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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulating age of air and distribution of SF_6 in the stratosphere with SILAM model" *by* Rostislav Kouznetsov et al.

Anonymous Referee #3

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This is an interesting manuscript exploring, in a model environment, the effects of chemistry, gravitational separation and diffusivity on SF6 mixing ratios in the stratosphere and the mean age of air derived from it. Clearly a lot of work has gone into devising the various model setups and I would in general support the publication of this work. However, some questions need to be answered and some potential issues resolved beforehand. One example is e.g. that even though it is driven by ERA-Interim there is no guarantee that this model will accurately reproduce stratospheric transport patterns including the overturning circulation, transport barriers, the QBO, etc., all of which can influence AoA. Perhaps this was demonstrated in Sofiev et al., 2015? If so, it would be good to give a short summary, if not, some further details are required. Some further points can be found in the below.

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Discussion paper

Title: Consider adding “the” before “distribution” and “SILAM”. There are various other places in the manuscript with small language deficiencies like this.

Abstract: An introductory sentence to alert the reader to the fact that this paper is on the stratospheric overturning circulation (and perhaps its importance) would be helpful.

Line 11: This should be “adds” and I would also recommend adding “up to”.

Line 32-33: Age is not the correct term here as oceanic water has been around for some time. I suggest replacing it with e.g. “transport times”.

Line 109-113: I was quite surprised to find a new satellite product hidden in this modelling-focused manuscript. Given that there are “considerable” differences to previously published SF6 data sets I urge the authors to provide more details and make their statements more quantitative (e.g. defining “considerably higher” and “closer”; where does the “new” CFC-11 band come from?; does the correction influence trends in the 2002-2012 period?), perhaps even by adding a figure to support their claims.

Line 118-119: Figure 1 is bad quality and Figure 2 needs some further explanation in the caption.

Line 119: Is it Silam or SILAM?

Line 170-171: Looking at Figure 2 none of the three profiles seem to capture the vertical gradient from the ERA-5 data. Why is that?

Line 219-220: Please quantify: How negligible does vertical advection need to be? And how does that compare to actual vertical advection in the stratosphere and mesosphere?

Line 259: The details of the simulation setup are beyond my expertise. However, this statement seems somewhat vague. What does “normally” mean here? And how large is the precision of the input wind fields? Does it e.g. vary over time?

Line 273-275: This is a major problem. A linear extrapolation can introduce biases,

especially since 4 years of the extrapolated period overlap with the MIPAS period. Why do the authors not use more up-to-date publically available data, e.g. from the AGAGE and NOAA ESRL networks. Looking at Figure 1-21 in the recent Scientific Assessment of Ozone Depletion (2018), global emissions of SF6 appear to have been much lower between 2008 and 2016, closer to 0.21 Gg/yr. The implications for the derived AoA and its trend could be quite severe and should at least be assessed.

Line 287-294: This paragraph raises a few questions. What does "0.001Kz eddy diffusivity" mean in detail and why was the initialisation performed that way? When was the initialisation started? Which emissions were used for SF6 species from 1980-1989 and which meteorological fields for 1970-1979? What about the pre-1970 time period?

Line 306: This should be "from".

Line 313-314, 353-355: Why are the lifetimes in Table 1 so long? It looks like the model is not able to reconcile realistic diffusion rates with recently published lifetime estimates for SF6 (e.g. Kovacs et al. and Ray et al.). This needs to be discussed. I also do not agree that there is good agreement with lifetime estimates from other studies (Line 353-355) as all of the higher lifetime estimates (>$\sim$1500 years) come from outdated studies.

Line 399-400: Please improve Figure 7. It is currently very hard to decipher the legend and text inside the graph area and the two lines for each colour are undistinguishable. Also, please add the uncertainties of the MIPAS data points (one could at least add standard deviations of the observed values as in Kovacs et al.) and why are SF6 mixing ratios increasing at the high altitude end for some profiles?

Line 471-475: Plotting the residual between 11a,b and c might help visualising the differences. Also, please quantify "slight old bias".

Line 547-548: Looking at Figure 7 I cannot agree with this statement, at least not until some realistic uncertainty estimates have been added to the observations.

Line 551-552: This is right at the upper end of recent estimates, so not too good agreement. Given that the authors state themselves earlier in the manuscript that “insufficient vertical resolution of ERA-Interim in the upper stratosphere and lower mesosphere, and lack of pole-to-pole circulation” limit model performance (resulting also no conclusion being drawn on AoA trends) I find that statement too strong.

Page 28-29: Figure 8 and 9 are currently not mentioned anywhere in the manuscript.

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