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Interactive comment on "Deriving stratospheric age of air spectra using chemically active trace gases" *by* Marius Hauck et al.

Anonymous Referee #1

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This manuscript presents an inverse method to infer the stratospheric age spectra from the mixing ratio of short-lived gases. The development of a method to determine the age spectra, and not just the mean age, from observations would a major step forward in our ability to quantify stratospheric transport. Unfortunately, this manuscript does not present such a method. The method presented can estimate the age spectra from 40 tracers with spatially-uniform loss of different rates. However, these tracers don't exist, and I don't see how the method can be extended to gases with spatially varying loss. In my view for this manuscript to publishable the authors need to present a possible way for this method to be applied to real tracers. Without this I am not sure of the value of the manuscript.

MAJOR COMMENTS

1. The method is tested with a totally unrealistic situation of 40 tracers with spatially-uniform loss with loss rate varying from 1 month to 5 years. As far as I know there are no observable tracers with spatially-uniform loss let alone 40 such tracers. To test if a method will provide useful information in the real world the authors need to consider (i) a much smaller number of tracers and (ii) tracers with spatially varying loss similar to observable tracers. It would be rather straight forward to repeat the analysis using fewer than 40 tracers to see who dependent the inversion is to the number of tracers used or the range of lifetimes of these tracers, and I am very surprised the authors have not done this. But item (ii) is the more challenging and a major draw back of the proposed method. If spatially-varying loss isn't included how will this be applied to real tracers?

2. The inversion method assumes that the age spectra is an inverse Gaussian, which I think limits it value as there is a lot of evidence that this assumption breaks down in many parts of the stratosphere. With 40 tracers with different spatially-uniform loss it should be possible to estimate the age spectra without this assumption. One possible method is the maximum entropy approach (e.g. Holzer & Primeau 2010), but even simpler approaches could be possible (e.g. estimating moments of age spectra, or by assuming a more general form of the spectra such as two inversion Gaussian combined so the spectra can be bimodal). Given comment 1, this is rather academic but if going to use large number of idealized tracers than should try to estimate as much as you can about the spectra.

3. It is unfortunately that the EMAC pulse simulations were only released every 3 months, as this limits the ability to test (i) if the age spectra are inverse Gaussian and (i) the seasonality. If the aim is just to estimate the annual-mean spectra then this would not be as important, but comparisons of the shape and timing of peaks for the seasonal spectra (shown in figs 4 to 6) is really limited by the 3 month resolution.

4. There is no reference or discussion of the Li et al. 2012a,b (references below) which used the same pulse method to calculate and examine the age spectra in the GEOS

CCM. The first paper focused on the seasonal cycle and used pulses every month, and is therefore very relevant to simulations in this manuscript.

5. I think the presentation in Figures 4-6 needs to be changed. The point of these figures is to compare the spectra from the inversion with the EMAC simulated spectra, but the two spectra are shown in different plots and it is difficult to make a detailed comparison. The spectra from the inversion needs to be overlaid over the EMAC simulation so a reader can see more clearly how well the inversion works.

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