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Interactive comment on "Validation of TROPOMI tropospheric NO$_2$ columns using dual-scan MAX-DOAS measurements in Uccle, Brussels" *by* Ermioni Dimitropoulou et al.

Anonymous Referee #2

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The manuscript presents the results of MAX-DOAS measurements for a combination of vertical and azimuthal scans, allowing for the investigation of horizontal gradients in NO2 concentrations, and demonstrates that the validation of TROPOMI columns benefits from this extra information. The paper is well written and matches to the scope of AMT. It should be published after dealing with the comments below.

Major drawback: Standard atmosphere

The authors use a standard atmosphere for their evaluation. This is quite odd, as the MAXDOAS measurements are taken right at the meteorological institute of Belgium, where I would expect that atmospheric profiles of temperature and pressure would be

available on daily basis.

The authors discuss the seasonality of their results. This discussion is hard to assess as the seasonality of T and p, which directly affects the O4 concentration (and thus aerosol inversion and thus NO2), is just ignored. Thus the authors at least have to study the impact of the used standard atmosphere on the seasonality of results. But I would highly recommend that the authors redo the complete data analysis for real atmospheric profiles.

Comments

5/25: For a DoF of 1, there is only 1 piece of information available (i.e. the total column). So for real "profile information" I would expect a threshold of DoF>2 rather than 1.

6/3: Is the pyrometer also pointing in the same direction as the MAX-DOAS instruments, or does it have a fixed viewing direction? If the latter, how could it provide information on cloudiness for low elevetaion angles?

6/27: Please add a direct comparison of the NO2 results for UV and Vis and compare with the listed uncertainties.

6/29: The subsection heading announces details on the dual scan retrieval. However, large parts of the following text just explain the par method. I propose to add a subsection dedicated to the par method for better clarity.

16/4: Please put this finding in relation to other comparisons (which have also reported a low bias of TROPOMI columns) and add respective references.

17/26: I don't agree with the general statement that cloud effects are quasi random and do not cause systematic biases, and I don't see these bold statements supported by the presented measurements. Cloud impact is definitely "complex" and may indeed "lead to positive or negative biases". So they definitely introduce considerable scatter to the retrieved columns. But underneeth this scatter, which might look "quasi random", there are very likely systematic effects as well, which probably could only be quantified

with large data samples.

Table 1: Please add the different sets of azimuth angles to Fig. 1, color coded for the three time periods.

Table 4: Please add results from a direct comparison between NO2 UV and vis - is the difference within the listed total uncertainty range?

Fig. 1: Please add the different sets of azimuth angles, color coded for the three time periods. What is the meaning of the symbols on top of the azimuth direction lines?

Fig. 7: The landscape background is not helpful here, but rather disturbing. I propose to show no background, but instead real color coded VCDs for both TROPOMI and MAXDOAS.

Fig. 12: Several MAX-DOAS VCDs have no errorbar. I assume that for these days no std could be calculated. I propose to also show the mean/typical uncertainty of single VCDs derived from the MAX-DOAS inversion, which would probably be more consistent for the time period. This might be added as second error bar with e.g. light color.

Fig. 15/16: Please add the corresponding a-priori profiles used in the TROPOMI retrieval, and add a discussion of this comparison.

Minor comments:

1/18: "concentrations" should be "volume mixing ratios"

3/26: "eventual" should be "potential" or "possible"

6/2: Skip the comma between "measurements" and "strongly"

6/10: "Smoothing error"

6/30: Please define what exactly is meant by "near surface VMR"

8/29: "are equal" should be "are similar"

9/21: "close to zero" is not unphysical