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Summary of Advances in the Heat-Pulse Technique: Improvements in Measuring Soil Thermal Properties

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Abstract
This essay provides a summary of "Advances in the Heat-Pulse Technique: Improvements in Measuring Soil Thermal Properties" recently appearing in Methods of Soil Analysis. Series.

Disciplines
Agricultural Science | Agronomy and Crop Sciences | Soil Science

Comments
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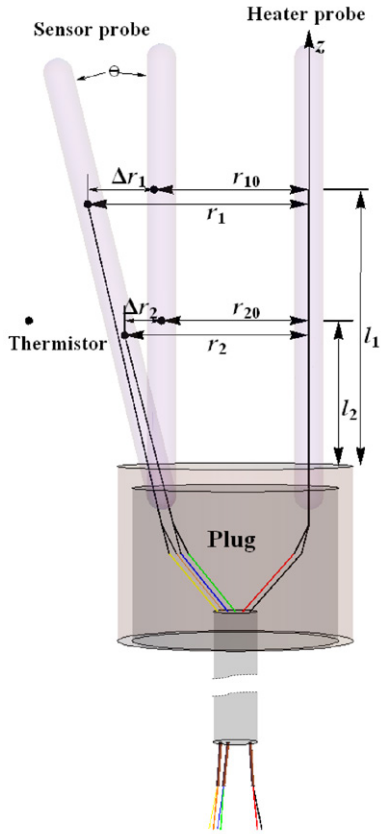

Fig. 1. Schematic of the in situ probe spacing correcting heat pulse sensor with outward deflection of the temperature probe (modified from Liu et al., 2013), where r_i is the deflected probe spacing of the *i*th thermistor; r_{i0} is the initial probe spacing of the *i*th thermistor; Δr_i is the displacement of the *i*th thermistor; l_i is the distance from the *i*th thermistor to the sensor body surface; and θ is the deflected angle.

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Abbreviations: DPHP, dual probe heat pulse.

The dual probe heat-pulse (DPHP) technique is used widely for in situ determination of soil thermal properties. Soil thermal properties, including thermal diffusivity (α), thermal conductivity (λ), and volumetric heat capacity (*C*), have important influences on soil heat and mass transfer processes. Special care is needed to obtain accurate DPHP measurements in field soil, because of potential problems of probe deflections, finite probe properties, thermal contact resistance, and influence of the soil–air interface. In a chapter of the recent Methods of Soil Analysis, the authors present a review of the theory, instrumentation, and procedures needed for the DPHP sensor to obtain accurate in situ soil thermal property measurements (Liu et al., 2017).

Probe-to-probe spacing, *r*, of a DPHP sensor is usually determined by calibrating the sensor in a material with known heat capacity. Unfortunately, when a DPHP sensor is inserted into soil, the probes are likely to deflect (see Fig. 1), which changes the value of *r*. Uncertainties in *r* lead to erroneous determination of soil thermal properties derived from DPHP measurements. A novel strategy for determining in situ *r* values is available, which leads to accurate estimates of soil thermal properties. In addition to accounting for DPHP probe deflections, finite probe properties, thermal contact resistance, and influence of the soil-air interface must also be considered. Methods to account for each of these potential problems are described in detail, and the benefits derived from employing these methods lead to improvements in thermal property determinations.

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Core Ideas

- **The dual probe heat-pulse (DPHP) method is used to measure soil thermal properties.**
- **Special care is needed to obtain accurate DPHP measurements in field soil.**
- **A review of theory, instrumentation and procedures needed is presented for DPHP.**

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