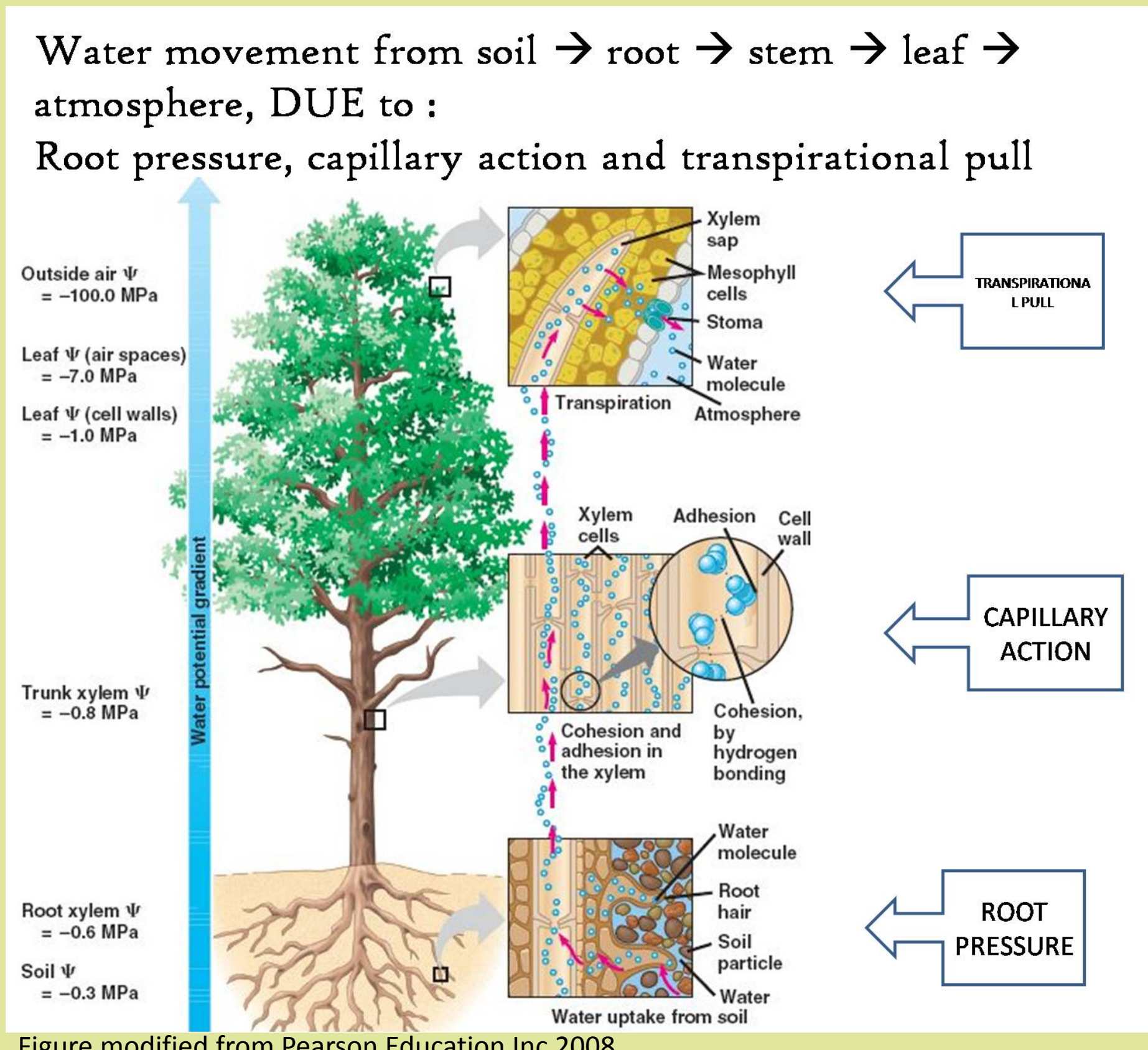




Soil Moisture Measurement and Modeling

PINEMAP 2013 Annual Meeting Field Tour
Tier III site, Taliaferro County, GA

Soil Plant Atmosphere Continuum



- To estimate changes in water use under throughfall exclusion, team members are measuring water use at the tree and soil level.
- Time Domain Reflectometry (TDR)** probes are being placed throughout the soil profile to quantify **volumetric soil moisture content** (θ , $\text{cm}^3 \text{cm}^{-3}$)
- Soil moisture contents are combined with **hydraulic conductivities (K)** and plant water uptake to estimate water flow through the soil profile

Figure 1. Soil Plant Atmosphere Continuum model showing key pressure potentials driving water use through plants. Potential are being measured by team members at the soil, plant, and atmosphere level. These estimates will be used to quantify plant water use from different depths in the soil profile.

TDR probes and wave forms

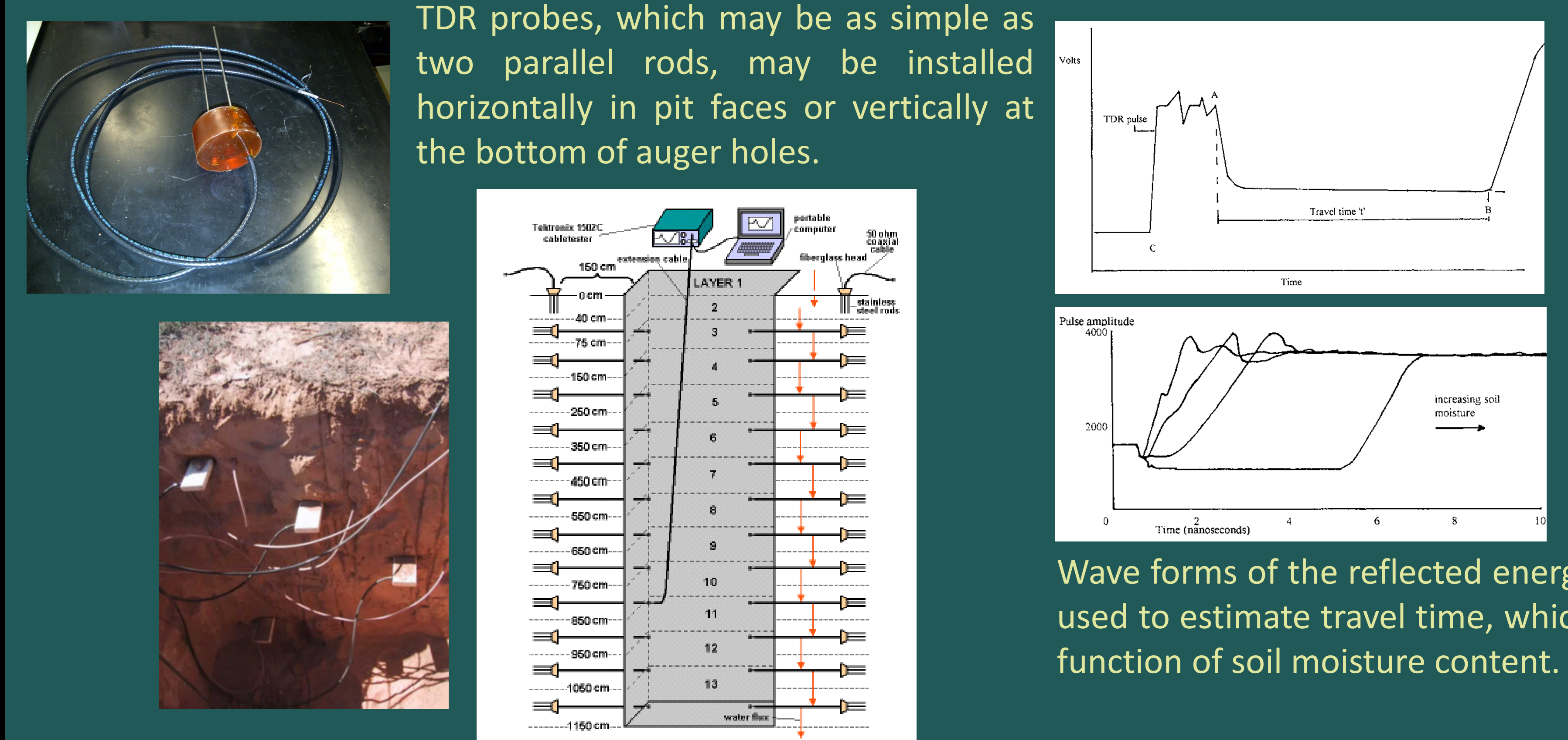
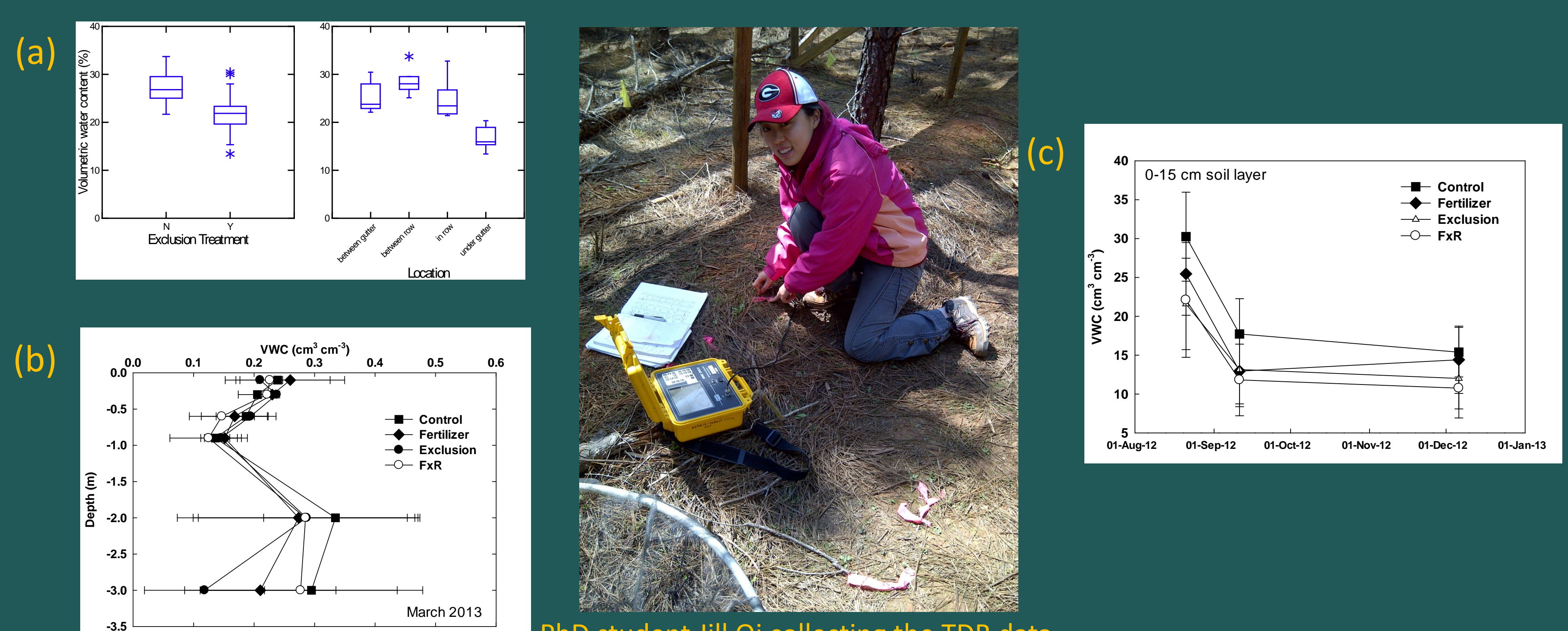


Figure 2. TDR works by transmitting a pulse of energy down a cable (note that the two rods and the insulating soil material are acting like a cable). When that pulse reaches the end of the cable, virtually all the energy is reflected back to the instrument.

Soil Moisture Measurements Spatially and Temporally



PhD student Jill Qi collecting the TDR data

Figure 3. Soil moisture will be collected spatially both horizontally under excluders (a) and vertically throughout the profile (b) as well as over time (c).

Modeling Soil Water Uptake and Drainage

Soil water content (θ) is determined for each soil using water depth (D) and layer thickness (Δz).

Water flux between soil layers is determined using Darcy's law for one-dimensional (vertical), unsaturated flow where q_z is the vertical water flux (m s^{-1}), $K(\theta)$ is the unsaturated hydraulic conductivity (m s^{-1}), ΔH is the difference in total hydraulic head between two adjoining layers (m) and Δz is the downward-directed, vertical distance between the midpoints of the layers (m).

The matric head of the soil water is determined by the van Genuchten equation relating water content to matric head where $\theta = (\theta - \theta_r) / (\theta_s - \theta_r)$ with s and r being saturated and residual water content.

Unsaturated hydraulic conductivity, $K(\theta)$, is calculated from saturated hydraulic conductivity, K_s , according to the equation of Mualem (see (E4)).

Changes in soil water storage are modeled using the Richards' (mass balance) equation that accounts for inflows and outflows in each layer. Root uptake is the main mechanism for water loss (see (E6) and (H)).

Figure 4. The flow of soil water from one layer to another and the uptake of soil water from different soil layers by plants is not measured directly but is modeled. The modeling requires measurement of other soil attributes (saturated hydraulic conductivity, soil moisture characteristic curves) and requires an estimation of plant water uptake. The model is constrained by the ability to represent the observed time series of soil moisture contents measured with TDR.