The authors use statistical analysis of observations and reanalysis data to examine a potential link between freshwater anomalies in the North Atlantic subpolar gyre region and summer weather in Europe in the following year. They propose that stronger freshwater anomalies resulting from increased glacial runoff in Greenland leads to an stronger meridional SST gradient between the subpolar and subtropical gyre and consequently increased baroclinic instability in the atmosphere above. The resulting deflection of the jet stream alters the advection pathway of maritime air masses over Europe. 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).

The revised version of the manuscript is a substantial improvement to the previous draft, particularly with respect to the derivation of the freshwater indices. However, there is still lack of clarity and detail in some methods, as well as precision in the description of the results. Therefore, the manuscript in its current form is not suitable for publication and I suggest major revisions based on my comments below.

I. General Comments and Suggestions:

Throughout the manuscript, multiple indices are used, but their exact definition unclear. Some details regarding the methods are often only mentioned in the figure captions leading to interruptions in the reading flow. Additionally, the description of results often remains rather vague or general, and does not necessarily match the figures. Similarly, I encourage the authors to be more concise and precise in their language, e.g., sometimes it is not immediately clear if they refer to the ocean or atmospheric anomalies or geographic descriptions are very broad. Some of these instances are mentioned in my comments below.

II. Main Comments:

1. Section 3: The combination of the appendices from the previous version with the main text helps better understanding and following the construction of the freshwater indices. However, there are a few points that require some clarification.
    1. l. 141-143: Equation (3) already has the mean state subtracted, yet you say “we subtract the mean values from the resulting equation”.
    2. l. 145: Please specify the the values of α and β.
    3. l. 165: There is no Figure 1a that shows the NAO in summer.
    4. Section 3.2: Some important information/motivation is either missing or presented later in the text which makes it difficult to follow the approach and understand the derivation of the freshwater indices:
        1. It is unclear how the resulting freshwater indices are defined. Are they (scaled) summer NAO indices, i.e., $F_E = \{-NAO_{S,i} \mid NAO_S < -0.5, i=F_E \text{ years}\}$ and $F_W = \{NAO_{S,i} \mid NAO_S > -0.5, i=F_W \text{ years}\}$?
        2. l. 173-179: This paragraph is missing some motivation why and how you use the meridional SST gradient to establish a relationship between the summer NAO and freshwater

anomalies in the following winter. I suggest something along the lines of: “Given the theoretical considerations based on the mass balance analysis (Section 3.1), there are certain conditions under which freshwater anomalies associated with the summer NAO are accompanied by temperature anomalies. To identify these conditions, we regress winter SST onto two subsets of the summer NAO…”. Please give a rationale for the seasonal lag.

3. l. 174-175 & l. 181: Is the “meridional SST gradient” the same as ΔSST? Please define ΔSST in the text.
4. l. 180: The “conditions c” are not explicitly stated in the text nor referred to in the remainder of the manuscript. I suggest to remove the variable name “c”.
5. l. 200-203: The significant SST anomalies associated with F_W extend from the Labrador Sea in the west almost all the way to the British Isles in the east while the SST anomalies associated with F_E occur mostly in the central North Atlantic subpolar gyre region. Thus the naming can be misleading unless you specifically refer to *maximum* cold anomalies.

2. Section 4.7: This section lacks a clear structure, clarity, and important details that make it hard to reconcile the results with the rest of the paper. In Section 3.2, you establish a non-linear relationship between a subset of summer NAO and SST anomalies associated with freshwater anomalies. Here, you use the “full, un-subsampled summer NAO” as a linear predictor to “assess the role of freshwater triggering the SST signal”. By regressing different variables onto the summer NAO and resulting SST pattern (which is quite different compared to the SST patterns related to F_E and F_W, cf. Figures 6a and 7a with Figure 10a), you describe the associated atmospheric response in both observations and models. As you point out in your concluding sentence of this section, “further studies are necessary to confirm the dynamical contribution of freshwater anomalies to the large-scale SST pattern”. Since an explicit link to freshwater anomalies, and their role in triggering your proposed chain reaction, is missing, this section creates confusion for the reader. I suggest to add more details following my comments below or remove this section entirely from the manuscript.
    1. Please specify what you are trying to predict using the “un-subsampled summer NAO as predictor”.
    2. l. 420: Please clarify what you mean by “reduced NAO states”.
    3. l. 422: I believe this should be Figure 10a-c.
    4. l. 423: Please discuss the significance that the warm anomalies occur mostly over land around the Mediterranean Sea, but the dry anomalies over the ocean.
    5. l. 429: Please specify that the upwelling occurs in the ocean below the center of the cyclone.
    6. l. 442-443: Please define SST_{FW} explicitly. Is this related to the F_W index? If not, I suggest to use a different name to avoid confusion.
    7. l. 443-444: This sentence is unclear. Please specify which “observational analysis” you are referring to. Does that mean you define the SST index based on the model simulations?
    8. l. 446: Please add more details in the text: Are you referring to temperature and precipitation anomalies from climatology or ensemble mean?
    9. l. 449-450: The observed and simulated atmospheric responses agree well over the ocean, while the simulated response over land is much smaller. It is not clear how you determined the statistical significance from the 90 ensemble simulations given that deems very small anomalies

close to zero as statistically significant – please add more details in the text and discuss the implications.

III. Additional Comments and Suggestions:

1. l. 4: What are “medium-term climate trajectories”?
2. l. 97: Please state years of “recent period”
3. l. 101-105: The 2 m-temperature trends are different over land than over the ocean (e.g., Simmons, 2022). Your averaging area includes large parts of the North Atlantic. Please discuss if this has any implications for your results.
4. l. 230-231: This is only true in the absence of vertical mixing.
5. l. 238-239: To keep the reader on board it would be helpful to state that "using this relationship, we estimate SSS from SST anomalies for the two NAO_S subsets”.
6. Figure 3: Did you actually do the regression? Given the linear relationship between SSS and SST, and assuming a constant coefficients, panels a and b should be equal to α/β * (negative areas in Figures 2a and b). However, the SSS anomalies show more structure. Is that due to the choice of contour levels? Please clarify.
7. l. 241-242: Please be more precise: the significant area of F_W SSS anomalies extend further eastward compared to the anomalies associated with F_E.
8. l. 244: Please refer to the appendix to ensure that the reader knows how the uncertainties were estimated.
9. l. 252-253: The different phases of the NAO are not associated with “opposite atmospheric circulation patterns”. They differ in the strength of the pressure difference between the subpolar low and subtropical high pressure system. In this regard, the wording “lower/higher NAO states” seems slightly odd. I suggest to make explicit links to F_E and F_W throughout the whole text.
10. l. 280-281: It is unclear how you identify “an intensified subpolar gyre circulation in the Labrador Sea” in Figure 4c.
11. Figure 4: What are the vectors in panel b? Please define dSSS in the text: it is unclear what you mean by “newly arriving, seasonal surface freshening from summer (August) to winter (January to March). Do you accumulate or take the mean of the freshwater anomalies during the winter months and subtract it from the August value?
12. l. 299-301: If the “seasonal freshening is mixed down and too small to affect the absolute SST anomaly in winter” when $NAO_S \geq -0.5$, does that not contradict the construction of the F_W indices or does the sentence refer to the years that were excluded in the optimization process?
13. l. 354-355: Please discuss the fact that the SST anomalies in Figure 6a are largely not statistically significant. What are the implications for your conclusions?
14. l. 359-361: This sentence is unclear. I don’t understand what you mean by “ the anticyclonic circulation anomaly is in part rotated over the continent”.
15. l. 362: Interestingly, the warm and dry anomalies during the first summer are not necessarily co-located. Please discuss/speculate why the dry anomalies occur more toward the southeast.
16. l. 364: Is the “cold SST anomaly” in Figure 7a statistically significant other than the very small region around 40°N, 40°W? What are the implications for your conclusions?

17. l. 367: Please discuss why, after F_W freshwater anomalies, the warm anomalies occur over France and Great Britain while the dry anomalies occur more to the northeast over the Baltic region.
18. Figure 6: The coastlines in panels c and d are hard to make out. This makes it difficult to relate it to the other maps, particularly since each row shows a different domain.
19. Figures 6 & 7: Does "SST with the 700-hPa winds (…) on F_E/F_W" mean you performed a multiple linear regression? Please provide more detail in the text.
20. l. 385: Please be more precise: Does "cold anomaly over the North Atlantic" refer to the composite of air temperature (Figure 8b) or the SST anomaly in the western subpolar gyre region (Figure 8e)?
21. Figure 8: What are the red lines in panel f?
22. l. 400: Please clarify what you mean by "SST variability each summer". Are you referring to the spatial distribution of summer SST anomalies?
23. l. 403-406: What is the correlation of the SST pattern with the summer NAO? It might be worthwhile adding the NAO time series in Figure 9e to demonstrate the relationship.
24. l. 407-410: To keep the reader onboard, I suggest to add a sentence that links the SST variability back to the freshwater anomalies.
25. Figure 9f: Please add a label for the x-axis.
26. l. 506: Please specify if you refer to an "increased meridional temperature gradient" in the ocean or atmosphere.
27. Figure A2: Why are the regions enclosing the 95% significance level different from Figure 2b?
28. l. 580-581: The cold anomaly regions cover the entire subpolar North Atlantic including areas of deep convection. Please discuss the implications and added uncertainty using a spatially constant value for the mean winter mixed layer depth.

IV. Typos/Wording:

I suggest the following changes:

l. 36: "requiring a high grid spacing of ~1/12° " to "requiring ocean models with high grid spacing of at least ~1/12°"
l. 64: "spatial resolution" to "grid spacing"
l. 84: "run at a resolution of" to "run with grid spacing of"
l. 158: "surface temperature" to "ocean surface temperature"
l. 160: "subpolar cold anomalies" to "subpolar SST cold anomalies"
l. 189: Please remove second "warm".
l. 317: "to north of" to either "north of" or "to the north of"
l. 326: "resolution" to "grid spacing"
l. 327: "resolution" to grid spacing"
l. 372: "subsets" to "subset"
l. 416: "autocorrelations" to "autocorrelation"
l. 417: "point" to "point out"
l. 435: "of SST signal" to "of the SST signal"

References:

Simmons, Adrian J. “Trends in the Tropospheric General Circulation from 1979 to 2022.” *Weather and Climate Dynamics* 3, no. 3 (July 21, 2022): 777–809. https://doi.org/10.5194/wcd-3-777-2022.