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Sensitivity testing of a model for the surface mass-balance of the Greenland icesheet

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A model for the surface mass and energy balance of the Greenland icesheet, including an englacial component modelling water percolation and refreezing in the fearn (henceforth SEMB), is intended to be coupled to a regional atmospheric model and forced at the boundaries with the ERA40 data set, producing a climatology of over 40 years of Greenland icesheet runoff. Here we examine sensitivies to parameterisations and forcing of the SEMB.

An automated approach to sensitivity testing is used. Firstly, physically meaningful value ranges for the 'tunable' parameters in the model are identified. A combination of linear and latin hypercube sampling of these parameters is used, enabling non-linear effects of parameter value combinations to be identified in this ensemble of tens of thousands of 1D SEMB runs. Key diagnostics and their acceptable ranges are pre-defined for given forcings, facilitating automated detection of parameter combinations to which the model is highly sensitive.

This work will identify aspects of model physics that could benefit from further development. For example, subsurface lateral runoff of meltwater is assumed not to interact with englacial physics as it runs off to the oceans. This assumption will be tested in the current ensemble of 1d model runs through the addition of an input of water at various depths to simulate runoff from upstream subsurface melt. This is one of over forty parameters relating to physics, numerical schemes, model initialisation, and forcing that is included in the study.

Sensitivity to variations in forcing fields used to drive the SEMB consistent with uncertainties in either observations or GCM model predictions are examined. This will

help in establishing envelopes of uncertainty for the planned SEMB meltwater climatology. The outcomes of these sensitivity studies will also feed into an ongoing comparison between this physical model for icesheet surface mass-balance and the simpler positive degree day method for approximating surface mass balance.