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Modelling atmosphere-icesheet feedbacks: beyond PDD

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There is a mismatch in both the spatial and temporal scales required in atmosphere and icesheet models. A general circulation model of the atmosphere with a grid fine enough to resolve the margins of an icesheet would be too computationally expense to run for the thousands of years required for significant evolution of the icesheet. Positive degree day (PDD) schemes are empirically-based parameterisations commonly used to produce an appropriate-resolution surface mass balance boundary (SMB) condition for an icesheet model from the local surface temperature and precipitation simulated by the atmosphere model. The results of PDD schemes are, however, heavily dependent on parameters that have been measured at only a few locations but which, in reality, vary significantly, both geographically and for different climatic conditions. In general, the forcing calculated from PDD scheme does not allow for conservation of either water or energy within a coupled climate system.

Here we report on work to produce a physically consistent icesheet SMB forcing directly from a general circulation model of the atmosphere capable of millennial climate simulations, allowing atmosphere-icesheet interactions to be modelled with greater fidelity. Subgridscale surface characteristics and hypsometry, along with a sophisticated multilayer snowpack model including refreezing and albedo dependent on snow characteristics have been implemented within FAMOUS, a low resolution version of the U.K. Met Office Hadley Centre climate model. The bottom boundary conditions of this snowpack model are then interpolated in three dimensions to provide SMB forcing for the Glimmer icesheet model, which simulates the evolution of the icesheet and feeds back on the AGCM topography and surface characteristics. The initial results of the scheme will be presented, examining the effect of the subgrid hypsometry on the climate and how the resultant SMB forcing depends on the resolution of the parent climate model.