Geophysical Research Abstracts
Vol. 12, EGU2010-5070-2, 2010
EGU General Assembly 2010

Microphysical properties of semi-transparent cirrus from AIRS

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Cirrus covers about 30% of the globe and has been identified as one of the most influential atmospheric components on the Earth's radiative budget. In order to improve the parameterization of cirrus clouds within GCMs, modellers need long term records of cloud properties. Due to their complex microphysical characteristics (consisting of non-spherical ice crystals of various shapes and sizes) their physical and radiative properties are still not completely understood.

Because of its high spectral resolution, the Atmospheric InfraRed Sounder (AIRS) onboard the NASA Aqua satellite is used for the identification of cirrus clouds night and day. AIRS can be easily collocated with the spaceborne lidar CALIOP of the CALIPSO mission and the Cloud Profiling Radar (CPR) of the CloudSat mission, as these instruments are part of the A-Train (a constellation of satellites that share the same orbit). These active instruments deliver accurate information on multi-layered clouds and geometrical cirrus thickness. We take advantage of the synergy between these passive and active remote sensing instruments to design a microphysical property retrieval for semi-transparent ice clouds.

A subset of 17 channels between 8 and 12.5 micron has been selected in order to retrieve the effective diameter (De) and the ice water path (IWP) of the cirrus. The retrieval of De is based on spectral differences of cirrus emissivities. Relationships are complex and non-linear. Therefore we simulate these emissivities for a large range of values for De and IWP and for two ice crystal shapes (randomly oriented columns and aggregates). Ice crystal single scattering properties have been integrated over a bimodal size distribution and have been implemented into the 4A radiative transfer model coupled with Disort (taking into account multiple scattering) to generate look up tables that link these emissivities to the microphysical properties.

We only consider clouds with temperatures less than 260 K and pressures below 440 hPa to ensure ice clouds. Since IR retrieval methods are based on spectral differences, we focus on semi-transparent cirrus with emissivities between 0.3 and 0.85. We also reject cases with ice surfaces.

In this study, we present a time series containing global microphysical cloud properties derived from AIRS for 6 years, from 2003 to 2008. A sensibility study is led over the key parameters and the stability, and the validity of the method is confronted with results obtained from other satellite retrievals. We also explore differences between single-layer and multi-layer clouds in combination with CALIPSO.