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Using hypsometric Parameterisation in Melt Modelling to minimise the Impact of DEM Uncertainty

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Many ice sheet models (ISM) run at low resolutions of the order of 5-20km for a number of reasons. A number of factors limit resolution, such as model physics, the fact that ISMs are often running at continental and global scales, the limited resolution of climate data available to drive these models and historically, because of the low resolutions of the available digital elevation models (DEM). However, ISMs have been shown to be susceptible to uncertainties in the input data, due to the limited amount of topographic detail at resolutions of 5km and above. Previous work has documented that uncertainties in DEM can significantly affect ISM results due to crisp altitude dependant thresholds of mass balance calculation and resulting impacts on inception. Typically, uncertainties in DEM are perceived to originate from measurement uncertainties, but resampling DEMs to resolutions suitable for ISMs introduces an even larger amount of ambiguity through the oversimplification of terrain, depending on the target and source resolution, the resampling method and terrain attributes.

Experiments using a temperature index melt model with an optional enhanced solar radiation component on the European Alps have shown the distribution and absolute amount of potential melt per area to depend on the resolution ranging from 1 to 10km, with significantly higher melt rates at 1km DEM resolution compared to 10km. By introducing DEM uncertainty using a model that simulates uncertainties typically inherent in GLOBE data, as well as the effect of resampling, the amount and distribution of melt is found to distinctly vary.

This problem has previously been recognized and addressed, e.g. by using a hypsometric subgrid approach, where subgrids within each DEM cell are internally coupled within the ISM. However, in this work, a simpler and more computationally efficient approach using hypsometric parameterisation is tested for its potential to minimise the impact of uncertainties in DEM on melt modelling.