10HS Volume of Sensitivity

By: Dr. Doug Cobos

Introduction:

One of the most important factors to evaluate when selecting a soil moisture sensor is the volume of soil that is integrated into the volumetric water content measurement. For some applications, a sensor with a small volume of sensitivity 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 accurately reflect the average volumetric water content at the measurement location. For most field applications a larger volume of sensitivity will minimize these issues and yield a more accurate measurement of the true volumetric water content. To this end, Decagon has spent considerable effort maximizing the volume of influence of the 10HS soil moisture sensor. This application note describes a set of tests that were conducted to quantify the volume of sensitivity of the 10HS, and the results of those tests.

Methods:

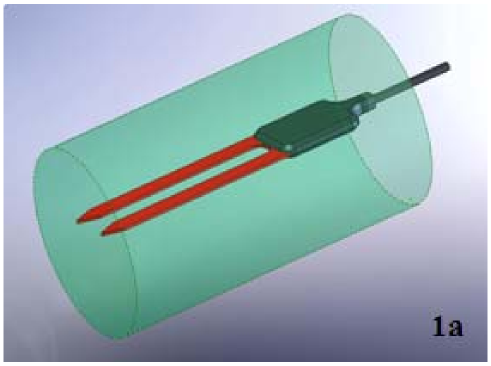
The tests used to evaluate the volume of sensitivity of the 10HS sensor have been described in Sakaki et al. 2008, and are described here briefly. With this method, the sensor is suspended in air above a large water surface. The sensor output is recorded as the sensor is lowered from a distance far from the water toward the water surface. When the output changes appreciably due to the proximity of the water, the outer edge of the volume of sensitivity has been reached. This process is repeated at different sensor orientations to obtain a three-dimensional representation of the sensor's volume of sensitivity.

Results and Discussion:

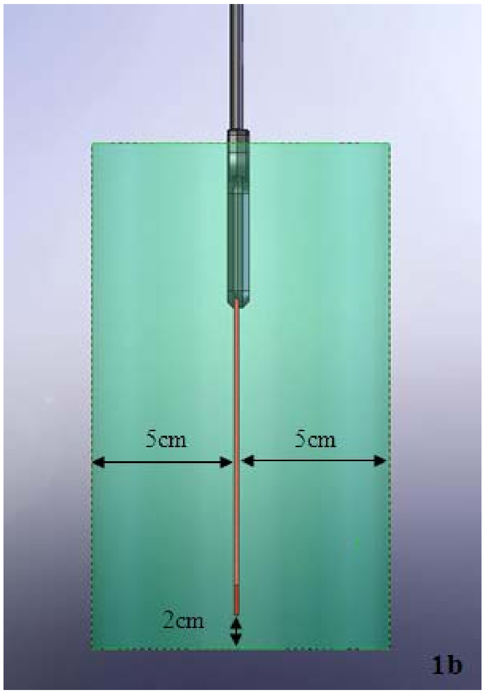
The 10HS volume of sensitivity is encompassed by an envelope shown in Figure 1. If an ellipsoidal cylinder is drawn around the sensor with the dimensions measured experimentally, the total volume of influence of the 10HS is approximately 1160 cm^3. It is well known that the electric field distribution inside the volume of sensitivity is strongly weighted toward the sensor surfaces, so this volume should be taken as a maximum possible measurement volume. Care should still be taken to ensure good soil-sensor contact to avoid air gaps at the sensor surface where the measurement is most sensitive. Also, be careful when installing the 10HS sensor near the soil surface or near any foreign object in the soil. Decagon recommends that the 10HS not be installed within 10 cm of the soil surface or any foreign object in the soil.

Figure 1a-1c. Idealized volume of sensitivity of the10HS sensor. It should be noted that this sketch is a highly simplified representation of the actual geometry of the volume of sensitivity, but the overall result should adequately approximate the real physical situation.

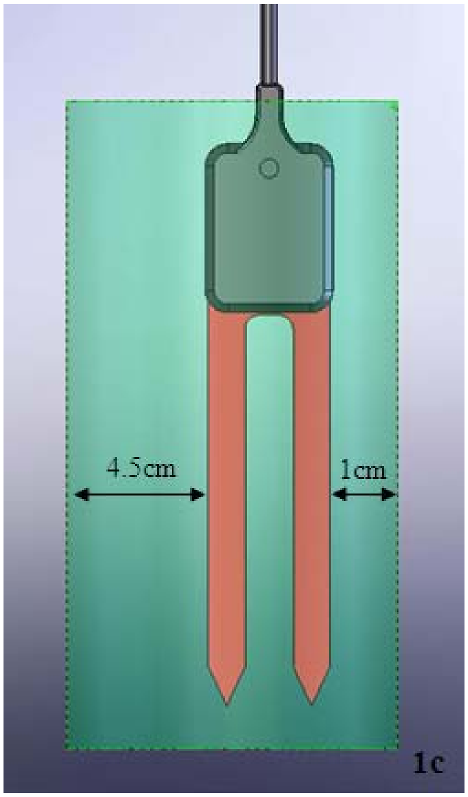
1a: Gives a conceptual view of the volume of sensitivity.



1b: Shows the volume of sensitivity looking across the prongs parallel to the flat plane of the prongs.



1c: Shows the volume of sensitivity normal to the flat plane of the prongs.



Reference:

Sakaki, T., A. Limsuwat, K. M. Smits, and T. H. Illangasekare (2008, *Water Resour. Res.*, Special Issue on Measurement Methods, in revision), Empirical two-point α-mixing model for calibrating ECH_2O EC-5 soil moisture sensor.