MEASUREMENT VOLUME OF METER VOLUMETRIC WATER CONTENT SENSORS

Contributors

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 soil moisture 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 METER VWC sensors.

METHODS

The tests used to evaluate the measurement volume of the METER 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 7 below. If the measurement volume for each sensor is approximated as an ellipsoidal cylinder with the dimensions measured experimentally, as Figures 1 to 7 demonstrate, then you can calculate the total measurement volumes in Table 1.

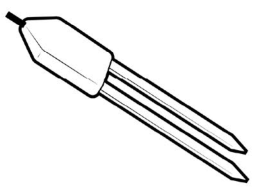
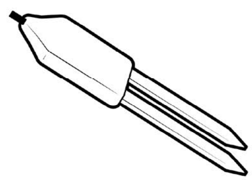
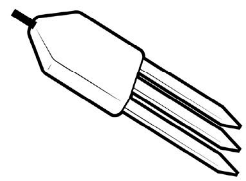
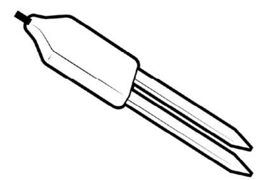
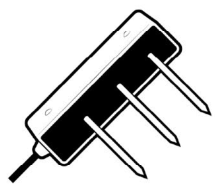
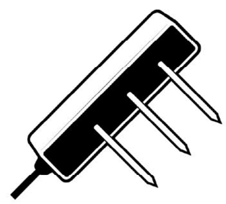
SENSOR	10HS	MAS-1	5TE/5TM	EC-5
MAX VOLUME	1320mL	450 mL	715 mL	240mL
				
SENSOR	TEROS 10	GS3	TEROS 11/12	
MAX VOLUME	430mL	160mL	1010mL	
				

Table 1. Measurement volume of METER soil moisture sensors

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 7 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, et al. “Empirical two-point α-mixing model for calibrating the ECH_2O EC-5 soil moisture sensor in sands.” *Water resources research* 44.4 (2008). Article link.

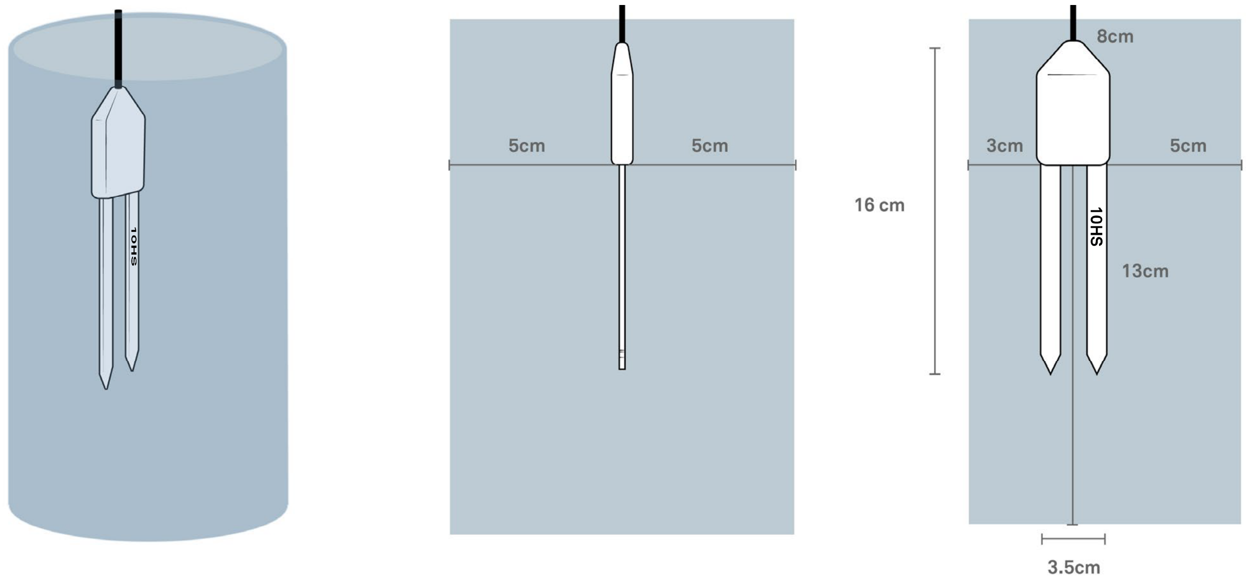


Figure 1. Idealized measurement volume of METER 10HS sensor

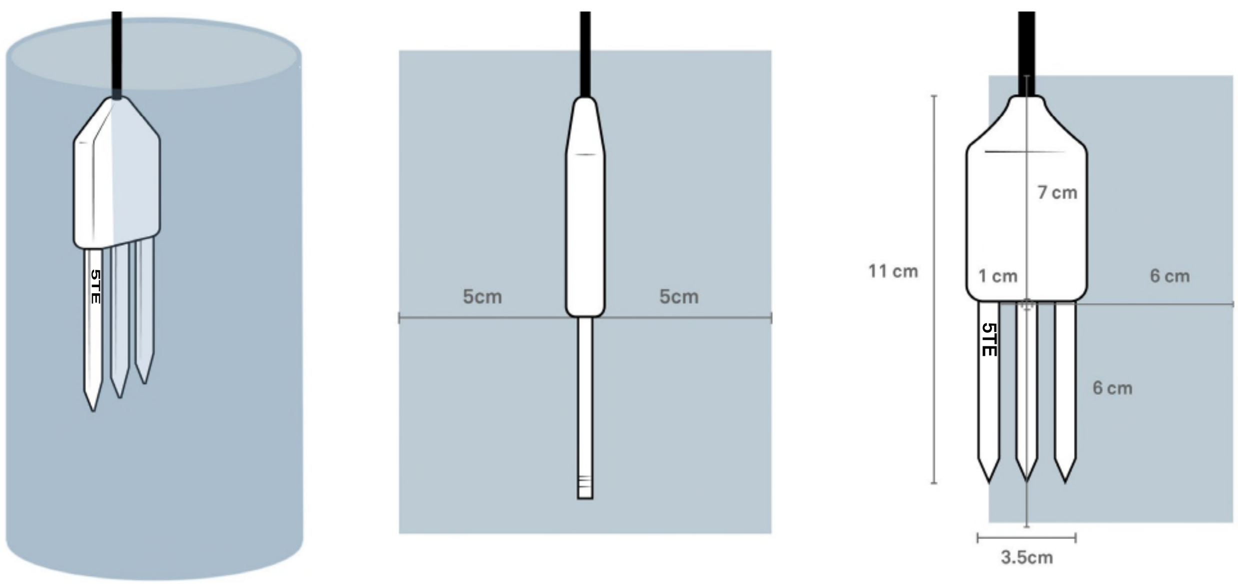


Figure 2. Idealized measurement volume of METER's 5TM and 5TE sensor

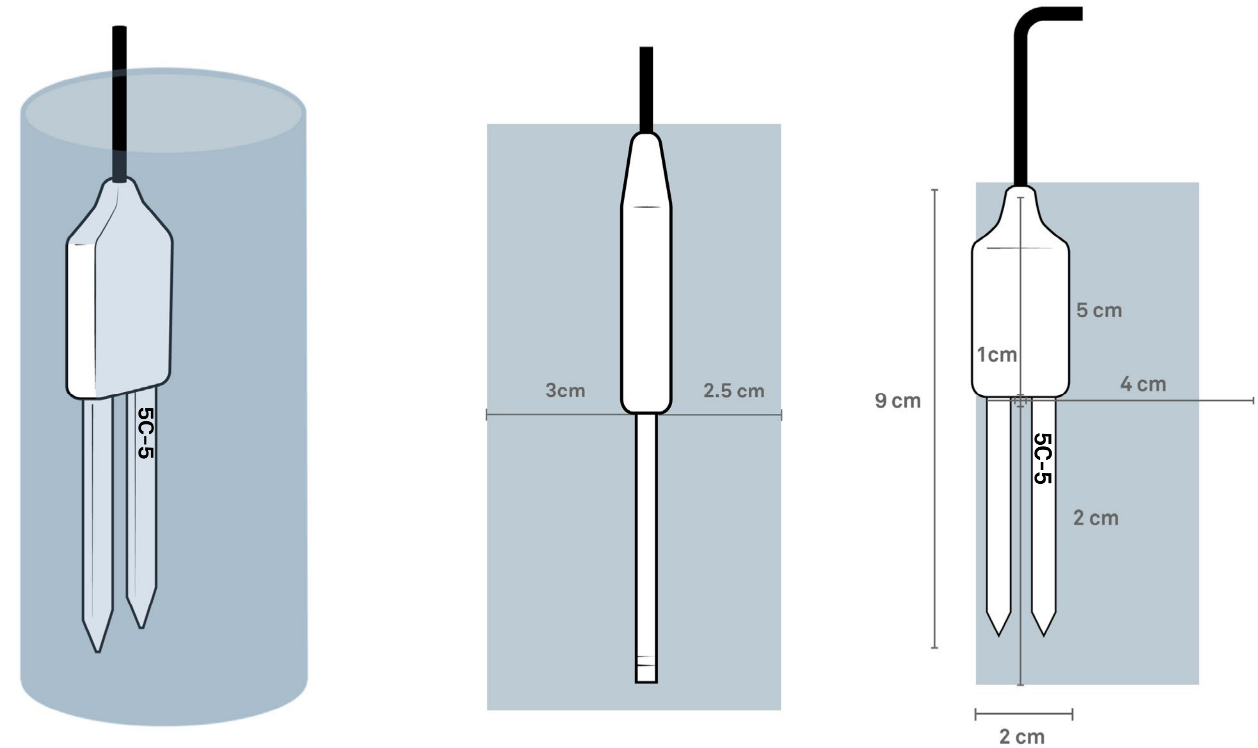


Figure 3. Idealized measurement volume of METER EC-5 sensor

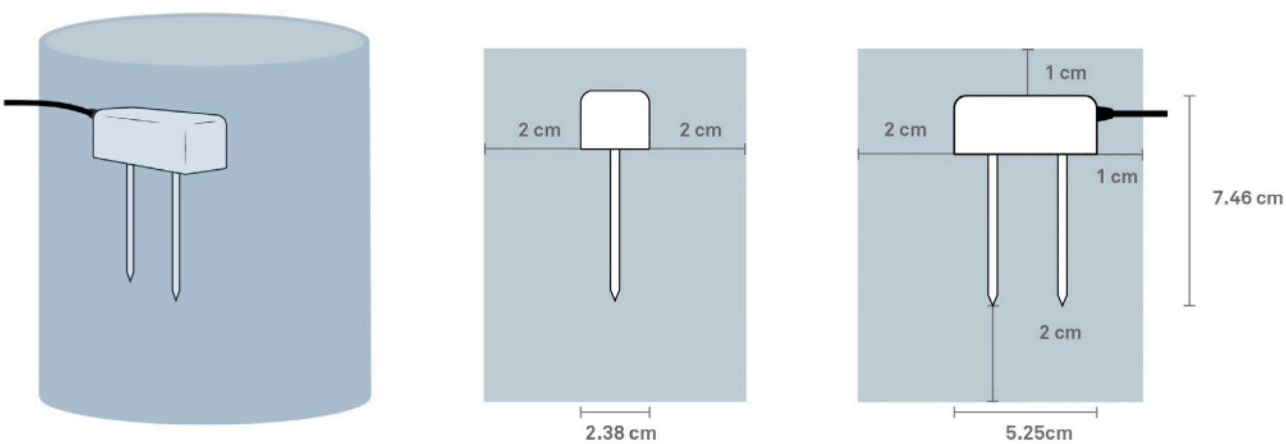


Figure 4. Idealized measurement volume of METER TEROS 10 and GS1 sensor

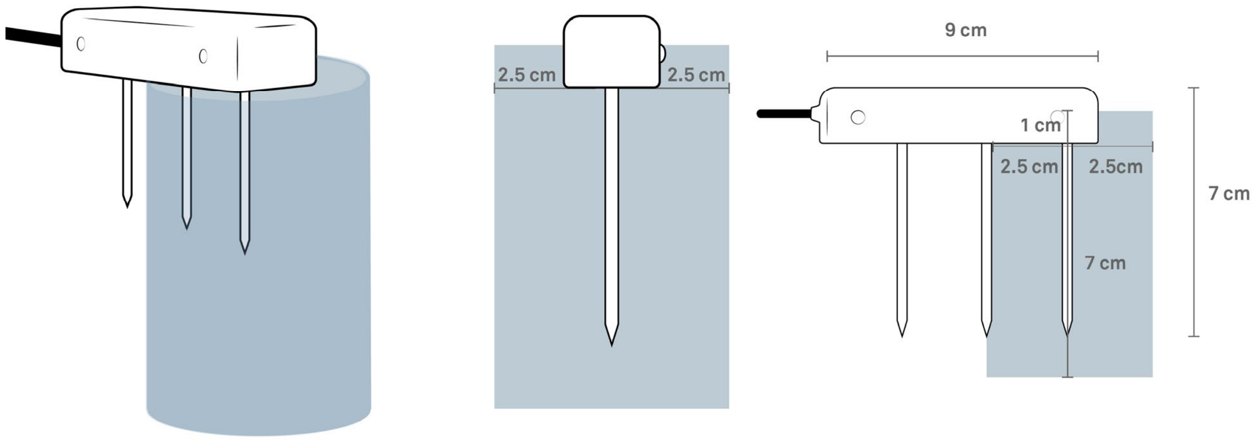


Figure 5. Idealized measurement volume of METER GS3 sensor

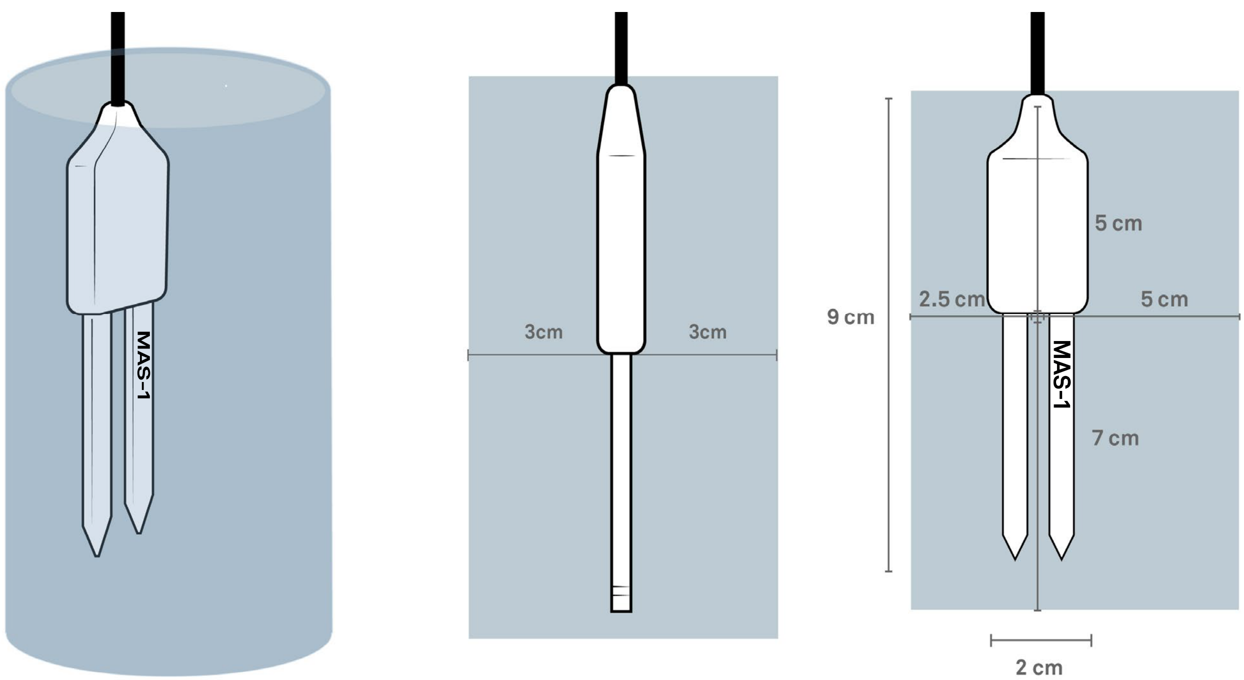


Figure 6. Idealized measurement volume of METER MAS-1 sensor

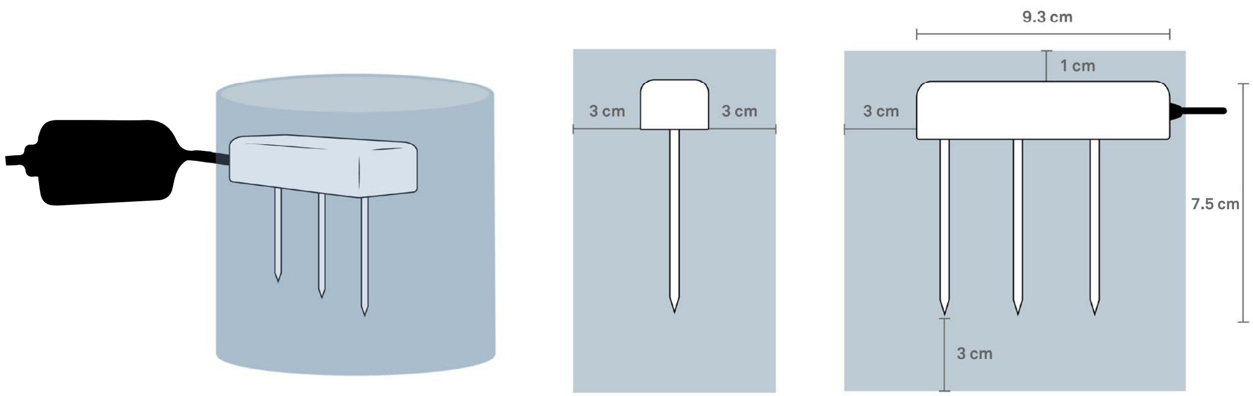


Figure 7. Idealized measurement volume of METER's TEROS 11 and TEROS 12 sensor

WHY WE SPENT 20 YEARS DEVELOPING TEROS SENSORS

With the TEROS 12, we've not only improved our sensor, we've also turned our attention to broader issues that are likely to confound soil moisture sensor data—things like sensor-to-sensor variability, volume of influence, air gaps, and preferential flow. Learn about:

- TEROS 12 data consistency and response to wetting fronts

- How the new calibration procedure works to minimize sensor-to-sensor variability

- How the installation tool reduces air gaps and site disturbance while improving consistency

- What to expect during an installation

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GET THE COMPLETE PICTURE

Learn everything you need to know about measuring soil moisture—all in one place: why you need it, how to measure it, method/sensor comparisons, how many measurements, where you should measure, best practices, data troubleshooting, and more.