1000 year adaptive mesh simulations of Antarctic ice dynamics

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Numerical modelling of Antarctic ice dynamics becomes more demanding as the simulation time increases, partly because drainage basins evolve and even merge over long timescales, and to a great extent because fine scale features - such as the grounding line - can migrate over continental length scales. Century long calculations - for example, the simulations of Pine Island Glacier described by Joughin (2010) Favier (2014) and Seroussi (2014) - need only consider single ice streams, and can take advantage of the relatively little grounding line migration likely to occur to limit fine resolution to a region close to the present day grounding line. As integration times grow the grounding line tends to sweep out a larger area - meaning that the region of fine resolution must either cover that growing area or evolve with it. At the same time, neighbouring ice streams may merge, so that they can no longer be treated separately. Ultimately, it becomes necessary to carry out simulations of the whole of Antarctica, potentially applying fine resolution everywhere.

We present 1000 year simulations of the whole Antarctic response to simplified ocean forcing using the BISICLES ice sheet model. Some of the simulations feature the complete collapse of the West Antarctic Ice Sheet, and we are able to use time-evolving adaptive mesh refinement to track the grounding line and reduce the computational complexity by orders of magnitude. We compare the size of pure numerical errors, caused by spatial and temporal under-resolution, with the differences due to approximations made in the model physics, and estimate an upper bound on the speed of West Antarctic collapse.