Geophysical Research Abstracts
Vol. 21, EGU2019-12579, 2019
EGU General Assembly 2019


# Mixing models vs. direct inference to quantify plant water sources in ecohydrological studies

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Mixing models are widely used in ecohydrological studies to quantify the contribution of various water sources to plant water uptake using stable isotopes. Mixing models are typically based on mass balance calculation and mixing space geometry. A common underlying assumption is that all water sources accessed by plant roots are adequately sampled and that the tracer signature is conserved through the mixing processes. But in field studies, sampling all potential water sources is not always practical or possible, creating potential bias in the mixing model estimation of plant water source.

Here we present and test a new direct inference method to estimate the proportion of water sources to root water uptake. The approach is based on graphical overlapping, within a statistically-defined space (95% confidence ellipse), between the isotopic composition (hydrogen and oxygen in a dual-isotope plot) of the potential water sources and the isotopic composition of xylem. The only assumption behind this method is that the isotopic signature of xylem is conserved during the water uptake (i.e. no fractionation during transport) and reflects the contributions of the different water sources. Based on its implicit assumptions, this approach has the advantage to quantify water sources even if one or more sources are missing and with no need for the source tracer means to sum to unity. We apply our inference approach to isotopic data of soil water at different depths, groundwater and precipitation across four climatic zones extracted from 30 scientific papers published between 1990 and 2017. We then evaluate our inference approach against two widely applied Bayesian mixing models, IsoSource and SIMMR.

Preliminary results show, on average, quite different source water estimates for the three methods, with larger fractions of soil water from different depths (up to 84%) and smaller fractions of groundwater and precipitation (up to 33% and 14%) estimated by the inference method compared to the two mixing models. The largest differences were observed for the arid, temperate, and cold climates and the smallest differences were found for the tropical climate zone.

More analyses on various species and in different climatic contexts will be carried out to further test this method, to evaluate the differences compared to mixing model results, including the incorporation of uncertainty of the estimates, and to provide recommendations about its potentials and limitations in quantifying water sources accessed by plants with respect to other methods in light of the different underlying assumptions and structures.

Keywords: direct inference method; mixing models; stable isotopes; water sources; root water uptake.