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Grounding line migration captured by flowline ice sheet models

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Marine ice sheet stability is mostly controlled by the dynamics of the grounding line, i.e. the junction between the grounded ice sheet and the floating ice shelf. This junction marks the change from inland ice sheet flow, dominated by vertical shear and basal friction, toward ice shelf flow, dominated by longitudinal stress. Grounding line migration was already investigated in the framework of MISMIP (Marine Ice Sheet Model Intercomparison Project). However, a major deficiency of the MISMIP experiments was the limited data output every 50 years, which is insufficient for a proper transient analysis. Furthermore, in order to render the perturbations more realistic, we performed experiments starting from a slightly different geometry from the MISMIP setup and perturbed the ice sheet by changes in sea level. Different sea level change rates and step numbers were used to test the reactivity of the ice sheet system.

The aim of the experiments is to compare the grounding line transient behaviour between different flowline ice sheet models, i.e. the Full Stokes finite-element model Elmer/Ice, a high polynomial-order moving grid model, and two versions of a finite-difference model using the shallow-shelf approximation, i.e. one with a regular grid and the so-called Schoof (2007) boundary condition, and one with a grid refinement at the grounding line. The overall response of the different ice sheet models to the sea level perturbations is found similar in terms of grounding line position, ice thickness and ice flux. Differences between models occur when looking at the grounding line migration rate and thickness change rate, which can be partly explained by the numerical approach used. A discussion is given on the robustness of numerical schemes to capture grounding line migration within short time scales (∼200 years).