Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-980-RC3, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Lower-stratospheric aerosol measurements in eastward shedding vortices over Japan from the Asian summer monsoon anticyclone during the summer of 2018" *by* Masatomo Fujiwara et al.

Anonymous Referee #3

Received and published: 19 November 2020

Comments on Manuscript No. ACP-2020-980

In the last decade the Asian Tropopause Aerosol Layer (ATAL) becomes in the focus of attention. This study shows that the transport of aerosol out of the ATAL by eastward shedding vortices were measured over Japan by two lidar systems during summer 2018. Several eddy shedding events were observed and backward trajectory calculations indicate that eddies including air masses with enhanced aerosol particles originate in the Asian monsoon anticyclone. The analysis of satellite observations and meteorological reanalysis confirm the eddy events and further show that the consid-

ered time period was free of the impact of volcanic eruptions and high forest fires.

This is a very interesting study, which merits its publication in ACP. The scientific content, the quality of the study and its presentation is good. Therefore, I suggest only some minor revisions before publication by ACP.

1) P2/L51: 'The enhanced aerosol particle signature in the ASM anticyclone at 14–18 km altitude is known as the Asian Tropopause Aerosol Layer (ATAL), which was believed to consist of carbonaceous and sulphate materials, mineral dust, and nitrate particles (Vernier et al., 2015, 2018; Brunamonti et al., 2018; Bossolasco et al., 2020; Hanumanthu et al., 2020).'

From this statement it is not clear if the knowledge about the chemical composition of the the ATAL particles is based on in situ measurements, remotes sensing observations or model simulations. The discussion about the chemical composition of the ATAL should be much more improved and clarified. I recommend to add a short summery about the current knowledge of ATAL particle characteristics (e.g. chemical composition, particle size distribution, particle form, possible sources etc.). This would help to better bring the results of the lidar measurements presented in this study into the context of previous publications.

2) P4/L114: ERA5 is a very new product from ECMWF, therefore I think it is worth to add a few references demonstrating the quality of ERA5 compared to the former ERA-Interim reanalysis.

3) P4/L122: Please add a statement like this: 'CO and the ATAL have not necessarily the same emission sources, however CO is a good chemical tracer to indicated the location of the Asian monsoon anticyclone.'

4) P5/L152: Is it possible that cirrus signal overlays the aerosol signal, so that cirrus and aerosol can coexist simultaneously? Or can you exclude this with your method?

5) P9/Fig.3: You could add a BSR profile from pre- or post-monsoon to show the differ-

ence. The difference can be use to better highlight the signal in BSR from the ATAL.

6) P10/L204: '... whereas those without enhanced aerosol particles tend to originate from edge regions surrounding the anticyclone.' and from the extratropical lower stratosphere. Right?

Why do you use only ten-days backward trajectories? What about 15- or 20-day backward calculations? In somewhat longer trajectories, the difference between air masses from the core the anticyclone or from the edge (or outside from the anticyclone) should be more pronounced.

7) P11/Fig.4: Is it possible to adjust the color bar more to the Z range of the trajectories to better highlight the gradients along the trajectories. The bluish colors are only used for one trajectory over the Pacific in Fig. 4b. It looks like that this trajectory is influenced by a tropical cyclone. If that is true that could be mentioned as a side remark.

8) P13/L230 : 'PV can be regarded as a dynamical tracer, with lower values in the ASM anticyclone along the same latitudes (e.g., 30°N), although background positive gradients in latitude and its noisier nature give more complicated features.'

PV can be very useful to see the edge of the Asian monsoon anticyclone at around 380K (e.g. Ploeger et al., 2015), above around 400K as shown in Fig. 6, the PV is not so useful. Instead you could try to use the (Montgomery) stream function or the geopotential height.

Ploeger, F., Gottschling, C., Grießbach, S., Grooß, J.-U., Günther, G., Konopka, P., Müller, R., Riese, M., Stroh, F., Tao, M., Ungermann, J., Vogel, B., and von Hobe, M.: A potential vorticity-based determination of the transport barrier in the Asian summer monsoon anticyclone, Atmos. Chem. Phys., 15, 13 145–13 159, https://doi.org/doi:10.5194/acp-15-13145-2015, 2015.

9) P16/Fig.8: Why do you show H2O from MLS and not CO from MLS? CO would be a better chemical tracer for transport as H2O which is in addition affected by micro-

physics. You could also use MLS O3 which should be anticorrelated to CO (low O3 in the anticyclone and high O3 in the lower stratosphere).

10) P20/L331: 'The PDR values obtained at Tsukuba, i.e., ∼5% (3%–10%) suggest that these enhanced particles are solid particles, rather than spherical, liquid H2SO4 particles (PDR ∼0%) or cirrus ice particles (PDR > 25%–30%). The observed values may be consistent with those of solid NH4NO3 particles recently suggested by Höpfner et al. (2019).'

Using the particle depolarization ratio, the study shows that the aerosol particles are most likely solid and it is concluded that the aerosol particles possibly contain NH4NO3. In the literature it is discussed that also carbonaceous aerosols, dust, nitrate-containing aerosol, black carbon and organic carbon could contribute to the chemical composition of the ATAL. Can you exclude with your measurements such types of aerosol particles? Please clarify this point.

Minor comments:

1) P3/L84: (senkrecht in German) –> (= "senkrecht" in German) ?

2) P5/L37: remove large white spaces

3) P13/L223: 'Horizontal distributions of CO and PV' add 'from CAMS'

4) P13/L233: 'are shown in Figure 7' -> 'are shown as Hovmöller diagrams in Fig. 7'

5) Fig.7/8: You could say that the Figures are 'Hovmöller diagrams'

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