Uncertainty Quantification for Large-Scale Ice Sheet Modeling and Simulation

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The ultimate goals of this project are to (1) create a new-generation ice sheet dynamics code that incorporates state-of-the-art mathematical/computational techniques (including adaptive mesh refinement/coarsening, high order accurate discretization, scalable linear and nonlinear Stokes solvers, error estimation, adjoint-based sensitivity analysis, fast parameter estimation, and scalability to petascale computers); and (2) develop scalable uncertainty quantification techniques for inferring uncertain parameters in ice sheet dynamics models from noisy observations.

The expected impacts of this project on ice sheet modeling are: (1) to enable faster and more accurate simulations of ice sheet dynamics via the advanced scientific computing methods described above; and (2) to equip ice sheet models with advanced uncertainty quantification capabilities, which is important for building credibility in climate system projections. The expected impacts of this project on applied math and computer science research are to provide a very challenging scientific problem that will stress and advance research on scientific computing methods that are applicable to a wider class of problems beyond ice sheets. These include (1) scalable parallel forward and inverse solvers and AMR methods for highly heterogeneous, multiscale nonlinear elliptic systems; and (2) uncertainty quantification methods for high-dimensional inverse problems governed by expensive forward models.