Referee Comments of "A climatology of atmospheric rivers over Scandinavia and related precipitation" by *Erik Holmgren and Hans W. Chen*

The manuscript studies the climatology of atmospheric rivers (ARs) in Scandinavia. The authors investigate the frequency, seasonality, and associated precipitation of four different pathways through which ARs reach Scandinavia, identified using k-means clustering. Additionally, they examine the relationship between large-scale atmospheric configurations (through the NAO index) and AR occurrences in the region. The manuscript is well written and well structured, and it addresses a relevant topic that has not been previously studied for the Scandinavian region. The manuscript is suitable for publication in *WCD* after some methodological clarifications.

1. The choice of ARDTs (*Section 2.1*): The ARTMIP project offers a large number of ARDTs. Why were these four chosen? Regarding the choice of ARDTs, there are other considerations to take into account:
    a. TempestLR algorithm (*Table 1*): The threshold used is based on the Laplacian of IVT. The threshold of 250 $kg \cdot m^{-1} \cdot s^{-1}$ stated there is probably not correct (Ullrich et al., 2021). Please make sure to include the correct threshold used in the catalogue.
    b. Reid500 algorithm: Using a fixed threshold of 500 $kg \cdot m^{-1} \cdot s^{-1}$ does not seem very suitable for Scandinavia, where some regions lie within the polar circle and these values of IVT might be too high. There are ARDTs specifically tailored for ARs in polar regions; perhaps one of those would be more appropriate for this study (Gorodetskaya et al., 2014).
    c. *Line 324*: Uncertainties regarding ARDTs are presented here. It would be nice if the authors could provide a recommendation of which of ARDTs are more suitable for this region, which lies between the mid-latitudes and polar regions, as no ARDTs are specifically designed for it.

2. In *Lines 105–107*, it is described how ARs are tracked, with the tracking condition being "4-connected component labeling". It is not clear what this means. Please expand this explanation to make it clearer. Could it mean that an AR should be detected through four consecutive time steps?

3. The AR tracking condition mentioned in the previous comment is applied to the detected blobs from the ARDTs in the catalogues, which themselves do not track ARs, this is not obvious since some of these ARDTs also track ARs. You mention this in Lines 334–336; this should be stated at this point as well.

4. In Line 113, the domain where the AR tracking is applied is introduced. It could be presented earlier (even in the previous Data Section), as this would improve the understanding of the methodology for readers who are not familiar with AR detection and tracking procedures. However, applying the tracking threshold to such a small domain might lead to missing ARs that reach the area for fewer than four time-steps. Considering a larger domain when applying the AR tracking condition could help prevent this issue. In *Figure 2a*, the Scandinavian AR frequency is shown, with a maximum around the west coast of Denmark, and the frequency decreases considerably around the British Isles, which typically exhibit a higher AR frequency (Thandlam et al., 2022; Guan et al., 2015) than the North Sea. Please ensure that this pattern

is indeed due to the condition that only ARs intersecting Scandinavia are included, and not an artefact of applying the AR-tracking condition within too small a domain.

5. In *Line 153*, it is explained how the AR precipitation is calculated, which is done by subtracting the non-AR precipitation. However, how is the non-AR precipitation calculated? I assume this is done when computing the field correlations between AR frequency and precipitation patterns. This process is not very clear, please clarify and improve the explanation in this section.

6. The NAO bins (*Lines 168–171*) are defined in four groups of equal size centered at 0. Nonetheless, this choice seems somewhat arbitrary and, later in the Results section, appears to limit the interpretation of the results (as all clusters seem to be mostly associated with a "strong positive" NAO). Since the NAO index is used as an indicator of large-scale patterns, the bins defined here might not be representative of specific large-scale configurations. For example, from 0 to 0.5 it is defined as a positive NAO, and between 0.5 and 3.5 as a strong positive NAO, but a value of 0.2 might not be representative of a positive NAO pattern, and a value of 0.7 might not represent a strong positive NAO, whereas a value of 2 likely would. Have you investigated whether your results are sensitive to the choice of these bins? One could consider defining NAO bins that are more physically relevant for certain weather patterns (e.g., Song et al., 2014, use a different threshold for NAO bins) or applying a weather regime approach (e.g., as in Messori et al., 2023), which goes beyond the NAO index.

References:

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