

**Review of “Lower-stratospheric aerosol measurements in eastward shedding vortices over Japan from the Asian summer monsoon anticyclone during the summer of 2018”
by Fujiwara et al.**

Ground-based lidar measurements obtained at two stations in Japan during July to September 2018 are analyzed to look for signatures of the transport of aerosols from the Asian summer monsoon (ASM). Particle enhancements were observed in the lower stratosphere in August and September; back trajectories and satellite and reanalysis data are used to show that those air masses originated within the ASM anticyclone and were not influenced by volcanic or biomass burning emissions, and thus they likely reflect extension of the Asian Tropopause Aerosol Layer (ATAL) associated with eastward eddy shedding events. The analysis presented is sound, the manuscript is well written and well organized, and the topic is timely and of interest to the ACP readership. Although I do have some substantive issues that I would like to see considered before the paper is accepted for publication, most of my comments are minor wording suggestions.

Specific comments and questions (major substantive issues and minor points of clarification, wording suggestions, and grammar / typo corrections are listed together for each Section in sequential order through the manuscript):

Introduction

- L41-42: It would be better to add “e.g.” in front of the list of references for aerosols and water vapor, as is done for trace gases.
- L53: was believed --> is believed
- L57-59: The way this sentence is constructed – first talking about the behavior observed during a specific week in August 1997 and then stating that the peak in NH_4NO_3 occurs around August – may be slightly confusing for readers, especially those who are not familiar with Höpfner et al.’s paper and the particular satellite data they analyzed. I can understand that the authors do not wish to add extraneous detail to the Introduction, but I think it would be better to break this sentence in two and make it more clear that the findings reported by Höpfner et al. were based on different satellite data sets. As it is now, the week of 8–16 August 1997 appears to hold some special significance, rather than just being when CRISTA data were taken.
- L70: data --> the data

Section 2

- L86: made --> done
- L97: The uncertainties of lidar data are discussed here, which are applied to the both systems --> The uncertainties of lidar data discussed here are applicable to both systems
- L121: Since “PV” is used below, “(PV)” should be added here after “potential vorticity”.
- L122 and L126: on to --> onto
- L124: Delete the comma after “but”.
- L126-127: PV ... are --> PV ... is
- L136-137: Young and Vaughan (2009) does not appear in the reference list.

Section 3

- L157: mixture --> a mixture

- Figure 1: The color bar, particularly for the PDR panel, could be improved. The pink color denoting the highest values is somewhat difficult to distinguish from the light purple used at the bottom of the PDR range; this would not really be a problem if more were filled in, but it complicates interpretation of such a sparse plot.
- L179: Delete the comma after “2018”.
- L191: For clarity, it might be good to repeat verbatim the description in the Figure 1 caption: “the daily (first) lapse-rate tropopause”.
- L192: with --> at
- L199: at a 400 K --> at 400 K
- L200: of boundaries --> of the boundary
- L201: The value for the CO concentration (65 ppbv) selected to identify the ASM anticyclone boundary seems reasonable, but nevertheless it would be appropriate to cite a reference to justify this choice.
- L210: Although it’s implicit, rather than stating “during July–September 2018”, it would be better to say “on all days during July–September 2018 on which measurements were made”.
- Figures 4 and 5:
 - The vast majority of back trajectories launched from Tsukuba indicate that the air parcels had been transported from altitudes above about 10–12 km over the preceding 10 days (and even slightly higher than that for trajectories run back from Fukuoka). It therefore seemed a bit odd to me that the color bar extends down to $Z = 4$ km. I had to look closely to spot the single trajectory that appears to originate in the middle of the North Pacific at that altitude (Figure 4, bottom panel). Some explanation for this apparently anomalous parcel should be given.
 - The greens in these color bars are impossible to distinguish, so if the authors feel that the trajectory geopotential height information is important, then they need to use a different color palette. Also, the color bar increments (0.8 km) are awkward.
 - Perhaps both of the above issues could be addressed by reformulating the plots. The existence of the outlier parcel could simply be mentioned in the text and not shown, allowing the geopotential height range to be decreased so fewer colors are needed.
- L230-232: I don’t find the discussion of PV very illuminating. First, for clarity it would be better to say “with lower values inside than outside the ASM anticyclone at the same latitude (e.g., 30°N)”. More importantly, I’m puzzled by the lack of a clear signature of anticyclonic flow in the PV field. Previous studies have diagnosed eddy shedding through examination of PV maps. In particular, Garny and Randel [JGR, 2013] (a paper that I am surprised to see is not cited in this manuscript) reported an episode of eastward eddy shedding in June 2006 not unlike the one depicted here, and they showed that the contours of CO (from MLS) and PV (from MERRA) follow very similar patterns (although they focused on a lower theta level, 360 K). Perhaps the authors should explore using different PV contours or applying some smoothing to the PV fields to see if a clearer signal emerges. In any case, more discussion of the behavior of PV associated with this event is warranted.
- L236: It seems to me that, in addition to Figure 7, the results of Figure 6 also suggest that the 60-ppbv CO contour is indicative of eastward eddy shedding vortices.
- L237-238: It is difficult for the reader to judge the timing of these events from Figure 7, especially given that some y-axis tick marks appear to be absent. For example, for the first episode listed, the 60-ppbv CO contour seems to be present at the longitudes of the lidar sites a

couple of days before 5 August. Are the 20-25 and 27-31 August events really separable? It might be helpful to guide the eye by overlaying colored horizontal lines to mark each event's start and end dates or perhaps pale (transparent) colored bands spanning the intervals.

- L223-240: Since previous studies have used MLS CO to look for evidence of eddy shedding (e.g., Garny and Randel [2013], Honomichl and Pan [2020]), and since MLS water vapor is shown in Figure 8, I am curious why only CO from the CAMS reanalysis – and not from MLS – is used here. Is it because the necessary longitudinal and temporal binning would smear out finer-scale structures too much? Clearly, despite such smoothing, the MLS H₂O data provide valuable information. On the flip side, the authors should probably offer an explanation of why water vapor from MLS was used but not that from CAMS.
- L268-269: types of particle and gas --> types of particles and gases
- L286: but not have --> but had not
- L287: I think it would be appropriate to add “at least not in a monthly mean view” at the end of this sentence (mirroring the zonal mean caveat in L282).
- L288: unlikely due to --> unlikely to be due to

Section 4

- L311: measurements at --> measurements made at; also, delete the comma after “2018”
- L314: the BSR --> BSR
- L315-316: The authors might want to specifically note that none of the 11 nights on which data were taken at Fukuoka fell during the intervals of strong enhancement observed at Tsukuba.
- L318: are of a few --> are a few
- L319: originate in the ASM anticyclone in association with eastward shedding vortices --> originate in the ASM anticyclone and are transported over these sites in association with eastward shedding vortices
- L320: eruptions and extensive --> eruptions or extensive
- L325-330: I'm not convinced that this is the best place for the discussion of the OHP measurements. I think it is generally inappropriate to introduce new aspects in the “Summary and Conclusions” section. In fact, these lines might belong in the Introduction.
- L332: Add a comma after “(3%–10%)”.
- L337: Is it necessary to repeat “PDR” 3 times in this line (i.e., is it needed after “8%” and “4%”)?
- L340-342: It seems to me that here again the Moana Loa and OHP information in these lines is out of place. Since these data add to the evidence that the signals observed at Tsukuba and Fukuoka must have arisen from the ATAL, this discussion could be moved to Section 3.3, which could then be renamed to reflect its exploration of other potential causes of the observed enhancements and not just focus on “Satellite aerosol data”.
- L341: any enhancement --> no enhancement
- L360: Delete the comma after “extent”; also, is --> are

References

- L440: The paper by Hanumanthu et al. has now been accepted for publication in ACP.
- L473: The reference for the MLS Data Quality Document (Livesey et al.) is missing the year.