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Modelling the transition zone of a marine ice sheet

S. Nowicki, D. Wingham

Centre for Polar Observation and Modelling, University College London, Gower Street, London WC1E 6BT, UK (smn@cpom.ucl.ac.uk)

Satellite observations have shown that the West Antarctic Ice Sheet (WAIS) is undergoing rapid changes, and have thus reopened the question of the stability of marine ice sheets. Current numerical models of marine ice sheets give contradicting scenarios for how the WAIS will respond to these observed changes. However, the flow in the zone of transition between the grounded ice sheet and the ice shelf is poorly understood, leading to no consensus on how this region should be treated in marine ice sheet models. To investigate the behaviour of the flow in the transition zone of a marine ice sheet, a finite element model has been developed. The problem is complicated due to the non-linear boundary conditions and unknown domain shape. Furthermore the shallow ice approximation does not hold in this region, so the governing equations cannot be simplified. The model presented solves the full steady state Stokes equation on a 2-D domain, and evaluates the position of the free surfaces. The density and temperature are treated as spatially homogeneous, and at present the ice rheology is considered linear. (Work in progress is implementing a non-linear rheology). Comparison of the model results to a semi-analytical solution demonstrates that the model handles singularities in the flow field suitably. Application of the model to the "die-swell problem", involving mixed boundary conditions and free surfaces as in the transition zone problem, give results that are in good agreement with published work. These examples indicate that the model behaves adequately and is suitable for gaining an understanding of the transition zone. Insight into the flow within the transition zone and sensitivity experiments are presented.