Submitted Abstract

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Abstract

Snow dynamics play a crucial role in the hydrology of alpine catchments in the Himalaya. However, studies based on in-situ observations that elucidate the energy and mass balance of he snowpack at high altitude in this region are scarce. In this study, we use meteorological and snow observations at two high-altitude sites in the Nepalese Himalaya to quantify the mass and energy balance of the seasonal snowpack. Using a data driven experimental set-up we aim to understand the main meteorological drivers of snowmelt, illustrate the importance of accounting for the cold content dynamics of the snowpack, and gain insight into the role that snow meltwater refreezing plays in the energy and mass balance of the snowpack. Our results show an intricate relation between the sensitivity of melt and refreezing on the albedo, the importance of meltwater refreezing, and the amount of positive net energy used to overcome the cold content of the snowpack. The net energy available at both sites is primarily driven by the net shortwave radiation, and is therefore extremely sensitive to snow albedo measurements. We conclude that, based on observed snowpack temperatures, 21% of the net positive energy is used to overcome the cold content build up during the night. We also show that at least 32–34% of the snow meltwater refreezes again for both sites. Even when the cold content and refreezing are accounted for, excess energy is available beyond what is needed to melt the snowpack. We hypothesize that this excess energy may be explained by uncertainties in the measurement of shortwave radiation, an underestimation of refreezing due to a basal ice layer, a cold content increase due to fresh snowfall and the ground heat flux. Our study shows that in order to accurately simulate the mass balance of seasonal snowpacks in Himalayan catchments, simple temperature index models do not suffice and refreezing and the cold content needs to be accounted for.