Microphysics in the Multi-scale Modeling Systems with unified Physics

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Abstract

In recent years, exponentially increasing computer power has extended Cloud Resolving Model (CRM) integrations from hours to months, the number of computational grid points from less than a thousand to close to ten million. Three-dimensional models are now more prevalent. Much attention is devoted to precipitating cloud systems where the crucial 1-km scales are resolved in horizontal domains as large as 10,000 km in two-dimensions, and 1,000 x 1,000 km2 in three-dimensions. Cloud resolving models now provide statistical information useful for developing more realistic physically based parameterizations for climate models and numerical weather prediction models. It is also expected that NWP and mesoscale model can be run in grid size similar to cloud resolving model through nesting technique.

Recently, a multi-scale modeling system with unified physics was developed at NASA Goddard. It consists of (1) a cloud-resolving model (Goddard Cumulus Ensemble model, GCE model), (2) a regional scale model (a NASA unified weather research and forecast, WRF), (3) a coupled CRM and global model (Goddard Multi-scale Modeling Framework, MMF), and (4) a land modeling system. The same microphysical processes, long and short wave radiative transfer and land processes and the explicit cloud-radiation, and cloud-surface interactive processes are applied in this multi-scale modeling system. This modeling system has been coupled with a multi-satellite simulator to use NASA high-resolution satellite data to identify the strengths and weaknesses of cloud and precipitation processes simulated by the model.

In this talk, the microphysics developments of the multi-scale modeling system will be presented. In particular, the results from using multi-scale modeling system to study the heavy precipitation processes will be presented.