Retrieving Liquid Cloud Droplet Size Distribution from the Geometric Parameters of Polarized Cloudbow: Novel Algorithm Development and Demonstrations

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Liquid cloud microphysics modulate the amount of short-wave radiation reflected back to space and the amount of long-wave radiation trapped close to Earth's surface [1]. A two-parameter gamma distribution (DSD) consisting of cloud droplet effective radius (CDR) and cloud droplet effective variance (CDV) is commonly used to represent liquid clouds. CDV is the width of the DSD and as such, it contains information on cloud evolution and radiative processes [2]. Previous works have shown that polarimetric measurements are sensitive to both DSD parameters simultaneously, and that CDR modulates the scattering angle of the primary and supernumerary cloudbow peaks while CDV varies the amplitude of the supernumerary bows [2]. The geometric parameters of the polarized cloudbow contain the first-order cloud DSD information which we have used to develop a Nakajima-King-style Lookup Table (LUT). By correcting for atmospheric transmittance, we can develop a LUT of polarized phase functions which would be applicable to a wide range of viewing geometries. This LUT allows for the efficient retrieval of the liquid cloud DSD from multiangular polarimetric measurements such as those from the Hyper-Angular Rainbow Polarimeter (HARP) suite of instruments. The Hyper-Angular Rainbow Polarimeter 2 (HARP2) aboard NASA's Plankton, Aerosol, Cloud ocean Ecosystem (PACE) satellite, is a wide field-of-view instruments capable of measuring polarized radiance at ~ 2.5 km resolution near nadir and up to 60 viewing angles in the 670 nm spectral band [3]. AirHARP2, the airborne version of the instrument will also be participating in the PACE-PAX validation campaign in September 2024. In this work we will demonstrate the LUT retrieval algorithm on HARP2 data and validate the retrieval with a separate parametric DSD retrieval.

References

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Session: Development of advanced retrieval algorithms and data processing