

A global meta-analysis reveals a significant isotopic offset between plant water and its sources.

Javier de la Casa, Adrià Barbeta, Asun Rodríguez-Uña, Lisa Wingate, Jérôme Ogée, Teresa E. Gimeno

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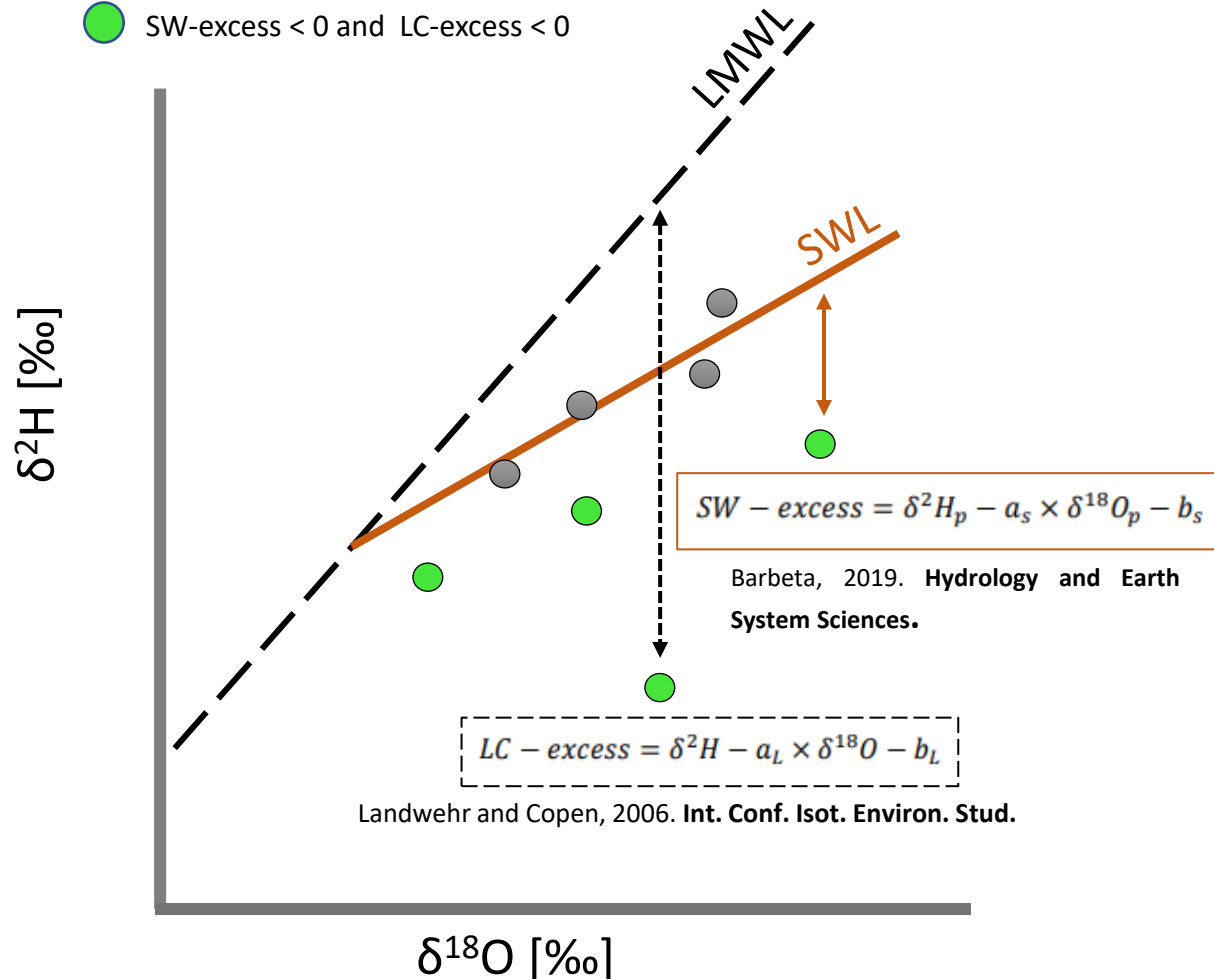


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Plant samples

- SW-excess ≥ 0 and LC-excess ≤ 0
- SW-excess < 0 and LC-excess < 0



Root water uptake is known as a non-fractionation process, and hence, stem water isotopic composition should resemble the composition of the soil profile. In this dual plot this is represented with the grey dots plotting close to the soil water line (SWL).

But there is growing number of studies reporting mismatches in the isotopic composition of stem water and soil, which is represented by the green dots.

In order to know more about this phenomenon, we conducted a meta-analysis of 112 studies and calculated the LC-excess and SW-excess of the different species within the sampling campaigns of each study.

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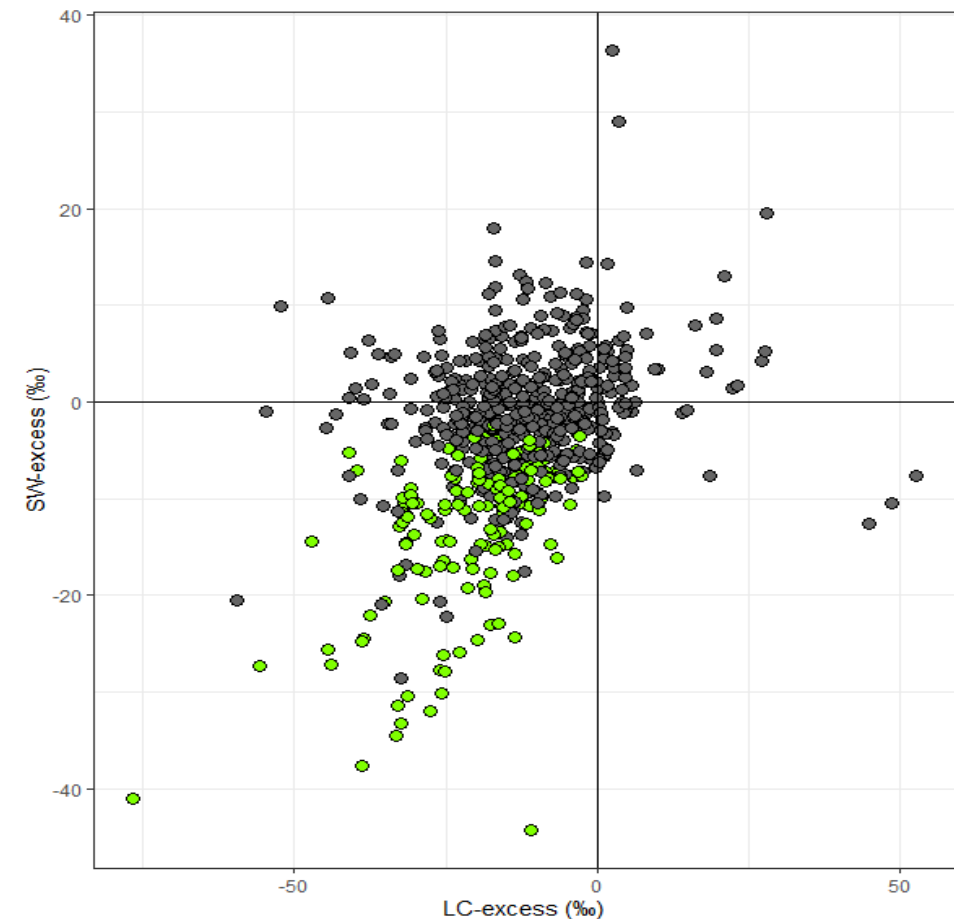
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Taking into account the random variability and the number of observations across studies, the average SW-excess was negative, indicating that this isotopic mismatch of stem water being below the SWL is generalized.

The combined analysis of LC-excess and SW-excess revealed that in 95% where the SW-excess was negative, the LC-excess was negative too (considering the standard error too). Those cases are represented with green dots, and cannot be explained by alternative sourcing of water, as the LC-excess is also negative and hence far from the LMWL (where most moles are usually placed in the dual isotope plot)

OVERALL SW-EXCESS ACROSS STUDIES: $-3.02 \pm 0.65 \text{ ‰}$, $P < 0.001$



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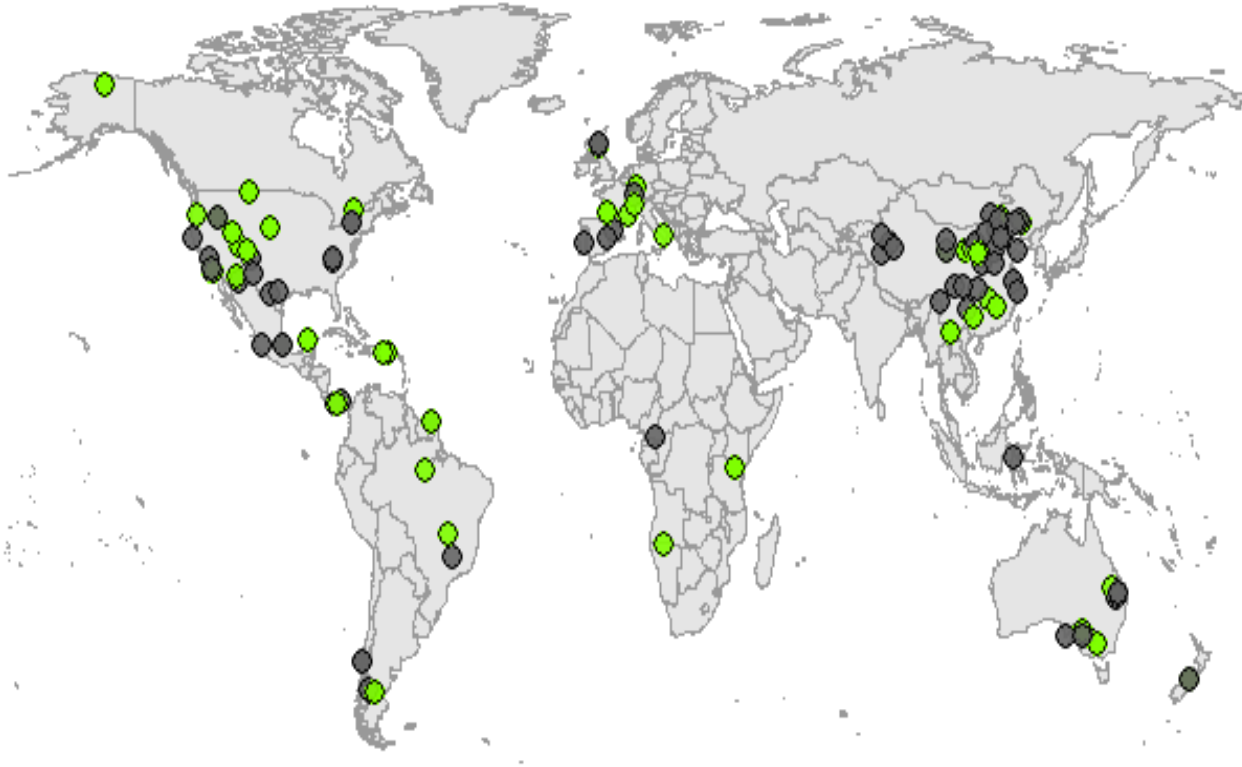
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Also, we see that this isotopic offset is widespread and not restricted to arid or saline environments. In this map, green dots depict sampling locations where the condition of stem samples having both negative SW-excess and LC-excess is met at least once.

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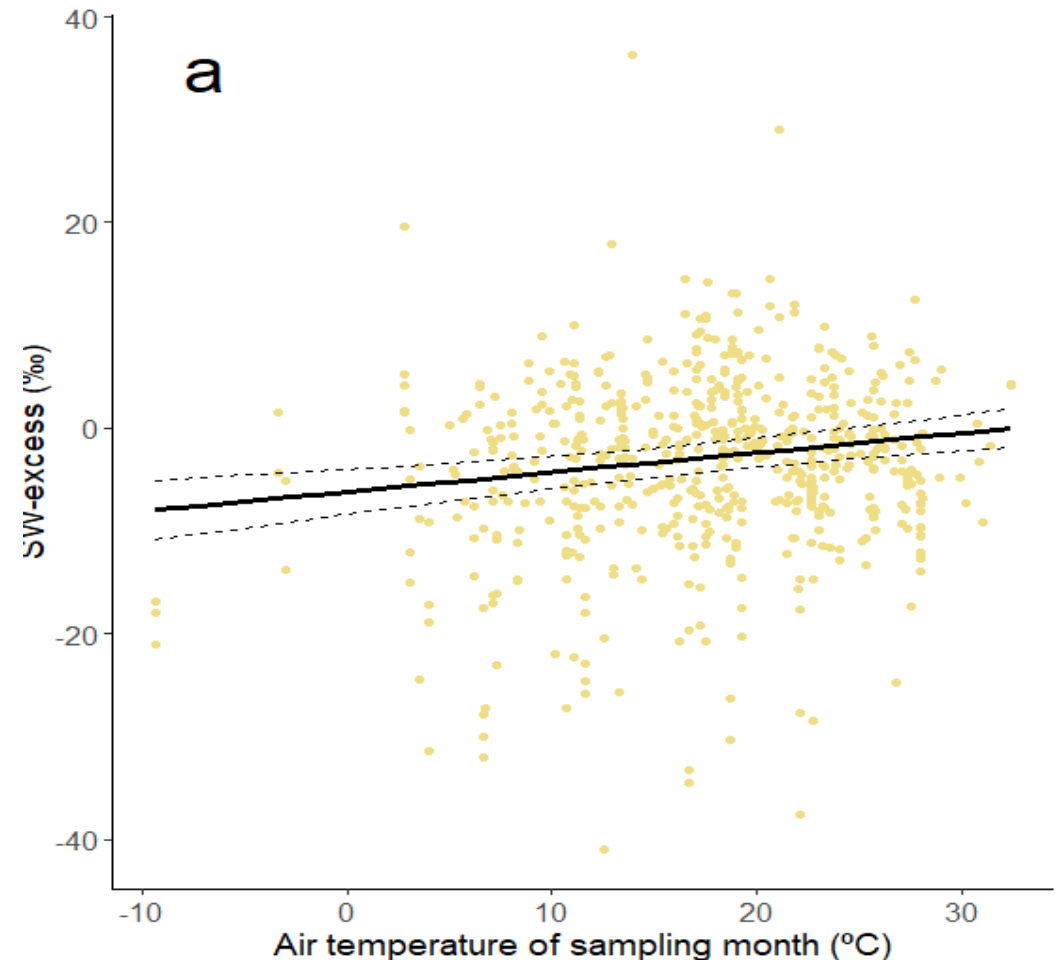
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Using data from the ERA-5 database, we aimed to underlie the possible effects of environmental conditions over the SW-excess.

We detected a significative positive effect of monthly values of temperature, and the effect is independent from other environmental conditions or to the effect that temperature causes in the SWL slope and intercept.

A possible explanation is that in warmer temperatures, stem water experiences evaporative enrichment.

Also, we detected a significative neagtive effect of monthly values soil water content of the upper 100 cm of soil, but this result was dependent to the effect of soil water content over the SWL slope and intercept itself.



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Thank you for the interest!

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