**Atmospheric
Chemistry
and Physics
Discussions**

Interactive
Comment

Interactive comment on "Age of stratospheric air in the ERA-Interim" *by* M. Diallo et al.
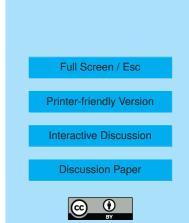
M. Diallo et al.

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Answer to referee #1

We thank referee #1 for his comments and suggestions. Comments by the referee are highlighted and followed by our answers.

1. *An obvious issue with this approach is that over this period the observa-tions assimilated by the reanalysis have undergone continuous changes (e.g. assimilation of COSMIC temperatures in 2006), the effect of which are fed back into the winds and heating rate fields used in this study to cal-culate the trajectories and age of air, and will affect the results obtained. Unless these effects can be quantified, the trends calculated should be*

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thought of as belonging to an "ECMWF world", and the utility of which is in doubt. While the authors mention this at the very end of the paper, this is an important issue that should be at least acknowledged in the section on trends before proceeding with the analysis and comparison with MIPAS.

We agree that the trend belongs to the ECMWF world. However, this world is not meant to be totally disconnected from the real world and is actually, along with other reanalysis, the best available estimation of the real state of the atmosphere over the last 30 years. Trends in reanalysis are liable to be due to changes in the observation systems it is nevertheless interesting to document them as they may also carry some information on the real world and because they may also help to correct some biases in the models. We have added some warning sentences in the section on trends.

2. *Page 17095 - Description of the method. Line 25, not sure how $F(\tau)$ is estimated - since it is the probability density function, are the authors calculating the cumulative distribution function as in Scheele (2005) for the trajectories, rather than actually estimating the pdf? And also, should the definition of mean age not be $\int_0^\infty \tau F(\tau) d\tau$?*

The referee is right. The two equations (1) and (2) were wrong due to some uncorrected mismatch in the writing and do not describe the performed calculations. This paragraph is now corrected as follows.

If we define $F(\tau)$ as the probability density of the age τ with , the mean age is

$$\bar{\tau} = \int_0^\infty \tau F(\tau) d\tau. \tag{1}$$

The truncated version of this integral up to $t_f = 10\,\mathrm{yr}$ can be calculated explicitly from the trajectory calculations. Assuming that $F(\tau) = F(t_f) \exp(-b(\tau - t_f))$

beyond this bound, the mean age can be estimated as

$$\bar{\tau} = \int_0^{t_f} \tau F(\tau)d\tau + F(t_f)\left(t_f + \frac{1}{b}\right).$$

(2)

In practice, the calculation is discretized in the following way. For a total of N particles, those with ages under t_f, which have crossed the tropopause during backward integration before t_f, are distributed in K ages bins between 0 and t_f with n_i particles in the bin i centered on time t_i. If M_f particles remain within the stratosphere at time t_f, the mean over this ensemble is

$$\bar{\tau} = \frac{1}{N}\sum_{i=1}^{K} n_i t_i + \frac{M_f}{N}\frac{bt_f + 1}{b^2}$$

(3)

3. ***P 17097: Section 3.1 The method of calculating the std. dev. after accounting for the time correlation of monthly ages is interesting and not altogether completely well-known. Perhaps this could be included as an appendix/in text.***

This is based on a fairly standard estimate of the number of degrees of freedom of the time series which is also applied to assess the significance of the trend. The method is now described in a short appendix.

4. ***Figure 1:The x-axis label says 'Mean age' (same goes for the y-axis labels of Figure 7)- this got me quite confused, since Mean age in the text means the 'stratospheric mean age of air', but here it seems to actually mean the length of the trajectories. Could this be cleared up? The labels in the graphs should read "τ" rather than 't'.***

The x-axis is now labelled 'ellapsed time' like in the caption and the text. t has been replaced by τ.

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5. ***Figure 2. - the text on P 17097 says standard deviation, but the figure label says 'variance', which is it?***

The text was correct and the label has been corrected.

6. ***P17109 - line 10 - could the authors just clarify in the text what the "strong hypothesis is"?***

Andrews et al. (1999) uses a predefined functional form of the age of air spectrum which is derived from the analytic solution of the 1-D diffusion equation of Hall and Plumb (1994). This functional form contains two independent coefficients which are function of the potential temperature and can be determined from CO_2 observations. This method can only be applied to young ages and does not take into account the variability of the Brewer-Dobson circulation. This approach was extended by Andrews et al. (2001) who proposed a bimodal spectral shape with two distinct peaks to represent respectively the fast quasihorizontal mixing and slow Brewer-Dobson circulation in the Northern hemisphere midlatitude lower stratosphere. Bonisch et al. (2009) adopted this bimodal concept and made the important revision that the superposition of the two modes does not necessarily lead to two distinct spectral peaks. Using several tracers with different stratospheric life times, up to five in Schoeberl et al. (2005), allows to adjust more parameters of the distribution.

7. ***6. Figure 6. I'm just wondering if the labels of the plots are mixed up - e.g. 6(a)in the text it says that the variation between JJA and DJF is smaller in SH, but it seems to be the opposite in the plot.***

The curves for north and south hemisphere had been inverted. This has been fixed and the text now agrees with the plots.

8. ***6.P 17111 line 16 - reference needed regarding to ERA-Interim/other reanalysis comparison***

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The missing reference has been corrected.

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