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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global modelling studies of composition and decadal trends of the Asian Tropopause Aerosol Layer" *by* Adriana Bossolasco et al.

Anonymous Referee #3

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General comments:

This study is very well written and addresses a hot topic in the scope of ACP. It provides interesting hypotheses about the nature of the ATAL, e.g. that there is a double-peak vertical structure, mineral dust dominates aerosol mass, and that the ATAL signature has been increasing from 2000 to 2015. This should be published, considering the following.

The paper would benefit from actually working out if one or more of the above hypotheses have something to do with reality. In the current version, the analyses and discussions are limited almost exclusively to the modelling world, to one simulation.

This simulation is linked to the real world just by a comparison to observed CO. However, the emissions contributing to ATAL have other source distributions than CO, and are affected by other processes.

Furthermore, the uplift of air from the ground to the UTLS - a crucial process for ATAL – might need a closer look in the model: simulated CO compares favourably to the observations in the UTLS, despite being off in the free troposphere (Figure 1e). A much more thorough model evaluation would be appropriate, covering (proxies for) all species, precursors and processes of relevance for the aspects of ATAL that are discussed in this study. Sensibly splitting this between the supplement and the main text would allow the paper to stay concise.

Apart from the mere model evaluation, it would help putting some effort into researching available observations for support of the model-based findings about ATAL.

A more detailed understanding of the strengths and weaknesses of the simulation might also help the discussion of how this study compares to other modelling results.

Specific comments:

L87: have -> has

L105: The bimodality of the AMA has been discussed for longer, see e.g. (Nützel et al. 2016, Pan et al. 2016) and references therein.

L107: beweekly -> biweekly or bi-weekly

L116: larger aerosols composition -> more comprehensive aerosol composition

L116: Please check the use of aerosols / aerosol / aerosols' / . . . throughout the paper.

L149: Isn't anvil associated with convective rather than stratiform clouds?

L179: Simulated ATAL trends are likely to critically depend these assumptions. Please

elaborate on the uncertainties in the emissions' setup, providing the reader with a sense on how this might print through to the results for ATAL.

L191: Different reanalyses have different peculiarities in representing AMA (see e.g. Nützel et al. 2016). Please shortly note whether there is something specific the reader needs to know about MERRA.

L281: A 30

L303: Please consider showing the comparison to the corresponding observations.

L330: Is the following understanding correct? There is no dynamic tracking of the AMA. Rather you choose a static box, which most of the time is part of the AMA. Any averages should thus be dominated by AMA conditions. This is ok, but some rewording might help to make the approach clearer.

L335: Isentropic surfaces might be better to describe horizontal transport and thus the horizontal extent of the ATAL (Santee et al. 2017, Gottschaldt et al. 2018). Please check whether or not your results crucially depend on the choice of the vertical coordinate system.

L363: The term "mode" is already in use for aerosol size ranges and for the dynamics of the AMA. Does it refer to different aerosol classes here?

L363: Is there any observational hint for such a double-peak layering?

L397: "Double-peak", when used as adjective? Please check throughout the paper.

L405: Please mention in the caption that this is modelling only.

L433: That is rather vague. Several models get an ATAL, so it seems to be a quite stable feature. Interestingly, the exact characteristics vary, probably depending on the various factors listed here. For improving our understanding of ATAL it is therefore important to really understand the model differences, and to find those explanations that are supported by observations.

L457: Please use subscripts in chemical compounds throughout the paper.

L484: showed -> shown

L493: Is there a chance to be more specific: Which aspects of the dust cycle are captured well by your model? Which are not and what are the implications for your conclusions about ATAL?

L503: Here you state model shows that increased emissions translate into enhanced ATAL, but in L567 alternative explanations are offered. Please check consistency. Furthermore, as already noted by reviewer2, emission trends are more complicated. A more detailed analysis might be needed, e.g. explicitely correlate emissions (by region) with ATAL parameters.

L552: This formulation is kind of suggesting that Vernier et al. might be wrong. Please elaborate.

L555: Is CESM1/CARMA from the same model family you are using? Then getting similar results could also indicate a common problem.

L562: Another interesting hypothesis. Please check whether there are any observations supporting it.

L585: Please consider rewording: The results show . . . -> Our modelling results indicate . . .

L594: Please make it clear from the beginning that nitrate aerosols might be an important aspect you omit.

L812: space between references missing

References:

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