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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Upper tropospheric CH_4 and CO affected by the South Asian summer monsoon during OMO" *by* Laura Tomsche et al.

Anonymous Referee #2

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This study presents analyses of a very unique set of in-situ measurements of CO and CH4 to investigate transport pathways from the surface to the upper troposphere in the Asian summer monsoon region. The FLEXPART model calculations and simulations from a global chemistry transport model, EMAC, were also used in conjunction with the in-situ measurements during the monsoon season. The results presented here contains vast information with numerous figures depicting transport processes. I think the overall quality of this paper can be improved even further by redefining the science goals and reorganizing the results for more simplicity and clarity. I have a number of comments and suggestions for the authors might take into consideration.

General Comments

1. The goal of this study is not clearly stated. Is it to explore transport pathways inside

the anticyclone or in the vicinity? For instance, flight 19 suggests the measurements took place outside the anticyclone based on the boundaries estimated from the model simulations (Fig. 7 & 8). I think it is important to clarify the goal of this study and explain different transport pathways separately.

2. The abstract and introduction can be reorganized and refined. In introduction, brief background of the Asian monsoon anticyclone and its role in chemical transport in the UTLS region should be mentioned first. Then why in-situ measurements are so valuable but challenging and limited should be mentioned along with pros and cons of other data sources, including, satellite measurements. The purpose of utilizing two separate models should be emphasized. The key factors of OMO field campaign should be included with proper citations as well. Additionally, the goal of this paper and why this paper is unique compared to previous work should be mentioned clearly. Abstract of this paper should be a summary of what is shown in this work without including general statements. In the current form, most of the information exists without clearly stating what the goal of this paper is.

3. Section 2 (methods) should include general information about OMO field campaign, including its science goal. What other species were measured during the campaign? What were the science questions? Are there any references?

4. Section 3.5 (AMA mode) should include discussions of bimodal mode of the monsoon anticyclone shown in Zhang et al. (2002) and Nützel et al. (2016). Also, it should be justified why it is necessary to have four modes instead of two. Is bimodal distribution of the anticyclone wrong?

Specific Comments

1. The abstract includes a few general statements, which makes abstract sound rather like introduction. For instance, L9-11 (However. . .expected) can be removed.

2. P1, L7 – It is connected to -> It is part of the South Asian summer monsoon system

3. P1, L17-19 – Are those based on the in-situ measurements?

4. P1, L21 – areas within the upper troposphere -> areas in the upper troposphere

5. P2, L3 – Park et al. (2008) might be relevant here.

6. P2, L4 – within the strong. . .monsoon -> by the strong monsoon convection

7. P2, L5 – Park et al. (2007) might be relevant here.

8. P2, L9 – physical -> physically

9. P2, L17-18 – Full name for CARIBIC and IAGOS-MIZAIC should be provided here as well.

10. P3, L1- It is also important to mention that there is a big uncertainty in source estimates of methane (Bloom et al., 2017 GMD and references there in).

11. P3, L8 – 'variability of the AMA' can be explained more detail here.

12. P4, L8 (section 2.2) – I assume the trajectory calculations are done backward. Where is the initialization location?

13. P5, L11 (section 2.4) – The reason why MODIS cloud top pressure is used is missing. Is this used as convective proxy?

14. P5, L28 – I would like to know if there are any in-situ measurements of methane and if so how the mixing ratios compare with them even over different regions in different season.

15. P5, L30 – I have tried to find CO observations from satellite in Randel and Park (2006) but they seem to have used only ozone and water vapor.

16. P5, L31 – to identified -> to identify

17. P6, L8 -12 – This paragraph is not convincing to me without supporting material or references.

18. P6, L18 – This is in consistent -> This is consistent

19. L6, L20-22 – Do the mixing ratios of CO in the upper troposphere agree as well?

20. P6, L30-31- Does this problem prevented from using the measurement or only degraded the data quality of CO measurements?

21. P7, Eq. (1) – I think this threshold is somewhat subjective. At least it should be mentioned that this might introduce uncertainty in the analyses and also how sensitive the results are depending on the threshold values.

22. P7, L28 – Does the difference between Scheeren et al. (2003) and this study agrees with the values in Zimmermann et al. (2018) quantitatively?

23. P8, L13 – cloud top height pressure -> cloud top pressure (also in P10, L23)

24. P8, L16-17 – This sentence should be revised for clarity.

25. P8, L34 – high pressure -> anticyclonic

26. P9, L13 (Figs. 7 & 8) – Here, it looks like the flight path is outside the anticyclone based on the model simulations. The high values from the flight almost should be at the center of the anticyclone. I am not sure how to understand those comparisons.

27. P15, L29 – Instead of 'these transport' describe specific transport processes here.

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