

Interactive comment on “Relationships among Brewer-Dobson circulation, double tropopause, ozone and stratospheric water vapour” by J. M. Castanheira et al.

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Response to the questions of **Anonymous Referee # 2**

General comments:

The following changes in the revised paper were performed:

1. Now, we present lagged correlations between -15 months to 15 months for both HALOE-MSL and ERA-I water vapour data. The results are now much more consistent for both the satellite data and reanalyzed data. Because the Brewer-C4574

Dobson circulation is faster in ERA-I, a correlation was not observed for the lag studied in the discussion paper. Another important change in this new version of the paper is that the correlations were calculated for variabilities on interseasonal and interannual time scales. The interdecadal variability was removed as explained in the paper.

2. A new important result is the correlation between DTs and the quasi-geostrophic wave activity. This correlation shows a clear association between DTs and wave activity in the lower most stratosphere (LMS).
3. **A copy of the revised manuscript is attached as a supplement file.**

Point by point responses:

- 1) We performed a correlation analysis between the area covered by DTs and wave activity in the NH. The analysis makes clear the association between DTs and Rossby wave activity.
- 2) The objective of the paper is to show the relationships between the Brewer-Dobson circulation, double tropopause, ozone and stratospheric water vapour. Special emphasis is on the association of DTs with quasi-horizontal advection and mixing. From the results, we think that is clear that it is difficult to untangle the effects of quasi-isentropic transport, in the subtropics, from the effects of cross isentropic transport by the residual circulation.
- 3) We comment on the quality of ERA-I total column ozone and reference work by *Dragani* (2011). We also comment on the quality of the ERA-I water vapour data and its signal in the atmospheric tape-recorder.

Although the ERA-I water vapour reanalysis at stratospheric levels has very little influence from observations being mostly a model field product (Dee et al, 2011), they reproduce well the minimum specific humidity in the lower most stratosphere in the tropics that is seen in the observations. Therefore the lower stratospheric water vapour variability in the reanalysis will also be sensitive to variability in the quasi horizontal advection, and useful to assess the effect of the variability in the area of DTs.

- 4) Now we show the correlation between U70 and the vertical shear of the equatorial zonal mean wind, $\partial\bar{u}/\partial z$: This correlation is positive in the LMS, with a value of $r = 0.79$ at the 100-hPa isobaric level. This means that the easterly U70 is associated with easterly zonal mean wind shear in the LMS. Therefore the value found for the correlation between U70 and $\langle\bar{w}^*\rangle$ is consistent with theoretical results found using a two-dimensional models of the QBO (*Baldwin et al.*, 2001, and references therein). According to those models, westerly shear zones of the QBO are associated with sinking anomalies of the residual circulation at the equator, whereas the easterly shear zones are associated with rising anomalies.
- 5) HALOE and MLS water vapour anomalies used in the present work are exactly the same used by *Randel* (2010). The MLS anomalies were adjusted to match the HALOE data for the overlap period June 2004 - August 2005 (see his Plate 4). In the Data and Method section of the revised version, we refer to that adjustment.

References

M. P. Baldwin, Gray, L. G, Dunkerton, T. J., Hamilton, K., Haynes, P. H., Randel, W. J., Holton, J. R., Alexander, M. J., Hirota, I., Horinouchi, T., Jones, D. B. A., Kinnnersley, J. S., Marquardt, C4576

C., Sato, K. and M. Takahashi: The Quasi-Biennial Oscillation, *Rev. Geophys.*, 39, 2, 179-230, 2001.

Dee, D. P., with 35 co-authors: The ERA-Interim reanalysis: configuration and performance of the data assimilation system. *Quart. J. R. Meteorol. Soc.*, 137, 553-597, doi:10.1002/qj.828, 2011.

Dragani, R.: On the quality of the ERA-Interim ozone reanalyses: comparisons with satellite data. *Q. J. R. Meteorol. Soc.* DOI:10.1002/qj.821, 2011.

Randel, W.J.: Variability and trends in stratospheric temperature and water vapor. in *The Stratosphere: Dynamics, Transport and Chemistry*, *Geophys. Monogr. Ser. 190*, American Geophysical Union, Polvani, Sobel and Waugh, Eds, pp. 123-135, doi:10.1029/2009GM000870, 2010.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/12/C4574/2012/acpd-12-C4574-2012-supplement.pdf>

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 12, 12391, 2012.