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Greenland Ice Sheet sensitivity to surface mass balance forcing using high resolution full-Stokes simulations

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The Greenland Ice Sheet (GrIS) has been increasingly loosing mass during the last two decades, enhancing its contribution to sea level rise. The total mass balance of an ice sheet is equal to the surface mass balance minus the discharge (ice flux to the ocean). Both terms are contributing increasingly to the observed GrIS imbalance .

Here, we use use the new generation continental scale ice-sheet model Elmer/Ice with
(1) an unstructured mesh allowing to model outlet glaciers with a sufficient resolution;
(2) a complete resolution of the full system of equations governing the ice flow and
(3) inverse methods to better constrain poorly known parameters from observations.
As a first result, we show that our model can reproduce the currently observed ice dynamics and the currently observed ice discharge.

We then study the sensitivity of the GrIS to surface mass balance. The model is forced by
three different Regional Climate Models (RCMs) both for the ERA-Interim period and for prognostic runs 200 years into the future under emission scenarios A1B and E1, following the experimental setups designed for the ice2sea simulations. These imposed surface mass balance forcings significantly differ in terms of total values and trends, and we show that it directly affects the predicted total ice volume. In the absence of perturbation of the basal and seaward boundary conditions, the difference in the predicted ice discharge remains small.
We finally investigate the dynamical response of the ice sheet to changes in basal lubrication by linking the basal sliding to surface run-off anomalies, according to the ice2sea experiments.