

Interactive comment on “El Niño Southern Oscillation influence on the Asian summer monsoon anticyclone” by Xiaolu Yan et al.

Anonymous Referee #1

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The authors present analyses which assess the impact of El Niño and La Niña episodes in NH winter on the atmospheric circulation and composition from the concurrent winter period to the following NH summer period. The paper is overall well written and well structured and the figures are well-composed. The impact of ENSO on the dynamics and chemical composition of the atmosphere is interesting and suitable for publication in ACP, however to me the impact of the results is not carved out, yet. I recommend the manuscript to be accepted if the following points are considered in a revised version of the manuscript.

General comments:

In my opinion, the current "Conclusion" section is rather a summary of the previous results. I think the paper would substantially benefit if you would also state the actual

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consequences of the presented results.

Please show some of the indicated/discussed differences in an extra panel/plot in the figures, for which the differences are relevant, e.g. Fig. 2. This would make the discussion and understanding of your line of arguments way easier.

In many of the analyses the differences of El Niño/La Niña decay after a couple of months and sometimes the results for El Niño seem to lag the results with respect to La Niña (e.g. Fig. 8 bottom). Please comment on how much of the observed differences is explicable through a time lag as e.g. diagnosed in the onset of the ASM anticyclone.

P.13 L.2-4: To me the differences in O₃ are small in JJA in Fig.7 and the significance decreases strongly from AMJ to JJA. Further I do not see any real indication that ozone is lower after La Niña in the ASM AC in JJA. Also the statement relating this result to SF and VP is unclear (to me the differences for SF and VP are small as well). Please add plots showing the differences. This would help to follow your statements. You even state yourself that the differences are small: P7 L.6-9....Please clarify and comment on this.

P.7 L.6-9: You state that the forcing of the summer dynamics is only weakly related to the winter forcing. However, there is a well-known connection of ENSO and the Indian summer monsoon. You also include a reference (Chowdary et al 2016) regarding this issue. Further, have you checked how the summertime results change if the composites are not made using ENSO prior to the monsoon season but ENSO subsequent to the monsoon, i.e. assessing the influence of developing El Niño/La Niña events on the ASM? Assessing these differences could really improve the understanding of the connection between ENSO and the ISM. Also the ENSO phase during NH summer might influence your results, i.e. your results might depend on if the ENSO phase is transitioning from El Niño to La Niña or vice versa or if you have a no-decay El Niño (this example is even mentioned in the discussion) or no-decay La Niña.

P.18 L.24: "The change..." This paragraph is difficult to follow. Please rephrase to

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make your analysis easier to follow. Also I do not understand why you are excluding in particular the ENSO events 1997/1998 and 2006/2007. Is this simply made to have a remaining set which contains an equal amount of El Nino years in QBO east and west phase? If so, I do not see why you would exclude these two events and not some others and I do not come to the conclusion that the results are robust because of this analysis. A better way might be to split the El Nino/La Nina events completely between QBO east and west and then make a comparison. (I know that this leads to a very limited number of cases, especially for the La Nina events. But you do this anyhow when you look at the no-decay El Ninos). The number of considered ENSO events could be increased by including/checking, JRA-55, which extends back to 1958.

P.11 L.2: You assess the significance of the changes of the Hadley circulation using a mean of VP from 20S to 20N. As a sensitivity: How does this change if you use a region centered around latitude of the peak value of \overline{VP} , or a mean over a region where \overline{VP} falls below a certain threshold?

Minor comments:

P.2 L.31-33: This sentence is strange; the part "... like weather patterns or precipitation..." seems disconnected from the previous part of the sentence.

P.3 Fig. 1: You might want to add a reference to Konopka et al. 2016; same for Table 1.

P.3 L.3: Add that you are using also O3 data from a Lagrangian CTM.

P.4 L.4: Please add a reference for the Monte Carlo method you are using and add a short explanation what the Monte Carlo method does.

P.4 L.6: You are using data for 2016 also as December 2015 is listed as El Nino month....so for the assessment of changes related to ENSO you are also using MLS, ERA-I and CLaMS data for 2016, right? Please update this in multiple occasion throughout the paper.

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P.5 L.4-6: Add the information of how many El Nino (La Nina) events are considered to the information of how many months contribute to the composites. Is the information on how many months are considered even important, as you show DJF composites anyhow? Do you average the months or the years when averaging the data over multiple years? Please clarify!

P.5 L.4: Please stick with one way: "6/8 ... La Nina/El Nino" or "6 (8) ... La Nina (El Nino)" throughout the whole paper.

P.5 L.9: Correct the URL for OLR data from NOAA and add statement to the acknowledgment! Probably also for the ENSO data!

P.5 L.24: "The climatological..." add "with respect to La Nina and El Nino conditions" or something like that and finish with "building the analogue composites for OLR as for the SF" or something similar.

P.5 L.26: Should this better state: "anticyclones are mainly located over the maritime continent during La Nina ... partially shifted towards the western Pacific during El Nino events.". Please clarify this sentence.

P.7 Fig.3: What does the hatching indicate in this figure? Remove if unnecessary.

P.7 L.10: Please add "climatological" after "mean" and add that the climatological mean is not shown. Otherwise it is hard to understand what you are referring to.

P.8 Fig. 4: Consider to make the hatching a little darker (for printed versions of the paper). Also in similar plots (e.g. Fig. 6).

P.8 L.17: Change to "The domain is supposed to...". How do the results change if you would check for the size of the area which lies within a specific VP contour, instead of using a fixed rectangle, where you might end up averaging positive and negative values of VP?

P.9 Fig.5: You may want to add a description for the blue rectangles and keep them

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in all panels, to guide the eye. P.10 Fig.6: The different colours of the seasons are difficult to read, especially JJA MJJ and MAM. Also consider to add a plot showing the differences.

P.11 L.32: "Ozone in mixing...." I do not see why they are delayed. Please refer to the figures showing this time delay.

P.12 Fig.7: Do you show ozone isolines at 380K or at the tropopause altitude for the black contours? This is also confusing in other figure captions and multiple occasions in the text (e.g. P.13 L.6, P.14 L.9, ...). If it is at 380K simply state "at 380K". Please clarify!

P.14 L.2: I do not think that "Thus" is the right wording here.

P.15 L.10: How do CLaMS results and MLS measurements compare if you restrict the CLaMS data to the period 2005-2015?

P.17 Fig.11: I guess you are showing longitudinal averages in the west and central Pacific region of zonal anomalies. Please try to be clear (also in several parts of the text). Also add "the" in front of ".../theta = 380K...".

P.18 L.13: Change "three years" to either "two years" (1987 and 1992) or "two ENSO events" or something similar.

P.18.L14: "In particular...". Please add the time periods when the ASM (Hadley circulation) is weaker (stronger). This will also help to follow your conclusion in the following sentences, which is not clear at the moment.

Additional remarks:

P.2 L.18: Add the full version of STE.

P.3 L.8: Add full version of abbreviation NOAA = National

P.5 L.1: Maybe change to: "Ozone distributions are used to validate our diagnostics of

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the flow and to understand the effect....in the UTLS region."

P.5 L.16: Change to: "The panels in Fig. 2 start from ..."

P.5. L.3: Remove ")((" and add ", " after "(SHADOZ...".

P.5 L.30: add "during NH summer" or "during JJA" after "(ASM) anticyclone"

P.5. L.32: I guess that "asymmetric" should be changed to "antisymmetric".

P.7 L.6 : "stronger localized" do you mean "stronger and more localized" or simply "more localized"?

P.8 L.12: I guess you want to state: "In spring (FMA)" the differences between the two composites are smaller than in winter."

P.9 L.9: Add blank after "variability"

P.10 L.4: Please add (\overline{VP}), to indicate that this is the zonal mean of VP.

P.10 L.8: Add "winters"/"events" or "episodes" after El Nino and change "with decreasing ENSO differences" to "and the differences between the El Nino and La Nina composites decrease from DJF to JJA"

P.14 L.8: I guess one should use "as" instead of "like"; this also occurs at multiple occasions in the text (e.g. P.5 L.8). Also add "(top)" after "Fig. 8".

P.15 L.21: If the sentence starts with Figure you should write "Figure" instead of "Fig." (this is easier to read and as I know this is Copernicus standard, check for other parts in the text)

P.15 L.12: Change "... simulations above ..." to "... simulations as described above ..."

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