Dear reviewer,

thank you for your positive feedback and the constructive comments. In the following, we address the comments individually.

Specific Comments:

L58-60: I was wondering how strongly your results depend on the choice that a grid cell is already defined as an AD grid cell when only a single forward trajectory finds its way to the given grid point. I would assume that the fact that the end point of one forward trajectory lies in a grid cell probably does not necessarily mean that the local air mass is then strongly characterized by the AD air mass properties. Maybe this could be tested by initiating a certain number of backward trajectories from an AD grid point? If a majority of these backward trajectories can be traced back to the African source region, then it is safe to say that the local air mass is indeed strongly composed of the AD air.

Thank you for this comment. You have a valid point. However, calculating the trajectories is costly in computing time and data output, and we want to make the detection method feasible to use on long time series of data. Therefore, we want to avoid this extra step.

Additionally, the number of trajectories that end up in one cell is not only dependent on whether this cell is actually dominated by AD air, but also on how many trajectories were started in the first place. As we aim to make the detection method described in this paper computationally feasible even when run over longer times (i.e. years), the total number of initiated trajectories has to be further reduced. Also a different handling of the nighttime CBL (see answer to your second comment) might reduce the total number of trajectories drastically. Hence, using the presence of at least one trajectory in a cell as an indicator is a useful approach.

One approach to embrace your comment without increasing the computational needs would be to set a higher minimum number required for the identification of an AD cell. As this decision influences the definition of the AD edge, this is important for all the results and discussion related to Figures 1, 4 and 5 in the manuscript.

As can be seen in Figures 1 to 3 included below, in the regions where the location of the AD edge is critical to the discussion, there are many trajectories in the cells, so that a higher minimum number would not change the identification. Figure 4 (included below) shows the maximal extent of the AD, i.e. the colouring stands for the amount of trajectories in the respective columns. It becomes clear again, that most columns have a very high number of trajectories in them, hence not many are classified just because there is one trajectory in them.

We hope, that with this answer we could convince you that labelling a cell as an AD cell when it contains at least one trajectory is a useful approach and likely does not misidentify the AD edges drastically.

L68-75: As far as I understand you want to include the nocturnal residual layer air masses for your Lagrangian approach. However, it is in my opinion not fully appropriate to use this kind of a smoothing algorithm because the residual layer might also be of similar height than the daytime convective boundary layer; it might also develop in a certain way over night depending on environmental parameters. The smoothing is unlikely to fully reflect this behavior.

You are certainly correct, our smoothing approach cannot reflect the true residual layer. The idea was to use a smoothed BLH that still is lower during the night, so we rather under- than overestimate the true residual layer.

I would suggest to test whether your results would substantially change if you would only use day-time data for which the use of ERA5's boundary layer height might be suitable to estimate the height of the convective boundary layer..

We recalculated the results using only trajectories that were initiated during the daytime (1-5pm, including 1 and 5pm) and from below the ERA5 BLH. As the results do not substantially change, we have incorporated this in the manuscript now. Note, however, that this reduces the total number of trajectories significantly and we therefore again have to assume that an AD cell can be identified as such based on a single trajectory (see comment before).

L80-83: Although I think that I understand how the clustering is performed, it would be beneficial to state a bit more clearly that you are using a multivariate clustering approach. I assume that the data points are clustered within a 11-dimensional space, in which each dimension reflects one of the 11 standardized variables? (such that any of the variables have the same weight)

You did understand that correctly and we have added the following sentence to increase clarity: "We employ the 11 variables listed in Tab. 1 and the data driven k-means-clustering method (MacQueen, 1967) to cluster the trajectories. This is a multivariate clustering approach,using the 11-dimensional data after normalizing all variables (zero mean and unit variance) in order to give all of them the same "weight" or "importance" in the clustering."

L245-248: At least in my opinion, this short paragraph appears to be of minor importance compared to earlier paragraphs. Looking at the plots, I also had problems to identify the air mass that is found between the near-surface air and the overlying AD air mass. Therefore I would suggest to rephrase or remove this short paragraph.

Indeed, this paragraph is not crucial to the discussion and was therefore removed.

L275-280: I would suggest rewording these three sentences. In their current form, they confused me somewhat because I had difficulty understanding which kind of diabatic processes predominate over other diabatic processes.

We have rephrased these sentences to: "Additionally, the trajectories that did enter the local BL by 19 June 2022, 12:00 UTC, have cooled considerably, while the trajectories that end up above the local BL have warmed (for trajectories initiated on 15 June 2022 the cooling is about 6 K and the warming about 2 K on average). One reason for this different behaviour is that the trajectories entering the local BL experience less radiative cooling along the way on average (not shown here). The development of the specific water contents indicates that another reason for the difference is latent heating. While the trajectories that end up above the local boundary layer seem to form condensate which causes latent heat, the trajectories that enter the local boundary layer cool due to evaporation, likely of precipitation falling through from above (not shown here)."

Minor Comments:

We incorporated the minor comments directly in the text.

L313: I think it should say "western edge" instead of "eastern edge" if I am not mistaken
Thank you for pointing this out to us. Actually, "eastern edge" was correct, but the coordinates were accidentally swapped, which we now corrected. The paragraph before is about the lightning that occurs at the surface front (close to the **western** edge, but this paragraph is about the lightning that occurs close to the **eastern** edge of the AD at the 8800 hPa level. The coordinates were corrected in the text. The content of the discussion was correct, however.

Additional Comments:

We found a minor error in the calculation of the 2m temperature anomaly, which we corrected, so an updated version of Figure 3 will be found in the revised version of the manuscript (changes are small and do not influence the discussion).

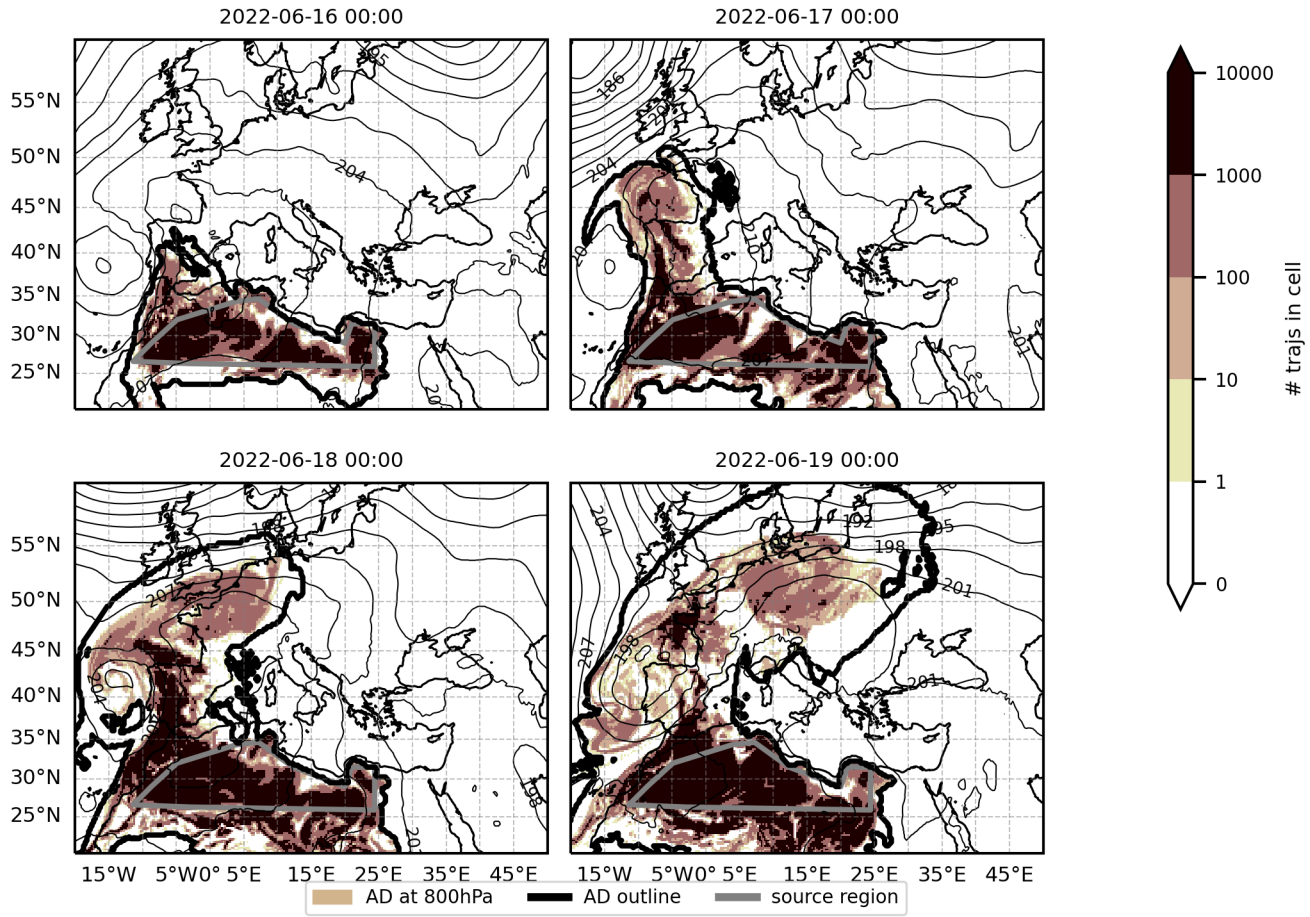

Figure 1: As Figure 1 in manuscript: AD extent in 800-750 hPa level in shaded contours, maximum extent outlined in black. Fronts and lightning omitted in this case, for better visibility. Colour scale refers to number of trajectories in the respective cell.

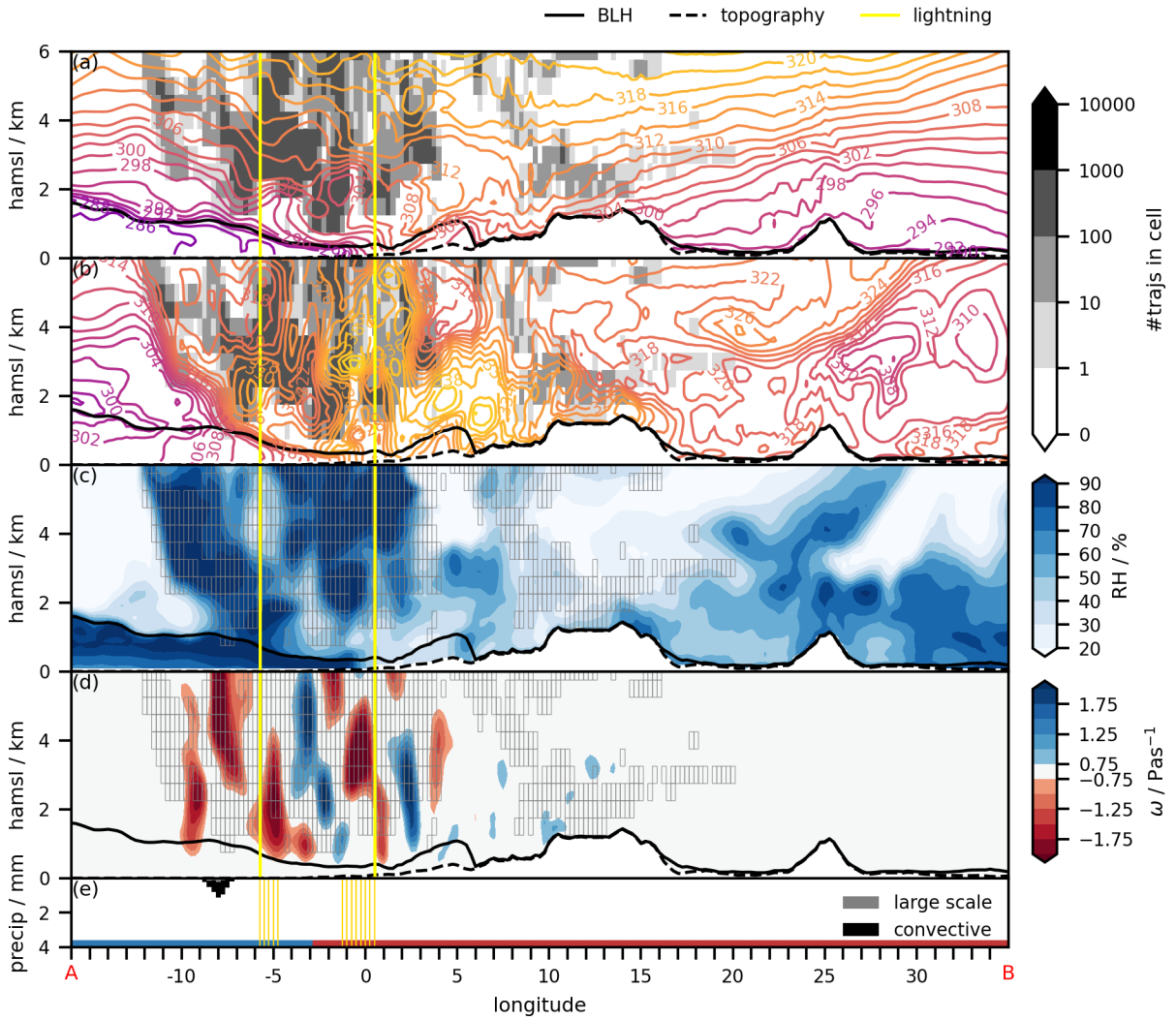

Figure 2: As Figure 4 in manuscript: AD air is marked in grey shading in the top 2 panels, the colour scale refers to number of trajectories in the respective grid box.

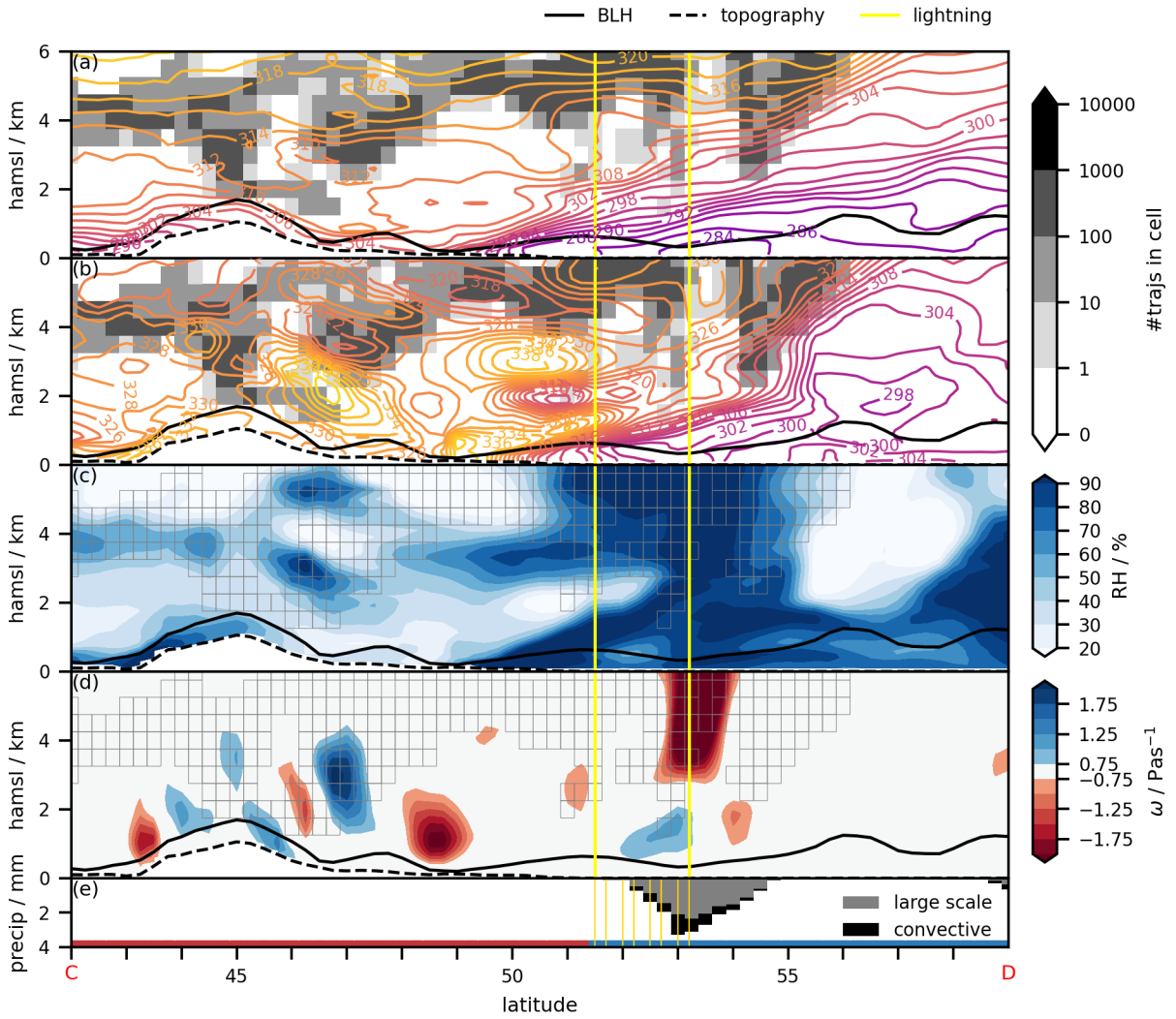

Figure 3: As Figure 5 in manuscript: AD air is marked in grey shading in the top 2 panels, the colour scale refers to number of trajectories in the respective grid box.

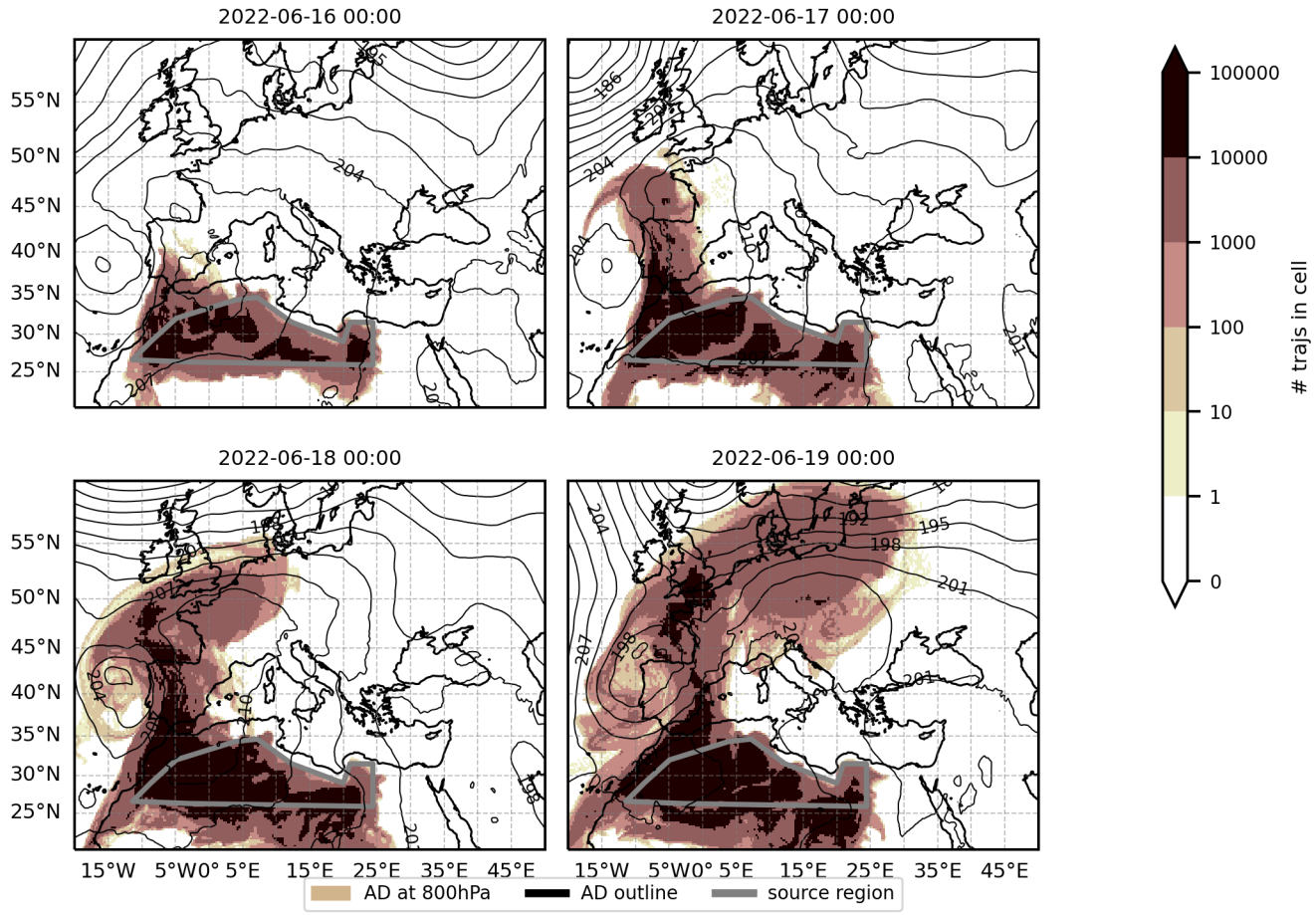

Figure 4: Colour shading for number of trajectories in the respective column, i.e. showing the maximal AD extent (as marked in black outline in 1). Attention: extended colour scale compared to Fig. 1.