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A fully coupled simulations of climate and ice volume of the Late Pliocene

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The contribution to sea-level rise of the Antarctic and Greenland ice sheets in a warming climate is uncertain. A better understanding of the physical mechanisms driving these changes is therefore needed to make more rigorous projections of the impact of regional sea-level rise. A warm interval within the Late Pliocene (3.264 to 3.025 million years before present) can be used to gain a better understanding of the response of the ice sheets to a warming climate with pCO_2 levels close to or higher than present. Here, we present the first results from a fully coupled transient climate ice-sheet model simulation across the Late Pliocene. The full transient experiment is initiated at Marine Isotope Stage (MIS) KM5c (3.205 Myr ago) and runs forward in time, coupling the atmosphere-ocean global climate model FAMOUS with the ice-sheet model ANICE simulating the Greenland and Antarctic ice sheets. Two distinct experiments have been performed. Both use orbital parameters that are varied every coupling time step of 1000 years. For the first experiment, only orbital parameters are changed, keeping atmospheric pCO_2 constant at 400 ppmv. With a second experiment, we varied both orbital parameters and atmospheric pCO_2 according to reconstructions or proxy data, updating the pCO_2 value every 1000 years. Our simulations indicate that the contribution during particular warm intervals to global-mean sea level from the Antarctic and Greenland ice sheets are of similar magnitude. In the simulation with only orbital forcing changing, the small changes in orbital radiative forcing already induces clear opposite change over the two regions. NH sea ice and Greenland temperature seem to vary more in sync with global mean temperatures and eccentricity. On the other hand, SH sea ice and Antarctic temperatures correlate more with obliquity. The contribution to sea-level change follow both local temperature and surface mass balance variations, whereas for Antarctica there is also a strong influence from sub-shelf melting. However, including variations in pCO_2 induces stronger variations, which are globally more uniform. When variations in precession are small, the changes on both hemispheres are more in sync.