Modelling the dynamics of tidewater outlet glacier: approaches, issues and perspectives

Andreas Vieli
Department of Geography, Univesity of Zurich, Switzerland
andreas.vieli@geo.uzh.ch

The recent rapid retreat, acceleration and related thinning of tidewater outlet glaciers in Greenland raised concerns regarding their contribution to sea-level in a warming climate. Current large scale ice sheet models, however, still lack a fully dynamic representation of their marine terminus, leaving major uncertainties in future predictions of mass loss.
Using a simple flowband model that includes a fully dynamic treatment of the ocean boundary, this paper explores the dynamic behavior of such outlet glaciers, discusses the issues and challenges apparent in predictive models and gives perspectives for future model development.
Applications of the model to outlet glaciers in Greenland and the Antarctic Pensinsula demonstrate a tight coupling between terminus position change and upstream dynamic response (thinning) and shows high sensitivity of retreat to different treatments of calving in the model but also to along flow variations in basal and lateral geometry. This indicates the need for accurate knowledge of geometry and improved dynamic models of calving in predictive ice flow models. Further, the modelling highlights the effect from rheological weakening (crevassing, rifting) on terminus dynamics, a process which is in current flow models largely ignored. A further obstacle in modelling of tidewater glaciers is the inclusion of climatic and oceanic forcing. In particular, ocean melt has been suggested to play an important control for the tidewater outlet glacier dynamics but this mechanism is only crudely represented in models and the required forcing data is sparse.