# Using a Cloud-Resolving Model to Identify the Role of Aerosols on Clouds and Precipitation

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**Research Highlight**

Anthropogenic sub-micrometer particles (i.e., aerosol particles) and their climate forcing are poorly represented in general circulation models (GCMs). Due to available computational resources, clouds are usually represented in a bulk parameterization in GCMs. Thus, there is a scale gap between aerosol particles and climate change in GCMs. To bridge the scale gap and properly represent the effect of aerosol particles on climate change, two forms of cloud model are employed that represent clouds at different levels of complexity. One form explicitly represents cloud particle size and simulates clouds with sophistical cloud microphysics (called spectral-bin models). The other form represents cloud microphysics in a bulk parameterization with explicit interactions with radiation and the surface, which can provide statistical cloud properties to improve the representation of the cloud processes for GCMs.

A spectral-bin model is used to examine the effect of aerosols on three different deep convective cloud systems that developed in different geographic locations: South Florida, Oklahoma, and the central Pacific. The results (Tao et al. 2007) show that cloud condensation nuclei (CCN), a form of aerosol particle, can change the life cycles of clouds and precipitation (see the case from Tropical Ocean Global Atmosphere-Coupled Ocean Atmosphere Response Experiment in Figure 1). Moreover, the effect of CCN on clouds and precipitation varies with geographic location, where evaporative cooling in the lower troposphere plays an important role.

A cloud-resolving model is used to simulate clouds and precipitation over the South China Sea and the middle Pacific Ocean for over a month (Zeng et al. 2007). The modeled climatic states (called ensemble states) are sensitive to cloud microphysics, especially ice nuclei (IN) number concentration. Since IN particles are a form of aerosol particle and vary greatly in space and time, this study suggests that it is necessary to properly represent IN in GCMs to accurately account for their role in climate change.

These modeling studies reveal the effects of CCN and IN on clouds and precipitation, which suggests that it is necessary for GCMs to properly represent CCN and IN in climate change.

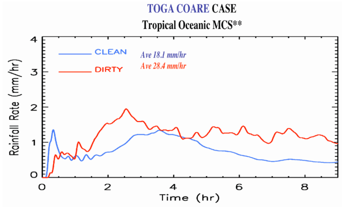


Figure 1. Dirty environment (or high CCN) enhances precipitation in a TOGA-COARE case. Blue and red lines represent the modeled precipitation rate versus time with clean and dirty environments, respectively.

**Reference(s)**

Tao, W.-K., X. Li, A. Khain, T. Matsui, S. Lang, and J. Simpson, 2007: The role of atmospheric aerosol concentration on deep convective precipitation: Cloud-resolving model simulations. J. Geophy. Res., (accepted).
Zeng, X., W.-K. Tao, S. Lang, A. Y. Hou, M. Zhang, and J. Simpson, 2007: On the sensitivity of atmospheric ensemble states to cloud microphyics in long-term cloud-resolving model simulations. J. Meteor. Soc. Jpn., (submitted).

**Working Group(s)**
Aerosol, Cloud Modeling



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