Geophysical Research Abstracts, Vol. 9, 07882, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-07882

The use of a coupled AOGCM–ice-sheet model to explore large-scale climate–ice-sheet feedbacks

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Ice sheet growth both influences and is influenced by changes in the Earth's climate. To examine how an ice sheet's current effect on climate leads to modifications in its evolution requires the coupling of an ice sheet model to a climate model that is capable of performing long runs and resolving climate physics well. The climate model we use is FAMOUS, a version of the UK Met Office Hadley Centre's AOGCM HadCM3. FAMOUS runs approximately 10 times faster than HadCM3 whilst using the same physical formulation. The ice sheet model is Glimmer, a 3D thermomechanical model based on the shallow ice approximation. It is a regional model which runs nested within the climate model. In this study we focus on glacial inception, and set up Glimmer over the Laurentide and Fennoscandian regions, which had large ice-sheets during past glacial periods. The coupled AOGCM–ice-sheet model is forced with insolation appropriate for 116ka BP, when there was a minimum in northern-hemisphere summer insolation, giving optimal conditions for ice-sheet growth at the start of the last glacial period. This climate is compared with the model modern preindustrial climate and the effects on ice formation are examined. We also force the stand-alone ice-sheet model with the 116 ka BP climatology produced from the AOGCM, suppressing all ice-sheet–climate feedbacks except the effect of changes in surface elevation on temperature through the lapse rate; this too is removed in a further run. Comparison of ice sheet growth across the runs allows the effects of feedbacks to be quantified.