Characteristics of Stable Hydrogen and Oxygen Isotopes in Precipitation over the Jiaolai Plain, and its Water Vapor Sources

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Abstract

Precipitation is the sole input of regional water resources in mountainous or hilly areas that are not traversed by large rivers. A prerequisite for using isotopic techniques to study the regional water cycle of a mountainous area is to examine the stable isotopic composition of its precipitation. The findings are of great significance for in-depth understanding of the water-cycle processes. In this study, each event of precipitation was sampled and used to investigate the characteristics of stable hydrogen and oxygen isotopes (δ2H and δ18O, respectively) in precipitation on the Jiaolai Plain and its surrounding areas. NCEP/NCAR data was used for the wind speed and direction, relative humidity, and precipitable amount in the study area during the sampling period. The water vapor sources of precipitation over the plain were revealed through a comparative analysis of seasonal variations in precipitation isotopes, between the Global Network of Isotopes in Precipitation (GNIP) stations located along different vapor transport paths. The results showed that the local meteoric water line (LMWL) was $\delta 2H = 6.38\ \delta 18O + 0.72$, with a gradient less than 8. This indicated that the precipitation process was affected by non-equilibrium evaporation occurred when the drops fell below the cloud base. Significant temperature and amount effects existed in the δ18O of precipitation, although the altitude effect was not significant. The water vapor source of the precipitation was controlled predominantly by the East Asian Monsoon from June to September, with the main source being evaporation from the adjacent Pacific Ocean. The plain was controlled by Westerlies from October through May, with the predominant vapor source being local evaporation. Water vapor from the polar region had minimal impact. During the sampling period, water vapor brought by Typhoon Lekima produced heavy precipitation on the plain. There was a significant depletion of δ18O in the precipitation at that time, indicating the existence of the cloud–rain zonal effect. These findings can serve as the basis for studying surface water–groundwater–seawater transformation.

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