The Cryosphere Discuss., 1, S9–S10, 2007
www.the-cryosphere-discuss.net/1/S9/2007/

The Cryosphere Discussions

Interactive comment on "The effect of the north-east ice stream on the Greenland ice sheet in changing climates" *by* R. Greve and S. Otsu

J. Oerlemans

j.oerlemans@phys.uu.nl

Received and published: 5 July 2007

In the past few years a number of papers have been published on the evolution of the Greenland ice sheet in the near future. It appears to me that the glaciologists doing these studies are not very critical with respect to the FORCING of their models. Predicting changes in the volume of the Greenland ice sheet requires a model that has two components: (i) an ice-flow model, calculating changes in ice sheet geometry as a response to a changing mass balance (and possibly sea level), and (ii) a mass-balance model, generating the distribution of the balance rate from meteorological data. I think that in many studies, including the one by Greve and Otsu, there is an imbalance between (i) and (ii). On one hand an attempt is made to include sophisticated ice mechancs (including ice stream, sliding related to water input, variable

geothermal heat flux, water-dependent rate factor for the rheology), and on the other hand the surface melt rate is calculated with a temperature index method. It has been noted for a long time now (perhaps most explicitly in Oerlemans, 2001, p. 44-45) that degree-day models overestimate the sensitivity of the melt rate to temperature change. The simple reason is that in such models it is implicitly assumed that the amount of solar energy available for the melt process is proportional to the temperature change. For annual temperature anomalies this may be reasonable to some extent because at many places warmer summers tend to be sunnier, but it certainly does not hold for longer time scales. A frequently heard argument for using degree-day models instead of energy-balance models is that the latter require much more input parameters. This is true, but by keeping all these input parameters constant one still does a better job than having global radiation proportional to air temperature! A simple modelling approach can always be defended as an academic exercise from which something can be learned. However, if we make statements about the future climate which can have political and social consequences, we have to be careful and do the best we can. Calculating melt with degree-day models to force high-resolution ice-sheet models should therefore not be supported anymore. Projecting the future of ice sheets and glaciers in a warming world is at least as much of a meteorological problem as of an ice-mechanical one. We should have mass-balance modelling up to date! Ref.: J. Oerlemans (2001), Glaciers and Climate Change, Balkema Publishers, ISBN 90 265 1813 7.

Interactive comment on The Cryosphere Discuss., 1, 41, 2007.