Realtime in-situ determination of $\delta^{18}O$ and $\delta^{2}H$ in liquid water

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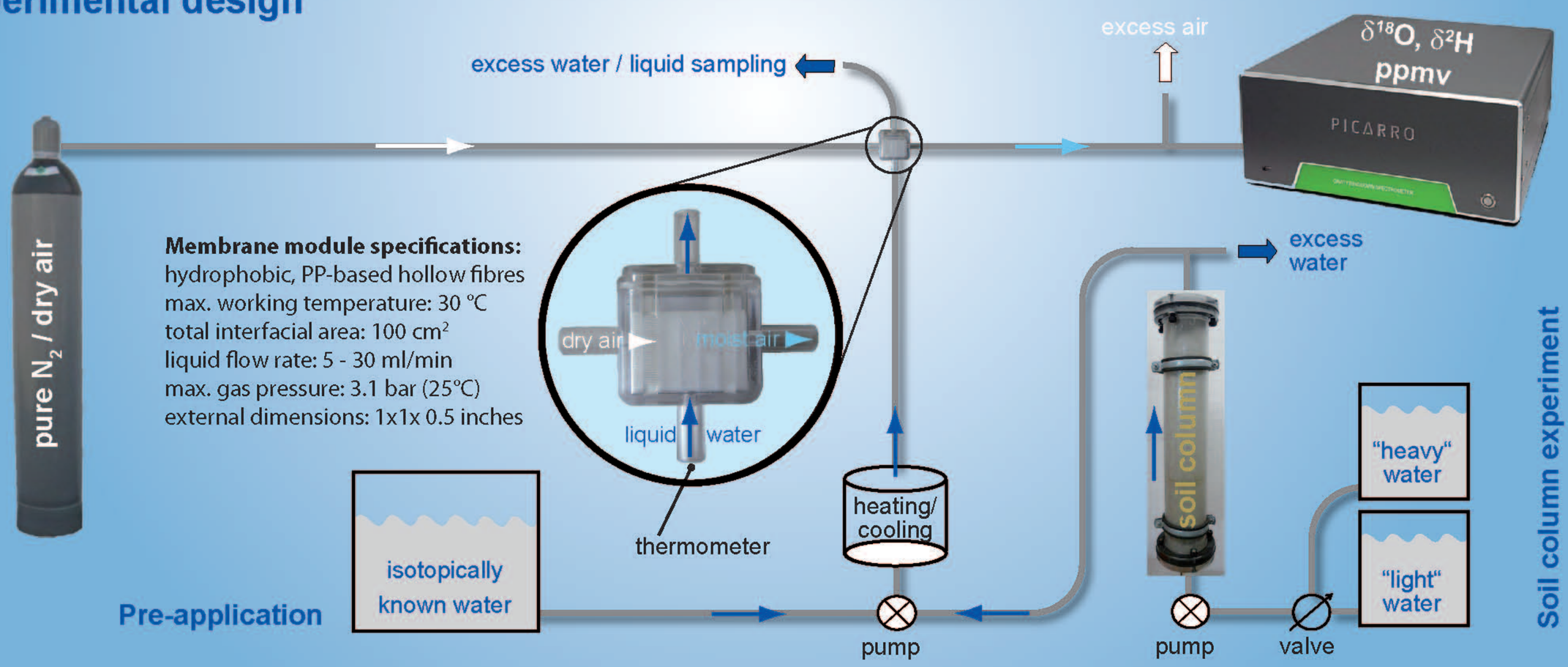
HYDROLOGY

Introduction

- Isotope studies are still a trade-off between limited spatio-temporal resolution and extensive lab work
- In conventional isotope analytics a significant time lag exists between sampling and data acquisition (unlike EC or T measurements)
- Laser-based analyzers are now available and capable of measuring stable water isotopes in the vapor phase directly and continuously

➤ **Challenge: Convert liquid water to water vapor and continuously provide it to analyzer**

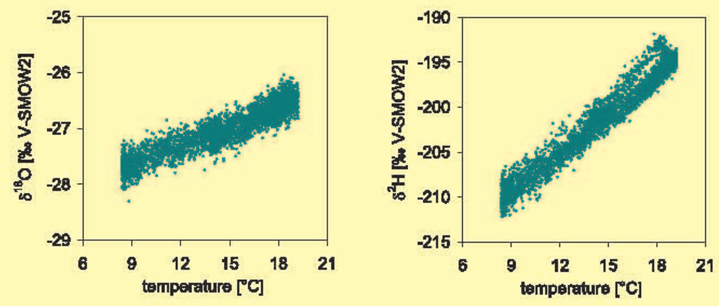
Experimental design



Pre-application steps

Determination of membrane-specific fractionation factors

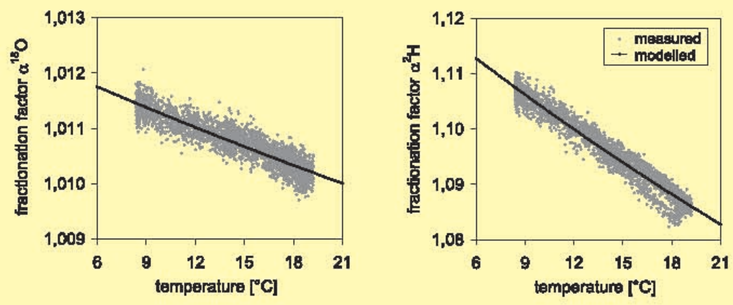
1. Measuring of thermal dependancy of water vapor isotopes and calibration



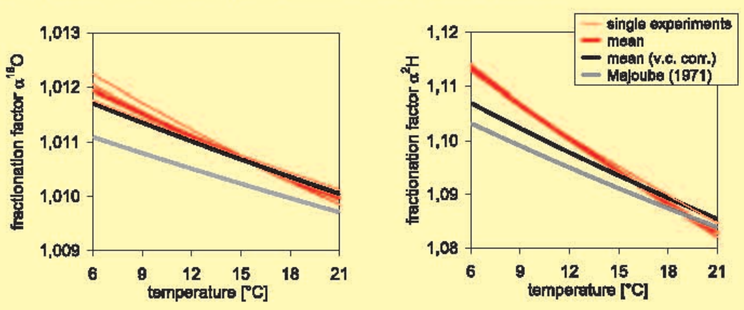
2. Calculation and modelling of fractionation factors α

$$\alpha = \exp\left(\left(a\left(10^6/T_K^2\right)+b\left(10^3/T_K\right)+c\right)/1000\right)$$

a, b, c - empirical parameters
T_K - temperature in K



3. Repetition and comparison with free water surface

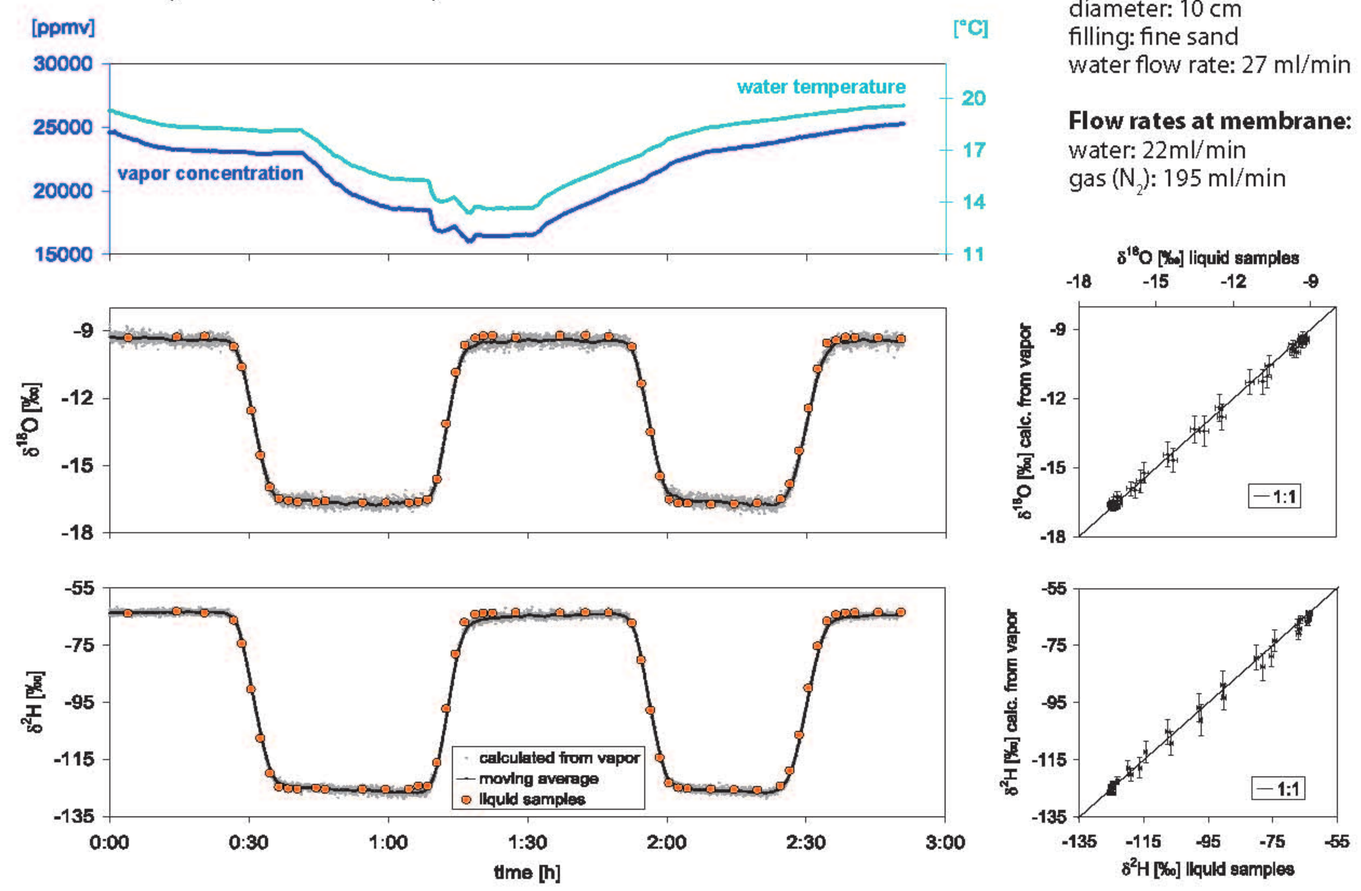


Application: soil column experiment

Testing the method under highly unstable conditions (isotopically, thermally)
Verification by conventional analysis

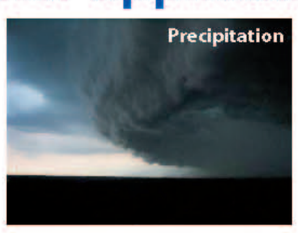
Soil column parameters:
length: 50 cm
diameter: 10 cm
filling: fine sand
water flow rate: 27 ml/min

Flow rates at membrane:
water: 22ml/min
gas (N_2): 195 ml/min



Possible further applications

Suitable wherever dynamic processes have to be observed in real time and with high temporal resolution



Conclusion

- Hydrophobic membranes may have specific isotopic fractionation factors
- The proposed method provides real-time data and captures even abrupt changes

Reponse time: about 10s (depending on setup dimensions and flow rates)
Resolution: minutes or below
Precision: comparable to conventional analysis (0.16‰ for $\delta^{18}O$, 1.1‰ for $\delta^{2}H$)
Supervision: minimum requirements
Restrictions: water temperature must not exceed ambient temperature (else: heating / dilution)

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