Fast vector radiative transfer solution using improved small-angle approximation

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If the scattering phase matrix has a forward diffraction peak, an accurate solution of the corresponding vector radiative transfer equation is time-consuming. By decomposing the scattering phase matrix at certain scattering angles into the forward component and the remaining component, the original vector radiative transfer equation is decomposed into three equations: the forward equation, the regular equation, and the error equation. The forward equation is approximately solved using the small-angle approximation [1]. The regular equation is solved using the adding-doubling method. The error equation is described using the single-scattering approximation. The summation of the solutions from the three equations generates the final solution of the original radiative transfer equation. Using this decomposition, the vector radiative transfer equations with respect to an arbitrary scattering phase matrix can be rapidly but accurately solved. The computational time is significantly reduced because the most time-consuming forward equation is solved by an analytic formula after using the small-angle approximation. The solution is verified against benchmarks and several applications are also shown in this presentation.

References

[1] Sun, B., G. W. Kattawar, P. Yang, and E. Mlawer, 2017: An improved small-angle approximation for forward scattering and its use in a fast two-component radiative transfer method. *J. Atmo. Sci.* **74**, 1959–1987.

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