**Introduction**

The Greenland and Antarctic ice sheets will likely make a dominant contribution to 21st-century sea-level rise (SLR) and their mass losses could also affect other parts of the climate system, such as the Atlantic Meridional Overturning Circulation and its poleward heat transport. Despite recent improvements in ice sheet modeling, much work is needed to make these models reliable and efficient, to couple them to earth system models, to calibrate the models against observations, and to quantify their uncertainties.

**Parallel efficiency**

**FO solver: Weak scalability results on Greenland ice-sheet**

**FO solver: Strong scalability results for Greenland ice-sheet using a non-uniform unstructured grid.**

**Robust, nonlinear solvers**

Stokes solver, Newton vs Picard convergence for ISMIP-HOM tests. Regularized viscosity: $\frac{1}{\alpha} + \frac{a^{-1} u u^T}{2} + \frac{1}{\alpha} |\nabla u|^2$.

**Ice sheet Initialization**

Scalable and robust initialization procedure are needed for ice sheet models to be used for sea level rise projections in full Earth System Model runs (FO solver).

Invert for unknown parameters by minimizing mismatch observed data and climate forcing.

$J(\beta, H) = \int_0^T \frac{1}{2} |u - u^*|^2 ds$ surface velocity mismatch

$+ \int_0^T \frac{1}{2} |H_0 - H|^2 ds$ SMB mismatch

$+ \int_0^T H_0 - H^\text{obs} ds$ thickness mismatch

$+ R(\beta, H)$ Regularization terms

SMB recovered using the proposed approach is much closer to the target one. A SMB mismatch can lead to unphysical transients lasting decades to centuries.

**Accurate, stable, mass-conserving, implicit discretizations**

FELIX FO: convergence study on 3D Greenland simulation.

**Coupling with CISM / MPAS**

Needed to enable dynamic simulations and to facilitate coupling with Earth System Models.

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**Publications**


