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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of tropospheric SO_2 retrieved from MAX-DOAS measurements in Xianghe, China" *by* T. Wang et al.

Anonymous Referee #2

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The study of "Evaluation of tropospheric SO2 retrieved from MAX-DOAS measurements in Xianghe, China" by T. Wang et al. presents the seasonal and diurnal variability of SO2 in the boundary layer of Xianghe, China retrieved by ground based MAX-DOAS. The interpretation of the results is aided by independent in-situ SO2 and meteorological measurements. The three years of MAX-DOAS measurements in the urban atmosphere of Xianghe, China, demonstrate the importance of this technique for air quality purposes and as indicator of boundary layer in-homogeneity. The manuscript is well written, however, it does not show an evident/noticeable novelty from the three continuous years of MAX-DOAS measurements, as they are not fully exploited. I suggest

the publication of this manuscript after considering changes/improvements according to the comments below:

According with the authors, the reliability of the SO2 retrieval vertical profile is demonstrated with the comparison of the near surface concentration retrieval profiles with in-situ and independent SO2 measurements. However, the sensitivity of air masses is quite distinctive for both methods. In-situ measurements detect air mass close to the instrument and might be able to detect localized air mass while moving close to the site. On the other hand, MAX-DOAS measures/averages the air mass over a long distance. From my point of view, this comparison is actually important in terms of air mass homogeneity in the boundary layer rather than validation process. I would recommend to use backward trajectories at different altitudes to identify air masses, especially aloft. This could help in a deep explanation of the vertical profile extent which is missing in the manuscript.

One important advantage of MAX-DOAS over other techniques, is the capability of measuring several species simultaneously. In the present manuscript, solely results of SO2 are shown, even though other species can be retrieved, such as NO2, and aerosol extinction profiles. Undoubtedly the manuscript would improve if results of NO2 and aerosol extinction (which are actually retrieved in the first step approach) are shown. The ratio of SO2/NO2 can be used, for example, as a metric to understand in more detail the emission level and atmospheric transport in the boundary layer. In the current manuscript meteorological conditions and qualitative seasonal domestic heating are used in order to know emission sources, however the metric SO2/NO2 ratio could be used adequately to know industry or power plant SO2 episodes, not only at the surface but also in the vertical profile inside the boundary layer. On the other hand, the correlation of SO2 and aerosol extinction would be important as an indication of SO2 conversion and aerosol production.

As pointed out in the introduction and in the conclusion, these three years of measurements are quite important for tropospheric SO2 satellite validation/comparison. Have

you thought in incorporating existing tropospheric SO2 VCDs obtained with satellites and compare with your data?. Throughout the manuscript the main results, being the annual and diurnal cycles, are shown in terms of tropospheric SO2 VCDs. Incorporating SO2 VCD comparisons with satellite retrievals would improve the quality of the paper.

Specific Comments

6505. DOAS analysis

As pointed out in the introduction, SO2 retrieval by MAX-DOAS have seldom been conducted in places far away from punctual sources such as volcanoes and/or industry. As far as I know, SO2 retrieval represent a challenge due to absorption by stratospheric O3 at the same wavelengths (< 325nm). In the DOAS analysis section it is mentioned that sensitivity tests were performed in order to choose the DOAS settings. Therefore, it would be valuable to know what kind of sensitivity tests were performed and applied in this work. I would recommend a detailed explanation and provide these results. This can be part of the supplementary information. Besides O3 interference and DOAS analysis, more instrumentation details might be necessary For example, were filters used in the spectrometer system? It is known that instrument artifacts might lead to a bias due to noise in the spectral features.

In the same section it is mentioned that the residual achieved in the fitting example is small, ranging from 2 -2$\times$10-3 to 2$\times$10-3. Please provide more information about the quality of the DOAS analysis. Please explain why a value of 2x10-3 residual error is small? What is considered a good fit residual, and RMS, etc. Since this is the first SO2 measurements of the MAX-DOAS what would be the detection limit of the MAX-DOAS (or please include a reference where this is mentioned).

6506. Profile Retrieval

It is mentioned that aerosol extinction and SO2 vertical profiles are obtained by means

of a non-linear approach. Usually this is the case for strong absorbers such as aerosols. Is SO2 considered a strong absorber? could you apply a linear inversion and save time in the analysis?

The retrieval approach is based in a two-step approach. First, the aerosol extinction is retrieved at different wavelengths and then is extrapolated to a shorter wavelength using just the AOD, the Angstrom formula, and an exponential profile shape. The determination of the aerosol extinction based in the O4 has been demonstrated before, but it is not well explained how and why the AOD, the Angstrom formula, and the exponential decrease profile were used here. In order to know the spectral dependence of the aerosol extinction and/or AOD you might need at least two wavelengths. Please describe what wavelengths you used in this step. Also, explain why the AOD was used with an exponential profile shape instead of applying the aerosol angstrom exponent approximation to the aerosol extinction profile?

6510.

I suggest to change “A very good agreement is found between both data sets, indicating the good overall reliability and the robustness of our MAXDOAS retrievals” according with the comments above.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 6501, 2014.