

Comment on acp-2021-345

Anonymous Referee #1

Referee comment on "Water vapor anomaly over the tropical western Pacific in El Niño winters from radiosonde and satellite observations and ERA5 reanalysis data" by Minkang Du et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-345-RC1>, 2021

In "Water vapor anomaly over the tropical western Pacific in El Niño winters from radiosonde and satellite observations" the authors use radiosonde observations from six sites in the Pacific as well as water vapor from the ECMWF reanalysis to show a correlation between column integrated water vapor and ENSO. They then use the velocity potential to determine the relative impacts of the Hadley, Walker, and monsoon circulations on 4 El Niño events (2006/07, 2009/10, 2015/16, and 2018/19). They find relatively little contribution to water vapor anomalies from the Hadley circulation, but find that variations in the Walker circulation drive the water vapor anomaly during these El Niño events, particularly during the 2015/16 event. Likewise, changes in the monsoon circulation were important for driving the water vapor anomaly for the 2009/10 event. While the importance of the Walker Circulation in driving ENSO-related changes in water vapor is well-known, this work does advance understanding of the relative impact of the different circulations on individual ENSO events and could be published in ACP once the deficiencies outlined below are addressed. Finally, while the authors' intent is, for the most part, clear, the manuscript needs to be closely read for grammar, as there are frequent minor errors that make understanding more difficult.

Major Concerns:

A more thorough evaluation of the water vapor product from the reanalysis dataset is needed to support the results of this work. The only comparison between the reanalysis water vapor and observations shows major discrepancies that the authors inadequately explain. Since the reanalysis water vapor underpins many of the conclusions in the paper, its accuracy is important and any uncertainties should be properly outlined. In addition to a more thorough comparison to the radiosonde observations discussed here (an equivalent figure to Figure 1 with the ECMWF data would make sense), comparison to satellite observations, preferably those independent of that assimilated for the reanalysis product, over the tropics is warranted. Are anomalies apparent in the ECMWF data evident in the satellite product? At the very least, the authors should cite previous work

that analyzes the accuracy of the reanalysis product and discuss how biases/errors in the reanalysis could affect their results.

The authors also do not do an adequate job of justifying their method for determining the relative effects of the Hadley, Walker, and monsoon circulations based on the potential velocity. The method used here, based on the work of Tanaka et al. (2004), was designed based on upper tropospheric (~200 hPa) values of the potential velocity. All the previous work the authors cite (Tanaka, 2005; Park and Sohn, 2008; Ma and Xie, 2013) as examples of this method also use upper tropospheric velocity potential for this calculation. Here, however, the authors use the velocity potential at 850 hPa. While this could ultimately be fine, some justification needs to be given as to why the method is applicable in the lower free troposphere. Further, there should be more discussion as to why fields derived from the upper tropospheric potential velocity are less relevant for this work than those at 850 hPa.

Minor Comments:

Title: The title is somewhat misleading as satellite observations play an extremely minor role in the analysis, unless you are considering the water vapor assimilated into the ECWMF reanalysis. I would recommend changing the title to more accurately reflect the bulk of the work in the paper.

Line 51: Instead of America, it's probably better to say USA if you're referring to the country, or be more specific (e.g. North, South, Central America) if you are referring to the continent/region.

Line 112: What percentage of observations were deemed to be outliers?

Line 116: I don't understand what you mean by "... and they are almost entirely from the several gaps of observations." Please reword this sentence.

Line 129: Since water vapor plays such a major role in this paper more discussion needs to be included about how it is determined in the reanalysis. Is it part of the data assimilation scheme? If so, what satellite products are used for the water vapor assimilation? Has the water vapor product been evaluated?

Line 148: You should list the satellite overpass time for NOAA18 and CALIPSO since these are both polar orbiting satellites.

Line 168: The phrase "... the observed water vapor also exhibit negative throughout the lower troposphere" does not make sense and needs to be reworded.

Line 182: How well does the CWV for the radiosonde data compare to that from the reanalysis? As discussed above, a more thorough analysis than that shown in Figure 9 is warranted.

Line 197: The phrase "... but tends to vary in opposite to the ONI" needs to be reworded.

Line 227: As described above, this explanation is insufficient to justify using 850 hPa to characterize the circulation as previous methods all use the upper troposphere for this type of analysis. Please explain this choice more thoroughly and demonstrate that this method is applicable to the lower as well as upper troposphere.

Line 262: Do you mean climatic "mean"?

Line 295: Can you explain/hypothesize as to what is causing the difference in the Hadley circulation anomaly between the CP and EP El Niños?

Line 312: This should be "super" not "supper".

Line 324: What distinguishes the 09/10 event from the other El Niño events, including the other CP event, to cause such a large anomaly in the monsoon index? Can you explain/postulate why the CP El Niños tend to have a higher monsoon-related anomaly?

Line 331: This is a dramatic understatement. The difference between the radiosondes and reanalysis is almost a factor of 2 different for one of the years, and about a factor of 5 for another. That's half of the data you show. This sentence needs to be reworded. Also, your assertion the CWV increases with increasing index only really applies to the sonde data. You need to qualify this statement.

Line 352: As discussed above, a much more thorough analysis of the accuracy of the water vapor is warranted than what is described here and in Section 5.

Line 374: It would make far more sense just to evaluate the water vapor product with actual water vapor observations than the hand waving argument used here. Also, what

implications does this have for the rest of the analysis, if you aren't confident in the accuracy of the water vapor product?

Figure 4: The plusses denoting the radiosonde sites aren't legible on the map. Please change the color.