IRS2012-495
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

Long Term Analysis of Cirrus Clouds Effects on Shortwave and Longwave Radiations derived from the data taken by Ground-based and Satellite-born Observations

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Cirrus clouds play an important role in the radiative forcing on the Earth's climate (Liou 1986; Schlimme et al. 2005). Cirrus clouds affect climate in two opposite ways such as reflecting sunlight, i.e. the albedo effect, and absorbing terrestrial radiation, i.e. the greenhouse effect. The balance between these two processes determines the net impact of cirrus clouds. Therefore, the cloud radiative forcing (CRF) is a very important parameter to quantify the impact of cirrus clouds (Chen et al. 2000; Chylek and Wong 1998). The radiative effect of cirrus clouds is particularly ambiguous in these kinds of research. Cirrus clouds exist in a very high altitude with ice cloud particles that are almost transparent to solar radiation despite the fact that some extent of infrared radiation from the Earth is absorbed according to their microphysical properties. Therefore, they are thought to have a warming effect on the climate of the Earth (IPCC 2007).

We have been performing radiative budget measurements at a ground-based observatory located at Fukue Island (32.752N, 128.682E), Japan. In this study, we analyzed the data from radiometers installed in the observatory and the infrared data observed by the geostationary satellite, MTSAT (Multi-functional Transport Satellite) to evaluate energetic budgets via radiation within cloud-atmosphere system.

In this study, we used ground-based data obtained from a Kip & Zonen CM21 pyranometer and a Kip & Zonen CG4 pyrgeometer. The lidar data was provided by the NIES (the National Institute for Environmental Studies). This lidar system was developed by the NIES with wavelengths of 532 nm and 1,064 nm and with a depolarization measurement capability at 532 nm. The all-sky photographs were taken by a PREDE Sky View camera.

The both short and long wave flux data are obtained per minute, and the MTSAT takes an image per hour, then we average the flux data to be coincident with the MTSAT image. The lidar takes its data per fifteen minutes, therefore they are also averaged to be one hour resolution.

We use the split window method (Inoue, 1985; 1987; 1989, Katagiri and Nakajima, 2004) to discriminate the existence of cirrus clouds above the ground site for one year, and calculated shortwave and longwave fluxes from bottom to top of the atmosphere. These results can yield how much energy the atmosphere absorbs therefore how much heating occurs in the atmosphere. For this estimation, we used the radiative transfer model "rstar" of OpenCLASTR for radiative flux calculation (Nakajima and Tanaka 1986, 1988) with the LOWTRN-7 gas absorption model (Kneizys et al. 1988).

All through this study, we will estimate the long term fluctuation of the radiative effects yielded by the existence of cirrus clouds.