

Weather Clim. Dynam. Discuss., referee comment RC3
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Comment on wcd-2021-79

Anonymous Referee #3

Referee comment on "European summer weather linked to North Atlantic freshwater events in preceding years" by Marilena Oltmanns et al., Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2021-79-RC3>, 2022

This study investigates a relationship between freshwater anomalies in the North Atlantic and summer European climate up to several years later. The proposed mechanism involves cooling over the subpolar region and warming over the subtropical region that increases the meridional temperature gradient, leading to enhanced baroclinicity that alters the atmospheric circulation. The physical relationships are plausible and there are some interesting implications for predictability. However, I find the approach and manuscript quite confusing, and I believe major revisions would be required before publication.

Main points

1) I am not clear on whether the analyses actually address the role of freshwater events on European climate. The authors spend quite a bit of time establishing that the relationship between the NAO index and the freshwater events in the period studied is robust and useful (mainly based on previous studies), and hence that the NAO index can be used as a proxy for freshwater anomalies. The justification/explanation comes back in several places throughout the manuscript, perhaps drawing more attention to it than the authors intended. However, I did not fully follow many some aspects of the justification (e.g., a number of other possibilities are eliminated in L86-87, but the explanation is quite brief and as far as I can tell, only focuses on Ekman processes). The main question I was left with was, why not just use an index of freshwater anomalies? Perhaps there is an obvious answer here, but it didn't come through to me in the manuscript, and makes statements like L102-103 quite unsatisfying.

2) In general, it would be extremely helpful to clarify what this study is about and to choose an analysis strategy that directly addresses the

problem. The idea of circulation-induced versus melt-driven freshwater events in section 4.5 came as a surprise to me. In fact, I only realized that F_M and F_C (introduced earlier) are related to this, but had spent quite a bit of the manuscript until then puzzled by the names. Is it really the NAO index that's used to discriminate between these types of events? These ideas should probably be introduced in section 1, as they seem to motivate quite a bit of the study. Interestingly, section 1 as written seems more focused on sea ice loss and the origin of summertime freshwater, but later, the manuscript states that this isn't the focus of the study.

Other points that may or may not be relevant once the main comments are addressed:

3) If the negative NAO index is kept: It's quite confusing to talk about more negative or more positive values of the negative NAO index. I think it's fine to flip the NAO index, but perhaps the text should just talk about higher or lower values of the NAO. Also, I don't think the NAO index was detrended, but 2m temperatures were detrended. What is the reason for this? If trends are kept in, then the autocorrelation needs to be accounted for in subsequent statistical analyses.

4) Some of the oceanography concepts could be better explained for the non-oceanographers, and the same goes for the atmospheric concepts. e.g., L89 "the mass increase, implied by the cold anomaly,..."; L112-115 connection between poleward vorticity transport and momentum transfer from STJ to EDJ, L138-140 is there some relevant theory for the time scales behind the delay in the shift of the North Atlantic Current?

5) L 148 "successfully extracts..." Perhaps related to my general confusion about F_C and F_M, I don't have a good feel for how downstream effects from other drivers and IV would influence F_M, so this statement is difficult to understand.

6) L224: This first line of the conclusions is not representative of the main message of this study, is it?

Technical points:

- L61: "well-correlated" should be quantified if the NAO is kept
- Fig 1a is encapsulated in Fig. 2a - maybe don't need both?
- L84: Fig 2d is SSS?

-L127: the increase in sea level height is just in the subtropical gyre?