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Climate of the Past Discussions

Interactive comment on "Influence of the North Atlantic subpolar gyre circulation on the 4.2 ka BP event" *by* B. Jalali et al.

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General comments:

Based on two new relatively high resolution SST records from the eastern subpolar gyre and off North Iceland, the authors document and discuss changes in the subpolar gyre between 4400–4100 years BP, this is during the 4.2 ka BP event. The dipole pattern that the authors identified in these SST records, combined with other paleoclimatic records from the North Atlantic and the Euro-Mediterranean regions, leads the author to suggest that those years were characterized by a weak gyre circulation, potentially connected to atmospheric blocked regimes. With these two new available records documenting changes in the oceanic conditions during the 4.2 ka BP event, the authors

go a step forward with respect to previous works and discuss changes in the oceanic circulation that could have driven climate changes in the Nordic and Barents seas and the Mediterranean region. I find the paper overall well written and illustrated, as well as insightful, as it applies newly developed ideas for the LIA into the 4.2 ka BP event. The authors also do a very detailed compilation of other available proxies in the region and interpret them in a very reasonable way. I therefore recommend the publication of this manuscript, although I encourage the authors to address the following comments before that:

L44 – Are this changes mostly seen in summer or winter?.

L50 – Evidence (remove s).

L51 – Berkelhammer (capital B).

L55 – North America.

L128 – Add comma between overflow and a. (In general, many commas are lacking throughout the text).

L144 – Regression here is confusing. Weakening would be better.

L143/145 – Moreno-Chamarro et al. [2017] find that the simulated weakening of the gyre during the LIA centuries starts during a solar maximum and a period of relatively high volcanic activity in the late 15th century; however, they do not attribute the weak gyre to such a solar maximum. In fact, a similar simulation with the MPI-ESM model and driven only by changes in the solar forcing [Moreno-Chamarro et al., 2016] is unable to reproduce the climate anomalies that full-forcing simulations show during the LIA. Moffa-Sanchez et al. [2014a] argued, in contrast, that a weakening in solar activity can lead to a weak gyre via persistent atmospheric blocking conditions during the past millennium, but this is not supported by simulations with the MPI-ESM model in Moreno-Chamarro et al. [2016; 2017]. I suggest the authors restate their conclusions about the role of the solar forcing. Besides, could they discuss other potential triggers,

like volcanism during the LIA?.

L154 – A δ is missing.

L166 – You could better cite here other works that have studied the particular dynamics of the SPG [for example, Langehaug et al., 2012; Born et al., 2014].

L168 – Replace “trending” for “trend”.

L168/170 – Replace “are suggestive of” for “suggest”.

L173 – interval “was/is” a long-standing.

L175 – Model results in Moreno-Chamarro et al. [2017] show a weak gyre associated with a salinity decrease in the Labrador Sea, not an increase. This does not exactly agree with the salinity reconstructions shown in Fig. 3g in the manuscript. In fact, colder and saltier ocean surface conditions in the Labrador Sea would lead to an increase in density that would, in turn, reinforce the oceanic deep mixing and eventually the SPG strength [e.g., Born et al., 2014]. I suggest few potential reasons: the first one is that the model does not correctly capture the pattern of changes in temperature and salinity in the Labrador Sea for a weak SPG; however, Moffa-Sanchez et al [2014b] find colder/fresher surface conditions in the Labrador Sea associated with a weak SPG during the LIA, in agreement with Moreno-Chamarro et al. [2017]’s results. Second, the fingerprint of SPG changes on the temperature and salinity in the Labrador Sea might have changed over the past 4000 years, although this might need to be proved. Finally, the proxy might not be fully reliable: this particular reconstructions has particularly low temporal resolution and presents a period of high salinity between 3600 and 2600 yr BP that does not differ much from values during the 4.2 ka BP event. I encourage the authors to discuss these results in the revised manuscript.

L185 – Nordic “and” Barents seas.

L201/205 – Split into two sentences.

L205 – “in this area”, which one?.

L207 – Are these changes mostly in summer? Winter? Year mean?.

– Paragraph starting in L208: I suggest the authors discuss the seasonality of these pollen records. The increase in atmospheric blockings in the models is mostly in winter, and the associated precipitation anomalies were not discussed. I would like to see whether the reconstructed changes in precipitation in are expected mostly in winter or summer.

L216 – (“>”750 mm).

L218 – Add an “a” before “Mediterranean precipitation regime”.

L222 – Add an “a” before “different picture”. Also, different with respect to what exactly?.

L333 – Replace “share resemblance with” for “resemble”.

L241 – “under sustained solar activity”. See my comment above about the connection between a weak gyre and the solar variability.

L255 – characterizes.

L256 and 257 – Replace “subpolar gyre” for “SPG”.

L259 – Here the high solar activity is again discussed.

References:

- Born, A., & Stocker, T. F. (2014). Two stable equilibria of the Atlantic subpolar gyre. Journal of Physical Oceanography, 44(1), 246-264.

- Langehaug, H. R., Medhaug, I., Eldevik, T., & Otterå, O. H. (2012). Arctic/Atlantic exchanges via the subpolar gyre. Journal of Climate, 25(7), 2421-2439.

- Moffa-Sánchez, P., Born, A., Hall, I. R., Thornalley, D. J., & Barker, S. (2014a). Solar

forcing of North Atlantic surface temperature and salinity over the past millennium. Nature Geoscience, 7(4), 275.

- MoffaâĂŘSánchez, P., Hall, I. R., Barker, S., Thornalley, D. J., & Yashayaev, I. (2014b). Surface changes in the eastern Labrador Sea around the onset of the Little Ice Age. Paleoceanography, 29(3), 160-175.

- Moreno-Chamarro, E., Schmiedl, G., & Jungclaus, J. H. (2016). Climate and ocean variability during the last millennium in paleo-observations and Earth system model simulations (Doctoral dissertation, Universität Hamburg, Hamburg).

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