On the Algorithm to Discriminate Cloud and Precipitation Particle Type from CloudSat and CALIPSO

*Maki Kikuchi[1], Hajime Okamoto[2], Kaori Sato[2], Yuichiro Hagihara[1]

1.Japan Aerospace Exploration Agency/Earth Observation Research Center, 2.Kyushu University/Research Institute for Applied Mechanics

Cloud and precipitation take key role in the climate system. Information on the cloud phase, shape, rain and snow (hereafter, hydrometeor particle type) are important factors that determine the radiative properties of cloud and precipitation. The knowledge of the hydrometeor type is also necessary to retrieve their microphysical properties, such as liquid/ice/rain/snow water content and effective radius. In this study, we first derived the hydrometeor particle type for a cloud profiling radar (CPR) onboard CloudSat and Mie-scattering lidar, Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP), onboard Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO), independently. The CloudSat and CALIPO are in operation since June 2006 and they have accumulated vertical profiles of cloud and precipitation over the globe for ten years. The final synergy hydrometeor particle type was derived by comparing the discrimination results from CloudSat and CALIPSO and registering a type that was most reasonable. The CALIOP algorithm was based on the previous scheme originally developed by Yoshida et al. [2010] and modified by Hirakata et al. [2014]. The CPR algorithm consisted of three main steps: (1) initial type classification by radar reflectivity and European Center for Medium-range Weather Forecasting (ECMWF) temperature; (2) precipitation correction by attenuation corrected surface radar reflectivity; and (3) spatial continuity test. The initial type classification was conducted by selecting a type from a look-up-table of CPR radar reflectivity and ECMWF temperature. The look-up-table was constructed using the cloud particle type discrimination from CALIOP and the precipitation detection by Precipitation Radar (PR) onboard Tropical Rainfall Measuring Mission (TRMM). For each CloudSat bin, an initial type was selected from the look-up-table that corresponded to the observed radar reflectivity and ECMWF temperature. The second step was the precipitation correction. Each profile was determined whether it was a precipitating profile or not by a simple threshold method of attenuation corrected surface radar reflectivity (Haynes et al. [2009]). If the profile was detected as precipitation but the initial classification had been registered as a cloud profile, the initial classification of the lowest hydrometeor classification was corrected to precipitation (and visa-versa). The last step of the CPR algorithm was the spatial continuity test to eliminate spike misclassification. The final CPR-CALIOP synergy scheme classified the hydrometer particles into 7 types: warm water, supercooled water, randomly oriented ice crystals (3D-ice), horizontally oriented plates (2D-plate), mixture of 3D-ice and 2D-plate, rain and snow. Taking the advantage of CPR's capability to penetrate cloud and light precipitation and CALIOP's capability to detect thin clouds, the synergy algorithm derived the global vertically resolved distribution of hydrometeor particle types from thin cirrus clouds to light precipitation.
The hydrometeor particle type algorithm is considered to be applied in upcoming Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) Level 2 Standard Products that will be processed and released from JAXA to observe global and vertical distribution of the hydrometeor particle types.

Keywords: cloud radar, lidar, satellite, cloud observation, precipitation observation

