

Replies to the comments:

We thank the reviewer for the comments. In the following, the comments are included in black while our replies are given in blue.

General comments:

This paper presents some heretofore-underappreciated morphology of stratospheric tracer variability. The results are clearly explained and in agreement with the authors, may provide useful diagnostics for upper stratospheric dynamical simulations. I recommend publication subject to some minor revisions.

One general comment: the authors might consider adding some thoughts on the inter-annual variability. Looking at Figure 6, the AO seems to illustrate considerable variation from year to year and seems to be largest in early 2008; this appears to be captured in Figure 12. Also there is a suggestion of this in early 2011. I'm assuming some of this would have to do with boreal winter planetary waves. Although its not straightforward since there was an SSW in January 2008, but the NH vortex was stable in 2011. Could the phase of the QBO matter? If nothing else, some discussion about this variation would provide some motivation for future work, which is always helpful.

General response: It is known that there is considerable QBO variability in the region of interest, as shown for example by Randel et al. (1998). Correspondingly, we have in our regression considered the QBO to provide a better climatological estimate of the enhanced annual variation. So far we have not investigated the inter-annual variability of the enhanced annual variation. There is a natural interest in this, since this also holds the promise to provide some information on longer-term variation, given the anticipated changes of the Brewer-Dobson circulation. However this will require multiple satellite data sets (SAGE II, HALOE, MIPAS and MLS to start with) and, thus, a careful characterisation of them to have any chance of success.

Specific comments:

Comment #1: Figure 12 says it's the same as Figure 8. In which case, the white contours should be dashed, not solid.

Response #1: Thanks for spotting this. It turned out to be a Matlab problem, plotting dashed lines only occasionally. It has been fixed now.

Comment #2: I found the captions for Figure 8 and 12 a bit confusing. Perhaps its only minor semantics, but I think of "time series" as single lines, as in Figure 6. The contour plots shown in Figure 8 and 12 are to me, more properly called "altitude variation as a function of time" (fig 8) and "latitudinal variation as a function of time" (fig 12). Alternatively, in Figure 4, an identical plot to figure 12 was called a "latitude cross section" which is OK. But not "time series".

Response #2: Okay, no problem. We denoted those kind of figures now as altitude-time sections or latitude-time sections. Also in the main text the terminology has been adapted.

References:

RANDEL, W. J., WU, F., RUSSELL, J. M., ROCHE, A., AND WATERS, J. W., "Seasonal cycles and QBO variations in stratospheric CH₄ and H₂O observed in UARS HALOE data", *Journal of the Atmospheric Sciences*, 55, 163 – 185, doi: 10.1175/1520-0469(1998)055<0163:SCAQVI>2.0.CO;2, 1998.