The heroic age of ice sheet modeling: Glimmer, CISM and all that

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Ice sheet models are evolving quickly, as a result of increased interest (and funding) from government agencies, as well as growing collaborations in the glaciology, applied math, and climate modeling communities. Several state-of-the-art ice sheet models are now openly available, including the Parallel Ice Sheet Model (PISM), SICOPOLIS, and Glimmer, the Community Ice Sheet Model (Glimmer-CISM). We are part of a U.S./U.K. group that is developing Glimmer-CISM (http://developer.berlios.de/projects/glimmer-cism/). A developmental version of this model now includes two "first-order" dynamical cores (e.g., Pattyn 2003): one developed by Tony Payne and Steve Price (in prep.), and the other by Tim Bocek, Jesse Johnson, and Frank Pattyn (in prep.). Many collaborators are working on improved parameterizations of key physical processes such as surface melting, basal water transport, iceberg calving, sub-shelf melting, and grounding-line migration. These improvements will be implemented and tested in Glimmer-CISM during the next one to two years. Glimmer-CISM will be used for IPCC simulations with at least two global climate models: the Community Climate System Model and the Hadley Centre model.

We will show some recent Glimmer-CISM results obtained with the new first-order schemes. Given the complexity of the field equations and boundary conditions, much work has focused on model diagnostics, including the ISMIP-HOM intercomparison tests (Pattyn et al. 2008) and the EISMINT-Ross experiment (MacAyeal et al. 1996). Results from these tests give us confidence that the initial large-scale runs for the Greenland ice sheet are valid with respect to the modeled ice dynamics.

The current Glimmer-CISM code is serial. A parallel version, which is needed to run the first-order schemes at higher resolution, is under development. A new DOE program, "Computational science research for ice sheet modeling," is supporting several projects whose aim is to develop efficient, scalable ice-sheet models (both first-order and full-Stokes) on adaptive grids using modern solver techniques (e.g., Newton-Krylov). If these projects are successful, ice sheet models will soon be among the most sophisticated climate model components. Scientific simulations that are impossible today will become routine. As in other heroic ages—such as the heroic age of Antarctic exploration a century ago—there will be setbacks as well as successes, but the journey is sure to be interesting.

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