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How to implement data for improved modelling - Results from an extensive field campaign on the debris covered Lirung Glacier in the Nepalese Himalayas

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Debris covered glaciers have become a focus of current research because of growing evidence of an increase in debris cover associated with a warming climate and the effect that debris has on melt rates. Mass balance models increasingly aim at including the melt rate enhancing/reduction effect due to a thin/thick debris layer, respectively. However, knowledge about debris cover and thickness, its distribution and characteristics is limited and data are scarce, especially in the HKKH region where debris-covered glaciers are numerous. In this work we present a data set that is complementary to modelling efforts carried out to improve our understanding of processes occurring at the debris cover surface and how debris effects can be implemented into melt and mass balance models of different complexity. A key requirement for distributed melt modelling is the availability of debris cover and thickness maps and knowledge about characteristics of the debris layer and their spatial variability.

An extensive field campaign was conducted from May to October 2012 on the debris covered Lirung Glacier in the Nepalese Himalayas. The collected data set consists of observations from an automatic weather station (AWS) measuring wind direction, wind speed, air and surface temperature, incoming and outgoing shortwave radiation, relative humidity and snow height, 14 sensors measuring 2 m air temperature and 7 surface temperature sensors, 3 temperature systems (tinytags) measuring temperature at the debris surface and the ice below the debris layer and one thermistors chain (with 8 temperature sensors) measuring the temperature profile in the debris layer.

In the study region there is a key difference between meteorological conditions during monsoon and the dry period. We analyze separately all meteorological records for these different climatic conditions and show how temperature, albedo, relative humidity and wind speed and direction are affected. Wind speed and direction show similar diurnal behaviour but wind speed maxima are lower during monsoon. The relationship of air and surface temperature is constant across the glacier but different for monsoon and the dry period. Further, even though incoming and outgoing shortwave radiation obviously change during monsoon, albedo is only slightly affected. We compare the main spatio-temporal variability to that of variables recorded off-glacier. We show for example that the presence of the glacier dampens the monsoon impact on temperature lapse rates. We also investigate the conductivity of debris across the glacier to test its spatial consistency and use the temperature profile in the debris layer to test the commonly made assumption of linearity. We compare the calculated values with those provided in the literature both for the Himalaya and other mountainous regions. We finally discuss how these data can be used for possible applications and improvements of models.