A coupled ice/water flow model for West Antarctica

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This poster firstly describes the incorporation of a model of subglacial water flow into the GLIMMER ice sheet model (http://forge.nesc.ac.uk/projects/glimmer/), for general application to the WAIS. Secondly, the poster briefly outlines a future application of the model; constraining the deglaciation of the Weddell Sea sector since the LGM.

In the GLIMMER ice flow model, basal sliding is predicted as a function of the basal shear stress (approximated using the gravitational driving stress) and a basal sliding parameter. Previously, a spatially fixed value for the basal sliding parameter was used, producing an ice sheet with a convex morphology, rather than the concave slopes observed in WAIS ice streams. The basal sliding parameter required to reproduce present day WAIS ice stream velocities (with a corresponding concave morphology) is here inferred though inverse modelling techniques, using the measured velocity and modelled basal shear stress for the present day ice sheet. The resulting required basal sliding parameter for the WAIS varies by a few orders of magnitude. The variation in the sliding parameter is proposed to be a result of the water content, and hence yield strength, of the subglacial till known to exist beneath parts of the WAIS. The continental distribution of this subglacial till is not known, so a parameterisation of the water system based on that of Alley (1996), using a Weertman-type film to represent the basal water depth is tested. Using modelled melt rates from Joughin et al. (2004) and the present day ice sheet configuration, a plausible relationship between basal water depth and the basal sliding parameter is established for the Ross Sea Sector. The subglacial water flow model is then incorporated into the ice flow model, using the previously derived relationship between water depth and the sliding parameter for the Ross Sea sector. The model shows a reasonable level of success in representing present day ice velocities whilst retaining the present day ice sheet surface morphology.

The second part of the poster outlines an application of the model; to infer WAIS dynamics (specifically grounding line and ice volume changes) in the Weddell Sea embayment, constrained against the geomorphological record of elevation change through time in the Ellsworth Mountains.

Alley, R.B., 1996. Towards a hydrological model for computerized ice-sheet simulations. Hydrological Processes, 10: 649-660.

Joughin, I., Tulaczyk, S., MacAyeal, D. and Engelhardt, H., 2004. Melting and freezing beneath the Ross ice streams, Antarctica. Journal of Glaciology, 50(168): 96-108.