We present an algorithm for retrieval of cloud droplet size distribution parameters (effective radius and variance) from the Research Scanning Polarimeter (RSP) measurements. The RSP is an airborne prototype for the Aerosol Polarimetery Sensor (APS), which is due to be launched as part of the NASA Glory Project. The described retrieval technique is focused on the sharply defined structure (rainbow) in the polarized reflectances of clouds within the scattering angle range between 135 and 165 degrees. The shape of the rainbow is dominated by single scattering of light. This allows to avoid the uncertainties due to 3D nature of radiation fields, which affect currently operational remote sensing methods based on the multi-spectral measurements. Our retrievals of the droplet size are independent of the optical depth and surface albedo. They also can be combined with correlative lidar-derived extinctions at the cloud top to compute the number concentration of cloud droplets.

Performance of the proposed method was tested on simulated cloud radiation fields generated using both 1D vector doubling/adding code and the 3D radiative transfer model MYSTIC (Monte Carlo code for the physically correct Tracing of photons In Cloudy atmospheres). The latter model was applied to a realistic cloud field obtained from large-eddy simulations.

We also present the results of comparison between our retrievals and in situ measurements of cloud droplet sizes performed during two recent field campaigns: the Coastal Stratocumulus Imposed Perturbation Experiment (CSTRIPE, 2003) and the Routine AVP CLOWD Optical Radiative Observations (RACORO, 2009).