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Separating the contributions of vegetation and soil to evapotranspiration using stable isotopes

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Semi-arid ecosystems contribute about 40% to global net primary productivity, although water-availability limits carbon uptake. Precipitation shows periodical summer droughts and evapotranspiration accounts for up to 95% of water loss of the ecosystem. Thus functional understanding of evapotranspiration and the contributions of evaporation and transpiration from over- and understorey vegetation to water cycling in semi-arid regions is key knowledge in forest management under future climate change.

Water isotopes trace water through the compartments of an ecosystem from soil and the vegetation to the atmosphere. They are used to partition evapotranspiration ET into its components evaporation E and transpiration T. The method is, however, sensitive to the knowledge of the isotopic composition of water at the evaporating sites. This led to a discussion recently about the dominance of transpiration in water loss from the terrestrial biosphere, and also how methodological problems could bias these results.

Here we present observations from a Portuguese cork-oak woodland. It is a bi-layered system of widely spaced cork-oak trees and a herbaceous layer dominated by native annual forbs and grasses. Water fluxes and their isotopic compositions were measured on bare soil and vegetated plots with a transparent through-flow chamber and a water isotope laser. Soil moisture and temperature were measured in several depths and soil samples were taken for soil water isotope analysis.

Based on these observations, we review current strategies of ET partitioning. We highlight pitfalls in the presented strategies and show uncertainty analyses for the different approaches. We show that the isotopic composition of evaporation is very sensitive to the sampling strategy but is described well by a steady-state formulation (Dubbert *et al.*, J Hydrolo 2013). The isotopic composition of transpiration, on the other hand, is not in steady state, most of the time (Dubbert *et al.*, New Phytolo 2014). We will demonstrate the consequences for the partitioning of ET of current simplifications in soil moisture isotope descriptions and current steady-state assumption for transpiration isotopes.