

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

Anonymous Referee #1

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Review of “NO₂ vertical profiles and column densities from MAX-DOAS measurements in Mexico City” by Friedrich et al.

This manuscript discusses a newly developed profile retrieval code - the Mexican Maxdoas Fit (MMF). Note: The first author’s initials match the acronym, nicely done! The retrieval code consists of 2 parts, 1) an aerosol retrieval and 2) a trace gas retrieval using the previously retrieved aerosol profiles. This code is then used on 19 months of MAX-DOAS data measured at a location in Mexico City and the results are discussed. A comprehensive error analysis (which is great to see!) is also included in the manuscript.

It certainly is interesting to look at the complete 19 months NO₂ data set (e.g. see the discussed averages of the diurnal variation) but my guess is the more interesting

studies (specially from an environmental view point) can be done by looking at individual days and using the right ancillary data to understand the NO₂ variability and what causes the observed peaks.

Overall, the manuscript is well structured and the figures and table are clear and straight forward to understand. However, in some places (e.g. in Section 5, Error analysis) the text can be somewhat difficult to follow, and the manuscript could gain from having another go at streamlining the text a bit more and simplifying the structure of some of the more complicated sentences.

Specific comments:

Page 2, line 16: Replace 'giving' with 'with'

Page 2, line 17: Section 2 should be Sect. 2 for consistency, check whole manuscript

Page 2, line 19: '(constituting the forward model)' - What exactly does this mean?

Page 2, line 30: UNAM – can you please spell this out once

Page 3, Figure 1, caption. Nice overview figure. For completeness, can you please also include a brief description of the yellow and red box in the caption.

Page 3, line 3: Replace 'large' with 'long'

Page 4, line 8: Typo: 'receiving'

Page 5, line 4: Typo: 'an average'

Page 5, lines 16-25: Why was O₄ not retrieved using the same wavelength interval as NO₂? The much older O₄ XS from Hermans et al. 1999 was used for the O₄ retrieval, why not Thalman and Volkamer (2013)?

Thalman, R. and R. Volkamer, Temperature dependent absorption cross-sections of O₂-O₂ collision pairs between 340 and 630 nm and at atmospherically relevant pressure., Phys. Chem. Chem. Phys., 15(37), 15371–81, doi:10.1039/c3cp50968k, 2013.

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Page 5, line 26: Would it be possible to say something briefly here about how the errors were determined?

Page 7: The authors explain that the retrieval code was recently updated from using the Gauss-Newton scheme to the more stable Levenberg Marquardt iteration scheme. However, this is not really relevant for the work presented here and seems to unnecessarily complicate the discussion. Unless there is a compelling reason to keep this information, I suggest to drop the relevant equations and just briefly mention in a couple of sentences (or one paragraph) that the retrieval code has been updated and how. It would also be better to have all the variables explained straight after Equation (1) and not further down the page.

Page 7, line 6: Change to 'non-linear'

Page 7, line 12: Change to 'dimension which is the number of telescope'

Page 7, line 17: Change to: 'equal to 1'

Page 7, line 23: Change to: 'for the trace gas'

Page 8, line 8: Change to: 'with the LM iteration scheme.'

Page 8, line 10: Change to: 'algorithms. For example, there are'

Page 8, line 20: Typo: 'high speed'

Page 8, line 21: 'instead of the 2x the number of layers calls'

Page 8, line 23: Jacobians always with capital J, also on Page 12 & 13

Page 8, line 23/32 and footnote: Why not refer straight to LIDORT if only that part if used anyway?

Page 8, line 32: Maybe replace with 'For each simulated atmospheric layer, '

Page 9, lines 9-14: It is not quite clear to me how the rate of change is represented in Figure 1, can you please explain ... or I might have misunderstood?

Page 9, line 13: Should be either 'enclosed' or 'included' ?

Page 9, line 21: Replace 'is' with 'are'

Page 11, line 2: Comma needed after QRay

Page 11, line 14: 'are assumed to be constant in all layers.'

Page 11, line 15: Replace 'are' with 'is'

Page 11, line 16: Change to 'density profiles in arbitrary units from ...'

Page 11, line 17: Change to 'heights h to provide

Page 11, line 19: I am not sure if all readers will know what is meant with an 'intensive quantity', maybe explain briefly in a footnote?

Page 13, Equation 16: Rogue bracket or is something missing?

Page 13, line 18: Gain is written in a strange font, on purpose (why?)? If not, please fix.

Page 13, line 21: 'produces'

Page 14, line 9: Add comma after fitting

Page 14, line 23: Change to 'AK matrices from the other errors.'

Page 15, line 1: 'the VMR(VMR)' – is that correct?

Page 15, lines 16/17: Why would the vertical aerosol extinction profile not be available?

Page 16, Figure 4 caption, last sentence: 'an ideal'

Page 16, line 6: Add comma after 'operator' – makes this sentence a bit easier to read.

Page 17, Equation 25: Should that be 3% instead of 0.3%?

Page 17, line 8: Should either be 'error ... is' or 'errors ... are'

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Page 17, line 14: Comma after retrieval

Page 17, line 15: 'contributions: a) smoothing error and b) .. error.

Page 18, line 1: Comma after (2017)

Page 18, line 3: Could use 'dependent' instead of 'not independent'.

Page 18, line 5: Delete 'it'. Comma after 'However'

Page 18, line 9: Delete 'the' before 'VLIDORT'.

Page 18, lines 10/11: Add commas after '(2017)' and 'the residual'

Page 19, Figure 6: The two solid orange lines are hard to distinguish, could use dash or dash/dot for one of them.

Page 19, Figure 6 caption: Change to 'a) The square ...' and delete full stop after 'total'

Page 19, line 3: Better: 'errors for No2 and O4 calculated '

Page 19, line 5: Change to 'errors' and delete 'fairly'

Page 19, line 7: Delete 'relatively'

Page 19, line 8: Something is not right with this sentence & it doesn't make sense as it is written. Maybe delete 'to' or rephrase altogether.

Page 20, Table 1, caption: The last sentence is a bit hard to read; would help to add a comma after included and it needs a 'with' after better.

Page 20, line 2: Add comma after 'In this section'

Page 20, line 4: Typo: 'approx.'

Page 21, line 10: Typo: 'Currently'

Page 23, line 1: I would rather say: 'Generally, a better ...'

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Page 24, lines 8-11 and Figure 10: Would be really interesting to get higher resolved surface measurements as well, otherwise a small increase might be hidden in the surface data set as well. The peak only shows up clearly in the individual measurements with sufficiently high temporal resolution. Similar peak also shows up on Aug 15 and one could argue to some degree even on 9 Sep and 22 Dec with a bit of a time shift. Any idea what causes it?

Page 24, line 28: Change to: 'This might have to do with the fact that during ...' otherwise something seems to be missing from this sentence.

Page 24, lines 20-23 & Page 26, Figure 11: Could you add a brief discussion here on the nicely (amazingly?) constant offset between surface and MAX-DOAS data, also including the uncertainties of both data sets in that discussion. Would you say that this is predominantly caused by NO₂ having strong emissions on the surface which are then just diluted over the vertical range which the MAX-DOAS measurements are covering?

Page 26, line 1: Change to: 'and certain trace gases. We ... NO₂ at one ...'

Page 27, line 1: delete 's'

Page 27, line 4: Add something like 'Sinces this study, it has been ...'

Page 27, line 10: Add 'the' before 'NO₂'.

Page 31-34, References: There seems to be some doubling up of information, please check through all the references for correct formatting.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-358, 2018.

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