

Review of Yamazaki et al. On Tropospheric Pathway for QBO Influence on Stratospheric Polar Vortex

This paper presents evidence for the QBO having an influence on the stratospheric polar vortex (the Holton-Tan effect) via the troposphere, rather than via the stratosphere as in previous proposed mechanisms (though they show that other mechanisms are also at work, particularly in late winter). The idea is that the QBO-E stimulates convection in the tropical West Pacific and suppresses it in the western Indian Ocean, and these produce Rossby wave forcing that constructively interferes with the extratropical Rossby wave structure, and hence increases planetary wave forcing of the stratospheric vortex. This is based on observations of differences in tropical convective activity in different QBO phases and model simulations used to estimate the impact of this on extratropical wave activity. Overall I think the sequence of experiments holds together well and I like the tests done to check that the ENSO phase is not a strong confounding factor. I think a few more diagnostics are needed to show that the findings are robust.

Most significant comments:

1. Some diagnostics need to be shown to explain why the mechanism does not seem to occur from January onwards – has the apparent difference in tropical convection disappeared (which would suggest to me that it's not robust) or is the forcing of extratropical planetary waves not effective for some reason?
2. L149 – it would be helpful to give some explanation of why tropopause temperature anomalies associated with the QBO would “provide favorable conditions for enhanced convective activity”, with references. Having confidence that the QBO really has the impact on tropical convection that is shown is crucial for believing the mechanism, so this would be useful.
3. The authors note that the impact of the QBO on tropical convection is associated with a changed strength of the Walker circulation. Misios et al. (2019, “Slowdown of the Walker circulation at solar cycle maximum”, PNAS) found that there is an impact of the solar cycle on the Walker circulation, so this could be a confounding factor. It would make sense to check that the impact of the QBO on tropical convection found here is not dependent on the solar cycle phase.
4. What method is being used for the statistical significance tests? What assumptions are being made for this? What has been done to check the assumptions are reasonable? This should be clearly explained in the text. (Personally, I think using a bootstrap method is best as it requires relatively few assumptions to be made, but another method can be used if the assumptions behind it can be justified.)

Other comments:

1. L32-35 It should be made clear that the “Holton-Tan mechanism” is just one proposed mechanism.
2. L80 The definition of ENSO phases used by the JMA should be given for clarity.
3. L90 It should be made clear that the “QBO signal” refers to the EQBO minus WQBO difference (rather than the difference from climatology).
4. L104 References are given claiming to show that “the performance of the model in the stratosphere is satisfactory”, but I couldn't see an evaluation of the stratospheric performance in any of these references. Please point out where this can be found, give a reference showing this, show data yourselves or remove this remark. (I am not too bothered about the model's stratospheric performance on the whole – for simulating the wave forcing from the tropical convection anomaly, it is the tropospheric performance that matters most I

think, and it looks adequate from the figures given – I say this just so a lot of work is not done to validate the model’s stratospheric performance.)

5. L134-5 What’s the relevance of the remark about vertical motion near the Equator being downward?
6. L167-70 Plots of the wave amplitudes as a function of latitude in the different QBO phases would be helpful.
7. L183 It seems worth noting that the wave-1 response to the convective forcing shows a large signal in the North Atlantic that is not shown in the full response in fig.9. Is the right interpretation that higher wavenumbers are cancelling out the response in the North Atlantic?
8. L218-9 This could do with being more quantitative e.g. compare the simulated and observed wave-1 amplitude change averaged over 30-60N.
9. L223-6 The text could do with being clearer about which results are from observations/reanalysis. (This goes for other parts of the results section as well.)
10. Appendix B – is there a reference supporting this method?