Response to reviewer 1

Second Review report on “QBO modulation of stratospheric water vapour in the Asian monsoon” by Cristina Peña-Ortiz et al.

The authors made substantial revisions in response to my comments. The authors now do not explicitly refer to “the Matsuno-Gill pattern”. This is probably a reasonable approach, avoiding unnecessary confusion by the readers (i.e. which “pattern” the authors are referring to?). But, a drawback may be that the authors’ idea of response to tropical convective heating may become less clear. One idea is to mention about the response to tropical convective heating and cite Matsuno and Gill papers, but not to say Matsuno-Gill “pattern”. (Please note that the revised manuscript still has the paper by Matsuno and the one by Gill in the reference list, though these are actually not cited currently. Please go through the manuscript and make necessary corrections which are related to the substantial revisions.)

In the new version of the manuscript we have added a sentence saying that the anticyclonic dipole, apearing as a response to the equatorial anomaly of diabatic heating, is possibly associated with the excitation of an internal Rossby mode as described in Matsuno (1966) and Gill (1980) studies. (Line 372)

The choice of QBO indices, i.e. at 10 hPa and 20 hPa, is still somewhat annoying to me. Perhaps, the authors add discussion for potential reasons. It is possible that the phase relationship between zonal wind at these levels and temperature around the tropopause would be relevant. Also, if not only local dehydration but also transport process are involved, we would need to consider a further phase shift (e.g. a month or two?). These might be a potential reason why 10 or 20 hPa zonal wind results in a better correlation. Please include such discussions, hopefully quasi-quantitative ones, for this problem.

The manuscript clarifies, in the methodology section, the reasons for the choice of the 10hPa and 20hPa levels for the QBO phase definition and explains that this is directly related to the fact that the phase definition at these levels maximises the signal over the water vapour in the AM. On the other hand, it is explained that it does not mean that the physical mechanism explaining the QBO signal on the AM water vapor has a direct relationship with the circulation or temperature of the QBO at these levels. However, the definition of the phase at high stratospheric levels fixes the characteristics of the QBO throughout the stratosphere including the UTLS, where the QBO wind and temperature can have an impact on lower stratospheric water vapour.

The reviewer is right in pointing out that, the QBO impact on the tropopause temperatures, other processes related to changes in vapour transport into the monsoon could also contribute to explain the observed signal. In the new version, in the Summary and Discussion section, we have included a paragraph discussing the possibility that changes caused by the QBO on the trajectories of the air masses reaching the AM, or the variations of such trajectories with the summer progress, could also explain part of the observed QBO signature on the AM water vapour or the intraseasonal evolution of this signature. We have indicated that future studies incorporating Lagrangian transport models will be necessary to address this question and determine the role of this pathway (Lines 596-602).

For other issues that I raised in the first review, it looks the authors made reasonable revisions.

Finally, I happened to notice that the caption of Figure 7 may need a correction. The figure legend says, now it is CI at 100-150 hPa, while the caption says, fraction of cloud cover averaged between 125hPa and 150hPa. This may be related to the changes for this revised version. There might be some other places where similar corrections are needed. So, again, please go through the manuscript and make necessary corrections which are related to the substantial revisions.

The caption of figure 7 has been corrected (Line 444).

We have revised the manuscript and corrected a couple of sentences to improve its understanding. (Lines 132 and 562).