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Effects of radiation and conduction on subsurface temperature profiles

I. Lunati, N. Vercauteren, and M.B. Parlange

School of Architecture, Civil and Environmental Engineering, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland

Modern measurement techniques allow observing the evolution of temperature profiles with high spatial and temporal resolutions. This permits to obtain information about energy flux in the subsurface, which results from the interaction of different physical processes. Based on a simplified model, we provide a theoretical framework to analyze experimental data and understand the importance of different mechanisms, which depends on the properties of the medium considered, e.g., soil, water, or snow.

In our conceptual model, the energy is provided by the net radiation available at the earth surface. According to the optical properties of the medium, this incoming energy can be either completely transformed into heat at the surface, or partially transmitted such that heat is generated in the medium. The first case is characteristic of soil, which is opaque to net radiation, whereas the second is the case of water, which is partially transparent. The presence of a radiative heat source in the subsurface changes the temperature profile with respect to the purely conductive case and modifies the amount of energy available at the surface for evaporation. This simple model suggests that, for the same incoming radiation, the fraction of energy available for evaporation is smaller on water than on soil surfaces.