Geophysical Research Abstracts
Vol. 18, EGU2016-11202, 2016
EGU General Assembly 2016

The physical basis of enhanced temperature index ice melt parameterizations in the Nepal Himalaya.

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Glacier melt is an important component of seasonal water flows in the Himalayas. Due to scarce data availability and computational convenience, most glaciological projections in the Himalayan region derive ice melt from temperature index (TI) or enhanced temperature index (ETI) parameterizations, which require only temperature and solar radiation as inputs. Still, the processes linking these variables to melt remain poorly documented under high-altitude climates, where the air is cold, and the main input is shortwave radiation. In this study, we question the physical basis of enhanced temperature index (ETI) melt parameterizations in the Nepal Himalayas. Using atmospheric weather station (AWS) installed on Yala glacier at 5090 m a.s.l and Mera glaciers at 6350 m a.s.l., we study the surface energy balance (SEB) during one melt season, i.e, the monsoon and surrounding weeks, in 2014. The SEB estimates provide insights into the atmospheric controls on the glaciers. We study the variability of correlation coefficients linking daily means of temperature, SEB and SEB components.

On Yala at 5090 m a.s.l, energy inputs are high during the pre-monsoon due to low surface albedo and strong incoming solar radiation near the solstice, and melt is strong. The temperature correlates moderately with the SEB (R = 0.58) mainly through sublimation and net longwave radiation. During the monsoon snow deposition reduces the magnitude of net shortwave radiation, thus dampening the melt rates. Strong longwave emission from clouds compensates for the surface emission, and the correlation of temperature with the SEB, mainly explained through net shortwave radiation, decreases (R = 0.49). During the post-monsoon, high albedo, heat losses through sublimation and clear-skies favoring longwave losses at the surface lead to a near zero SEB, and reduced melt. Temperature correlates well with the SEB (R = 0.88) through net longwave radiation.

On Mera at 6300 m a.s.l, high surface albedo and sublimation rates limit snow and ice melt. During the pre-monsoon, the temperature does not correlate with the SEB (R = 0.24). During the monsoon, the correlation is higher (R = 0.65), mainly due to the temperature control on turbulent fluxes.

Our results suggest that net longwave radiation, which is controlled by cloudiness, and sublimation are the main mechanisms controlling the relation between SEB and temperature. We discuss the validity of the TI and ETI models in this context.