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# Transient ice sheet-climate simulations over the Eocene-Oligocene transition: when did the Antarctic ice sheet appear?

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A continental-scale Antarctic ice sheet is thought to have originated at the Eocene-Oligocene transition, an event characterized by a sharp increase in deep-sea $\delta$18O. Small ephemeral ice sheets might have existed during the late Eocene, but they probably did not reach the coast. The development of the Antarctic ice sheet occurred at a time when ocean gateways surrounding Antarctica opened and atmospheric $CO_2$ concentrations declined from values likely above 1000 ppm to below 600 ppm. Recent work suggests that the elevation and configuration of the Antarctic continent was rather different from today when accounting for the effects of erosion and tectonic uplift, which impacts have not yet been studied in much detail.

Previous work considering off-line ice sheet simulations or asynchronous coupling with climate models show that $CO_2$ might have been the decisive factor in cooling the Antarctic climate and initiating ice sheet growth. There is still a large uncertainty on the $CO_2$ threshold and the boundary conditions. Here we present transient simulations around the Eocene-Oligocene transition using HadSM3, a climate model that performs particularly well above the Antarctic continent, and couple it with the Antarctic ice sheet model VUB-AISM. The latest insights in paleogeography and bedrock topography are used for the reconstruction of the boundary conditions. We make use of an emulator to predict temperature and precipitation above the Antarctic continent for a large range in $CO_2$, orbital parameters and ice sheet volumes to determine under what conditions ice sheet initiation is favoured.