

Interactive comment on “Differential optical absorption spectroscopy (DOAS) and air mass factor concept for a multiply scattering vertically inhomogeneous medium: theoretical consideration” by V. V. Rozanov and A. V. Rozanov

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Dear Reviewer, we would like to thank you for spending time to review our paper as well as for helpful comments. Please find below our answers to your comments.

General Comments

As a general comment, in order to improve the readability of the manuscript, I suggest to reduce the number of formulas and the length of the paper.

Answer: *We think that a substantial shortening of the paper will cause difficulties in*

C412

the understanding rather than increase the readability.

I would appreciate somewhere in the text some references dealing with inverse problems and their solution. Authors just mention them (when they deal with the WF (page 723 line 6) or cite Volterra at page 723 (line 12), or mention the Fredholm integral equation of first kind (page 732, line 16), which is the general form of every inverse problem), but do not supply any specific references, for instance: (1) Deepak, A., Inversion methods in atmospheric remote sounding, Academic Press, 1977; (2) Rodgers, C. D., Characterization and error analysis of profiles retrieved from remote sounding measurements, J. Geophys. Res., 95, 5587-5595, 1990; (3) Rodgers, C. D., Inverse methods for atmospheric sounding, World Scientific, 2000. Please, add at least one of them.

Answer: *References to Deepak and Rodgers are added.*

For me, authors could explain better which advantages and disadvantages one can have using the different DOAS approaches described in the text. They describe in which conditions the approaches converge, but could better illustrate their limits of applicability, restrictions, which applications are advisable for specific applications (from the ground, satellite). This should help the reader to understand, for instance, when it is preferable using either MDOAS or WFDOAS approach.

Answer: *If treated properly, the correct solution for each particular observation setup can be obtained using any DOAS equation. One of main topics of the paper is to establish a correct way of the application for each approach. The selection of a particular DOAS equation is rather a matter of the experience and available tools and is not directly related to the measurement setup. We have added these explanations to the conclusions.*

Some more considerations about non-satellite DOAS applications ... would be appreciated.

Answer: *The presented theoretical results are valid for both satellite and non-satellite geometry. Additional practical examples for a non-satellite geometry would only increase the length of the paper without illustrating any new aspects.*

C413

Some more considerations about ... the use of Radiative Transfer Models for the AMF derivation would be appreciated.

Answer: *We have added the following sentence in Sect. 9: "Obtained in this manner intensities and weighting functions contain already information on observation and illumination conditions, i.e., on the observation geometry, providing a basis to calculate AMF for any DOAS equation."*

Specific comments

Page 699, lines 6-7: In Platt and Perner (JGR, 1980) measurements of trace species using an active DOAS system are described. Therefore, I suggest to mention here that the tropospheric measurements presented in Platt and Perner do not exploit direct or diffuse solar radiation but an artificial source of radiation, in that they are different from the measurements presented in the references cited just above (Brewer et al. (1973), and Noxon et al. (1979)).

Answer: *We have mentioned that Platt and Perner have used an artificial source of radiation.*

Page 699, lines 23-24: After the sentence "Most critical is the extension of the DOAS technique to observation scenarios where the contribution of multiple scattering processes is significant", could you mention some cases where multiple scattering processes have a role and cannot be neglected? (near the ground, with clouds, when looking near the horizon?)

Answer: *A typical example of such a case is given.*

Page 711, line 21: I would add "low order" before "polynomial"

Answer: *Done.*

Page 713, lines 5-6: I would remove the sentence you put enclosed in parenthesis. The standard DOAS equation assumes the slant column to be constant with respect to the wavelength, but it depends on the SZA, instrumental line of sight, atmospheric parameters. So, for me, the parenthetical sentence may be confusing. You say after

C414

that the slant column in this case is wavelength independent (line 7). Moreover, the SCD does not depend on the wavelength but, however, it is implied working within a wavelength window.

Answer: *The sentence in parenthesis is removed.*

Page 713, line 25: please define what you mean for elevation angle; at least you should say that it identifies the instrumental line of sight

Answer: *We have replaced 'elevation angle' by 'viewing angle'.*

Page 714, line 5: Could you add here any recent references that discuss the retrieval of trace species vertical profile from DOAS measurements? (besides Harrison (1979) and McKenzie and Johnston (1982))

Answer: *We have added references to Hendrick et al., 2004 and Haley et al., 2004.*

Page 722, line 1: In my opinion, authors should add a reference after the sentence "neglected the linearization error" (e.g., Rodgers, 2000).

Answer: *Done.*

Page 725, line 18: what does that "and so on" account for?

Answer: *"and so on" means all other parameters which can affect the radiative transfer in the Earth's atmosphere.*

Page 771: I think that Table 2 is not really necessary as it is.

Answer: *We agree, Table 2 is removed.*

Technical corrections

Page 698, line 28: replace "details" with "detail"

Answer: *Done.*

Page 706, line 10: replace "trough" with "through"

Answer: *Done.*

Page 707, line 18: replace "coarse" with "course"

C415

Answer: Done.

Page 713, line 18: I would suggest to replace “is not explicitly indicated in course of the discussion” with “will not be indicated hereinafter”.

Answer: Done.

Page 721, line 6: I suggest to put here the number of the equation you are referring to

Answer: The number of the equation is given.

Page 727, line 9: Replace week with weak

Answer: Done.

Page 730, line 1: add a coma after “Concluding” (here and elsewhere in the text)

Answer: Done.

Page 730, line 4: replace “variating” with “varying”

Answer: Done.

Page 730, lines 6-7: replace “OF scattering parameters (Rayleigh scattering and aerosol extinction) and OF [...]” with “ON scattering parameters (Rayleigh scattering and aerosol extinction) and ON [...]” (the same at page 735 line 22)

Answer: This sentence is reformulated to avoid misunderstanding.

Page 736, line 21: I would replace “in application to the” with “for the”

Answer: Done.

Page 742, line 5: add a coma after “DOAS technique”

Answer: Done.

Page 742, line 8: not necessary

Answer: The sentence is removed.

Page 742, line 25: add a coma after “satisfied”

Answer: Done.

C416

Page 742, line 27 and page 743 line 1: Could you rephrase this sentence ?

Answer: This sentence is reformulated.

Page 742?(743), line 7: add a coma after “DOAS equation”

Answer: Done.

Page 743, line 11: “it follows from a more general assumption 3 in Table 5”. Please, rephrase the sentence, e.g. “it follows from a more general assumption (number 3 in Table 5)”.

Answer: Done.

Page 748, lines 8-10. Delete the sentence (or rephrase it) “As expressions [...] below.”

Answer: The sentence is rephrased

Page 751, line 16: replace “appropriate to GOME [...]” with “consistently with GOME [...]”

Answer: Done.

Page 752, line 5: for me, the sentence “[...] the only source of the retrieval error is the linearization error”., should be replaced with “[...] the only source of error in the retrieval is the linearization error”

Answer: Done.

Page 771: I suggest to add in the caption of Table 1 the number of equation(s) authors refer to.

Answer: The number of equations is added.

Page 778, Figure 1: even if you have commented it in the text, I think that the caption should describe what the red and black lines represent in the plot.

Answer: Done.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 697, 2010.

C417