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Are Greenland Ice Sheet Reconstructions for the mid-Pliocene Climate Model Dependent?

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During the mid-Pliocene Warm Period (3.264 to 3.025 million years ago), global mean temperature was similar to that predicted for the next century, and atmospheric carbon dioxide concentrations were higher than pre-industrial levels (400 ppmv). Sea level was also higher than today (high-stands of ∼+22m), implying a reduction in the extent of the ice sheets. Thus, the mid-Pliocene Warm Period provides a natural laboratory in which to investigate the long-term response of the Earth's ice sheets and sea level in a warmer-than-modern world.

A combination of climate and ice sheet models can be used to enhance our understanding of ice sheet stability. At present, our understanding of the Greenland and Antarctic ice sheets during the warmest intervals of the mid-Pliocene is based upon predictions using generally only one climate model and one ice sheet model. Therefore, it is essential that the model dependency of these results is assessed.

The Pliocene Model Intercomparison Project (PlioMIP) has brought together 14 international modelling groups to simulate the warm climate of the Pliocene. Here we use the climatological fields derived from the results of both the atmosphere-only climate models (Experiment 1) and the coupled atmosphere-ocean climate models (Experiment 2) to force an offline shallow ice approximation ice sheet model (BASISM). This will test the climate model dependency of ice sheet simulations over Greenland.

We show that climate model dependency is high over Greenland, with Pliocene reconstructions ranging from an ice-free state to a near modern Greenland ice sheet. An analysis of the surface albedo differences between the models over Greenland offers some insights in to the reasons for inter-model discrepancies.

Although these results are unable to identify the causes of the major differences between modelled reconstructions, they do serve to highlight the differences between model predictions of climate over the ice sheet regions during the mid-Pliocene Warm Period.