High-cloud property responses to SST change: sensitivity study using a global nonhydrostatic model

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Since it has been recognized that the uncertainty of cloud feedback is one of main contributors to the intermodel spread of climate sensitivity, the reduction of the uncertainties associated with cloud response to global warming has been one of central issues for robust projections and predictions of climate variability and change. High clouds have large impacts on the Earth’s radiative energy budget, and the uncertainty of their response to climate change is known as one of large sources of the climate sensitivity spread although several possible hypotheses to predict the response have been proposed. As the radiation-cloud interaction plays a crucial role in the determination of life time of high clouds, the improvement of the understanding of cloud property responses to global warming helps the reduction of climate-sensitivity variability associated with the high-clouds feedback.

In order to investigate the cloud-property response to climate change, we conducted simulations with RCE configurations using a high-resolution nonhydrostatic global circulation model (the Nonhydrostatic Icosahedral Atmospheric Model; NICAM) with the earth-like sphere for simplifying the problem. Sea surface temperatures (SSTs) are fixed at 300K and 304K and a double-moment bulk scheme are used without cumulus parameterization scheme.

We found that high cloud amount increases with SST increase, as consistent with the previous NICAM studies. It was also determined that the change in particularly optically thin clouds whose optical thicknesses were <3 was dominant, and such thin clouds tended to have large particle sizes. These suggests that the slow evaporative property of ice phase clouds and their representability can play one of key roles in the uncertainty of the high-cloud amount change in global warming.

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