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Miocene Antarctic ice sheet simulations using an asynchronously coupled RCM-ISM

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Both direct and indirect evidence suggests that there was fluctuation of the Antarctic ice sheet over the past 34 million years. For example, sediment provenance studies suggest retreat into the Wilkes Subglacial Basin during the Pliocene and possibly earlier, in the Miocene. Indirect evidence, such as from the oxygen isotope record from benthic formanifera, suggests fluctuations in ice volume exceeding 50 m in sea level equivalence during the Miocene. Ice sheet models have struggled to achieve such large-scale retreat under the relatively modest atmospheric CO_2 concentrations suggested by proxy records.

Attempts to resolve this data-model conflict have recently focused on simulating retreat into the marine basins of Antarctica, with retreat into the Wilkes Subglacial Basin during the Pliocene simulated in 2 recent ice sheet modeling studies using different approaches. Although retreat into the subglacial basins may explain approximately 20 m of ice volume fluctuation from Antarctica, it is still lower than the magnitudes suggested by the oxygen isotope record for the Miocene.

Here we focus on improving simulation of the Antarctic ablation zone by using an asynchronously coupled RCM to provide climate forcing to an ice sheet model. We use a GCM with a Miocene paleo-geography to provide boundary forcing for the RCM, with atmospheric CO_2 at various concentrations. In previous simulations there was limited retreat of the ice sheet away from the continental margin, due to a strong hysteresis mechanism. In these asynchronous simulations there is increased retreat of the Antarctic ice sheet, with continental sectors retreating away from the continental margin. This results in a greater overall decrease in ice volume than for non-asynchronously coupled simulations.