Reply to reviewer 1

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1 Reply

First of all we would like the thank the reviewer for his/her comments, and careful reading of the manuscript. We will follow most of the suggestions made in the revised manuscript. There are several main points made, which will be addressed as indicated below.

- *I am missing a critical discussion and the connection between the model's difference with the different set-up, such as vertical and horizontal resolution, nudging and reanalyses-driven models.* This point is also raised by Reviewer 2. The main aim of this first paper is to present the protocol and first results. The intercomparison brings a lot of interesting information, however, analysing the exact causes for the inter-model differences would lengthen the paper considerably. We agree with the fact, at the current state, it is too early to diagnose convection as the main source of the differences (see also Reviewer 2). We will rephrase out conclusions accordingly. To make a detailed analysis, models should be run with different convective parameterisations, resolution, and advection scheme. This is partly done by the LMDZ and TM5 models. To analyse the differences in nudging data (ERA-interim vs. JRA25) would require detailed analysis of the driving meteorological fields, and maybe a single model using both data streams. At this stage, we think this is beyond the scope of the paper, which presents the protocol and first analysis. This is fully in line with the scope of the GMD journal, and hopefully many follow-on studies will further analyse the results that are already available.

- *The organisation of the figures*: We will consider re-organising the figures in the revised manuscript.

- *Section 5 (Conclusions) provides mostly a brief summary of things which have been stated before.* We think this is an efficient way to present the main conclusions. We will be more textual in the revised manuscript.

Below we address the other points of the reviewer.

1. *Page 2, line 12: " is only broken down in the upper stratosphere ". Please add citation after "stratosphere" about stratospheric SF6 photodissociation.* Will be included.

2. *Page 2, line 32: " . . upper-tropospheric equatorial westerly duct,. . .". Please cite Waugh and Funatsu, 2003 after "duct".* Will be done.

3. *Page 3, line 1: please replace "again" by "also".* OK.

4. *Page 3, lines 9: ". . . troposphere-stratosphere exchange . . ." please cite Holton et al., 1995 which is the suitable reference for STE.* OK

5. *Page 3, line 12: "Stratospheric age of air and its temporal trend have been determined from SF6 measurements from the MIPAS satellite (Stiller et al., 2012)" and from balloon observations (Engel et al, 2009).* OK.

6. *Page 5, line 21-23: The tracers that are not used in this study don't need to mentioned or listed in this paper. Please remove this sentence. "Note that we also included a 222 Rn simulation with monthly varying emissions over Europe during 2006–2010, based on the high resolution emissions maps presented in Karstens et al. (2015). The current paper will, however, not analyse these simulations."* On this point, we disagree. This paper is intended as a first presentation of the intercomparison exercise, and readers should be made aware of the data that is available for further analysis.

7. *Page 9, lines 2: "For this inter-comparison . . ." coma after "inter-comparison".* OK.

8. *Page 9, lines 5-7: "Recent analysis (Tsuruta et al., 2016) shows that the mass fluxes produced with the ERA-interim data set (Dee et al., 2011) lead to faster inter-hemispheric transport compared to the old model version using the Tiedtke (1989) scheme that was used in the earlier TransCom study (Patra et al., 2011)." Sentence should be revised "According to Tsuruta et al., 2016, the mass fluxes . . . ". There is also an over citing Dee et al., 2011 in this page.* Will be revised.

9. *Page 10, line 28: . . . (Austin and Houze Jr, 1973; Belikov et al., 2013a) A modified. . . there is a missing dot before the "A.. ".* OK.

10. *Page 12, line 7: ". . . signalling stratosphere-troposphere exchange." Please add Holton et al., 1995 at the end of the sentence.* OK.

11. *Page 12-13, line 12/line 1: "Here, all models agree on an interesting asymmetry: AoA derived from "SHsurface" around the North Pole is older than AoA derived from "NHsurface" around the South Pole." Why?* This is explained in the answer to Reviewer 2. This is likely due to a seasonal rectifier effect, with wintertime trapping and efficient mixing in summer over NH landmasses. In the manuscript (abstract

and page 22), we also mention that the asymmetric position of the ITCZ may play a role. In the revised manuscript we aim to add an Appendix in which the seasonal rectifier effect will be further explained.

12. *Page 13, line 1: What the cause of the differences between TOMCAT and NIES results?* We think this issue is clearly discussed in the remainder of the manuscript, when SF6 and 222Rn results are analysed. The bottomline is that both TOMCAT and NIES are diagnosed with slow vertical transport. NIES still appears to have fast interhemispheric transport, likely related to a diffusive advection scheme.

13. *Page 13, line 12: ". . . emission from the NH." Please replace by ". . . from the NH emissions."* OK.

14. *Page 14, line 1: "Indeed, the lowest CH4 concentrations on the Earth's surface are found at NOAA site Eastern Island (EIC) (Patra et al., 2009b), which was attributed to "old" air in combination with strong removal of CH4 by OH at tropical latitudes". Please rephrase this sentence.* Will be rephrased.

15. *Page 14, line 6: How Louis (1979) scheme would impact the transport? Please be more explicit.* We will refer here to earlier studies, e.g. Chipperfield (2006) and Wang (1999) and Section 2.7, where is stated that local BL transport schemes like Louis (1979) lead to slower exchange between the BL and free troposphere.

16. *Page 14, line 10: "Here it should be noted that the TOMCAT and NIES AoA is already systematically older at the tropopause (see Figure 2)." But in the stratosphere, the AoA from LMDZ, TM5, EMAC are even older than TOMCAT and NIES. Therefore, the sentence is not useful here.* We think it is still useful to remark here that the AoA of the surface tracer differs in TOMCAT and NIES. We will slightly rephrase.

17. *Page 15, line 9: "Further analysis on the stratospheric AoA in this model ensemble is left for future exploration." Before this sentence please discuss Garny et al., 2014; Ploeger et al, 2015 concerning the impact of the aging by mixing which play important role.* OK.

18. *Page 17, paragraph 2, line 5-15: Please combine fig. 8 and 9 and rephrase the paragraph. This will make this paragraph easy to follow. Please improve the ticks and legend of actual fig. 8. Enumerating the panel would be helpful.* We will revise the figures.

19. *Page 23, line 21-22: Please rephrase this ". . . five AoA tracers..."* OK.

2 Reference

Wang, K. Y., Pyle, J. A., Sanderson, M. G., & Bridgeman, C. (1999). Implementation of a convective atmospheric boundary layer scheme in a tropospheric chemistry transport model. Journal of Geophysical Research, 23729–23745.