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Interactive comment on "On the ability of chemical transport models to simulate the vertical structure of the N_2O, NO_2 and HNO_3 species in the mid-latitude stratosphere" *by* G. Berthet et al.

G. Berthet et al.

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Reviewer #1 comments were very helpful to clarify the paper. He makes some suggestions that we take into account as described in details below:

1) We agree with the reviewer that the statement "This seems to demonstrate that dynamical effects constitute ... in the middle-stratosphere" in the introduction (Pg. 12375, l.25) is directly related to our conclusions. Thus this sentence has been removed from the paper.

2) Description of the balloon measurement errors (Chapter 2, Pg. 12377): as suggested by the reviewer we have added a paragraph about the measurement error

estimation concerning the N2O, NO2 and HNO3 species studied in the paper. This discussion about the errors is more detailed in the Moreau et al. (2005) paper cited in our manuscript. However during the preparation phase of the SPIRALE flight of January 2006 at high latitude some laboratory work was conducted on the instrument. The examination of the HNO3 detector revealed an unexpected non-linear response leading us to re-assess the estimation of the HNO3 measurement error. For this reason the error bars on the HNO3 plots have been increased to be of 20% on the whole profile presented in the manuscript. Note that the HNO3 detector has been replaced for the next flights which will reduce the above uncertainty. Regarding NO2 the uncertainty has been revised to reach a maximum of 30% below 15 km, 20% around 20 km, 7% between 25 and 30 km, and 5% above 30 km for the flight presented in the manuscript. The new figures shown in the revised version of the manuscript are represented with this new estimation of the error bars.

3) Concerning comparisons with other instruments, no other balloon measurements are available for direct comparisons with SPIRALE observations. The flight presented in the paper occurred in the frame of a validation campaign of the MIPAS instrument onboard the ENVISAT satellite. Unfortunately MIPAS did not offer measurements at the period of the SPIRALE flight. We checked for possible other space-borne measurements such as HALOE (N2O and NO2), POAM III (NO2) and SAGE III (for NO2) but no acceptable space-time coincidence is available for direct comparison with our balloon measurements. We have added this sentence in Chapter 2, Pg. 12376: “Unfortunately measurements from the instruments onboard ENVISAT were not satisfyingly close in time and space to the SPIRALE observations for direct comparison and validation.” Note that modelling work with an assimilation code is currently done with other balloon and space-borne instruments for indirect comparisons with our measurement and will be integrated in a next publication.

4) Chapter 4.1.1, Pg. 12378-12379 about the PV maps: reviewer # 1 suggests to add on figure 2 the potential vorticity fields at the level where a mixing event is observed.

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We have then completed figure 2 accordingly with a PV map at the 625 K level (around 25 km) which reflects N2O mixing ratios between typical mid-latitude and tropical values as shown in the Urban et al. (2004) paper cited Pg. 12379. We have then modified the text accordingly around l.20: “Between 23 and 29 km the N2O profile is clearly non-monotonic (Fig. 1) and the measurements appear to be located very close to the maximum PV gradient region such as at 625K (Fig. 2b). The vertical profiles of the CH4 and N2O tracers are associated with a significantly different [CH4]:[N2O] correlation with respect to Michelsen et al. [1998] correlation curves (Huret et al., 2005).” The reviewer also suggests that the CH4-N2O correlation plot would be helpful to emphasize that different origins of air masses were observed by the instrument. This mentioned figure is shown in the work Huret et al. (cited as work in preparation in Pg. 12378 of our manuscript) which has recently been accepted for publication in JGR and is now cited in our manuscript (see reference Huret al. (2005), doi:10.1029/2005JD006102, in press). The complete reference should be available soon.

5) Pg.12379, l.17: the choice of the modelled profile location for comparison with the measurements is an important point underlined by reviewer # 1. The REPROBUS model has a horizontal resolution of 2x2° and a vertical resolution of about 1.5 km in the mid-stratosphere (the vertical levels are those of the ECMWF model). The simulated vertical profiles shown in the paper correspond to the 44°N-0°E grid point and are located as close as possible to the SPIRALE measurements; indeed the balloon remained close to the same grid point during the flight since its displacement was only from 43.7°N-0.18°W to 43.60°N-0.16°E. It is then not necessary to interpolate the CTM results to the location of the SPIRALE measurements. Also this nicely ensures a very weak geographical variability in the observed profiles. But since we did not give enough information about the SPIRALE flight configuration, we have added the information about the displacement of the balloon in the revised version of the manuscript: Chapter 2 Pg.12376:“The measurement position remained rather constant during the ascent with a displacement of the balloon from 43.7°N-0.18°W to 43.60°N-0.16°E.”

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However following Reviewer #1's comment one could consider that the REPROBUS grid point at 42°N0°E should also be taken into account for the comparison with the SPIRALE measurements. We think it is more robust to take also into account the model profile at this location. Then we have done new plots shown in the revised version of the manuscript that correspond to the average of the profiles simulated at 42°N-0°E and 44°N-0°E. This average improves the comparisons between REPROBUS and SPIRALE but does not change our conclusions. The percentage difference values have been updated in the manuscript. Note that we have assessed that other grid points appear to be farther from the measurements and in different solar zenith angle conditions so that they can be also considered. We have added in Chapter 4.1.2 Pg. 12379: "The SPIRALE measurements were located between the 42°N-0°E and 44°N-0°E model grid points and remain close to these positions during the balloon ascent (from 43.7°N-0.18°W to 43.60°N-0.16°E). The profiles simulated at these two positions have been averaged for comparisons with the observations."

The diurnal variation of NO2 has also been included in the modelled profiles shown in the new figures following Reviewer # 2's comment though this variation is only of 3-6% above 25 km. This information has been added in the text: Chapter 4.2 Pg. 12380: "The diurnal variation of the species has been taken into account in the simulated profiles described hereafter. The solar zenith angle varies from about 64° to 74°; between 07:30 and 08:30 UT at the studied locations resulting in a variation of 3-6% for NO2 above 25 km."

6) Pg.12379, l.20: We agree with the reviewer's comment, we have to point out the fact that the Reprobus overestimation of N2O above 30 km is in contrast to former KASIMA 3D CTM comparisons with the MIPAS-B balloon-borne instrument showing a distinct underestimation of N2O above 28 km (see Stowasser et al., 2002). This information is now added in chapter 4.1.2 Pg. 12379: "The Reprobus overestimation of N2O above 30 km is in contrast to former KASIMA 3D CTM comparisons with the MIPAS-B balloon-borne instrument showing a distinct underestimation of N2O above

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28 km (see Stowasser et al., 2002). Other..."

7) Pg.12381, l.24: Reviewer #1 is correct, we have then changed the sentence "We conclude from Fig. 5 that the NOy partitioning seems to be correctly reproduced by the CTM" into "We conclude from Fig. 5 that the NO2/HNO3 partitioning seems to be correctly reproduced by the CTM".

8) Pg.12382, l.18: Since satellite measurements of N2O were not available at the time of our balloon measurements to compare with the plots of figure 6, we follow reviewer's comment by changing the sentence "It can be seen that using 3-hourly winds clearly leads to more realistic N2O values in the upper stratosphere, as a result of a slower circulation and reduced vertical diffusion" into "It can be seen that using 3-hourly winds leads to a slower circulation and a reduced vertical diffusion".

9) We prefer keeping figures 1, 4, 7, and 8 as separated plots since it would provide too much information at the same time and allows the reader to follow more easily the evolution of the paper.

10) All figures: the label size has been increased or corrected.

Other minor modifications:

. Pg. 12374 Introduction: we have suppressed reaction 1 which is a weak source of NOy in comparison with reaction 2.

. Huret et al. paper (cited in chapter 4.1.1 Pg. 12378) has been accepted for publication in JGR and is then cited in the reference list as: "Huret N., Pirre, M., Hauchecorne, A., Robert, C., and Catoire, V.: On the vertical structure of the stratosphere at mid-latitude during the first stage of the polar vortex formation and in the polar region in the presence of a large mesospheric descent, J. Geophys. Res., in press, doi:10.1029/2005JD006102, 2005."

. Urban et al. (2004) reference (chapter 4.1.1 Pg. 12379) has been completed and changed in Urban et al. (2005)

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. Chapter 4.2 Pg. 12380 l.28: since the SPIRALE instrument is generally able to measure the NO species which was not possible for the flight presented in the paper, we have added this information in the brackets.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 12373, 2005.