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Isotope characteristic of rain water and atmospheric vapor in Hiratsuka, Japan

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Introduction

The stable isotope ratios of hydrogen and oxygen in meteoric water (δD and δ^{18}O) are affected by geological and climatic conditions. Global meteoric water line (GMWL) describes the average isotopic compositions in the world. According to Craig (1961), the relationship between δD and δ^{18}O was expressed as

$\delta D=8\delta^{18}O+10$ (1)

However those intercept are not always 10 in each area. In Japan, the meteoric water originates in both Pacific Ocean and Japan Sea. The effects of two seas vary due seasonally. The isotope ratio of atmospheric vapor is important for study of atmospheric circulation, however, the number of published paper is not so much. In this study, we investigate the d-excess ($d=\delta D -8\delta^{18}O$) of rain water and atmospheric vapor in Hiratsuka, Japan.

Sampling methods

Samples were collected on the roof of a No.17 building at Shonan campus, Tokai University from May to December 2013. Rain water samples were collected based on a method described by Negrel et al. (2011) and Yoshimura (2002). The collection duration was days or hours in scale. Rain water samples were percolated through 0.2 μm filter, and kept into a 100 ml low-density polyethylene bottle. Atmospheric vapor samples were collected through a trap cooled with ethanol and dry ice mixture. Samples were 42 of rain water and 11 of atmospheric vapor. δD and δ^{18}O of samples were measured by a Cavity Ring-Down Spectrometer analyzer (model L2120-I from PICARRO). Some data of rain water, which were sampled several times in a day, were processed to be the average value.

Results and discussion

Rain water shows a wide variation in δD and δ^{18}O from -86.4 to +6.2 ‰ and -12.6 to -2.6 ‰, respectively. Atmospheric vapor shows a variation from -223.5 to -98.6 ‰ and -31.2 to -14.7 ‰, respectively. The δD-δ^{18}O relationship of rain water gives a regression line: $\delta D=9.2\delta^{18}O+24.0$ ($R^2=0.95$) and that of atmospheric vapor gives a regression line: $\delta D=7.3\delta^{18}O+7.9$ ($R^2=0.96$). The d-excess values show a variation from 4.4 ‰ to 33.2 ‰. In Japan, origin of meteoric water affects to d-excess (Waseda and Nakai, 1983). In case of Pacific Ocean, d-excess is low ($10\geq d$). In case of Japan Sea, d-excess is high ($20\leq d$). In this study, the d-excess was low in summer when southern winds were blown from Pacific Ocean as the seasonal wind, and that value was high in winter when northern winds were blown from Japan Sea. Samples of atmospheric vapor show also this trend. Suggesting that atmospheric vapor is influenced by the same effect of meteoric water. The meteoric water line of rain samples was affected by d-excess which reflects variations of moisture sources, which is the reason why the slope of this line would be bigger than GMWL.

Keywords: rain water, isotope