The transient response of ice volume to orbital-driven climate changes of the Late Pliocene

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Funded by the European Union's Horizon 2020 programme under the Marie Sklodowska-Curie grant agreement No 660814.

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INTRODUCTION

The contribution to sea-level rise of the Antarctic and Greenland ice sheets in a warming climate is uncertain. A better understanding is evidently 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 CO_2 levels close to or higher than present.

APPROACH

Here, we first present a one-way coupling using FAMOUS, a low-resolution version of the HadCM3 GCM, to force the ANICE ice-sheet models in a transient mode. The FAMOUS simulation is driven by PRISM3 boundary conditions (which were also used in PlioMIP phase 1: *Haywood et al., 2010*), where we apply a changing orbit. This 40 kyr simulation is centred on MIS KM5c (3.225 to 3.185 Myr ago). The ice-sheet model is forced with monthly 2-m temperatures and precipitation. The OBLIMAP program (*Reerink et al., 2010*) is used for interpolation to the ice-sheet grid. We performed two simulations, one with starting the ice sheets from their present-day size and one with starting the ice sheets from the PRISM3 ice-sheet topography. 15 sensitivity tests are performed by varying ice melting.

RESULTS

The results are comparable to the equilibrated response of the ice sheet on Greenland and Antarctica to the PlioMIP phase 1 climate model output, as done so for the PLISMIP experiments (*Koenig et al, 2015; De Boer et al., 2015*).

FIGURE 1: SCHEME OF MODELLING FRAMEWORK

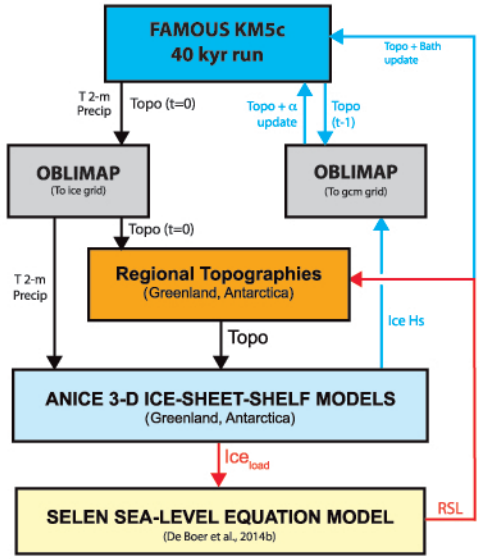

Fig. 1 - Black arrows show current set up, red arrows show next step including sea-level modelling. Blue arrows indicate a 2-way coupling with FAMOUS.

FIGURE 2: FAMOUS YEARLY MEAN 2-M TEMPERATURE AND PRECIPITATION

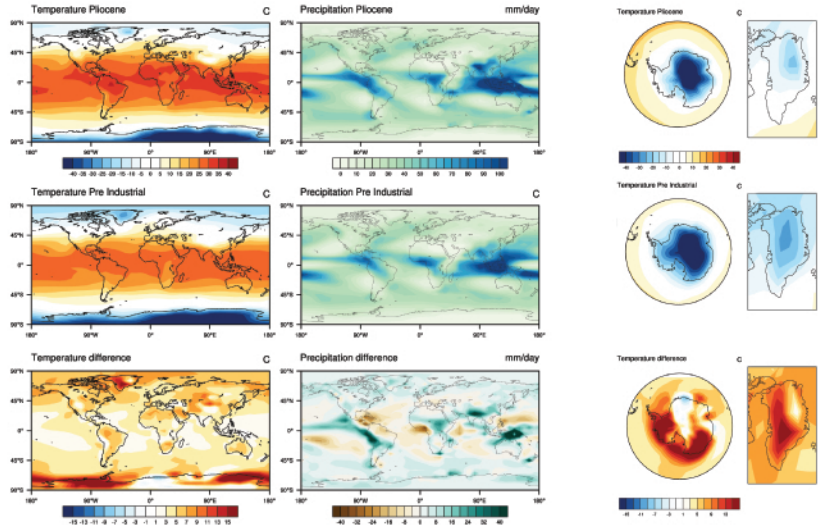

Fig. 2 - From left to right: yearly mean 2-meter temperature (°C), precipitation (mm/day) of FAMOUS over the globe, 2-meter temperature over Antarctica and Greenland. From top to bottom, Pliocene, Pre Industrial and the difference between Pliocene and Pre industrial.

FIGURE 3: ORBITAL PARAMETERS, INSOLATION, CO_2

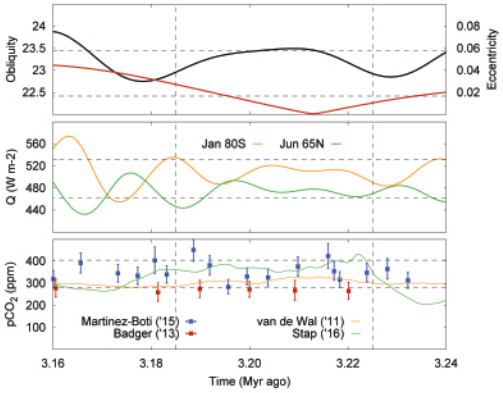

Fig. 3 - From top to bottom: the orbital parameters, as input to FAMOUS. The insolation from January at 80S (orange) and June at 65N (green). Model and data reconstructions of CO_2. Horizontal dashed lines show the modern reference values. For CO_2, the top horizontal line shows the value as used in Famous: 405 ppm.

FIGURE 4: ANTARCTIC AND GREENLAND TEMPERATURE AND ICE VOLUME

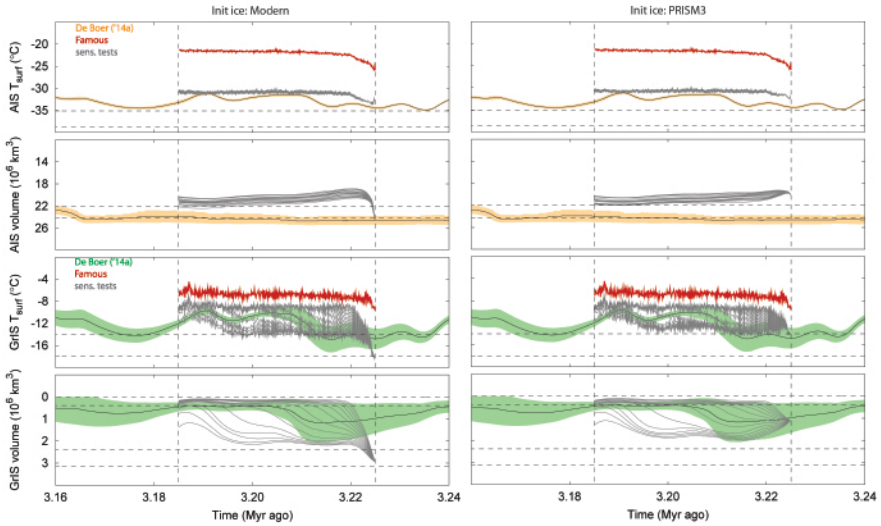

Fig. 4 - Modelled ice-surface temperature and ice volume of Antarctica (top two panels) and Greenland (bottom two panels). Famous 'raw' temperatures are shown in red. The grey curves show the 15 sensitivity tests, orange and green curves show results from *De Boer et al. (2014a)*. Horizontal dashed lines represent results from PLISMIP (*Koening et al., 2014; De Boer et al., 2015*).

Fig. 5 - Modelled sea level . The grey curves show 15 sensitivity tests, the blue curve is the modelled sea level from *De Boer et al. (2014a)*.

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FIGURE 5: SEA LEVEL