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Testing ice sheet models using the Raymond effect: constraining ice rheology and basal sliding

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One of the major difficulties in numerical modelling of ice sheets is the constraint of the model with subsurface data in order to verify some glaciological hypothesis or control some model parameters, for example those defining the ice rheology or the basal sliding. One data source is the use of radar layers. In particular, we will use the amplitude of the anticlines formed beneath the ice divide by the operation of the non-linear phenomenon known as Raymond effect.

The distribution of bump amplitude with elevation (BAE-curve) evolves with time to a steady configuration that depends on ice rheology, basal sliding, temperature, accumulation and the evolving geometry of the ice mass. If the bumps have not evolved to a steady configuration we are able to date the onset of the divide flow.

We present a partially time-dependent free-surface full-Stokes thermomechanical model solved by means of finite element and semi-Lagrangian techniques.

We apply this methodology to three locations in West Antarctica. Firstly, Roosevelt Island where Conway et al.(1999) estimated the onset of the divide flow with a similar method but using a parameterized model. Roosevelt divide bumps have not reached steady-state and there is no evidence of sliding. We next consider the divide in Marie Byrd Land between Siple Coast and the Amundsen Sea Sector. Here, BAE-curve is far from the steady configuration and we explore thermal hypotheses for the likely presence of sliding. Finally we consider the Hercules dome. Here the bumps are shown to be comparable in size to the steady configuration.