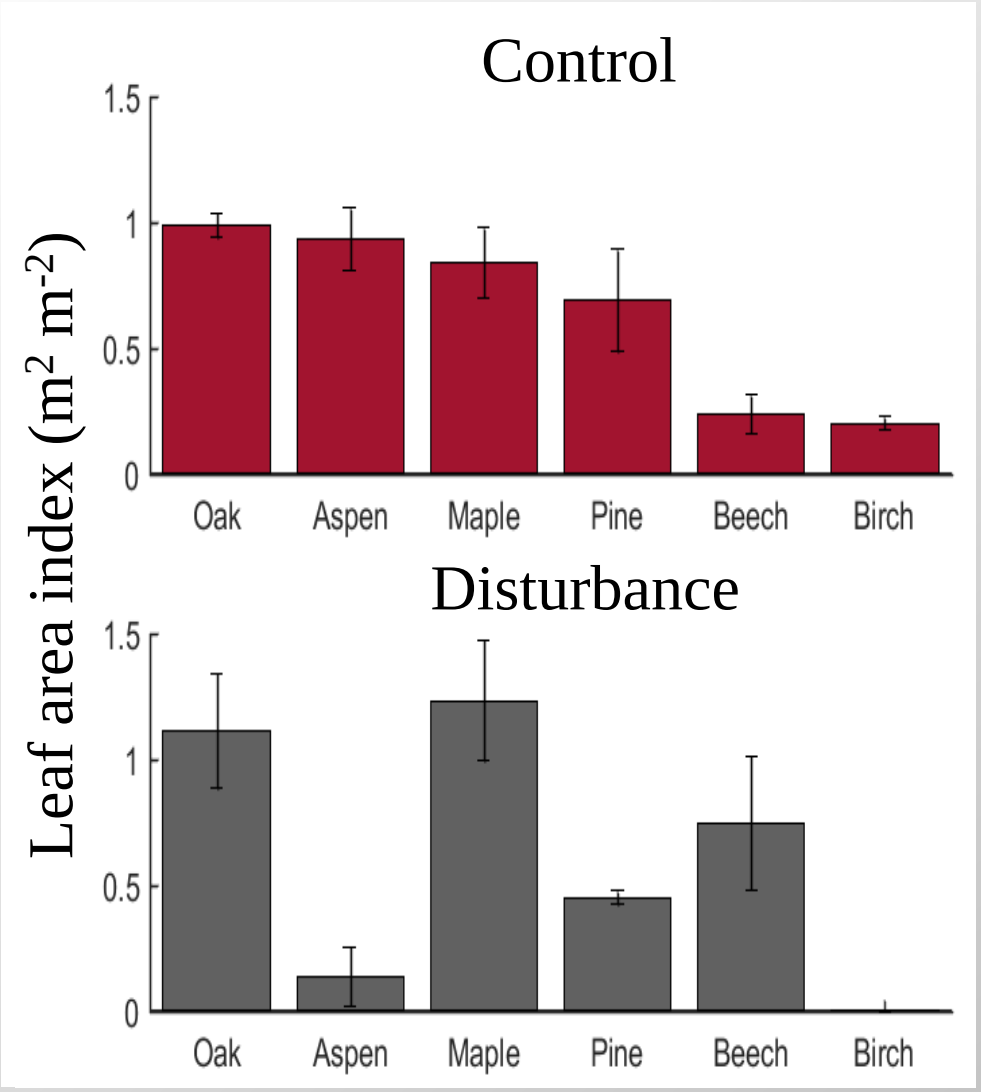
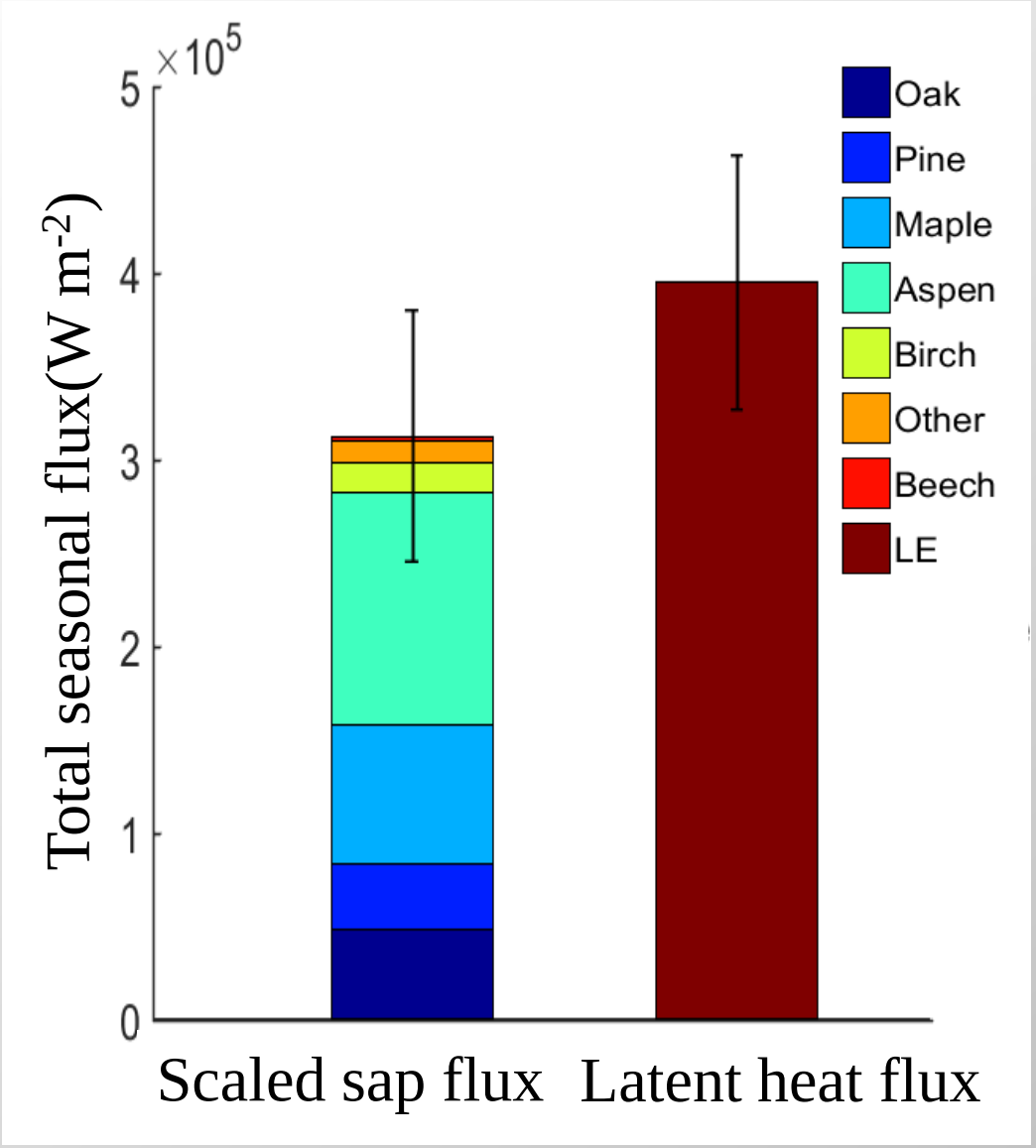
U. of Michigan Biological Station (UMBS) Ameriflux site



- Control LAI ≈ 3.89 m^2m^{-2}
- Disturbance LAI ≈ 3.68 m^2m^{-2}

Transpiration and latent heat at the plot level

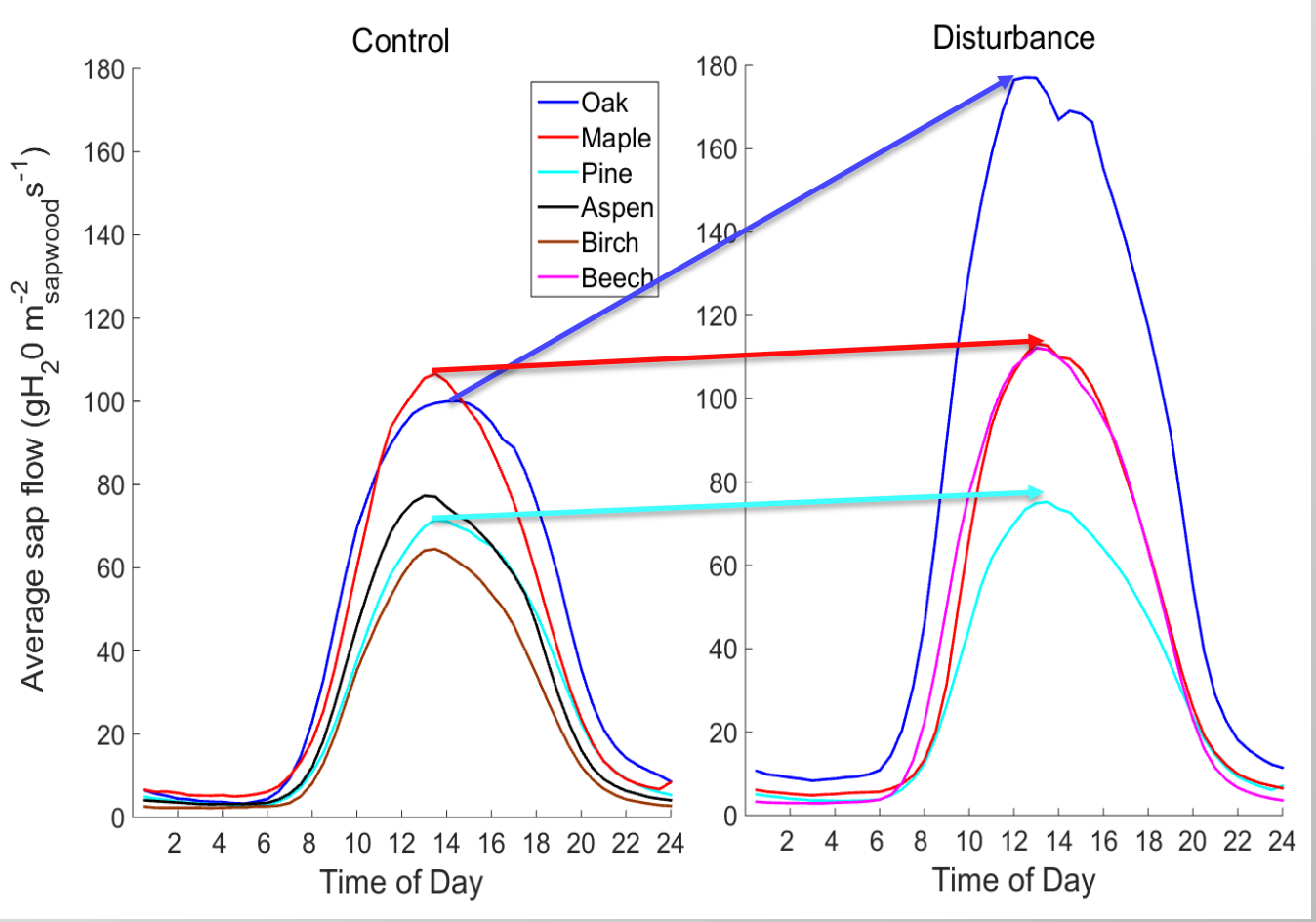


Sap flux ≈ 78% of LE

- Matheny et al. 2014, JGR Biogeosciences

Behavioral changes at the species level

Sap flow density



- Oak: 53% ↑
- Maple: 5% ↑
- Pine: 6% ↑

Stomatal conductance

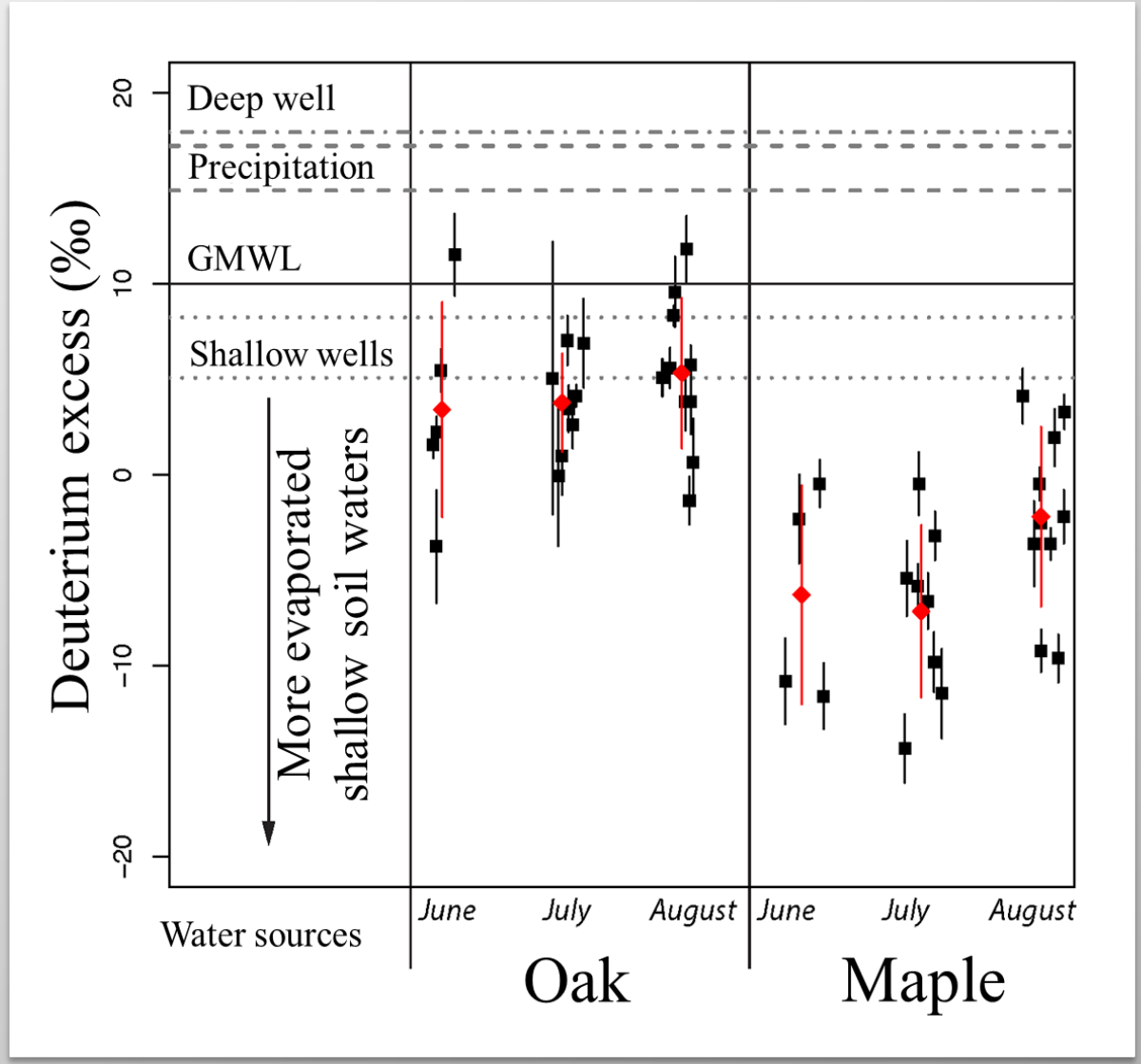
- Oak: 63% ↑
- Maple: 37% ↓
- Pine: 132% ↑

➢ Matheny et al. 2014, JGR Biogeosciences

Rooting depth differences enable sustained water uptake

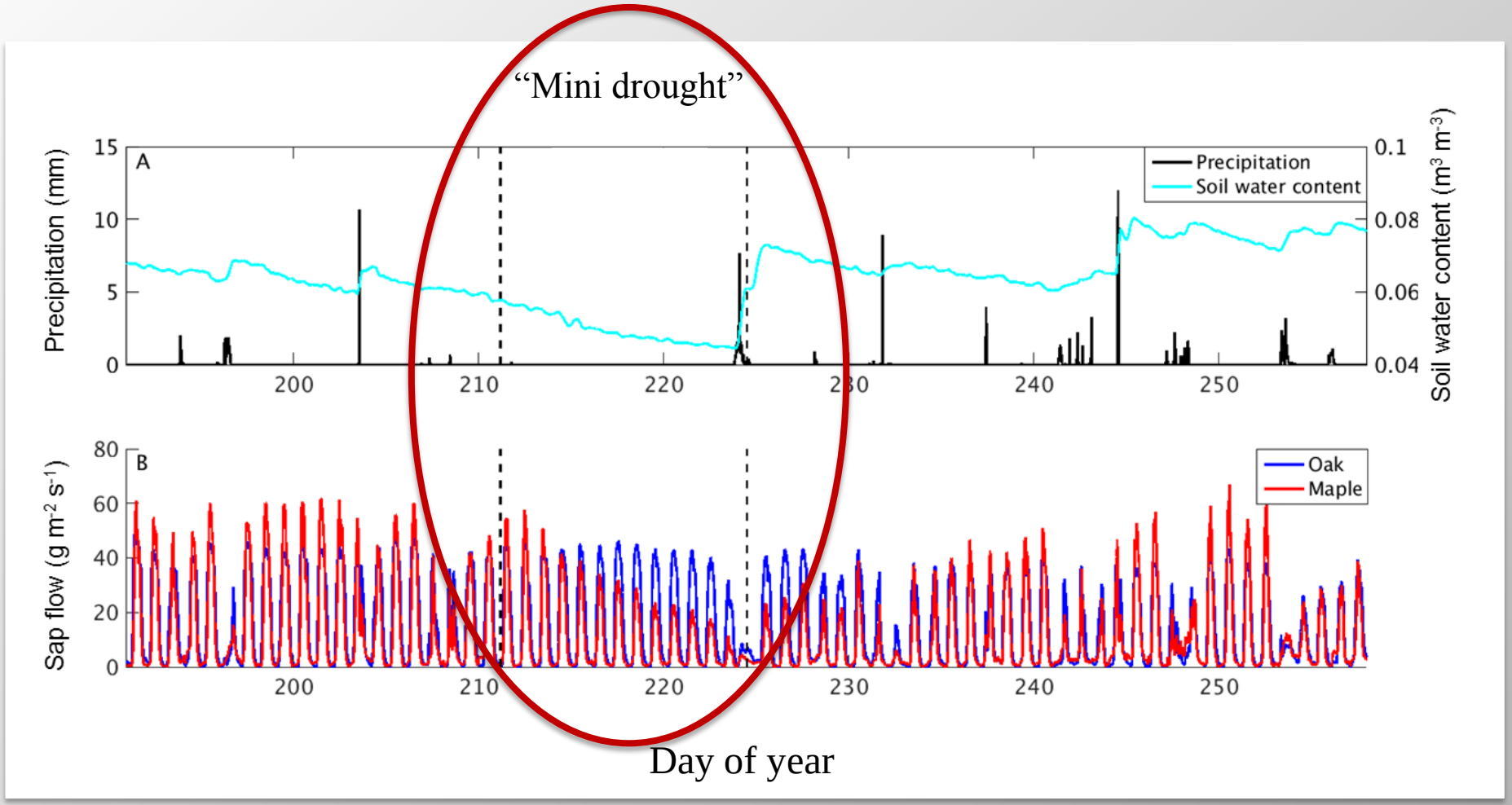
- D-excess:

  $\delta D - 8 * \delta^{18}O$



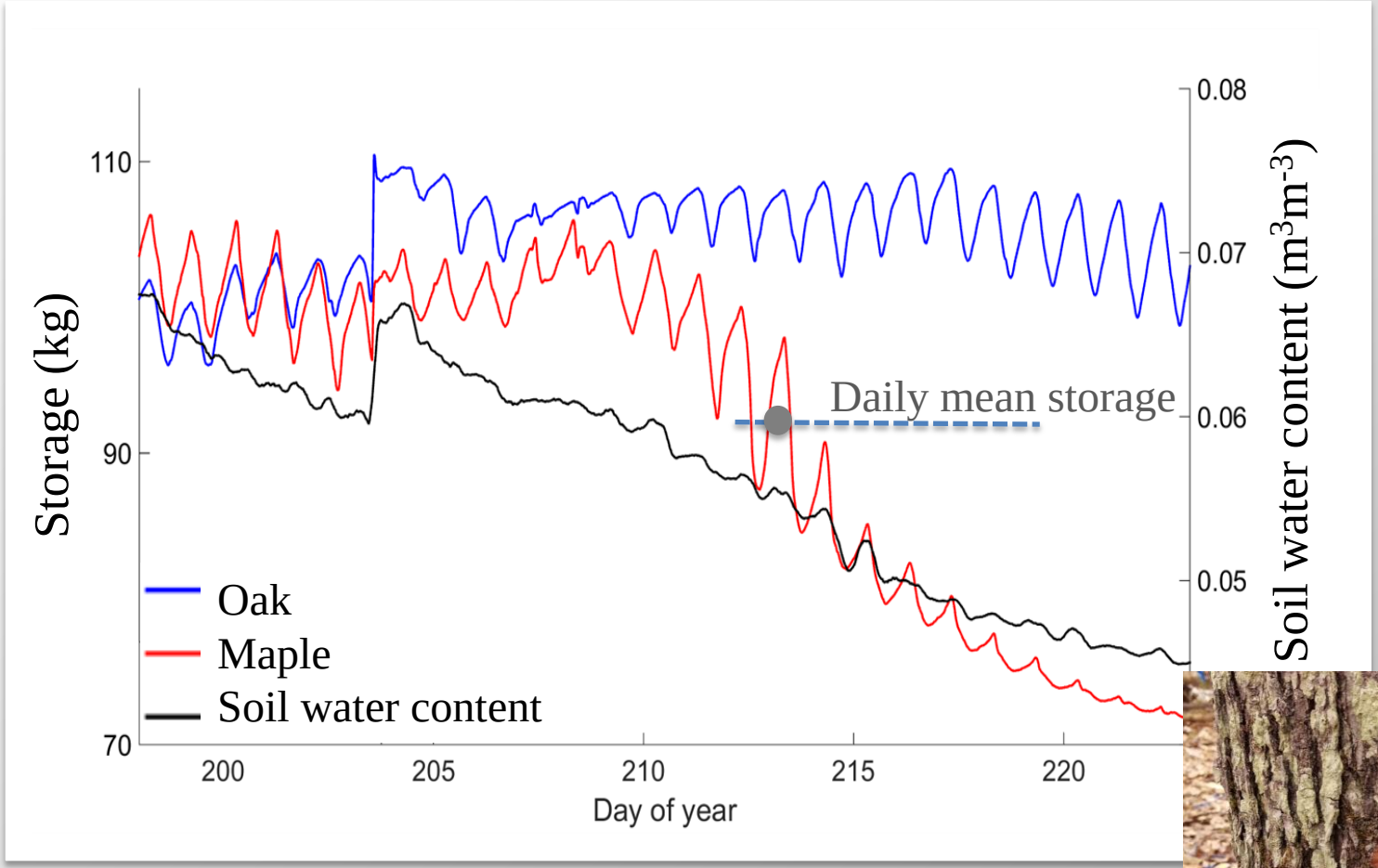
➢ Matheny et al. 2016, Ecohydrology

Species-specific dynamics during dry conditions



- Matheny et al. 2016, Ecohydrology

Water storage dynamics with declining soil water



- Matheny et al. 2015, Ecosphere

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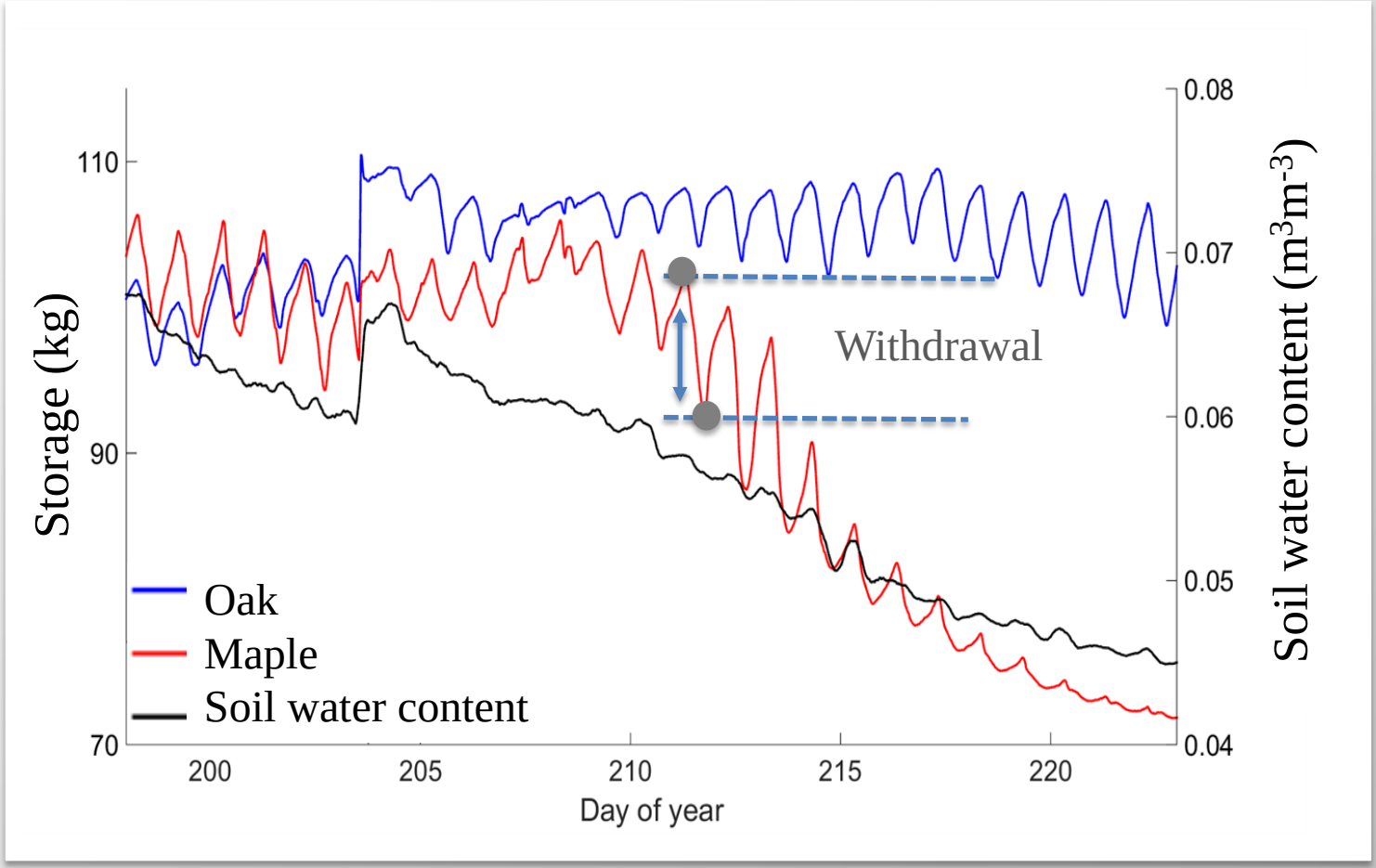

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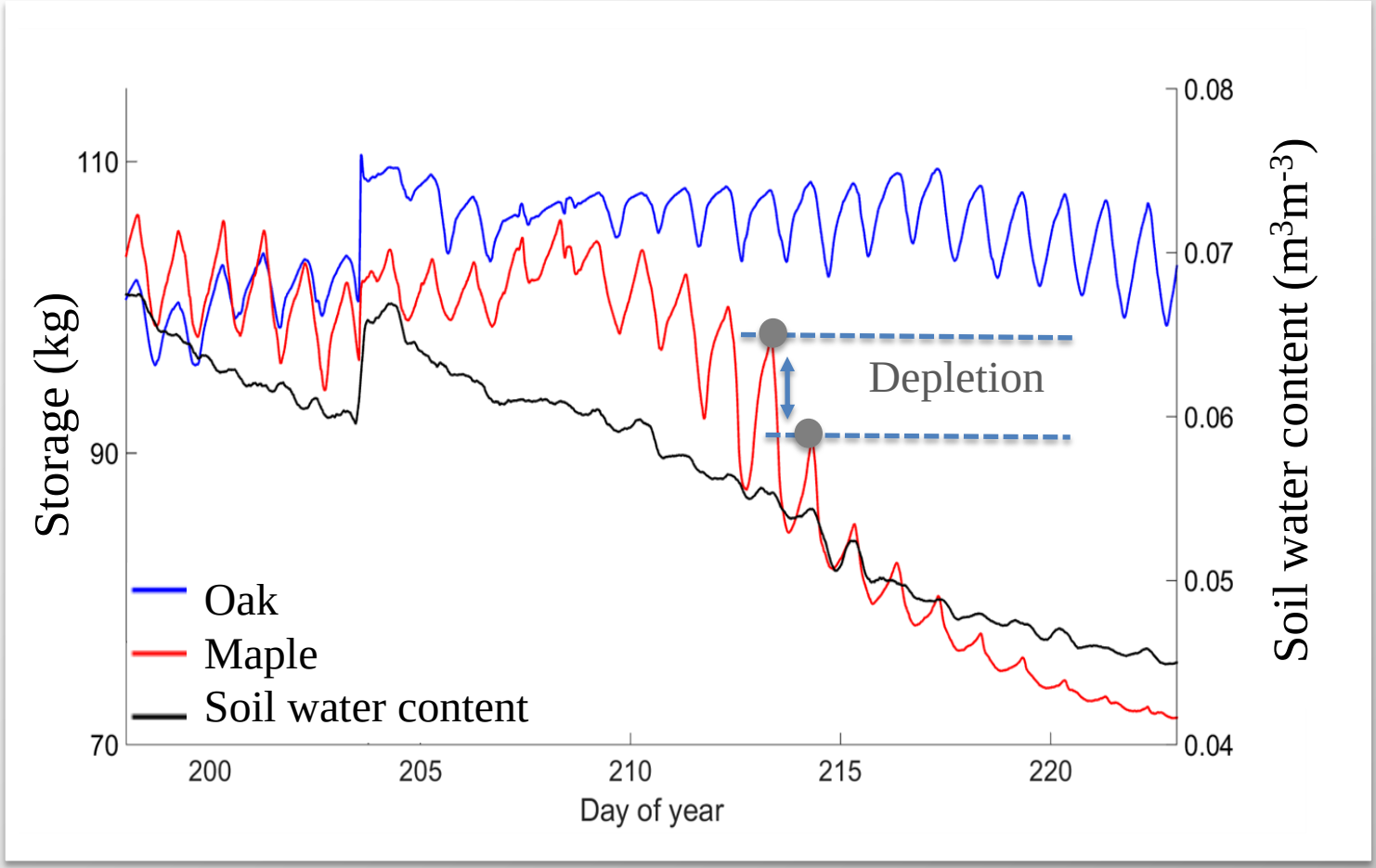

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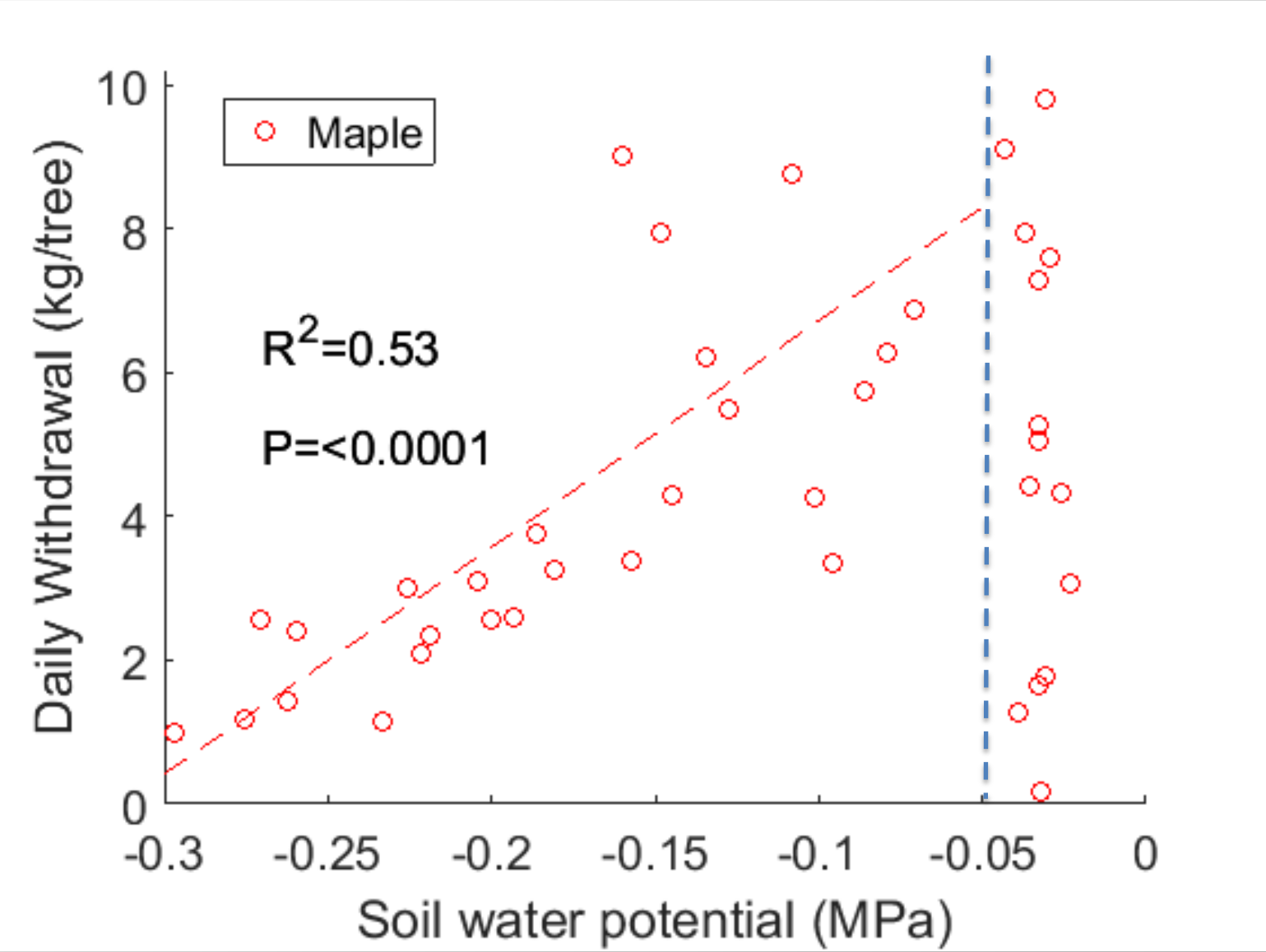
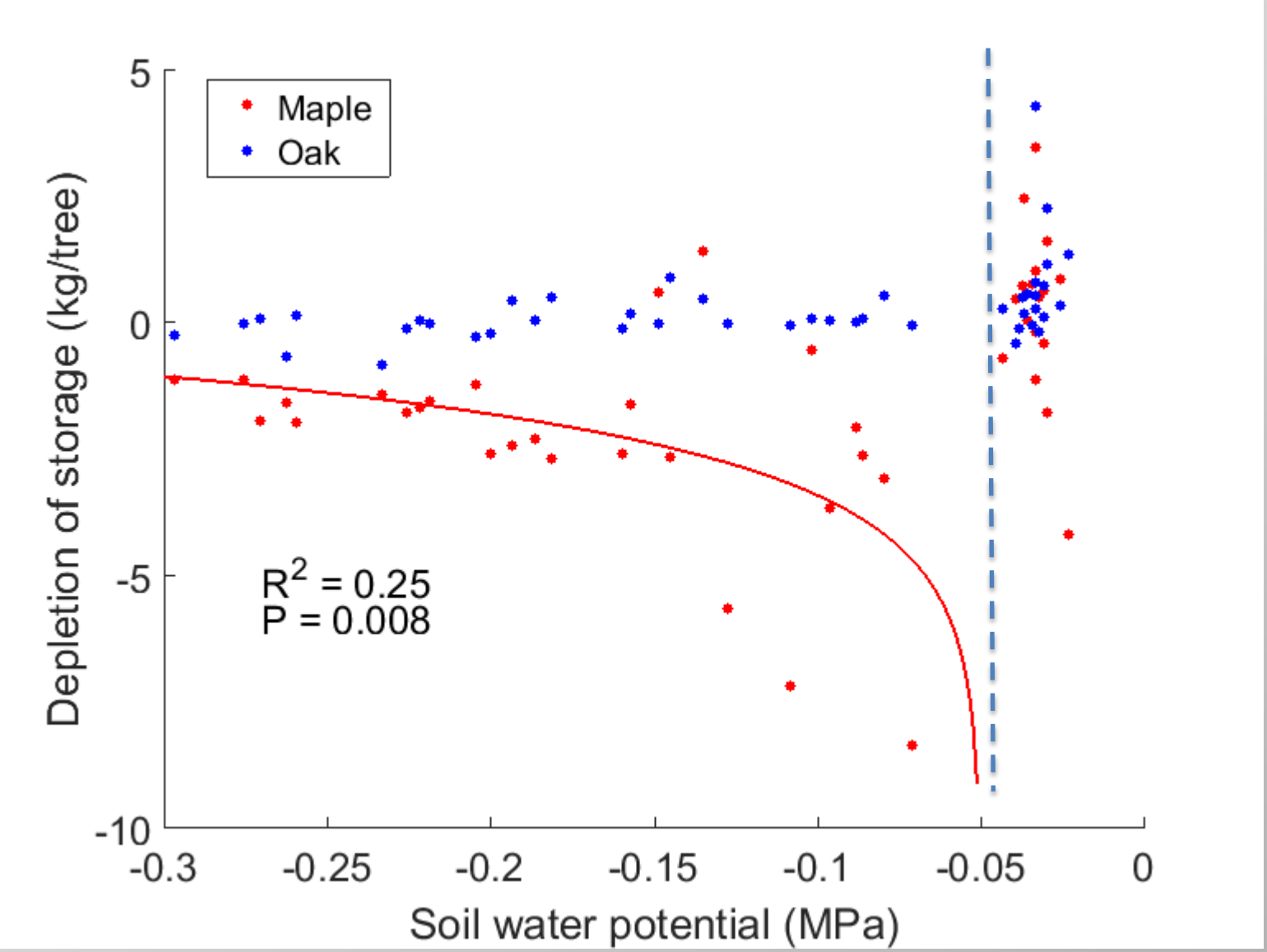
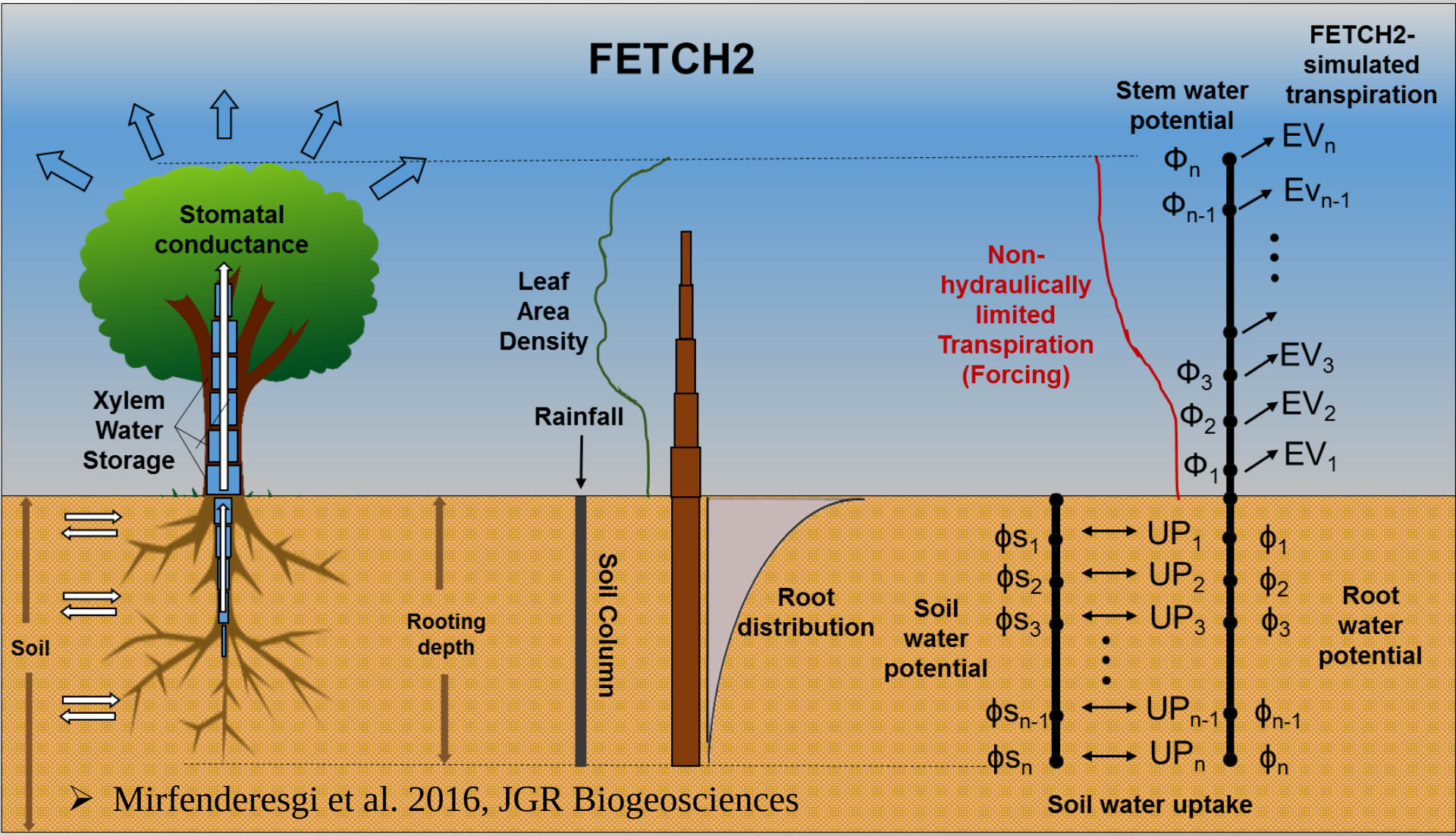


Water storage dynamics with declining soil water



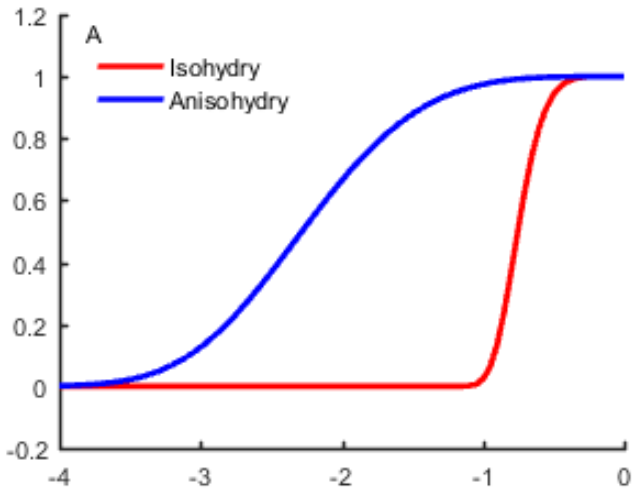
Finite-difference Ecosystem-scale Tree-crown Hydrodynamics (FETCH2)



- Mirfenderesgi et al. 2016, JGR Biogeosciences

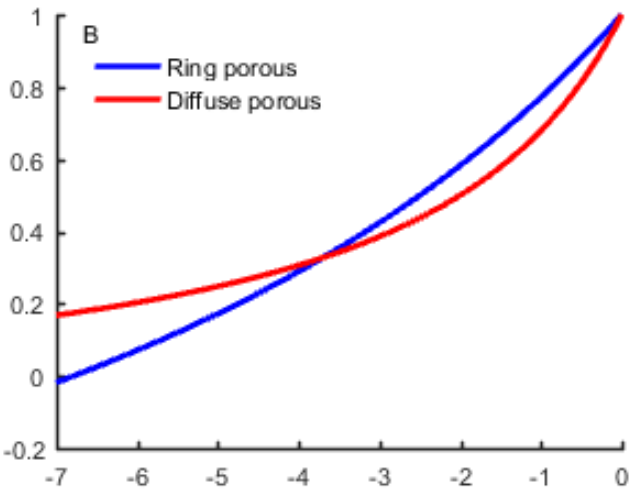
Model parameters define hydraulic strategy

Stomatal response (β)



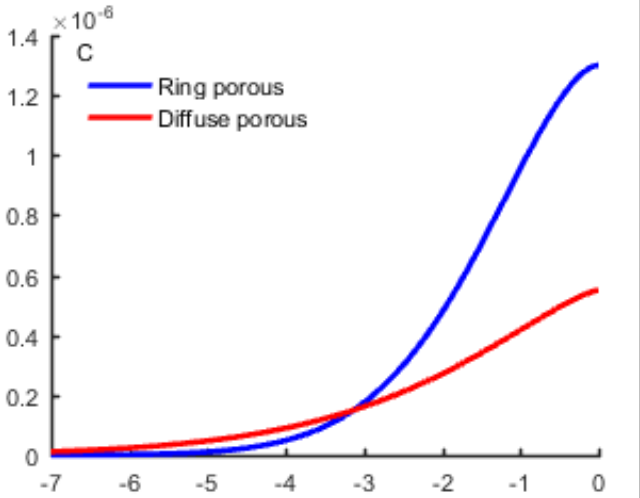
Leaf water potential (MPa)

Capacitance response

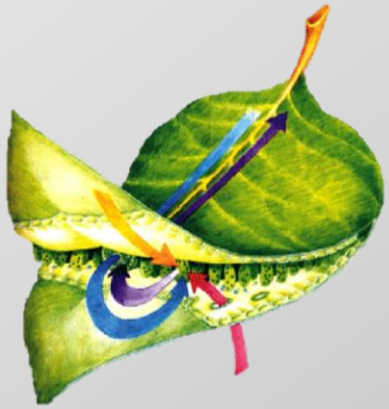


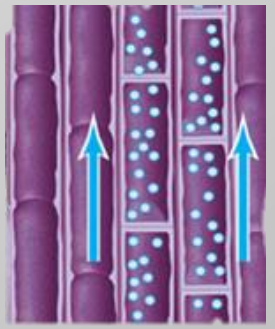
Xylem water potential (MPa)

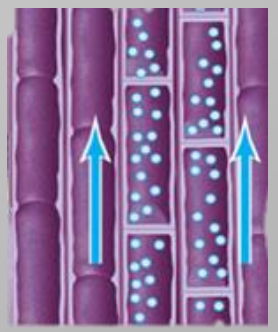
Conductance (kg $m^{-1}s^{-1}MPa^{-1}$)



Xylem water potential (MPa)

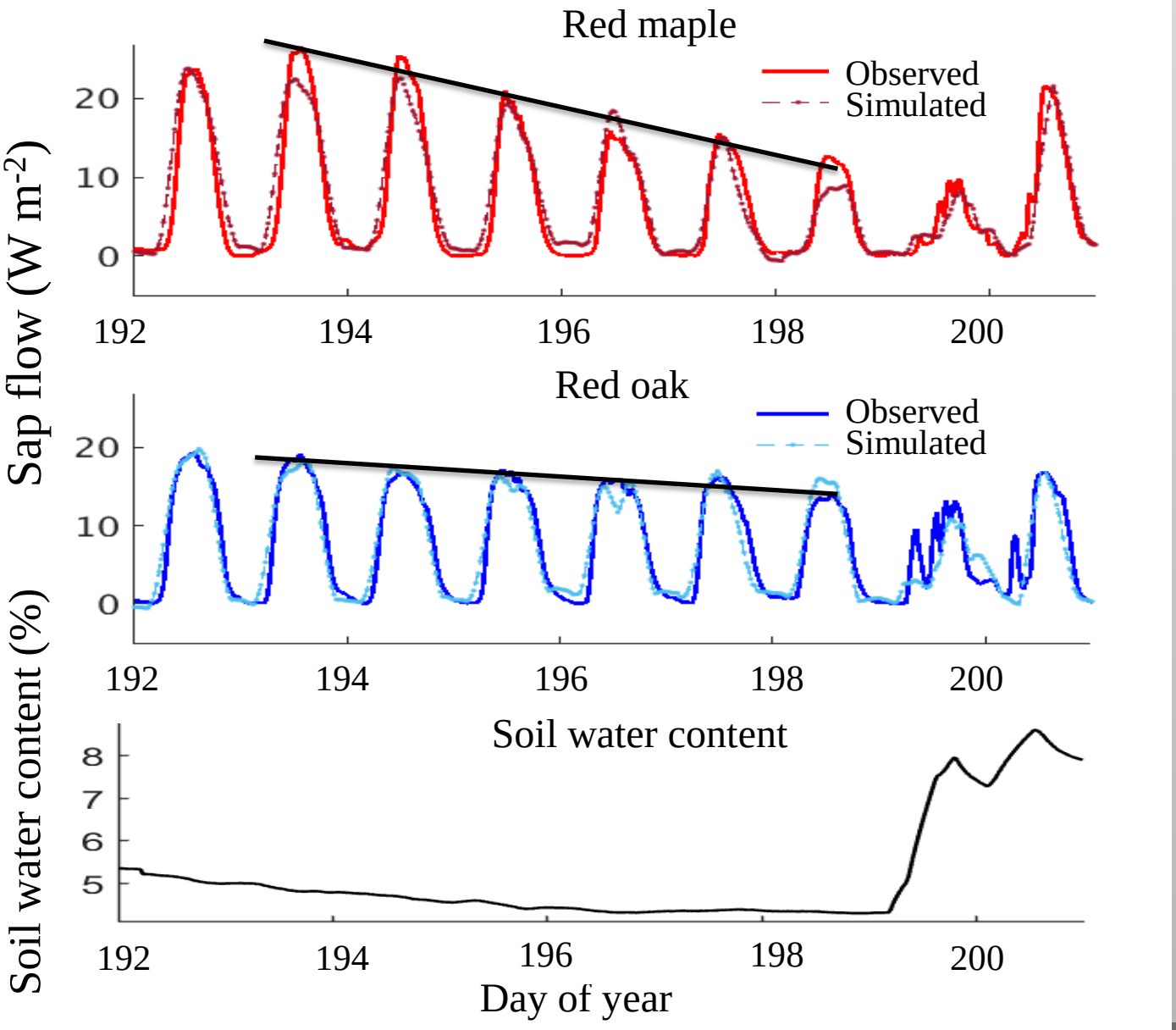






- Matheny et al. 2016, Ecohydrology

Preliminary FETCH2 simulations



Things the AMS asked for

Observations (or networks) that are needed: Ameriflux (flux network), TRY (plant trait network), Soil moisture observations

Recommended instruments that are needed: Sapflow sensors, flux towers, spaceborne microwave radiometers, spaceborne hyperspectral images

Greatest observational needs for your discipline:
High resolution global soil moisture reanalysis

Acknowledgements

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Ohio Supercomputer Center
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National Science Foundation
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