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Parameterizing moisture in glacier debris cover using a bucket scheme

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Due to the complexity of treating moisture in supraglacial debris cover, full surface energy balance models to date have neglected both moisture fluxes and phase changes in the debris layer. However, the presence of liquid and frozen water has an important influence on the thermal properties of the debris layer. In addition, large spikes in the latent heat flux over supraglacial debris have been measured, suggesting that neglecting this flux in a surface energy balance calculation may be an inaccurate assumption under certain meteorological conditions. Here, we explore the utility of a bucket scheme for parameterizing moisture fluxes and phase changes in a glacier debris layer. The bucket scheme simulates infiltration of liquid water into pore spaces in the debris cover. The thermal properties of the debris cover, which partially determine the energy flux to the underlying ice, are then computed as a function of the water content and phase. We employ the bucket parameterization in a high-resolution, physically-based, and integrated atmosphere-glacier mass balance model to quantify the importance of moisture on the surface energy and mass balance of debris-covered glaciers through an application over the Karakoram region of the northwestern Himalaya.