Geophysical Research Abstracts
Vol. 13, EGU2011-8399, 2011
EGU General Assembly 2011

Full-Stokes finite element modelling of the Greenland ice-sheet using inverse methods

Fabien Gillet-Chaulet (1), Olivier Gagliardini (1), Maelle Nodet (2), Catherine Ritz (1), Gael Durand (1), Thomas Zwinger (3), Hakime Seddik (4), and Ralph Greve (4)

(1) Laboratoire de Glaciologie et Géophysique de l'Environnement, CNRS, UJF-Grenoble I, BP 96, F-38402 Saint-Martin d'Hères Cedex, France, (2) Laboratoire Jean Kuntzmann, BP 53, F-38041 Grenoble Cedex 9, France, (3) CSC – IT Center for Science Ltd., P.O. Box 405, FIN-02101 Espoo, Finland, (4) Institute of Low Temperature Science, Hokkaido University, Kita-19, Nishi-8, Kita-ku, Sapporo 060-0819, Japan

The contribution of the Greenland ice sheet to sea level rise has continuously increased during the last decade and is a concern for the next centuries. Within the two international efforts ice2sea and SeaRise, many groups are now running prognostic simulations of the Greenland ice sheet. The quality of the model predictions depend primary on the good description of the physical processes involved and on a good initial state reproducing the current observations (geometry and surface velocities). But, these two points remain weaknesses of the current ice flow models:
(i) The mass loss is equally split between surface processes and ice dynamics (Van den Broeke et al. , Science, 2009). For the dynamical part, the ice discharge is localized on small outlet glaciers and is impossible to capture in large scale ice flow models using shallow approximations.
(ii) The quantity and quality of the observations has considerably increased during the last decades, but data assimilation techniques are still under-employed during the spin-up procedures.

Here, we model the flow of ice of the whole Greenland ice sheet using the full-Stokes finite element code Elmer/Ice. The finite element mesh is generated using the anisotropic mesh adaptation tool YAMS. The resulting mesh size varies from few tens of kilometers in the central parts, down to 1km in the main outlet glaciers. Two inverse methods are used to initialize the basal sliding coefficient field to reduce the mismatch between the present day surface velocities and the model surface velocities:(i) a Robin Inverse problem recently proposed by Arthern and Gudmundsson (J. Glaciol., 2010), and (ii) a control method using the fact that the Stokes equations are self-adjoint for a Newtonian rheology (Morlighem et al., GRL, 2010).

We show that magnitude and repartition of the modelled present day ice discharge compares well with the observations. Finally, transient forecast simulations of the Greenland ice sheet for the 21st century are run to investigate the model sensitivity to the initialization procedure.