Geophysical Research Abstracts,
Vol. 11, EGU2009-12112, 2009
EGU General Assembly 2009

Hydrostatic equilibrium: A suitable condition for grounding lines?

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Accurate grounding line determination remains one of the challenges faced by marine ice sheet models. The traditional approaches are to set the grounding line position with the condition of hydrostatic equilibrium (floatation condition), or from a migration rate based upon differentiation of the floatation condition. In the case of ice sheets that slide rapidly over the bedrock and flow into freely floating ice shelves, Schoof (2007) showed that the grounding line position could be determined by a flux condition. In this presentation, we consider the situation where vertical shearing in the grounded ice is not negligible. We demonstrate with a free surface full Stokes finite element model that the floatation condition for the position of grounding lines is not always appropriate, as it can result in steady state solutions that violate the contact conditions, and are therefore not physically acceptable. This behavior is observed for a range of sliding laws and ice rheology. The contact conditions reflect that upstream from the grounding line, the compressive normal stress at the base of the grounded ice should exceed the equivalent water pressure, while downstream from the grounding line, the shelf cannot get into contact with the bedrock. Violation of either condition would result in grounding line migration.