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Atmospheric Chemistry and Physics Discussions



# *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 #3:

We want to thank this referee for the positive assessment of our manuscript and the helpful comments. We almost completely followed them (and explain the reasons in cases we did not follow them completely), 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°, 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



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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: 'Ěwhich is a fundamental prerequisite for their correct interpretation.' changed into 'Ěwhich 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. #3

General comments 1. This paper presents comparison of different radiative transfer model calculations of radiances and so called Box-air mass factors (Box AMF) for multi axis differential optical absorption spectroscopy (MAX DOAS). These radiative transfer models are usually used for ground-based as well as for satelite observation of atmospheric trace gazes like ozone and NO2, as well as for aerosol. 8 models are compared and four exercises are conducted in this paper. 2. All teams and radiative transfer models involved in this paper have an international recognation, indicating the high quality of the paper. 3. Also, the general way the comparison exercices have been conducted are fully relevant for this sort of comparison, as well as the searched ways to interpret results and differences between models.

Major comment 1. Very difficult exercises driven in very friendly way. The complexity of models and calculations are fully described and interpreted in the paper. 2. A general link between exercises is missing. The reader has difficulty to understand the evolution in exercises, why they are made in this order and not differently. A comment at the begining of the chapter 3, Basic settings and test, a brief but constructive plan should be provided, in complement to the aims of the intercomparison provided at the end of chapter 2.

Author reply: We added the following text at the beginning of section 3: ‘Before the specific MAX-DOAS geometries are simulated by the models (section 4), some basic



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model parameters were prescribed and also selected model results were compared for basic cases. In this way it was possible to identify and correct (simple) errors of individual models.'

At the end of section 1 (I guess the referee meant end of section 1, not end of section 2) we added the detailed section number to the outline of the paper.

Detailled minor comments 1. p 9827, l. 25: ...combination of observations at several elevation angles... and several wavelengths

Author reply: We added 'and several wavelengths' in brackets. It is true that from the wavelength dependence additional information on the vertical profile can be derived. For most typical cases, however, we think that the most important information comes from the changing elevation angles. Thus we added the wavelength aspect in brackets.

2. p 9828 l.5-6 : is multiple scattering enhancement solved for O2 - O4, if yes, please state.

Author reply: To our knowledge, there are several publications showing enhanced absorptions of O4 and O2 for thick clouds (and high optical depth). Such enhancements can also be well simulated by current radiative transfer models. It would be in particular a very interesting aspect to compare the results of different RTM for prescribed situations of thick clouds (this might be a subject for a future RTM comparison?). Since in this comparison exercise the optical thickness (and the geometrical thickness) of the aerosol layer is rather small, absorption enhancement due to multiple scattering plays only a small role - far beyond the observed absorption enhancements for thick cloud cover. Thus we think that a discussion of strongly enhanced absorptions of O2 and O4 is not in the direct scope of this paper and we did not include any additional discussion or reference in our manuscript.

3. p9837 l. 7 -8 and 11 - 12, remove jump between lines (in acpd-6-9823-2006-print pdf version)



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Author reply: We corrected the text as suggested.

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Interactive Comment