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**Speleothem evidence for late Miocene extreme Arctic amplification - an analogue for near future anthropogenic climate change?**

By Umbo et al.

The authors have carried out admirably almost all of the revisions I suggested. The only one to follow up, which I think was missed in the response document, was in my general comments about the Introduction:
*The introduction must also state clearly how this ms differs from the Vaks et al. ms in review.*

Overall, I find the revised manuscript to be nicely focused on the Late Miocene palaeoclimate, having omitted the speculative and tangential carbon and permafrost behaviour. I'm very happy to recommended that the manuscript is accepted for publication, following some minor suggested edits. The line numbers refer to the clean copy of the revised manuscript.

Line 37: "warmer-than-present temperatures", as per line 41.

Line 55: replace semi-colon with comma.

Line 59: "Greenland Ice Sheet…" (proper noun).

Line 72: "Late Miocene", i.e., upper case 'Late' (see Aubry et al., 2023, Fig. 1 in Newsletters on Stratigraphy Volume 57 Number 1 (2024), p. 25 – 36; DOI: 10.1127/nos/2023/0767. See also Aubry et al. 2021. Both pdfs are attached, I hope.

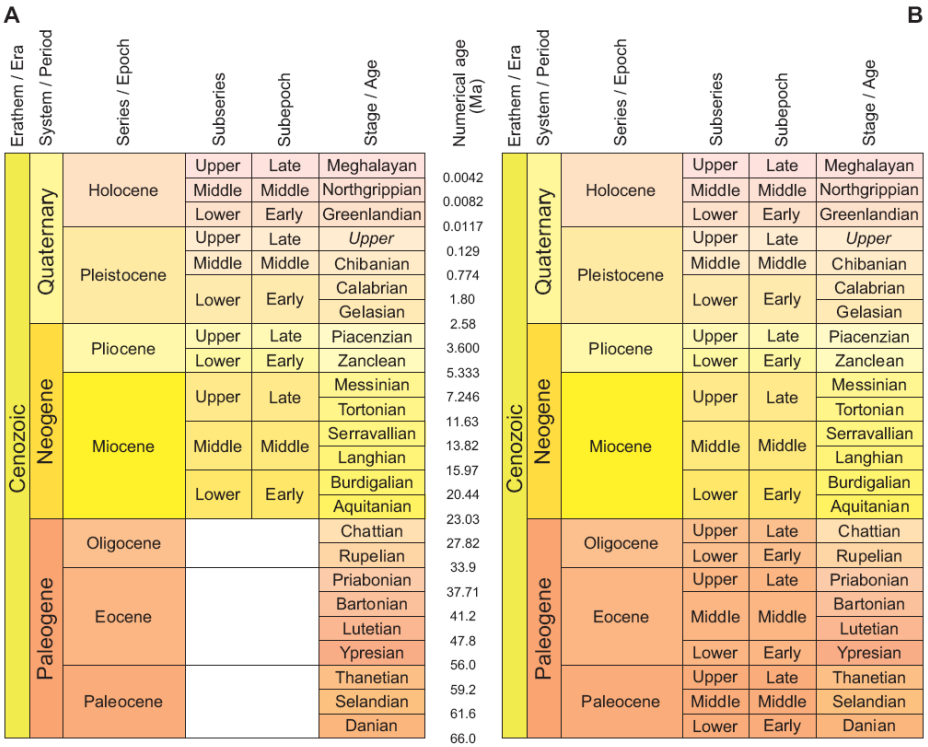


**Fig. 1.** Subseries/subepochs in the Cenozoic chronostratigraphic hierarchy. A. Hierarchy in the ICC as of 5 December 2022. As shown, the subseries/subepochs are formal for the Quaternary and the Neogene, and all chronostratigraphic boundaries are aligned with the GSSPs of the bounding stages. B. Desirable hierarchy in the ICC. Ideally all Cenozoic subseries should be formally defined and with official status. Following the terminology of Head and Gibbard (2015a), subseries/subepochs are official (i. e., included in the ICC) for the Quaternary and Neogene and formal for the Paleogene, although the current lack of reference to them in relation to the definition of stage GSSPs instead makes them effectively informal for the Paleogene. Ideally all Cenozoic subseries should be formally defined and have official status (as shown on B). Note that discordant chronostratigraphic procedures for the Quaternary and Neogene successions on the one hand, and the Paleogene record on the other (Fig. 1A) have regrettable ramifications. For instance, there is a formal, duly defined Lower/Early Miocene (Aubry et al. 2022); but there is no equivalent Upper/Late Oligocene. Although it is conceivable to refer to the boundary (or transition) in terms of stages (Chattian/Aquitanian) or series/epochs (Oligocene/Miocene), the boundary cannot be described at the practical level of subseries if Paleogene subseries are not formally recognized, and hierarchical cross-ranking (e. g., Chattian/Lower Miocene) is awkward, confusing, and not recommended. This conceptual break in chronostratigraphic hierarchies and units results in an unfortunate and unnecessary distancing between the Quaternary/Neogene and Paleogene communities which can and should be readily resolved by formalizing Paleogene subseries/subepochs (Fig. 1B).

Line 73: between … and…

Lines 77, 82, 83, 304, 350 etc.: “Late Miocene”, “Middle Miocene”, “Late Miocene”, as above.

Line 92: “Tortonian Stage of the Late Miocene Subepoch”

Line 126: “Tortonian Stage” (proper noun, see p. 6, column 2, paragraph 1 of Aubry et al., 2023)

Lines 151-2: please write out acronyms: IUPAC, VPDB and VSMOW before using them.

Line 176: Tables S1 and S2 are missing from the 14-page pdf of the Supplementary Online Materials. Please add them or delete reference to them.

Line 295 and number of supporting figures: Do you mean Fig. S6 rather than S5, because S6 shows trace element spectral analysis results? Please check and update the numbering of all the supplementary figures, because the first citation I can find of Fig. S4 is on line 457, AFTER the narrative has referred to Fig. S5.

Lines 301-2: “An additional principal component (PC2) is identified in STBB I – 1 but is not explored further.” I’m confused, because two PCs have been identified in lines 285 – 292. Is this additional PC therefore PC3 rather than PC2?

Line 333: insert ‘the’ before ‘surface’.

Line 336: avoid use of colloquial English “it’s” and write “it is”.

Line 337: insert ‘of heat’ after ‘conduction’.

Line 346: insert a comma after ‘Spain’.

Line 349: insert a semi-colon after ‘Eagle Cave’, and a comma after ‘however’. Ditto line 460.

Line 349: when you say ‘a small offset (<2˚C)’ it may be clearer to write “a small offset (≤ ± 2˚C)”.

Line 351. Insert a full stop after ‘present day’.

Line 384: ‘suggest’ [subject ‘findings’ is plural]

Line 386: insert ‘a’ before ‘Tortonian’.

Line 391: remove full stop after ‘2022)’

Line 419: ‘marine’ [common noun as you are referring to more than one MIS]. Also insert ‘that formed’ after ‘speleothems’.

Line 420: ‘Middle Pleistocene’ [proper noun’ see Aubry et al., 2023, referred to above]

Line 401: ‘provides’

Julian Murton
29 October 2024