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A two-year record of stable isotope characteristics of monthly rainfall at the Douala and Yaounde urban cities, Cameroon

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The stable isotopes of oxygen (^{18}O) and hydrogen (^{2}H) in precipitation are useful tools in environmental studies including hydrological and climatological investigations. Like in most of tropical Africa, stable isotope data of rainfall is regrettably limited in Cameroon. As a contribution to desired data, 43 monthly rainfall samples have been collected from January 2013 to December 2014 in the urban cities of Douala and Yaounde (in the tropical evergreen forest of Cameroon). The objectives were to produce local meteoric water lines (LMWLs), define the spatial and temporal variations of the stable isotopes and controlling factors. The conventional delta (δ) ^{18}O-δ^{2}H diagram for the two-year data gave the regression lines: δ^{2}H= 7.92δ^{18}O + 12.99 (R^{2}=0.97) and δ^{2}H = 8.35δ^{18}O +15.29 (R^{2}= 0.99) for Douala and Yaounde, respectively. These lines represent the LMWLs for the two cities. The similarity of slopes to the Global Meteoric Water Line (GMWL) of 8 indicates that rain formation processes in both areas occurred under conditions close to isotopic equilibrium with insignificant evaporation effect during precipitation. Douala precipitation showed a wide range of δ^{18}O from -5.22 to -0.75 ‰, mean of -2.71 ‰ (2013); and -5.26 to -1.28 ‰, average of -3.09 ‰ (2014). A similar range was observed in Yaounde for δ^{18}O from -5.20 to 1.81 ‰, mean of -2.49 ‰ (2013); and -5.86 to -0.66 ‰, average of -3.37 ‰ (2014). The large range suggests varied controls on precipitation in both localities. Despite the closeness of the Douala sampling point to the Atlantic Ocean (35 km), the weighted mean d-excess value of 13.12 ‰ was higher relative to 10 ‰ of the Atlantic moisture. Further inland in Yaounde (191 km), a relatively higher weighted mean d-excess value (14.55 ‰) was also observed. The high d-excess values in both cities reflect an addition of recycled continental moisture to precipitation. The additional moisture is likely from the evergreen rainforest and a network of rivers in the areas. Weighted mean δ^{18}O and δ^{2}H values for the sampling period were -3.27 ‰ and -13.01 ‰, and -3.07 ‰ and -10.04 ‰ in Douala and Yaounde, respectively. The slight increase in weighted mean δ values from Douala to inland Yaounde reflects a lack of continental effect probably due to the additional supply of inland recycled moisture to rain. Monthly weighted mean δ values showed a definite seasonal variability in both areas. Isotopically enriched and depleted values were observed during the pre- and post-monsoon low rainfall and heavy monsoon rains, respectively, in agreement with the amount effect of tropical low latitude rains. This effect is probably controlled by northward and southward oscillation of the Intertropical Convergent Zone and associated air masses. The δ^{18}O and δ^{2}H of rainfall in the tropical cities of Douala and Yaounde show a similar temporal variability that is mainly controlled by the addition of inland recycled moisture and amount effect. The generated isotope data and LMWLs can be used as tools for groundwater recharge and atmospheric moisture circulation studies in the region.

キーワード: Stable isotope variation, Local meteoric water line, Amount effect, Moisture recycling, Douala-Yaounde, Cameroon
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