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Droplet growth process of clouds observed from satellites: Recent progress and future observation plan

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The IPCC 4th assessment report pointed out that aerosols, clouds, and their interaction processes present large uncertainties in climate change predictions. In fact, many sensors aboard satellites, aircrafts, and ground segments have been developed in the past thirty years, and many datasets have been obtained from these observation systems. One of the features of recent existing and/or planning missions is installations of some active sensors such as radar and lidar that enable us to observe the vertical structure of cloud and aerosol. These observation systems are developed for the purpose of revealing global scale distribution of aerosols and clouds and the mechanism of particle transition, from cloud condensation nuclei (CCN) to rain droplets, by estimating the vertical structure of aerosol, cloud, and rain properties from space. For example, spaceborne cloud profiling radar (CPR) reflectivities by CloudSat classified by cloud droplet radii obtained from a passive imager (MODIS) show transition of cloud growth, from cloud droplet mode to rain mode via drizzle mode very clearly (Nakajima et al. 2010, Suzuki et al., 2010). We plan to have more earth observing satellites in the next decade. For example, the EarthCARE satellite which equips cloud profiling radar (CPR) with Doppler capability, high-spectral resolution lidar (ATLID), multispectral imager (MSI), and broad band radiometer (BBR) will follow the CloudSat / CALIPSO missions from middle 2010-era. Moreover, the Second-generation Global Imager (SGLI) aboard the GCOM-C satellite will start observing global distribution of clouds and aerosols over land and ocean from middle 2010-era. In the next decade, we demand more accurate observation results with high consistency between observations and model simulations, so that the collaborative work between observations and models become important. For example, cloud droplet evolution process simulated from global and cloud-resolving models were compared with that obtained from satellite measurements in order to examine accuracy of model-simulated cloud process (Suzuki et al. 2011, in revision). In this presentation, we will talk about the recent progresses of the cloud observations from A-Train, showing multi-sensor views (CloudSat and MODIS) of cloud droplet growth process, and comparison between observations / models. We will also introduce an idea for observing the time-line of the cloud evolution process using the third generation geostationary satellites, e.g. Himawari (Japan), GOES (US), Meteosat (Europe), that enable global scale multispectral imaging by every 10 minutes or more frequently. Both polar orbit and geo-stationary satellites are key observation systems for better understanding of our climate.