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Retrieving Liquid Cloud Droplet Size Distribution from the Geometric Parameters of Polarized Cloudbow: Preliminary demonstrations and a direction forward

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The spatial and temporal variation of liquid water clouds and their interactions in the atmosphere are key to quantifying the impact they have on global radiative forcing. The cloud droplet size distribution (DSD) offers key insight on how cloud microphysical properties affect radiative forcing. Traditional radiometric observations provide some insight into the cloud droplet effective radius (CDR) but cannot retrieve the cloud droplet effective variance (CDV). This can significantly impact subsequent radiometric retrievals of CDR and optical thickness. Previous works on polarimetric DSD retrievals have shown that CDR modulates the scattering angle of the primary and supernumerary cloudbow peaks and CDV varies the amplitude of the supernumerary bows. The geometric parameters of the polarized cloudbow, i.e., the angular span of the primary and secondary bows and the amplitude of the secondary bow, are believed to contain the first-order cloud DSD information. In this work, we will show a preliminary lookup table retrieval method based on the geometric parameters of simulated cloudbow signals which will allow for the simultaneous retrieval of CDR and CDV from the Hyper-Angular Rainbow Polarimeter (HARP) CubeSat. HARP is a wide field-of-view (FOV) polarimeter designed by the University of Maryland, Baltimore County (UMBC), which is capable of measuring polarized radiance over a 900-km swath at ~ 4km resolution and up to 60 viewing angles in the 670nm spectral band. The proposed approach can be also applied to the HARP2 instrument onboard NASA's upcoming Plankton, Aerosol, Cloud ocean Ecosystem (PACE) satellite. The simulation of HARP observations is an approach to study the efficacy of cloud retrieval in the cloud-aerosol transition region and therefore to gain insight into how aerosols affect cloud retrieval. Our study examines these effects by simulating observations using 1D and 3D radiative transfer code in order to further understand how these effects affect the retrieval of aerosol and cloud parameters.

Keywords: retrieval algorithm, clouds, cloud polarimetry, polarimeter