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Deriving groundwater table dynamics from Sentinel-1 radar data at the Drömling peatland area

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Shallow groundwater levels are of essential importance for the development and preservation of peatlands. A good water management of peatlands is therefore crucial not only for nature conservation but also for implementing climate mitigation activities in peatlands. Radar remote sensing offers great possibilities to improve both monitoring and water management by supplying spatial information on hydrology. The Sentinel-1 mission of the European Space Agency provides radar data with high spatial and temporal resolution. The satellites transmit microwave radiation at C-band to the earth's surface where it scatters back to the sensor based mainly on dielectric permittivity and roughness of the surface. Since the radiation is able to penetrate into the first centimetres of the soil, backscatter intensity provides information on soil moisture. In peatlands, shallow groundwater tables are often in hydrostatic equilibrium with soil moisture of topsoils, which establishes a connection to groundwater table depth. In this study, we compare backscatter coefficients $\sigma 0$ of vv polarisation (vertical transmission – vertical reception) with ground truth data from 37 observation wells at Drömling nature park. The study focussed on fen sites with peat layers up to 1 m used as extensive or intensive grassland. Additionally, soil moisture samples were regularly taken and the water retention functions of the topsoils were determined at four sites. With this information we estimated the state of hydrostatic equilibrium and therefore refine the derivation of water table depth from C-band backscatter. The correlation between backscatter coefficients and groundwater levels was determined based on a change detection approach and the TU Vienna cross-over angle approach. Up to a depth of about -0.6 m and when filtering for data from acquisitions with steep incidence angles as well as dry and frost-free acquisition dates, good temporal correlations between backscatter and groundwater table depth were achieved.