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Impact of arithmetic asymmetries on simulated thermodynamical ice-sheet evolution

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Numerical ice sheet model experiments sometimes exhibit asymmetries in the solutions despite the symmetric conditions imposed. Identifying the arithmetic asymmetry in the models as one of the reasons for symmetry breaking through loss of trailing digits, this paper presents a numerical procedure to preserve the symmetries by restructuring of the order of the floating-point evaluation of the equations in the numerical ice sheet model. Reexamination of the series of experiments in the HEINO topic of the ISMIP demonstrates that small perturbations triggered by arithmetic asymmetries significantly amplify to cause qualitative differences in the simulated ice-sheet evolutions. It is imperative to apply a symmetric scheme to maintain overall symmetries for the simulation of ice-sheet evolution, at least under such highly idealized configuration.

Keywords: Numerical model, Ice sheet, Asymmetry