IRS2012-568
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

A stochastic approach for representing small-scale cloud effects in radiative transfer

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Detailed geometry and structure of cloud fields cannot be resolved by large scale models despite of the important roles they play in precipitation and radiative transfer processes. To improve the situation, we have developed a system of equations that can be used to describe statistical characteristics of the radiation field in three-dimensional (3D) cloudy atmosphere. These stochastic equations are closed using Probability Density Functions (PDFs) and two-point spatial correlation functions of cloud condensate. The stochastic radiative transfer approach has the following features: (1) It is a one-dimensional approach designed to capture most of the 3D effects; (2) Cloud overlap in any direction and cloud internal variation are treated consistently through spatial correlation functions and cloud PDFs; (3) Radiative heating/cooling in clear and cloudy regions can be readily obtained. The calculated fluxes using the stochastic approach in general agrees well with those from 3D Monte Carlo simulations.