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Climate of the Past Discussions

Interactive comment on "120,000 year record of sea ice in the North Atlantic" *by* Niccolò Maffezzoli et al.

Anonymous Referee #2

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Review "120,000 year record of sea ice in the North Atlantic" by Maffezzoli et al.

The paper by Maffezzoli presents the first data on sea ice coverage of the North Atlantic and the Greenland, Iceland, Norwegian (GIN) Seas based on an ice core recently drilled on a coastal ice cap from East Greenland (Renland ice core). Following the previous approach by Spolaor et al. (2016) they use the Br enrichment above sea salt concentrations (Br_enr) linked to halogen explosions occurring on seasonal sea ice surfaces. In principle, the data and argumentation of the paper are convincing although at some points not explained in detail enough. The paper represents an important contribution to the field that will be of interest for ice core specialists, marine geologists and modelers alike.

In its current state, however, the paper still suffers from some language issues (see

annotated pdf file attached), some structural deficits and some issues with the argumentations that I outline in my general comments below. I am convinced that these changes can be accommodated and recommend to accept the paper after major revisions.

General comments

- Page 2 Line 17-23, "We compare ... Belt and Muller, 2013)": This text should only come at the end of section 2

- Section 2, 2nd paragraph: In this paragraph it is stated that the origin of Renland sea salt is the North Atlantic and the text refers to Appendix B. This is a crucial piece of information and should not be hidden in an Appendix but included in the main text. Moreover some more information on this statement would be helpful for the reader:

a) sea salt aerosol has a pronounced seasonal cycle with a broad maximum in the winter half-year. This also holds for eastern coastal sites (Oyabu et al., Polar Science, 2016). Thus, the Renland sea salt record is mainly representative for the winter half-year. The back trajectory analyses should be done both for the winter and summer half-year separately and shown in two panels. Note also that due to the limited lifetime of sea salt aerosol, short trajectories are likely to bring more sea-salt aerosol to Renland compared to longer trajectories.

b) transport pathway (trajectories) is one side of the coin, the sea ice source is the other. An additional figure/panel showing the multiyear and first year sea ice distribution in spring (at its maximum) would be helpful to support the claim that the source regions identified in the trajectory study are covered by FYSI or OW. The National Snow and Ice Data Center provides this information (https://nsidc.org/data/nsidc-0611).

- A method section is missing. Again, this is hidden in an Appendix A but should be part of the main text.

- Page 3 line 15-20, "The Br_enr ... Holocene value.": This text should be the beginning

of section 3

- Page 3 line 22-29. Here the NEEM Br_enr record is mentioned and compared to Renland. In order to allow the reader to make this comparison, the NEEM data should be shown in one of the figures!

- Page 4 line 1: Here the expression “tipping point” is used. There is no clear definition of what a tipping point is, but in climate science it is usually used for a rapid regime shift (see IPCC). The change from MYSI to FYSI to OW, however, is likely a gradual process. Accordingly, I would suggest to avoid the expression tipping point in the manuscript. Along this line, I think section 3.2 (linearization of the Br_enr record) and its application on the 120 kyr record in section 3.3 does not provide added value and in fact is misleading due to the gradual nature of the MYSI/FYSI/OW transition. Instead of trying to force this mathematically to a monotonous function, I would recommend to just use color bars in the figures underlying the records to indicate where MYSI, FYSI or OW dominate the Br_enr record. Moreover, mean Greenland temperature may not be the only parameter determining the amount of FYSI present (see next comment).

- The high resolution data presented in Figure 3 clearly show that the YD is the time period of largest Br_enr (clear maximum) during termination I, thus the largest FYSI presence. In particular Br_enr is clearly higher in the YD than in the OD period. Note that there is no similar Br_enr maximum during the OD/BA transition as seen in the YD at the point when temperature during the OD/BA transition is crossing the same temperature as found in the YD. Either this point is just missed in the record (unlikely), or NGRIP temperature alone is not able to fully explain the observations. Here additional information could be used to elaborate on this issue. First of all, FYSI is strongly dependent on the seasonal temperature variation, this should be mentioned somewhere. Models suggest (Buizert et al., Science, 2014) that temperature seasonality during the YD and OD was much higher than during the BA. This could explain why the YD has higher FYSI than the BA. The difference between YD and OD sea ice conditions (Br_enr levels) may potentially be explained by the overall much lower temperatures

encountered during the OD than in the YD (Buizert et al., 2014), which may push the OD sea ice regime toward more MYSI. This difference may be linked to the generally higher AMOC strength in the YD compared to the OD (McManus et al., Nature 2004).

- Page 4 line 29-33: Here the paper by Rasmussen is referred to, but I am not sure - based on the text provided - whether it is referred to correctly and whether the statement made in the manuscript is correct. Rasmussen et al. (2016) claim that in the North Atlantic south of Iceland SST warming already starts during stadial conditions, while in the GIN seas the warming starts only with the Greenland DO onset, i.e., when sea ice rapidly declines. Rasmussen et al., do not explicitly discuss the YD/BA/OD transitions and in fact their record does not show a clear early warming during the reduced AMOC conditions of the YD and OD. Accordingly, to make this statement would require high resolution Br_enr data for selected DO events from the Renland record, which are not available yet. I would suggest to remove this statement and also the reference to mean ocean temperatures, Antarctica and CO2.

- Page 6, line 26. Here you refer to the GI numbers. These should be included in the figures

- Include Fig. 1 in Fig. 2

- Add the NEEM record in Fig. 2 or provide a separate figure for the NEEM/Renland comparison. Add color bars for sea ice conditions underlying figure 2

- add color bars for sea ice conditions underlying figure 3

- remove figure 5

- remove the transformed BR_enr in figure 6, add color bars

- move Appendix A to a Method section

- move Appendix B to section 2 and add more information as outlined above

Specific Comments

- see annotated pdf

Please also note the supplement to this comment:
https://www.clim-past-discuss.net/cp-2018-80/cp-2018-80-RC2-supplement.pdf

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