Authors' response to final comments

First of all, we want to express our gratitude to the topic editor and Referee #1 for their thoughtful revision of the latest version of the manuscript. This document presents a point-by-point reply to their final suggestions. Reviewer comments are shown in **black**. The authors response is included in **red**. The implemented changes are marked in **blue**.

Some final rather cosmetic comments the authors may consider:

From the reply to rev #1:

The threshold value is an absolute value established by the user. It is not latitude dependent and it is not determined by computing percentiles, at least in the algorithm itself. However, we recommend computing them beforehand to decide the threshold. For instance, we have chosen an IVT threshold of 300 kg m-1 s-1, based on the 99th percentile value of the IVT on L1 (260 kg m-1 s1). As for the L1 question, detection line 1 extends over a wide range of latitudes but we do not think that any of them are more represented than the others. In fact, this methodology is also applied by other ARDTs. In the figure below, we show the distribution of the mean impact latitude of the identified ARCI ARs (similar results were found for the other experiments), which turned to be more or less even.

I agree there is at least no significant increase with the higher latitudes up to 44°N. However, what would be if L1 would extend up to 55 to 65 °N. Would you recommend then the use of latitude dependent values to detect Ars impacting the UK or Norway? If so, you may consider mentioning this.

This is a very interesting question. In Rutz et al. (2019), Fig. 6 (shown below) illustrates the AR frequency of different ARTMIP methods for selected transects depending on the latitude. Along the European West Coast (from 35 ºN to 62 ºN), some methods diverge for latitudes higher than 44 ºN, especially *absolute* methods, like AIRA. This greater AR frequency was explained by a higher climatological value of IVT at these latitudes. In addition, this study attributed the dramatic jump in AR frequency around 45 ºN to the potential combination of climatology (placement of the storm track) and the greater number of coastal transect points at higher latitudes.

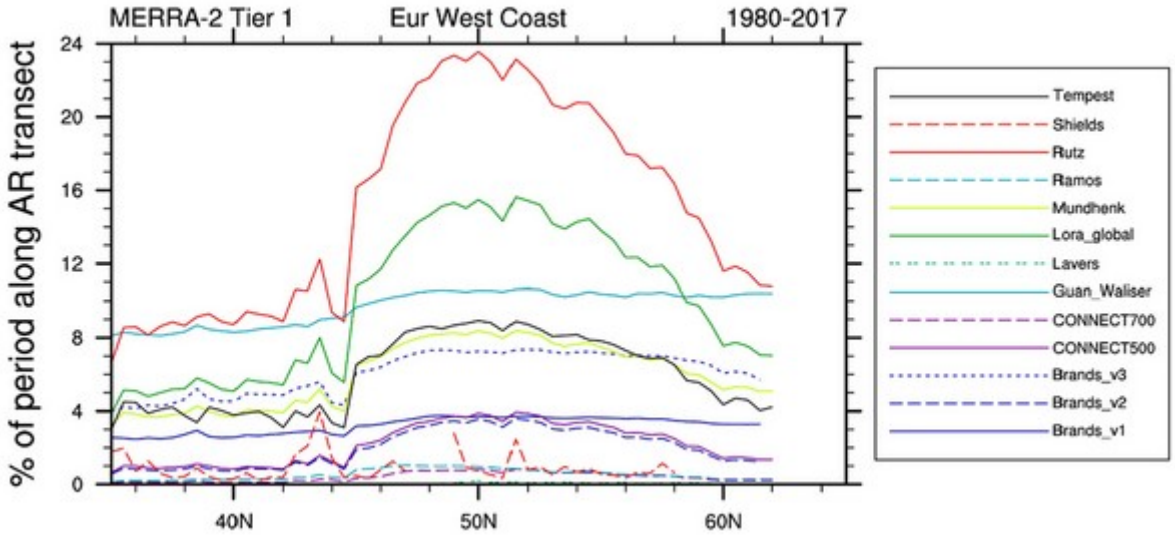

Figure. AR frequency of ARTMIP methods for selected transects along the European West Coast. Image extracted from Rutz et al. (2019) Figure 6.

Bearing these results in mind, we recommend calculating IVT percentiles before choosing the established absolute threshold. Furthermore, in response to your question, it may be advisable to use multiple smaller pairs of identification lines (sub-regions) if the region of interest comprises a wide range of high latitudes or if it includes the 44-45 ºN point, to mitigate the aforementioned divergence.

Rutz, J. J., Shields, C. A., Lora, J. M., Payne, A. E., Guan, B., Ullrich, P., O'Brien, T., Leung, L. R., Ralph, F. M., Wehner, M., Brands, S., Collow, A., Goldenson, N., Gorodetskaya, I., Griffith, H., Kashinath, K., Kawzenuk, B., Krishnan, H., Kurlin, V., Lavers, D., Magnusdottir, G., Mahoney, K., McClenny, E., Muszynski, G., Nguyen, P. D., Prabhat, M., Qian, Y., Ramos, A. M., Sarangi, C., Sellars, S., Shulgina, T., Tome, R., Waliser, D., Walton, D., Wick, G., Wilson, A. M., and Viale, M.: The Atmospheric River Tracking Method Intercomparison Project (ARTMIP): Quantifying Uncertainties in Atmospheric River Climatology, Journal of Geophysical Research: Atmospheres, 124, 13 777–13 802, https://doi.org/https://doi.org/10.1029/2019JD030936, 2019.

We have included this recommendation in Section 3.1:

"The identification lines employed in this study span a wide range of latitudes. However, no over-representation of the highest latitudes was observed. In order to study northern regions, like the UK coast, the use of smaller sub-regions may be advisable to mitigate the potentially over-increased frequency of ARs when applying absolute ARDTs at latitudes higher than 45º N (Rutz et al., 2019). Furthermore, the computation of IVT percentiles before establishing Γ is highly recommended."

Line 64: ***Nevertheless, it should be taken into account that the spatial tracking given a fixed time step method may not be suitable for data obtained from RCMs whose spatial limits are very close to the detection area. This is the case for most of the RCM runs, as they are primarily land-focused***.

That's true. However, not the limited size of domain may be problematic but also the fact that ARs loose moisture after landfalling which makes so that mapping over land methods with fixed time stepping deliver very uncertain results.

Thank you for your comment. It's true that once ARs make landfall they start to loose moisture and thus this is another difficulty that has to be faced when tracking ARs over land. AIRA could be useful in such cases, adjusting the IVT threshold. However, we have located the identification lines (L1 and L2) employed in this study close to the IP but over the ocean, in order to avoid said problem.

In my point of view Appendix D1 could be omitted. It is used in the main text to identify which of the aerosol treatment experiment is closest to observations. But a general statement about this would likely require more than two cases studies.

Thank you for your suggestion. You are right. The aim of Appendix D was just to show the observed precipitation distribution during the two case studies to deepen their understanding, following some suggestions of Referee #3. We did not intend to extract general conclusions. However, taking into consideration that no other relation between simulated and observed precipitation is mentioned during the manuscript, this appendix may seem out of place. Therefore, we have agreed to omit it in the final version.

We have omitted Appendix D and removed the sentences related to it:

"Furthermore, Fig. 15 displays the total accumulated precipitation distribution of this event. BASE and ARI present a similar magnitude, while the ARCI experiment exhibits a notably higher amount

of precipitation on the west coast of the IP. ~~The recorded accumulated rainfall can be found in Fig. D1 (left).~~"

"The southward displacement of the sea salt distribution in the ARCI experiment coincides with the deviation of the AR trajectory. As a result of this shift, the ARCI simulation displays the highest values of accumulated precipitation over land (Fig. 18)~~, which aligns with the observed data for this event (Fig. D1 (right))~~."