Reply to RC3

Manuscript information:

- Title: Mean age from observations in the lowermost stratosphere: an improved method and interhemispheric differences
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- MS type: Research article
- Iteration: Final response

We would like to thank the reviewer for the kind words and the constructive comments. In the following document, the reviewers' comments are marked in *italic font* and indented, our answers are in regular font. Changes in the manuscript are marked-up in red and listed as framed screenshots below the respective comment. The line numbers in our listed changes refer to the marked-up version of the revised manuscript, that is provided separately.

Point-by-Point reply

1. *Line 25. … isentrope, **and** approximates*

Done.

> The lowermost stratosphere (LMS) is the lowest part of the extra tropical (exTR) stratosphere. Its upper boundary usually is
> 25 defined as the 380 K isentrope, ~~which~~ and approximates the lower boundary of the stratosphere in the tropics. The chemical

2. *Line 39. … made contact **with***

Done.

> infinitesimal fluid elements enter the stratosphere across a source region. The transit time (or "age") of each individual fluid
> element is the elapsed time since it last made contact ~~to~~ with a source region. A macroscopic air parcel in the stratosphere
> 40 consists of an infinite number of such fluid elements, each with its own transit time. The transit time distribution for the air

3. *Line 48. making **fewer** assumptions **compared to** deriving age spectra.*

Done.

> 45 studies to derive the mean age of air from observations (e.g. Engel et al., 2017; Leedham Elvidge et al., 2018).
> Age of air from observations provides a stringent test for numerical models. The number of available trace gas observations
> that are suited to derive mean age is vastly higher than that to derive age spectra. In addition, deriving mean age relies on
> making ~~less~~ fewer assumptions ~~than does~~ compared to deriving age spectra. This makes mean age a valuable measure to

4. *Line 51. … measurements, an infinite lifetime is **commonly** assumed.*

Done.

> 50 depending on the trace gas used, which significantly add to the uncertainty in mean age across large areas of the stratosphere.
> For example, in order to derive mean age from SF_6 measurements, ~~commonly~~ an infinite lifetime is commonly assumed. In

5. Line 308. Our findings indicate that… (no comma needed after 'indicate')

Done.

> 315 Our findings indicate, that on the one hand, during ST1 old air from higher altitudes descends in a confined way at high
>   latitudes. There is a sharp vortex edge with a strong gradient in the SH. On the other hand, during PGS2 descending old air is

6. Lines 313, 385, 390, 420: 'extend' should be 'extent'.

Done.

> 310 mixed vertically and horizontally with young air in the LMS. The vortex edge is less sharp than during ST1, resulting in
>   younger air at high latitudes and altitudes and older air outside the PGS2 vortex region compared to ST1. ¶
>   These results cover only isolated time periods of less than two months for each campaign. In addition, as discussed by
>   Jesswein et al. (2021) the extentd of the respective polar vortices and therefore also the location of the respective vortex edge

> 380 The contribution of the individual parameters (i)-(v) is shown in Fig. 6. Each row depicts isolated sensitivities to
>   uncertainties in a single parameter with all other parameters being held at their best estimate. This allows us to test the
>   relative importance of the individual parameters to the exTR-TR method's overall sensitivity. Most strikingly, uncertainties
>   in the ratio of moments (parameter (v)) seem to contribute only to a negligible extentd to the overall sensitivity (panels (m),

> 390 in the ratio of moments (parameter (v)) seem to contribute only to a negligible extentd to the overall sensitivity (panels (m),
>   (n), (o)). Measurement uncertainties in the stratospheric mixing ratio $\chi(x)$ contribute evenly distributed to the overall
>   sensitivity to a moderate extendextent (panels (j), (k), (l)). Due to the slightly worse measurement precision during

> 420 TR method instead, the number and extentd of negative mean age values is reduced. Maximum absolute differences between