

Interactive comment on “Land–sea coupling of Early Pleistocene glacial cycles in the southern North Sea exhibit dominant Northern Hemisphere forcing” by Timme Donders et al.

Anonymous Referee #3

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The authors use a multiproxy record from the southern North Sea to investigate phase relations between forcing and climate response in order to test the hypothesis that northern hemisphere obliquity forcing is the primary driver for glacial and interglacials during the Early Pleistocene. The paleoenvironmental record presented in this study certainly deserves publications as it contains important new information on paleoenvironmental change for a critical period in Earth history. The record also provides very interesting insights into how different terrestrial and marine proxies respond (or may not respond) to environmental changes.

However, after reading the manuscript, I am not entirely convinced that the selected

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record is suitable to study leads and lags in high resolution and hence to test the main hypothesis of this study. The authors state that they “investigate the leads and lags of regional marine vs. terrestrial climatic cooling during MIS 102-92” (line 101). In fact, the record shows many gaps, and data resolution seems to be sufficient for high resolution studies from MIS 99 to MIS 94 only (Fig. 3). Unfortunately, the age model for this time interval (2.5-2.39 Ma), which is based on magnetostratigraphy and dinocyst events, does not seem to be very well constrained (Fig. 2).

Below is a figure with selected proxies for MIS 98-97, enlarged from Fig 3 and SI Fig. 2. The transition MIS98-97 have been chosen by the authors and described in detail to analyse forcings and responses in high resolution (line 442-445). The enlarged figures show that many proxies were measured at different depths and with gaps, which at least for some intervals hamper a robust identification of leads and lags. I also struggle to see the parallel initial decrease of cold water dinocysts and Sphagnum biomarkers (first two curves) and the final decrease in T/M ratio and $d_{18}\text{O}$ (last two curves), which, according to the authors, followed with a delay of a few thousand years. The arboreal pollen and T/M ratio curve shows large fluctuations and hardly reveal any clear trends. These fluctuations may have resulted from a) the extremely low pollen sum after exclusion of bisaccate pollen, and b) the fact that the pollen results were merged from two different sites. I have added the *Pinus* pollen percentages to demonstrate the large differences between the sample of the two sites (marked in red and blue). Given these limitations, I am not sure if the pollen curves are suitable at all for high resolution studies.

The manuscript would benefit from a longer and more detailed interpretation and discussion section and a critical evaluation of the limitations. I recommend the following revisions:

1. An excellent age control is critical for all high-resolution studies of leads and lags. The authors should therefore provide more information on how the specific section has been dated. Which tiepoints have been used? Fig. 2 is not sufficient and also includes

time intervals not relevant to this study.

2. It would be very helpful if the authors could provide a conceptual model describing in detail what they would expect to see in regard to the timing of each proxy, if obliquity forcing were the major driver.
3. The multiproxy approach makes the method chapter the longest section of the entire manuscript. Consider moving parts of the methods into the Supplementary Information and focus mainly on describing what the proxies show and discuss the methodological limitations relevant to this study.
4. The palaeoenvironmental interpretation of the record lacks depth and should be more detailed. In fact, the section “6.1 Paleoenvironmental settings” hardly contains any paleoenvironmental reconstructions and mainly focusses on the analysis of phase relations. For example, the first sentence does not explain why the pollen record indicates “generally warmer and more humid conditions”. MIS 93 also contains surprisingly high Ericales percentages. Supplementary Fig. 1 is important to fully understand the paleoenvironmental settings and I recommend moving it into the main text.
5. The analysis of lead and lags needs to be more detailed in order to provide convincing evidence for the main conclusion. This requires the identification of multiple cycles with the same pattern (following the “conceptual model”), a precise dating of changes and, if possible, statistical analysis.

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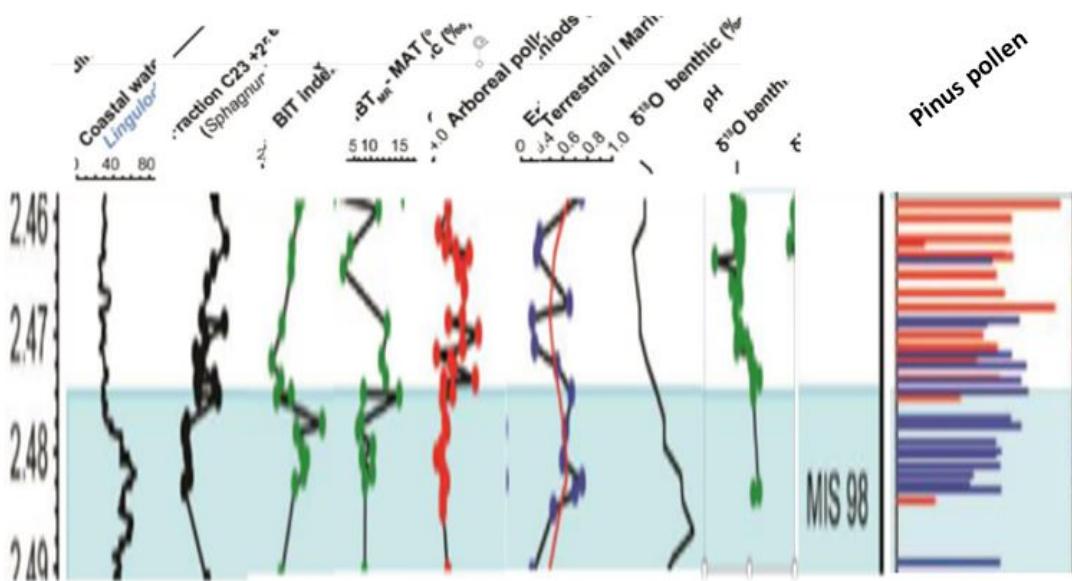


Fig. 1. Selected proxies described in line 442-445

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