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Antarctic ice sheet evolution across the Eocene Oligocene boundary: an emulator-based approach

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The Antarctic ice sheet history dates back to the late Eocene-early Oligocene, a time when carbon dioxide concentrations were declining from values around 1000 ppm towards values below 600 ppm. The continental position of Antarctica was different than today and the Drake Passage and the Tasman Seaway started to open. A large δ18O excursion in deep-sea foraminifera, known as the Oi-1 event (33.9 Myr), is interpreted as a global cooling and major ice sheet formation event. At this time, it is thought that small ephemeral ice sheets grew into a continental scale ice sheet on the Antarctic continent.

Up to date there is a debate on how the Antarctic ice sheet developed and what were the decisive actors. The ocean gateway opening theory with the thermal isolation and cooling of the Antarctic continent has been a valid explanation for Antarctic ice sheet formation for a long time. However, the timing is vague, the process is very slow and the simulated cooling is limited. Therefore, ocean gateway opening is thought to have played a secondary role. Carbon dioxide forcing might have been the main driver, but both concentrations and pathways over the transition period show a large uncertainty in the literature.

Here we present the Antarctic ice sheet evolution over a million year timescale crossing the Eocene-Oligocene boundary using the Antarctic ice sheet model VUB-AISMPALEO coupled to the emulated climate from HadSM3. The high uncertainty in the CO_2 concentrations is investigated using different carbon dioxide pathways from the late Eocene towards the early Oligocene. The role of slightly different initial conditions and the speed of decline of carbon dioxide concentrations are investigated using the emulator.