



SENSORS FOR SOIL PROFILE WATER CONTENT MEASUREMENT: ACCURACY, AXIAL RESPONSE AND TEMPERATURE DEPENDENCE

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We compared sensors for soil water measurement that can be used in access tubes, including the Sentek EnviroSCAN and Diviner 2000 capacitance devices, the Delta-T PR1/6 capacitance probe, the Trime T3 tube-probe, all called electrical devices, and the soil moisture neutron probe (SMNP). Measurements were made before, during and after wetting to saturation in triplicate re-packed columns of three soils: a silty clay loam (30% clay, 53% silt), a clay (48% clay, 39% silt), and a calcic clay loam (35% clay, 40% silt) containing 50% CaCO_3 . Each 75-cm deep, 55-cm diameter column was weighed continuously to 50-g precision. Conventional time domain reflectometry (TDR) measurements of water content and thermocouple measurements of temperature were made at several depths in each column. Axial sensitivity of each device was investigated by taking measurements as its probe was lowered from a height well above the soil surface to well below the soil surface. Comparisons of soil water content reported by the devices vs. soil temperature showed that all of the devices were sensitive to temperature except for TDR and the SMNP. The Trime and Delta-T devices were so sensitive to temperature (0.020 and $0.025 \text{ m}^3 \text{ m}^{-3} \text{ }^\circ\text{C}^{-1}$, respectively, at the wet end) as to be inappropriate for routine field measurements of soil water content. All devices exhibited measurement precision better than $0.01 \text{ m}^3 \text{ m}^{-3}$. Accuracy of the devices was judged by the root mean squared difference (RMSD) between mass balance column-mean water contents and those determined by the devices using factory calibrations. The Delta-T system was most inaccurate, with an RMSD of $1.30 \text{ m}^3 \text{ m}^{-3}$ on the wet end. At the saturated end, the Diviner, EnviroSCAN and Trime devices exhibited RMSD values $>0.05 \text{ m}^3 \text{ m}^{-3}$, while the neutron probe and TDR exhibited RMSD $<0.03 \text{ m}^3 \text{ m}^{-3}$. All of the devices would require separate calibra-

tions for soil horizons with widely different properties. Of the electrical devices, only the Delta-T exhibited axial sensitivity larger than the axial height of the sensor, indicating small measurement volumes generally, and suggesting that these systems may be susceptible to soil disturbance close to the access tube during installation.