

Multidecadal Variations of the Effects of the Quasi-Biennial Oscillation on the Climate System- review by Indrani Roy

This study first investigates additional observations of stratospheric winds to test the existing QBO reconstruction. It then uses that time series to test reconstructions and reanalyses data. It also compares the results with outputs from coupled ocean-atmosphere-chemistry climate model with forced reconstructed QBO. This work mainly focuses on testing tropical-extratropical interaction in the stratosphere and subsequent downward propagation. It also investigates tropical deep convection, surface air temperature, precipitation, snow cover, tropospheric wind fields, and hurricane tracks. The QBO imprint on the northern polar vortex and Berlin surface air temperature both shows different results during 1908-1957 to that from the later period. However, there is a small influence of the QBO on tropospheric climate in general. It is an interesting research and merits publication after minor revision.

Main Points:

- Page 7, line 27: Discuss clearly the method 'heteroscedastic t-testing to assess statistical significance'. Also page 8, line 1: Explain standardized differences. As those are the main methods to capture signal QBO east to that from QBO west, describe those methods in details and give the formula.
- Page 10, line 20: "predominantly negative, as expected from the Holton-Tan (H-T) effect." Also in page 9, line 7: there are some remarks about H-T effect. It is better to mention some discussions in this context relating to change in the behaviour of H-T effect during period 1977-1997. Lu et al. (2008) discussed that H-T effect weakened and even reversed around that time. Though it was statistically significant during solar min and 1959-1976 and 1998-2006 for extended winter (Nov-April).

Ref:

Lu, H., M. P. Baldwin, L. J. Gray, and M. J. Jarvis (2008), Decadal-scale changes in the effect of the QBO on the northern stratospheric polar vortex, *J. Geophys. Res.*, 113, D10114, doi:10.1029/2007JD009647.

- Page 7, line 29: It is good as the different period is used '1908-1957 and 1958-2012'. Considering longer period, Roy (2014) also showed that some tropospheric signatures were different before and after 1958. I liked the idea of Table 1. Give little discussions with a possible explanation for the change in the northern hemisphere polar vortex and Berlin surface air temperature during that periods. One explanation could be that there

was a change in mean state of tropospheric circulation during 1958 (Vecchi and Soden (2007)). Change in tropospheric circulation can directly impact Berlin surface temperature. Also, the circulation change can modulate upward propagating planetary wave activity and subsequently can influence Polar Vortex.

Page 1, line 29: In the abstract it is mentioned that ‘In the model simulations, likewise, both links tend to appear alternatingly, suggesting a more systematic modulation.’ Discuss possible mechanism in the text, in line with the earlier paragraph, to make that argument strong.

Ref:

Roy, I., (2014), ‘The role of the sun in atmosphere-ocean coupling’ *International Journal of Climatology*, 34 (3), 655-677, doi:10.1002/joc.3713.

Vecchi GA, Soden BJ. 2007. Global warming and the weakening of the tropical circulation. *Journal of Climate* **20**: 4316–4340.

- Fig. 4: It is hard to distinguish the colours in f, g and h.

Minor comments:

- Heading 3.1.2.: Apart from Berlin, other places also show interesting results as you discussed in this section. Hence better not to mention only Berlin in this heading and change it accordingly.
- Page 3, line 14: correct the inverted comma.
- Page 5, line 13: correct the inverted comma.
- Page 10, line 3: different period shows a different result. Also page 10, line 5: “The 30-yr moving windows difference in the model simulations shows a similar behaviour.” It is an interesting result that model results match with observation. Elaborate those parts.
- Page 7, line 26: Explain a bit more why and mention roughly how many easterly and how many westerly?
- Page 7, line 11: replace ‘season’ with ‘months’.
- Page 4, Line 18: Use the full form with abbreviation at the first place in all cases, for e.g. CHUAN.
- Page 5, line 27, Heading 2.2: It is not only Troposphere as in line 17 it mentions Z100 (defined at 100 hPa level). Hence change the heading accordingly.

- Page 4, line 13: It is easier for readers if there is a mention Berson's profile 'that started on'
- Page 7, line 15: Instead of boreal summer (JJ) only mention June-July (JJ) and likewise for ND (Nov-Dec)?
- Line 17: change 'that season' with 'in those months'.
- Table 1 caption: 'F??' does not look nice and change it.
- Table 1: F13 and F14 instead F013 and F014.
- Table 1: Used abbreviated form of REC and NNR without defining in the text.
- Fig.1 caption: In the second line for dots mention about 'first three rows'. If possible improve dots in the first row, as some are placed below the x-axis.
- Fig 2 caption: Boreal winter is mentioned in the first line. But afterwards it is stated that for (c) GPH in Jan.-Mar., using the 50 hPa QBO early winter. Omit 'boreal' from the first line.
- Page 10, line 20: Describe this line a bit more.
- Page 10, line 15, 'The SAT signal over North America is totally different.' Any explanation?
- Page 24, line 8: use ';' instead of last ','.
- Fig S1: For 30th Aug 1908, two different colour profile indicates opposite. Give a possible explanation for that.
- Fig S3: Mention about the data in the figure caption.
- Fig S10: Make the significant region clearer. In the current form, it is hard to distinguish.