Dr. Kuan-Man Xu
Science Directorate
NASA Langley Research Center
Mail Stop 420
Hampton, VA 23681
Tel: 757 864-8564
Fax: 757 864-7996
Email: Kuan-Man.Xu@nasa.gov

Cloud-resolving Model Simulation of Tropical Deep Convective Systems Observed During 1998 El Niño

Kuan-Man Xu[1] and Yali Luo[2]

[1] NASA Langley Research Center, USA
[2] National Institute of Aerospace, Hampton, VA; USA

Cloud-resolving model (CRM) simulations are commonly driven by advective forcing data obtained from field experiments such as GATE, TOGA-COARE and ARM. They can also be driven by advective forcing data produced by numerical weather prediction (NWP) models. The former approach is restricted to a limited number of geographic locations while the latter one can be used in a variety of large-scale environmental conditions over many geographic locations and can be matched with satellite-observed cloud systems. By adopting the latter approach, statistical distributions of the simulated cloud properties can be directly compared with those from satellite footprint data. In this study, a total of 330 tropical deep convective cloud objects, each of which is a contiguous patch of satellite footprints, are simulated and their statistical properties are compared with those observed from TRMM satellite over the tropical Pacific during a period of 1998 El Niño. This study will address the following question: can the CRM reproduce the different statistical characteristics among the three size categories of observed cloud objects?

As in simulations with field experiment data, there are two types of uncertainties in simulations driven by NWP data, one type is related to model deficiencies and the other is due to uncertainties in the forcing data. With these in mind, both the CRM results and the observations show consistently larger differences between the large- and small-size categories than between the large- and medium-size, or between the medium- and small-size categories for most cloud parameters such as cloud top height, cloud top temperature, optical depth, OLR and TOA albedo. However, the simulated cloud properties do not change as much with size as observed. This is likely related to the spatial averaging of the forcing data which disaproportionally impact the large-size category and the mismatch in time and in space between NWP modeled and TRMM observed cloud systems for the small- and medium-size categories.

Although there is general agreement in the shapes of the observed and simulated cloud property distributions, each cloud physical property produced by the CRM also exhibits different degrees of disagreement with the observations over different ranges of the property. The simulated cloud tops are generally too high with too low temperatures except for the large-size categoryof March 1998. This is related to the systematic biases of satellite retrievals of these two parameters (3.5 K too warm and 0.5 km too low). Probability densities of TOA albedos for all three size categories are underestimated in the high range and those of cloud optical depth are overestimated at its lowest bin. These disagreements are related to uncertainties in the ice-phase microphysics parameterization and input to the radiation calculation.