

Stable water isotope behavior associated with the Baiu front simulated by NICAM-isotope

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Stable water isotopes (SWI) are an observable water tracer that reflects integrated history of phase change and mixing. SWI are exploited not only for climate proxy (e.g. Dansgaard, 1993) but for studying precipitation systems.

The Baiu Front (BF) is a stationary front during the late spring and early summer near Japan, which is the “boundary” between tropical and extratropical air mass. BF is characterized by a large gradient of SWI as well as equivalent potential temperature. To study BF from the viewpoint of SWI, it is expected to improve our understanding about the water cycle associated with the front.

From an observational study by Kurita et al. (2015), the highest isotope ratio in water vapor near the surface corresponds to the warm air mass advection by southerly flow, while abrupt isotopic depletion corresponds to cold air advection associated with southward migration of BF. Rainfall results in isotopic depletion of water vapor since heavy isotopologues (HDO) preferentially condensate and are taken away from water vapor by rainout. In this study, we attempt to quantify the effect of water vapor (air mass) advection and depletion by rainout on isotopic variability associated with the BF.

We developed an isotope-incorporated microphysics scheme based on NSW6 (Tomita, 2008), which is a version of the microphysics scheme by Lin et al. (1983). We simulate the isotopic behavior associated with BF using this scheme on the global cloud-resolving model NICAM (Satoh et al. 2008; 2014).

To check the validity of our isotope-incorporated model, simulated values in our model are compared with observation at a paddy field in Tsukuba, Japan (Wei et al. 2015; 2016). Although there is some discrepancy between the observation and our simulation, our model successfully reproduced ascending/descending timing of dD.

From composite analysis against precipitation intensity by BF, the dD contrast between north and south of BF reflects air mass difference in the case with weak precipitation, which is consistent with Kurita et al. (2015). On the other hand, the heavy precipitation case is almost the same with the weak precipitation case except for “V-shape” depletion near the BF region. This result is consistent with the temporal V-shape change in isotope ratio of precipitation associated with front passing (e.g. Celle-Jeanton et al. 2004).

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