Hydrol. Earth Syst. Sci. Discuss., 4, S363–S365, 2007
www.hydrol-earth-syst-sci-discuss.net/4/S363/2007/

Hydrology and Earth System Sciences Discussions

Interactive comment on "A method to determine plant water source using transpired water" *by* L. B. Menchaca et al.

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Received and published: 13 June 2007

A practical non-destructive and non-invasive technique for assessing the isotopic composition of plant source water would certainly be of great value. The approach described by Menchaca et al. in the paper "A method to determine plant water source using transpired water" appears to have some practicality, but theoretical models describing fractionations and predicted results were lacking. The lack of model predictions greatly reduces the value of this study.

The isotopic composition of transpired water under steady-state conditions matches that of plant source water. Therefore, capturing transpired water vapor in a leaf chamber under isotopic steady-state (ISS) conditions should be a straightforward solution to the problem. Using this approach, only a single water vapor sample would be required to assess the isotopic composition of plant water source. The collection would have to

be done using an open-flow gas exchange system, rather than a closed-loop system, whereby conditions in the chamber could be controlled and maintained for long enough to achieve ISS. Several commercially available plant gas exchange systems could be employed to do this under rigorous field conditions. Although a bit slow (reaching ISS could take as long as 90-120 minutes), this could meet the requirement of being non-destructive and non-invasive. Of course, this approach has serious limitations relative to the Menchaca et al. approach (critiqued below) in terms of cost (for an expensive gas exchange system) and throughput rate (one sample at a time).

However, this was not the approach employed by Menchaca et al. These investigators used a closed-flow chamber system for collection of transpired vapor. Here, the transpired water was allowed to build in the chamber with progressive mixing with water in the liquid phase inside leaf tissues, allowing the humidity in the collection chamber to build to saturation. Water was drained off the as condensate from inside the collection chamber and analyzed. This seems to be a theoretically complicated way to assess plant source water, but if validated from a theoretical perspective, could be quite practical. The comprehensive review by Farquhar et al. (2007, Plant Physiology 143:11-18) is a very good starting point for understanding the theory of leaf water isotopic enrichment and isotopic composition of transpired water. The isotopic composition of bulk leaf water at the strarting point of collection using the Menchaca et al. approach has very likely been influenced by mixing with atmospheric vapor to a degree that is difficult to know a priori (see Farquhar et al. 2007). Therefore the leaf water at the first collection period is somewhat 'contaminated' by atmospheric vapor. Indeed other factors need to be considered here, such as the contamination of background air vapor into the collection chamber during installation and the degree of back-mixing of bulk leaf water with stem water over the period of sampling. A more serious concern is that the condensate drained from the collection chamber is easily fractionated to a degree dependent on temperature of the collection system. Were isothermal conditions met, such that condensed water removed from the chamber had an isotopic composition identical to that of bulk leaf water? How much back-diffusion of bulk leaf water into

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the stem and thus removed from the enclosed leaf and chamber is taking place, and would this affect the isotopic composition over time? The Menchaca et al. paper does not describe the theoretical framework needed to understand the results obtained, nor does it sufficiently describe details of the field collection methods (temperature, etc.) to adequately reproduce the work or assess the results. Frankly, the results are puzzling without a clear theoretical description of the processes involved and predictions from theory.

Overall, the method described by Menchaca et al. is potentially very useful. Some of the concerns, mentioned above, need to be addressed before this approach is widely applied.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 863, 2007.