Response to comments by anonymous reviewer #1

CPD manuscript “Coupling between the North Atlantic subpolar gyre vigor and forest fire activity in northern Scandinavia”

By the authors 09.01.2020

We would like to thank the reviewer for a clear and constructive review report. Please find below the point-by-point comments and answers. Important details about the revision are found in the author response to referee report 2.

Reviewer comment: “My only concern is that I missed the use of paleofire and paleoclimate reconstructions in this study. Observational data retrieved from reconstructions could help to understand the results (or lack of results) of this paper. I encourage the authors to include, at least in the discussion, a paragraph referring to previous paleoclimate and/or paleofire studies carried out in the study area (if there is any), summarizing their main results and comparing them with the simulations.”

This comment is highly relevant and has been discussed between the authors already. In the revision we will expand the discussion to involve published proxy data analyses in the manuscript, representing multidecadal to centennial scale variability due to the inherent low temporal resolution of the proxy data. Very few publications present proxy records for subpolar gyre circulation strength. Past surface salinity derived from planktonic foraminifera was used for this matter in Thornalley et al. (2009), Moffa-Sanchez et al. (2014) and Moffa-Sanchez & Hall (2017). Thornalley et al. (2018) used sortable silt to infer past near-bottom current flow speeds. All proxy records originate from marine sediment cores and cover the past millennium, but with low temporal resolution corresponding to multidecadal to centennial timescales. The seasonal variability therefore cannot be studied in detail from these records.

Moffa-Sanchez & Hall (2017) argue from proxy-based salinity records that the subpolar gyre circulation strength was weakened during the Little Ice Age, which is consistent with our hypothesis and the results from Drobyshev et al. (2016), namely that Scandinavian forest fire activity increased during this time period. We will include this information in the revised manuscript, and add more details of the relevant findings of selected proxy studies as suggested by the reviewer. Note that we do not include all main results of these proxy-based studies, since they comprise other and interrelated aspects of northern North Atlantic Ocean variability that are not within our focus.
The only study focusing directly on coupling North Atlantic Ocean dynamics with past forest fire activity in Scandinavia is Drobyshev et al. (2016). We feel this article is thoroughly described in the text already, see e.g the introduction lines 29-30 and discussion lines 210-213.

The relationship between North Atlantic SSTs/gyre circulation and atmospheric blocking has been investigated in model studies (introduction lines 37-41). There are no studies using purely observational data for this type of analysis. The closest alternative might be the study of Häkkinen et

al. (2011) which is already cited, they use wind stress curl and 500 hPa geopotential height from atmospheric reanalysis data to study the relationship between subpolar gyre circulation and atmospheric blocking events during the 20th century.

Reviewer comment: Please indicate the differences between R1, R2 and R3 simulations.

This will be added to section 2.1 - Data.

Initiated from the last year of the MPI-ESM control simulation, a 400-year spin-up period using AD 850 boundary conditions is the basis for the three simulations. They differ by the settings of the ocean state, parameters and initial conditions, but the differences are considered small enough so that all three simulations are probable for the past climate evolution under parameter and forcing uncertainties (Jungclaus et al. 2014).

Reviewer comment: L86-91 I would recommend to move this paragraph to the previous section (2.1. Data). More details about the MDC are welcome.

In the revised manuscript, the climate model soil moisture variable will be used to extract model years subject to extreme drought instead of the MDC. We make this choice based on comments from referee 2, in addition to the weakness that the MDC cannot properly model cold season drought.

Reviewer comment: what data was used to obtain the monthly drought code? Is that code based on simulations or paleoclimate data?

The text in Sect. 2.1 and 2.2 will be rewritten. The MDC is calculated using monthly maximum SAT and total precipitation data from the model simulations. In the text we attempt to justify our threshold for extreme drought (in terms of spatial extent and MDC values) by comparing the model MDC with real-world MDC and LFY thresholds. However, due to your confusion we understand the differences between the model- and real-world must be made even more explicit.

References

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