

Introduction

Water partitioning at soil-vegetation-atmosphere interface has been recognized as an important aspect of catchment water balance, but the lack of field data often hinders such studies in high latitude, snow-dominated catchments. Soil water distribution and recharge timing in Northern regions primarily depend on snow accumulation and ground freeze-thaw processes, and future climate with increased air temperatures and modified precipitation patterns can significantly alter these processes. Soil water fluxes are further modified by vegetation water uptake, and some studies indicate that forest trees rely on winter precipitation throughout the growing season.

Our aim is to understand how rain and snowmelt are stored and partitioned in subarctic soils by assessing distinct soil water pools in vadose zone and examining what factors control soil water variability within the catchment. Main research questions are:

- What is the extent of soil water variability on plot and catchment scale?
- How soil properties affect isotopic composition of soil water?
- What is the effect of groundwater level, snow cover depth and soil/freeze thaw?
- Is soil water dynamics reflected in tree xylem?

Pallas catchment (4.42 km²) is located in Finnish Lapland, approximately 170 km north of Arctic Circle and at the edge of northern-boreal and subarctic climate zones. It comprises spruce and pine forests intersected with different types of mires, and underlying soils are mainly sandy tills. Mean yearly temperature is 0.4 °C and it is one of the places with thickest snow cover in Finland.

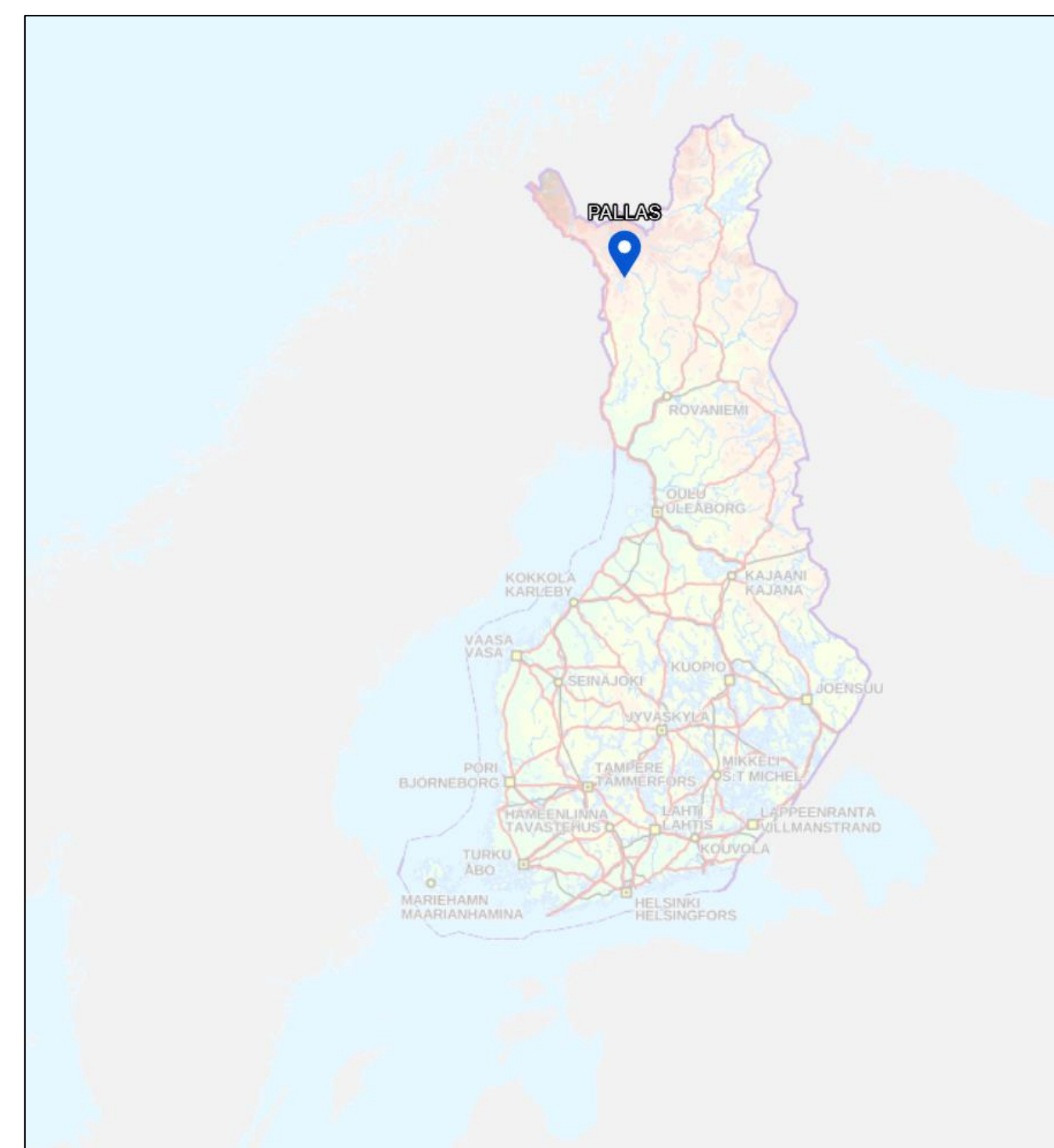


Figure 1. Location of Pallas within Fennoscandia

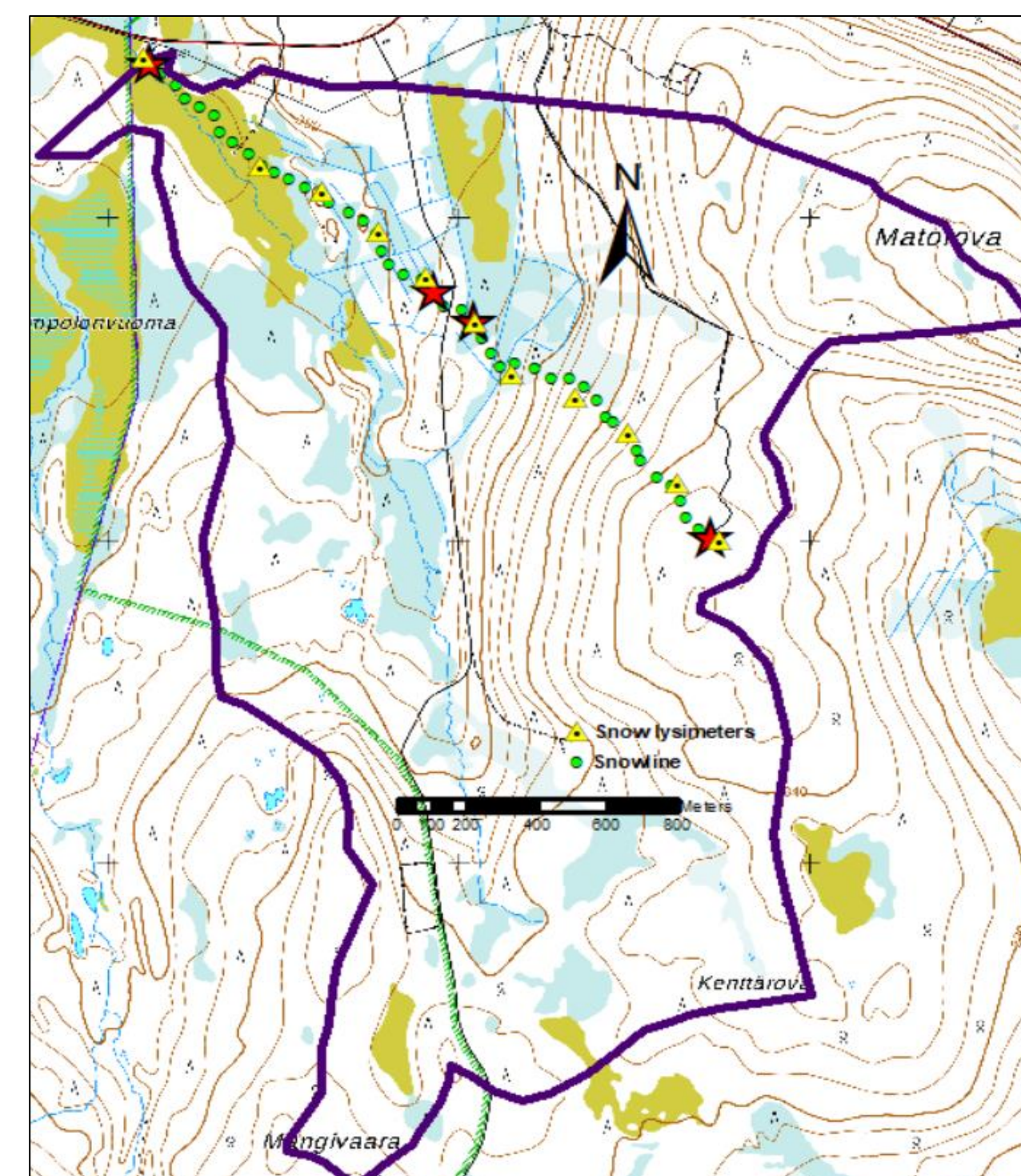


Figure 2. Pallas snowline and coring locations

Data collection:

- 4 coring locations were established along the existing snowline
- Sample collection took place from May 2019 to June 2020
- Xylem samples of 2 different trees for each present tree species were collected from ~2.5 m height
- 2-4 soil cores up to 1 m depth were collected and sampled at 5 cm increments from 0-50 cm depth and at 10 cm increments from 50-100 cm depth
- Soil temperature was measured *in-situ*
- Additional topsoil (0-10 cm) and xylem samples from 20 locations scattered throughout the catchment were collected in June and August 2019
- Supplementary data include isotopic and hydrometric data gathered from snow lysimeters, groundwater wells, precipitation and stream water samplers

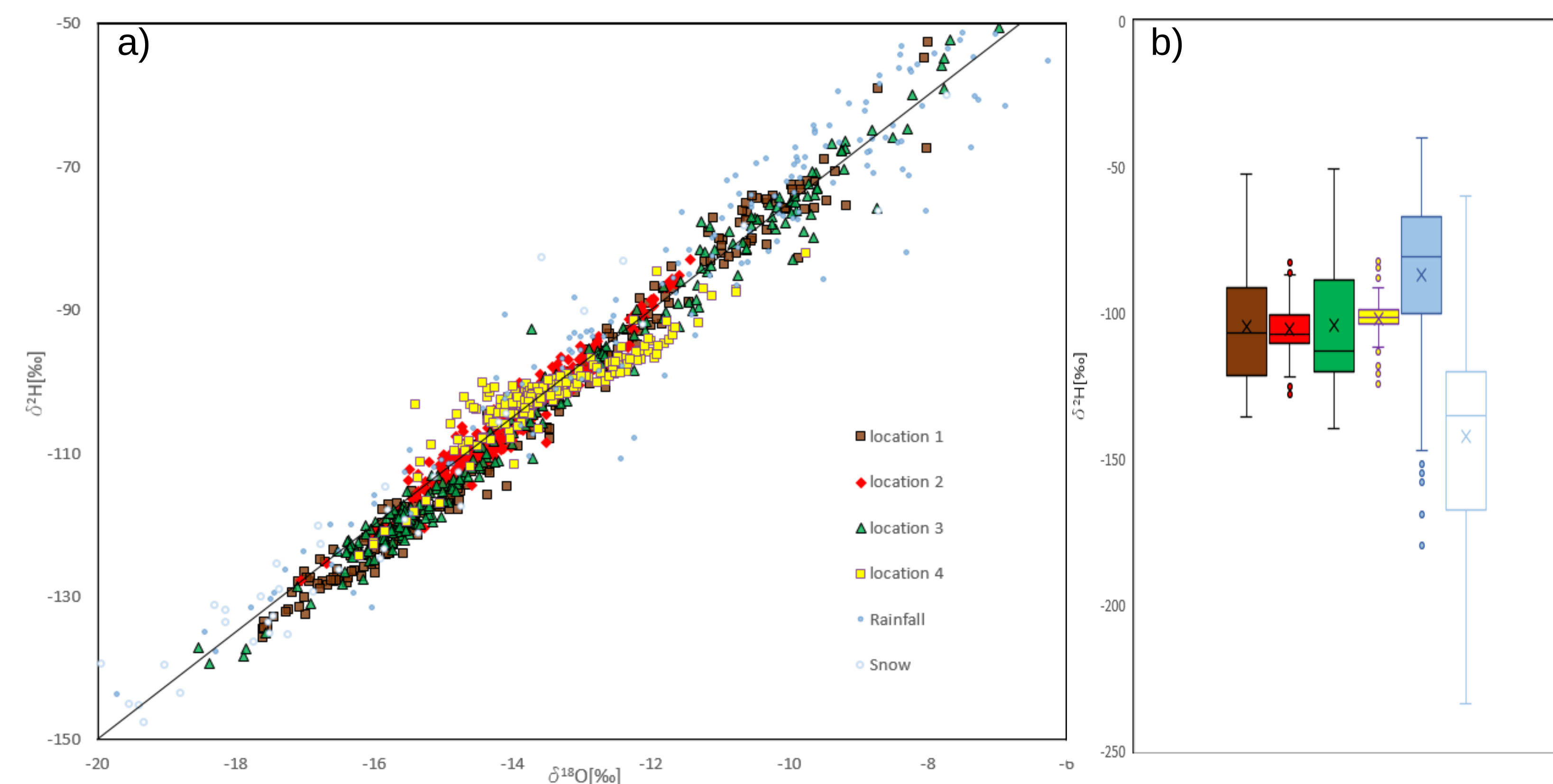


Figure 3. (a) Dual isotope plot for soil samples from all locations and depths; and (b) box plot representation of deuterium signal in soil and precipitation during sampling period

Initial results

- Samples from all locations plot close to LMWL
- Weighted annual deuterium signal of winter precipitation is -150.31 ‰, with the most depleted snowfall events reaching -233.84 ‰, but such depleted signal is not present in soil
- The most depleted signal in soil is present in late May, immediately after the snowmelt, while the most enriched signal occurs during mid Autumn
- More variability in forest sites (location 1 and 3) than in peatland sites (location 2 and 4)
- Forest sites have similar soil water isotope dynamics, especially at 0-60 cm depth

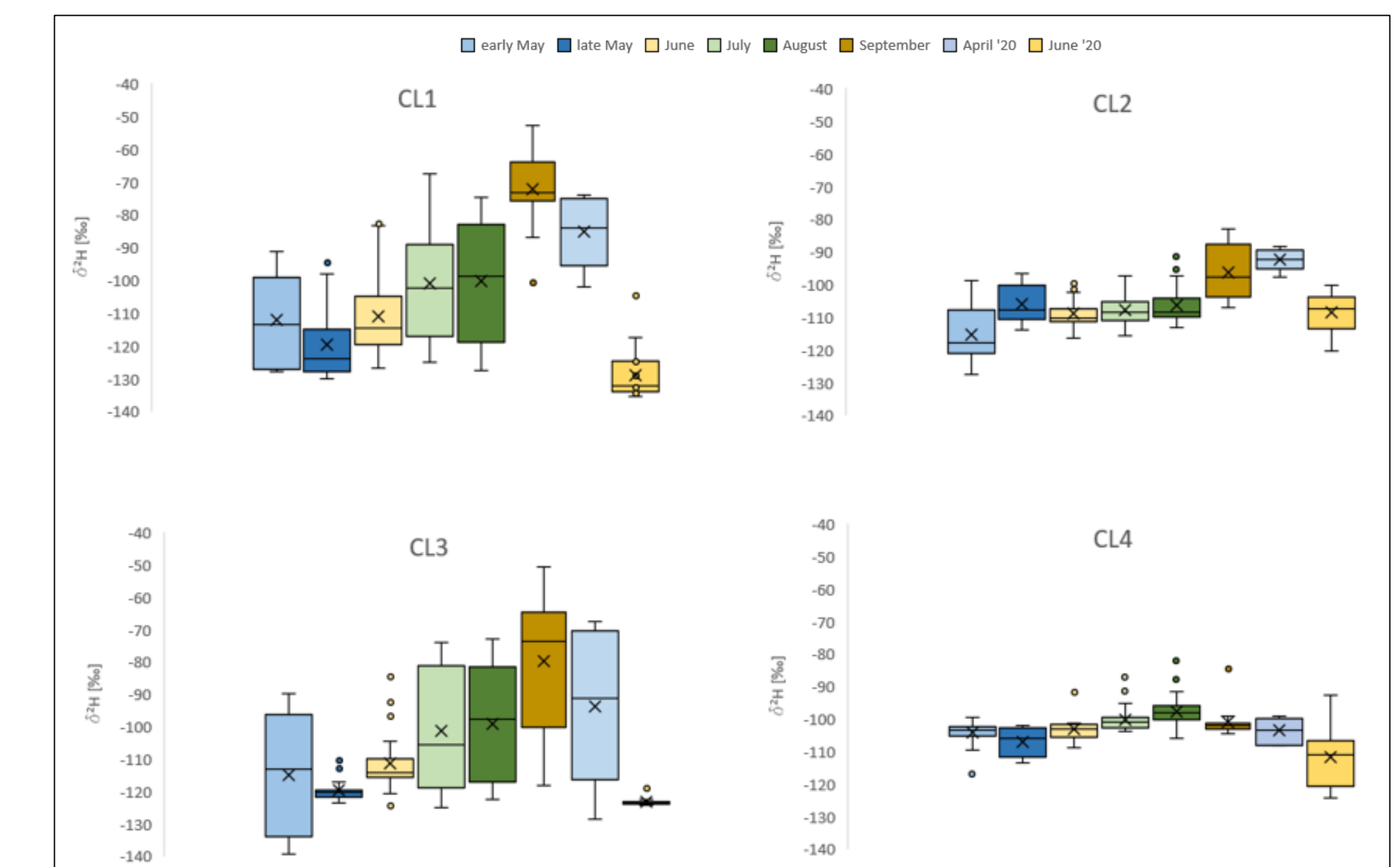


Figure 4. Seasonal variability of bulk deuterium signal for all coring locations (CL)

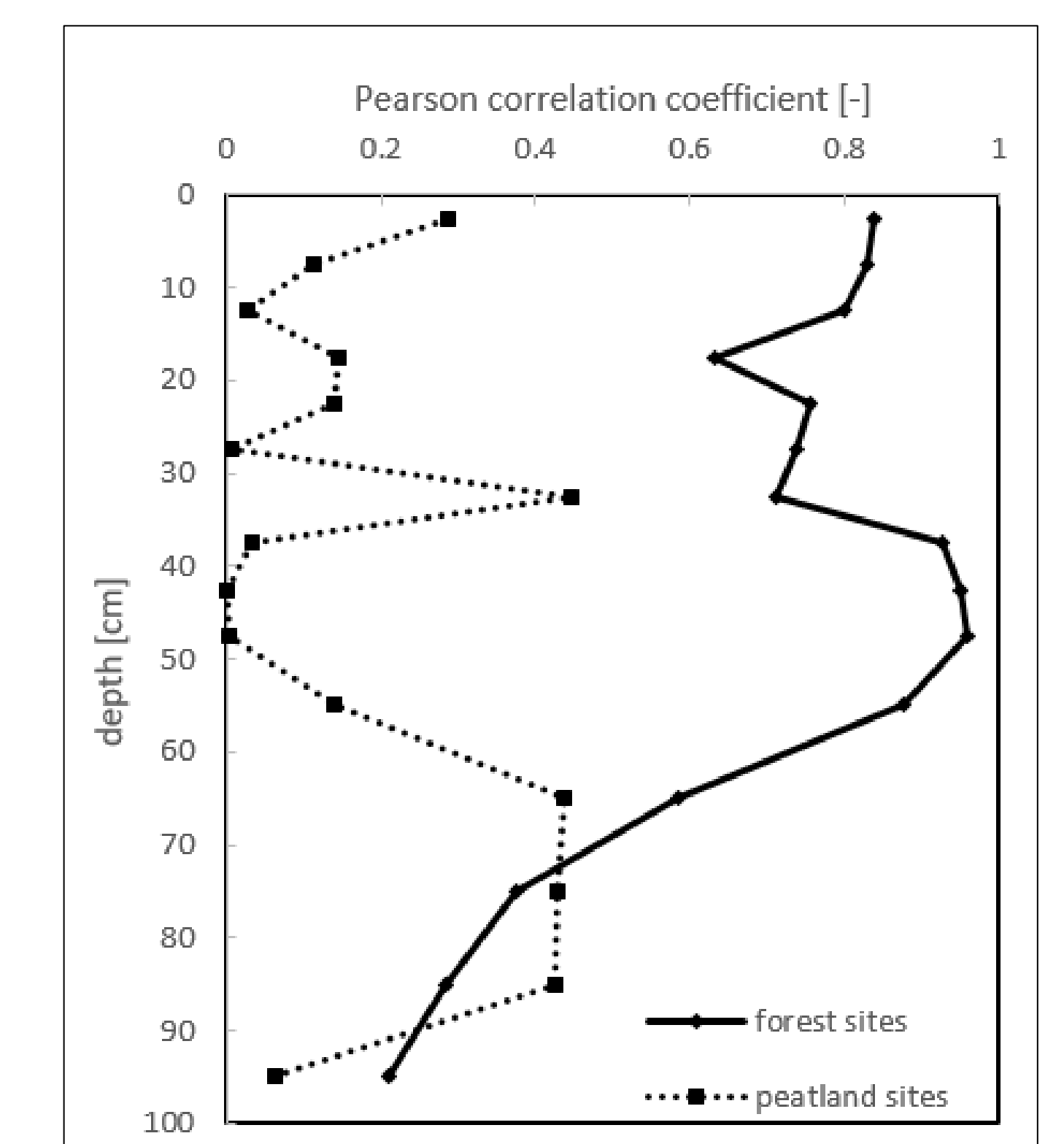


Figure 5. Depth-dependent correlation of deuterium signal for peatland sites (CL2 and CL4) and for forest sites (CL1 and CL3) for the entire observation period