The authors use statistical analysis of observations and reanalysis data to support their hypothesis that warmer and drier summer weather in Europe can be linked to freshwater anomalies in the North Atlantic subpolar gyre region during the preceding year. The proposed mechanism for this link is a northward shift of the North Atlantic current leading to a similar deflection of the jet stream and therefore altering the advection pathway of maritime air masses. The foundation of the analysis are freshwater indices derived from a mass balance equation that are used to identify freshwater anomalies in relation to simultaneous sea surface temperature (SST) anomalies linked to the North Atlantic Oscillation (NAO).

I understand that this is a re-submission of an earlier version of the manuscript, but I was not involved in the previous review process. Therefore, I cannot assess how the manuscript has been improved, but rather provide a fresh pair of eyes.

I. General Comments and Suggestions:

1. One of central results of this study is the description of “a coherent, deterministic mechanism that links North Atlantic freshwater events to European summer weather” (l. 315-316). However, the actual role of the identified freshwater anomalies in the subpolar gyre remains unclear. Given the lack of salinity observations, SST anomalies in relationship to the NAO are used as proxy for freshwater anomalies. In turn, a substantial part of the described link between the freshwater anomalies and European summer weather is based on the enhanced meridional SST gradient between the subpolar and subtropical gyre, and its influence on the storm track over the North Atlantic. This raises the question to what extent the freshwater anomalies actually influence the proposed mechanism and the downstream response?
2. At times, it is difficult to follow the analysis which might be in part due to the overall structure of the manuscript and lack of some details in the text (often they are only mentioned in figure captions). Additionally, some of the terminology is unclear or inconsistent throughout the manuscript which is possibly an artifact from the refactoring of the previous version. Hopefully, the comments below will help to streamline the text and make it more accessible for the reader.
3. Some of the figures are hard to read as individual panels are small or details are obscured. For most maps, the colorbars and axis labels take up valuable “real estate”. I suggest to decrease their size and use the free white space to increase the maps wherever possible. Furthermore, I recommend to decrease the thickness of the coastlines since they can be quite distracting, especially on maps with vectors. It might also be worthwhile to mention differences in color scales in the caption wherever it can help guide the reader (e.g., Figure 2).

II. Main Comments:

1. Section 3/Appendix A: It took me a long time, including going back and forth between the main text and appendix to follow the approach. Given the importance of the freshwater indices as

foundation for the subsequent analysis, I suggest to combine Sections 3.1, 3.2, with Appendices A1, and A2 to describe the derivation in the main text including the clarification of the following points:

1. l. 126: Please state this equation.
2. l. 129: I think that M is not the same "downward mixing", but rather entrainment of water masses below the pycnocline into the surface ocean mixed layer as a result of a deepening mixed layer. In the context of this sentence, you refer to increased stratification due to large freshwater anomalies that inhibits a deepening of the mixed layer due to convection.
3. l. 135-137: This sentence becomes only understandable after reading the appendix.
4. Section 3.2/Appendix A2: The whole derivation of the freshwater indices is based on the NAO. I can't help but notice the striking similarity between the spatial pattern of the cold anomaly in the subpolar gyre for F_E and regression pattern of SST anomalies on the North Atlantic SST Index of the Atlantic Multidecadal Oscillation (AMO) in that region (see Fig. 11 in Deser et al., 2010). The AMO has been in its warm phase since the mid-1990s and thus during the time of most of the F_E years. This raises the question to what extent longer-term climate variability influences the relationship between the NAO and freshwater anomalies and if this can be utilized in the design of the freshwater indices?
5. l. 152-153: How do you estimate the correlation between the index and freshwater anomalies and how well the index represents the initial freshwater anomalies if they "are not known a priori" (cf. l. 148-149)? I think you are referring to SST anomalies which serve as proxies for the freshwater anomalies.
6. l. 156: Please define F_E and F_W explicitly. Without going through the appendix, the reader might ask themselves why there are two indices? What do the subscripts refer to? How are the two related?
7. l. 160: Please refer to Appendix A3 to show how these uncertainty estimates were obtained.
8. l. 161-162 & Figure 3: I think Figure 3 deserves more prominence in the text as these are the actual freshwater anomalies your hypothesis is based on. I suggest to move this sentence into its own paragraph and add more details, e.g., by being explicit that the shown salinity anomalies are estimate based on the surface mass balance (I think?), how you obtained the relationships, and what the white areas represent. Please define SSS.
9. Figure 2: Panels (a) and (b) should be the same as Panels (a) and (e) in Figure A1, but the structure of the largest values looks different. Is this just because of the differences in the color scale?
10. Equation (A2): Please define ρ_0.
11. l. 350: Strictly speaking, given Equation (A2) is the result of an integral over time, h_n is the mixed layer at the end of winter.
12. l. 359-361: How realistic are these conditions and at what timescales do you expect this assumption to hold?
13. l. 369 & l. 371: "lower NAO index" and "higher NAO index" – do these refer to the magnitude and/or phase of the NAO?
14. l. 375-377: It would be helpful for the reader if you add a sentence how the relationship was obtained. This is partially described in the caption of Figure A1, which makes it more difficult to follow the arguments in the text.

    15. l. 377: How did you determine the threshold?
    16. l. 377-378: I think it is important to also mention the significant positive SST anomaly in the subtropical gyre/western North Atlantic (Figure A1a) which has a substantial contribution to ΔSST for NAO < -0.5.
    17. l. 380-400: The description of the optimization process is unclear. I understand the rationale of increasing the signal-to-noise ratio, however, the selection of included years appears very subjective. How did you choose the number of years to include in the index? How did you select the discarded years? What about the two outlier years?
    18. l. 387: Please define the SST gradient in the text.
    19. l. 388-389: It is unclear what you mean by "spatial gradients are more robust to local variations in the surface fluxes". What if the spatial gradient is the result of local heat flux variations as one might expect from the response to the NAO (e.g., Cayan, 1992; Marshall et al., 2001; Deser et al., 2010).
    20. Figure A1: It would be more intuitive and consistent with the text if you wrote $NAO_S < -0.5$ in the title of Panel (a) and in the caption. Do you include the significant cold tongue off western Africa in the calculation of ΔSST?
2. Section 4.1:
    1. The circulation anomaly you describe (Figure 4b) is reminiscent of the positive NAO phase for which the atmospheric variability patterns and corresponding ocean response are known (e.g., Cayan, 1992; Marshall et al., 2001), and are in line with your findings. It would make this section stronger if you make an explicit link of your results to the winter NAO.
    2. Changes in the wind field associated with the NAO not only change the Ekman transport as you discuss (l. 198), but also lead to changes in latent and sensible heat fluxes. Can you elaborate to what extend these changes in air-sea heat fluxes are important for creating and maintaining the meridional SST gradient?
    3. l. 200: It is unclear why you bring in the second winter. A short motivation will help to keep the reader on board.
    4. l. 210-213: From the presented figures, I cannot see a northward shift of the North Atlantic Current during the first winter (I think it shows up nicely int Figure 4d for the second winter). Is it possible that different timescales between heat fluxes and Ekman transport can explain the differences between the first and second winter? A SST gradient which is set up in the first winter and shifted northward during the second year seems also more in line with the summer SST pattern that you describe in Section 4.2 (l. 227-229).
3. Section 4.2: This section seems rather short given that it addresses one of the main results of the study. It would be helpful for the reader if you add more details and clarify the following points:
    1. l. 231: "more northerly location" compared to what?
    2. l. 237, 238, 241: "cold anomaly" in the ocean or atmosphere?
    3. l. 240: "over Europe" is rather vague (e.g., the warm and dry anomalies (Figures 6c and d) occur in different regions). See also next comment.
    4. l. 241: Is it actually true that "the overall patterns are similar after F_E and F_W freshwater anomalies"? The significant air temperature anomalies one year after F_E extend across the Iberian Peninsula all the way to northern Africa while they are more centered around over

France and Great Britain after F_W. Similar the the dry anomaly occurs over the Alps and eastern Europe during the first summer after F_E, but more over Baltic region after F_W which is more similar to second summer response after F_E.

5. It seems like that patterns after F_W are one order of magnitude smaller compared to the patterns after F_E. Is this an artifact of the smaller correlation in the construction of the freshwater indices or is it due to the stronger meridional SST gradient that exists in the F_E subset with significant positive SST anomalies in the subtropical gyre region?
6. Is there a reason why you show the zonal wind at 700 hPa for the F_E subset and the meridional component for the F_W subset?

4. Sections 4.4 and 4.5.: I have to admit that I got lost here. In general, I am wondering whether the analysis of the model simulations adds any additional information that warrants its inclusion in the manuscript.
   1. l. 271: It is not clear which pattern (F_E or F_W) you project the on.
   2. l. 273: Most of the analysis in Sections 4.1 and 4.2 is focused on the first summer after both F_E and F_W years with only a brief discussion of the second summer after F_E. It is unclear why you construct a new index for the analysis of the model simulations based on the SST pattern in the second summer.
   3. l. 289: cold anomalies in the ocean or atmosphere?
   4. l. 294-295: Given your derivation of the freshwater indices using the surface mass balance, any cold anomaly coinicides with with a freshwater anomaly, by construction. Your analysis of the observations points out the importance of the the meridional SST gradient and its influence on the position of the jetstream. This raises the question whether the freshwater anomalies are just side effect of the mechanism that sets up the SST gradient. It is unclear to me how the model simulations help to answer this question.

III. Additional Comments and Suggestions:

1. l. 37, l. 83, l. 84: It would be more appropriate to use “grid spacing” instead of resolution (e.g., Grasso 2000).
2. l. 44: It’s not just cold air, but also stronger winds that increase heat fluxes.
3. l. 46: Please summarize the conditions here or refer to the derivation of the freshwater indices.
4. Section 2.1: Please add details about grid spacing, temporal resolution, and any processing (e.g., calculation of anomalies, spatial interpolation, etc.). This would help make the study more reproducible. It might also be worthwhile to specify in this section which months you refer to by “summer” and “winter” throughout the text, especially since they are different from the standard definitions June-August (JJA) and December-February (DJF), respectively.
5. l. 63: How did you combine the two datasets given their different temporal and spatial resolutions?
6. l. 94-97: This sentence is unclear. I do not understand why warm anomalies due to shift in the jet stream “must” be balanced by a cold anomaly elsewhere.
7. Here are a few wordings that are either inconsistent or remnants of the previous version of the manuscript:

    1. l. 185: “in winters after stronger freshwater anomalies” – based on the construction of your freshwater indices, the the anomalies should occur during winter.
    2. l. 211, 271, 316, 498, 499: what are “freshwater events”?
    3. l. 273, l. 419: What are “melt-driven” or “melt-induced” events? How are they connected to F_E and F_W?
    4. l. 421: What are “circulation-induced freshwater events”?
8. Figure 4: I suggest to mask out the Ekman transport vectors over land. This would make it more intuitive that they refer to an ocean variable
9. l. 253: Please add a reference for the statement that “most current coupled global climate models have large freshwater biases”.
10. l. 408: Do you integrate the wind stresse or resulting Ekman transport over the winter period?
11. l. 429: In l. 412-413, you define the heat flux (Q) as positive downward. A positive surface buoyancy flux (B) anomaly means Q needs to be positve (unless it its overcompensated by the freshwater flux), i.e., the ocean gains heat.
12. l. 439-440: What is the uncertainty in the freshwater fluxes due to the constant mixed layer depth used in your analysis?
13. Figure A4: It is unclear whether these are composites just for the winters before the warmest summers or also the difference with the coldest summers.
14. l. 498: This goes back to my first general comment (I.1.): If the SST pattern drives the observed atmospheric response, what is the role of the freshwater anomalies?

IV. Typos/Wording:

l. 53, 301: “ocean atmosphere” to “ocean-atmosphere”
l. 273: “over the central North Atlantic” to “in the central North Atlantic”

References:

Cayan, Daniel R. “Latent and Sensible Heat Flux Anomalies over the Northern Oceans: The Connection to Monthly Atmospheric Circulation.” *Journal of Climate* 5, no. 4 (April 1, 1992): 354–69. https://doi.org/10.1175/1520-0442(1992)005<0354:LASHFA>2.0.CO;2.

Deser, Clara, Michael A. Alexander, Shang-Ping Xie, and Adam S. Phillips. “Sea Surface Temperature Variability: Patterns and Mechanisms.” *Annual Review of Marine Science* 2, no. 1 (2010): 115–43. https://doi.org/10.1146/annurev-marine-120408-151453.

Grasso, Lewis D. “The Differentiation between Grid Spacing and Resolution and Their Application to Numerical Modeling.” *Bulletin of the American Meteorological Society* 81, no. 3 (March 1, 2000): 579–86. https://doi.org/10.1175/1520-0477(2000)081<0579:CAA>2.3.CO;2.

Marshall, John, Helen Johnson, and Jason Goodman. “A Study of the Interaction of the North Atlantic Oscillation with Ocean Circulation.” *Journal of Climate* 14, no. 7 (April 1, 2001): 1399–1421. https://doi.org/10.1175/1520-0442(2001)014<1399:ASOTIO>2.0.CO;2.