Primary cloudbow retrieval of cloud droplet size distribution from POLDER

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Abstract

The Polarization and Directionality of Earth Reflectances (POLDER) instrument provides unique cloud droplet radius (CDR) and effective variance (EV) observations for the analysis of clouds on the global scale. However, the cloud droplet size distribution estimated using the conventional POLDER algorithm (Bréon et al, 2005) is limited by its coarse spatial resolution (150 km) and insufficient information for large droplets (CDR>15 μm). In this study, we proposed an improved primary cloudbow retrieval (PCR) algorithm to estimate CDR and EV from POLDER. Simulated retrievals based on a radiative transfer model indicate that primary cloudbow measurements are sensitive to large droplets (CDR>15 μm) and enable the retrieval to be applied at a higher spatial resolution; therefore, we employ POLDER polarized measurements from both primary and supernumerary cloudbow regions in the PCR algorithm. Retrieval cases using POLDER measurements reveal that the PCR algorithm

is robust when the cloud fields are homogeneous. When the cloud field is heterogeneous, the estimation of CDR is sensitive to the scattering angle ranges as well as the grid size, with uncertainty less than 1 μm. In addition, a spatial resolution of 40-60 km is suitable for the PCR algorithm based on the relationship between the retrieval grid size and the total successful retrievals. Further comparisons between the PCR retrievals and operational products are conducted on the global scale using POLDER measurements for February, May, August and November 2008, revealing that PCR retrievals agree well with operational products on the global scale as CDR<15 μm. Our analysis indicates that most of the large droplets estimated using the conventional procedure are overestimated due to the absence of primary cloudbow measurements. The PCR algorithm permits an extended range of CDR (3-25 μm) and EV (0.01-0.29) estimates and a higher resolution (40-60 km) in the retrieval.

Reference

Bréon F M, Doutriaux-Boucher M. A comparison of cloud droplet radii measured from space[J]. IEEE Transactions on Geoscience and Remote Sensing, 2005, 43(8): 1796-1805.