Geophysical Research Abstracts
Vol. 19, EGU2017-18525, 2017
EGU General Assembly 2017

Estimating Soil Thermal Conductivity and Diffusivity from Single Heated Needle

Paolo Castiglione and Gaylon Campbell
Meter Engineering Inc., Pullman, United States (paolo@ metergroup.com)

Estimating thermal properties in low conductivity media such as dry soil is a challenging task. Typically, steady state techniques are employed, such as the guarded hot-plate. Such measurements are expensive, time consuming and experimentally difficult. More importantly, they can't be used in situ or on wet samples where moisture migrates in a thermal gradient. Transient methods overcome both limitations, offering rapid and simple measurements. Most importantly, they permit estimates of thermal diffusivity as well. One such technique relies on a metal needle placed in the sample and heated at a uniform rate. Thermal conductivity and diffusivity of the surrounding medium are estimated from temperature recorded inside the needle via a suited inversion scheme. Measurements in dry soils remain a challenge, due to the large mismatch between specific heat of the probe and the sample. We revisited the traditional algorithm, based on a simplified model of the conduction process, and analyzed the actual response in a multilayered system, where the thermal properties of the probe, including the contact resistance, are accounted for. The analysis suggests a simple transformation of the temperature signal, which permits us to solve the inverse problem through a straightforward iteration scheme. The proposed method is especially beneficial with low conductivity samples, yielding accurate estimates even with measurement durations of less than five minutes. Moreover, since the transform involves the time derivative of the temperature signal, the presence of the contact resistance is uninfluential, thus effectively eliminating one of the hairiest problems afflicting transient methods.