



EGUsphere, referee comment RC2
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Comment on egusphere-2022-707

Anonymous Referee #2

Referee comment on "Dansgaard–Oeschger events in climate models: review and baseline Marine Isotope Stage 3 (MIS3) protocol" by Irene Malmierca-Vallet and Louise C. Sime, EGU sphere, <https://doi.org/10.5194/egusphere-2022-707-RC2>, 2022

Review Malmerica-Vallet et al., 2022. COPD.

General comments

This manuscript seeks to do three things: 1. Define nomenclature surrounding Dansgaard-Oeschger (DO) events; 2) Summarize existing model studies, which attempt to model MIS3 climate and/or replicate DO events; 3) Propose a set of protocols for future model studies (via CMIP/PMIP) of MIS3 climate and a so-called "kicked Heinrich meltwater experiment".

In terms of points (2) and (3) this study should prove a useful addition to the literature. I did wonder if Geoscientific Model Development might be a better home for it though, alongside other CMIP/PMIP protocol papers. Overall, I am supportive of the proposed modelling effort – it is long-overdue and will undoubtedly help to shed light on processes involved in millennial climate change during MIS3 (and is a great improvement on the approach of just using LGM conditions, given that we know from the data these are not conducive to DO events). However, the manuscript itself needs some substantial work before publication.

Specific comments:

- Unclear aim or focus of proposed experiments

The abstract states: "*The climate modelling community up to now has not been able to answer the question: Are our climate models too stable to simulate D-O events?*" and this appears to be the central question driving this study. Surely we are interested in much more than this binary question? Some might argue we already know the answer – yes, some models are too stable – the important questions are WHY this is, what are the processes that contribute to relative levels of model stability? I suggest that the scientific motivation behind this proposed model intercomparison protocol is explicitly laid-out and justified by the data available. For example at Line 60 "*The design of a common MIS3 experimental protocol would allow the modelling community to address the questions posed above*" – I have a hard time working out what the questions above are. I note that some questions are introduced later at Line 78.

- Conflation of model and data

Related to the above, the logic of this manuscript is quite difficult to follow because from the abstract onwards knowledge of DO events from primary data (e.g., ice cores, marine sediments) is conflated with model simulations. It is not clear if the project's motivation is grounded in the data or in model nuances (that may of course be relevant). For example, Line 104-5 states that D-O type behavior shouldn't be seen under full glacial conditions because it isn't present in the data – surely that information should be upfront, included as a primary pillar of your protocol design, not mentioned because some models might agree with it? In Section 2.1, please make clear with D-O type oscillations are in models...in which parameters? What timescale and amplitude satisfies your definition? [n.b., Table 1 states "*It is not clear that series of D-O events are oscillations in the strict sense.*"]

- Nomenclature

Table 1 is not a useful addition to the literature as it stands. It is littered with errors (too many for me to highlight every one) and introduces further ambiguity and confusion. The ambition to reset nomenclature usage across the entire palaeoclimate community is a

large one. It would better to state that you wish to define nomenclature for use within this proposed PMIP protocol and associated papers only.

In table 1: "stadial-interstadial" – these occur in many other time periods in addition to MIS3. Might be worth referencing the INTIMATE naming system here.

"Heinrich events" – entirely inaccurate definition. There is little, if any, evidence to support your claim that Heinrich events "have a role in DO oscillations". There are small methane peaks within some (but not all) Heinrich stadials that have been linked to Heinrich events. They typically occur mid-stadial not "before a stadial has begun".

"Heinrich Stadial" This term denotes a Greenland Stadial in which a Heinrich event is thought to occur. A stadial can therefore be both a HS and a GS. Sentence about H event provenance is out of place here!

"Bond cycle" is the term/concept useful or relevant here?

- Heinrich "kick"

Line 68: *"In addition to the protocol for a baseline simulation, we also outline a protocol for a Heinrich event (Bond cycle event one type; Table 1) preconditioned variant."* This statement makes no sense to me and Table 1 does not help. Scanning down to section 3.3...the term "kicked Heinrich event" is still not explained. This section needs dedicated attention from co-authors. Stocker and Johnsen 2003 do not discuss *"The freshwater delivered during Heinrich event iceberg discharge extends GS duration and suppresses the AMOC"*. Why is it *"logical to presume that these freshwater events are important in preconditioning the climate system with respect to D-O behaviour"*. There seems to be an equally strong argument which states DO events would continue to occur without Heinrich events.

Could the authors clarify what they are trying to achieve or test with this "kicked H-event"? How will they distinguish freshwater flux related to a Heinrich event (iceberg discharge from Laurentide) with other ice sheet instability delivering IRD and [potentially] contributing to AMOC variations that occurred within every DO cycle, H event or not.

- Sections 2.1 and 2.2 contain interesting discussion of the likely processes and feedback involved in generating D-O like events, and the associated figures are well-presented. Throughout though, it needs to be clear how the new protocol will address key questions related to the role of sea ice etc. that the discussion identifies.
- Atmospheric gases

Could you comment further on choice to keep atmospheric CO₂ constant? (section 3.1)
What does that assume about the role of CO₂ in D-O behavior?

Technical corrections

Line 62: "Given..." This is a phrase not a sentence.