Séminaire

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A comparison of ice flow relations for ice sheet modelling

Incorporating a physically accurate description of ice deformation processes into ice sheet models is a key component in reducing the uncertainty in predictions of ice sheet contributions to changes in global mean sea level. Recent developments in some ice sheet models, in particular the capability to determine the three dimensional distribution of stresses throughout an ice mass makes it possible to incorporate a description of anisotropic ice flow properties into large-scale dynamic simulations. Despite these model developments the selection of an appropriate numerical relationship between ice strain rates and the stresses driving the flow remains an issue in improving the accuracy of simulations.

In this study we use observations from Law Dome, East Antarctica - including crystallographic data from the Dome Summit South (DSS) ice core and borehole inclination measurements - to model the vertical distribution of deviatoric stress components at the DSS borehole site. We compare predictions of four flow relations that have been proposed in the literature. These range from grain-scale flow relations incorporating a description of ice microdynamic processes, including nearest-neighbour grain interactions, through to empirical parameterisations derived from laboratory ice deformation experiments. For grain-scale flow relations the effect of polycrystalline anisotropy on enhancing flow rates is based primarily on consideration of crystal orientations and the applied stress configuration. This leads to lower estimates of flow enhancement when compared to scalar flow relations in complex combined stress situations. Of the flow relations we consider, those where the effects of anisotropy are parameterised by a scalar function of the deviatoric stresses provide the most realistic and computationally efficient simulations.