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Uncertainty Assessment in the Retrieved Cloud Properties from the Multi-spectral, Multi-viewing Airborne Polarimeter OSIRIS

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Cloud feedbacks remain one of the major uncertainties in climate prediction models, particularly the aerosols-clouds-radiation interactions that are poorly evaluated (IPCC, 2013). Airborne remote sensing measurements with a tens of meters resolution are very suitable to improve our knowledge about cloud properties and their variabilities at high resolution.
The airborne radiometer OSIRIS (Observing System Including Polarization in the Solar Infrared Spectrum), developed in the Laboratoire d'Optique Atmosphérique (LOA) has recently been operated. It is based on POLDER concept as a prototype of the future spacecraft 3MI (Multi-Viewing Multi-Channel Multi-Polarization Imaging Mission) that will be part of the EPS-SG Eumetsat-ESA mission.
An optimal estimation method is used to retrieve cloud optical thickness and effective radius of cloud droplets from OSIRIS measurements. This methodology is more flexible than the pre-calculated Look-Up Tables (LUT) and allows a direct estimation of retrievals uncertainties originated from both observations and physical model errors. Three types of errors are considered: (1) retrieval noise coming from the instrument, (2) incorrect estimation of fixed model parameters (ocean surface wind, cloud altitude and effective variance of water droplets distribution...), and (3) errors linked to the simplified physical model that does not take into account heterogeneous vertical profiles and 3D radiative transfer effects.
As OSIRIS has two separated optical sensors, one for the visible and the other one for the shortwave infrared (SWIR), we developed two algorithms based on two different types of information: (a) the total and polarized multi-viewing reflectances from the visible optical sensor and (b) the multi-viewing total reflectances from two SWIR wavelengths. Retrieved cloud properties and corresponding uncertainties are compared and analyzed in order to evaluate the contribution of model parameters and assumptions in the retrieval errors.