Stable isotopes in precipitation and water vapor simulated by isotope-incorporated NICAM

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The stable water isotopes (SWIs) ($\delta^{18}O$ and $\deltaD$) are used as an indicator of the intensity of the atmospheric hydrological cycle due to their large variability in time and space. Although data about vapor isotope ratio with high frequency and high resolution are now available by satellite observations and spectroscopic analyses, there is some room for discussion on the variability of isotope ratios in vapor and precipitation related to cloud microphysical processes.

Here, we incorporated SWI tracer into the latest version of a global cloud system resolving model (the Nonhydrostatic Icosahedral Atmospheric Model (NICAM)), iso-NICAM, and investigated the contribution of cloud microphysical processes to the variability of isotope ratios in precipitation and vapor. One of the merits used NICAM is that its physical process can cover from low spatial resolution to high spatial resolution. We conducted two mode simulations (GCM and CRM). The GCM mode simulation is based on the Arakawa-Schubert scheme as convective parameterization and a large-scale condensation scheme as the cloud physical process. In contrast, the CRM mode simulation is based on the a single-moment bulk cloud microphysics scheme with 6 water categories as cloud microphysical scheme, convective parameterization scheme was not used. These simulations are set to about 223 km of horizontal mesh resolution and 78 vertical layers. We conducted an AMIP-type climate experiment for one year from 1979.

The simulated precipitation $\delta^{18}O$ showed the latitude effect pattern (high $\delta^{18}O$ in low latitude region, low $\delta^{18}O$ in high latitude region), but those values in the CRM mode was slightly lower than that in the GCM mode . The simulated precipitation $\delta^{18}O$ in the CRM mode was lower in high altitude or inland regions compared with those in the GCM mode . Besides, the precipitation d-excess in the CRM mode shows large spatial variability compared with the GCM mode. Although the low spatial resolution was set in this study, these simulations indicated cloud microphysical processes are important for understanding the variability of isotope physics. We will conduct these simulations with finer spatial resolution and a more extended simulation period.