

Interactive comment on “Multi-proxy fingerprint of Heinrich event 4 in Greenland ice core records” by M. Guillevic et al.

Anonymous Referee #2

Received and published: 27 April 2014

The paper “Multi-proxy fingerprint of Heinrich event 4 in Greenland ice core records” by Guillevic et al. represents an interesting multiproxy ice core study that sheds substantially more light on the sequence of events happening during two selected Greenland Stadials (GS). Based on various climate and biogeochemical ice core tracers, the authors conclude that the actual Heinrich event did occur in the middle of the GS, which itself is characterized by a 3-stage structure. The conclusions of the paper are in parts speculative (and should be more clearly marked as such), but the derived sequence of events is largely a convincing solution to the observations. Accordingly, the major results make a very important contribution to the understanding of the climate dynamics during stadial/interstadial cycles. The paper is generally well written and sufficiently concise. I suggest some language corrections in the specific comments below. In short, I recommend publication of the paper in CP after minor revisions.

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General comments

There are two points, where the paper should go deeper in its discussion and beyond its current status. The first one pertains the discussion of the $17O_{excess}$. $17O_{excess}$ is not yet a well established addition to the ice core parameters previously studied and deserves a more detailed introduction and detailed explanations in the manuscript. For instance on page 1184 the background given on this parameter is quite vague. Given that the $17O_{excess}$ represents the central parameter in the discussion, the information hidden in the $17O_{excess}$ and the underlying physics should be explained in more detail on page 1184. Again in section 3.1 the information gained from the $17O_{excess}$ is just stated (and a reference to the paper by Risi et al. is given) without explaining in more detail, why exactly this information (for example on water vapor recycling) can be gleaned from this parameter. This should be explained in significantly more detail in the revised version.

The second general comment is more a pledge than a request. The new results by Guillevic et al. suggest that the H event itself (related to a collapse of one or several ice sheets) is not the trigger for the stadial cooling as it comes later in the game. I would like to read the authors' opinion, on what initiated the Stadial in the first place in the Discussion and/or Conclusion chapter of the manuscript. I am sure they have thought about this thoroughly and may be able to make an educated guess.

Finally, not all of the tracers used in this study provide unambiguous information on certain aspects of the climate system. Alternative ways of interpretation (for example on sea ice extent) should be discussed and speculations made in the paper more clearly qualified as such.

Specific comments

P1180, L10: “...could, however, never...”

P1191, L5: “... temperature, unveiled...”

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P1181, L12: "... conditions, while..."

P1181, L27: "Meridional Overturning Circulation"

P1182, L2: "...Atlantic marine sediment cores..."

P1182, L11: "... in a sediment core..."

P1183, 1st paragraph: A few more words to motivate this discussion would be helpful. You may want to cite in this respect the recent paper by Skinner et al. 2014 in PNAS.

P1183 2nd paragraph: This discussion goes into a lot of detail on the accuracy of the chronologies etc. This may be justified but an introductory sentence, why the following discussion is important at this point of the paper, would be helpful. You may want to cite the recent paper by Jo et al., 2014 in Nature and an older one by Bozbiyik et al, 2011 in Climate of the Past on hydrological responses to ITCZ changes.

P1183, L15: "...,(ITCZ), which..."

P1183, L17: "...without Heinrich events."

P1184, last paragraph: Please provide more detail on 17Oexcess

P1185, L1-2: " We have performed the first 17O excess measurements on the NEEM core (Dahl-Jensen...)"

P1185 and throughout: exchange "homemade standard" with "in-house standard" or "working standard"

P1186, L3. "With d18O varying between -43 and -58 permille, we used working standards at around ..."

P1186, L11 and L20: "two point calibration"

P1186, L22: "necessarily"

P1187 2nd paragraph: Explain in a little more detail, how this correction is done

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Section 3.1 Explain in sufficient detail the arguments concerning what information is hidden in the 17Oexcess

P1188, L11 & L26: "southward shift"

P1188 last paragraph: Again, the 17Oexcess argument needs more explanation

P1189, L22 "shifts of the ITCZ"

P1189, 2nd paragraph: The use of MSA as a sea ice tracer for the Arctic is not really established yet. Accordingly, this discussion should be more clearly qualified as speculation and alternative ways to interpret this record should be explored.

P1189, L29: " with a potential clathrate release"

P1190, L1: I agree with this statement, but you should explain the reader in more detail why.

P1190, L6: "such a southward ITCZ shift"

P1191, L3: "(phase 2), which"

P1191, L10: "suggest a globally"

P1191, L19: "2008), while"

P1191, L27: Please provide a reference

P1192, L1 "measurements"

P1192, L3: "As discussed above, we argue for a ..."

P1192 L23: "of events in phase 3:

Section 3.4: I would suggest to place 3.4 immediately after 3.2 (potentially without an extra header) and only after that go to the discussion in 3.3

P1193, P10: "ends with the MSA"

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P1193, P23: “phases 1 and 3, a hypothesis to be tested in future studies.”

P1194, L7: “may mark the maximum...”

P1194, L25: Is “trigger” the right expression here?

P1195, L7: “sea ice extent”

P1196, L12-13: “...from warm subsurface waters in the North Atlantic Drift, to where...”

P1196, L20: “state, while”

P1196 last paragraph: Can you speculate also on the role of sea ice in the Baffin Bay and Labrador Sea, which appear to be of more importance for water vapor transport to Western Greenland.

P1197, L16: “between the constantly cold Greenland”

P1198, L22: “approach by matching”

P1198, L25: “...using the mid-slope of each GI onset as match points...”

Fig. 1: It may be helpful to indicate (e.g. by lettering) from which ice sheet which H event originated in this figure

Fig. 4: This central figure should be two columns wide in the final print. It was hard to discern things in the CPD version.

Fig. 5: What caused the cooling into phase 1?

Fig. 6: Add numbering of the DO events

Fig. 7: I don't understand the comment in line 5 on the use of a PICARRO instrument.

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