An analysis of the atmospheric circulation around the Tibetan Plateau revealed by the stable isotope in precipitation—A case study of GEWEX-GAME/Tibet in 1998

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Data of stable isotopes obtained from glaciers and tree rings on the Tibetan Plateau are useful in restricting the paleoclimate. It is important to meteorologically analyze stable isotopes in precipitation over the Tibetan Plateau, which are affected by complicated atmospheric circulation processes, because the ratio of stable isotopes in precipitation based on the transport process is affected by atmospheric circulation. However, this approach has not yet been well implemented.
Data of temporally and spatially stable isotopes in precipitation were obtained over the Tibetan Plateau and Nepal during a field campaign of the Global Energy and Water Experiment Asian Monsoon Experiment/Tibet in 1998. The data reveal a relationship between stable isotopes in precipitation over the Tibetan Plateau and active/break variations of the Indian monsoon.
During a break phase, low $\delta^{18}O$ values and low d-excess values were observed at all observational sites. Transportation in this phase was an upslope process in which an air parcel gains altitude near the Himalayas. This trend can be explained by air parcels crossing over the Himalayas.
During an active phase, a characteristic trend of stable isotopes in precipitation over Tibetan Plateau was observed. Low $\delta^{18}O$ and low d-excess values were observed around the south of the Tibetan Plateau (hereinafter called region 1) while high $\delta^{18}O$ and high d-excess values were observed around the north of the Tibetan Plateau (hereinafter called region 2). The phase of region 1 coincided with the break phase, and transport might be an upslope process. However, the phase of region 2 was different because of the inland effect. To interpret the high $\delta^{18}O$ values, we used the forward trajectory from convective cloud over central India, and examined the top height of convective cloud around region 2 over the Tibetan Plateau using measurements made by the precipitation radar onboard the Tropical Rainfall Measuring Mission satellite. Results showed that air parcels at an altitude exceeding 8,000 m in convective cloud around central India were transported to the Tibetan Plateau, and high $\delta^{18}O$ values between 8,000 and 10,000 m in convective cloud around central India might be associated with precipitation around region 2 over the Tibetan Plateau.
To interpret the characteristics of stable isotopes in precipitation around the Tibetan Plateau, it is important to consider the active/break phase and trajectory of air parcels of the Indian monsoon. Clarifying the vertical distribution of stable isotopes in precipitation in convective cloud can improve our knowledge of the paleoclimate and help determine an isotope model in future work.

Keywords: stable isotope in precipitation, the Tibetan Plateau, atomospheric circulation

