

Interactive comment on “Three-dimensional simulation of stratospheric gravitational separation using the NIES global atmospheric tracer transport model” by Dmitry Belikov et al.

Anonymous Referee #1

Received and published: 18 October 2018

This paper shows results of a CTM with molecular diffusion added to diagnose gravitational separation (GS) in the stratosphere. The different processes that control the diffusive velocity due to GS are discussed and the model distributions are compared to modeled age of air as well as observed profiles of derived GS and mean age. The model theory is clearly described and the comparisons to observations are interesting.

My main concern with the paper is the lack of clear evidence that the GS calculation adds significantly to our understanding of the stratospheric circulation. The conclusion section states that the model GS characteristics provide useful insights into structure changes in the UTLS, particularly over mean age. Mean age from measurements is ill-

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defined in the UTLS so it is not used as a measurement-based indicator of circulation changes in that region. There are a number of other trace gases, such as ozone, water vapor and CO, that are commonly used to define the transport and structural changes of the UTLS circulation. Even in the lower stratosphere above 100 hPa, where the seasonal cycle of CO₂ can impact mean age estimates, a careful consideration of the boundary conditions can alleviate much of the uncertainty. The simple lag technique used to calculate mean age in this paper is inappropriate for a trace gas with nonlinear growth such as CO₂.

The topic is appropriate for ACP and the model simulations of GS are novel. The benefits of these simulations to help interpret stratospheric circulation variability should be more clearly shown and described in my opinion. There are also a number of grammatical errors so I would suggest a more thorough proofreading of the paper is necessary.

Specific comments:

Pg. 2, line 4: add TM abbreviation here since you refer to it on line 7.

Pg. 2, line 23: This is a confusing sentence, the mean meridional circulation is part of the BDC.

Eq. 7: This is an oversimplified way to calculate the mean age from a non-linearly growing trace gas such as CO₂. Why not compute the true model mean age using an idealized linearly growing tracer?

Figs 2-4: Very little discussion of these figures in the text. Figure 2 is interesting but the scales are different on each plot and the terms are labeled 1-3 rather than by the physical mechanism responsible for each term so it's difficult to understand what's the important take away. There is only one sentence describing Figure 3, that's not enough. Better to fully discuss the important features of the figure or it should be removed.

Pg. 11, line 20: change "part" to "altitudes"

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Pg. 12, line 1: change “sampling” to “sample”

Pg. 12, line 6: change “the model” to “a model”

Pg. 16, lines 20-22: As mentioned above, these statements aren't necessarily supported in the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-835>, 2018.

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