Uncertainties in ice-sheet simulation due to a variation in the numerical schemes of the ice transport equations

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Generally the evolution of ice-sheet thickness in an ice-sheet model is formulated using the divergence term of horizontal ice flux and the mass balance terms at the upper and lower surfaces, derived from the continuity equation with the assumption of incompressible fluid (i.e., a non-linear transport equation). There are many variation of the formulation, which differs in numerical aspects such as stability, accuracy, numerical diffusivity, conservation, complexity, computational costs and so on.

Since ice-sheet thickness near grounding line is relatively steep, simulated evolution of thickness over this region is expected to be much influenced by numerical diffusion and/or oscillation caused by characteristics of numerical schemes to represent the transport equation. Often the evolution near the grounding line is a dominant aspect for large-scale ice-sheet evolution, the uncertainties due to the numerical characteristics should be evaluated.

In this study implementation of a variation of Constrained Interpolation Profile (CIP) in a numerical ice-sheet model IcIES is reported. Simulation under configuration of past ice-sheet model intercomparision experiments (e.g., EISMINT, ISMIP) is reported, comparing to those using typical schemes such as an upwind scheme and/or diffusion-type scheme.

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