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Simulation of the late Eocene climate: impacts of regional atmospheric circulation changes on the Eocene-Oligocene Transition

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The Eocene (56-34Ma) is a challenging period for palaeoclimate modelling. While the early Eocene saw the warmest temperatures of the Cenozoic, the entire epoch was characterised by a low meridional temperature gradient. It has been proven notoriously difficult to reproduce these conditions using numerical model simulations.
Here, we present the results from a set of moderate horizontal resolution (ocean $\sim$1 degree, atmosphere $\sim$2 degree) fully-coupled CESM simulations using a new 38Ma late Eocene geography reconstruction. The improved resolution and Eocene geography allow for a better representation of the general circulation. The model manages to reconstruct both low and high latitude temperatures reasonably well, using realistic greenhouse gas concentrations (2x and 4x pre-industrial levels).
Most importantly, the absence of an ACC allows meridional heat fluxes that keep southern high latitudes warm. As a result, the Antarctic continent can heat up in summer and develops a sub-tropical summer monsoon. Such a circulation can explain proxy records of vegetation and chemical weathering on Antarctica. A monsoonal climate would keep Antarctica ice free even at relatively low greenhouse gas concentrations and hence demonstrates the importance of regional climate shifts on the continental scale glaciation at the Eocene-Oligocene boundary.