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Application of a fully 3D numerical model for ice dynamics

A. Deponti, V. Pennati, L. De Biase, V. Maggi

Dipartimento di Scienze dell'Ambiente e del Territorio, University of Milano–Bicocca
(alberto.deponti@unimib.it / Phone: +39 02 6448 2759)

One of the main issues in ice dynamics modelling is the description of the pressure field which is related to the description of the stress field. In most glaciological models, part of the stress field is neglected and the pressure is considered purely hydrostatic. This assumption is not always true; for example, it does not hold for the flow over strong bedrock perturbations or in the in presence of sliding discontinuities. Since this is usually the situation when valley glaciers or ice–streams are to be studied, the full Stokes system should be considered.

In this work a fully three–dimensional model for ice dynamics is considered. The model is based on the full Stokes equations for the description of pressure and velocity fields, on the Saint Venant equation for the description of the free surface time evolution and on a constitutive law derived from Glen's law for the description of ice viscosity. The model computes the complete pressure field by considering both the hydrostatic and hydrodynamic pressure components and the full stress field; it is time evolutive and uses high–order numerical approximation for the space discretization of equations and boundary conditions.

Results of the application of the model to theoretical tests in which particular aspects of ice dynamics can be emphasised and thus deeply studied are presented in this work. Particular attention is paid to the study of the influence of physical parameters related to basal sliding and sliding along side walls and to the study of flow over big bedrock perturbations. These tests show the importance of the hydrodynamic pressure component and thus the importance of using a fully three–dimensional model capable to deal with the complete stress field in a glacier. This theoretical investigation is important and useful for real case applications. As an example, the application to Priestley

Glacier (West Antarctica) for a preliminary study of its velocity and pressure fields is presented.