Geophysical Research Abstracts,
Vol. 11, EGU2009-1740-1, 2009
EGU General Assembly 2009

Cirrus cloud statistics derived from CALIOP and MODIS measurements

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One of the important current objective of climate research is to understand the impact of clouds on the global radiation budget. Indeed, clouds have a significant influence on the Earth's radiative balance and induce various climatic feedbacks that are still not completely understood. The spatial heterogeneity of cloud structures and their microphysical properties significantly contributes to the modulation of the Earth's energy budget. Moreover, the surface flux distribution in longwave radiation is very sensitive to both the geometrical structures and cloud base altitude. A better knowledge of the three-dimensional distribution of cloud layers is then required to improve cloud parameterizations in climatic models.

Systems including spaceborne backscatter lidar systems (such as LITE (NASA, 1994), ICESat/GLAS (NASA, 2003) and CALIPSO/CALIOP (NASA&CNES, 2006) provide the potential for new insights into the vertical distribution of clouds in the atmosphere. Additionally, they offer an opportunity to better determine the presence of optically thin targets such as cirrus clouds, but the analysis of optically thin targets must account for the signal to noise ratio characteristics of the sensor. For lidar systems operated in space, atmospheric backscattered signals present reduced signal to noise ratios (SNR) in comparison with ground-based systems.

Cloud vertical structure (height/pressure/temperature) has become a well studied and often used product from MODIS. It is also a standard product from the VIIRS (Visible Infrared Imager Radiometer Suite) instrument on board the future National Polar-Orbiting Operational Environmental Satellite System (NPOESS) satellites.

Indeed, with the launch of CALIPSO and CloudSat in EOS A-Train, NASA has provided us a new opportunity to evaluate the characteristics of cloud remote sensing from passive instruments.

The matched CALIOP nighttime spaceborne lidar database and the MODIS/Aqua are used here to investigate cloud structural parameters, in particular the cloud top height (CTH) and the cloud chord length (CCL).
The cloud characteristics are first obtained since the lidar measurements. To complete this objective, an algorithm, yet developed and applied in the view of the processing of the LITE lidar measurements has been applied now to the CALIOP lidar measurement. This algorithm is based on a 2-step method. In the first step, a threshold method is used to infer the cloud structures. In the second step, a cloud pattern recognition method is applied to treat a cloud as an isolated object. Then, cloud layers are tested following their proximity to other structures. If the objects are sufficiently close together, they are merged into a single object.

MODIS provides multiple infrared channels that allow for the estimation of the cloud-top pressure, emissivity and microphysics. We will first characterize the performance of the standard MODIS cloud top pressure products using the information provided by CALIOP. In addition, we will derive cloud emissivities values from each MODIS IR channel. From the spectral variation of the emissivity values, we will infer the cloud microphysical properties. This will allow us to study the spatial variability of cloud microphysics and its correlation with the CALIOP information. The Cloud Chord Length (CCL) distribution could also be extracted from the MODIS data. The cloud mask product, associated to the phase function process, helps us to retrieve this parameter.