Atmos. Chem. Phys. Discuss., 7, S6585–S6588, 2007
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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.

D. Schaub et al.

Received and published: 5 November 2007

We would like to thank the referee for the constructive comments. The main concerns of the referee were as follows:

1. Missing leitmotif: We have completely changed the story line of the paper. Instead of presenting the first two chapters as a kind of motivation for the last one the three parts now stand as individual and equivalent sections looking at different aspects of SCIAMACHY observations over Switzerland. The first part compares SCIAMACHY data to a high quality emission inventory available for Switzerland. This comparison is used on one hand to demonstrate the ability of SCIAMACHY to observe sources of air pollution in Switzerland and to calculate seasonal mean NOx lifetimes. The section

on lifetime estimation has been significantly enhanced (see more detailed response to referee #1). It now presents a new innovative method account for the strong diurnal cycle in NOx emissions. The second part shows a comparison with GOME to demonstrate the enhanced capability of SCIAMACHY to resolve regional scale features. Seasonally averaged NO2 columns are then used to quantitatively compare the seasonal cycles observed by SCIAMACHY and GOME over the Swiss Plateau. This comparison shows a reduced seasonal cycle in SCIAMACHY data as compared to GOME and ground-based observations but this is no longer presented as a motivation for the last part. Rather, the last part is investigating another aspect of the measurements over Switzerland, that is, the potential effects of the complex topography on the retrieval. Based on a sensitivity analysis it is shown that the use of a coarse resolution surface pressure data set in the retrieval may lead to systematic errors of NO2 columns retrieved over the Swiss Plateau.

2. In order to better reflect the new leitmotif we have also adapted the manuscript title to "SCIAMACHY tropospheric NO2 over Switzerland: Estimates of NOx lifetimes and impact of the complex Alpine topography on the retrieval"

3. Reason for incredibly low number of GOME measurements for all seasons: There are simply no more GOME pixels within the defined region of interest over the Swiss Plateau fulfilling our criteria which are 1. Classification as anticyclonic day by the Alpine Weather Statistics, 2. Clear sky pixel with cloud fraction < 0.1. The very low number (7 pixels in winter) is most likely due to the fact that anticyclonic conditions are typically associated with the formation of a stable fog layer. By relaxing the threshold to 0.2 we obtain a reasonable number of 32 GOME pixels in winter. A new panel has been added to Fig. 9 (former Fig. 8) showing these value. For more details see our response to referee #1.

4. Why is there no difference in autumn? Relaxing the cloud fraction threshold to 0.2 reduces the differences in the seasonal cycles observed by GOME and SCIAMACH probably because the statistics of the seasonal estimates is significantly improved. As

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mentioned before the wintertime differences are no longer used as the motivation for investigating the effect of the topography. The topography effect will be present in all seasons. It will be largest when most of the NOx is located close to the surface as typically observed in winter (and less so in other seasons).

5. Albedo: Snow is clearly a complicating factor over Switzerland. However, by using a tight threshold of 0.1 (or 0.2) for the cloud cover effectively rules out any chance that our analysis has been systematically influenced by land-snow transitions. Note that the FRESCO algorithm will interpret the snow cover as a low-lying cloud. It should also be stressed that the Swiss Plateau is covered by snow during only a small part of the winter. We agree that it would be very useful to have an albedo data set taking into account the snow cover changes throughout the winter. This is actually planned in a forthcoming PhD thesis at Empa which is starting just now.

6. Impact of FRESCO retrieval error: Cloud fractions are taken into account in the retrieval through computation of a weighted AMF (linear combination of the cloud-free and cloudy AMFs). Subsequently the stated uncertainties in the cloud fraction propagate along with other uncertainties and result in a theoretical estimate of the retrieval precision, that is stored in the TEMIS data files and used in the present work (for instance on Page 435, line 1-8 and Fig.5 in the first manuscript). Unless there is a significant systematic error in the FRESCO cloud fractions, we have no reason to believe that the FRESCO cloud retrieval error impacts our results in a systematic way. Given the uncertainties in cloud fractions estimated by FRESCO of about +/-0.05 indicating a cloud fraction of e.g. 0.027 in Table 2 indeed makes no sense. Numbers in Table 2 have been changed as suggested.

7. Using a high resolution topography database: The referee is absolutely right that this would be an easy way to go forward. This will involve a complete reprocessing of the SCIAMACHY data (since the AMF have to be recalculated) which has been outside the scope of the present study. However, this will also be one of the tasks of the new PhD thesis (yet focussing on OMI data). Nevertheless, we believe that identifying the

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problem and estimating its potential effects through a simple sensitivity analysis is still valuable for the scientific community.

Minor corrections:

1. Introduction. Indeed, there are cases where the SCIAMACHY pixels have a dimension of 30x30 km2. Changed as suggested. 2. Changed as suggested and reference to Platt (1994) added.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 429, 2007.