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Atmospheric Chemistry and Physics Discussions

Interactive comment on "SCIAMACHY tropospheric NO_2 over the Alpine region andimportance of pixel surface pressure for the column retrieval" *by* D. Schaub et al.

Anonymous Referee #1

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The paper "SCIAMACHY tropospheric NO2 over the Alpine region and importance of pixel surface pressure for the column retrieval" by D. Schaub et al. analyses tropospheric NO2 column densities for Switzerland. The paper is clearly written. It presents simple, but clear estimates on mean seasonal NOx lifetimes, and discusses for the first time the impact of strong topographic gradients on the retrieval of tropospheric NO2 column densities.

I generally recommend publication in ACP. However, in its present stage, the study has some inconsistencies, and some questions remain (see bolw) that have to be resolved first.

Comments:

P431 19: All lifetime estimates that you present and discuss are definitely shorter than “one day”! This value may be a good order of magnitude for the troposphere, but it clearly seems to be too high for the boundary layer.

P432 9: OMI resolution 13x24km2 is only true for the direct nadir view. So please add an “up to”.

P434 1: The modelled spectrum should also account for filling-in of Fraunhofer lines by Raman scattering (“Ring-effect”).

P437 1: For the conversion of NO2 to NOx, seasonal mean NO2/NO ratios derived from measurements are applied; why don’t you use the TM4 output for every observation? What are the seasonal mean NO2/NO ratios from TM4? P437 16ff: Please further justify the assumption of the seasonal NO2/NO ratios to be 3,4,3,2! This is a critical issue; the study is discussing at length unexpected low winter VTCs / lifetimes, but these might also be a consequence of a too high winter NO2/NO ratio assumed! This must also be discussed in section 4, e.g. first paragraph on page 443.

P438 16: “is considered to be unimportant”: Have you checked this, e.g. by looking at the daily satellite maps and using backward trajectories?

P439 4: Check the multiplication character.

P439 25: (i) is not true: For the calculation of AMFtrop, a priori NO2 profiles are used (eq.1) that are obtained “for every location and all times” (434/20) from TM4 CTM. P439 25: (ii) why is the smearing effect not taken into account? On 436/6-8, it is said that the emission data is integrated to SCIAMACHY resolution. This accounts for the smearing effect!

P440 23: In contrast to Fig. 4, you now choose a cloud threshold of 20%. What would be the result of your lifetime study if you apply a 10% threshold?

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P441 13: Not only summertime lifetime estimates are added in Fig. 6.

P443 1-16: The a-priori assumption of the seasonal mean NO2/NO ratios has to be discussed here (see above). This should also be considered in the resulting uncertainty range. Another aspect is your selection of cloud free, high pressure scenarios that could lead to a systematic bias of the retrieved mean lifetime.

P444 9-10: The investigation of the topography/pixel resolution effect is motivated by lower SCICMACHY VTCs in wintertime compared to GOME. However, as written in Fig. 8, the GOME winter mean is based on only 7 observations! This is a definitely too small number to calculate a representative mean VTC! There might be strong impacts from accidentally high/low measurements, and also systematic biases from sampling effects, e.g. if these 7 measurements are all taken in the end of February. Why are there so few selected GOME wintertime observations in a 7 year time period???

Section 4.3.2 The discussion of the importance of topography on AMF calculation is interesting and plausible. However, I don't understand why this should only affect SCIAMACHY. As displayed in Fig. 9, the mean model elevation is quite representative for the mean GOME elevation. However, this is NOT the elevation needed for the calculation of the true AMFtrop, as far as the NOx pollution resides over the Swiss Plateau and the Alps are clean (what is at least the case on average, see Fig. 11b). For that case, the situation is the same as for SCIAMACHY! A part of the pixel "sees" no NO2, the other does, but for the polluted part the modelled surface pressure is wrong! So I cannot see the "benefit" of GOME having a spatial resolution closer to TM4 than SCIAMACHY. You point out that the topography effect could explain too low SCIAMACHY TCDs in winter. However, the described effect should always occur, its strength depending on the actual profile. I do not understand Table 2: What does "Profile A" and "Profile B" mean? Did you calculate all AMFs for the winter data with the same a priori profile A and all summer data with B??? I thought you use daily model profiles for the AMF calculation! In this case, you could add a mean summer and a mean winter profile (for the scenarios in table 2) in Fig. 3.

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Summary: You started with the calculation of lifetimes and used the deviations in winter as kind of “motivation” for the study on topography effects. However, now the reader has learned that (mainly wintertime) VCTs are underestimated due to the effects described in 4.3. So it is quite irritating to read again the lifetime estimates that are based on too low VTCs! So you should extend your recalculation of tropospheric AMFs to the VTCs shown in Figs. 4/5 and redo the lifetime estimation. At least there should be an estimate on the effect of the updated AMF calculation on the lifetime estimates.

General remark: The authors note that the albedo has an impact on the calculation of tropospheric AMF, but they do not discuss the possible impact of snow. I would expect large areas of the Swiss Plateau being covered by snow in wintertime. Is this accounted for in the AMF calculation? Where do you get the snow information from? How was the situation for the days listed in table 2? What could be the consequences of snowy pixels?

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