The Antarctic ice sheet during the mid-Miocene and mid-Pliocene

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Abstract

Geological data indicate that there was major variation in the volume and extent of the Antarctic ice sheet during past warm intervals, such as the mid-Pliocene (~3 million years ago) and the mid-Miocene (~15 million years ago). Sea level reconstructions and records of the oxygen isotope composition of benthic foraminifera can be used to infer past changes in Antarctic ice volume. However, neither of these records can provide a direct estimate of Antarctic ice volume without additional corrections. Sea level records from passive margins must be corrected for glacial-isostatic adjustment and dynamic topography, the magnitude of these corrections can be similar to the original signal and are especially problematic further back in time (Raymo et al., 2011; Rovere et al., 2014). The oxygen isotope record is a mixed climate signal, recording changes in deep-sea temperature in addition to changes in ice volume. Additionally, changes in the oxygen isotope composition of the ice sheets can also affect interpretations of past ice volume (Langebroek et al., 2010). Here we present simulations of the Antarctic ice sheet for the mid-Miocene and mid-Pliocene, using oxygen isotope enabled climate and ice sheet models that account for changes in the isotope composition of the ice sheets. The ice sheet model used includes recently proposed mechanisms for the retreat of marine-based ice sheets through the hydrofracture of ice shelves and subsequent retreat of exposed ice cliffs in deep basins (Pollard et al., 2015). These simulations highlight that the Antarctic ice sheet was dynamic during past warm intervals of the Miocene and Pliocene (Gasson et al., 2016a,b; DeConto and Pollard, 2016). However, we also show that changes in the oxygen isotope composition of the ice sheets means that the change in ice mass may have been less than previously estimated.

Keywords: mid-Miocene, mid-Pliocene, Antarctic ice sheet, Oxygen isotopes

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