Responses to Referee #2 (Dr. Michelle Santee)

The authors have done a good job in revising the manuscript in response to the comments of the three referees. In my opinion the reviewers' concerns have for the most part been adequately addressed. I have only a few remaining suggestions (mostly minor wording changes where edits or additions were made during revision) that I feel should be considered before publication.

Thank you very much for your evaluation.

• L108-109: Assuming that I am interpreting this sentence correctly, then I think that both instances of "with" in "… uncertainty of the normalization value of BSR with … and that of the extinction-to-backscatter ratio with …" should be "to be". In addition, "uncertainty of BSR were then estimated" should be "uncertainty of BSR was then estimated".

Corrected.

• L140-144: I think it would be good to add "(not shown)" somewhere in this sentence (perhaps right after "quick comparison").

Added.

• L146-148: Since the papers by Popovic & Plumb [2001] and Santee et al. [2017] are already referenced in this manuscript, it would be appropriate to note here that those studies also employed MSF.

These two papers have been added here.

• L151: this isentropic surface will be focused in Section 3.2 --> the isentropic surface we will focus on in Section 3.2

Corrected.

• L158: We found that CAMS --> We found (not shown) that CAMS

Added.

• L181: prevent from characterizing the --> prevent characterization of the

Corrected.

- L182-183: highly variable around this date and was located at 17 km on that date --> highly variable at the time and was located at 17 km on that date

Corrected.

- L196: for Tsukuba data we do not plot the data --> for Tsukuba we do not plot the data

Corrected.

- L287: 20-25 August event--> 20-24 August event

Corrected.

- L325-326: My apologies for not commenting on this point in the original manuscript, but it would be appropriate to add two recent publications on the Australian New Year's pyroCbs to the list of papers showing that extensive wildfires influence stratospheric aerosol loading: Kablick et al. [GRL, 2020; https://doi.org/10.1029/2020GL088101] and Khaykin et al. [Communications Earth & Environment, 2020; https://doi.org/10.1038/s43247-020-00022-5].

Thank you for pointing us to these papers. We have added these.

- L393: showed the PDR values --> showed PDR values

Corrected.

- L443-445: An author was added in revision, but the author contributions section has not been updated accordingly.

Updated.

Responses to Referee #3

The manuscript '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., is ready for publication after revising the following comments:

Thank you for your evaluation.

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 is 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).'

I still recommend to revise this sentence to better make clear which information is from measurements and which from model simulations (e.g. as follows):

The enhanced aerosol particle signature in the ASM anticyclone at 14–18 km altitude found in satellite as well as in in situ balloon-borne measurements is known as the Asian Tropopause Aerosol Layer (ATAL) (e.g. Vernier et al., 2015, 2018; Brunamonti et al., 2018; Hanumanthu et al., 2020). Based on model simulations ATAL is believed to consist of carbonaceous and sulphate materials, mineral dust, and nitrate particles (e.g. Fadnavis et al., 2013; Gu et al.,2016; Lau et al., 2018; Fairlie et al., 2020; Bossolasco et al., 2020;...). However, only limited information on the chemical composition of the ATAL particles is available from measurements (e.g. Martinsson et al., 2014; Vernier et al., 2018; Höpfner et al., 2019;....).

I just mentioned a few references. Feel free to add some other references or select some other references. I propose to better check the current status of publications to the issue of chemical composition of ATAL.

Fadnavis, S., Semeniuk, K., Pozzoli, L., Schultz, M. G., Ghude, S. D., Das, S., and Kakatkar, R.: Transport of aerosols into the UTLS and their impact on the Asian monsoon region as seen in a global model simulation, Atmos. Chem. Phys., 13, 8771–8786, https://doi.org/10.5194/acp-13-8771-2013, 2013.

Martinsson, B. G., Friberg, J., Andersson, S. M., Weigelt, A., Hermann, M., Assmann, D., Voigtländer, J., Brenninkmeijer, C. A. M., van Velthoven, P. J. F., and Zahn, A.: Comparison between CARIBIC Aerosol Samples Analysed by Accelerator-Based Methods and Optical Particle Counter Measurements, Atmos. Meas. Tech., 7, 2581–2596, https://doi.org/10.5194/amt-7-2581-2014, 2014.

Gu, Y., Liao, H., and Bian, J.: Summertime nitrate aerosol in the upper troposphere and lower stratosphere

over the Tibetan Plateau and the South Asian summer monsoon region, Atmos. Chem. Phys., 16, 6641–6663, https://doi.org/10.5194/acp-16-6641-2016, 2016.

Lau, W. K. M., Yuan, C., and Li, Z.: Origin, Maintenance and Variability of the Asian Tropopause Aerosol Layer (ATAL): The Roles of Monsoon Dynamics, Sci. Rep., 8, 3960, https://doi.org/10.1038/s41598-018-22267-z, 2018.

Fairlie, T. D., Liu, H., Vernier, J.-P., Campuzano-Jost, P., Jimenez, J. L., Jo, D. S., Zhang, B., Natarajan, M., Avery, M. A., and Huey, G.: Estimates of Regional Source Contributions to the Asian Tropopause Aerosol Layer Using a Chemical Transport Model, J. Geophys. Res., 125, e2019JD031506, https://doi.org/10.1029/2019JD031506, 2020.

Thank you very much for the detailed suggestions. We have added the suggested sentences and the references with some modifications as:

The enhanced aerosol particle signature in the ASM anticyclone at 14–18 km altitude was first discovered from satellite observations (Vernier et al., 2011) and thereafter referred to as the Asian Tropopause Aerosol Layer (ATAL). It was later verified from in situ balloon-borne measurements (Vernier et al., 2015, 2018; Yu et al., 2017; Brunamonti et al., 2018; Hanumanthu et al., 2020). Information on the chemical composition of the ATAL particles is limited (e.g. Martinsson et al., 2014; Vernier et al., 2018; Höpfner et al., 2019). Based on model simulations, the ATAL is expected to consist of carbonaceous and sulphate materials, mineral dust, and nitrate particles (e.g., Fadnavis et al., 2013; Gu et al., 2016; Lau et al., 2018; Fairlie et al., 2020; Bossolasco et al., 2020). Through analysis of satellite and high-altitude aircraft observations and laboratory experiments, Höpfner et al. (2019) provided evidence that. . .

2) P22/L400:

'However, it should be noted that the lidar BSR and PDR measurements cannot exclude the possibility of co-existence of other types of solid aerosol particles such as mineral dust, black carbon, and some types of carbonaceous aerosols which are solid.'

Please add here some references for publications that propose that ATAL could consist of solid aerosol particles such as mineral dust, black carbon, and some types of carbonaceous aerosols which are solid. It would be an added value for the paper to know if these references are based on simulations or measurements of ATAL.

We have added some (recent) references as:

“. . . the possibility of co-existence of other types of solid aerosol particles such as mineral dust (e.g., modelling work by Lau et al., 2018; in situ measurements by Vernier et al., 2018), black carbon (e.g., modelling work by Gu et al., 2016), and some types of carbonaceous aerosols (e.g., modelling works by Gu et al., 2016; Lau et al., 2018; Fairlie et al., 2020) which are solid.”