

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

### **Anonymous Referee #3**

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This paper investigates the distribution and variability of the age of stratospheric air in the ERA-interim reanalysis data. Age spectrum and mean age are calculated using the backward trajectory method. The calculated mean age in the ERA-interim agrees well with mean age derived from in-situ and satellite measurements. The authors show that the mean age has a strong annual cycle in the lower stratosphere. They also find that the QBO has an important impact on age of air in the tropics. Finally the linear trend of the mean age is discussed. These results are important to understand stratospheric transport in the ERA-Interim. I recommend publication of the paper after my concerns are addressed.

#### Major Comments:

1. Section 2.3. I am confused by how the age spectrum and mean age are calculated in this study. My understanding is that  $F(\tau)$  in equation 1 is the age spectrum. Equations

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(1) and (2) are not correct because mean age is the first moment, not the mean, of the age spectrum [e.g., equation (1) of Scheele et al., 2005]. This is not a trivial issue: mean age weighs heavily on the tail of the age spectrum and thus could be significantly older than what is calculated from equation 1. Please clarify.

2. Section 4.4, My personal opinion is to drop this section. Reanalysis data should not be used for trend analysis, especially for highly derived diagnostics such as age of air. If the authors really want to keep this part, they should also investigate what causes the trend of age.

#### Minor Comments:

Page 17094, line 20, Age of air cannot be directly measured. It is deduced from CO<sub>2</sub> and SF<sub>6</sub> measurements with some assumptions [e.g., Garcia et al., 2011].

Page 17097, line 1, Tropical pipe is not the ascending branch of the Brewer-Dobson circulation.

Page 17098, lines 11-15. I don't follow this statement.

Page 17099, lines 12-13, The previous sentence explains why mixing leads to older age. So why do you expect that mixing should lower the mean age?

Page 17099, line 13, What is indeed observed?

Section 3.2, It would be interesting to compare the seasonal variations of the mean age with observations [e.g., Andrews et al., 2001; Bonisch et al., 2009] and models [Reithmeier et al., 2008; Li et al., 2012].

Page 17099, last paragraph, There are many factors that could cause different ages in CCMs and in this study. For example, the stronger gradient in mean age between the tropics and midlatitudes means that the tropical upwelling is weaker in this study than in CCMs. Maybe that is the most important factor. In addition, it is not clear to me why large numerical diffusion makes the mean age younger in CCMs.

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Section 3.4, I suggest the authors to compare the seasonal and latitudinal variations of the age spectrum with previous model studies [Reithmeier et al., 2008; Li et al., 2012].

Page 17101, lines 8-17, I don't understand what is a "flat maximum at about 4-5 yr" and I don't see it in the figure. I suggest dropping the discussion of the two-modal spectrum structure.

Page 17101, lines 18-22, These statements are not consistent with what Figure 6 shows.

Page 17101, line 24, consider "older ages" instead of "larger values".

Page 17102, lines 2-6, This statement is too general. Could you explain in more detail? What does age spectrum at high latitudes look like? Are there significant changes in spectral shape at polar region as reported by previous model studies?

Page 17102, lines 15-19, Why the 2-3 years old air has the largest annual cycle?

Please increase the label font size for all the figures.

Figure 1, label for x-axis should be "elapsed time" or "transit time", not "mean age".

References:

Andrews, A. E., K. A. Boering, S. C. Wofsy, B. C. Daube, D. B. Jones, S. Alex, M. Loewenstein, J. R. Podolske, and S. E. Strahan (2001), Mean ages of stratospheric air derived from in situ observations of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O, *J. Geophys. Res.*, 106, 32,295–32,314, doi:10.1029/2001JD000465.

Reithmeier, C., R. Sausen, and V. Grewe (2008), Investigating lower stratospheric model transport: Lagrangian calculation of mean age and age spectra in the GCM ECHAM4, *Clim. Dyn.*, 30, 225–238, doi:10.1007/s00382-007-0294-1.

Li, F., D. W. Waugh, A. R. Douglass, P. A. Newman, S. Pawson, R. S. Stolarski, S. E. Strahan, and J. E. Nielsen (2012), Seasonal variations of stratospheric age spectra

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in the Goddard Earth Observing System Chemistry Climate Model (GEOSCCM), *J. Geophys. Res.*, 117, D05134, doi:10.1029/2011JD016877.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, 12, 17087, 2012.

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