

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

Anonymous Referee #2

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The manuscript by Rozanov & Rozanov presents a broad investigation of the applicability of the passive DOAS technique to retrieve information on atmospheric trace gases abundance for the cases in which multiple scattering processes in inhomogeneous media cannot be neglected. The paper is in general well written and addresses an important discussion on the consistency among different forms of the DOAS equation and related AMF, and also has some points of originality (e.g. the definition of a criterion of absorption weakness). The “educational” approach followed at the beginning of the manuscript, introduces well the reader with the DOAS concepts. I recom-

C222

mend publication of this work in AMT after addressing the specific points listed in the following sections.

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.

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.

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.

Some more considerations about non-satellite DOAS applications and the use of Radiative Transfer Models for the AMF derivation would be appreciated.

Specific comments

C223

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)).

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?)

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

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 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.

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

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))

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

C224

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

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

Technical corrections

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

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

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

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

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

Page 727, line 9: Replace week with weak

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

Page 730, line 4: replace "variating" with "varying"

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)

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

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

Page 742, line 8: not necessary

Page 742, line 25: add a coma after "satisfied"

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

C225

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

Page 742, line 7: add a coma after “DOAS equation”

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)”.

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

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

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”

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

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.

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