**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "Comparison of GOME tropospheric NO$_2$ columns with NO$_2$ profiles deduced from ground-based in situ measurements" by D. Schaub et al.
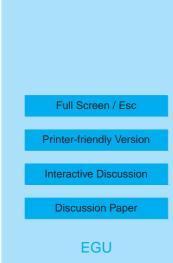
Anonymous Referee #2

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The manuscript is a valuable contribution to the current efforts of validating tropospheric column densities from satellite measurements. It is well written and presents an exhaustive comparison of satellite data with ground based measurements in Switzerland, discussing several relevant parameters and possible problems that have to be further assessed in future. I recommend publication in ACP after dealing with the following comments.

Comments

- some abbreviations are not explained (e.g. SCIAMACHY, OMI, KNMI/BIRA)

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- abstract: 2190/15-16: please add the relative difference to document the "good agreement"; there can be any factor between correlating datasets.

- 2191/19: there have been reports on mean NO2 lifetimes definitely shorter than 1 day, in particular in summertime (e.g. Spicer, Science, 1982; Martin et al., JGR, 2003; Beirle et al., ACP, 2003).

- 2191/25: "C-shape profile": You have to distinguish between the profiles of NOx and NO2. While NOx increases in the UT under lightning/deep convection conditions, this is not necessarily so for NO2 as NOx is shifted to NO with increasing altitudes. However, the "C-shapes" reported by Ridley and Ziemke are mainly due to LNOx and convection and thus do not represent average conditions (e.g. on cloud free days).

In particular none of the cited studies really reports on industrialized areas. So the NO2 profile is rather expected to have a maximum in the PBL and decreasing with altitude, what is consistent with your results (e.g. 2197/10 and fig. 3)

- Section 1.1: You should mention the fundamental problems of comparing point measurements with satellite measurements having large footprints.

- 2194/23: How do you account for the filling-in of Fraunhofer lines ("Ring-effect")?

- 2195/14: One further very important parameter controlling tropospheric AMFs is the aerosol load. Do you account for aerosols in the AMF calculations? If not, can you assess the error range caused by neglecting aerosols?

- 2196/17: It would be helpful to indicate the principal idea of the construction of profiles already at this point, and announce that this approach and possible limitations will be discussed in detail later.

- 2197/4: You should repeat the GOME overpass time here.

- 2198/13: It is not apparent from Fig. 1 what region is actually considered in this study. The frame shown in Fig. 1 is rather misleading: from the center of the GOME

pixels, 160 km have to be added in ESE and WNW direction. I recommend to add the resulting area covered by the considered GOME pixels in Fig. 1 or an additional subplot that may also show an altitude map, e.g. from aLMo.

- 2199/15 see comment 2191/19; add references.

- 2199/16 please explain how data from ONE station is used to assess vertical fluctuations.

- 2199/26 the measurements presented by Ridley have been performed at lower latitudes. Are the results representative for Switzerland?

- 2000/9 See 2198/13: the respective area should be displayed in Fig. 1. How far could the highly polluted Po valley affect your study?

- Section 3.1.2 c) Free tropospheric NO2 levels are assumed to equal those of in-situ ground measurements of corresponding altitude, and several aspects of this approach are discussed in the manuscript. However, several assumptions are made where it is difficult to decide how far they are justified. Is there any work in progress trying to validate this method of gaining NO2 profiles?

- 2206/5 replace "above the slash" with "of the numerator".

- It is the general (important) idea of calculating Delta2 that it is independent from the a-priori profile; however, this is mentioned quite often (2205/17, 2206/4, 2206/10).

- 2208/19 what is a "case"? A day, or a single GOME pixel?

- 2209/8 Unit of the slope is missing.

- 2210/8 Unit of the slope is missing.

- 2211/13 By comparing the standard deviation of your subdataset with the a priori GOME error you have to be aware that you have selected cloud free pixels, where cloud information is taken from FRESCO as well as (independently) from MeteoSwiss.

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This dataset (i.e. NO2 VTCs for well defined viewing geometries and easy radiative transfer) is indeed expected to have a lower error.

- Section 5

A GOME VTC of ˜500e15 molec/cmˆ2 is unrealistically high; this should be clearly mentioned in the text (2216/4) as well as in the caption of Fig. 7.

One aspect is totally missing in the discussion of the clouded scenarios: The AMFs and AK may be wrong! While for cloud free conditions radiative transfer models work quite well, the modelling of multiple scattering in clouds is a difficult task. So seeing the high VTC on Feb 2001, my guess would be that a far too low AMF is the cause, probably caused by insufficient modelling of multiple scattering in the cloud. In any case, this aspect must be added to the discussion; the modelled AMFs and AKs cannot be assumed to represent the truth for cloudy conditions (that can also be quite different due to CTH, OD, heterogeneity etc.).

2217/25 The 50% threshold is somehow arbitrarily. One parameter that might help to understand what's happening in Fig. 7 could be the CTH that is also part of the FRESCO product. Have you analyzed the cloudy scenes for high/low clouds separately?

Conclusion

The difficulties of AMF/AK modelling for clouded scenes should be discussed.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 2189, 2006.

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