High Cloud Responses to Global Warming Simulated by Two Different Cloud Microphysics Schemes Implemented in the Nonhydrostatic Icosahedral Atmospheric Model (NICAM)

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This study examines cloud responses to global warming using a global nonhydrostatic model with two different cloud microphysics schemes. The cloud microphysics schemes tested here are the single- and double-moment schemes with six water categories: these schemes are referred to as NSW6 and NDW6, respectively. Simulations of one year for NSW6 and one boreal summer for NDW6 are performed using the nonhydrostatic icosahedral atmospheric model with a mesh size of approximately 14 km. NSW6 and NDW6 exhibit similar changes in the visible cloud fraction under conditions of global warming. The longwave (LW) cloud radiative feedbacks in NSW6 and NDW6 are larger than the average LW cloud radiative feedbacks in the Coupled Model Intercomparison Project Phase 5 (CMIP5)/Cloud Feedback Model Intercomparison Project 2 (CFMIP2). The LW cloud radiative feedbacks are mainly attributed to cirrus clouds, which prevail more in the tropics under global warming conditions. For NDW6, the LW cloud radiative feedbacks from cirrus clouds also extend to mid-latitudes. The changes in cirrus clouds and their effects on LW cloud radiative forcing (LWCRF) are assessed based on changes in the effective radii of ice hydrometeors (R_{ei}) and the cloud fraction. We determined that an increase in R_{ei} has a non-negligible impact on LWCRF compared with an increase in cloud fraction.

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