Reply to Anonymous Referee #2

The authors would like to thank the reviewer for her/his ideas, which helped a lot to make the paper more concise. We also appreciate the insightful comments on desirable additional analyses, which match the scope of an almost finished follow-up study.

General comments:

"The paper shows new in-situ data observed in the upper tropospheric part of the Asian monsoon anticyclone. Because trace gas observations in this region are very rare, it is important to publish this data. The observations show a very unique type of air composition in this region with contributions of variety of different processes. Due to the nature of the subject, it is probably difficult to give a more clear picture. As one of the most important findings, the unexpected high ozone levels are reported. Of course, it is difficult to explain this effect only from experimental data. However, using model (EMAC), it would be desirable to see how in the region around 150 hPa, the forming of the enhanced ozone levels during summer and September can be understood, or, at least is resolved by EMAC."

We agree with the reviewer that additional analyses are needed to understand the observed specific trace gas signatures in the broader context of processes generally relevant for the ASMA. Various such analyses were already part of an earlier version of the paper, which however became too voluminous. Thus we split the original draft. Now the current paper focuses on the HALO ESMVal ASMA measurements and their straight interpretation. Placing the measurements into the context of temporal and spatial ASMA variability is now the focus of an accompanying follow-up study (Gottschaldt et al., 2017). The model-based analyses there provide other insights into the underlying processes than the direct interpretation of the measurements. However, a detailed analysis of at least some representative measurements is still needed to understand the results of the more climatological analyses in the follow-up study. Furthermore, the current paper shows that our EMAC simulation reproduces the HALO ESMVal measurements reasonably well. Therefore the simulation may be used for the interpretation of the measurements (this paper), and the measurements provide some ground truth for the simulation-based analyses (accompanying paper). We found it impossible to reconcile those complementary aspects in just one concise paper of reasonable length.

"Furthermore, the paper tries to report everything one can say without trying to concentrate on the most important points. Thus, I would recommend to get rid of some unnecessary ballast (for some ideas see below). Thus because of these two reason (missing model-related explanation of enhanced ozone levels and too many details) the paper needs a major revision."

Following the reviewer's recommendations to shorten the text (his/her points 3. to 6.), we removed most of the discussion of POI2/4/5/6 from the main text. POI1/7 are not relevant for the ASMA and have also been moved to an appendix. Now the main text is more concise, but the entire flight is still documented for follow-up studies. The revised main text focuses on POI3, while the other flight segments are only discussed as far as needed to put POI3 into the context of the entire flight. Considering the recommendation of reviewer 1, we also shortened section 6.1

Minor points:

1. P 3/L 25: "On the contrary" - what do you mean. Contrary to "no decrease" is decrease. Please reformulate

The revised formulation is: "The in-situ measurements considered in our study also show enhanced CO mixing ratios in the ASMA, but instead of decreased O_3 we found significantly increased O_3 mixing ratios - relative to the UT air encountered south of the anticyclone. "

2. P 6/L 27: You are talking about streamlines but your never show them. You are only showing trajectories which, in general, do not follow streamlines. (only for a stationary flow streamlines and trajectories are the same lines). After presenting your data (Fig 1) and the vertical and horizontal cross sections through the model (Fig 2) it would be nice to see also the meteorology at e.g. p=150 hPa showing streamlines of the geopotential for few days before the flight.

We did pay attention to the difference between streamlines and trajectories when writing the paper, but indeed only had streamlines' plots for monthly mean fields in the Supplementary material of this paper and some hand-drawn streamlines in Fig. 2c. A figure with daily streamlines' plots had become part of the accompanying study (Gottschaldt et al., 2017). We thank the reviewer for noting this and added a new figure (now Fig. 3) to the main text, showing a daily sequence of streamlines and geopotential height from 9 days before to 1 day after the HALO flight at the altitude of the measurements.

3. P 6/L 33: POI2 - here is potential to shorten the text. This flight segment has nothing to do with ASMA

Most of the discussion of POI2 has been moved to Appendix A.

4. P 7/L 15: POI4 - too much information. However, the difference between the slow rotation (lower level) and fast rotation (higher level) is an interesting feature.

Most of the discussion of POI4 has been moved to Appendix A.

5. P 7/P 8: POI5/POI6 - in my opinion there is no reason to discuss these two flight segments separately. Also one trajectory figure would be enough. The difference between the Iranian and Tibetan mode cannot be seen from your investigation. I would recommend to remove this part of the text

Most of the discussion of POI5/6 has been moved to Appendix A.
There is an ongoing discussion about different modes or phases of the ASMA (Nützel et al., 2016; Pan et al., 2016). The study of Pan et al. (2016) that came out after our discussion paper distinguishes four phases: Tibetan plateau phase, Iranian plateau phase, longitudinally elongated phase, double center phase. We are aware that a single transect of measurements in the ASMA can contribute to this debate only marginally, at best. Nevertheless we need to discuss the ASMA splitting event that occurred during HALO ESMVal and could be inferred from Figs. 2 + 7, 5e, 5i, S6 in the original draft. It is even more clearly seen in the new Fig. 3 (revised manuscript) and might correspond to the transition from a longitudinally elongated phase to a double center phase in the new nomenclature of Pan et al. (2016). We just use the terms Iranian or Tibetan part/eddy/anticyclone to describe the splitting of one big into two smaller anticyclones, but avoid the words "mode" or "phase" in this context completely.

6. caption of Fig 3: Please explain only a, b, c, and d panels in this caption. For POI5/6 would be enough to write: same like for POI3

Done.

7. P9-11: I agree that the model performs good to represent the in-situ measurements. In the following chapter the tracer-tracer correlations are discussed. It would be nice to see (or only to know) how such correlations are represented in the model. Typically, models do not correctly represent such correlations. Maybe EMAC is better?

A direct comparison for short flight segments isn't meaningful because of the coarse resolution of the simulation. For instance POI3 is represented by just two points in a simulation with 12 min time stepping. Thus we sampled the entire region throughout September to get an idea on how those tracer-tracer correlations come out in the simulation. However, this rather climatological analysis is not needed for the straight interpretation of the measurements. Thus the tracer-tracer plots from the EMAC simulation are shown in Gottschaldt et al. (2017), together with the ranges covered by the in-situ data.

8. P11/L3: "...which is carried forward to the related large scale trace gas distributions" – this sentence is not clear for me. Please reformulate

The revised version reads: "This means in return that a large scale feature like the ASMA is likely to be represented well by the specified dynamics simulation setup, which is also well suited to reproduce the corresponding trace gas distributions."

9. P11 L15: "might not leave too much freedom" - much too speculative

We removed that sentence.

10. P13 L20: Figure 6 is difficult to understand. In particular the marks "N" and "S" are very confusing. I do not see north or south of the ASMA here.

The "N", "S", "W" and "E" marks have been replaced by a single "SW" mark and a note in the caption that the cuboid is seen from the SW corner (now Fig. 7).

References

Gottschaldt, K., Schlager, H., Baumann, R., Cai, D. S., Eyring, V., Graf, P., Grewe, V., Hoor, P., Jöckel, P., Jurkat, T., Voigt, C., Zahn, A., and Ziereis, H.: Working title: Interplay of dynamics and composition in the Asian summer monsoon anticyclone, Atmos. Chem. Phys. Discuss., in prep., 2017.

Nützel, M., Dameris, M., and Garny, H.: Is there bimodality of the South Asian High?, Atmospheric Chemistry and Physics Discussions, 1-30, 10.5194/acp-2016-362, 2016.

Pan, L. L., Honomichl, S. B., Kinnison, D., Abalos, M., Randel, W. J., Bergman, J. W., and Bian, J.: Transport of chemical tracers from the boundary layer to stratosphere associated with the dynamics of the Asian summer monsoon, Journal of Geophysical Research: Atmospheres, 121, 10.1002/2016JD025616, 2016.

Original manuscript	Revised version
Fig. 1	Fig. 1
Fig. 2	Fig. 2
	Fig. 3
Fig. 3 abcd	Fig. 4 abcd
Fig. 4	Fig. 5
Fig. 5	Fig. 6
Fig. 6	Fig. 7
Fig. 7	Fig. 8
Fig. S4 abcd	Fig. A1
Fig. S6	Fig. A2
Fig. S4 efgh	Fig. A3
Fig. 3 efgh	Fig. A4 abcd
Fig. 3 ijkm	Fig. A5 abcd
Fig. S4 ijkm	Fig. A6 abcd
	Fig. S1
Fig. S1	Fig. S2
Fig. S2	Fig. S3
Fig. S3	Fig. S4
Fig. S5	Fig. S5
Fig. S7	Fig. S6
Fig. S8	Fig. S7
Fig. S9	Fig. S8

Table 1: Mapping of figures between original and revised manuscript