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Inverse modelling of Jakobshavn Isbrae from a sequence of Sentinel-1 velocity observations, using a thermomechanically coupled ice flow model

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Since the late 1990s Jakobshavn Isbrae, a major outlet glacier of the Greenland Ice Sheet, has dramatically accelerated, thinned and retreated. The causes of this retreat and acceleration have been the focus of much scientific activity. Previous studies have shown that the loss of buttressing due to retreat of the calving front is the main driver of upstream acceleration and thinning, however the controls on the timing and magnitude of the retreat remain unclear.

Using the BISICLES ice sheet model, we apply inverse modelling techniques to a sequence of ice velocity observations to derive associated spatial patterns of basal traction and ice rheology. The observations, comprised of Sentinel-1 image pairs at weekly or bimonthly intervals, provide a record of velocity since November 2014 with high temporal resolution. As a required input for the inverse modelling study, we spin up a background temperature field for the Jakobshavn drainage basin by fixing the geometry and ice velocity at their present-day values and applying surface temperature and basal heat flux boundary conditions. The resulting temperature field is validated against observations and an analytical model.

Results from these experiments will allow us to discriminate between the relative influence of potential controls of the currently observed behaviour, including calving front location, shear margin weakening and reduced basal drag. Furthermore, these experiments will be a stepping stone toward future prognostic modelling experiments with a freely moving calving front.