An assessment of the cloud properties simulated by NICAM using ISCCP, CALIPSO, and CloudSat satellite simulators

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Horizontal and vertical distributions of hydrometeors simulated by global nonhydrostatic atmospheric model with explicit cloud microphysics, NICAM, are evaluated using ISCCP, CALIPSO, and CloudSat satellite datasets. A package of satellite simulators (The CFMIP Observation Simulator Package; COSP) is employed to consistently compare model output with the satellite observations. Qualitatively, the 14 km-mesh NICAM simulation captures basic structures of the high, middle, and low cloud fractions, both horizontally and vertically. In addition, NICAM shows quantitatively a good performance in reproducing CALIPSO low cloud fraction. CloudSat radar reflectivity-height histograms show that NICAM qualitatively simulates cloud development process. CALIPSO data reveals that NICAM overestimates high thin cirrus, which was not clearly found in the comparison using ISCCP dataset. Sensitivity experiments for the high thin cirrus show that threshold of autoconversion from cloud ice to snow, and introduction of a fall process for cloud ice improve reproducibility of both cloud fraction and cloud top height in the upper troposphere. Our results suggest that the use of multiple satellite datasets, especially those based on the active sensors is essential to evaluate and improve global model with explicit cloud microphysics.