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Geoscientific Model Development Discussions

Interactive comment on "A benchmark for testing the accuracy and computational cost of shortwave top-of-atmosphere reflectance calculations in clear-sky aerosol-laden atmospheres" *by* Jeronimo Escribano et al.

Anonymous Referee #1

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General Comments:

This is a good, solid, and useful inter-comparison paper that can be accepted after minor revision. Since a vector radiative transfer model has been employed as a reference model, the polarization importance in radiative transfer applications could be further highlighted by a few additional citations. In addition to this, a deeper interpretation of the differences between the reference vector model and the scalar models should be given.

Minor Comments:

1. Page 2, lines 20 - 22:

(A) "It should be noted that accounting . . .(e.g. Kotchenova et al., 2006)". This is true but it should be further elaborated to avoid generalizations. Some helpful comments that could be considered:

This holds true in case of pure molecular or pure aerosol atmospheres, where errors up to 11.5% and 5% are found, respectively (Mishchenko et al., 1994, Kotchenova et al., 2006, Barlakas 2016). In contrast to this, for realistic inhomogeneous atmospheres involving molecules, water soluble, and irregular shaped dust particles, the errors induced by neglecting polarization are insignificant, below 1% (Barlakas 2016). In the same direction are the findings of Hansen (1971). He reported that the corresponding vector versus scalar differences in case of spherical cloud particles (with sizes of the order or greater than the wavelength of the incident electromagnetic radiation) are below 1%.

(B) "but also because. . . polarised radiances (e.g. Tanré et al., 2011)." The polarization importance should be highlighted a bit more by adding more citations. For example,

Illustrating the use of polarization in retrievals: Li et al., (2009) investigated the improvement in dust properties characterization resulting from additional polarization sun photometer measurements. In short, polarization helps constraining the size distribution, the real part of the refractive index, and determines a better non-spherical parameter.

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2. Page 15, lines 12 - 28: Some general comments and hints to help interpreting the deviations between scalar and vector calculations.

(A) Concerning the dependency on the single scattering albedo for a given wavelength. It has been reported that the errors are decreasing with increasing single scattering albedo (Mishchenko et al., 1994, Barlakas, 2016).

(B) line 17, “As expected,“: An explanation should be given here. Here, are some hints:

Aerosol scattering phase function is more polarized at longer wavelengths. In general, the aerosol contribution to the polarized reflectance is approximately proportional to its phase function and optical thickness (Bréon et al., 1997); For optical thickness larger than 1 - 2, the increasing multiple scattering process, leads to a decrease of the bias (scalar vs vector calculations), depending on isotropic reflection, and more importantly, on the single–scattering albedo (Mishchenko et al., 1994). Barlakas (2016) reported that these errors are subject to high-order multiple scattering and the asymmetric scattering phase matrices of irregular shaped particles (Strongly polarized first–order scattering supplies the second– order, and as a consequence, the second–order supplies the third–order, et cetera.); Outgoing TOA radiation becomes more polarized at longer wavelengths proportional to its phase function and optical thickness (Kotchenova et al., 2006).

Technical Corrections: Please see the attached file.

References:

Note that, in Emde et al. (2018) and https://www.meteo.physik.uni-muenchen.de/∼iprt/doku.php?id=start, a list of vector radiative transfer applications and list of benchmark data are tabulated.

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Please also note the supplement to this comment:
https://www.geosci-model-dev-discuss.net/gmd-2018-216/gmd-2018-216-RC1-supplement.pdf

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