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On the accuracy of modeled visible-near IR polarized radiance depending on phase matrix truncation method

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Clouds have a major impact on the Earth radiation budget so that the current lack in understanding feedbacks of external forcing on them remains one of the largest uncertainty in climate modeling. Aerosols via their effect on radiative budget and their indirect effect on clouds also are crucial components in predicting climate evolution. In that context, polarized, multidirectionnal, multispectral space based measurements, such as that provided by POLDER/Parasol, offer a unique possibility to characterize and follow aerosol and cloud optical and microphysical properties. To analyze such high accuracy polarized radiance observations requires the use of equally accurate atmospheric radiative transfer modeling.
When modeling polarized radiances using 1D radiative transfer models, the phase matrix coefficients dependency on the scattering angle is generally expended in Legendre polynomials. The number of terms of this expansion is usually linked to the number of points used to approximate the integral over the polar angle (i.e. streams) in the radiative transfer equations. The number of those streams must offer a good balance between accuracy and computational time. Strong features (like the forward peak in phase function of water cloud particles) prevent the good representation of phase matrix coefficients unless we use a high number of terms in the Legendre polynomials expansion that would dramatically increase the computational time. In order to ensure a good representation of the rest of the phase matrix with only a few terms, such a feature must be truncated.
Several methods were developed in the last decades for the truncation the forward peak, the most used are the delta-M scaling, the potter truncation and the delta-fit. Several studies already looked at the difference between those methods, especially the number of terms needed to reach an acceptable accuracy on the phase function and the total radiance. However very few were conducted to see the effects of those truncation on the other terms of the phase matrix and on polarized radiance. In the present work, we study the accuracy on modeled visible near-IR polarized radiance when using either a delta-fit, a Delta-M or a Potter truncation for different atmospheric components (e.g. aerosol, liquid cloud or ice cloud), as a function of the number of terms in the decomposition. The radiative transfer code used in this study is an adding-doubing model whose results are compared to the output of a Monte-Carlo model for which no Legendre polynomial expansion is required.