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Towards a model of rheological weakening in lateral margins of ice streams and ice shelves: the case of Pine Island Glacier, West Antarctica.

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Lateral shear margins are prominent features of ice streams and ice shelves and the involved crevassing, rifting and heat dissipation as a consequence of the high shearing lead to a rheological weakening of the ice within these zones. Such rheological weakening is essential for realistically reproduce ice flow in numerical models and may provide an enhancing feedback in the observed dynamic acceleration of marine based ice streams such as Pine Island Glacier (PIG), West Antarctica.

For the case of PIG, we use satellite derived velocity fields and control methods to invert a 2d ice-stream/shelf model for ice rheology and basal stress. We find that such weak lateral shear zones occur along the whole extent of the ice shelf and extend upstream into the grounded ice stream.

We further develop a simple dynamic model for the evolution of ice rheology, based on principles of damage mechanics. The rheological weakening is linked to the evolution of a damage variable that is itself related to the stress field and that is integrated into the constitute equation of Glen's flow law. This ice-rheology weakening parameterization is implemented into the 2d ice-stream/shelf model and applied to the case of PIG. Starting from a uniform ice rheology and no damage we compute the evolution of rheology to its stable end state and compare it to the inverted ice-rheology field.