Many thanks to the reviewer for the comments, and they have helped to improve the clarity of the manuscript. In the following, we address all the points raised in the review (denoted by italic letters). Text changes in the manuscript are highlighted in red or blue.

1. General comments

The paper is an interesting and important contribution for assessment of the monsoon influence on the global stratosphere and should be published in ACP. New against earlier studies (e.g. Ploeger et al., 2017) is the analysis of NASM effects. However, the paper would gain a lot if simulations on the sensitivity of results on the positions of the boundaries of the monsoon boxes are included, especially the southern edge of ASM, which appears to be rather close to the equator, and the eastern edge of NASM (too far east). The position of the southern edge of ASM (e.g. 20N instead of 15N) might be critical for transport to the tropical pipe and to the southern hemisphere as indicated in Yu et al. (2017). This should be included in Figures 8 and 9. Also some sentences should address the differences to the method where the monsoon air masses are separated using PV instead of a rectangular box and if results are different to Garny and Randel (2016).

A. Thanks for this important remark. We now added a sensitivity simulation with the ASM source region defined as [20° N, 45° N, 30° E, 120° E] and the NASM source region defined as [15° N, 40° N, 120° W,

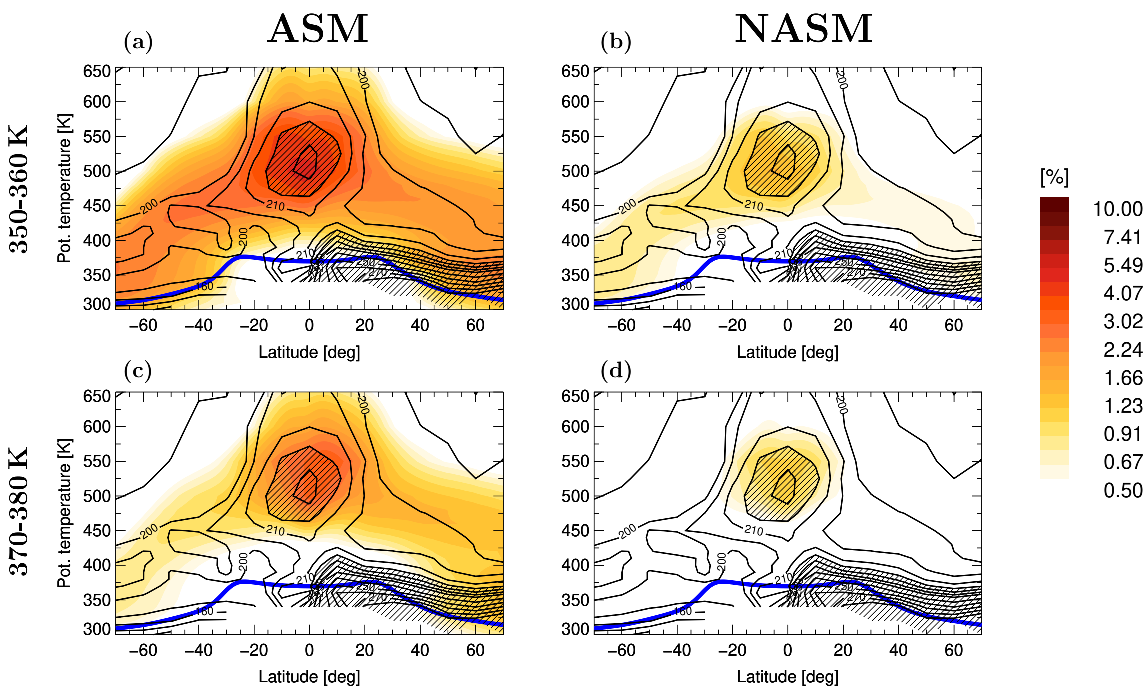

Figure RL 1: Climatological (2010−2013) zonal mean air mass fraction from the ASM (a and c) and the NASM (b and d) initialized at 350−360 K (upper) and 370−380 K (lower) in CLaMS-EI (color shading) during the following April−June. HCN from ACE-FTS observations (black contours) is also shown for context. Regions with HCN volume mixing ratios greater than 215 pptv are hatched. Blue lines mark the lapse rate tropopause. (Note the logarithmic color scale.)

60° W]. Figure RL 1 shows the average air mass fraction from ASM and NASM regions initialized in the 350−360 K and 370−380 K layers in July and August of 2010−2013 in the CLaMS-EI simulations during the following April−June. We can see a lot of similarities between Figure RL 1 and Fig.3 in the manuscript. In particular the transport patterns are not depending on the exact boundary of the source region. Here, more monsoon tracer is transported into the stratosphere from the 350−360 K layer than from the 370−380 K layer for both the ASM and NASM regions. The abundance of monsoon air initialized at 350−360 K is higher in the SH stratosphere than in the NH, while monsoon air initialized at 370−380 K is more likely to remain in the NH. The monsoon air mass in the stratosphere is lower than it from Fig.3 in the manuscript mainly because of the smaller domain used here.

To quantify the transport from source regions with different domain to the destination regions, we do the

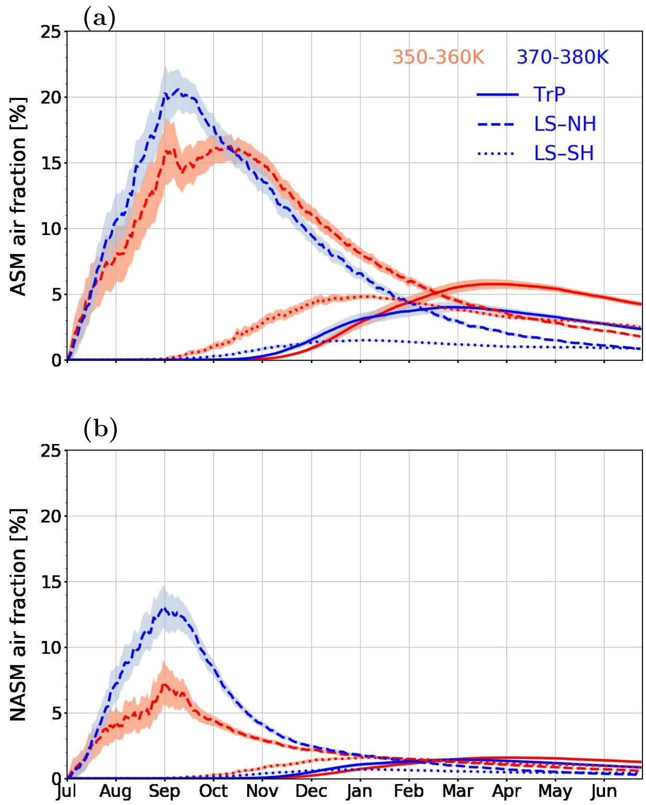

Figure RL 2: Climatological time series based on the CLaMS-EI simulations of source regions: (a) ASM and (b) NASM air mass fractions (in %) and diagnosed in three destination regions (see Fig.2 in the manuscript): tropical pipe (TrP, solid line), extratropical lower stratosphere in the NH (LS-NH, dashed line) and in the SH (LS-SH, dotted line). Shading shows the mean standard deviation in the zonal average (multiplied by 0.2 for better visibility). Red and blue lines respectively represent the tracers released in the 350−360 K and 370−380 K layer.

same as Fig.8 in the manuscript. Figure RL 2 shows CLaMS-EI time series of ASM and NASM tracer in the three destination regions (TrP, LS-NH and LS-SH). The abundances of ASM air in the three destination regions are slightly lower than those from Fig.8 in the manuscript as we expect because of the smaller domain. While the contributions from NASM to the LS-NH are much smaller compared to the results from Fig.8 in the manuscript because the domain used in the manuscript is almost twice larger than the domain here, we can see better comparison results from the transport efficiency (TE) below. However, the transport patterns are quite similar including the daily structures. Hence, the conclusions of our study are qualitatively robust to reasonable definition of the monsoon boundary.

Figure RL 3 compares the TE from the ASM and NASM source regions each divided into two layers

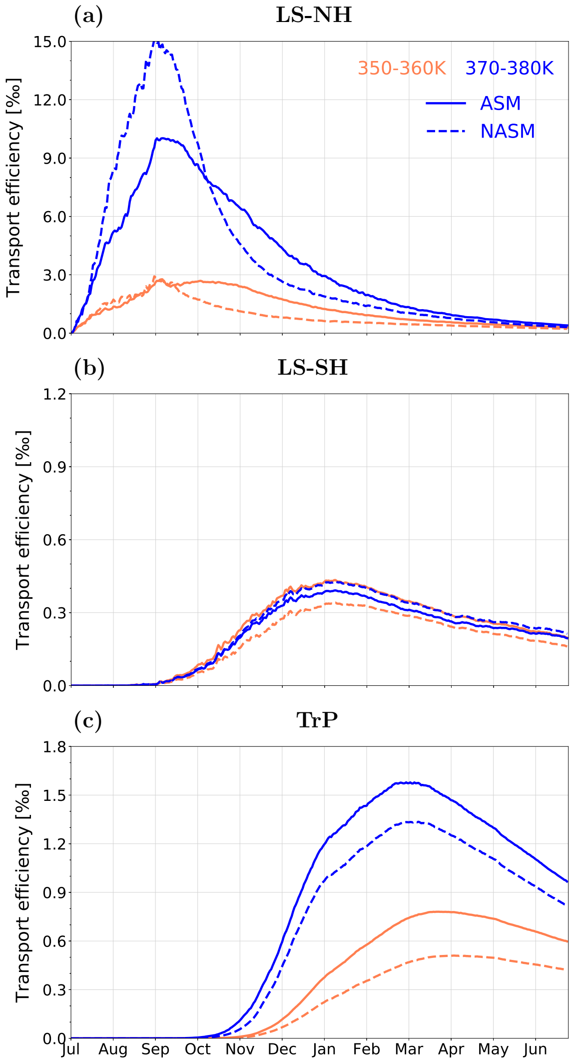

Figure RL 3: Climatological time series of transport efficiency (TE) as derived from the CLaMS-EI simulations and calculated for transport from the ASM (solid line)and NASM (dashed line) source regions to the (a) LS-NH , (b) LS-SH and (c) TrP destination regions. TE is defined by normalizing the average monsoon or tropical air mass over the destination region by the mass of the source region. Different colors of the lines represent tracers released at different levels.

(350−360 K and 370−380 K) to the three destination regions. Comparing the TE here and the TE from Fig.9 in the manuscript, we can see that the TEs from ASM/NASM to the three destination regions are slightly larger than those from Fig.9, especially for the NASM source region. The differences are small, we included a remark of this result in the discussion section (P22) of the manuscript instead of changing the figures.

Regarding the last point, the comparison results between our study and the results from Ploeger et al.(2017)

and Garny and Randel (2016) are included in the revised version of the manuscript. There is good agreement with the work from Ploeger et al.(2017), we also include the difference in the manuscript. We can not compare the contributions of transport to different destinations from our study with the results from Garny and Randel (2016) because we use different method, and the meaning of the numbers in their work are also different from ours. The main comparison is related to the transport pathways to different destination regions from 360 K and 380 K. The insensitivity of the results to the source domain boundary in our study is in agreement with the findings shown by Garny and Randel (2016), where they found that the differences are small regarding a change in the source region definition from PV-contour to box.

2. Specific comments

(1) ***In Figure 1 it would be more useful to show CO for 350 or 360K. At 340K the reader is distracted by the large effects of biomass burning in the tropics.***

A. The CO at 350 K is shown in Fig.1, the text is changed correspondingly.

(2) ***Line 110: For clarity say 'tracer is reset to zero every...'. This should also go into the caption of Fig. 5.***

A. This is included in the caption of Fig.5 and Fig.6.

(3) ***Line 129ff: Please define more clearly on what the percentage mass fraction is based. Are the masses in the monsoon boxes during July and August 100%?***

A. The percentage mass fraction is based on the source air mass concentration (mixing ratio) in the stratosphere. Yes, the air masses in the monsoon boxes during July and August are 100%. The text is changed as well.

(4) ***Line 199: What is annual mean here? Is there each year different or is the mean of the 4-year time series meant? It might be sufficient just to show the MLS-data.***

A. The annual mean used here is different from each year. Figure RL 4 and Figure RL 5 respectively show the vertical and horizontal distribution of monsoon tracers together with the original MLS water vapor. We can see that the connection between monsoon tracers and MLS water vapor looks clear if we removed the annual mean.

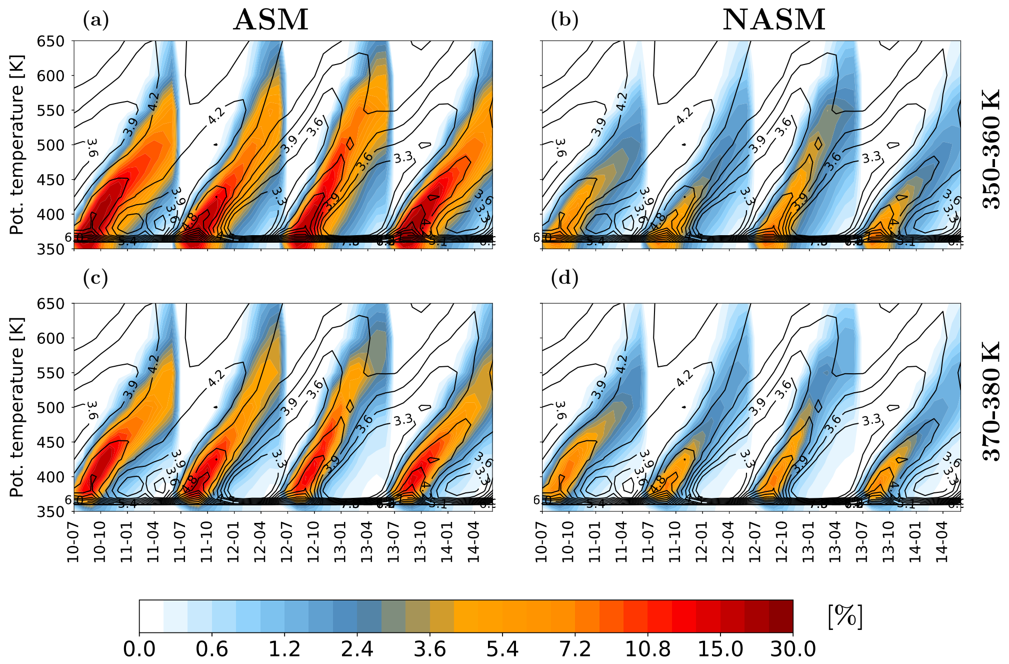

Figure RL 4: Potential temperature−time sections of mean monsoon air fraction (color shading) between 15° S and 15° N released in the 350−360 K (upper; a and b) and 370−380 K (lower; c and d) layers within the ASM (left; a and c) and NASM (right; b and d) based on CLaMS-EI simulations. Tape-recorder signals calculated from Aura MLS water vapor (in ppmv) are shown as black contours for context. Note that the tracer is set to zero everywhere on 1 July of each year.

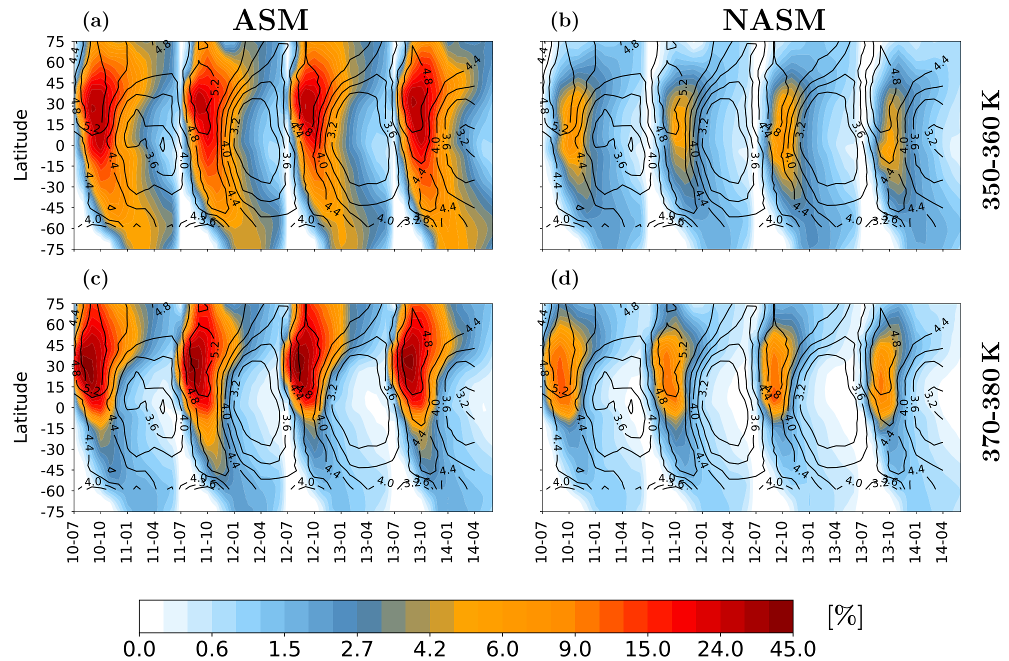

Figure RL 5: Zonal-mean tracer concentrations (color shading) for the ASM (left; a and c) and NASM (right; b and d) tracers initialized at 350−360 K (upper; a and b) and 370−380 K (lower; c and d) as functions of time and latitude on the 400 K isentropic surface based on CLaMS-EI. MLS water vapor retrievals (in ppmv) are shown as black contours for context. Note that the tracer is set to zero everywhere on 1 July of each year.

3. Technical corrections

(1) ***Line 17: Remove 'in contrast'.***

A. It is removed in the manuscript.

(2) ***Figure 1a: The rather arbitrary spacing of contours and colors should be more systematic (e.g. linear or a function mentioned in the caption) and fit to each other. Here also less colors are more.***

A. The colorbar and contour space are changed in Fig.1.

(3) ***Figure 3 and 4: Enhance sizes for legends and labels.***

A. The size of the legends and labels are enhanced in Fig.3 and Fig.4.

(4) ***Figure 5 and 6: Avoid smoothing artefact when tracer is reset, include 'zonal' in caption.***

A. The data is not smoothed. 'zonal' is included in the caption of Fig.5 and Fig.6.

(5) ***Check 'Competing interests'.***

A. 'Competing interests' is included in the manuscript.

(6) ***References: Correct Latex errors and remove second link for several entries.***

A. The errors about the references are corrected, and the second link of each citation is removed.