**Modelling seminar 2022 Abstract**

**Fully-integrated groundwater-surface water physically based modelling is a unique method showing temporal variability in groundwater exfiltration dynamics**

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Groundwater-surface water (GW-SW) interactions play an essential role in water, carbon and nutrient balances in many northern ecosystems, but they are poorly understood due to the difficulty in quantification. Numerous techniques can be used to assess the ecosystem's groundwater dependence but field methods that allow direct measurement of GW-SW exchange are rare and not applicable to each environment. In this case study, we investigated if a fully-integrated physically-based model can identify the temporal and spatial variability of GW-SW interactions within peatland ecosystems. A small sub-arctic headwater watershed Pallaslompolo, Finnish Lapland, was modelled with HydroGeoSphere HGS software. Then, the simulation results were evaluated with spatial field datasets of thermal infrared imaging (TIR) and surface peat pore stable water isotopes.

Our simulation results show that the fully-integrated physically-based modelling can provide comprehensive information on the spatial and temporal variability and magnitudes of exchange fluxes within the modelled catchment. The model highlights GW hotspots but also areas with strong transitional behaviour. Overall, the GW exfiltration sites identified by modelling comply well with the results of the stable water isotopes and TIR images, but some discrepancies exist. The main reasons behind mismatches might be related to simplifying model assumptions but also the limitations of each field method. The complex and dynamic nature of GW-SW exchange suggests that any of the three methods can provide a complete picture of GW-SW interactions, and thus, all methods should be treated as complementary in studying groundwater's role in sub-arctic peatland water and carbon balances.