Submitted Abstract

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Abstract

Glaciers in Central Asia provide essential water resources for an increasing socio-economic water demand. However, glacier ablation is spatio-temporally highly heterogeneous, revealing hot-spots of the complex glacier response to climate change. A darkening of glacier surfaces caused by varying sources ranging from light absorbing mineral particles and black carbon to organic matter such as algal bloom, impacts the surface energy balance of glaciers. The albedo of the bare-ice surface is particularly crucial in regard to the ablation magnitude.

In this study, we present across scale results of the dependence of glacier mass balance on surface albedo for a large number of glaciers in the Tien Shan and Pamir Mountains. We used over 3000 surface reflectance scenes from the Landsat suite over the last two decades to produce distributed albedo maps. Daily, seasonal, and annual mass balance time series are modelled using a temperature-index and distributed accumulation model for each glacier and year individually.

A comprehensive analysis of albedo variability and trends is performed at varying scales, ranging from pixel to catchment. Glacier specific long-term trends as well as sub-seasonal variability are investigated to enhance our understanding of processes controlling melt dynamics. A relationship between the distributed albedo information and the detected trends with the mass balance rates and variabilities is established. We highlight the sensitivity of glacier mass balance on surface albedo and stress the importance of the enhanced albedo feedback that will be amplified due to atmospheric warming and suspected darkening of glacier surfaces in the near future. This feedback will accelerate glacier melt and thus put the availability of melt water to river run off at sustainable risk.