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The influence of small-scale topography and redox conditions on DOC mobilisation from riparian wetlands to a headwater stream in boreal Sweden

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During recent decades, an increase of mobilisation of dissolved organic carbon (DOC) to freshwater systems has been observed in northern regions. This browning had implications for carbon storage, drinking water production and ecology of receiving waters. Before entering the streams, water chemistry is shaped by riparian soils at the groundwater/ surface water interface. They fulfil the role of biogeochemical hotspots especially where disproportionally large areas of the catchment drain into the streams through discrete riparian inflow points (DRIPs). In these DRIPs, organic rich soil layers are connected to the streams by high watertables which in turn also influence redox conditions in the soil. Under reducing conditions, DOC previously bound to iron (oxy)hydroxides could be jointly released by reductive mobilisation of iron. Reducing conditions increase pH, which additionally desorbs DOC from mineral surfaces.

In this study, results from sampling campaigns conducted in DRIPs adjacent to a headwater stream located in the Krycklan Catchment in boreal Sweden in summer/ autumn 2023 and 2024 and in spring 2024 are presented. Groundwater composition significantly differed between seasons but also between individual DRIPs. In summer, the direction of the relationship between oxygen saturation and groundwater levels changed depending on whether watertables were above or below ground levels and thus on small-scale topography. As DOC and iron were co-mobilised under low oxygen saturation, their concentrations differed between sites. During snowmelt, the relationships of redox conditions, DOC mobilisation and pH increase were closer than in summer in a large, very wet DRIP even though DOC and iron concentrations were overall lower than in summer. In the stream, DOC and iron concentrations were higher early in spring. Older water, that might have been subject to more reducing conditions from late summer to winter, was likely released on the onset of snowmelt, before the diluting effect of melting snow dominated. In conclusion, seasonal differences in the link of ground- and streamwater could be observed, yet supporting an interaction of DOC mobilisation with reducing conditions and concomitant changes in pH. Groundwater chemistry differed based on small-scale topography and redox conditions, with a joint mobilisation of DOC and iron.