Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-856-RC2, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Water vapor increase in the northern lower stratosphere by the Asian monsoon anticyclone observed during TACTS/ESMVal campaigns" *by* Christian Rolf et al.

Anonymous Referee #2

Received and published: 15 November 2017

General comments

The paper of Rolf et al. presents analyses of aircraft in-situ measurements of water vapor and methane in the northern extra-tropical lower stratosphere (Ex-LS). Trends of H2O and CH4 within the observational period are attributed to tropospheric inmixing in the Asian monsoon anticyclone (AMA) and subsequent transport to the region of the measurements, using the CLaMS model.

The topic of the paper is relevant and well within the scope of ACP(D). The current manuscript is well structured, but in places the writing impedes understanding of what the authors want to convey. So if one of the following comments seems to miss the

Printer-friendly version

Discussion paper

point completely, it might just be a language issue.

My main concern is the novelty or substance of the paper. Moistening of the Ex-LS via the AMA has been reported before (Randel and Jensen, 2013), even based on in-situ data from the same 2012 campaign and a similar methodology (Müller et al., 2016, Vogel et al., 2016). Vogel et al. (2016) also already quantified the moistening for the entire monsoon season of 2012. Although Rolf et al. provide additional and detailed analyses, new findings should be brought out better in the paper.

The analyses of this paper are based on measurements in a rather limited region and during a short period of time. It's a case study, which is not always properly reflected by the writing. Additional modelling (or observations) might help to scale up the results and draw more general conclusions, e.g. if the results hold for several monsoon seasons; or provide an estimate for the impact of the Ex-LS moistening on surface temperatures ... just ideas for adding some substance.

Methodology:

(1) I don't really see the point in using tracers of airmass origin here. The tracer(s) described in the paper do not seem to be reliable indicators of AMA air, and do not provide additional relevant information as compared to back-trajectories.

(2) The choice of the two time periods for detecting changes to H2O and CH4 seems to be rather arbitrary. The delta should be discussed in the context of the transport time scales involved, which might be available from back trajectories. Transport time scales also seem to be the key for relating the results of this paper to the numbers found by Vogel et al. (2016).

(3) Convection is an important process when it comes to the AMA, but is notoriously hard to capture in large-scale models. Please discuss, how you consider convection.

(4) The term "statistic" seems to have been added to the corresponding terms in re-

sponse to the initial review, but I still do not see actual statistical calculations. Please provide details on the statistical methods used for those obviously non-Gaussian distributions, mark significant points/ranges where applicable, provide correlation coefficients, confidence intervals etc. This might not apply to each and every use of statistical terms (correlation, significance, ...), but you should make clear where it is normal language rather than backed by maths.

(5) Flight paths determine the region of study and should be shown. Citing Müller et al. (2016) only helps partially, because they analyse slightly different periods.

(6) Please distinguish between "concentration" and "mixing ratio" throughout the paper. For instance, "ppbv" is a unit for mixing ratios (better: nmol/mol). The SI unit for molar concentration is mol/m3, for number concentration 1/m3.

Specific comments

P1L8: Are those the exact numbers? Otherwise please use “about”

P1L13: exclusively -> mostly/predominantly

P2L9: AMA is leaky

P2L29: ESMVal went around Africa

P2L30: Why those dates? The Monsoon starts in June/July, but your approach seems to be based on the assumption that less trajectories from the AMA have reached the flight paths at the beginning of Sep compared to the end of Sep. Please discuss the time scales for transport from the AMA to the measurements.

P3L12: explain acronym

P3L28: Does that mean that this type of emission tracer preferentially ends up in the AMA? For using MON as a proxy for the AMA, it is not enough to show that MON is the main source of AMA air. Additionally, MON must not end up in significant amounts

outside the AMA.

P4L17: Does possible supersaturation play a role for these analyses?

P4L20: Consider rewording to make clear that both conditions must be met.

P5L9: The motivation for choosing potential temperature difference to the local thermal tropopause is not clear to me. Water vapour depends on temperature, but the thermal tropopause is based on a lapse rate. Also, potential temperature is good for characterizing isentropic transport, but not necessarily temperature history.

P5L10: Please briefly motivate using equivalent latitude

P5L11: consider choosing the contours in Fig. 1 to display the threshold used in the text

P5L15: Fig. 1 only shows equivalent latitude as vertical coordinate. Were similar longitudinal regions sampled during both phases?

P5L16: This sentence is not clear to me. Do you mean that below 8PVU some "pixels" in your eqLat-DTTP-space show larger differences than others of H2O between the two phases? How does the thermal tropopause affect local variability? Fig. 1c shows local differences in water vapour. It sounds a bit odd to attribute local differences of water vapour to local variability of water vapour. Consider revising.

P5L26: You point out that the distribution is compact for period 1. This gives the impression that most of the moistening happens between the two periods. However, period2 is already at the end of the monsoon season. Why is 0.5ppmv consistent with 1-1.5ppmv then? What are the transport time scales involved?

P5L28: How did you test significance for those non-Gaussian distributions?

P5L28: Are your measurements representative of the entire Ex-LS?

P5L33: Please show CH4. It might support your claim that the signature originates in

the AMA.

P6L4: 100

P6L5: Do you just want to say increasing H2O corresponds to increasing MON? However, providing some correlation coefficients for the region above 8PVU would be good. To me the pattern above 8PVU looks different between Figs. 1c and 2c.

P7L8: "Thus" and "because" in one sentence is confusing. Please clearly express why you consider CH4 to be a monsoon tracer. Please provide references for each argument.

P8L4: What is the statistically significant region in this plot? Please provide numbers for the background mixing ratios.

P8L5: The grammar of this sentence is odd. However, no matter how I interpret it, the definition of the core region remains unclear. If the core region is defined by the 75

P8L11: sounds odd, consider rewording

P8L12: This sentence is not clear to me. Did you test statistical significance? If so: How exactly did you do that? The scatter plots show H2O mixing ratio versus CH4 mixing ratio. If you want to discuss the statistics of deltas ("increase"), please show deltas.

P8L12: slope CH4/H2O -> tilted towards a higher ratio or higher CH4, but not towards higher H2O. Please revise. Also, you discussed that contributions from the ASM increase H2O and CH4. Fig. 3 looks like the ratio CH4/H2O changes. Is that also a tell-tale sign of ASM origin?

P8L17: 1. "Water vapor is dehydrated" sounds odd; 2. Do you mean that dehydration typically happens close to the saturation mixing ratio, or that air masses typically get close to saturation at the LCP? (Only wet air might produce ice crystals). Please revise.

P9L2: Are you considering only trajectories that originate in the troposphere here? The

LCP that determined water vapor might lie further back than the reach of the backward trajectory.

P9L10: remove "notably" or "interestingly"

P9L20: ... and region of the flights?

P9L23: Fig. 5 can be removed. The next sentence contains all the information.

P9L25: amount -> fraction or percentage

P9L25: in phase -> contributing to phase (Please have in mind that transport from the AMA needs some time.)

P10L5: How did you calculate the correlation? Please provide numbers.

P10L6: distinguish between AMA and the respective surface tracers

P10L11: I am not convinced. Please elaborate on how you relate your results to Vogel et al. (2016). Is water vapour transport from the AMA to the ex-LS constant throughout the monsoon season? How do you relate your phase1/gap/phase2 periods to the monsoon period? Are the diagnostics comparable?

P10L19: crossing is displaced OR crossings are displaced; What is combined with quasi-isentropic transport? Please revise and consider splitting it into two sentences.

P10L21: "picture of influencing" sounds odd

P10L25: This should be shown, at least via a rough estimate.

References:

Müller, S., P. Hoor, H. Bozem, E. Gute, B. Vogel, A. Zahn, H. Bönisch, T. Keber, M. Krämer, C. Rolf, M. Riese, H. Schlager, and A. Engel (2016), Impact of the Asian monsoon on the extratropical lower stratosphere: trace gas observations during TACTS over Europe 2012, Atmospheric Chemistry and Physics, 16(16), 10,573–

10,589, https://doi.org/10.5194/acp-16-10573-2016.

Randel, W. J. and Jensen, E. J.: Physical processes in the tropical tropopause layer and their roles in a changing climate, Nat. Geosci, 6, 169–176, doi:10.1038/ngeo1733, 2013.

Vogel, B., G. Günther, R. Müller, J. U. Grooß, A. Afchine, H. Bozem, P. Hoor, M. Krämer, S. Müller, M. Riese, C. Rolf, N. Spelten, G. P. Stiller, J. Ungermann, and A. Zahn (2016), Long-range transport pathways of tropospheric source gases originating in Asia into the northern lower stratosphere during the Asian monsoon season 2012, Atmospheric Chemistry and Physics, 16(23), 15,301–15,325, https://doi.org/10.5194/acp-16-15301-2016.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-856, 2017.