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Importance of basal processes in simulations of a surging Svalbard outlet glacier

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The outlet glacier of Basin 3 (B3) of Austfonna icecap, Svalbard, has increased in velocity dramatically since 1995. B3 is known to exhibit a seasonal summer speed up associated with the melt season, and has accelerated approximately five fold in terms of pre-melt velocity. We use the Elmer/Ice full Stokes model for ice dynamics to infer spatial distributions of basal drag for pre-melt time periods in 1995, 2008 and 2011. This "inverse" method is based on minimising discrepancy between modelled and observed surface velocities, using satellite based velocity fields. We generate steady state temperature distributions for the three time periods. Frictional heating caused by basal sliding contributes significantly to basal temperatures of the B3 outlet glacier, which exhibits a uniform steady state basal temperature at pressure melting point in all three cases.

We present a sensitivity experiment consisting of transient simulations under present day forcing to demonstrate that using a temporally fixed basal drag field obtained through inversion can lead to thickness change errors of the order of 2m per year. Hence it is essential to incorporate in a model for future projection the evolution of basal processes governing outlet glacier speed. Informed by a combination of our inverse method results and previous studies, we hypothesize a system of processes and feedbacks involving till deformation and basal hydrology to explain both the summer speed up and the ongoing pre-melt speed up, and speculate on the wider relevance of deformable till mechanics to non-surging glaciers.