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Stable isotope ratios in precipitation and their relationship with meteorological conditions in the Kumaon Himalayas, India"

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ABSTRACT

For the first time, environmental isotopic (δ^2H, $\delta^{18}O$, ^3H) data, predominantly based on precipitation samples in the Kumaon Himalayas, India, have been used to understand the influence of various meteorological factors governing rainout processes in the region. Further, the data are also used to understand the orographic effects in precipitation and to estimate the altitude effect in stable isotopic ratios in precipitation, etc.

The interpretation of the isotopic data revealed that the source of moisture for winter (October–February) and summer (May) precipitation in the Kumaon Himalayas is mainly from the Western Disturbances whereas for the remaining period the source is monsoonal (southwest). The δ^2H–$\delta^{18}O$ relationship in the local precipitation during the monsoon season shows a distinct seasonal effect, with a slope of 7.6. The winter and summer precipitation samples measured higher environmental ^3H compared to southwest monsoon samples, thus indicating continental evaporated moisture. There is wide range of altitude effects ($\delta^{18}O$ variation per 100 m elevation: −0.30‰ [July–August]; −0.57‰ [September]) with the mean altitude effect being −2.61‰ and −0.36‰ per 100 m elevation for δ^2H and $\delta^{18}O$ respectively. These values are different from that reported earlier for the region based on the isotopic compositions of springs/rivers samples. The 'altitude effect' in successive precipitation is basically a temperature dependent phenomenon and is explained on the basis of adiabatic cooling related rainout process (dry adiabatic lapse rate, moist adiabatic lapse rate and saturated adiabatic lapse rate for moist air mass). The altitude effect is found to be more reliable in case of δ^2H, as deuterium is least affected by secondary evaporation. The effect of secondary evaporation has been observed on the true "altitude effect". Secondary evaporation of rainfall increases the oxygen isotopic ratios and the increase is directly proportional to the vertical distance travelled by the raindrops through air.