Uncertainties in ice-sheet/ice-shelf simulation due to a variation of numerical formulation of the ice transport equation

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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. There are many variation of the formulation, which differs in numerical aspects such as stability, accuracy, numerical diffusivity and/or conservation. Several studies have argue that uncertainties in the ice-sheet simulation due to the variation of such numerical formulation (e.g., Hindmarsh & Payne, 1996). However, systematic experiments, in particular, those including ice-shelf processes are not performed.

In this study, the past ice-sheet model intercomparision experiments, such as EISMINT Benchmark experiment (Huybrechts et al., 1996), MISMIP Pattyn et al. (2012), are reperformed using a numerical ice-sheet model $\boldsymbol{I_{C}IES}$, with three or more schemes to formulate the transport equation in order to present effect of uncertainties in these formulation on the steady-state and transient simulations.

Currently, other numerical schemes that have relatively less diffusivity (e.g., Constrained Interpolation Profile scheme, CIP; Interpolated Differential Operator scheme, IDO) are being examined to introduce in to $\boldsymbol{I_{C}IES}$. This study show preliminary results as a reference to study the effect of these sophisticated numerical schemes.

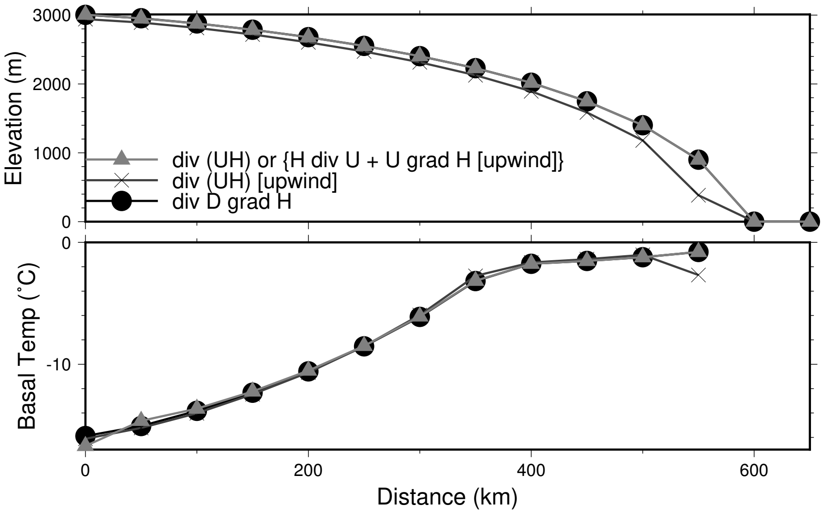

Figure: Results of steady-state experiment under configuration of the 'moving-margin experiment' of (Huybrechts et al., 1996). Note that temperature field is computed while the rate factor is a uniform constant.

References

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