

A photograph of a forest research site is shown on the left side of the slide. In the foreground, there is a grey metal cabinet on a tripod stand, connected to various cables and sensors. A blue plastic container is also visible. The ground is covered in green moss and fallen twigs. In the background, a dense forest of tall, thin trees, likely Douglas firs and pines, stands under an overcast sky.

Tiefenversickerung unter Douglasie und Kiefer im Norddeutschen Tiefland

Ergebnisse eines Tracerversuchs mit Deuteriumoxid

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24.04.2024

Context of the study



Project “KLIBW-GW” (01.12.2021 -30.11.2024):
“Effects of climate-adapted tree species selection on
groundwater recharge”

Projekt KLIBW-GW” (01.12.2021 -30.11.2024):
„Auswirkungen einer klimaangepassten Baumartenwahl auf die
Grundwasserneubildungsmenge“

Gefördert durch:



Bundesministerium
für Ernährung
und Landwirtschaft

Bundesministerium
für Umwelt, Naturschutz, nukleare Sicherheit
und Verbraucherschutz

aufgrund eines Beschlusses des Deutschen Bundestages



Projektpartner:



NW-FVA

Nordwestdeutsche
Forstliche Versuchsanstalt

Context of the study

Understanding processes of groundwater recharge at six monospecific stands via:

- Electrical resistivity tomography
- Soil probes (time domain reflectometry & tensiometers)
- Tracer experiments (peak-shift method)
- Forest hydrological modelling



Spruce
Picea abies



Beech
Fagus sylvatica



Douglas fir
Pseudotsuga menziesii



Scots pine
Pinus sylvestris



Red oak
Quercus rubra



Common oak
Quercus robur

Study site

Understanding processes of groundwater recharge at six monospecific stands via:

- Electrical resistivity tomography
- Soil probes (time domain reflectometry & tensiometers)
- **Tracer experiments (peak-shift method)**
- Forest hydrological modelling
- Intensive Forest Monitoring



Depth [cm]

-7.5 – 0

0 – 70

70 – 460

Texture

Needle litter

Silty sand

Fine sand



Douglas fir
*Pseudotsuga
menziesii*



Scots pine
*Pinus
sylvestris*

Depth [cm]

-9.1 – 0

0 – 50

50 – 460

Texture

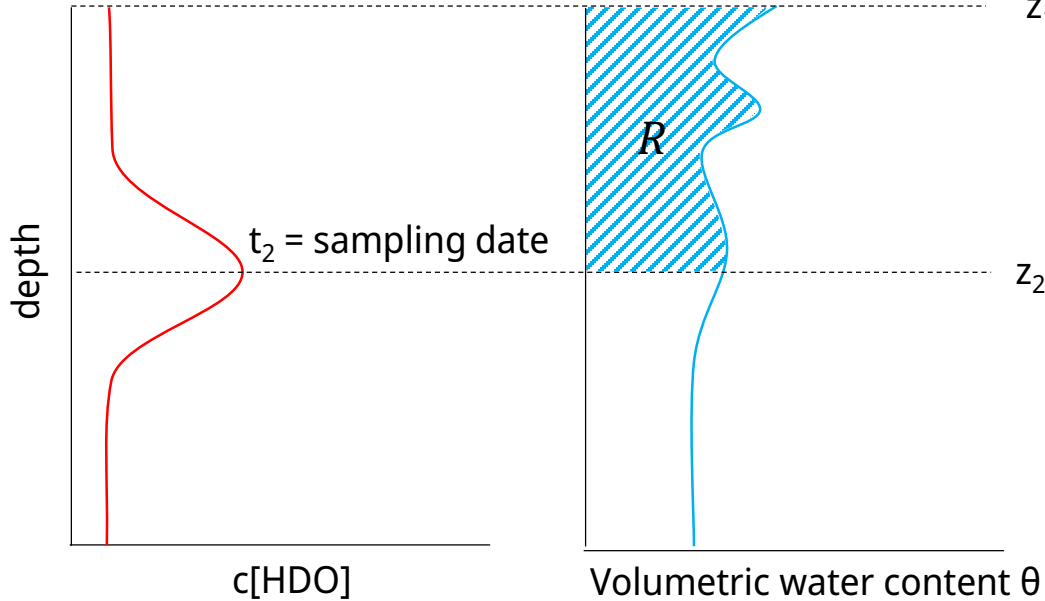
Needle litter

Silty sand

Fine sand

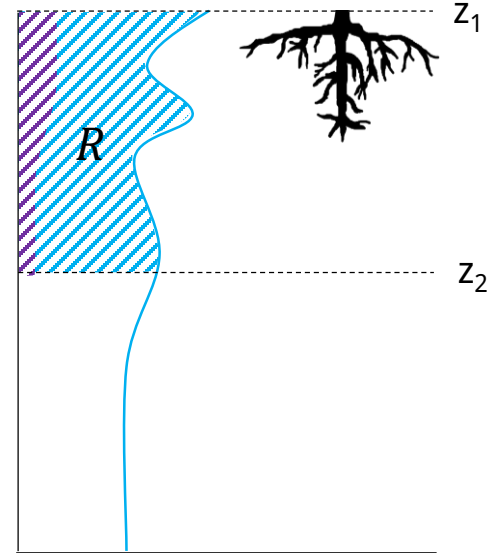
Peak-shift method

t_1 = tracer application date



$$R = \frac{1}{t_2 - t_1} \int_{z_1}^{z_2} \theta(z) dz$$

Leibundgut et al. (2010)



$$R = \frac{1}{T} \int_{z_1}^{z_2} (\theta(z) - \theta_r) dz$$

Chesnaux and Stumpff (2018)

Experimental design

Plot size: 4 m²

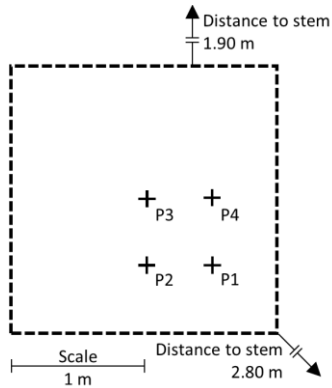
Irrigation amount: 20 L water + 0.35 L of D₂O (99.8 atom % D) = 5.1 mm

Concentration: 100180 ‰ VSMOW (calculated)

Duration: 72 min / 87 min

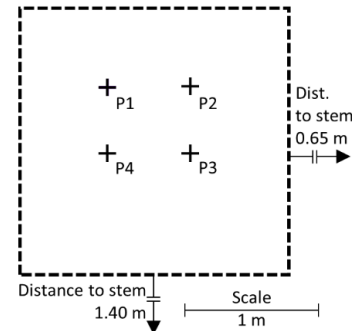
Douglas fir

Irrigation: 10.01.2023
P1: 70 cm, 07.02.2023
P2: 220 cm, 18.04.2023
P3: 460 cm, 25.07.2023
P4: 460 cm, 12.12.2023



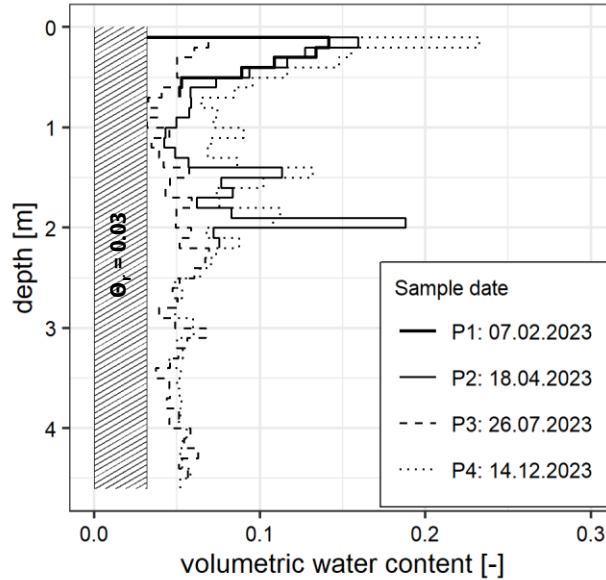
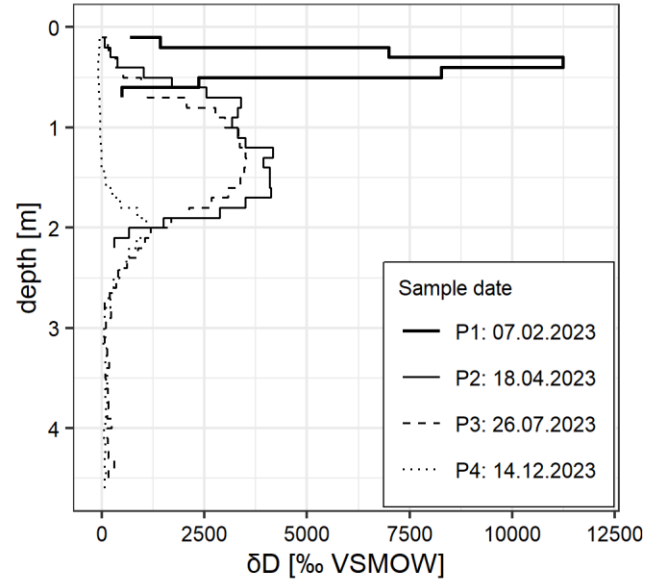
Scots pine

Irrigation: 10.01.2023
P1: 70 cm, 07.02.2023
P2: 220 cm, 18.04.2023
P3: 450 cm, 26.07.2023
P4: 460 cm, 14.12.2023



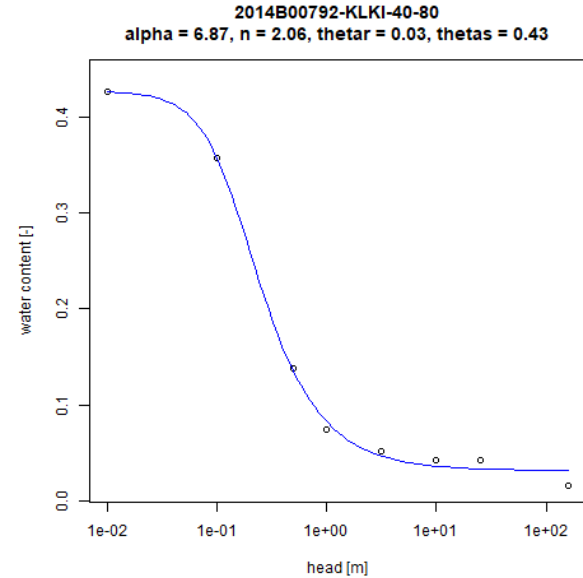
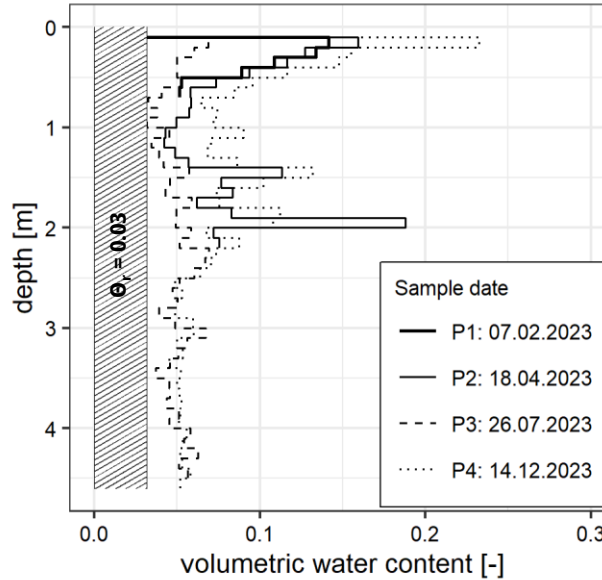
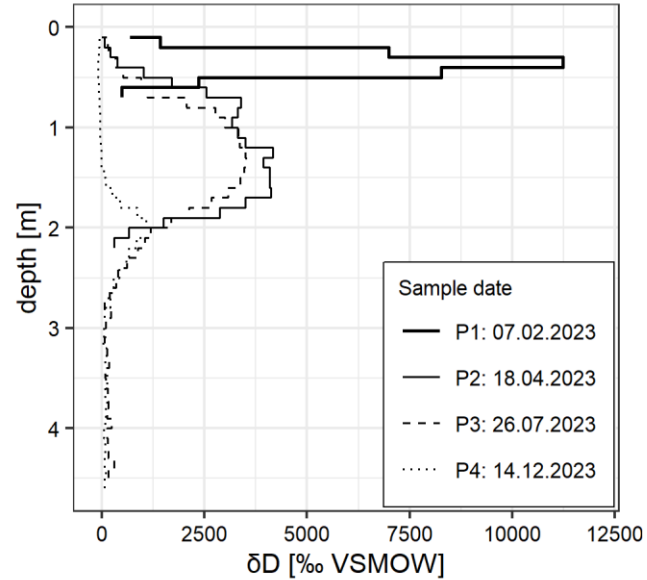
Results: Scots pine

Irrigation: 10.01.2023



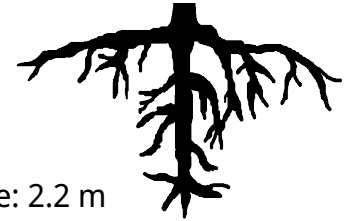
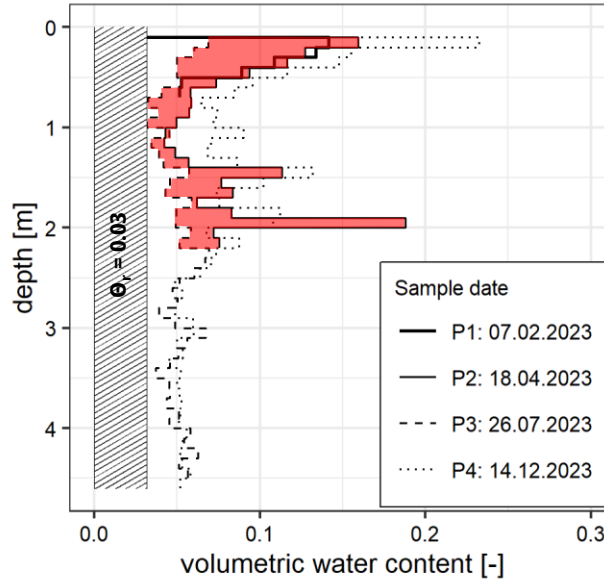
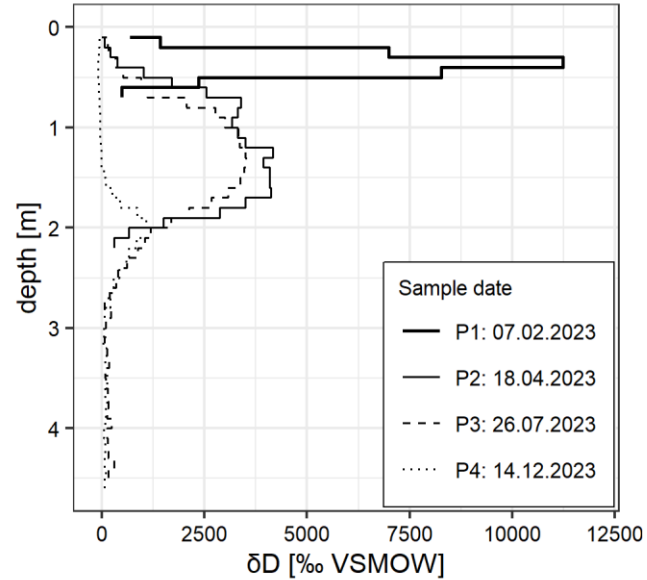
Results: Scots pine

Irrigation: 10.01.2023



Results: Scots pine

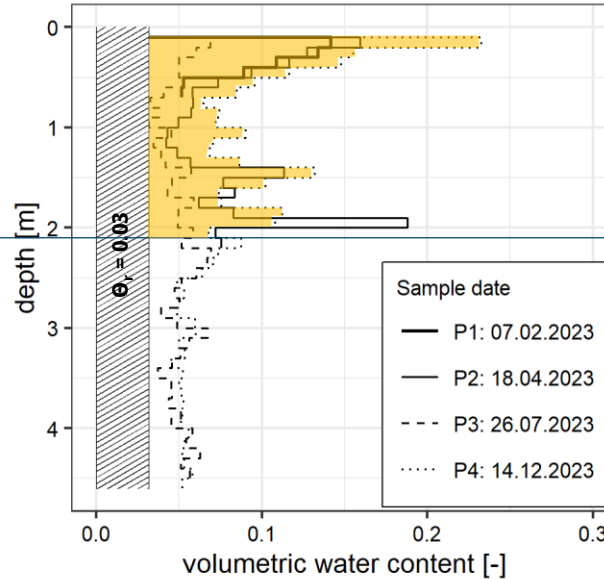
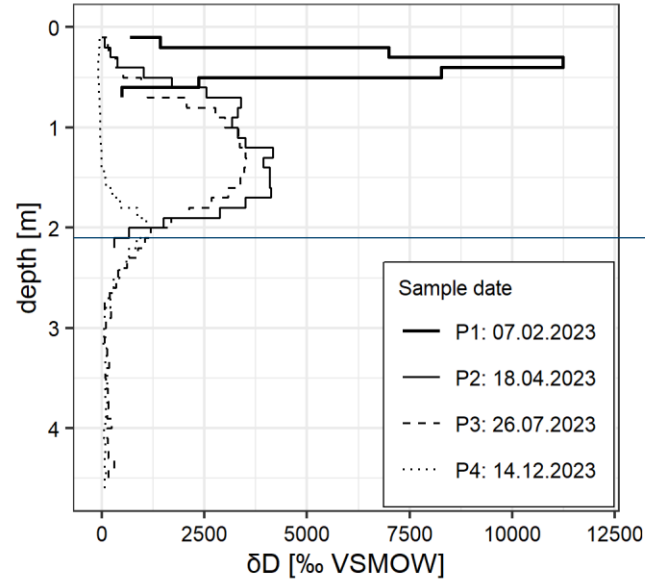
Irrigation: 10.01.2023



Active root zone: 2.2 m

Results: Scots pine

Irrigation: 10.01.2023



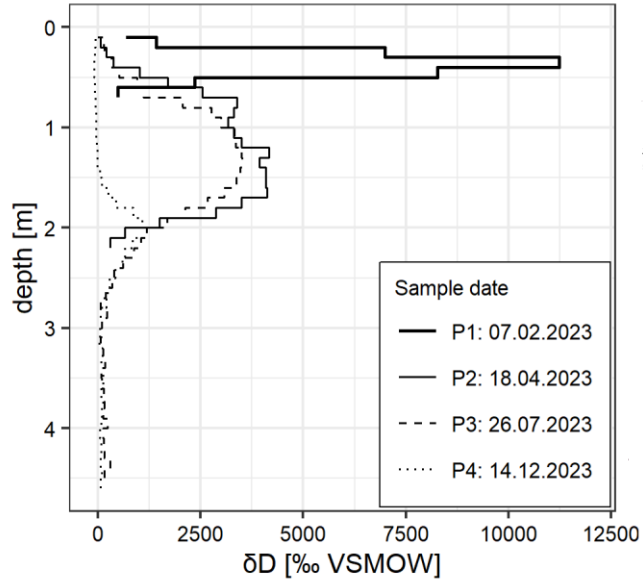
Precipitation that infiltrated into the soil and that was not transpired, 10.01.2023 to 14.12.2023:

138 mm / 18 % of field precipitation

Sum of field precipitation
10.01.2023 - 14.12.2023: 765 mm

Results: Douglas fir

Irrigation: 10.01.2023



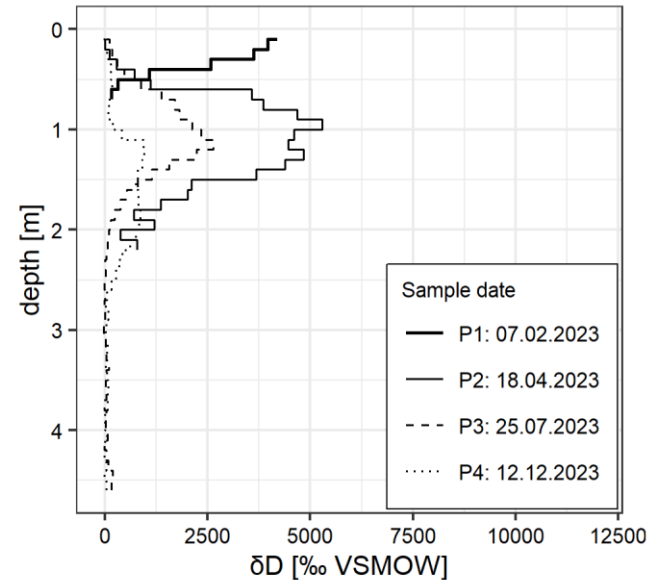
Scots pine



Douglas fir

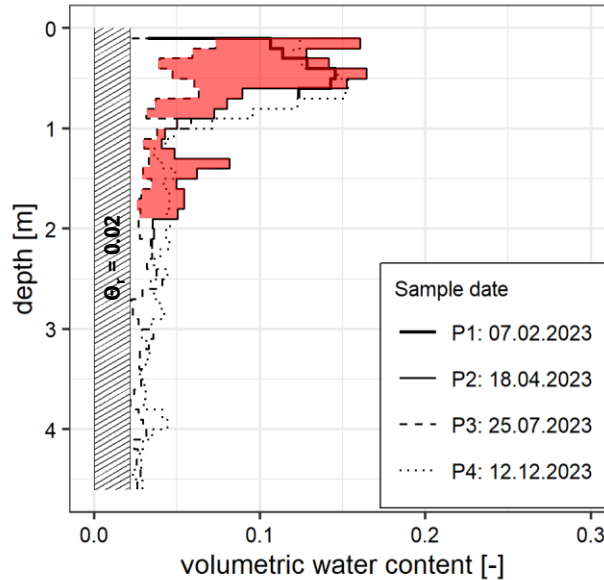
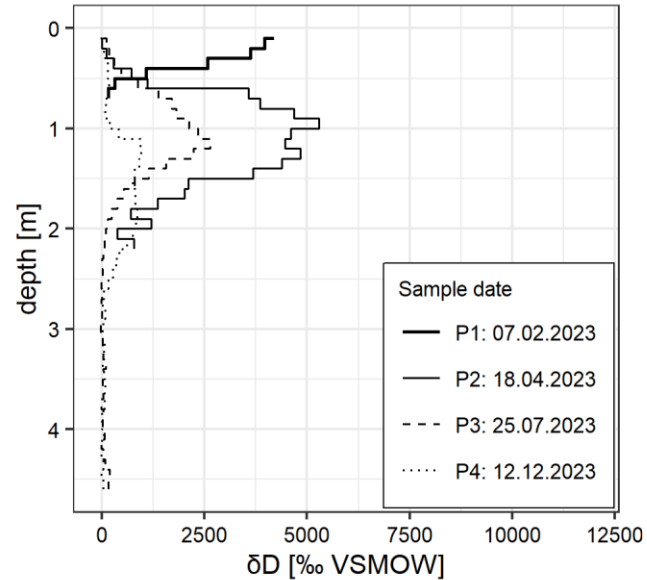


Irrigation: 10.01.2023



Results: Douglas fir

Irrigation: 10.01.2023

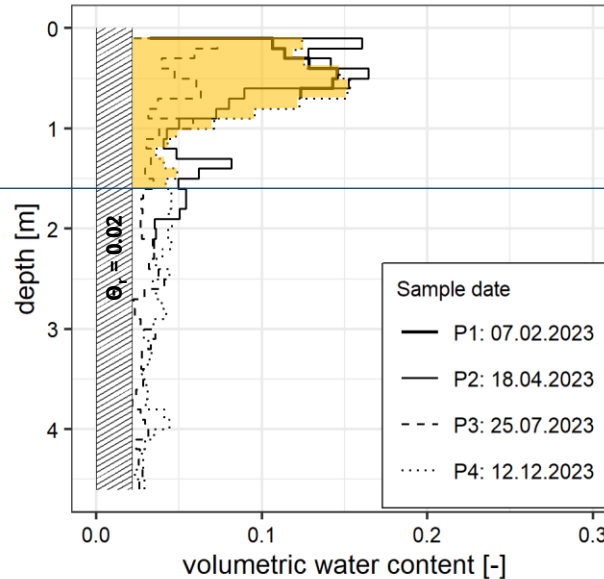
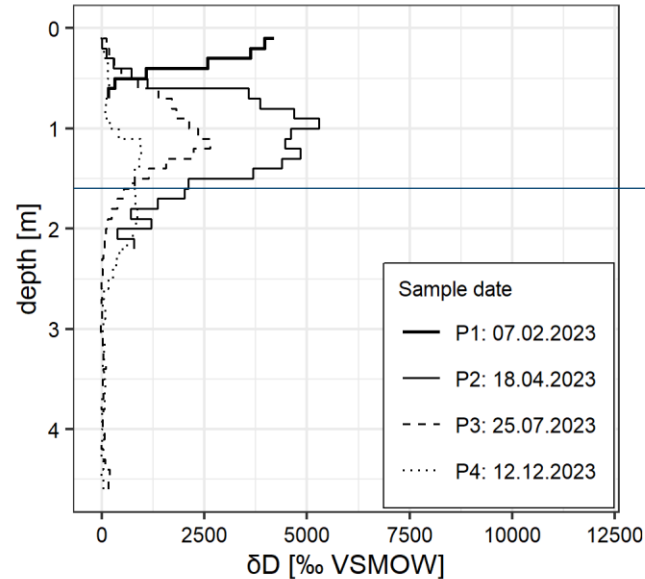


Active root zone: 1.9 m



Results: Douglas fir

Irrigation: 10.01.2023

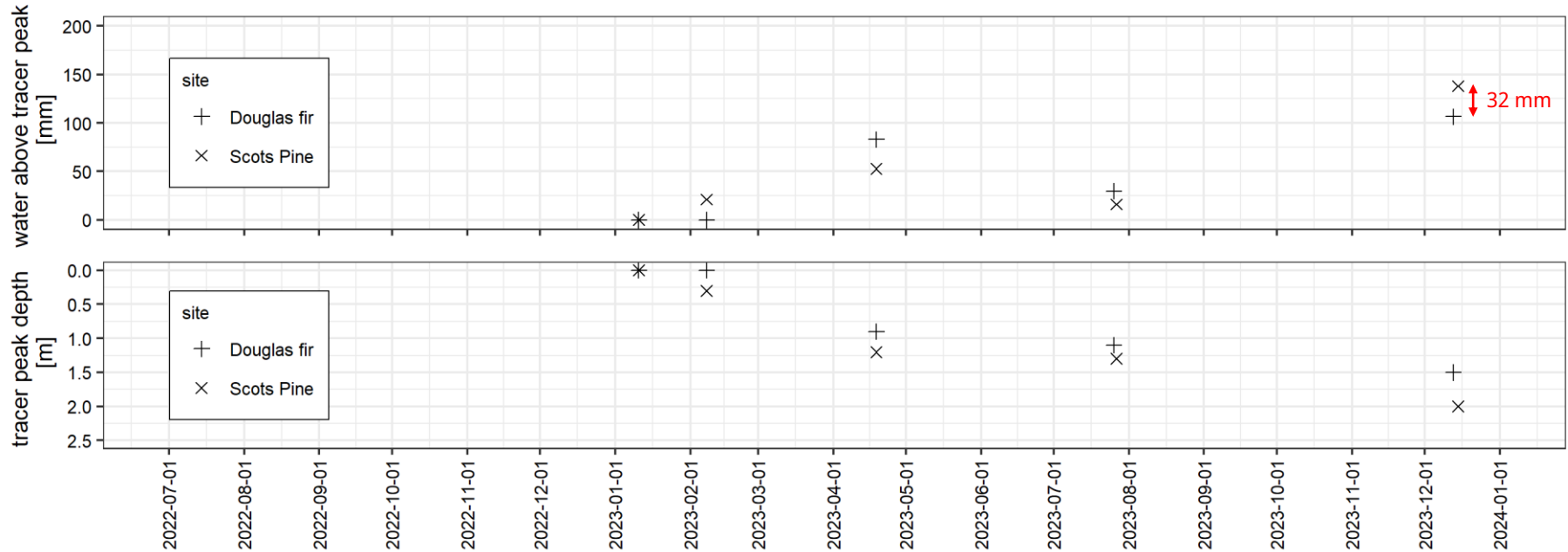


Precipitation that infiltrated into the soil and that was not transpired, 10.01.2023 to 12.12.2023:

107 mm / 14 % of field precipitation

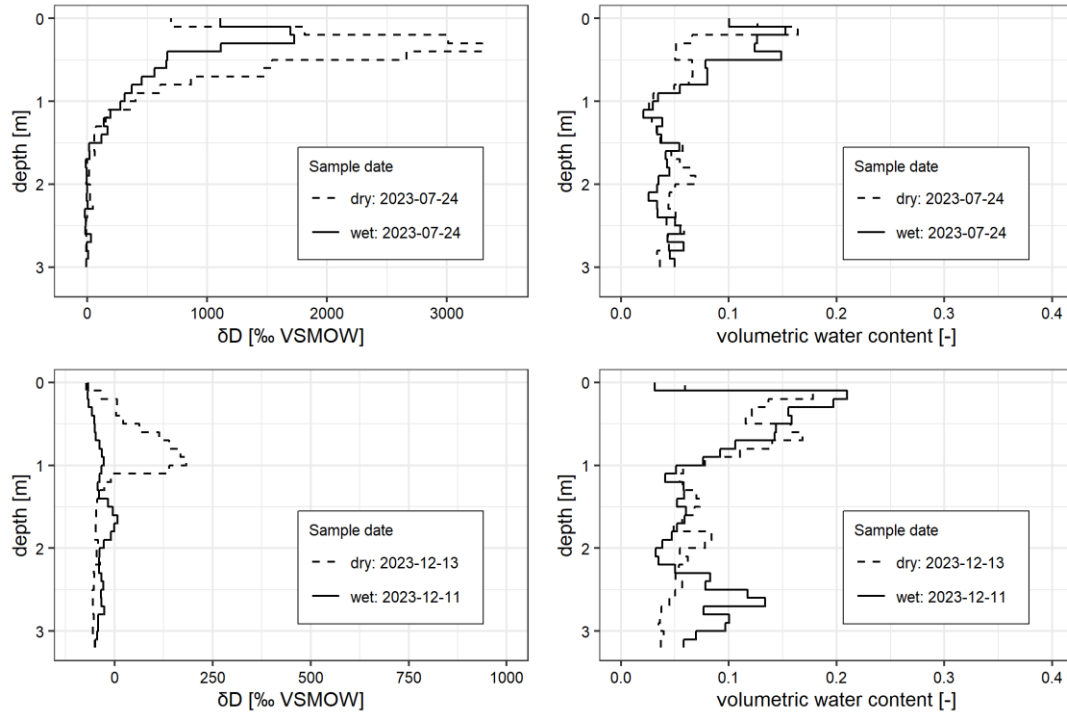
Sum of field precipitation
10.01.2023 - 12.12.2023: 760 mm

Douglas fir vs. Scots pine

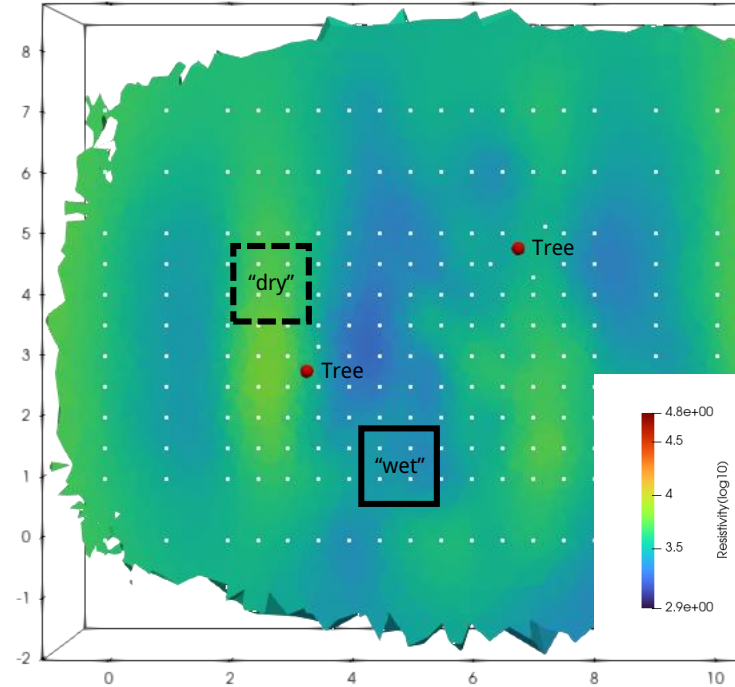


Representativity

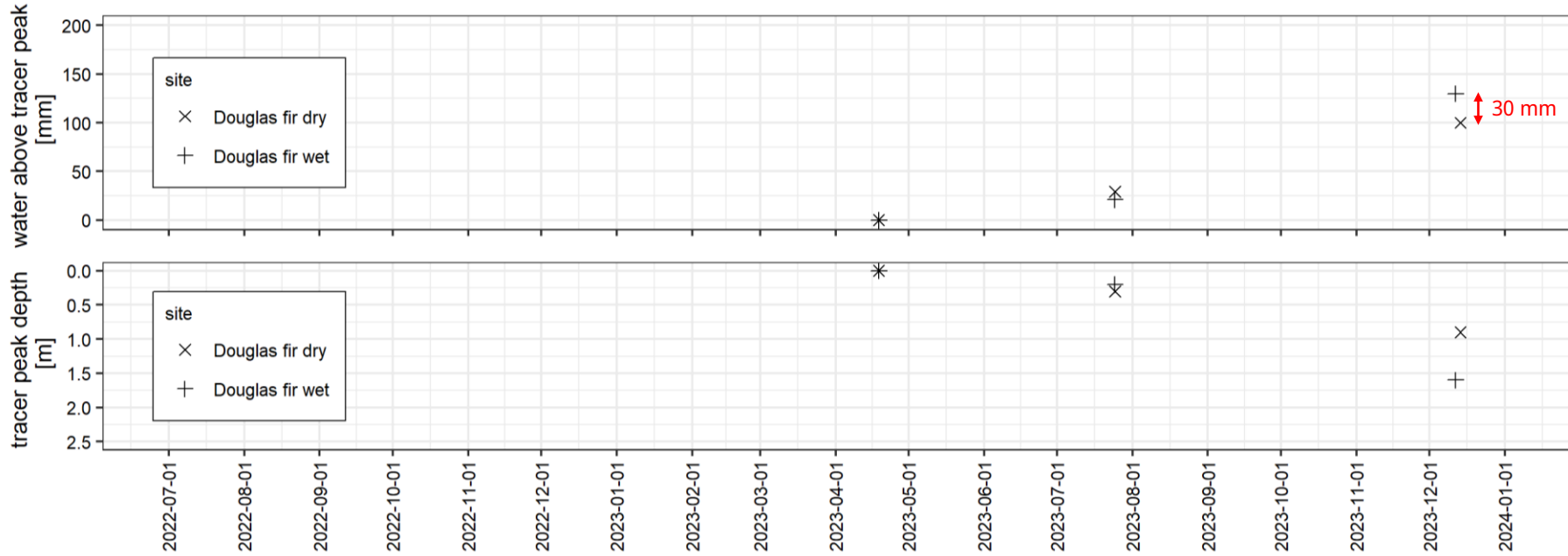
Tracer plots:
Irrigation 2023-04-18, 7.25 mm, $c[D_2O] = 113\ 000\ \text{‰ VSMOW}$



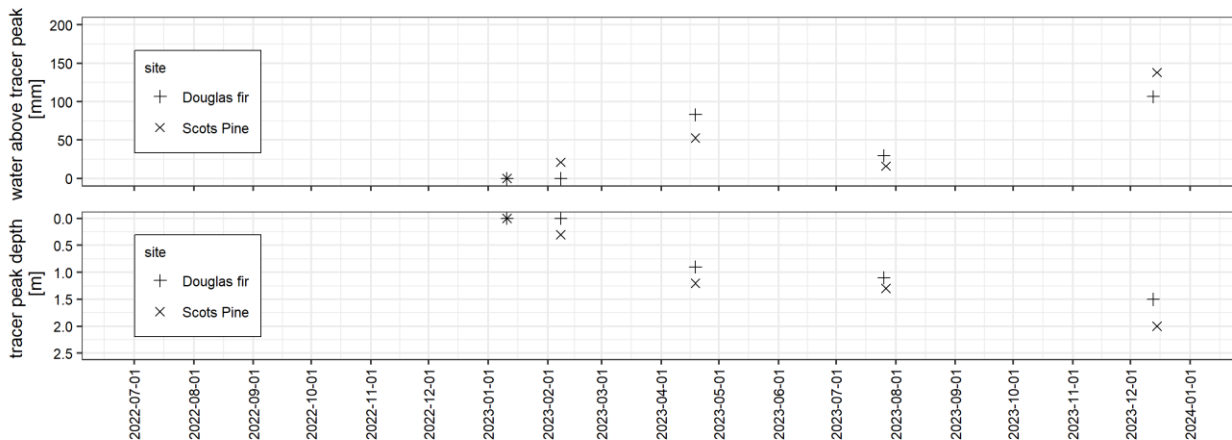
Electrical resistivity tomography:
2023-12-11, depth: 0.3 m



Representativity

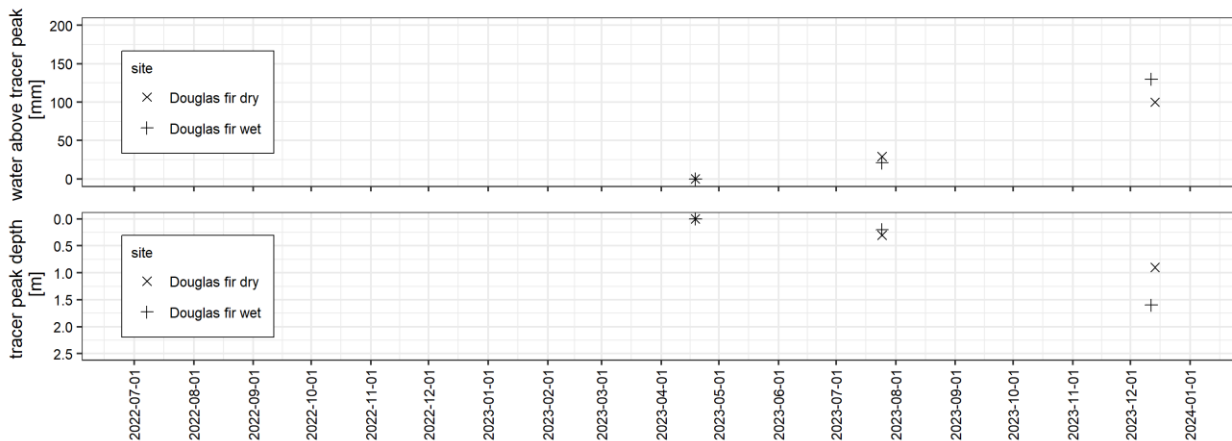


Representativity



↕ 32 mm

Douglas fir & Scots pine



↕ 30 mm

Douglas fir wet & Douglas fir dry

Summary & Outlook



- Tracer concentrations of 100 180 ‰ VSMOW (calculated) in combination with small amounts of irrigation (5.1 mm) in winter are well suited for studying water fluxes within the root zone;
 - The active root zone can be effectively determined by comparing spring and summer water contents
 - At both stands precipitation water takes more than 11 months to percolate below the active root zone;
 - Differences in soil water dynamics between single tracer plots in the Douglas fir and in the Scots pine stands were as large as differences in the Douglas fir stand itself.
- Sampling campaign in April 2024 to quantify deep percolation;
- Forest hydrological modelling

Thanks for your attention!

Kolja Bosch¹, Erkki Hemmens¹, Paul König¹, Susanne Stadler¹,
Stefan Fleck², Bernd Ahrends², Henning Meesenburg²,
Christoph Neukum¹

- ➔ *Erkki Hemmens (Poster heute)*
Räumliche und zeitliche Dynamik der Bodenfeuchte im Wurzelraum –
Anwendbarkeit der elektrischen Widerstandstomographie (ERT) auf einem
grundwasserfernen Standort unter Kiefer (*Pinus sylvestris*)

- ➔ *Christoph Neukum (Poster morgen)*
Klimaangepasste Baumartenwahl und Grundwasserneubildungsmenge –
Das Projekt KLIBW-GW

24.04.2024