Modeling the Snow Surface Temperature in an Energy Balance Snowmelt Model

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Abstract. In energy balance snowmelt models the snow surface temperature is an important variable in the quantification of heat transfers between the snow and atmosphere above and in the conduction of heat into or out of the snow. The thermal conductivity of snow is relatively small so surface temperature is different from the average temperature of the snowpack. This difference means that single layer snowmelt models that use the average snowpack temperature to estimate the snow surface energy exchanges perform poorly, a fact that has led many to advocate multiple layer snowmelt models. In an effort to keep snowmelt modeling simple and parsimonious the Utah Energy Balance (UEB) model uses only one layer but allows snow surface temperature to be different from the snow average temperature, using an equilibrium parameterization. This procedure, although an improvement over using the average temperature, still gives rise to discrepancies between modeled and measured snowpack energy contents. In this paper we examine the parameterization of snow surface temperature in single layer snowmelt models from the perspective of heat conduction into a semi-infinite medium. We evaluate the equilibrium gradient approach currently used and a force restore approach and modified force restore approach. These parameterizations are tested against data from the Central Sierra Snow Laboratory and Utah State University experimental farm. We compared modeled and measured snow surface temperature, energy content, snow water equivalence, and snowmelt outflow.