We are grateful to the two anonymous reviewers for their careful and critical reading of the manuscript. Our point-by-point responses follow; the reviewers' original comments appear in black and our answers are given in blue and marked "Response".

Kind regards,
Claire Routledge and co-authors

## Reply to RC1

### General Comments

This manuscript presents an interesting high-resolution, long-time-series dataset of calcareous nannoplankton community dynamics spanning 44 million years of Cenozoic history, integrating new middle Eocene to Lower Miocene data from the Northwest Atlantic with existing Paleocene–lower Eocene records from the Pacific. By applying the summed coefficient of variation () metrics, the authors evaluate how calcareous nannoplankton responded to major climatic shifts, ranging from Paleocene hyperthermals to the Eocene–Oligocene cooling and Antarctic glaciation.

The overall quality and scope of the manuscript are very good. The core conceptual finding of plankton communities exhibiting a persistent baseline of ecological stability only periodically disrupted when environmental stress exceeds a clear threshold is an interesting contribution withn the palaeoecological palaeoceanographic fields. The manuscript is well-structured and thoroughly illustrated. Although, the manuscript would benefit from some improvement in the discussion and from some clarification along the text. Thus, I recommend the publication in *Biogeosciences* following moderate revisions addressing the specific comments detailed below.

### Specific Comments

1. I appreciated the usage and discussion of both resistance and resilience in the manuscript, since I believe it is very interesting and still less studied in the nannoplankton record. Although, I encourage the authors to double check the usage of the two terms along the text and carefully use one or the other depending on the context. For example, in lines 325-326 the ability to resist and the recover seems to be subsumed under the term resilience. Please also rephrase these lines.

   Response: Resistance and resilience have now been clearly defined in the introduction (with reference to usage in ecological studies), we have clarified their use in the above mentioned lines and have checked their use throughout the manuscript.

2. The manuscript, specifically the discussion sections, would benefit from a deepening on the comparison of the displayed data with other previously published work worldwide distributed. In fact, the Shatsky Rise and the NW Atlantic have a very different oceanography and hydrography that are not mentioned in the manuscript. Although, especially the NW Atlantic is strongly influenced by local currents and productivity shifts that can affect the data displayed. I suggest to expand in this direction the discussion including also other sites drilled in different areas highlighting better in this way how the baseline threshold of remains constant across different depositional settings. This deeper discussion would also document better, for example during the EOT, that the nannoplankton response was more a synchronized phenomenon in the Atlantic instead to be related to a specific local setting (see e.g. Bordiga et al., 2015 https://doi.org/10.5194/cp-11-1249-2015, Henderiks and Pagani 2008; https://doi.org/10.1016/j.epsl.2008.03.016 and Viganò et al. (2024; https://doi.org/10.1029/2023pa004738).

   Response: We recognise that the two datasets come from different ocean basins, however, as discussed in the introduction, the long-term, high-resolution nature of this data (~10–80 kyr resolution across an interval of ~36 Myr) is unprecedented and is the basis for this study. Other sites do not offer comparable resolution over long time intervals and especially lack data from the intervals between known climate events that are crucial to our approach, providing vital context for those events and allowing us to distinguish background and above background response. We have added further details to explain the integration of these two datasets in the methods section. We also agree that nannoplankton community response may be expressed differently depending on location and oceanography and refer to this in the text, including additional references.

3. Intervals with poorer preservation, especially in the NW Atlantic and in the MECO, can artificially altering relative percentage abundances and influencing by removing the more fragile species? Pleas add a brief comment clarifying and discussing how the sample spacing and visual preservation evaluation through the MECO and along other significantly affected intervals would rule out any artifacts potentially altering the .

   Response: The sites were chosen to provide relatively consistent preservation and highest quality nannofossil records. We used consistent estimates of preservation quality and have excluded intervals where preservation quality may have compromised the analysis, as discussed in the text. The MECO interval at Site U1408 displays good preservation, as do other event intervals in the new dataset. We have also run sensitivity tests on the data to check for the influence of more fragile groups, and these tests confirmed that the signal

was maintained with or without these taxa being included (see e.g., Gibbs et al. 2012, p. 4681-4682 and Supplementary Info).

**Introduction**

- Since the manuscript cover very well the different aspect of resistance and resilience, the introduction would benefit from a clearer highlight of both "resistance" and "resilience" definition and how they are operationally distinguished using fossil data.

  Response: These have now been defined in the introduction

- State clearly what are the scopes of the manuscript at the end of the introduction, without overstating a linkages to the ecosystem “services and functions” which would include defining more deeply, for example, the carbon export fluxes.

  Response: We have completely revised the paragraph describing the scope of the manuscript. We set out the objectives of the project, defining clearly the concepts of community stability, resistance and resilience, and explain how we address these concepts using nannoplankton data and the summed coefficient of variation metric.

- Line 68-69: “we extend the range of comparable data by 24 Myr, adding new middle Eocene through Lower Miocene records from the North Atlantic Ocean” it is not so clear to which previous data the studied record is adding new outcomes. Please add references of the dataset previously studied and to which the authors are here referring to.

  Response: We have clarified this now

**Methods**

- Add specifics on the time interval covered by the stratigraphic sequences, or refer more appropriately in the supplementary material, indicating both time interval and also the depth, cm.

  Response: The data come from 4 different sites and therefore we feel that reference to sample depths within the main manuscript is unnecessary but this information is readily available in the Supplementary Information, where the age model and depths are provided for the IODP Expedition 342 sites. Data from Alvarez et al., 2019 can be found in that publication’s extended data section.

- Please add a map with the location of the studied sites, both new ones and those used for comparison. Include the map either in the main text or as supplementary figure.

  Response: We have now added a map to the Supplementary Data (new SI F1)

**Results and Discussions**

- Line 224-229: cite also Bordiga et al., 2015 (https://doi.org/10.5194/cp-11-1249-2015) since this paper record in the Atlantic Ocean the size reduction in reticulofenstrids across the EOT and the nannofossil assemblage size rapid shift across the EOT together with the trophic/threshold responses across the EOT at ODP Site 1263 (Walvis Ridge), as the authors in this paper and as the other two cited papers. Also Henderiks and Pagani (2008; https://doi.org/10.1016/j.epsl.2008.03.016) and Viganò et al. (2024; https://doi.org/10.1029/2023pa004738) should be cited for similar reasons. Moreover, adding these papers would widen the discussions to a broader and more global context, as suggested above.
  Response: We have addressed this point as mentioned in the above "Specific Comments 2" reply

**Detailed comments**

- Line 14: remove "in detail"
  Removed
- Line 17: define here million year as Ma, and not after in Line 19
  This was outlined in lines 9-10
- Line 18-19: "of biotic response from the base of the marine food web." Be more specific referring only to nannoplakton. The presented data are exclusively from the nannofossil community and thus referring to the whole base of the marine food web is widening the concept too much in my opinion.
  This has been reworded for clarity
- Line 34: change "initiation" with a more technical term such as onset or establishment.
  "Initiation" has been replaced with "emergence"
- Line 44: change "exoskeletons that provide an abundant and continuous fossil record stretching back over 240 Myr" with "exoskeletons that can be preserved in the deep-sea sediments, providing…". Otherwise a logical step is missing in the sentence.
  We have changed to "have robust calcite exoskeletons, which are readily preserved in marine sediments providing an abundant and continuous fossil record"
- Line 48: remove "mass extinction" it is redundant.
  "Mass extinction" has been removed
- Line 51: define "a/yrs"
  This is now just "/yrs"
- Line 54: change "asses" with "assessing"
  We believe that "assess" is correct
- Line 79: redefine here the IODP acronym.
  The acronym was defined in the paragraph immediately preceding

- Line 81: change “intensity” with “resolution”
  This has now been changed to “resolution”
- Line 82-83: state clearly which “two events”, also in the introduction they have not been stated so clearly, only in the abstract.
  This has been clarified
- Line 92: change “%relative abundance” with “relative abundance (%)”
  This has been updated
- Line 100: specify the interval both in depth and time.
  As mentioned in the response to “Methods”, the data are from 4 different sites and will have overlapping depths which could be confusing within the main manuscript. However, this information is available in the Supplementary Information, where the age model and depths are provided for the IODP Expedition 342 sites. Information for the Alvarez et al., 2019 dataset can be found in that publication’s extended data section.
- Line 123: when stating “several statistically relevant peaks specify better to which peaks you are referring, or make it visually clearer using the figure. Which kind of statistics has been applied to define the statistical relevance? Please specify.
  We have added here a reference to Figure 1b which shows how above-background levels were identified
- Line 361-363: do not refer to the evidence on the global warming with “we” as it may seems that this findings come from this manuscript, whereas they come from the previously published papers.
  We have emphasised that the discussion regarding future global warming is from the publications listed and not this study
- Figure 1: specify in the caption the presence of hiatuses for those intervals where there are no data reported.
  This has now been added to the figure caption
- Probably for the references Newsam (2016) and Routledge (2021) it needs to be added in the refs that they are PhD thesis? This would calrify the sentence in the supplementary information “The middle Eocene to lowermost Oligocene (45.26–32.02 Ma) nannofossil data comes from Newsam (2016), and the lower Oligocene to Lower Miocene (31.90–21.77 Ma) from Routledge (2021), but are previously unpublished.”
  This information has been updated in the references
- Line 504: fix the typo “eEnvironmental change”.
  Typo has been corrected
- Line 5 in supplementary information: change precision with resolution.
  Resolution has now been used
- Figure S1: to help the reader, in the caption please make explicit all the symbols and abbreviation, do not refer to them as “in Fig. 1”.
  The symbols and abbreviations have been re-listed in the caption for Figure S1 now

- Table S4: specify from which site those data are from in the caption.
  This is a global compilation from Lowery et al., 2020
- Table S3: specify in the caption all the acronyms for completeness.
  The symbols and abbreviations have been re-listed in the caption for Figure S3