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Review of “Persistence of moist plumes from overshooting convection in the Asian monsoon anticyclone” by Sergey M. Khaykin et al.

Anonymous Referee #1

Referee comment on "Persistence of moist plumes from overshooting convection in the Asian monsoon anticyclone" by Sergey M. Khaykin et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-653-RC1>, 2021

General Comments:

This study presents comprehensive analyses of water vapor, temperature and cloud measurements made during the StratoClim field campaign, which was completed in the summer of 2017. The main goal of the study is to understand the complicated role of convection in the water vapor budget over the Asian summer monsoon region in the upper troposphere and lower stratosphere. The authors seemed to have performed such a thorough analyses of all the available in-situ, satellites measurements and a trajectory model to shed bright light on this subject. It is fascinating to learn that overshooting convection indeed play two roles, both hydrating and dehydrating. I have three general, rather minor comments that I would like to make. First, even though the focus of this study is the Asian summer monsoon, it is important to remind us that the North American monsoon also plays role in the lower stratospheric water vapor budget. There are some parts of the text that needs to be clarified (see the first specific comment below). Second, I would like to see some statements about uncertainties in the trajectory model results. Can we trust 100% of the result? How sensitive is the result to the input variables or dynamical fields? Third, the figures in the manuscript and the supplement material are outstanding and yet complex. Some figures are probably too complex. I had hard time understanding Figure 1, in particular, as it contains so many variables and colors. It would be helpful to revisit the figures and improve if there is time.

Specific Comments:

This study focuses only on the Asian summer monsoon. There also exists the North American summer monsoon, which is one of the wettest regions and one of the primary contributors to the water vapor maximum in the lower stratosphere. I think it is fair to treat the Asian summer monsoon as one of the contributors instead of the only contributor. I have listed a couple of examples as a way of accomplishing this without

making significant changes below.

Examples

P1, L21 – ‘the wettest region’ can be replaced by ‘one of the wettest regions’

P1, L30 – ‘water vapour enhancements’ can be replaced by ‘water vapour measurements during the campaign’

P2, L40 – ‘the primary contributor’ could be replaced by ‘one of the primary contributors’

P2, L57-60 – It would be helpful to add a sentence summarizing the findings, e.g., is the degree of convective impact different? Or do the source regions differ in different studies?

P3, L82 – ‘in the other flights’ could be replaced by ‘the rest of the flights’

P3, L86-87 –Do Stroh et al. (2021) include the description of the instruments as well?

P3, L91 – ‘and then substantially’ could be replaced by ‘and substantially’.

P3, L107 – Does ‘under UTLS conditions’ mean low temperature and low humidity?

P4, L126 – Here, ‘They’ refers to Singer et al. (2021)?

P4, L136-137 – Here, ‘distribution’ could be replaced by ‘distributions’ on both sentences.

P5, L153 – The meaning of ‘evenly distributed’ is unclear. Also, there is a newer version of MLS H₂O (v5), which became available more than a year ago. It is also known that MLS

H₂O (v4.2) has drift issues in the stratosphere.

P5, section 2.3 – I think this section provides useful information. It would be helpful to add a sentence explaining the purpose of this section here.

P5, L178 – It is unclear why the thermal approach to TTL definition is only suitable for this study. Is this related to the fact that water vapor is sensitive to vertical structure of temperature?

P5, L185-186 – It would be useful to include references for the hydration vs. dehydration processes in the TTL.

P6, L197 – Are there any references for HIMAWARI-8 could be cited here?

P6, L207 – Would 'a specific version of product based on the version 2018.1' be the same as 'version 2018.1'?

P6, L211 – Is '100 hPa' an arbitrary threshold or based on a statistical analysis?

P6, L219 – How is the 2017 Asian monsoon season characterized as a stable anticyclone? Compared to 10-year climatology or compared to previous three years? Some statistics might be helpful here.

Comments for Fig. 1

Fig. 1a - It is not easy to tell from Fig. 1a. In Fig. 1a, the water vapor contours can be smoothed (1-2-1 smoothing) or one can use bigger grid boxes to show smooth contours. Also, what do black colors mean in Fig. 1a? I think the wind vectors can be improved here as well (likewise in Fig. 5). For instance, one can put wind vectors every 2.5 degree latitude instead of 5.

Fig. 1b – I think the AMA boundary looks rather too broad here. Adding more contours or choose a smaller threshold of Montgomery stream function might work better.

P7, L241 – Is Brunamonti et al. (2018) also based on summer of 2017?

P7, L247 – I would recommend using a quantitative adjective than 'striking' here, e.g., 'large' variability.

P7, L261 – Do 'those' refer to the high RHi values?

P7, L263 – It would be helpful to add an explanation about 'Lagrangian temperature history' here.

P7, L274- Is '14%' higher or lower than any statistics or expectations?

Comments for Fig. 4

It would be useful to add approximate altitude for Figs. 4a and 4b. Also, in Fig. 4b, high delta D exists as high as 420K potential temperature surface.

P9, Section 4.2 – I am wondering is there a way to quantify the uncertainty in the derived convective age. Is it sensitive to the type of cloud top data and also meteorological fields?

P10, L340 – Does 'mixing ratio enhancement' mean the actual water vapor mixing ratios or only the increased amount of water vapor?

P10, L350 – Fig. 6a,b could be replaced by Figs. 6a and 6b

P10, L350 – Does 'at this level' mean local CPT?

P10, L359 – Here, 'such an amount' could be replaced by 'such high amount'. I am also wondering what is the mechanism that enables the convective plume preserve high water vapor for 5 days.

P11, L373 – 'intersecting a large convective system' – It looks like the trajectories lie

between the large convective system and the group of small cells to the west.

Comments for Fig. 7c

I assume temperature means potential temperature in Fig. 7c. Also, it is hard to locate 140 or 160% RHi in this figure as explained in the text.

P11, L389 – Does ‘across’ mean from below to above the CPT?

P11, L393 – It would be helpful to give the time marks for the presence of subvisible cirrus clouds in Fig. 8a.

Comments for Fig. 9a

Fonts for T1-B7 could be bigger.

P12, L435 – Instead of ‘around the CPT’, near or close to might be more accurate.

P13, L448 – Does ‘there is typically no more than one case’ apply to all the cases referred above?

P13, L454 – In this sentence, the meanings of ‘over these regions’ and ‘in the summer monsoon anticyclones’ are not clear. Are those referring to the North American monsoons?

P13, L467 – ‘around the tropopause’ could be replaced by ‘near the tropopause’.

P14, L483 – This sentence could be split into two -> introduction. However,...

P14, L505 – It would be helpful to add a sentence about what the authors think the future direction or need is in terms of field studies related to StratoClim.