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Was the Antarctic Circumpolar Current initiated by the Cenozoic cooling?

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Growth of Antarctic ice sheet during the Cenozoic 34 million years ago appears as a potential tipping point in the long-term cooling trend that began 50 Ma ago. For decades, the onset of the Antarctic Circumpolar Current (ACC) following the opening of the Drake Passage and of the Tasman Seaway has been suggested as the main driver of the continental-scale Antarctic glaciation. However, recent modelling works emphasized that the Eocene/Oligocene atmospheric carbon dioxide (CO_2) lowering could be the primary forcing of the Antarctic glaciation, questioning the ACC theory. Here, we used a fully coupled atmosphere-ocean model (FOAM) with a mid-Oligocene geography to depict the response of the ACC to changes in the atmospheric CO_2 level. Our results suggest that the opening of southern oceanic gateways does not trigger the onset of the ACC for CO_2 typical of the late Eocene (> 840 ppm). We find that a cooler background climatic state such as the one prevalent at the end of the Oligocene is required to simulate a well-developed ACC. In this cold configuration, the intensified sea-ice development around Antarctica and the resulting brine formation lead to a strong latitudinal density gradient in the Southern Ocean favouring the compensation of the Ekman transport, and consequently the ACC. Our results imply that the ACC was initiated after the onset of the Antarctic ice sheet growth, acting as a feedback rather than as a driver of the global cooling.