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A Greenland Ice Sheet surface mass balance model designed for coupling with a GCM

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In future climate warming scenarios, the Greenland Ice Sheet (GrIS) may halve in volume within as little as 500 years. Although uncertainties remain in estimates of the response of the ice sheet, the freshwater flux into the North Atlantic could increase by 0.1 Sv from the present-day value of $\sim$0.018 Sv. The increase of fresh water input as well as the ongoing reduction of sea ice extent may perturb the thermohaline circulation in the North Atlantic, and consequently the climate.

As part of the UK NERC, RAPID Climate Change programme, we are investigating the role of the cryosphere in modulating the thermohaline circulation in the North Atlantic, and examining the feedbacks between land and sea ice and the rest of the climate system. To achieve this, a suite of numerical models have been coupled, including an atmosphere-ocean GCM (based on the UK Hadley Centre model: HadCM3), a surface mass balance and a thermo-mechanical model for the GrIS. Here, we present the surface mass balance model and the results of validating it against *in-situ* observations. In addition to computing the energy balance at the surface, the model, based on previous work by Greuell and Konzelmann (1994), includes subsurface and snow metamorphism processes within the upper $\sim$30m of firn. Snow aging, settling, compaction, melting and refreezing of percolating water within the layers and formation of superimposed ice are all computed within the model. It was tested using data from two automatic weather stations located along the K-transect (in the southwest Greenland ablation zone), the model output was compared with four years of mass balance observations. In addition, the model was forced with 10 years of ERA40 climatology, and run on a 20km grid with present-day surface topography. The ability of the model to capture the inter-annual and spatial variability of the mass balance was as-

sessed for the whole ice sheet using the results of these simulations. The ability of the model to adequately reproduce the pattern of albedo and melt extent (compared with satellite-derived estimates) is presented along with the mass balance comparisons at two automatic weather station sites along the K-transect.