

In their manuscript “Midlatitude cooling across the Oligocene-Miocene transition”, Tanner et al. present new sea surface temperature reconstructions from the Southern Ocean and North Atlantic spanning the Oligocene-Miocene transition using well-established proxies derived from alkenone concentrations. The resolution of their records allows for a novel analysis of surface temperature evolution across this interval that was not captured by previous lower resolution records. In addition, they use their temperature reconstructions along with new bulk oxygen isotope measurements to reconstruct surface water oxygen isotope variability at these sites.

Surface temperature records such as these that resolve orbital-scale variability are critical, but are often lacking in intervals such as the Oligocene and Miocene. I think this data will be impactful among the readership of this journal and is absolutely worthy of publication. The methods applied in this paper are sound, and the figure quality is good. My suggestions for revision are generally minor, with a focus on improving the clarity of the text and figures for the reader, as well as some questions about interpretation.

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Line 18: Please clarify “lower values” of benthic $\delta^{18}\text{O}$ as either more enriched or more depleted.

Line 18: I suggest being more specific about what is meant by “limited warming”. What is the magnitude of warming if any?

Line 20: I’m not sure what is meant by “consistent cooling”. The previous sentences stated there were different magnitudes of cooling between the sites. Is ‘synchronous’ what is meant here?

Line 22-23: I suggest clarifying that bulk carbonate $\delta^{18}\text{O}$ at Site 1168 is being compared to benthic $\delta^{18}\text{O}$ at Site 1264.

Lines 40-50: I find this paragraph a bit confusing to follow as a reader as it jumps between many topics. I suggest some restructuring here to more tightly focus on explaining the motivation of this study to the reader. I strongly agree with the authors’ point that high-resolution surface temperature records are needed, and their data helps fill this important gap.

Lines 80-87: I find it a bit confusing why this description of Oligocene-Miocene deep ocean circulation is within the section about describing Site 1168.

Figure 1: How were the positions of the subtropical front reconstructed? A “subtropical” front approaching 60°S seems unrealistic even during warm interglacials.

Lines 187-190: I suggest including information on how variable $U^{k'}_{37}$ of the in-house alkenone standard as well as if any replicate measurements were made on samples to give an estimate of the analytical uncertainties associated with these measurements.

Lines 195-196: The $U^{k'}_{38Me}$ calibration of Novak et al. (2022) saturates at 30.5°C, not 32°C. Also, they analyzed core tops with a maximum mean annual SST of 29.5°C, so I think the authors should also emphasize the uncertainty associated with extrapolating to temperatures beyond the calibration range. I suggest showing the calibration equations used for $U^{k'}_{37}$ and $U^{k'}_{38Me}$ in the main text or supplement, as $U^{k'}_{38Me}$ is less commonly applied and less well-known among the community.

Lines 204-215: Some of this is repetitive.

Line 211: Bulk $\delta^{13}C$ measurements are mentioned here and in line 204, but are not shown in any figures in either the main text or supplement. Could the authors please clarify why this is? Is $\delta^{13}C$ data reported here? If not, I suggest removing references to that data.

Figures 3 and 4: I think it would be helpful to show in the figure where Mi1 and Mi1.1 are. Also, I suggest that the y-axis label for panel (b) be changed to “ $\Delta\delta^{18}O_{sw}$ ” or similar to clarify that these are not absolute $\delta^{18}O$ values of seawater, but rather changes relative to the lightest sample.

Line 314: It is unclear what “cold extreme” means here. From Figure 4, the temperatures around 22.58 Ma look fairly unremarkable compared to temperatures observed both before and after.

Line 339: Specifically, what is the “age model uncertainty” being referred to here? Within how many kyr?

Line 348: Please be specific about the timescale of “abrupt” cooling here. Within how many kyr?

Figure 5: I again suggest showing where Mi-1 and Mi-1.1 are to give context to the reader.

Line 352: “High amplitude orbital scale variability” of what? SSTs, benthic $\delta^{18}O$, or both?

Lines 358-359: Would changes in albedo from ice sheet changes during this interval be relevant to both site locations in this study? Temperature changes in both hemispheres are synchronous, but continental-scale ice sheets were presumably limited to only the Southern Hemisphere. I am skeptical that albedo changes on Antarctica are a significant

“global climate forcing” during this interval and would significantly impact mid-latitude ocean temperatures.

Figure 6 caption: “MI index” is redundant, as MI stands for methane index.

Line 384: “The magnitude of $\delta^{18}\text{O}_{\text{benthic}}$ change at Site 1168” over what time interval?

Lines 399-408: The authors argue here that the large changes in benthic $\delta^{18}\text{O}$ at Site 1168 arise from large temperature changes in intermediate waters, which originate from “significant temperature change in high latitude regions where such waters outcrop” (Line 405). However, they do not address that the other benthic $\delta^{18}\text{O}$ records shown in Figure 7 (with presumably less temperature variability) reflect deep waters that also originate from the Southern high-latitudes, likely from even higher latitudes than intermediate water sources. If sea ice extent and duration and/or polar-amplified cooling influenced large temperature variability in both Southern high-latitude surface waters and intermediate waters, why would it not most strongly influence the deepest waters sourced most directly from the regions of sea ice formation?

Lines 429-430: It is unclear to me what the connection between surface salinity at U1406 and deep ocean reconstructions are here. I suggest explaining this point further.