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Modelling ice sheet evolution and atmospheric CO_2 during Marine Isotope Stage MIS M2

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In order to investigate the relation between ice sheets and climate in a warmer-than-present world, recent research has focussed on the Late Pliocene, 3.6 to 2.6 million years ago, since it is the most recent period in Earth history when such a climate state existed for a significant duration of time. Marine Isotope Stage (MIS) MIS M2 (∼3.3 Myr ago) is a strong positive excursion in benthic oxygen records in the middle of the otherwise warm and relatively stable warm Late Pliocene. However, the relative contributions to the benthic [U+F064]18O signal from deep-ocean cooling and growing ice sheets are still uncertain. Here, we present results from simulations of the late Pliocene and early Pleistocene (3.65 – 2.65 Myr ago) with a hybrid ice-sheet—climate model. Initial experiments simulating the last glacial cycle indicate that this model yields results which are in good agreement with proxy records in terms of global mean sea level, benthic oxygen isotope abundance, ice core-derived surface temperature and atmospheric CO_2 concentration. For the Late Pliocene, our results show an atmospheric CO_2 concentration during MIS M2 of 224 – 253 ppmv, and a drop in global mean sea level of 9 to 28 m. Uncertainties are larger during the warmer periods leading up to and following MIS M2. An important source of uncertainty in our reconstruction of MIS M2 is the effect on climate of changes in paleotopography in possibly glaciated areas, such as the Canadian Archipelago and Antarctica.