Continuous observation of tree interception effects on water stable isotopes

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Motivation

The isotopic composition of throughfall is affected by complex exchange and mixing processes in the canopy. The differences are driven by evaporation from the canopy during or between storms, isotopic exchange with ambient vapor and canopy storage effects, where water is differentially retained by the canopy during rainfall events. These interception processes occur simultaneously in time and space generating a complex pattern of throughfall in amount and isotopic composition. Therefore, the aim of this study is to

- investigate the dynamics in gross precipitation ($P_g$) and throughfall (TF) in high temporal resolution to test the different hypotheses of canopy interception processes
- adequately predict the isotopic signal of throughfall under a variety of precipitation and environmental conditions

Methodology

In combination with a CRDS instrument we established an in-situ method to transfer liquid water to water vapor within seconds (Herbstritt et al., WWR, 2012). Core of the method is an off-the-shelf microporous hydrophobic membrane contactor, originally designed for degassing liquids. It is used in reverse mode with nitrogen as carrier gas in order to continuously transform a small fraction of liquid water to water vapor which is then transferred directly to the analyser.

Based on this method and with two CRDS instruments in parallel, the isotopic composition of throughfall (TF) below a deciduous tree canopy and gross precipitation ($P_g$) 15 m away were measured continuously (0.5 Hz) by the analysers.

Additionally, rainfall amounts were recorded every minute at both sites by tipping buckets. Liquid grab samples, representing rainfall sums of 30' were taken from time to time, as well as bulk samples for each event. Meteorological parameters RH (%) and $T_s$ ($^\circ$C) were recorded every minute.

Results

Conclusions

Gross precipitation exceeds throughfall amounts.

- Throughfall typically starts and ends later than gross precipitation
- A negative exponential correlation exists between interception loss and rainfall intensity
- Throughfall is enriched in heavy isotopes.
- A weak positive correlation exists between Dd18O and interception loss
- Antecedent conditions seem to have an impact on isotope enrichment of throughfall.

Reference