Reviewer # 2

Comment: The authors present a valuable dataset from the Ross Sea region that offers insights into the dynamics of the West Antarctic Ice Sheet over the past ~780,000 years. While they provide a substantial amount of data, there are several issues that need to be addressed.

1. General Comments

1.1 Age Model:

In Lines 90-99, the authors state that the age model for RS15-LC47 is based on correlating magnetic susceptibility (MS) to a nearby core referenced in Bollen et al. (2022). They assert a "noteworthy" similarity between their MS records and those from Bollen et al. (2022) in Line 119 and mention a "comprehensive approach utilizing 12 tie points" (Line 114) to align their records with the Bollen et al. (2022) record. However, the authors do not clearly demonstrate how they tested this "similarity" or explain the methods and rationale behind correlating the MS records. For instance, in Figure 2C, the patterns older than 250 ka, according to the current age model, appear quite different. Bollen et al. (2022) show a relatively muted signal during ~300-550 ka, yet the LC42 record still displays numerous high-frequency peaks. Given the potential for bioturbation and hiatus/event layers in LC47, how can the authors confidently assert that these correlations are "robust"? This issue is fundamental since an unreliable age constraint undermines the entire discussion. The authors are encouraged to meticulously re-examine their sedimentation records, incorporating more biostratigraphic controls as in Bollen et al. (2022), before making further interpretations.

Reply: We appreciate the reviewer’s concerns regarding the age model. In our study, we compare the magnetic susceptibility (MS) records of the sediment core with those from a nearby core, which has an established magneto-biostratigraphic age model (Bollen et al., 2022). Previous research on core RS15-LC42 by Bollen et al. (2020) indicates that the environmental settings of the Antarctic continental margin are not always synchronous with global events. Additionally, we compared our records with the EDC δD record (Jouzel et al., 2007) (Fig. 2), which did not yield consistent results.

For our study, we rely on the following age markers:

1. The Brunhes-Matuyama (B-M) boundary of the studied core, previously established magneto-biostratigraphically by Ohneiser et al. (2019).
2. The dampened MS values observed between 550-250 ka in sediment cores from the Ross Sea (Ohneiser et al., 2019).

These age markers are well-established and consistently observed across sediment cores from the Ross Sea, providing confidence in their accuracy. We used the established ages as tie points for age correlation, focusing on broad time intervals: 750-550 ka, 550-250 ka, and 250 ka to the present. Our results do not aim to reconstruct high-resolution paleoenvironmental changes; instead, they emphasize broader temporal trends. Therefore, our interpretations are unlikely to be significantly affected by small chronological uncertainties. The studied intervals are clearly defined by the established age markers, and previous studies on the nearby sediment core (Bollen et al., 2022) do not indicate any erosional hiatus within these time frames. Thus, we are confident that our interpretations are robust against potential chronological errors that could affect the conclusions.

In addition, We have done DTW analysis to the MS values of two cores to test their their similarity (Supplementary material I). DTW is a robust statistical technique used to measure the similarity between two time series by optimally aligning their temporal sequences, accounting for potential shifts and variations along the time axis. This method is particularly suited to our data, as it allows for the alignment of similar trends even when minor temporal discrepancies exist, which is expected due to natural variability between cores in close proximity. The DTW analysis shows that the MS values of two cores have similar patterns, with the DTW distance of 184.76 indicating a reasonable degree of similarity after accounting for temporal or local shifts.

1. Typos and Other Comments:

2.1 The manuscript frequently repeats full names and acronyms. For instance, "Middle-Pleistocene Transition (MPT)" is repeated in Lines 50, 229, 399, 449, and 457, and numerous other terms (AABW, MS, CDW, ASC, etc.) are also redundantly mentioned. The authors should carefully review the manuscript for such repetitions before resubmission.

Reply: Thanks for the comment. We have taken care of this. The revised manuscript does not repeat full names and acronyms.

2.2 The discussion on the MPT event is also perplexing since the record in this manuscript only covers a very brief portion of the later part of the MPT. The authors should consider comparing their records with well-dated ice core records instead. Although the introduction suggests a lack of records for the past few hundred thousand years, especially in the Ross Sea, many high-quality records exist that are not referenced in this manuscript.

Reply: Thanks for the comment. We have compared our results with that of Ohneiser et al. (2019), Ohneiser et al. (2023) and Hillenbrand et al. (2009). Which are some of the well dated sediment records from the region.

2.3 Another point of confusion is the extensive discussion on the importance of Be isotope measurement and principles in Lines 65-75. By the end of the manuscript, Be isotopes do not seem to play a significant role in the model the authors propose, instead serving a supportive role that requires support from other evidence.

Reply: Thank you for your valuable feedback. We appreciate your concerns regarding the role of Be isotopes in our manuscript. The Be isotope measurements were crucial in interpreting the paleoenvironmental conditions of the studied time interval, particularly in understanding the depositional environments of biogenic sedimentary components. While we acknowledge that different proxies capture distinct environmental signatures, the Be isotope analysis provided critical confirmation of the environmental conditions under which various sedimentary components were deposited. For instance, the results from Be isotope analysis were instrumental in interpreting the organic geochemical components, offering insights that sedimentological analyses alone could not fully resolve. Be isotopes provided a higher resolution of paleoenvironmental signals, which significantly enhanced our understanding of the depositional dynamics. Notably, Section 4.3, "Production and Preservation of Biogenic Material at the Ross Sea Continental Margin," heavily relies on interpretations derived from Be isotope data, demonstrating their key role in our study. While Be isotopes may appear supportive, they underpin critical interpretations throughout the manuscript, especially in contexts where other evidence alone would not suffice. We have revised the manuscript to better emphasize this pivotal role, ensuring that the integration of Be isotopes into our model is clear and well-justified.

2.4 The correlation presented in Figure 6 lacks clarity and statistical robustness due to the limited data points for each time period. The authors should consider grouping some of the time periods and providing clear descriptive statistical tests to support their arguments. A similar issue is present in Figure 3, where there is no clear evidence indicating which correlations are strong and which are not.

Reply: Thank you for your thoughtful feedback. In response to your comments, we have added statistical data to all relevant figures. For Figure 6, we focused on analyzing the slopes of the bivariate plots rather than relying solely on correlation coefficients. This approach allowed us to better capture the relationship between the variables over different time periods. Most of the Be isotope groups presented in the bivariate plots demonstrate strong correlations, with the exception of the longer records for the 250 ka – Present and 773 ka – Present intervals. These longer records tend to provide more generalized slopes, which are less precise compared to shorter intervals that exhibit better correlation and more defined trends. Regarding the 250 ka – Present timeframe, we were unable to divide this period into distinct subgroups because the Be isotope data for each subgroup were too limited to generate statistically robust slopes and trendlines.

Finally, Figure 4 is difficult to read due to an overload of poorly organized information, and the color labeling is inconsistent with Figure 2.

Reply: Thank you for your feedback on Figure 4. To improve the clarity and readability of the data, we have divided the original Figure 4 into two separate figures: Figure 4 and Figure 8. This separation allows for a more organized presentation of the information, enhancing overall quality and interpretability. Additionally, we have refined the cartography for better visual representation and ensured that the color labeling is now consistent. These adjustments should make the figures more accessible and easier to compare across the manuscript.