Modelling of frozen soil thermal conductivity

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Frozen soil thermal conductivity (FSTC), which describes frozen soils’ ability to conduct heat under a unit temperature gradient, is a critical parameter of the partial differential heat conduction equation required for numerical studies of coupled heat and mass transport processes and engineering applications in cold and arid regions. FSTC is complicated because it is affected by factors such as temperature, unfrozen water and ice content, and soil texture. Although many FSTC models are available in literature, many of these models were developed using steady-state method that are subject to errors associated with phase change and water redistribution or not even tested with experiments. In addition, no studies have assessed their applicability and reliability. We conducted an extensive literature review and collated over 30 FSTC models. Their performance was evaluated with a large compiled dataset measured with transient method (e.g., heat pulse method), which is less likely to be affected by phase change and water redistribution at unfrozen or low subfreezing temperatures. In addition, a new FSTC model that is capable of accurately estimating FSTC at both unfrozen and frozen conditions is proposed.