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Comparison on the performance of five different electromagnetic sensors in sphagnum peat

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Electromagnetic (EM) soil moisture sensors are widely used to measure water contents in porous media, particularly in field studies. The accurate determination of saturation states in soils is vital for many environmentally related research questions. Electromagnetic water content measurements are based on the determination of the dielectric permittivity of a medium. As the dielectric permittivity is high in water compared to other soil constituents it can be related to soil water content. However, this method is affected by the properties of the medium investigated and until now there is little knowledge about its applicability to peat soils. The aim of our study was to investigate the performance of electromagnetic sensors to measure water content in sphagnum peat and to identify problems of the EM method associated with this special substrate.

For this purpose, a comparison under laboratory conditions was conducted. Five different commercially available types of soil moisture sensor were selected with a range of geometries and various measurement principles. These included a time domain reflectometry probe, IMKO Trime Pico 64, and four frequency domain technique devices, namely the Stevens Hydra Probe, Delta-T Wet-2, Decagon 5TM and Decagon GS3. For this a sphagnum sample (40 cm by 60 cm by 30 cm), taken from a soli-ombrotrophic peat bog, was instrumented with the five sensor types at two different depths. Water content was altered by continuous evaporation at the top. To check the water content readings for plausibility, matrix potentials in four depths and the weight of the sample were monitored during the evaporation experiment. The dielectric permittivity readings from the soil moisture sensors were converted to volumetric water content either by calibration equations for organic substrates supplied by the manufacturer or from calibration equations for sphagnum found in scientific publications.

In both parameters, dielectric permittivity and volumetric water content, large systematic differences between the sensor types were observed, especially in the wet range. With four sensor types giving plausible results in both measurement depths, one sensor type gave unplausible readings during most of the experiment. While the earlier suggests that a sphagnum- and possibly peat type specific calibration equation for each sensor might be necessary, the latter indicates that some sensor geometries could be inappropriate for peat soils.