Analytical Delta-Four-Stream Doubling-Adding Method for Radiative Transfer Parameterizations

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ABSTRACT. Though the single-layer solutions have been obtained for the delta-four-stream discrete ordinate method (DOM) in radiative transfer (Liou et al 1988), there lacks a four-stream doubling-adding method (4DA), which enables us to calculate the radiative transfer through a vertically inhomogeneous atmosphere with multiple layers. In this work, based on the Chandrasekhar's invariance principle (Chandrasekhar 1950), a analytical method of delta-4DA is proposed.

Applying delta-4DA to an idealized medium with specified optical property, the results in reflection, transmission and absorption are the same by treating medium as a single layer or dividing it into multiple layers. This indicates that delta-4DA is able to solve the multi-layer connection properly in a radiative transfer process. In addition, the delta-4DA method has been systematically compared with the delta-two-stream doubling-adding method (delta-2DA) in the solar spectrum.

By applying delta-4DA to a realistic atmospheric profile with gaseous transmission considered, it is found that the accuracy of delta-4DA is superior to that of delta-2DA in most of cases, especially for the cloudy sky. It is shown that the relative errors of delta-4DA are generally less than 1% in both the heating rates and fluxes, while the relative errors of delta-2DA can be as high as 6%.

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REFERENCES
