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Comparison of Full Stokes and Shallow Shelf solutions regarding grounding line dynamics on a variety of synthetic geometry.

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The Antarctic ice sheet is currently loosing mass and significantly contributes to the current sea-level rise. Pine Island and Thwaites Glaciers are suspected to be embarked in a self-entertained retreat and current imbalance of West Antarctic ice sheet is presumed to be maintained at a rate poorly constrained by current projections. Therefore, it is of importance to better assess the change in the dynamics of Antarctic outlet glaciers in response to the ongoing climate warming.

Numerical modelling of ice flow remains the only available tool to establish physically reliable projections. The most physically complete way to model ice stream flow is to resolve the full Stokes (FS) problem, but its current numerical cost reasonably prohibits any modelling at the whole Antarctic scale for a couple of centuries. The Shallow Stream/Shelf Approximation (SSA), and its improved version where vertical shearing modifies effective viscosity (SSA*) are the best alternatives. During the previous large inter-comparison exercise MISMIP3d, a model solving the SSA* equations has shown to be remarkably consistent with a reference FS solution on that particular setup. Here, we aim to extend the comparison to a larger range of geometries and basal friction conditions.

We use the Elmer/Ice model, originally a FS ice flow model in which the SSA and SSA* have been implemented. For the two latest equations Elmer/Ice has been further improved by implementing a sub-element parametrisation of the friction and a mesh refinement algorithm (h-refinement) in the grounding line vicinity. We can thus, within a single framework, resolve the three equations (FS, SSA and SSA*) and compare, all other things being equal, their solutions. This is investigated on a variety of synthetic glaciers geometries with various ice shelf buttressing and basal shear conditions representative of actual Antarctic outlet glaciers.