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A Full Ice Stream Model for Jakobshavn Isbræ

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With the aim to reproduce, understand and predict the evolution of Jakobshavn Isbræ and other polar ice streams, we are currently implementing a full ice stream model. Our FISMO code base solves the full mass, momentum and energy balance equations in three dimensions with the Finite Element method. We build on Libmesh, a high performance Finite Element library written in C++. Libmesh implements adaptive mesh refinement with hanging nodes, and uses automatic mesh partitioning (Parmetis) and fully parallelized solvers (PETSC). We can achieve reasonably accurate solutions with the eight computing nodes of a small cluster computer.

We have reached the first milestone in the development of the FISMO code base. FISMO solves the full 3D-Stokes equations with Glen's flow law. Coupled to it is a heat diffusion and advection system. Boundary conditions can be prescribed on velocity (Dirichlet) or stress (Robin) boundaries. Basal motion is taken into account with a soft viscous layer. The surface geometry can freely evolve and is iteratively adapted to be consistent with the flow field and the prescribed mass balance. Model meshes are generated with a newly developed mesh generator for hexagonal meshes of parametrized ice stream geometries.

The first milestone in the development of the FISMO code base is geared to stationary states. The next milestone will allow to calculate the time evolution of the model geometry and the system equations. Further steps include the implementation of more processes, such as a calving condition, the appropriate treatment of the phase transition, the coupling of a subglacial hydraulic model, and basal motion as function of the modeled subglacial water pressure. We also intend to couple FISMO to an ice sheet model.

FISMO will be released under an open source license.