

***Interactive comment on “Comparison of Box-Air-Mass-Factors and Radiances for Multiple-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) Geometries calculated from different UV/visible Radiative Transfer Models” by T. Wagner et al.***

**T. Wagner et al.**

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Reply to ref #2:

We want to thank this referee for the positive assessment of our manuscript and the helpful comments. We almost completely followed them as outlined in detail below. Before we respond to the specific comments, we briefly describe some additional changes, which were recommended by two other referees and/or the co-authors of our study.

## A) Figures

Of course it is difficult to present this huge amount of information within a limited space. We tried to solve this dilemma by increasing the labels of almost all figures. In some cases, it will also be possible to increase the size of the figures (depends also on the final layout).

## B) Better separation of main foci

It was stated by the referee that the two main foci (RTM comparison and investigation of MAXDOAS sensitivities) should be better separated. We agree and modified the abstract, introduction and conclusions accordingly. In the abstract and conclusion we added one sentence which points out the two main foci of the paper ('Besides the assessment of the agreement between the different models, a second focus of the comparison was the systematic investigation of the sensitivity of the MAX-DOAS technique under various viewing geometries and aerosol conditions.') In the introduction we rearranged the text to better separate both foci. In particular, we introduced to sub-sections 1.1 (Modelled quantities used for the comparison exercise) and 1.2 (MAX-DOAS observations). To make the structure of the paper more clear we added the section numbers at the end of section 1 and we added some more explanatory text at the beginning of section 3.

## C) Statement on refraction

In the original version of the manuscript, only one sentence at the end of section 4.3 gave some information on the importance of refraction. We now added statements on the influence of refraction at the end of section 3.1: 'It should be noted that in contrast to the observation of zenith scattered light at large solar zenith angle, the influence of atmospheric refraction on MAX-DOAS observations is typically small. Even in the case of very long lines of sight (e.g. for 577nm, elevation angle of  $1^\circ$ , no aerosol, see section 4.3), the effect is at maximum a few percent. For typical atmospheric situations and measurement geometries it is negligible. Thus for this comparison exercise, the

treatment of refraction in the individual models was not specified.'

Also in the conclusions we added more information (at the end of the sentence: '...the correct treatment of the Earth's sphericity becomes indispensable') we added: '(while the effect of atmospheric refraction is typically negligible)'

D) additional minor corrections

Page 2, equation 2:

In many cases, the normalised radiance is defined with  $\pi$  in the numerator. In our RTM comparison, the normalised radiance was simply formed by the ratio of the modelled radiance and the solar irradiance. Thus we changed equation 2 accordingly.

Page 3, line 14: 'Ėwhich is a fundamental prerequisite for their correct interpretation.' changed into 'Ėwhich is a fundamental prerequisite for the correct interpretation of these observations.'

Page 5, line 10: The sentence 'For these cases, they can also be approximated by the intensity weighted average geometrical path length extension with respect to the vertical thickness of the selected layer.' Is replaced by 'For these cases, they can also be approximated by the intensity weighted geometrical path length extension with respect to the vertical thickness of the selected layer, averaged over all contributing light paths.'

Page 6, point A): The sentence 'A) The comparison and quantification of the differences of current RTMs from different research groups.' is replaced by 'A) The comparison of current RTMs from different research groups and quantification of the differences.'

Page 18, line 11: at the end of the sentence: 'Both factors cause a monotonous increase of the normalised radiance with increasing elevation angle over the whole range of elevation angles.' The following text is added: '(it should be noted that this dependence can be different for relative azimuth angles other than zero)'

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References: We removed the reference Rozanov, A., V. Rozanov, and J. P. Burrows, Software package SCIATRAN 2 - New developments in the radiative transfer modeling and the retrieval technique, paper presented at COSPAR 2006, to appear in ASR, 2007. because the paper is currently restructured and the date of appearance is uncertain at the moment.

Technical correction: Since end of 2006, I am also at MPI for Chemistry in Mainz, Germany. I added this affiliation to the list of affiliations.

## Ref. #2

This paper describes the results of an extensive RT model intercomparison exercise, based on a workshop held in Heidelberg, Germany during June 2005. A wide variety of state-of-the-art RT models from various international research groups participated in this exercise. The study presented here concentrates on the comparison of normalised radiances and box AMFs calculated for typical MAX-DOAS viewing geometries. Results for MAX-DOAS case studies done under different atmospheric scenarios are presented. The chosen exercises proved to be very useful for discovering errors made within the model calculations and a very good overall agreement was found for the radiances as well as the box AMFs (<5%). This study also confirms that MAX-DOAS observations are indeed very sensitive to the lowest atmospheric layers. In spite of the complex material presented, the paper is very well organised and well written. The material is highly relevant especially since there is an urgent need to gain the capability to properly interpret the increasing number of MAX-DOAS observations made during the last years. In my opinion, the paper can basically be published as is. My only problem with the paper was that trying to read the figures was rather strenuous. Although the figures are well prepared, they are very difficult to read when printed because they are far too small. If it is not possible to increase the size of the actual figures, than at least all axis labels need to be blown up considerably. Probably a combination of both (slightly bigger figures with bigger labels) could work quite well.

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Author reply: Concerning the quality of the figures, it is of course difficult to present this huge amount of information within the limited space available. We tried to solve this dilemma by increasing the labels of almost all figures. In some cases, it will also be possible to increase the size of the figures (depends also on the final layout).

I have also some more specific but all minor comments added below. Specific comments: Author reply: Many thanks for these very helpful suggestions!

Page 9833, line 14-16: This sentence doesn't read very well, e.g. what are model bases? Could be changed to something like: "The model was developed at FR-CGC/JAMSTEC, Japan, to study the energy budget in a cloudy atmosphere and remote sensing of E&#711;"

Author reply: We corrected the text as suggested.

Page 9835, line 2: should probably be "between 50 and 120 km" not "50 and 12 km"

Author reply: We corrected the text as suggested.

Page 9835, eq. 4, line 8/9: in the equation the symbol 'rho' is used to refer to the trace gas concentration; should also be 'rho' in line 9 instead of 'sigma'.

Author reply: We corrected the text as suggested.

Page 9837, lines 7,11: typo, no new paragraph required

Author reply: We corrected the text as suggested.

Page 9839, line 25: no full-stop after "chosen"

Author reply: We corrected the text as suggested.

Page 9842, line 2: should be "independent of the elevation angle"

Author reply: We corrected the text as suggested.

Page 9842, line 6: could start a new paragraph here

Author reply: We corrected the text as suggested.

Page 9845, line 13 + line 16: should be “scenario A3” in line 13 and “scenario A2” in line 16, right?

Author reply: We corrected the text as suggested.

Page 9845, line 19: (Fig.6, centre) same spelling as used in caption of Fig.7

Author reply: We corrected the text as suggested.

Page 9846, line 5/6: I have problems following this discussion when looking at Fig. 7 and 8 (middle row, A2 scenario). As I understand from Table 4, A2 has an aerosol layer spanning 0-2km. The box AMFs seem to rather show a minimum around 1 km, maybe even a little below 1km, so not really at the top and above the aerosol layer but rather within the layer???

Author reply: The referee is right. We changed the sentence into: ‘For the scenario with strong aerosol extinction (scenario A2, see Table 4), the box-AMFs show minimum values within the aerosol layer.’

Page 9850, line 17: one bracket too many

Author reply: we deleted one bracket.

Fig. 9, caption, 2. line: delete “show”

Author reply: We corrected the text as suggested.

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Interactive comment on Atmos. Chem. Phys. Discuss., 6, 9823, 2006.

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