A new dataset of supraglacial debris thickness for High-Mountain Asia

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Introduction

Supraglacial debris thickness is an important control on the surface melt rates of debris-covered glaciers, which are common features of the cryosphere in High-Mountain Asia. Here we present a new dataset of altitudinally distributed supraglacial debris thickness for 4689 glaciers in the region, generated using remote sensing and numerical modelling techniques.

Methods

To generate our dataset, we took a simplified inverse approach, using a melt model for debris-covered glaciers in combination with remote sensing 'observations' of specific mass balance, from Miles et al (2021). We used the melt model to generate a series of Østrem curves for each glacier, then interpolated debris thickness from these curves using the mass balance observations (Fig 1). We did this in a Monte Carlo simulation setup, in order to account for uncertainties in the parameters in the melt model, and the meteorological data we used to force it. We validated our dataset using in-situ observations of debris thickness from around High-Mountain Asia.

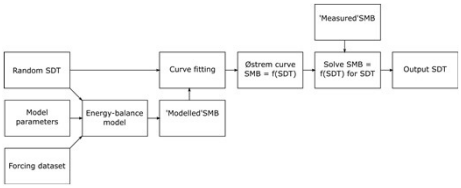

Fig 1. Flow chart of inverse approach.

Conclusions

We hope our new dataset will enable improved representation of the complex response of High-Mountain Asia's glaciers to climatic warming in future modelling efforts. It is available for download at: 10.5281/zenodo.7070657. A supporting article is preliminarily accepted at Communications Earth & Environment.

References

Miles, E., McCarthy, M., Dehecq, A., Kneib, M., Fugger, S., & Pellicciotti, F. (2021). Health and sustainability of glaciers in High Mountain Asia. Nature Communications, 12(1), 1-10.

Results

Our modelled debris thickness data are consistent with in-situ data by less than 0.1 m 79% of the time at 14 glaciers, and show similar altitudinal patterns (Fig 2). However, the performance of our approach is limited by the quality of its input data, and results are not always satisfactory (e.g. Hailuogou Glacier).

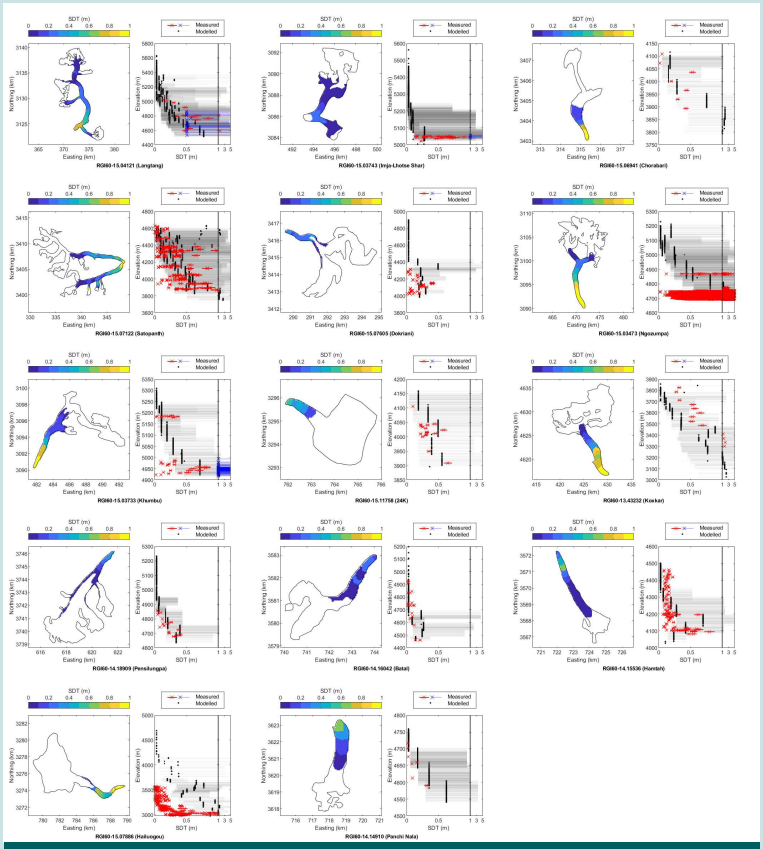

Fig 2. Supraglacial debris thickness at validation sites.

We found that debris is thicker on glaciers in a more advanced stage of their debris-cover evolution, and on glaciers with larger debris-covered areas (Fig 3). Mean debris thickness on the study glaciers is relatively low, at only 0.20 m, and more than 50% of debris is thinner than 0.10 m.

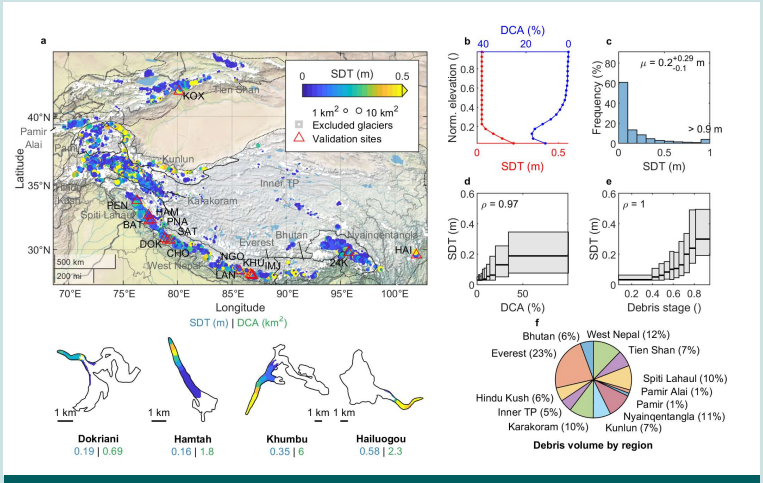

Fig 3. Supraglacial debris thickness in High-Mountain Asia.