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Atmospheric Measurement Techniques Discussions

Interactive comment on "Parameterizing radiative transfer to convert MAX-DOAS dSCDs into near-surface box averaged mixing ratios and vertical profiles" *by* R. Sinreich et al.

Anonymous Referee #2

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General Comments:

This paper presented parameterization method to convert slant column densities into near-surfaced-boxed averaged volume mixing ratios. Retrieved NO2 mixing ratios were retrieved from this method and long-path DOAS measurements made during MCMA-2006. While, the idea behind this paper using a simple parameterization method is useful and novel, in its current form it is difficult to understand and evaluate. My first concern is as this is a parameterization method the assumptions used should be clearly the many of the assumptions are not clearly stated or poorly presented. Second, the

statement that the method does not need vertical profile information in not sufficiently justified as the correction factors are dependent on vertical profile and the authors did not show sufficient evidence that under the assumptions these dependencies disappear. I am, also, unsure of the general applicability of the method and in some placed the authors seem to indicate a versatility that does not seem to be justified in this work. Finally, the overall structure of the paper needs revision as it is hard to follow and seems to jump around quite a bit.

Specific Comments:

Specifically addressing the authors conclusions

Conclusion 2 : "It does not depend on knowing the actual aerosol profile as it is typically necessary for MAX-DOAS concentration retrievals, and can be applied already under conditions of moderately low aerosol load"

I believe that Figure 3 is meant to show that for the lowest angles and for high AOD the correction factor is relatively stable. These plots were hard to understand and did not focus on the information you wish to present. From these plots I see that the correction factor IS profile and angle dependent. I would suggest that rather than presenting all the data (particularly for angle you do not use and AOD's not used) the focus is on the regime within the assumptions so that the reader can see that the correction factor is really within the 10% DOAS error. Also, I think this needs to be coulple with the assumption of the trace gas species vertical profile. In the bottom set of plot the calculation is run for 2 types of trace gases profiles and they appear significantly different. I would suggest that you first show that the O4 correction factors collapse into a single values for a the regime of angles and AODs appropriate for the model. And then show that these collapsed correction factors are independent of trace gases vertical profile. See comment on conclusion 4

Conclusion3 : "The approach does not suffer from the limited sensitivity of MAX-DOAS at higher altitudes that poses limitations to the use of optimal estimation approaches

to infer vertical profiles in situations of high PBL. Yet, this method also can be used as input parameter for more complex retrievals, such as optimal estimation, especially since it provides a reasonably high near-surface vertical resolution (depending on the elevation angle)."

Conclusion 3 seems to be comparing apples to oranges. This is a method for near surface retrievals and does not provide any information about higher altitudes.

Conclusion 4: "It does not require a-priori assumptions about trace gas vertical distributions."

I am still unclear on how this method does not make assumptions about the vertical distribution of the trace gas species. I see that for your data you assumed either a box profile or a linearly decreasing profile with height for NO2. You then apply a correction factor which is profile, angle, wavelength etc. dependent. As stated above from figure 3 I see profile dependence. To clearly demonstrate that the correction factor does not depend on the vertical profile of trace gas species plots of correction factors with differing structures such as: a) A box profile, b) A linearly decreasing layer with height, c) A linearly increasing layer with height, d) A layer slightly aloft should be shown. Figure 4 shows clearly that the correction factor depended on the assumed height of the trace gas layer this is in conflict with the statement of the authors that the method is independent of information on the vertical profile.

1) The discussion of the correction factors need expansion and restructuring as the method and the authors conclusions depend on the correction factors in a specific range being independent of the trace gas vertical profile more time is needed on demonstration this fact. The discussion of the correction factor on Page 13 line 3 needs to be in the method section.

2) The description of the method and explanation of figure 1 need reworked. It is cumbersome to read and understand as it jumps from what is needed for your collapsed dSCD and a traditional ground based DOAS method. I would suggest a comparison

between what occurs in the higher angle (traditional ground based DOAS retrieval) and the lower layers (your collapsed method). On page 5 line 29 you could add the contrast to the higher elevation and then go on to clearly state your assumptions a) Strongly attenuated light path (High AOD verified by collapse of the lowest elevation angles into a single light path Leff) b) Leff must terminated within the trace gas layer c) I do not see the added value of the scattering probability panel, it adds un-needed complexity and interrupts the flow of the text.

3) There is no discussion about decreased sensitivity. As the light path is attenuated the path length is shorter in the troposphere what effect does this have on detection limits?

Technical Comments: Page 1 Line 30: Is the agreement with well mixed layers evidence that there is more of dependence on the vertical profile than assumed as you assumed a well mixed profile?

Page 4 Line 25: Remove the "Then"

Page 5 Line 17: Remove the "Then"

Page 5 Line 22: "it" change to "sunlight"

Page 5 Line32 to Page6 line2: This sentences is unclear as what plays a minor role

Page6 Line 2: Remove the "Then"

Page 6 Line 5 and 6: not sure what you try to say by "cancels out applying the DOAS method..." I do not think you can cancel a method, under certain conditions the advantages of making DOAS observations on multiple angles may not yield information about the vertical profile bit is does not cancel the method.

Page 6 Line 13: the light is less constrained is awkward, think about stating that is is a place where you assumption about Leff breaks down.

Page 8 Line 5: shouldn't equation 3 be sin not tan?

Page 8 Line 7: Figure 2 either needs to be cut as it added little or expanded to include the equations and assumptions used as is it adds little that the equation on their own do not

Page 9 Line 19: Figure 3 this figure does not illustrate the collapsing correction factors so I would re-work see comment above but independent of that. the figure is unclear is what vertical profiles are used for the top row, if all box profile why? For bottom row what is the elevation angle. Also use same y scale for all plots as it will help in clarity

Page 10 Line 13: Poorly worded sentence

Page 10 Line 17: “constantly decreasing profile” do you mean “linearly decreasing” or something else?

Page 10 Line 18: Did not understand this sentence are you stating that a linearly decreasing profile would result in the divergence of Leff sooner

Page 10 Line 26: triangle profile should be linearly decreasing profile

Page 11 Line 14: The discussion of a collocated layer and fixed trace gas layer is confusing

Page 11 Line 20: Figure 4 I think the x title should just be aerosol layer height the height of the NO2 layer is in the legend, I first thought is was a ratio between the layer heights.

Page 20 Line 1: I find this section difficult to follow as higher and lower are not good references. I would rework the figure to have circles and triangle and square to refer to each type of points

Page 21 line 16 solar relative azimuth angle (SRAA) should be relative solar azimuth angle (RSAA)

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 7641, 2012.