Leaf water (18) O and (2) H enrichment along vertical canopy profiles in a broadleaved and a conifer forest tree

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Distinguishing meteorological and plant-mediated drivers of leaf water isotopic enrichment is prerequisite for ecological interpretations of stable hydrogen and oxygen isotopes in plant tissue. We measured input and leaf water δ(2) H and δ(18) O as well as micrometeorological and leaf morpho-physiological variables along a vertical gradient in a mature angiosperm (European beech) and gymnosperm (Douglas fir) tree. We used these variables and different enrichment models to quantify the influence of Péclet and non-steady state effects and of the biophysical drivers on leaf water enrichment. The two-pool model accurately described the diurnal variation of leaf water enrichment. The estimated unenriched water fraction was linked to leaf dry matter content across the canopy heights. Non-steady state effects and reduced stomatal conductance caused a higher enrichment of Douglas fir compared to beech leaf water. A dynamic effect analyses revealed that the light-induced vertical gradients of stomatal conductance and leaf temperature outbalanced each other in their effects on evaporative enrichment. We conclude that neither vertical canopy gradients nor the Péclet effect is important for estimates and interpretation of isotopic leaf water enrichment in hypostomatous trees. Contrarily, species-specific non-steady state effects and leaf temperatures as well as the water vapour isotope composition need careful consideration.
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