Geophysical Research Abstracts
Vol. 14, EGU2012-9151, 2012
EGU General Assembly 2012
© Author(s) 2012

A sensitivity analysis for a thermomechanical model of the Antarctic ice sheet and ice shelves

F. Baratelli (1,2), G. Castellani (3), C. Vassena (1), and M. Giudici (1)

(1) Università degli Studi di Milano, Dipartimento di Scienze della Terra "A.Desio", Milano, Italy (fulvia.baratelli@unimi.it), (2) Università degli Studi di Milano, Dipartimento di Fisica, Milano, Italy, (3) Alfred Wegener Institute, Bremerhaven, Germany

The outcomes of an ice sheet model depend on a number of parameters and physical quantities which are often estimated with large uncertainty, because of lack of sufficient experimental measurements in such remote environments. Therefore, the efforts to improve the accuracy of the predictions of ice sheet models by including more physical processes and interactions with atmosphere, hydrosphere and lithosphere can be affected by the inaccuracy of the fundamental input data. A sensitivity analysis can help to understand which are the input data that most affect the different predictions of the model.
In this context, a finite difference thermomechanical ice sheet model based on the Shallow-Ice Approximation (SIA) and on the Shallow-Shelf Approximation (SSA) has been developed and applied for the simulation of the evolution of the Antarctic ice sheet and ice shelves for the last 200 000 years.
The sensitivity analysis of the model outcomes (e.g., the volume of the ice sheet and of the ice shelves, the basal melt rate of the ice sheet, the mean velocity of the Ross and Ronne-Filchner ice shelves, the wet area at the base of the ice sheet) with respect to the model parameters (e.g., the basal sliding coefficient, the geothermal heat flux, the present-day surface accumulation and temperature, the mean ice shelves viscosity, the melt rate at the base of the ice shelves) has been performed by computing three synthetic numerical indices: two local sensitivity indices and a global sensitivity index.
Local sensitivity indices imply a linearization of the model and neglect both non-linear and joint effects of the parameters. The global variance-based sensitivity index, instead, takes into account the complete variability of the input parameters but is usually conducted with a Monte Carlo approach which is computationally very demanding for non-linear complex models. Therefore, the global sensitivity index has been computed using a development of the model outputs in a neighborhood of the reference parameter values with a second-order approximation.
The comparison of the three sensitivity indices proved that the approximation of the non-linear model with a second-order expansion is sufficient to show some differences between the local and the global indices.
As a general result, the sensitivity analysis showed that most of the model outcomes are mainly sensitive to the present-day surface temperature and accumulation, which, in principle, can be measured more easily (e.g., with remote sensing techniques) than the other input parameters considered. On the other hand, the parameters to which the model resulted less sensitive are the basal sliding coefficient and the mean ice shelves viscosity.