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Abstract

When a dual probe heat pulse (DPHP) sensor is installed near the soil-atmosphere interface, the basic assumptions of the infinite line heat source (ILS) model and its improvement, the infinite line heat source model with an adiabatic boundary condition (ILS-ABC), might not be satisfied because of wind. This study aims at exploring the effect of wind on DPHP measurements and comparing the performance of the ILS and ILS-ABC models with different values of wind velocity (υ) and burial depth (d). Our study showed that the results of laboratory experiments COMSOL simulations and field experiments are consistent with each other. For dry sand with d ≤ 4 mm, the effect of wind is non-negligible when υ = 3.5 m s-1, and the DPHP method does not provide accurate estimations whether the ILS model or the ILS-ABC model is used. Further, field experiment results showed that in general, υ measured in the field was less than 2.7 m s-1 and when d = 5 mm the ILS-ABC model provided more accurate estimations than the ILS model did. When the ILS-ABC model was used, relative error was less than 15% and 9% in thermal conductivity (λ) and heat capacity (c), respectively. Compared with laboratory experiment and simulation, field experiment is prone to large background temperature fluctuation and result in poor performance of the linear de-trend method of Jury and Bellantuoni (1976).

Figures used in the abstract

Figure 1: COMSOL simulated relative errors in λ and c for probes in dry sand and saturated sand with υ = 3.5 m s-1 and varying d. The subscript ILS and ILS-ABC means DPHP temperature signals were processed by the ILS and ILS-ABC model, respectively.