

Revealing seasonal plasticity of whole-plant hydraulic properties using sap-flow and stem water-potential monitoring

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Abstract: Plant hydraulic properties are critical to predicting vegetation water use as part of land–atmosphere interactions and plant responses to drought. However, current measurements of plant hydraulic properties are labor-intensive, destructive, and difficult to scale up, consequently limiting the comprehensive characterization of whole-plant hydraulic properties and hydraulic parameterization in land-surface modeling. To address these challenges, we develop a pumping-test analogue method, using sap-flow and stem water-potential data to derive whole-plant hydraulic properties, namely, maximum hydraulic conductance, effective capacitance, and Ψ_{50} (water potential at which 50 % loss of hydraulic conductivity occurs). Experimental trials on *Allocasuarina verticillata* indicate that the parameters derived over short periods (around 7 d) exhibit good representativity for predicting plant water use over at least 1 month. We applied this method to estimate near-continuous whole-plant hydraulic properties over 1 year, demonstrating its potential to supplement existing labor-intensive measurement approaches. The results reveal the seasonal plasticity of the effective plant hydraulic capacitance. They also confirm the seasonal plasticity of maximum hydraulic conductance and the hydraulic vulnerability curve, known in the plant physiology community, while neglected in the hydrology and land-surface modeling community. It is found that the seasonal plasticity of hydraulic conductance is associated with climate variables, providing a way forward to represent seasonal plasticity in models. The relationship between derived maximum hydraulic conductance and Ψ_{50} also suggests a trade-off between hydraulic efficiency and safety of *Allocasuarina verticillata*. Overall, the pumping-test analogue offers potential for better representation of plant hydraulics in hydrological modeling, benefitting land-management and land-surface process forecasting.

Keywords: Whole-plant hydraulic properties, water potential, sap flow, seasonal plasticity