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Cloud properties retrieved from infrared sounders and their analysis in synergy with active remote sensing

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Clouds play an important role in the energy budget of the planet: optically thick clouds reflect the incoming solar radiation leading to cooling of the Earth while thinner clouds act as "greenhouse films" preventing escape of the Earth's infrared radiation to space. Satellite observations provide a continuous survey of clouds over the whole globe and IR sounders have been observing our planet since 1979. The spectral resolution has strongly improved from the TIROS-N Operational Vertical Sounders (TOVS) onboard the NOAA polar satellites to the Atmospheric InfraRed Sounder (AIRS) onboard Aqua (since 2002) and to the InfraRed Atmospheric Sounding Interferometers (IASI) on board the METOP (since 2006). Their spectral resolution along the CO_2 absorption band makes IR sounders most sensitive to cirrus, day and night. In addition, they provide atmospheric temperature and water vapour vertical distribution, surface temperature, and dust aerosol properties.

The LMD IR sounder cloud property retrievals are based on a weighted χ^2 method. Once the cloud physical properties (cloud pressure and IR emissivity) are retrieved, cirrus bulk microphysical properties (De and IWP) are determined by investigating their spectral emissivity difference between 8 and 12 μm.

The AIRS instrument is a part of the A-Train constellation, which also includes two active sounders, the CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation) lidar and the CloudSat radar, providing the vertical structure of the clouds. The IASI observations with their improved spectral and, therefore, vertical resolution complement the AIRS observations in the diurnal cycle. In addition to satellite data, we use temperature, water vapor, and wind distributions from the ERA Interim reanalysis to better assess the environmental conditions for the clouds.

The analysis of the joint dataset helps to (1) extend the quantitative and global characterization of cloud properties into a statistical model of the 3D distribution of cloud properties, (2) establish the relationships between cloud properties and atmospheric circulation, and (3) estimate the energetic effects of the clouds in the context of the Earth's atmosphere energy budget.