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Distinguishing snow and ice melt contributions using daily MODIS and a temperature index melt model in the Hunza River basin

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In mountainous regions of High Asia, snow and ice both contribute to streamflow, but few in-situ observations exist that can help distinguish between the two components of melt. Our goal is to develop a melt model that can distinguish between seasonal snow and glacier ice melt at a continental scale. We use a combination of MODIS-derived data sets to distinguish three surface types at daily resolution: 1) exposed glacier ice, 2) snow over ice and 3) snow over land. We use MODICE to map glacier area and then distinguish areas of exposed ice from snow over ice using thresholds on MODIS-derived albedo or grain size products. We map snow over land using the daily MODSCAG fractional snow cover product, and use the time series of three surface types as input to a temperature index melt model. The model outputs melt volumes from exposed glacier ice, snow over ice and snow over land, respectively.

To partition the glacier surface into exposed glacier ice versus snow over ice, we threshold MODIS albedo or grain size based on higher-resolution Landsat 8 imagery. During the ablation period, the high elevation mid-latitude snowpack receives intense incoming solar radiation resulting in surface albedo decreases and snow grain growth. We compare differences in modeled melt using two albedo products (Terra Daily Snow Cover algorithm (MOD10A1) and Surface Reflectance BRDF/Albedo (MCD43)) and two grain size products (MODIS Snow Covered Area and Grain Size Model (MODSCAG) and MODIS Dust Radiative Forcing in Snow (MODDRFS)). For the Hunza basin, a sub-basin of the Upper Indus basin, for the years 2001-2004, the modeled melt from exposed glacier ice accounts for: 26-44% (MOD10A1 albedo), 24-32% (MCD43 albedo), 17-28% (MODSCAG grain size) or 23-26% (MODDRFS grain size) of the combined melt from all three surface areas.