

7-26-2018

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

Minmin Wen
China Agricultural University

Gang Liu
China Agricultural University

Robert Horton
Iowa State University, rhorton@iastate.edu

Yili Lu
China Agricultural University

Tusheng Ren
Follow this and additional works at: https://lib.dr.iastate.edu/agron_pubs
China Agricultural University

 Part of the [Agricultural Science Commons](#), [Agronomy and Crop Sciences Commons](#), and the [Soil Science Commons](#)

The complete bibliographic information for this item can be found at https://lib.dr.iastate.edu/agron_pubs/515. For information on how to cite this item, please visit <http://lib.dr.iastate.edu/howtocite.html>.

This Article is brought to you for free and open access by the Agronomy at Iowa State University Digital Repository. It has been accepted for inclusion in Agronomy Publications by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.

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

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

This summary is published as Wen, Minmin, Gang Liu, Robert Horton, Yili Lu, and Tusheng Ren. "Summary of Advances in the Heat-Pulse Technique: Improvements in Measuring Soil Thermal Properties." *Soil Science Society of America Journal* (2018). doi: [10.2136/sssaj2018.02.0067](https://doi.org/10.2136/sssaj2018.02.0067).

Creative Commons License



This work is licensed under a [Creative Commons Attribution-Noncommercial-No Derivative Works 4.0 License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

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

Minmin Wen

Gang Liu*

Dep. of Soil and Water
College of Resources and Environment
China Agricultural Univ.
Beijing 100193, PR China

Robert Horton

Dep. of Agronomy
Iowa State Univ.
Ames, IA 50011

Yili Lu

Tusheng Ren

Dep. of Soil and Water
College of Resources and Environment
China Agricultural Univ.
Beijing 100193, PR China

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*.

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.

REFERENCES

- Liu, G., M. Wen, X. Chang, T. Ren, and R. Horton. 2013. A self-calibrated dual probe heat pulse sensor for in situ calibrating the probe spacing. *Soil Sci. Soc. Am. J.* 77:417–421. doi:10.2136/sssaj2012.0434n
- Liu, G., Y. Lu, M. Wen, T. Ren, and R. Horton. 2017. Advances in the Heat-Pulse Technique: Improvements in Measuring Soil Thermal Properties. *Methods of Soil Analysis 2*. doi:10.2136/msa2015.0028

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.

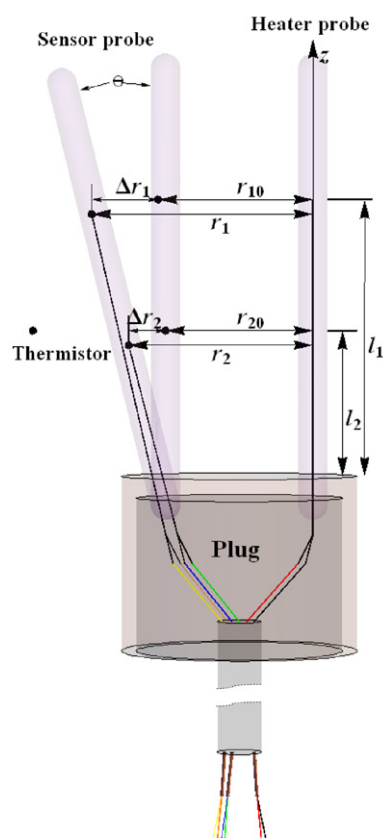


Fig. 1. Schematic of the in situ probe spacing correcting heat pulse sensor with outward deflection of the temperature probe (modified from Liu et al., 2013), where r_i is the deflected probe spacing of the i th thermistor; r_{i0} is the initial probe spacing of the i th thermistor; Δr_i is the displacement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

Soil Sci. Soc. Am. J.
doi:10.2136/sssaj2018.02.0067

Received 5 Feb. 2018.

Accepted 28 Mar. 2018.

*Corresponding author (liug@cau.edu.cn).

© Soil Science Society of America. This is an open access article distributed under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)