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Atmospheric Chemistry and Physics Discussions

Interactive comment on "McSCIA: application of the Equivalence Theorem in a Monte Carlo radiative transfer model for spherical shell atmospheres" *by* F. Spada et al.

F. Spada et al.

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We thank the reviewer for his/her comments. We reply below point-by-point.

Comment #1 *The manuscript is a comprehensive description of a specific Monte Carlo code for a spherical shell atmosphere. The features and techniques are well-described. Basically it may serve as a manual to build such a code from scratch. Although this is valuable in itself, (if one wants to reproduce McSCIA) in my view the manuscript does not qualify as a scientific paper.*

Reply #1 We do not agree with the reviewer. In this paper we give the formulae and implementation details that are needed to make a Monte Carlo RT model for a spherical geometry, including the ET principle. This application is very important to interpret

new satellite measurements of limb-scattered radiation from SCIAMACHY, OSIRIS, GOMOS, and, in future, OMPS. The formulae, which come from various sources to which we refer, are needed to make the paper self-contained, to help the reader, and still be concise. There is no such publication in the literature yet.

Both other referees (anonymous #1 and Dr. R. Loughman) find the paper interesting and with enough new material, and are commending us for the self-containedness and interesting details on the implementation. So we are of the opinion that it is a useful scientific paper.

We plan, as suggested by this referee, to shorten the paper by moving some material to the appendix, and to include some missing references.

Comment #2 *In particular I do not see any new results or techniques which have not already been described elsewhere:*

Reply #2 While the ET in itself it is not a new concept, we found that it was not investigated in the limits to which it can be used. The ET principle has been used previously, but with quite different implementations (e.g. Partain et al., 2000). Our paper applies the ET for the first time to spherical geometry, and gives results for this geometry. This is said in the Abstract and Introduction. We are currently working on a paper with new results obtained with McSCIA.

Comment #3 *1. Several of the techniques which are described in this manuscript have been described elsewhere. E.g. - the local estimate technique (Davis et al. [1985]; Marshak and Davis [2005]) - the analytical treatment of Rayleigh and Henyey-Greenstein scattering; the equations in the appendix can be found in identical form in (Cahalan et al. [1994] and I3RC [1999]). A good overview of different techniques is also given by Cahalan et al [1994], Marshak et al [1995], and the new textbook by Marshak and Davis [2005]. The text could be shortened considerably by replacing some lengthy descriptions with references to the existing literature.*

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Reply #3 We will add the suggested references where appropriate.

Comment #4 *2. The main scientific finding of the paper, the application of the equivalence theorem is also not new. It has e.g. been explicitely described by Cahalan et al [1994] (and references therein), O'Hirok and Gautier [1998], and has been used by several participants of the Intercomparison of 3D radiation codes (I3RC), see also I3RC [1999].*

Reply #4 While the concept of the ET is quite old, the various implementations of this concept have been very different, due to different use of the statistical information from ray-tracing. This statistical information is used here fully. The application of the ET to spherical geometry is new.

Comment #5 *To consider absorption by reducing the photon weight instead of "killing" the photon is quite common for wavelength regions where absorption is high.*

Reply #5 We will add the appropriate reference in Sect. 4.1.

Comment #6 *The good agreement of different codes based on the equivalence theorem and using "traditional" absorption in the I3RC [Cahalan et al., 2005] illustrates that the equivalence theorem works. If it works in plane-parallel atmospheres there is no reason to assume that it should not work in spherical atmospheres as well.*

Reply #6 While the agreement between the codes in the I3RC shows that the ET works, we felt it necessary to demonstrate how well it can perform. The fact that in McSCIA we have statistically identical results, while there is a biasing in Partain et al. case, shows that not every implementation of the ET is the same and that people should be aware of it when they employ the ET in their model. The paper contains the implementation of the ET principle in spherical geometry. This is new.

Comment #7 *[...] An alternative would be to add some more scientific content, but in any case the technical description needs to be shortened. The best alternative, in my view, would be to add the shortened model description as an appendix to a paper*

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presenting scientific results based on McSCIA (as e.g. in Cahalan et al. [1994]) instead of publishing it stand-alone.

Reply #7 We will move the formulae-part of Sect. 2 (on the ray-tracing approach) and the description of the 1D model to the Appendix. See also the reply to the first comment.

Comment #8

References: Cahalan, R.F., W. Ridgway, and W.J. Wiscombe, S. Gollmer, and Harshvardhan. Independent pixel and Monte Carlo estimates of stratocumulus albedo JAS 51, 3776-3790, 1994.
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Marshak, A., A. Davis, W. Wiscombe, and R. Cahalan, Radiative smoothing in fractal clouds JGR 100(D12), 26247-26261, 1995.
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Oikarinen, L. and E. Sihvola, and E. Kyrolae, Multiple scattering radiance in limbviewing geometry JGR, 104(D24), 31261-31274, 1999.

Reply #8 Missing references will be added to the revised version.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 1199, 2006.