Response to anonymous Referee #2

We thank the reviewer for her/his valuable comments.

Major comments:

p28404: On this page you detail the spatial resolution of the observational data. On p28406 you explain the need to consider observations in the same month in each year due to the seasonal cycle in the distribution of N2O. It is also the case that tropical upwelling (referring here to the residual circulation) has a strong semidiurnal cycle. Please also include comments as to what was done to take account of this.

We assume that the reviewer question refers to the seasonal (or semi-annual) cycle but not to the semi-diurnal cycle in tropical upwelling because anything with such a short timescale will certainly be negligible in this analysis.

The reviewer is right, the upwelling and therefore the tracer profile in the tropics have a seasonal cycle and the effect of this seasonality on the trace gas distribution in the tropics is not covered in this paper. However, in the case of residual circulation, the seasonality of tropical upwelling through a given isobar surface is directly coupled with the extratropical downwelling through the same surface by mass balance (see p.28405 l.1-9). Therefore, the effect of seasonal variable tropical upwelling is included in the observed tracer distributions in the extratropics (in addition, there is also influence of the seasonality of two-way mixing on the tracer distributions). That means, the comparison of only extratropical observations from the same month - as done in this paper - covers indirectly also the tropical seasonality.

Currently all text on Figure 5 actually refers to Figure 6, and all text on Figure 6 actually refers to Figure 5. Please either swap the figures or the text around.

We revised the incorrect numbering of figure 5 and 6.

Minor comments:

p28401, lines 21–22: It is noted that a "temperature drop" is consistent with an "intensified Brewer-Dobson Circulation". This important point makes sense because the BDC is wave driven. I think this is worth a comment, since the wave-driven nature of the BDC is not mentioned explicitly until the following page.

It is true, the section addressed by the reviewer (containing a very brief summary of two relevant papers for our manuscript) comes prior to the more detailed description of the BDC (including also Fig 1) and of its wave driven nature. However, we think that the subsequent description of the BDC is close enough to the relevant section before so that an additional comment on the BDC is not mandatory.

p28402, line 25: Following "leaky" you might consider referencing:
Neu, J. L., and R. A. Plumb, 1999: Age of air in a "leaky pipe" model of stratospheric transport. J. Geophys. Res., 104, 19243–19255.
The leaky nature of this "transport barrier" is also relevant on p28409, line 23.

The Reviewer is totally right, the paper by Neu and Plumb is relevant for the understanding of our paper and we referenced it in the revised manuscript.

p.28405, lines 14–16: Please comment on the statistical significance of the elevated post-2000 lower stratospheric ozone signal.

We calculated the spring (March-April-May) averages for the stations (Edmonton, Goose Bay and Churchill) shown in Figure 2. For the 3-station average, 2002 shows the largest spring anomalies in the record, for both 250-158 hPa and 158-100 hPa, even larger than the negative anomalies in 1993 (from the Pinatubo eruption). Both are more than 2 standard deviations above the mean. 2004 and 2005 are also among the highest spring anomalies. The 3-station average is, of course,

only a partial zonal mean; but the three stations individually show much the same behaviour. We add a short comment on this in the revised manuscript.

Figure 2: Why the change in colour scheme from red and yellow lines to blue and red lines at 100hPa? If this is to separate troposphere and stratosphere please make a comment to this effect in the figure caption.
The colour code in Figure 2 illustrates the vertical transition from the troposphere (400-250 hPa) to the lowermost stratosphere (250-100 hPa) to the stratospheric overworld (100-6.3 hPa). This explanation has been added to the figure caption in the revised manuscript.

Typographical errors:
p.28403, line 21: data set ! data sets
We revised it.

p.28413, line 21: has been identified ! identified.
We revised it.