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Finite volume modelling of an icefield with subglacial lake

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ABSTRACT

Momentum, mass and energy balance laws provide the tools for the study of the evolution of an icefield covering a subglacial lake. The ice is described as a non-Newtonian fluid with a power-law constitutive relationship with temperature- and stress-dependent viscosity (Glen's law) [1]. The phase transition mechanisms at the air/ice and ice/water interfaces yield moving boundary formulations, and lake hydrodynamics requires equation reduction for treating the turbulence.
Under boundary conditions of stationary glacier surface, we have built a finite volume code to solve the unsteady Stokes model of ice [2] and LES formulation of lake, aimed at the investigation on the conjecture of the existence of a subglacial lake under the Amundsenisen icefield in South Spitsbergen, Svalbard.
We shall present the icefield and lake flow and thermal fields along a vertical section following a well defined glacier flowline, previously determined by the authors [3]. As it is critical for the heat balance of the whole system, the thermal field of the uppermost layer of the icefield, consisting of *firn,* is defined from field-measured data [4]. Mesh sensitivity analysis supports the reliability of our numerical results, which also compare satisfactorily with the measured glacier surface (nodal) velocities and the typical maximum subglacial lake velocity estimates in the literature (e.g. Vostok Lake, Antarctica). Our numerical simulations do not contradict the conjecture of the existence of a subglacial lake.

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