Spatial variability of rainwater stable isotopic composition (δ18O and δ2H) over the French territory

Emmanuelle Petelet-Giraud, Romain Millot, Catherine Guerrot, Philippe Négrel

Abstract Template

Spatial variability of rainwater stable isotopic composition ($\delta^{18}O$ and $\delta^{2}H$) over the French territory

Emmanuelle Petelet-Giraud, Romain Millot, Catherine Guerrot, and Philippe Négrel
BRGM, Metrology Monitoring Analysis Department, Orléans, France
(e.petelet@brgm.fr)

Regarding isotopic hydrogeology, one important step for characterizing an aquifer is to compare the stable isotope signature of local rainwater with that of groundwater, which should reflect the mean weighted value of recharge by the successive rain events. Thus, considering that rainwater constitutes the main input into a hydrogeological system, the knowledge of the spatial variability of rainwater isotopic composition appears to be essential for hydrogeological investigations as well as for achieving sustainable water management.
Five stations over France were monitored monthly for the $\delta^{18}O$ and $\delta^{2}H$ atmospheric signal (Brest, Dax, Orléans, Avignon and Thonon). They constitute the French monitoring network which is part of the IAEA/IOW Global Network for Isotopes in Précipitation (GNIP ; http://www-naweb.iaea.org/napc/ih/IHS_resources_gnip.html and log to WISER) for isotopes of the water molecule. Other rain data originate from the BDISO databank, gathering isotopic data available on French groundwaters, surface waters and rainwater (http://infoterre.brgm.fr/). They often represent only a few months of monitoring and do not refer to the same periods, as they stem from dedicated studies of local aquifers by the five French laboratories involved in BDISO (BRGM in Orléans, University of Paris-Sud in Orsay, University of Avignon, Centre de Recherches Géodynamiques in Thonon-les-Bains and CEA in Saclay). Among the available data, data points were selected applying the following criteria: (1) at least one year of monitoring should be avaliable, (2) isotopic data should be associated to the rain amount, (3) when two points are close, only the longest and more recent series of measurements are chosen. A total of 44 rain chronicles were selected. Some regions are poorly documented and complementary data were gathered: (1) lakes, that can be considered as natural pluviometers under specific conditions (upper part of watershed to limit runoff, pristine environment), are used after correction for evaporation, (2) young groundwaters were used as they often represent long term rainfall reasonably well, (3) landsnail shells integrating over the lifetime of the animal. Finally, to better constrain the isotopic signature near the borders of the French territory, we selected some data from the bibliography or long term rain monitoring in the GNIP database in the neighboring countries.
The contour maps of $\delta^{18}O$ and $\delta^{2}H$ values reflect well the main effects that are known to affect the isotopic signature of precipitations; the continental and altitude effects are clearly visible. These maps constitute unique tools to assess the stable isotopic signature of oxygen and hydrogen in aquifer recharge. Nevertheless, it is worth noting that frequently rainwater data are used which integrate only over one year of precipitations and it was evidenced that the mean annual weighted $\delta^{18}O$ values may vary by 1 to 2‰. Under these conditions our maps can constitute good complements to a local rain monitoring when studying a specific aquifer.