EGU2020-20062
https://doi.org/10.5194/egusphere-egu2020-20062
EGU General Assembly 2020

Glaciological controls on the spatial variability of supraglacial debris extent and thickness in the eastern Himalayas

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Debris cover is particularly prevalent in High Mountain Asia, with SW Asia alone containing 3,264 km2 of debris-covered ice (Scherler et al., 2018), which is increasing over time (Thakuri et al., 2014). The presence of supraglacial debris alters the energy balance by either enhancing or inhibiting ablation, depending on its thickness (Östrem, 1959). Therefore, debris cover is fundamental to the response of Himalayan glaciers to climate change. However, there remains a need to understand the glaciological characteristics that control the spatial pattern of debris cover and thus how it may evolve in the future.

Previous research has explored some controls of the spatial distribution of debris cover on a glacier scale (Gibson et al., 2017; Nicholson et al, 2018), but this research will take place on a regional scale. The chosen area is a ~9300 km2 region in the eastern Himalayas that encompasses both Ngozumpa and Lirung glaciers.

The GAMDAM glacier inventory (Sakai et al. 2019) will be used to delineate the glaciers. Within each glacier, the debris extent and thickness will be determined. Extent will be estimated through the supervised classification of optical imagery, using training data obtained from high-resolution Google Earth imagery. Thickness will be calculated through the derivation of a relationship between thermal satellite data (redistributed to a finer spatial resolution) and debris thickness measurements of Lirung glacier (McCarthy et al., 2017) and of Ngozumpa glacier (Nicholson et al., 2018).

An 8m DEM (from NSIDC) will be used to calculate slope, aspect and curvature over each glacier and repeat-pass SAR acquisitions will be used to calculate the velocity field for each glacier. The statistical relationship between debris extent and thickness with each of the aforementioned glacier characteristics is the intended output. Sensitivity tests will subsequently be carried out to determine the relative influence of each glaciological characteristic.