Diffusion-tight bags for repeated discrete soil and xylem water vapor isotope sampling

HYDROLOGY

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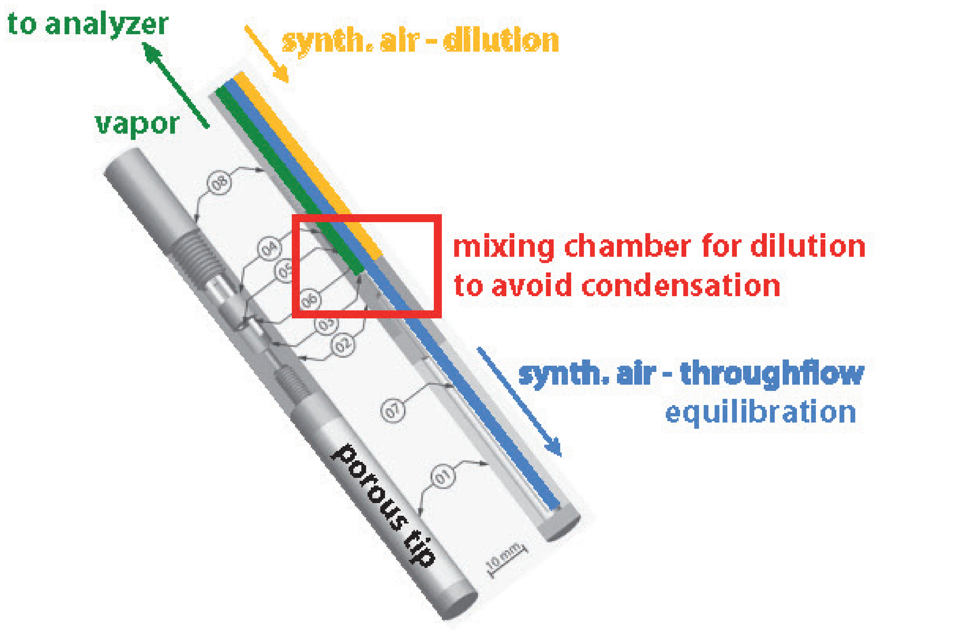
Motivation

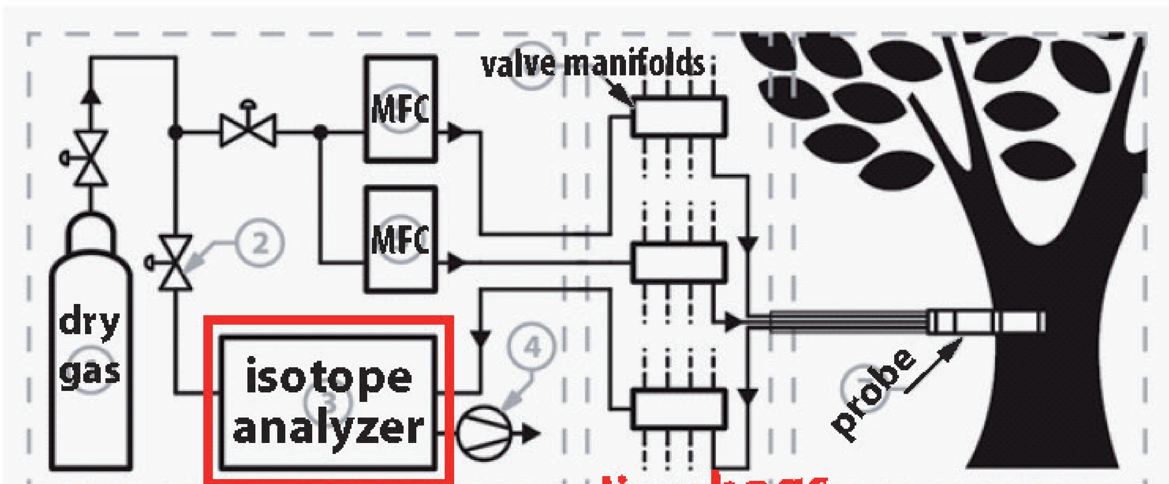
In-situ analysis with a recently developed isotope probe for $\delta^{18}O$ and $\delta^{2}H$ in soils (Volkmann & Weiler, 2014) and xylem (Volkmann et al., 2016) are non-destructive and field-deployable, but the method requires heavy and expensive equipment to be brought to the field. Rough and/or spacious terrains are virtually excluded with this approach. Therefore, the aim of this study is to

- sample via these probes the isotopic signature in xylem sap
- **develop a sampling procedure to collect vapor samples in the field in gastight bags**

Soil water isotope probe



Working principle of the in-situ soil water isotope probe
Volkmann & Weiler, 2014, HESS



replace analyzer by gas-sampling bags

Setup for direct in-situ monitoring of xylem water stable isotope compostion — Volkmann et al., 2016, PCE

Methodology

Required properties for gasbags

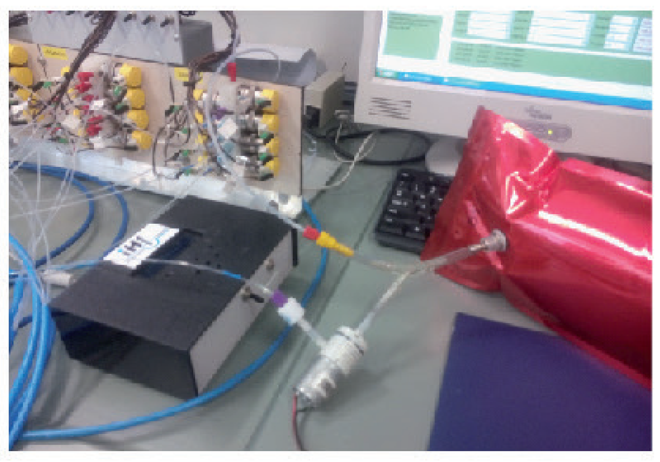
- inexpensive
- reusable
- **sufficient volume**
- quick and easy to handle
- robust
- conservative:
  - > inert
  - > **diffusion-tight**
  - > suitable for longterm storage

Diffusion-tightness and long-term storage

Filling with pure N_2 to identify mixing with ambient air.

Application test

- Sampling 'conventionally' directly through the probe
- Sampling of vapor via probe into bags
- **Increased flowrate (150 mL/min)** compared to Picarro-method (35 mL/min) **for reasonable filling times in the field**
- **Isotopically different sources (moist sand)**



Filling of bags with vapor from probe

Gasbag types

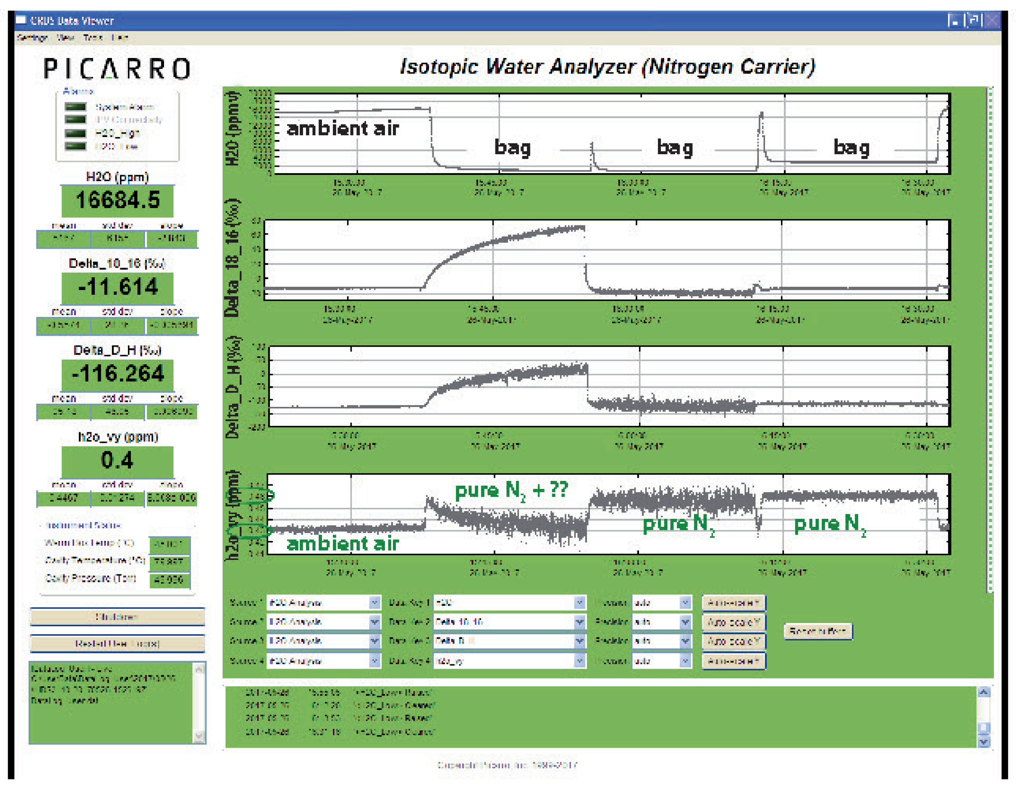
PE-spoutbags and Al-spoutbags
Caps were replaced by caps with septa
Filling and sampling through septum via needle and 1/8" tubing

3-layer metalized ziploc bags
Silicone blot serves as septum
Filling and sampling through septum via needle and 1/8" tubing

3-layer metalized ziploc bags
Commercially availble gasvalves were **applied for filling and sampling**

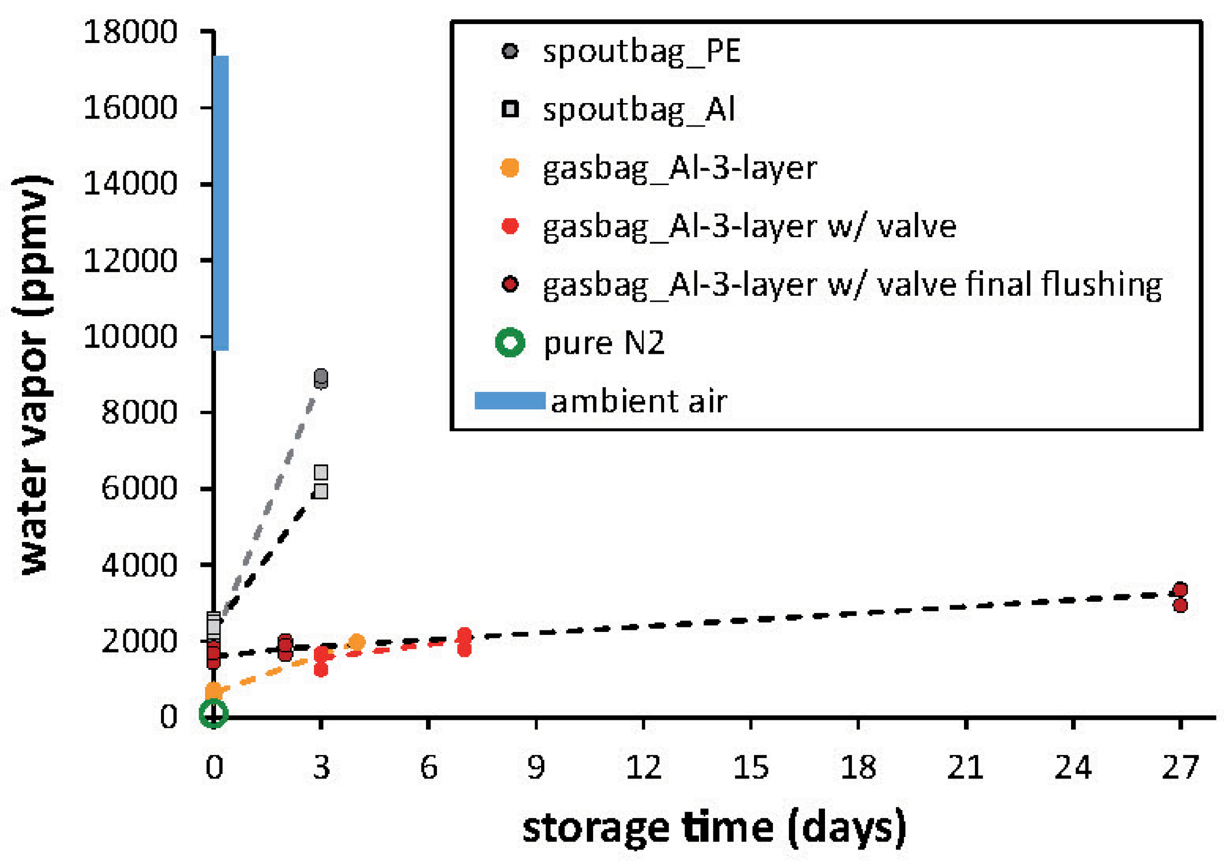
Results

Contamination



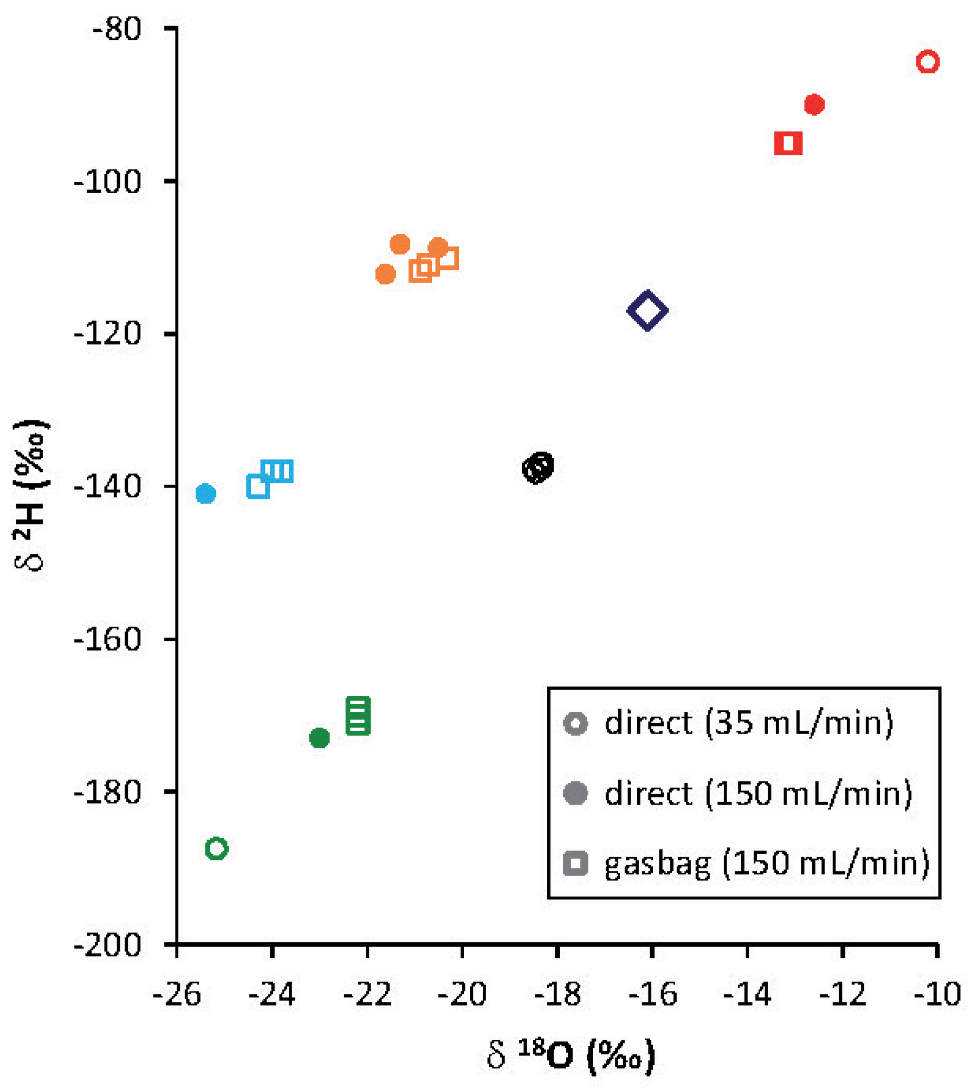
Different components may lead to erroneous isotope data, even though vapor concentration looks reliable. In this case, the variable for gas-composition 'h2o_vy' shows clear evidence of contamination.

Diffusion-tightness and long-term storage



Performance of different bag-types, filled with pure N_2. Increasing vapor concentration over time for different bag-types indicates insufficient diffusion-tightness.

Application test



Sampling of vapor directly with the probe (dots) vs. sampling via probe into the one trustworthy bag-type (open squares). Colors represent source waters of **different isotopic composition.**

→ Potential reasons for higher variation of replicates with high flowrate (150 mL/min) compared to 35 mL/min

- pump not properly diffusion-tight
- manual filling and sampling of bags perhaps sometimes leaky
- kinetic fractionation, no complete equilibrium

Conclusions

Soil probe data agree with data of gas bags but can be improved.

Proper calibration has to be performed.

Procedure is suitable for rough terrain and unlimited scaling.

Handling of expensive equipment in the field is avoided.

Outlook

Next steps to improve precision and minimize carry over effects:

- **Test Pump for diffusion-tightness and flow stability**
- **Optimize flowrate**
- **Finish automatic control of pumps and valves to optimize filling and sampling of the bags**

References

Volkmann, T. H. M.; Weiler, M.; 2014, Continual in situ monitoring of pore water stable isotopes in the subsurface, HESS, 18 (5), 1819–1833
Volkmann, T. H. M.; Kühnhammer, K.; Herbstritt, B.; Gessler, A.; Weiler, M.; 2016, A method for in situ monitoring of the isotope composition of tree xylem water using laser spectroscopy, PCE

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