Measurement Volume of Decagon Volumetric Water Content Sensors

by Doug Cobos

Introduction

One of the most important factors to evaluate when selecting a soil moisture sensor is the volume of soil that the sensor integrates into the volumetric water content (VWC) measurement. For some applications, a sensor with a small measurement volume is desirable (e.g. greenhouse applications, near-surface measurements). However, in many field situations significant small-scale heterogeneity is present in the soil, meaning that a small volume measurement may not adequately reflect the average volumetric water content at the measurement location. For many field applications a larger measurement volume minimizes these issues and yields a more representative measurement of the true VWC. This Application Note describes the results of tests that were conducted to quantify the measurement volume of Decagon's VWC sensors.

Methods

The tests used to evaluate the measurement volume of the Decagon sensors were based on those in Sakaki et al. 2008, and are described here briefly. Each VWC sensor was suspended in air in a stationary position using a ring stand and clamp. A plane of water (water-filled, flat-sided plastic container) was then incrementally brought horizontally toward the sensor while recording sensor output. The outer edge of the measurement volume was identified as the distance where the presence of the water changed the sensor output appreciably. We repeated this process at six different sensor orientations to obtain a three-dimensional representation of the sensor measurement volume.

Results and Discussion

The sensor measurement volumes are encompassed by envelopes shown in Figures 1 through 8 below. If the measurement volume for each sensor is approximated as an ellipsoidal cylinder with the dimensions measured experimentally, as Figures 1 to 8 demonstrate, then you can calculate the total measurement volumes in Table 1.

It is well known that the electric field distribution inside the measurement volume is strongly weighted toward the sensor surfaces. Care should still be taken to ensure good soil-sensor contact to avoid air gaps at the sensor surface where it is most sensitive. It is also likely that electromagnetic field lines propagate further through air than through higher dielectric material (i.e. soil), so the dimensions in Figures 1 through 8 and the volumes in Table 1 should be taken as the maximum possible for each sensor. They should be good guidelines for installing the sensors near the soil surface or near a foreign object in the soil.

References

Sakaki, Toshihiro, Limsuwat, Anuchit, Smits, Kathleen M., and Illangasekare, Tissa H. (2008). Empirical two-point a-mixing model for calibrating the ECH_2O EC-5 soil moisture sensor in sands. *Water Resource Research*, 44 4, W00D08.

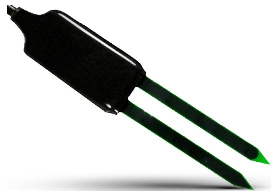
Sensor	**10HS**	**MAS-1**	**5TE/5TM**	**EC-5**
Max Volume	1320 mL	450 mL	715 mL	240 mL
				
Sensor	**GS1**	**GS3**		
Max Volume	1430 mL	160 mL		
				

Table 1: Maximum Sensor Measurement Volumes

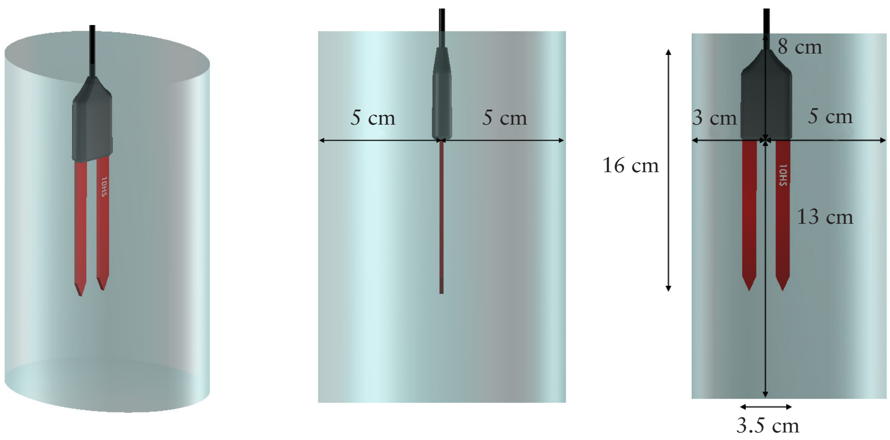


Figure 1: Idealized Measurement Volume of Decagon 10HS Sensor

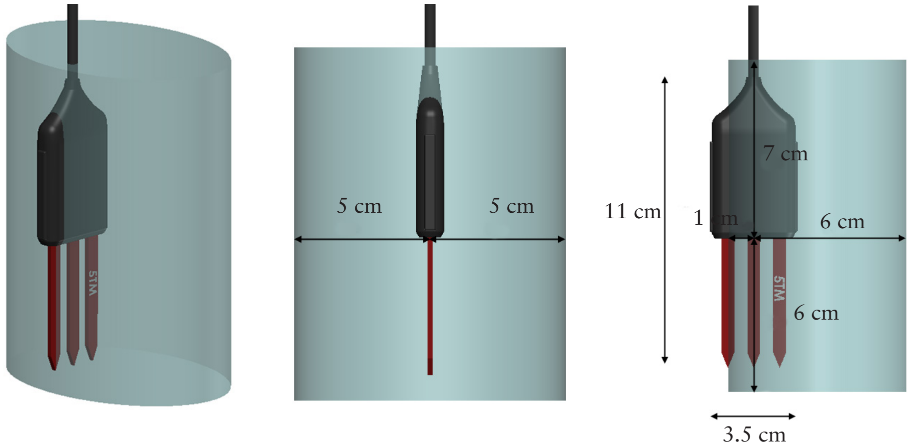


Figure 3: Idealized Measurement Volume of Decagon 5TM and 5TE Sensor

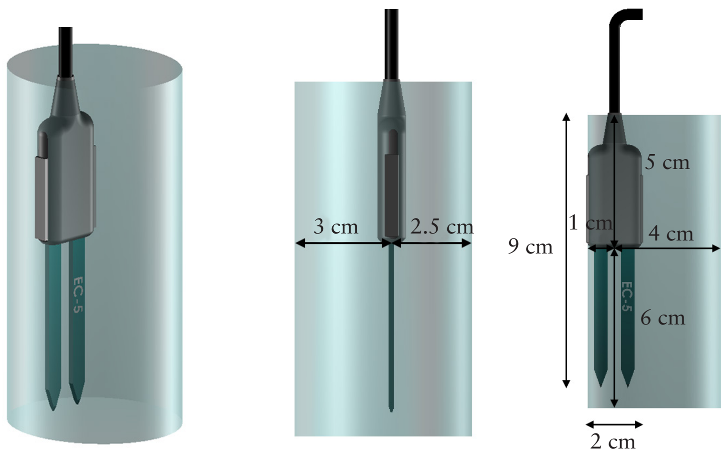


Figure 4: Idealized Measurement Volume of Decagon EC-5 Sensor

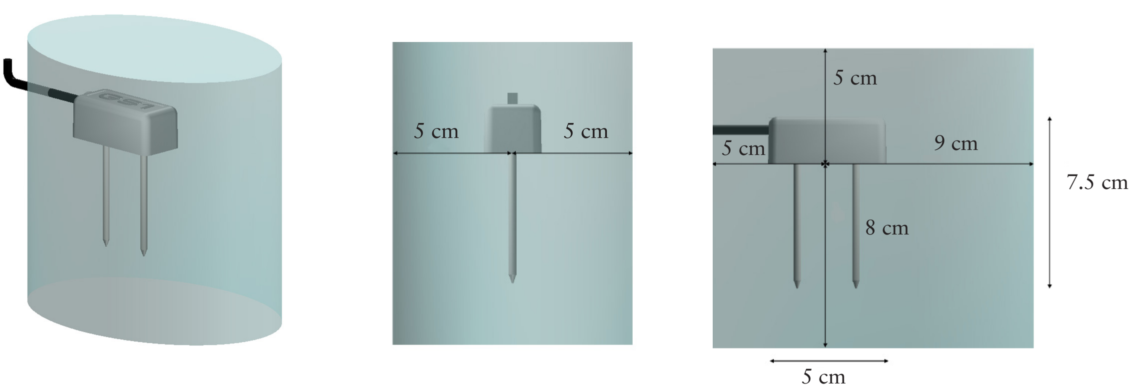


Figure 5: Idealized Measurement Volume of Decagon GS1 Sensor

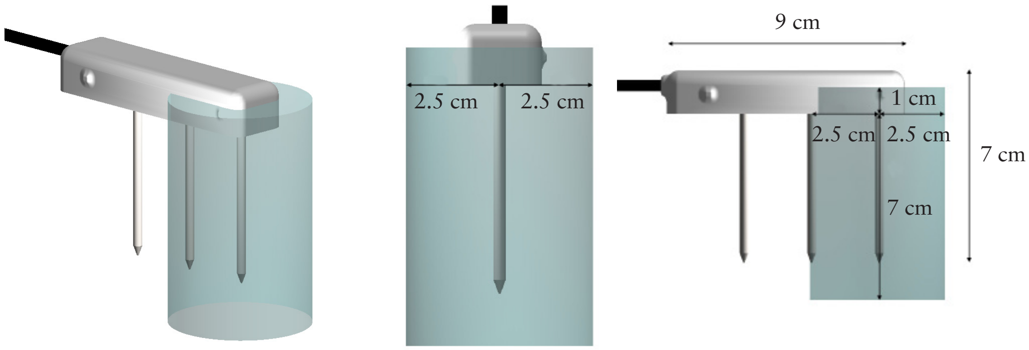


Figure 6: Idealized Measurement Volume of Decagon GS3 Sensor

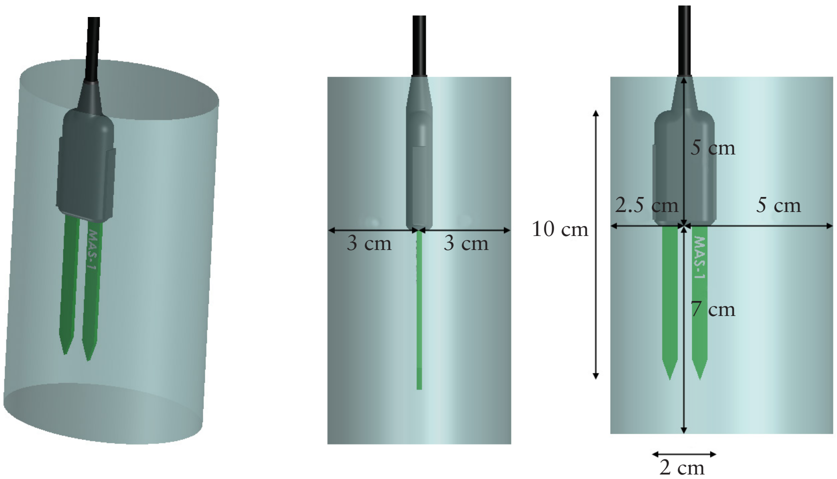


Figure 7: Idealized Measurement Volume of Decagon MAS-1 Sensor

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