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Southern Ocean temperature change during the middle Miocene revisited with clumped isotopes

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The Middle Miocene Climate Transition (MMCT) around 14 Ma represents one of the major global climate reorganizations during the Cenozoic era. It is characterized by ice sheet expansion on Antarctica and decreasing atmospheric CO_2, probably accompanied by significant changes in ocean temperature (e.g., Shevenell et al., 2004; Sosdian et al., 2018). However, the temperature evolution across the MMCT is poorly constrained, because of the small number of middle Miocene paleotemperature records and the current limitations of the applied temperature proxies. For example, Mg/Ca ratios in foraminifera are not only sensitive to calcification temperature but also to seawater Mg/Ca and pH (e.g., Evans et al., 2016). These non-thermal controls complicate the interpretation of Mg/Ca, especially in times where major variations in seawater Mg/Ca and/or pH occurred. Here, we revisit temperature change at Ocean Drilling Program (ODP) Site 1171 in the Southern Ocean, previously derived from planktic foraminiferal Mg/Ca (Shevenell et al., 2004), with the clumped isotope technique. Our clumped isotope temperature record, which is not affected by seawater composition changes, suggests generally lower temperatures as well as later and less abrupt cooling in comparison to Mg/Ca. The observed differences between Mg/Ca- and clumped isotope-based temperatures can be explained by variations in ocean pH, similar to those documented in previous studies (e.g., Sosdian et al., 2018). Our results call for a re-evaluation of middle Miocene temperature change using multi-proxy approaches.

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