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Measuring canopy interception of precipitation at the ecosystem level

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Canopy interception, the amount of precipitation evaporated from the leaf surfaces of vegetation, is a key component of the ecosystem water cycle as it constrains the water flux to the ground below vegetation. Canopy interception loss detection relies on indirect approaches and displays substantial spatiotemporal variability linked structure of the vegetation. Thus, it is challenging to obtain the whole ecosystem canopy interception loss. In turn this limits our abilities to estimate evapotranspiration and consequently constrain the water and solute balances for ecosystems.

In this study, we test whether real-time cosmic-ray neutron (CRN) measurements can be used to provide coupled direct estimates of the canopy interception and soil moisture content at the ecosystem level for a Danish oak forest. We will validate the CRN measurements by scaling spatiotemporal patterns of throughfall measured with automated rain gauges and leaf wetness sensors (LWS) below the canopy using terrestrial laser scanning of the forest canopy to derive the relation between canopy structure and density and water fluxes.

So far, we have used CRN to determine the soil moisture content in the upper decimeters of the ground within a circular footprint area of around 30 hectares. By measuring neutrons of different energies using the CRN methods we have been able to detect changes in the CRN signal to changes in the canopy interception.

Compared to precipitation measurements in a nearby clearing the rain gauges show a consistent interception in the oak forest in all seasons. In combination with the LWS sensors, the interception loss and throughfall dynamics shows a spatial, but temporally stable, variation within the forest. This clearly indicates that spatial variation of the canopy structure is related to the magnitude of the interception. To determine the spatial variation of the canopy structure, the oak forest has been scanned with a mobile laser scanner twice; during the leaf-on and leaf-off season. This will provide spatially explicit canopy structural metrics that will be related to measured patterns of throughfall.

We will discuss how 1) our research may improve the field methods and analytic approaches to directly estimate canopy interception loss at large spatial scales, 2) interception relates to soil moisture dynamics at the ecosystem scale, 3) this can forward the basic understanding of the interaction between vegetation structure with evapotranspiration and the soil water cycle and lastly 4) the application of our approach can be used in distributed hydrological modeling.