Efficient RT calculation using truncation correction methods under aerosol and cloud atmospheres implemented in GRASP

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The computational efficiency of solving the radiative transfer equation is a crucial issue for ground- and satellite-based remote sensing and monitoring of aerosols, clouds, and radiation, all of which involve the analysis of large volumes of data. In order to adequately model scattering by atmospheric aerosol and cloud particles, a large number of Fourier decomposition is required due to anisotropic phase function. Since the 1970s, the delta-scaling technique, which cuts off the forward lobe, has been developed to reduce the number of terms in Fourier decomposition. This technique adequately reconstructs the radiance field, except for solar aureole, glory, and sun-glint regions. In the recent decade, two types of correction methods, Waquet-Herman method [1] and a series of IMS methods (Improved Multiple and Single scattering; [2-4]) have been developed for correcting a forward lobe contribution in I, Q, and U components of Stokes radiance vector in solar aureole regions. Furthermore, PnIMS methods are extending to include the interaction between surface anisotropic scattering (e.g., sun-glint) and particle forward lobe. In this study, we theoretically investigated the difference among the methods and, then attempted to compare the performance of both methods (Waquet-Herman and P^n-IMS) in the frame of the same radiative transfer implementation: (1) The P^n-IMS method was implemented into the GRASP (Generalized Retrieval of Atmosphere and Surface Properties) code, which uses a successive order of scattering method for the numerical solution of the Fourier decomposed radiative transfer equation. (2) Two methods realizing efficient computational treatment of scattering in aureole and sun-glint regions were compared and discussed in terms of computational speed and accuracy. The results suggest that the P^3-IMS method provides better results for total radiance calculations than the truncation approach based on the Waquet-Herman method. In contrast, for polarized components (i.e., Q and U), the calculation efficiency is similar for both methods.

Keywords: radiative transfer solver, aerosol, clouds

References

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