Author's response to second round of review

Dear Editor and Reviewer,

We thank you for your continued guidance and feedback to improve our paper. We carefully considered the comments and now provide a marked-up manuscript detailing the revisions and corrections. A "clean" and reader-friendly version of the revised manuscript and supplementary materials are also uploaded. Please see below for our detailed response (in red) to the reviewer's comments.

Reviewer's comments:

I believe that the authors provided adequate answers to most of my comments and I am generally happy with the corrections. I only have minor comments related to:

The vertical profiles of ocean temperature (Figure 1): Which season do they represent? I believe it is important information as the temperature profile may change through the year, with the development of a strong thermocline in sub-surface (25-50 m) in summer resulting in lower temperature at depth than at the surface (Foldvik et al., 1985; Martinson et al., 2008; Venables et al., 2013; Vorrath et al., 2023). I however reckon that it may depend on the region (Muench et al. 1990) and I do not know how the vertical structure in the Powell Basin evolves throughout the year. I would recommend presenting a spring-summer vertical profile as the diatom transfer function provides spring-summer SST while the RI-OH is understood as summer OT (Vorrath et al., 2023). In this view, I do not understand why the same team refers to the RI-OH OT as a summer signal in Vorrath 2023 and here as an annual signal. This discrepancy must be explained and, if OT is lower than SST in summer, the discussion about the vertical stratification probably needs to be re-evaluated.

Author's response: We thank the reviewer for the helpful suggestion. The original temperature profile we used represented the annual profile for both core sites. After careful consideration, we have adopted the reviewer's proposed spring/summer vertical profile. This adjustment offers a surface temperature profile that aligns more closely with the diatom-based proxy records for both core sites. In the Scotia Sea (PS67/219-1), the spring/summer temperature remains warmer than the annual mean temperature down to a water depth of ca. 50 m. Below this depth, the spring/summer temperature and the annual mean temperature exhibit a congruent profile down to 2000 m water depth (see Fig. 1 below). In the Powell Basin (PS118_63-1), the spring/summer temperature remains warmer than the annual mean temperature even down to 150 meters water depth, which may point to a deeper mixing during summer. Below this depth, both temperature profiles are identical down to 2000 m water depth.

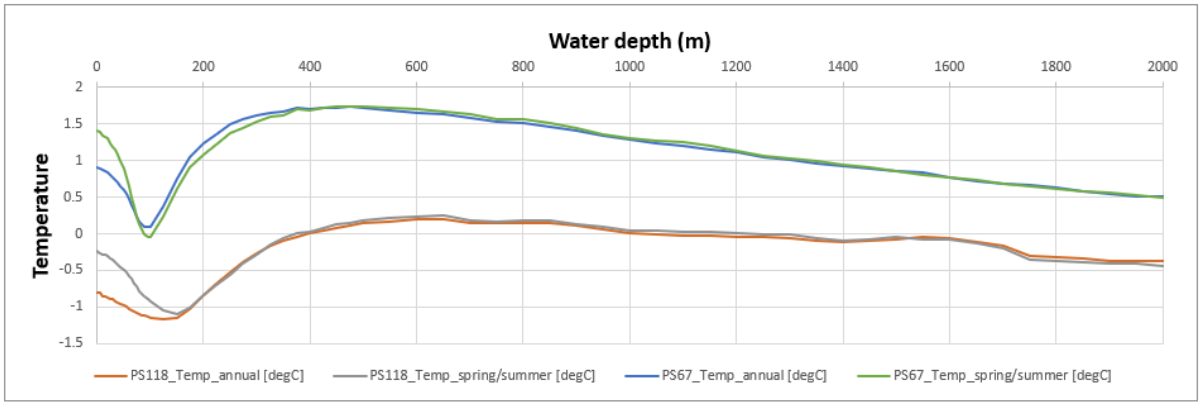

Figure 1. Vertical temperature profiles (annual vs spring/summer) for core sites PS118 and PS67.

The RI-OH'-derived ocean temperatures for core PS118_63-1 (ca. -2 to 0 °C) are in the range of both the modern spring/summer and annual mean temperatures. The reviewer's assertion that RI-OH' temperatures signify a summer signal is contradicted by a comparison of summer insolation values with the OT record (Fig. 2, below). In the case of Vorrath et al. (2023), the authors observed a similar trend between their RI-OH' OT, diatom-derived SSSTs and summer insolation (see Fig. 5 in Vorrath et al., 2023) and thus proposed that the RI-OH' OT could reflect a summer signal. However, at our core site, we do not observe this correlation between RI-OH' OT and summer insolation (see Fig. 2 below). Instead, we propose that the observed OT variations may be influenced by changes in ocean circulation as well as dense and cold shelf (and melt) water advection between 0-200 m water depths. Also, as the RI-OH'-SST calibration equation was derived from the World Ocean Atlas mean annual SST datasets (Fietz et al., 2013; Huguet et al., 2013; Lü et al., 2015), we here prefer to report the RI-OH' OT as reflecting an annual signal and note that further efforts in developing seasonal and/or regional calibrations for hydroxylated (and also iso) GDGTs are needed to overcome this uncertainty.

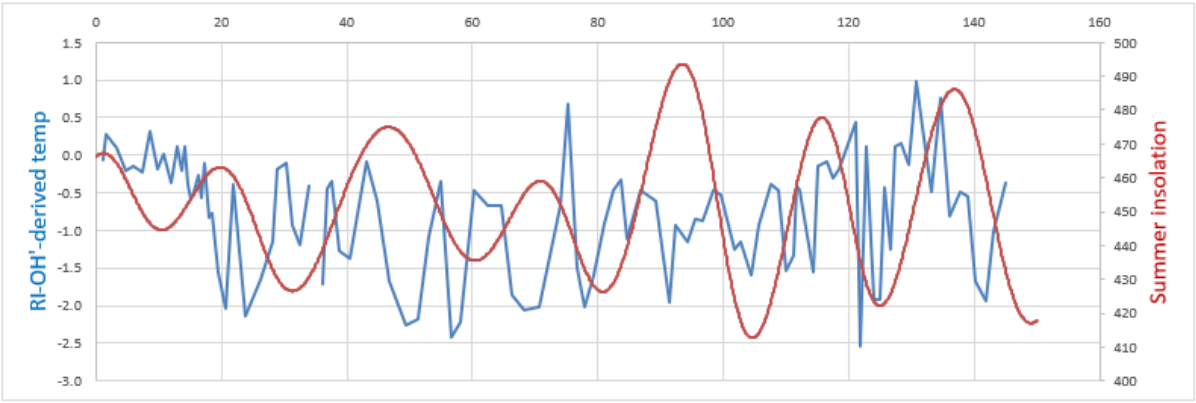

Figure 2. RI-OH'-derived temp at core site PS118_63-1 vs mean summer insolation.

Figures: I would recommend adding the simulated values (SSI, SWI, summer SST, summer OT) at both core sites on the temporal plots (right column of each figure) for each time slice. This will help grasping the similarities or discrepancies between the data and model output. For example, the color increment is 1°C in Figure 6, which does not allow a quick comparison. I also realized that I did

not understand the last sentence of the caption in figures 5-7. The proxy-derived data are shown by the curves, not by the shaded areas as it written (or at least as I read it).

Author's response: We thank the reviewer for the suggestion. We have incorporated the suggestions to improve the figures and revised the respective caption.