Author Comment to Referee #1

Egusphere-2025-1670, 'Interannual variability of the Asian summer monsoon anticyclone' by O. Kachula et al.

We thank Referee #1 for the positive review and valuable comments for the revised manuscript. Our reply to the reviewer comments is listed in detail below. Questions and comments of the referee are shown in bold face.

1. **Q: I want to clarify the question, since I did not phrase it clearly. You use the optimisation method to find the background value which minimises the negative of the quotient of the Montgomery stream function (MSF) inside the ASMA box $[0° - 90°\,\mathbf{N}, 0° - 180°\,\mathbf{E}]$ vs outside the ASMA box [rest] +1. And you describe two cases, one where many MSF values inside the ASMA box are larger than outside (Fig. 1 of the manuscript), and one where there are MSF values outside of the ASMA box which are of comparable size to those inside (Fig. 2 of the manuscript). I would assume case one occurs most of the time during the peak phase of the ASMA in JJA, while the second case happens at the ASMA's start and end. I wondered whether the optimised background value during the peak phase of the ASMA is typically comparable to the maximum MSF value outside the ASMA region.**

   A: It is indeed possible to find a day, especially during the ASMA peak phase, when the background value would be equal to the maximum value outside of the ASMA box. But there is no guarantee that such favourable condition would cover all data. This leads to a set of heuristic rules when different treatment is required or a unified approach as the one proposed in this work.

2. **Q: And secondly, I would like you to elaborate and to clarify why your method provides physically robust results to define the ASMA region, and why your results should be more accurate than those of Plöger et al. 2015, Santee et al. 2017 or Manney et al. 2021. I think this is important, especially because your ASMA area trend is negative in contrast to previous studies. What troubles me is that your optimisation method to derive the boundaries of the ASMA region is not based on physical quantities or gradients in the area, but on a comparison of MSF on the globe. With which physical reasoning should the strength of MSF values, e.g. over North America, affect the boundaries of the ASMA?**

   A: This is a purely mathematical method. The evidence of its applicability to solve the problem of finding the boundary of ASMA can be gathered through statistical analysis and comparison with the existing methodologies. The moment quantities provide the information about the spatio-temporal evolution of the ASMA. The explanation of why the method provides improvements to Santee et al. 2017 and Manney et al. 2021 was given in the manuscript with Figure 3 (also answered with Q2 in the response to Referee #1). Figure C2 of the manuscript highlights situations when the proposed method determines the boundary in contrast to Plöger et al. 2015 that provide the interpolated PV barrier value for this day.

3. **Q: I saw that you removed (line 120 in the track changes) text pointing to the meaning of the ASMA boundary. Is there a reason for that?**

   A: Because in the manuscript we do not work with trace gases and aerosols hence the claim was removed.

4. **Q: Some clarification would help me here. My question is whether the optimised background value changes when area weighting is applied in the calculation. This is not answered by Figure 4 in your reply, by area weighting the MSF on a map plot, and cannot be addressed by just stating the choice of a different projection. However, your reply ("At the same time after applying area weighting, we see a difference...") suggests that you also performed some tests, including area weighting in calculating the optimised background value. If this was done, a discussion of the sensitivity of the results to this adaptation should be added to the manuscript if the unweighted calculations are further used, or the entire calculations may be done area-weighted for the whole manuscript. In my opinion, some area weighting should be included in the calculation of the absolute vortex moment and in optimising the background value. In the updated manuscript, the area is weighted by applying the Lambert Cylindrical Equal-Area projection "in our regional calculations". What are the regional calculations meant by and affected by it? And any influence by the projection is not represented in the equations that should be affected. Matthewman et al. 2009 also introduced a projection to account for area weighting. There it seems that the projection is included in the dx dy (Eq. 5), for the absolute vortex momentum. It may also be included in your equation indirectly, but for me, it is harder to see (e.g. with delta x and delta y being 1). If that is the case, I would suggest clarifying your calculation.**

   A: We are sorry for the confusion to this matter. "in our regional calculations" means that we applied area weighting to find the optimised background value based on the regions ratio. Delta x and delta y being 1 are just stated to highlight that we work with the grid of size 181×360.

   Figures 1 and 2 of this reply show the difference between optimised background value calculated with and without area weighting. As you can see the difference is biased toward positive values which tells us that the area weighting affects the optimized background values by slightly increasing them. But for majority of the background values the change is negligible. It also can be noticed that the higher standard deviation is caused by contribution from the outside of the ASMA active phase.

   We also agree that the area weighting is needed for the moments quantities (centroid position, excess kurtosis, etc.) determination. We updated the plots in the manuscript. The analysis remains the same, the trend lines were not affected by the area weighting procedure. The moment quantities have slightly changed. The biggest change can be seen for the centroid longitude and excess kurtosis. The area of the ASMA was not affected at all because it was calculated using the polygon of the ASMA boundary instead of following Matthewman et al. 2009 approach (it is mentioned in the manuscript, see L239). To clarify this issue we updated the manuscript.

The rest of the comments were taken into account and corrected accordingly.

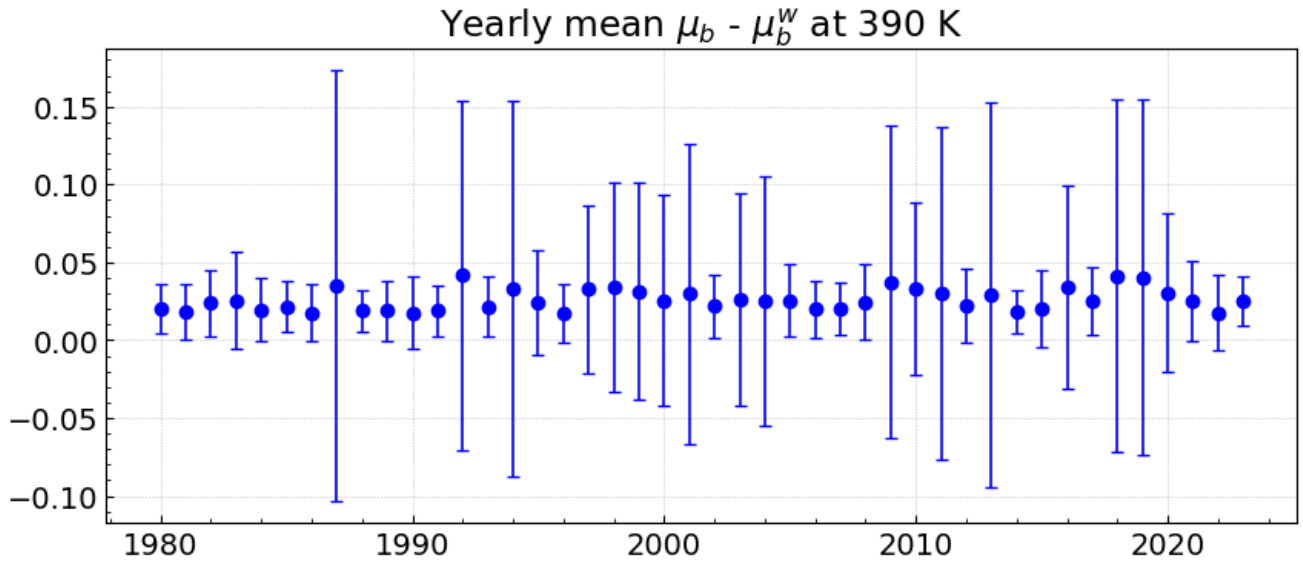

Figure 1: The yearly mean difference of the original μ_b and the one calculated without area weighting (μ_b^w) at 390 K.

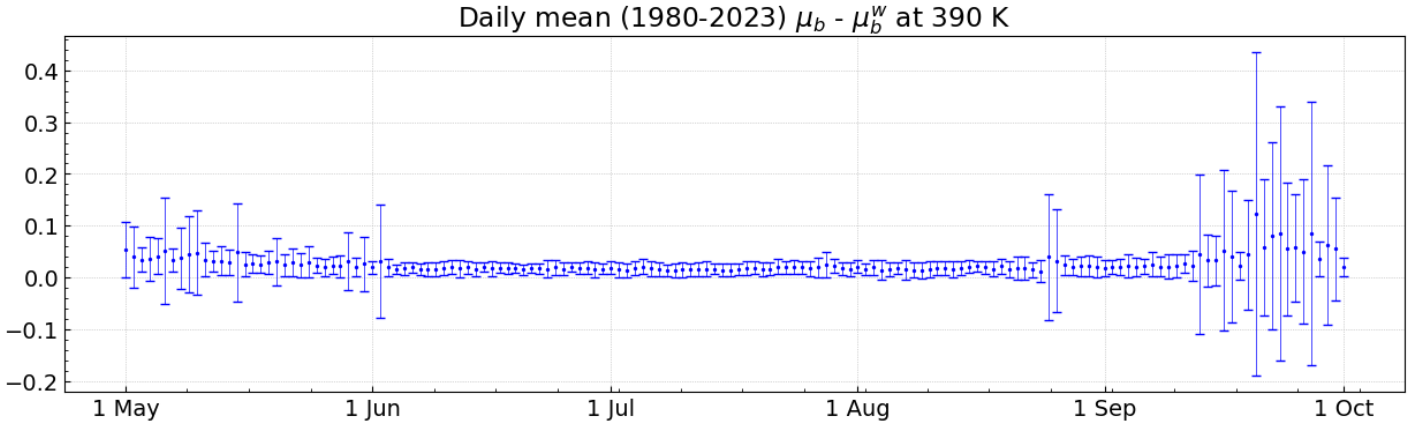

Figure 2: The daily mean difference of the original μ_b and the one calculated without area weighting (μ_b^w) at 390 K.