

Editor decision for paper

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**Climatology and variability of air mass transport from the boundary layer to the Asian monsoon anticyclone**

by M. Nützel et al.

I thank the authors for submitting their revised version. While reviewer 2 is happy with the revisions and accepts the paper for publication, reviewer 1 – a very experienced colleague – contacted me offline and indicated that “the authors largely rejected my comments and did not do much, if anything, that I suggested. I can’t recall having a review treated this way before. I see two options: 1) to ask them to take my comments seriously and revise the paper, or 2) to publish as is. I am OK with option 2, although I think it leaves the paper much weaker than it needs to be. I will leave the decision up to you.” While I understand that redoing the entire study with ERA5 would be an enormous task and beyond what can be done during revisions, the remark that the reviewer felt his/her comments to be largely ignored is problematic. I therefore had a closer look at the revised version, having in mind the general comment 6 from reviewer 1 about the conciseness of the writing. Although you shortened certain parts, the text is not yet fully reader friendly. I found several parts of the text unclear or distracting. Below my comments and suggestions.

L4: to me this sentence only makes sense if I insert hyphens “... displacements of the AMA with the PBL-to-AMA-transport”. Is this what you intend to say? This term appears many times in the paper. If you prefer a formulation without hyphens then I would suggest “... with the transport from the PBL to the AMA”.

L11: why “above”?

L15: why not simply “variability of PBL source regions”?

L34: you might like to add here a reference to the recent paper by Clemens et al. 2022:  
Clemens, J., F. Ploeger, P. Konopka, R. Portmann, M. Sprenger, and H. Wernli, 2022. Characterization of transport from the Asian summer monsoon anticyclone into the UTLS via shedding of low potential vorticity cutoffs. *Atmos. Chem. Phys.*, 22, 3841–3860.

L46: you often use “with respect to” when – in my view – a simpler construction would be much clearer, see also remark above. Here my suggestion would be “highlighted the importance of the Tibetan Plateau for the transport ...” Please ask the native speakers in the team of authors to check the use of “with respect to” throughout the paper.

L55: “analysis” should read “analyses”

L78: not sure whether I understand this question. Do you mean “Are the PBL source regions and the transport pathways affected by / sensitive to interannual east-west shifts of the AMA?”

L82: no need for “In particular”

L83: this sentence does not work, maybe “Results from the Lagrangian model will serve for a comparison with ...”

L97: I wonder whether the results of the study are sensitive to the choice of the starting level – here 150 hPa. This choice is not well motivated. Would you have trajectories at hand to check, whether a starting level of 100 or 200 hPa would lead to different results? At least you should better explain why this starting level is appropriate (and sufficient) to capture the entire transport from the PBL to the AMA.

L149: Is it correct that you use this GPHA threshold criterion only at 150 hPa? If yes, please mention this explicitly.

Section 2.3.1: I find it a bit painful to read this section. Please shorten the text, if I understand correctly, what you explain here is that you do not consider all years from 1979 to 2013, but only 14 years, and you selected them such as to capture the variability in the W-E position of the AMA as expressed by the South Asian High Index. This can be said in a few lines. And please list the 7 years each that were chosen for the west/east position of the AMA.

I don’t think that Fig. 2 is needed in this paper. Vertical motion at 150 hPa is not very relevant for the transport from the PBL to this level.

L198: Just write “First, we investigate the climatological ...”

L204: I think this is a very important point: you write here that you only consider trajectories that reach the PBL top within 90 days. How many of the AMA backward trajectories started at 150 hPa fulfill this criterion? I think it is important to mention this percentage. If it is substantially lower than 80%, then it might make sense to show Fig. 3 only for the trajectories that also fulfill the PBL criterion. Currently it is a bit strange that so many trajectories are started at 150 hPa over the Arabian Peninsula (Fig. 3), but this region does not appear at all when looking at the 200-hPa crossings (Fig. 4a). This should be discussed, and maybe the reason is that the Arabian Peninsula trajectories don’t reach the PBL within 90 days(?).

L207: I don’t understand “or below”

L209: I apologize but I am lost here. What you show in Fig. 4 are trajectories that fulfill at 150 hPa your AMA criterion and that cross the PBL height within 90 days (backward in time). I don't understand what you mean by "not necessarily the full three-dimensional pathways", do you mean by this, e.g., trajectories that don't go back to the PBL or trajectories that rise up only to 200 but not 150 hPa? And I am totally at lost with understanding why you show Fig. 5. Why is Fig. 5a so totally different from Fig. 4a? Also, the distinction between trj1 and trj2 does not seem very relevant to me. Things should be clear if you write that Fig. 4 shows the last upward crossing of the XX hPa level. (I assume that if a trajectory crosses a certain pressure level more than once, you only retain one crossing?).

L218: Here you write "To get a better picture of the full transport pathways ...", which is now confusing after Fig. 5. Do you now continue with the trajectories shown in Fig. 4, or does "full transport" mean that you include here other trajectories as well?

I wonder whether the results in Figs. 4 and 6 are fully consistent. Fig. 4a shows no 200-hPa crossings west of 60°E, whereas Fig. 6d shows many trajectories west of 60°E at altitudes from 9-15 km. Please discuss this discrepancy or my misunderstanding when comparing the two figures. And as noted by one of the reviewers, it would be most helpful to have a pressure axis in Fig. 6 (e.g., to make a good comparison with Fig. 4). This would be much more reader-friendly than the barometric height formula and the complicated text in L219.

L238: where can the reader see the "upward circling"? I don't doubt that this interpretation is correct, but I don't see it in the results shown. My understanding of upward circling is that the trajectories follow a circular path in the horizontal from the PBL to the AMA at 150 hPa. But the panels in Fig. 4 allow all sorts of interpretations of how air parcels, e.g., from the Northern Philippines move from the PBL to 150 hPa. This ascent could also be rather vertical according to Fig. 4, so what does "circling" mean?

L239: typo in "refines"

L256: very complicated "on individual dates with respect to the initialization date". I assume that Fig. 9 is done in the same way as Fig. 6?

L259: "remain stable" is not clear enough, what you mean is that the PBL sources seem to be very similar in years with an eastern position of the AMA vs. years with a western position of the AMA.

L267: Oh, now you quantify for the first time the trajectories that do not cross the PBL within 90 days (see my comment above)! I don't find it ideal that now, in Fig. 10, you consider all trajectories started from the AMA, whereas Figs. 4-9 only considered those that crossed the PBL. Therefore, the percentages in Fig. 10 do not correspond to percentages of trajectories shown, e.g., in Fig. 4. It

would be more reader-friendly, if the noX trajectories were mentioned earlier in the paper (before Fig. 4) and from then on, only PBL-crossing trajectories were considered.

L273-284: I suggest omitting this analysis, because it is already clear from Figs. 8b and 9 that the east-west position of the AMA does not matter for the PBL source regions.

L301: “transport from the TP into the AMA occurs vertically” – how does this correspond to the “upward circling” mentioned before?

L304: no need to motivate here again the need to look at intraseasonal variability, as you already discussed this in the previous subsection!

L309 and Figure 14: again, it is not ideal / not necessary that the noX trajectories are included.

L339: To me a supplement is a separate document, but you include Fig. B2 in an appendix, which is part of the main paper. Please decide about your strategy and terminology.

L363-366: I suggest omitting this short paragraph, because the reader does not really understand how you varied the PBL identification, and it is a bit arbitrary to test this sensitivity for LG-D but not for TRJ.

Discussion of Fig. 17: I am a bit confused why now hemispheric results are shown and the discussion includes the North American monsoon. Why not confine the analysis and discussion to the main theme of the paper?

L427-435: Why introducing here a discussion about the MHI? I think it is one conclusion that the west-east position of the AMA does not influence the upward transport substantially, so why then adding an excursion about MHI and SAHI?

L454: I would not dare to make such a statement. All data sets used so far for studying the transport into the AMA are far away from convection-resolving simulations. I think we need such simulations to really assess the impact of deep convection.

L500: “However, we found an upward circling already considerably below 150 hPa for approximately half of the PBL crossing trajectories.” I don’t understand where this result has been shown in this study.

L501 “The attribution of PBL source regions, however, is less clear” – what do you mean by less clear? Do you mean are more sensitive to the model / approach used? Or do you mean that a large set of source regions contributes?

Finally, I would like to briefly comment on your replies to the general comments of reviewer 1. While I can follow your argumentation about the difference between PBL source distributions and precipitation – indeed, you “only” look at upward transport that reaches 150 hPa – I thought that you might be able to do some sensitivity tests with your TRJ approach using hours ERA5 data. You mention that doing this for the entire study would be a huge effort. I fully agree. But already backward trajectories from 150 hPa for a single JJA season with hourly ERA5, 6-hourly ERA5 and 6-hourly ERA-Interim would be tremendously insightful. I cannot estimate how difficult it is for you to do such an analysis, and therefore I leave it up to you whether you include it or not in the final version of your paper. And about the complex link of the source maps and precipitation: could it make sense to discuss this in your discussion section? I find it interesting that with a starting level of 150 hPa, one obviously “misses” a lot of the vertical transport in the monsoon region associated with intense precipitation.