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Plant and root-zone water isotopes are difficult to measure, explain, and predict: some practical recommendations for determining plant water sources

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The following two tables contain information about the data sources of the values reported in Table 1 and 2 in the paper “Plant and root-zone water isotopes are difficult to measure, explain, and predict: some practical recommendations for determining plant water sources” published in the journal ‘Methods in Ecology and Evolution’.

Table 1: Ranges of natural isotopic variability, expressed as 1 standard deviation (σ) or mean isotopic difference (Δ), that can occur within trees and soils.

Source of variability	Experimental details	Observed natural variability (‰ VSMOW) $\delta^{18}O$	$\delta^{2}H$	Data source $\delta^{18}O$	Date source $\delta^{2}H$
Within the tree crown	*P. abies* branch xylem water (σ_{ID} of 5 samples, averaged across 3 trees)	1.6	4.4	Goldsmith et al. (2019): σ_{5}=1.44, σ_{78}=1.25, σ_{823}=2.23	Goldsmith et al. (2019): σ_{5}=2.61, σ_{78}=3.49, σ_{823}=7.16
Among-tree variability within plot	*P. abies* branch xylem water (σ of 4-8 trees per plot, averaged across 71 plots)	0.8	2.1	Supplementary material in Allen, Kirchner, Braun, Siegwolf, and Goldsmith (2019)	
Laterally in deep soil	Soil water from 40-50cm depth across 1ha (σ, n=8)	1.0	7.1	Data in Goldsmith et al. (2019)	
Laterally in shallow soil	Soil water from 0-10cm depth across 1ha (σ, n=150)	1.7	10.6	Data in Goldsmith et al. (2019)	
Isotopic separation during root water uptake	Irrigated sealed pots with *Persea Americana*, $\Delta=\delta_{soil}-\delta_{xylem}$ (mean Δ, n=32)	1.1	9.2	Data extracted from Figure 6 in Vargas, Schaffer, Li, and Sternberg (2017)	

Table 2: Analytical uncertainties of commonly-used extraction and measurement methods for stable water isotopes in soil and plant samples. Error was quantified as the mean absolute deviation from an isotope reference value (mostly that of spike water) and repeatability was quantified as one standard deviation of that mean.

Extraction methods	**Experimental details**	**Metric**	**$\delta^{18}O$ (‰ VSMOW)**	**$\delta^{2}H$ (‰ VSMOW)**	**Data source $\delta^{18}O$**	**Data source $\delta^{2}H$**
Suction lysimeter (70–75kPa), IRMS	Soil water, spiked sandy loam (n=10)	Error	0.68	1.9	Table 1 in Thoma, Frentress, Tagliavini, and Scandellari (2018)	
		Repeatability	0.71	1.5	Table 1 in Thoma et al. (2018)	
Centrifugation (5000rpm, 15min), OA-ICOS	Soil water, spiked silty sand, 20% GWC (n=5)	Error	0.19	1.08	Table II in Orlowski, Pratt, and McDonnell (2016): Spike water $\delta^{18}O$ = - 8.6‰, sampled water $\delta^{18}O$ = - 8.79‰	Table II in Orlowski et al. (2016): Spike water $\delta^{2}H$ = 59.8‰, sampled water $\delta^{2}H$ = - 60.88‰
		Repeatability	0.06	0.36	Table II in Orlowski et al. (2016)	
Microwave extraction (330W, 15min), OA-ICOS	Soil water, spiked silty sand, 20% GWC (n=5)	Error	0.57	24.95	Table II in Orlowski et al. (2016): Spike water $\delta^{18}O$ =-8.6‰, sampled water $\delta^{18}O$ =-8.03‰	Table II in Orlowski et al. (2016): Spike water $\delta^{2}H$ =59.8‰, sampled water$\delta^{2}H$ =-34.85‰
		Repeatability	0.32	1.47	Table II in Orlowski et al. (2016)	
Cryogenic vacuum distillation (98°C, 45min), OA-ICOS	Soil water, spiked silty sand, 20% GWC (n=5)	Error	0.71	5.54	Table II in Orlowski et al. (2016): Spike water $\delta^{18}O$ =-8.6‰, sampled water $\delta^{18}O$ =-9.31‰	Table II in Orlowski et al. (2016): Spike water $\delta^{2}H$ =59.8‰, sampled water$\delta^{2}H$ =-65.34‰
		Repeatability	0.18	1.17	Table II in Orlowski et al. (2016)	
Cryogenic vacuum distillation (100°C, 210min), IRMS	Xylem water, root crown, irrigated open pots with *Triticum aestivum* L., (n=5)	Error	Not reported		Table 1 in Millar, Pratt, Schneider, and McDonnell (2018)	
		Repeatability	0.35	0.86	Table 1 in Millar et al. (2018)	
Cryogenic vacuum distillation (90°C, 120min), IRMS	Xylem water, irrigated sealed pots with *Salix viminalis* (n=68)	Error	0.84	Not signif.	Sect. 4.2 in Newberry, Nelson, and Kahmen (2017)	
		Repeatability	1.13	Not reported	Sect. 4.2 in Newberry et al. (2017)	
Direct vapor equilibration method with bags (6d), OA-ICOS	Soil water, spiked coarse sand, medium sand, coarse silt, 8-50% GWC (n=9)	Error	0.52	2.87	Average values of $\Delta\delta^{18}O$ data in Table 4 in Mattei et al. (2019)	Average values of $\Delta\delta^{2}H$ data in Table 4 in Mattei et al. (2019)
		Repeatability	0.76	4.67	Average values of $\delta^{18}O$ data in Table 4 in Mattei et al. (2019)	Average values of $\delta^{2}H$ data in Table 4 in Mattei et al. (2019)
In-situ equilibration method with membranes (DDS, TI), IRIS	Soil water, slightly clayey silt (n=9)	Error	0.12	1.10	Table 1 in Volkmann and Weiler (2014)	
		Repeatability	0.15	1.32	Table 1 in Volkmann and Weiler (2014)	
Analysis methods						
IRMS (Thermo Fischer Delta Plus Advantage mass spectrometer (Thermo Fisher Scientific Inc., Massachusetts, USA) connected to a GFL 1086 equilibration device)	Water, 10 replicates (n=13)	Repeatability	0.02	0.46	Average values of Std. dev. $\delta^{18}O$ in Table 1 in Penna et al. (2012)	Average values of Std. dev. $\delta^{2}H$ in Table 1 in Penna et al. (2012)
OA-ICOS (Los Gatos Research Inc., off-axis integrated cavity output spectroscope model DLT-100 version 908-0008 or newer)	Water, last 8 of 18 injections (n=72)	Repeatability	0.33	0.33	Average values of Std. dev. LGR-1, LGR-2 and LGR-3 in Tables 3b in Penna et al. (2012)	Average values of Std. dev. LGR-1, LGR-2 and LGR-3 in Tables 3a in Penna et al. (2012)
IRIS (Picarro Inc., model L1102-*i* liquid analyzer or newer)	Water, last 8 of 18 injections (n=72)	Repeatability	0.1	0.13	Average values of Std. dev. PIC-1, PIC-2 and PIC-3 in Tables 3b in Penna et al. (2012)	Average values of Std. dev. PIC-1, PIC-2 and PIC-3 in Tables 3a in Penna et al. (2012)

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