AGU session H55N, “Evapotranspiration (ET) - Advances in In Situ ET Measurements and Remote Sensing-Based ET Estimation, Mapping, and Evaluation”, H55N-0887

Can Dense, Deep Profiles of Soil Water Sensors Determine Change in Storage as Well as a Weighing Lysimeter or Neutron Probe?

Steve Evett, Gary Marek, Robert Schwartz, Paul Colaizzi, and Dave Brauer
USDA ARS Conservation & Production Research Laboratory, Bushland, Texas

USDA
United States Department of Agriculture
Agricultural Research Service

Motivation:

Evapotranspiration (ET) can be calculated from the soil water balance: ET = ΔS + I + P + R + F, applied to a control volume where the change in soil water stored in the volume, ΔS, can be determined by weighing lysimeter, soil coring, or soil water sensing. Weighing lysimetry is considered the most accurate method for ΔS but is not portable and is difficult to replicate. The neutron probe (NP) is considered an accurate method for ΔS but is manual in application and cannot be left unattended in the field. Soil water sensors based on time domain reflectometry (TDR) with waveform capture and reduction to travel time have been shown to be accurate but sense a much smaller volume than does the NP. Early attempts to determine ΔS using TDR methods were unsuccessful but the recent development of true TDR soil water sensors motivated another attempt.

Methods:

In this endeavor we assumed that accurate values were available for irrigation (I), precipitation (P), the sum of runon and runoff (R), and flux into or out of the control volume (F) so that ET values would only vary according to ΔS values.

Over a cotton cropping season at Bushland, Texas, USA we compared the soil water storage, S, and change in storage, ΔS, in a 2.3-m deep profile of silty clay loam soil as assessed by a large, precision weighing lysimeter, the neutron probe in two access tubes in the lysimeter, and three profiles of TDR soil water sensors installed in the lysimeter, each profile consisting of 15 sensors (Fig. 1). Weighing lysimeter mass was recorded every 5 minutes and TDR sensors were read every 15 minutes, both automatically using dataloggers, while the neutron probe readings were done manually at approximately one-week intervals. We compared profile water content and ΔS determined using TDR to respective values determined using both the NP and the lysimeter.

Results:

Profile water contents sensed using NP were different from those sensed using TDR because the NP senses a much larger volume of soil (Fig. 2). Comparing TDR sensors with neutron probe, coefficients of determination (r^2) for S and for ΔS were 0.97 and 0.91, respectively, when one-week intervals were considered. Coefficients of determination for comparisons of TDR sensors to lysimeter were 0.95 for S and 0.92 for ΔS (Fig. 3), while r^2 values for comparison of neutron probe to lysimeter were 0.91 for water storage and 0.83 for ΔS, again for one-week intervals. The TDR method worked reasonably well to determine soil profile water storage and ΔS. The NP method worked less well, likely because it was not possible to read the NP at depths greater than 1.90 m, which limited the profile sensed to the top 2.0 m of soil (Fig. 4). Scatter in the data for both the NP and TDR methods was likely due to surface wetting events that were not completely sensed by those methods but caused changes in lysimeter mass.

Fig. 1. 3 TDR sensor profiles, 15 sensors each; 2 neutron probe tubes; 1 weighing lysimeter

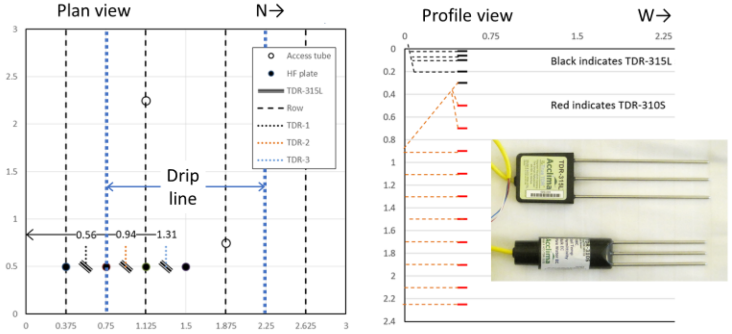

Fig. 2. Mean water content profiles

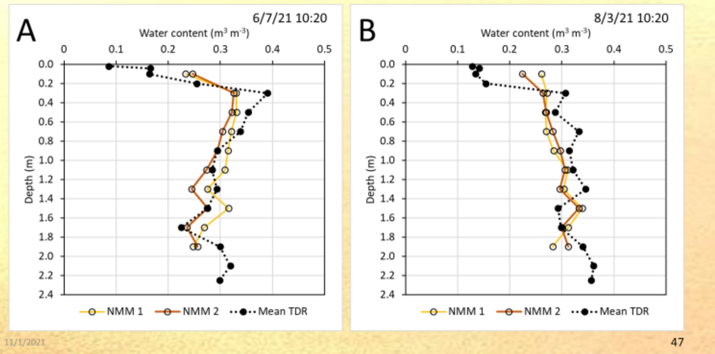

Fig. 3. TDR vs. lysimeter

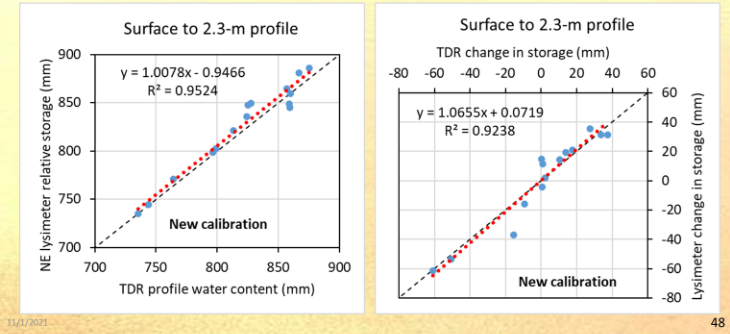

Fig. 4. NP vs. lysimeter