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Coaxial probe for water content measurements in forest floor litter by time domain reflectometry technique

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Time domain reflectometry (TDR) techniques are strongly limited in forest litter water content monitoring due to the inconsistency of the litter material, that limits the contact with the classic two or three rods probes. In order to guarantee good contact and easy insertion in inconsistent material of vegetal origin constituting the forest litter, a 9 rods coaxial probe has been developed for TDR water content measurements. The aim of this work is twofold: (i) testing the 9 rods coaxial probe versus a stainless steel laboratory coaxial probe and a three rods probe; and (ii) testing the response of three models for water content determination from the measured apparent dielectric constant and evaluating their suitability for measurements in forest floor litter. The 9 rods probe was made from a brass pipe, 48 mm in diameter and 1.5 mm thick end the centre rod by a 6 mm stainless steel rod soldered to the inner pin of a 50 ohm male TNC connector. The connection between the outside armature and the TNC connector was ensured by a brass cone soldered to both. A Tektronix 1502C with RS 232 interface was used to take TDR measurements. The probe was calibrated according to the Heimovaara (1993) method. The test procedure followed two steps. First, the probes were tested in a known medium represented by a sandy soil; then in the second step, the tests were carried out on forest litter. TDR measurements were taken in several reconstructed specimens of undecomposed and decomposed litter. The litter material came from black pine, beech, birch and larch forests, respectively. The comparison between the models for water content estimation from TDR measurements showed that the Topp et al. (1980) model was unsuitable for litter water content estimation.

The Hook and Livingstone (2004) and Roth et al. (1990) models allowed for water content estimations in the litter with errors around 3%, similar those obtained for the sandy soil. The results showed that the response of the 9 rods probe was systematically better than that obtained by the three rods for all test cases. The errors generated by the former method was within the interval of 3% of water content, while those obtained for the three rods probe often exceeded 7%. In conclusion, it can be stated that the 9 rods coaxial probe is a promising tool for measuring water content in material which is inconsistent with contact problems such as litter floor material.