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An analysis of satellite-derived debris-covered glacier surface temperatures for determining debris thickness on a Himalayan glacier

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The thickness of supra-glacial debris cover exerts a powerful control on the degree to which the ablation of underlying ice is altered compared to clean ice ablation. However, direct measurements of debris thickness are scarce as they are very labour intensive. As an alternative, satellite-derived surface temperatures over debris-covered glacier surfaces have been used to estimate the thickness of supra-glacial debris cover because, all other things being equal, the surface temperature of exposed supra-glacial debris increases with debris thickness.

However, the surface of a debris-covered glacier is a complex assemblage of uneven debris-covered ice, ponds and exposed ice cliffs. Here we first describe the surface topography and terrain features of the Ngozumpa glacier, Khumbu Himal, Nepal, using field surveys carried out 1, 3 and 7km from the glacier terminus and terrain analysis from a 2m resolution GeoEye digital terrain model (DTM) of the debris-covered portion of the glacier. We then provide an assessment of the impact of surface ponds and ice cliffs on the ASTER surface temperature using both textural analysis and a 2m resolution GeoEye digital terrain model to identify the incidence of these surface features within each ASTER surface temperature pixel. The findings are discussed in the context of the impact of surface inhomogeneity on estimates of typical supra-glacial debris thickness determined from ASTER-derived debris surface temperature.