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Investigation of the cloud evolution process using the 3rd generation satellite system: research plan

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In the latter part of 2010-era, the 3rd generation satellite system will start operation and contribute revealing uncertainty in climate change study. Some satellites are in polar orbit and some in geostationary orbit. Among them, we focus on the EarthCARE, the GCOM, the A-Train (now in orbit), and some 3rd generation geostationary weather satellites in terms of comprehensive observations of the cloud evolution process; from cloud condensation nuclei (CCN) mode to rain mode, by investigating global state analysis of aerosol/cloud properties and by time-line tracking of the cloud evolution.

Since clouds exert an important influence on the planet's water and energy balances and processes, the better understanding of cloud growth process is strongly required. One of the features of recent satellite missions is installation of active sensors such as cloud radar and lidar that enable us observing the vertical structure of cloud and aerosol layers. The CloudSat and the CALIPSO observations represent a new epoch in earth observations with the purpose of revealing the particle transition, from CCN to rain droplets via cloud and drizzle particles. The CFODD (Contoured Frequency by Optical Depth Diagram), a new visualization method of the CloudSat/CPR reflectivities, suggested by Nakajima et al. (2010), Suzuki et al. (2010) show transition of cloud growth, from cloud droplet mode to rain mode via drizzle mode very clearly and monotonically. Moreover, advanced geostationary (GEO) weather satellites, 3rd generation, that will firstly appear in 2015 observe global scale aerosol and cloud system in every 10 minutes or more frequently. The 3rd generation GEO satellites equip imager that has 16 bands from visible to infrared wavelength including some shortwave infrared bands such as 1.6-um, 2.1-um, and 3.9-um that contribute cloud particle size retrievals. Therefore, combined use of polar orbit passive/active sensors and geostationary satellites will reveal details of cloud evolution process via using multi-spectral capability of passive sensors and the vertical sounding capability of active/passive sensors.

In this paper, we are going to show recent progresses of observation of cloud optical and microphysical properties from satellites, showing multi-sensor views of cloud droplet growth process obtained from CloudSat+MODIS, and comparison results between observations and models. We will also introduce our future research plan using coming missions, EarthCARE, GCOM, Himawari (Japanese 3rd generation geostationary satellite), GOES (US), and Meteosat (Europe) etc. Both polar and geostationary satellites are key observation systems for better understanding of our climate.