IRS2012-287-2
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012


# Statistics on CALIOP backscatter profiles in presence of cirrus clouds: application to radiative transfer computations

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A nearly global statistical analysis of vertical backscatter and extinction profiles of cirrus clouds collected by the CALIOP lidar, on-board of the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation, is presented.
Statistics on frequency of occurrence and distribution of bulk properties of cirrus clouds in general and of horizontally homogeneous (on a 5-km field of view) cirrus clouds only are provided. Annual and seasonal backscatter profiles (BSP) are computed for the horizontally homogeneous cirri. Differences found in the day/night cases and for midlatitudes and tropics are studied in terms of the mean physical parameters of the clouds from which they are derived.
The relationship between cloud physical parameters (optical depth, geometrical thickness and temperature) and the shape of the BSP is investigated. It is found that cloud geometrical thickness is the main parameter affecting the shape of the mean CALIOP BSP. Specifically, cirrus clouds with small geometrical thicknesses show a maximum in mean BSP curve located near cloud top. As the cloud geometrical thickness increases the BSP maximum shifts towards cloud base. Cloud optical depth and temperature have smaller effects on the shape of the CALIOP BSPs. In general a slight increase in the BSP maximum is observed as cloud temperature and optical depth increase.
In order to fit mean BSPs, as functions of geometrical thickness and position within the cloud layer, polynomial functions are provided. The impact on satellite radiative transfer forward simulations in the infrared spectrum when using either a constant ice-content (IWC) along the cloud vertical dimension or an IWC profile derived from the BSP fitting functions is evaluated. It is, in fact, demonstrated that, under realistic hypotheses, the mean BSP is linearly proportional to the IWC profile.
The impact of the CALIOP derived IWC statistical profiles on cloud microphysical and optical properties retrievals based on high spectral infrared measurements provided by AIRS (Atmospheric InfraRed Sounder) are evaluated. CALIOP and MODIS (Moderate Resolution Imaging Spectroradiometer) data are also used to improve the quality of the retrievals. For this purpose a database of collocated AIRS, CALIPSO and MODIS data is developed. The database also includes NCEP-GDAS reanalysis data.