Hydrostatic equilibrium: a good assumption for the position of grounding lines?

Dr Sophie Nowicki
Centre for Polar Observation and Modelling University College London
228 Pearson Building, Gower Street
London WC1E 6BT, UK

Accurate determination of the position of the grounding line remains one of the challenges faced by current marine ice sheet models. Traditionally, the grounding line has been prescribed by a floatation condition (hydrostatic equilibrium) or from a migration rate based upon differentiation of the floatation condition. More recently, a boundary layer theory for marine ice sheets proposed by Schoof (2007), suggest that in the case of rapidly sliding ice sheets, grounding line migration rate should be replaced by a flux condition at the grounding line. Considering the situation where shearing in the grounded ice becomes important, Nowicki and Wingham (2008) used contact conditions to show that the floatation condition is not always appropriate, as it can result in steady state solutions that are not physically acceptable.

Nowicki and Wingham drew their conclusions from the results of a full Stokes finite element numerical model, which also solves for the position of free surfaces (air-ice and air-water interfaces). The grounding line and sea level are fixed, but the mass flux at the grounding line is varied. Once a steady state solution is reached, it is checked that (i) the compressive normal stress at the base of the grounded ice exceeds the equivalent water pressure, and (ii) the shelf lower surface does not get into contact with the bedrock. Violation of either of these two contact conditions would result in grounding line migration.

In this presentation we repeat these experiments, but with a non- linear ice rheology. We also look at the effect of different basal sliding law, and compare the numerical mass fluxes at the grounding line with Schoof's analytical expression. Following the theme of this session, we aim to show how these results can be of use for marine ice sheet models that do not solve the full Stokes equations.