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How the Pyrenees influence the δ18O and δD compositions of rain and rivers?

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Documenting Earth surface past elevation is critical to understand the dynamics of collisional domains and to investigate tectonics vs. climate interactions and their relative influence on erosion and sedimentation. Topography exerts a direct control on precipitation and it is possible to determine the paleoelevation of a mountain range from analyses of minerals created from paleorainfall, because the isotopic composition of rain (δ18O & δD) decreases with elevation. Topography modifies the patterns of atmospheric circulation and thus the local isotopic lapse rate and the resulting isotope-in-precipitation patterns at high elevation. Thus, before reconstructing paleoelevation, the local modern isotope lapse rate has to be documented to quantify the amount of orographic effect on precipitation and get a first-order understanding of the interactions of topography and rainfall in the study area.
Here, we characterize the modern isotope lapse rate in the Pyrenees, a well-know collisional orogen, which is a privileged area for paleotopographic investigations. It presents the advantage to be a small orogen, with mean maximum elevation of $\sim$3000 m, which allows for a reliable and large sampling. We sampled streams and creeks from small catchments that integrate near-surface runoff (i.e. precipitation) over months to years and hence provide a time-averaged signal of elevation. We collected 100 samples in 9 different valleys from N and S Pyrenees during the dry season (August and July), because it is the period during which groundwater, which is comprised by a mixture of rainfall of the annual cycle, dominates the stream water budget. Results reveal a good correlation of δ18O vs. δD values and mean δ18O and δD altitudinal gradients of -3.6‰ and -29‰ /km respectively. Distinct areas can be distinguished over the range according to their isotopic features. In particular, the southern Pyrenees exhibit lowers ratios than the north, suggesting an orographic effect of the range on the precipitations. The northern Pyrenees can also be divided in three distinct isotopic provinces from west to east due to different moisture sources from the Atlantic Ocean and the Mediterranean Sea and continentality effect.