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Atmospheric Chemistry and Physics Discussions

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

**M. Diallo et al.**

mdiallo@lmd.ens.fr

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**Answer to referee #2**

We thank referee #2 for his comments and suggestions. Comments by the referee are highlighted and followed by our answers.

1. ***Specific comments: p.17095, l.26: I'd prefer to distinguish between transit time $\tau$ and the mean age as given by the integral over the PDF of transit times (or the age spectrum). $F(\tau)$ is rather a PDF of transit times (of single trajectories) than a PDF of age. Does the value of b depend on the underlying driving data set?***

   The equations (1) and (2) have been corrected. See also the answer to referee



   #1.

2. ***p.17098, l.18: What is the error of the satellite derived ages (not the statistical error of the means?). What are the uncertainty ranges given by Stiller et al?***

   According to Stiller et al. (2008), the systematic errors of $SF_6$ ages are such that ages are 0 to 0.5 yr too low in the lower stratosphere and 0 to 1 yr too high between 25 and 35 km. Stiller et al. (2008) mention that they are not expected to change with time, so they do not play a role for trend assessments or temporal variability.

3. ***p.17099, l.1: Is there a seasonal bias? Diurnal or weekly sample biases would not show up, due to the long lifetime of $SF_6$.***

   According to G. Stiller (personal communication, see also Stiller et al. (2008)) the only season-dependent bias found was in the very polar regions due to illumination conditions which affect the neighboring $CO_2$ lines. This can lead to a season-dependent bias of 2 years (peak to peak). i.e. the amplitude of the seasonal variation over the poles (75-90 N/S) might be too high. In addition, G. Stiller mentions that uncertainty of spectroscopic data may introduce another 5 % error on the SF6 retrievals which translates into an systematic error in the order of 1.5 years. Again, this systematic error does not depend on time. G. Stiller stresses that these estimates of systematic errors are worst case scenarios, and the real systematic errors are much smaller.

4. ***p.17099, second paragraph: The finding that kinematic trajectories produce larger ages than diabatic is interesting. If recirculation between the TTL and the extratropical lowermost stratosphere affects this, there should be significantly younger air in the extratropical lowermost stratosphere in the kinematic scenario (and older air in the tropical tropopause region below 380K). Did the authors check for this?***

Actually, the kinematic ages are older than the diabatic ages in most of the extra-tropical lowermost stratosphere but the difference is larger in the southern hemisphere.

5. ***p.17100 and Fig.5: Are only diabatic age profiles are shown? How do kinematic profiles compare to this (see previous commment)***

   We have added a new figure showing the difference between mean kinematic and diabatic ages as a function of latitude and altitude. There is a large difference between the two hemispheres. In the northern hemisphere, kinematic ages are younger than kinematic ages by up to 1 yr in the mid-stratosphere while in the southern hemisphere they are older by up to 1.5 yr in the lowermost stratosphere. The mid southern stratosphere exhibits no discrepancy between kinematic and diabatic ages and the kinematic ages are only slightly older than diabatic ages in the bottom half of the northern lowermost stratosphere. We do not have so far a simple explanation for such an unexpected pattern.

6. ***p.1702, l.1: If the oscillations are the product of a seasonaly varying Brewer-Dobson circulation, why are they not visible in Fig.5 as significant age differences between summer and winter?***

   The seasonal modulation of the Brewer-Dobson circulation seen in Fig. 6 does not mean that the mean age changes a lot between winter and summer as it modulates an underlying distribution which is fairly flat over a scale much larger than one year.

7. ***p.17104, Fig.8: How does the strong gradient of phases in Fig.8 between the tropics and the extratropics between 17km and 22 km form? What is the reason for this? Did the authors consider a seasonally varying phase lag? It would be interesting to see the mean phase lag for late spring and early autumn separately.***



   As the phase lag is based on fitting a sinusoidal shape on the seasonal variations, it is not possible to define a seasonally variable lag. The phase gradient results from the modulation of the mixing across the subtropics between the extratropical stratosphere and the region of the tropical stratosphere above the tropopause and below the basis of the tropical pipe. As a result air is younger in the tropics and older in the mid-latitudes when the barrier is high and the opposite when the barrier is low.

8. ***Fig.12 and discussion: could you give potential reasons for the asymmetry between the northern and southern lower stratosphere? Is the difference related to differences in the downwelling of aged vortex air? Changes of this should be stronger in the SH?***

   This is an interesting suggestion as younger extratropical air would result from a decrease of the Antarctic downwelling associated with the polar vortex. However, this effect would not extend to the tropics as seen in Fig. 13 (previously Fig. 12). The trend is more consistent with an increase of the lower branch of the Brewer Dobson circulation in the southern hemisphere. We do have yet an explanation for the hemispheric asymmetry.

9. ***Figs.13 and 14.: Given the importance of significance for trend analyses I recommend to clearly indicate in the captions of Figs. 13 and Figs.14, in which cases the deduced trends are significant.***

   The p-values are now indicated in the caption.

## References

Stiller, G. P., von Clarmann, T., Hörfner, M., Glatthor, N., Grabowski, U., Kellmann, S., Kleinert, A., Linden, A., Milz, M., Reddmann, T., Steck, T., Fischer, H., Funke, B., López-Puertas, M., and Engel, A.: Global distribution of mean age of stratospheric air from MIPAS SF6 measurements, Atmos. Chem. Phys., 8, 677–695, doi:10.5194/acp-8-677-2008, 2008.

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