

Interactive comment on “NO₂ vertical profiles and column densities from MAX-DOAS measurements in Mexico City” by Martina Michaela Friedrich et al.

Anonymous Referee #3

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This paper presents MMF, a new algorithm developed to retrieve vertical profiles of trace gases from MAX-DOAS measurements. The MMF code and the inversion methods implemented in it are first thoroughly described. Then MMF is applied to MAX-DOAS measurements of O₄ and NO₂ in Mexico City and NO₂ retrieval results are compared to co-located in-situ observations. A detailed error analysis of both NO₂ profile and vertical column density is also presented.

The manuscript is well written and clearly structured and the presented data set is scientifically important, especially for the validation of NO₂ satellite observations in highly polluted area like Mexico City. I recommend the paper for publication in AMT after addressing the following comments and technical corrections:

General comments:

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1/I think it would help the reader to include a map (that could be Figure no 1 of the manuscript) of the Mexico City area showing the locations of the different instruments (MAX-DOAS, AERONET, in-situ). Moreover, indicating the pointing directions of the MAX-DOAS instrument involved in this study could maybe also give some insights on the interpretation of the discrepancy between MAX-DOAS and in-situ NO₂ surface concentration values. For instance, part of the underestimation of the in-situ values by the MAX-DOAS could be related to the fact that the MAX-DOAS instrument points towards a part of Mexico City which is less polluted than the location of the in-situ instrument.

In addition to the map, the location (latitude, longitude, altitude) of all the instruments should appear in the text.

2/AERONET data are used as input in the retrieval but also as ancillary data for the sky conditions screening. Was there any attempt to compare the retrieved AODs with those from AERONET ? It can be a good check for the aerosol retrieval part of the profiling. Also related: it seems that the availability of AERONET observations has been used as a quality control (QC) flagging for the MAXDOAS retrievals. Was there any attempt to apply a QC flagging which is more specific to the MAX-DOAS retrievals, e.g. using parameters like DOF and the RMS of the differences between measured and calculated dSCDs ?

Specific comments:

1/Page 4, beginning of Section 2.3: It would be good to list the exact elevation angle values of a typical scan.

2/According to Section 3, it seems that aerosol profile retrieval is done in the UV range and then retrieved profiles are used as input for the NO₂ profile retrieval in the visible range. Has a correction been applied to the retrieved extinction/AOD for taking into account for the wavelength dependence of the AOD/extinction ? If not, then this approximation should be included as an additional error source in Table 1.

3/Page 6, lines 8-11: Maybe you could add a couple of sentences about the performance of MMF in these profile comparison exercises. Please note that in the meantime, Friess et al. is now published in AMTD.

4/Page 8, line 7: Is it IO or HONO (cf page 6, end of Sect. 4) ?

5/Page 8, Sect. 4.2: You should add a paragraph on the SCIATRAN RTM, which has been also used in past MAX-DOAS profiling studies (see e.g. Friess et al., AMTD, 2018).

6/Page 10, line 1: what type of interpolation is done for the pressure, temperature profiles ?

7/Page 10, line 14: a correlation length of 500m is used. Did you perform sensitivity tests on this parameter in order to estimate its impact on the retrieved profiles and on the level of agreement with in-situ measurements ?

8/Page 19, Figure 6b: A priori profile should be also included in this Figure in order to see how far the retrieved profile differs from the a priori one.

9/Page 26, lines 5-10: According to the authors, a possible reason for the underestimation of the in-situ surface concentration by the MAX-DOAS is the fact that the MAX-DOAS instrument has a maximum sensitivity around 1km and less sensitivity close to the ground. This feature is quite unusual since normally lowest elevation angles have a higher weight in the retrieval due to higher AMFs, and therefore MAX-DOAS measurements close to the ground. Could the authors elaborate on that ? Another possible explanation for the discrepancy is that, related to the horizontal extent and the pointing direction of the MAX-DOAS measurements, both instruments probe different air masses. I think this point should be also added in the discussion.

10/Acknowledgements: Depending on the conditions of use, the sources of ancillary data included in your study should be acknowledged here.

Technical corrections:

'->' denotes 'should be replaced by'

1/Page 1, line 1: '...to retrieve profiles...' -> '...to retrieve vertical profiles...'

2/Page 1, line 10: '...at the Universidad Nacional Autónoma de México (UNAM) campus.'

3/Page 1, line 20: '...The Multi-AXis Differential Optical Absorption Spectroscopy (MAX-DOAS) technique...'

4/Page 2, line 30: '...at the Universidad Nacional Autónoma de México (UNAM).'

5/Page 6, line 5: 'Sect.4.1' -> 'Sect. 4.1'. This typo should be corrected throughout the manuscript; similar corrections also needed for 'Fig.' and 'Eq.'.

6/Page 6, line 9: 'CINDI2' -> 'CINDI-2'

7/Page 10, line 14: '...Eq. 4:; same on Page 11, line 4

8/Page 11, line 20: 'extincion' -> 'extinction'

9/Page 16, legend of Fig. 4: '(b,right)' -> '(b, right)'; should be also corrected for (a, left).

10/Page 19, legend of Fig. 6: 'total error'

11/Page 19, line 3: 'algorith' -> 'algorithm'

12/Page 20, line 4: 'aprox.' -> 'approx.'

13/Page 21, line 11: 'Curretly' -> 'Currently'

14/Page 24, end of line 23: A reference could be added here.

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