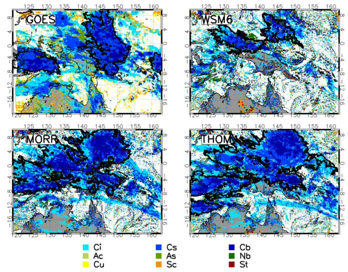
The Role of Microphysics Parameterization in Simulating Tropical Mesoscale Convective Systems

Research Highlight

Progress in the representation of Mesoscale Convective Systems (MCS) within cloud-resolving models can only be achieved if the physical reasons for discrepancies between different models are truly understood.

Department of Energy scientists at Brookhaven National Laboratory and collaborators performed simulations at high resolution (4 km) over a large Tropical Western Pacific (TWP) domain. Simulations employed three commonly used microphysics parameterizations with varying complexity and evaluated them against satellite-retrieved cloud properties. An MCS identification and tracking algorithm was applied to the observations and the simulations. Different from many previous studies, these large individual cloud systems could be tracked over large distances due to the large domain employed.

The analysis demonstrates that MCS simulations are very sensitive to the parameterization of microphysical processes. The most crucial element was found to be the fall velocity of frozen condensate. Differences in this fall velocity between the different simulations were more related to differences in particle number concentrations than to the fall speed parameterization. Microphysics schemes with slow sedimentation rates for ice aloft experienced a larger buildup of condensate in the upper troposphere, leading to more numerous and/or larger MCSs with larger anvils. Mean surface precipitation was found to be overestimated and insensitive to the microphysical schemes employed in this study. In terms of the investigated properties, the performances of two-moment schemes were not superior to the simpler one-moment schemes, since explicit prediction of number concentration does not necessarily improve processes such as ice nucleation, the aggregation of ice-crystals into snowflakes, and their sedimentation characteristics.



The spatial distribution of cloud types at 3 UTC on 27 December 2003 as observed by GOES-9 and as simulated by the three commonly used microphysics schemes (WRF Single-Moment 6-Class Microphysics Scheme [WSM6], Morrison [MORR], and Thompson [Thom]). Cloud types, defined based on the International Satellite Cloud Climatology Project classification technique, are: cirrus (Ci), cirrostratus (Cs), cumulonimbus (Cb), altocumulus (Ac), altostratus (As), nimbostratus (Nb), cumulus (Cu), stratocumulus (Sc) and stratus (St). Land masses are grey. Thick black contours denote identified MCSs.

Reference(s)

Van Weverberg K, AM Vogelmann, W Lin, EP Luke, AT Cialella, P Minnis, MM Khaiyer, ER Boer, and MP Jensen. 2013. "The role of cloud microphysics parameterization in the simulation of mesoscale convective system clouds and precipitation in the Tropical Western Pacific." Journal of the Atmospheric Sciences, 70(4), doi:10.1175/JAS-D-12-0104.1.

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Cloud Life Cycle