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Active remote sensing of cloud microphysics

H. Okamoto
Kyushu University, Research Institute for Applied Mechanics, Fukuoka, Japan (okamoto@riam.kyushu-u.ac.jp)

We discuss about recent progresses in analyses of retrieved cloud properties by combined use of cloud profiling radar (CPR) and lidar. We have developed several types of algorithms that can be applied to these active remote sensing data to retrieve cloud microphysics. The active sensors have provided vertically resolved information of cloud microphysics. The retrieved properties include cloud occurrence, cloud particle phase, orientation and microphysics. In the synergetic use of CPR and lidar, we use differences in wavelength dependence of the backscattering properties of ice particles at the lidar and radar wavelength. The differences actually make the retrieval of particle size and ice water content possible, provided that the scattering signatures of ice particles at the wavelengths of CPR and lidar are known. Single scattering properties of ice particles are one of the key elements in the retrieval algorithms. It has been necessary to develop appropriate methods that can take into account the particle shape and the orientation for the analyses of CPR and lidar data.
We have been analyzing the data obtained by the ground based, ship-borne and space-borne active sensors. We show the global analyses of cloud macro-scale and microphysical properties by using the CloudSat and CALIPSO. These active sensors results have been used to evaluate representation of cloud fields in the climate models such as general circulation model. For the purpose we developed a active sensor simulator that can provide the observables of the sensors from the model output. We also discuss about the results of the comparison of observables and retrieved properties between the GCM and the active sensors. We also introduce the EarthCARE mission, related algorithms and its products as extended version of CloudSat and CALIPSO. Current issues and on-going activities in the active remote sensing of clouds are summarized at the end of the presentation.