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Summary of Advances in Heat-Pulse Methods: Measuring Near-Surface Soil Water Content

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Abstract

Surface layer soil water content is important for evaporation, surface energy balance, seed germination, residue decomposition, microbial activity, and many other biological, chemical, and physical processes. The standard method (i.e., the gravimetric method) for measuring soil water content requires destructive sampling and is unsuitable for continuous measurement. Techniques such as neutron thermalization and time domain reflectometry suffer relatively large errors in measuring soil water content near the surface. In a recent Methods of Soil Analysis article, the authors present the principles and procedures for using a heat-pulse sensor to determine near-surface soil water content.

Disciplines

Agriculture | Hydrology | Soil Science

Comments

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Methods Summary

Summary of Advances in Heat-Pulse Methods: Measuring Near-Surface Soil Water Content

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Surface layer soil water content is important for evaporation, surface energy balance, seed germination, residue decomposition, microbial activity, and many other biological, chemical, and physical processes. The standard method (i.e., the gravimetric method) for measuring soil water content requires destructive sampling and is unsuitable for continuous measurement. Techniques such as neutron thermalization and time domain reflectometry suffer relatively large errors in measuring soil water content near the surface. In a recent Methods of Soil Analysis article, the authors present the principles and procedures for using a heat-pulse sensor to determine near-surface soil water content.

Measurements of near surface soil water content with a heat-pulse sensor are influenced by natural ambient heating and cooling processes and by proximity to the soil-air interface. The recently published article (Zhang et al., 2017) describes approaches to minimize errors associated with changes in ambient soil temperature and by the influence of soil–air interface. Trends in ambient soil temperature were determined and used to decrease ambient soil temperature effects. The pulsed infinite line source-adiabatic boundary condition (PILS–ABC) solution successfully reduced the soil–air interface effect. Results from a field experiment showed that in the 0- to 6-mm soil layer, water contents from the heat-pulse method agreed well with gravimetrically measured water content values, with a coefficient of determination of 0.95 (Fig. 1). Thus, the heat-pulse method provided accurate soil layer water content values, which could be used for studying mass and energy exchanges at the land-atmosphere interface.

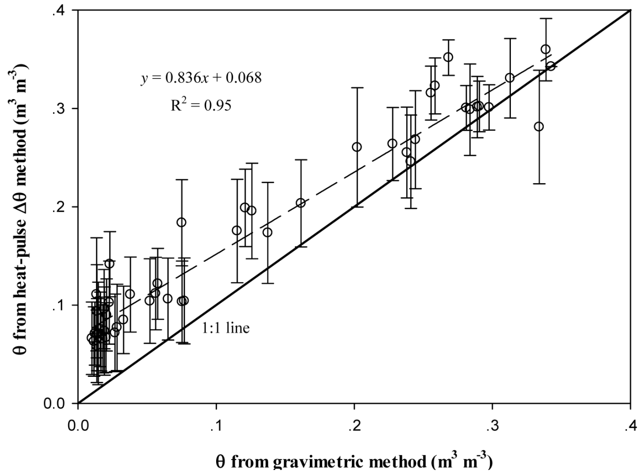

Fig. 1. Comparisons of soil water content (θ) in the 0- to 6-mm soil layer determined with the heat-pulse method and gravimetric method. Each circle represents a mean value of four θ measurements from the heat pulse sensor one θ value from the gravimetric method. The error bars are standard deviations of the four heat-pulse θ values.

Core Ideas

- **Describes the method for determining near-surface water content with heat pulse sensors.**
- **Temperature data prior to a heat-pulse are used to reduce ambient temperature effects.**
- **The PILS–ABC model is used to minimize errors because of the soil–air interface.**

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