

Cloud Droplet Radius Estimates from multi-directional polarization measurements

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The first weeks of measurements from the POLDER instrument onboard the ADEOS spacecraft in late 1996 revealed polarization features that had not been anticipated. These features were observed over extended cloud fields and exhibited polarized radiances that oscillate from positive (perpendicular to the scattering plane) to negative (parallel to the scattering plane) as the scattering angle varies within the range 140–180°.

It was quickly understood that these features were associated with the polarized phase function of cloud droplets at the cloud top [1]. Their occurrence requires a relatively narrow droplet size distribution, which explains why they had not been predicted prior to launch, as pre-launch simulations typically assumed broader size distributions.

These polarization signatures enable a very precise estimation of the cloud droplet radius at the cloud top [2]. Comparisons with the more traditional spectral retrieval method show a strong correlation, although with a systematic bias. This bias has been interpreted as resulting from the vertical structure of the cloud: the polarization-based method is primarily sensitive to the very top of the cloud, whereas the spectral method probes deeper layers within the cloud [3].

The polarization-based retrieval approach was selected for use in the NASA Glory mission [4], which was unfortunately lost during launch. It will now be implemented operationally using measurements from the ESA 3MI instrument onboard the EUMETSAT Metop satellite series.

The invited talk will present the development of cloud droplet radius retrievals based on polarization measurements, from the first applications using POLDER observations to their implementation for the 3MI mission.

References

- [1] Bréon, F.-M., and Ph. Goloub; 1998 : Cloud droplet effective radius from spaceborne polarization measurements. *Geophys. Res. Let.*, 25(11), 1879-1882
- [2] Bréon, F.-M., and S. Colzy, 2000 : Global distribution of cloud droplet radius from POLDER polarization measurements. *Geophys. Res. Let.*, 27 (24), 4065-4068.
- [3] Bréon, F.M. and M. Doutriaux-Boucher, 2005: A comparison of Cloud Droplet Radii measured from space, *IEEE Trans. Geos. Rem. Sens.* 43 (8): 1796-1805.
- [4] Mishchenko, M. et al., Accurate Monitoring of Terrestrial Aerosols and Total Solar Irradiance: Introducing the Glory Mission . *BAMS*, 88, 5. <https://doi.org/10.1175/BAMS-88-5-677>

Preferred mode of presentation: Invited