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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Gauss-Seidel Limb Scattering (GSLS) radiative transfer model development in support of the Ozone Mapping and Profiler Suite (OMPS) Limb Profiler mission" *by* R. Loughman et al.

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Response to Anonymous Referee #1 for Loughman et al. (2014):

We appreciate the suggestions offered, and see relatively few areas of possible disagreement. Point-by-point responses follow:

Suitability for ACP: We are open to transferring this article to AMT. We have not pursued it so far for purely practical reasons (we were midway through the payment process for

the publication when the suggestion was originally made), but will continue to confer with the editors to determine the best journal for publication.

- The initial paragraph of Section 4 is probably more suited for a User's Guide for the GSLS model (or a similar document). We will replace this paragraph with a briefer introductory paragraph that outlines the importance of polarization, without dwelling on the details of the GSLS model development.

- The MS source terms are calculated independently at each solar zenith angle in the current GSLS model, and this will be clarified in the text. One might consider this model's MS calculation as a form of the "independent pixel approximation", with its attendant limitations (such as neglecting the interaction between the various solar zenith angles, as noted by Anonymous Referee #1). The calculation with 143 source term calculations was quite slow, taking many hours (indicating a lot of "memory paging"), but did not require any special memory handling steps to run on a moderately powerful laptop PC (Intel Core Dual CPU P8400 @ 2.26 GHz, 1.58 GHz, 2.93 GB of RAM).

- In the LOS integration, the MS source function is assumed to vary as a linear function of the cosine of the solar zenith angle between the calculated solar zenith angles. Anonymous Referee #2 has requested a new section to explain this method in greater detail, which we will provide in the revised manuscript. We tried this fairly crude method and got acceptable improvement in the radiance accuracy without extraordinary numbers of added solar zenith angles, so we did not explore the sensitivity of the radiances to the chosen interpolation method in significant detail. Our brief investigation indicated that the fairly crude method currently used is sufficient for moderate solar zenith angles, but we would not assert that we have optimized this portion of the model for general circumstances (particularly for low sun conditions, when the illumination changes quickly along the LOS).

- The calculations featured in Fig. 11 use the number of solar zenith angles indicated in Fig. 12 for each case. To make the exact conditions clearer, we will add a table

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indicating the number and locations of the solar zenith angles along the LOS for the calculations illustrated in Fig. 11.

- The radiance change due to the "Chapman layer improvement" is indeed very small for the cases illustrated in this paper. Its necessity was pointed out to us by a colleague who was attempting to simulate radiances accurately at much larger tangent heights, to assist with retrievals for mesospheric temperatures and polar mesospheric cloud detection [Steve Taylor, private communication, 2014]. We would prefer to keep some mention of this GSLS model change, but will defer to the editor's decision on this point.

- The reason for the outlier radiances in Figs. 4-5 was discovered after submission of the initial manuscript, and this correction will be described in the revised manuscript. Anonymous Referee #1's speculation is very close to the mark: Two aerosol phase functions are calculated in the GSLS model, one using the exact scattering angle (appropriate for use in single-scattering calculations), and one calculated at 1 degree increments in scattering angle (used in the multiple scattering calculations). In the version of the GSLS model used in the initial manuscript, the latter function was mistakenly used in single-scattering calculations. The associated error was small in most instances, but grew largest when the single-scattering angle was near a half-integer, the aerosol phase function was changing rapidly, and the scattering was dominated by aerosols (i.e., the forward scattering region).

- The suggested changes to pair together Figs. 2 and 4, 3 and 5, and 7 and 11 will be made, with a figure legend also added.

- Figs. 8, 9 and 10 will also be combined as requested, with a legend added.

- Fig. 12 will be revised to use clearly-defined symbols.

- A legend will be added to Fig. 13.

Minor points:

- We were uncertain whether the CDIPI model was a predecessor for SCIATRAN, or

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whether CDIPI had been further developed and effectively renamed SCIATRAN. But we will investigate this point and clarify it in the text.

- We would like to mention the polarization capability somewhere in the abstract, but its reappearance probably should not be mentioned in the numbered list (partly because we suspect that few noticed its absence between 2004 and today!).

- We accept "multiple solar zenith angles" as a clearer expression for the introduction of MS source function calculations at multiple points along the LOS.

- The duplicate definition of L04 will be removed in the revised manuscript.

- Siro radiances were used as a benchmark partly for historical reasons: The RT model intercomparison that was eventually recorded in Loughman et al., 2004 was initiated by L. Oikarinen, who provided the initial model atmospheres and Siro radiances to the other authors for the comparison. As noted in Loughman et al., 2004, the Monte Carlo Siro model also uses fewer approximations and shortcuts than the other models. The argument that Siro was most accurate was further bolstered by its unique (at that time) ability to model radiance variations within a model layer (as shown in Fig. 4 of Loughman et al., 2004).

- The model atmosphere used in this study includes Rayleigh scattering (but excludes molecular depolarization), ozone absorption, and aerosol scattering (modeled by the Henyey-Greenstein phase function). In fact, it might be more useful to include the atmospheric profiles and radiance values as supplements to the paper - we will discuss that possibility with the editor.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 19315, 2014.