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Interactive comment on "Transport of Asian trace gases via eddy shedding from the Asian summer monsoon anticyclone and associated impacts on ozone heating rates" *by* Suvarna Fadnavis et al.

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"Transport of Asian trace gases via eddy shedding from the Asian summer monsoon anticyclone and associated impacts on ozone heating rates" Fadnavis et al. studies the eddy shedding aerosol by ASM in UTLS. The study shows eddy shedding from the monsoon is more frequent over west-Africa vs. West-Pacific. The lag is about 3-6 days from the center of ASM to Africa and Pacific. I found this study is interesting; however, I suggest major revisions before publication. Especially the causes of the ozone anomaly near the tropopause due to emission change is unclear, and this is important to understand the ozone heating rates, which is the major conclusions of the

study.

Reply: We thank the reviewer for the positive comments and valuable suggestions. We have now added supplementary figures and discussions to explain the variation of ozone anomalies near the tropopause. Changes are indicated in blue color and associated line numbers are mentioned below. A copy of the revised manuscript is provided as a supplement (also Fig.R1 and Fig. R2)

(1) Regarding Section 4.3: The authors did sensitivity experiment by reducing surface emissions of NOx and NMVOCs. Figure 8 and text (Section 4.3). The anomalies of chemical tracers in UTLS region are very interesting. PAN shows an extended negative anomaly in LS, which indicates cross-tropopause transport. Can you show figure 8 (e-h) for all longitudes? I am still confused with the high anomaly of O3 near the tropopause is shown in Figure 8 (i-l). The discussions in the paper (Line 306-320) are rather vague. What causes the ozone positive anomaly in LS?

Reply(1):We have now incorporated supplementary figures and discussions to elaborate on the variation of ozone anomalies near the tropopause (revised Fig-8i-l, Fig.S2-Fig.S4 and discussions at Lines 334-360).

We have plotted Figure 8(e-h) for all the longitudes (shown as Fig. R1). This indicates that the negative anomalies of PAN extend to ~20W, which is why we decided to choose this value as the western most longitude in our figures.

(2) Put model data significance (e.g. dots) on top of the plots (e.g. Figure 8). If the LS anomaly is real and significant, I guess you should be able to see better from inert tracers e.g. CO. Please add CO plots in Figure 8 as well.

Reply(2): Our model simulations (nudged runs) are forced with meteorology (vorticity, surface pressure, divergence, and temperature). Since simulations are driven by above mentioned meteorological fields from European Centre for Medium-Range Weather Forecasts operational analyses (Integrated Forecast System (IFS) cycle-32r2), every six hours during 2003, model's mean state is forced towards the real atmospheric condition of 2003 (see discussions on Lines 153-155). Therefore simulations give representation atmospheric conditions of 2003 and therefore are supposed to be significant.

The significance test is applied to the free runs (not forced with meteorology) which are conducted for numbers of years (not for a particular year, unlike 2003 in the current paper). Since they are free runs, it is important to show statistical significance. The numbers of years are the numbers of samples on which one applies the significance test. In the case of current model set-up, numbers of samples are not available to apply significance test (only one sample which represents meteorological state atmosphere during 2003). Figure 8 shows 6-8% reduction in PAN and O3 in response to 10% reduction of Asian NOx and NMVOCs which is quite significant.

In emission perturbation experiments, we have changed Asian emissions of NOx and NMVOCs. Therefore variations in CO are subject to many different influences and thus not clear (figure shown as Fig. R2).

(3) Your conclusions/findings on ozone heating rate (Section 4.4) require your understanding and clarification of the ozone anomaly.

Reply(3): We have incorporated discussions (Lines 334-360).

(4) Regarding MIPAS: Following the other reviewer, pls correct/improve MIPAS data display.

Reply (4): We have now updated the figures with the data re-gridded by the MIPAS team members. Therefore data gaps are less (but still present due to presence of clouds) in the updated figures.

(5) Regarding Section 3.2: Please explain details of a power spectrum

Reply(5): Thank you for the suggestions. As suggested details of the power spectrum analysis are incorporated in the revised manuscript (Lines 211-L217). “The PSA uses the temporal-to-frequency fast Fourier transform in order to identify dominant signal

frequencies. It provides information of signal power (square of variance) associated with the frequency components of the signal, with the dominant signal periodicity being the inverse of the dominant signal frequency. Figures 3a-b show the distribution of power spectral variance over the West-Africa and West-Pacific regions. The variances corresponding to the periodicities of 3-5 days, 12-15, and 18-21 days are significant at 95 % confidence level for both the regions indicating that the eddy shedding activity is dominated in the range of synoptic frequency ($\sim$10 days).:

(6) Regarding Model: You define a center of ASM as 85-90E, any reason you pick the 5-deg longitude within the ASM (80-120E)?

Reply(6): The 85áţŠ-90áţŠE; 28áţŠ-30áţŠN is the core Tibetan anticyclone zone where the center of the climatological monsoon (Tibetan) anticyclone is located. Therefore it is taken as a representative region of Tibetan anticyclone zone. Also, the monsoon anticyclone is highly dynamic in nature with respect to its position and shape (Popovic and Plumb, 2001; Garny and Randel, 2013; Vogel et al., 2016) also see Fig.1. Therefore we have defined a center of ASM 5-deg wide, as 85-90E. (Lines 222-224)

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-168/acp-2018-168-AC2-supplement.zip

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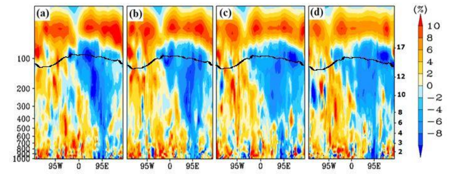

Figure R1: Longitude-pressure distribution (averaged for 20°-40° N) of anomalies of PAN (%) for (e) 02 July, (f) 04 July, (g) 06 July, (h) 08 July 2003.The black line indicates the tropopause. Pressure (hPa) is indicated on left y-axis and altitudes (km) on the right y-axis.

Fig. 1.

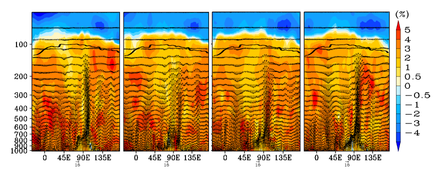

Figure R2: Latitude-pressure section of CO anomalies (averaged for 18-20°N) expressed as % change, (a) 02 July, (b) 04 July, (c) 06 July, (d) 08 July, 2003. Black thick line indicates the tropopause.

Fig. 2.