# Comparison of thermodynamics solvers in the polythermal ice sheet model SICOPOLIS

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In order to model the thermal structure of polythermal ice sheets accurately, energy-conserving schemes and correct tracking of the cold-temperate transition surface (CTS) are necessary. We compare four different thermodynamics solvers in the ice sheet model SICOPOLIS. Two exist already, namely a two-layer polythermal scheme and a single-phase cold-ice scheme, while the other two are newly-implemented, one-layer enthalpy schemes, namely a conventional scheme and a melting-CTS scheme (Blatter and Greve, 2015). The comparison uses two scenarios of the EISMINT Phase 2 Simplified Geometry Experiments (Payne and others, 2000), one with no-slip conditions at the base and one with basal sliding. In terms of temperate ice layer thickness, CTS positioning and smoothness of temperature profiles across the CTS (a requirement for the assumed case of melting conditions), the polythermal two-layer scheme performs best, and thus its results are used as a reference against which the performance of the other schemes is tested. Both the cold-ice scheme and the conventional one-layer enthalpy scheme fail to produce a continuous temperature gradient across the CTS, and both overpredict temperate ice layer thicknesses to some extent (the cold-ice scheme more). In the one-layer melting CTS enthalpy scheme, a continuous temperature gradient is explicitly enforced, and results match those obtained with the polythermal two-layer scheme better (Fig. 1).

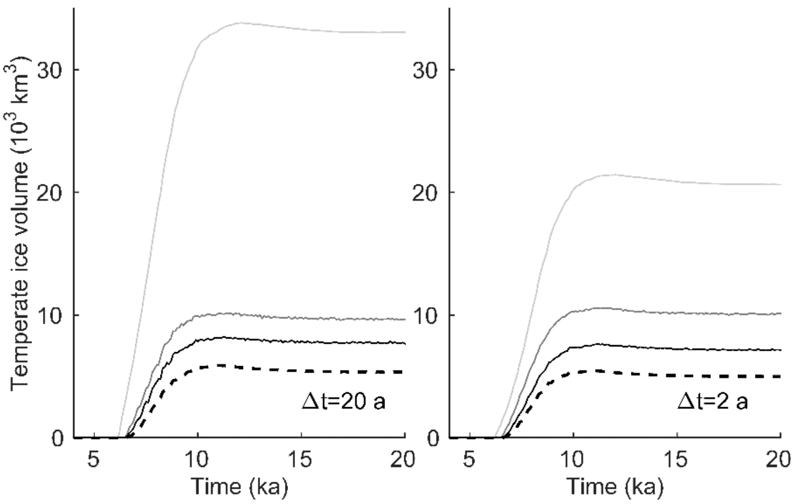


Figure 1. EISMINT experiment A1 (no-slip conditions at the base): Evolution of the temperate ice volume over the first 20 ka model time, starting from ice-free initial conditions.

Black dashed: polythermal two-layer scheme, light-gray solid: cold-ice scheme, medium-gray solid: conventional one-layer enthalpy scheme, black solid: one-layer melting CTS enthalpy scheme. Grid resolution 10 km, time steps 20 a (left panel) and 2 a (right panel).

**References**

Blatter, H. and R. Greve. 2015. Comparison and verification of enthalpy schemes for polythermal glaciers and ice sheets with a one-dimensional model. *Polar Sci.* 9 (2), 196-207.

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