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Adaptive mesh refinement for large ice sheets using the CHOMBO toolkit

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Models of the West Antarctic ice sheet face a challenge of length scales: while the ice sheet extends across millions of square kilometres, its evolution is affected by structures, such as the grounding line and ice streams, which change over much finer length scales. It would be impractical, or at least inefficient, to treat the whole of the ice sheet on the finest scale, so we are motivated to investigate adaptive methods where each part of the ice sheet is treated at the resolution it merits.

This is done in at least three stages . Starting from a solution found on a uniform, coarse mesh, we need to decide where the resolution is insufficient, either by estimating the truncation error, or using criteria specific to ice sheet models, such as distance from the grounding line. Second ,we must generate a new, non-uniform mesh and find an (improved) solution upon it. Finally, we reevaluate the refinement criteria, and if they are not yet satisfied, refine the mesh and solution until they are.

The CHOMBO C++ toolkit provides a set of tools which can be applied to these tasks: a method to generate meshes with varying resolution and methods for solving both elliptic equations (such as those governing higher-order stress models), and time dependent equations (such as the thickness evolution equation) on those meshes. We will present initial results from a CHOMBO-based two-dimensional isothermal ice sheet model with first order stresses, looking specifically at the problem of grounding line migration.