

# High Cloud Annual Variation and Its Responses to Global Warming in the NICAM AMIP Experiment

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Uncertainties in climate sensitivity mainly come from the ambiguities in simulations of both high- and low-level clouds. The previous studies using NICAM's short time simulation showed that the both the altitudes and amount of high clouds increase under the global warming condition, while other climate models show high cloud amount contrarily decreases.

Due to the progress in computer performance, long term climate simulation with  $\Delta x < 20$  km becomes available. A pair of 25-year climate simulation (present and warming climate) with 14-km horizontal resolution (NICAM AMIP-like simulation, Kodama et al. 2015) has been performed by K computer. In this study, we analyze how the annual variation in high clouds is presented in the NICAM AMIP-like simulation. Satellite and in-situ data are used to investigate whether NICAM captures the observed responses of high clouds to the mean sea surface temperature (SST). Regressions between the high cloud amount variation and the SST variation is different with altitudes; positive regressions appear at altitudes above 100 hPa while negative regressions are found in altitudes below 100 hPa. The results are consistent with previous study based on observations (Zelinka and Hartmann 2011). Further analysis showed that the spatial pattern of high clouds is mainly associated with the El Nino response; as SST warmer, the high clouds shift in the eastern Pacific with higher. The increase of high clouds is associated with the increase of ice water content of cloud ice and snow. We argue that the response of high clouds to global warming is also explained by the change in the spatial distribution of the high clouds.

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