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Map of rainwater stable isotopic composition (O and D) over the French territory: signature of aquifer recharge

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In isotopic hydrogeology, one important step to characterise an aquifer is to compare the stable isotope signature of local rainwater with that of groundwater, which should reflect the mean weighted value of the successive rain inputs. Thus, considering that rainwater constitutes the main input in a hydrogeological system, the knowledge of the spatial variability of rainwater isotopic composition appears to be an essential tool for hydrogeological investigations and also for sustainable water management.

Five stations were monthly monitored for the δ^{18}O and δ^{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) 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. They often represent only a few months of monitoring and do not refer to the same period, as they refer to studies dedicated to the knowledge and functioning of local aquifers from the five French laboratories analysing isotopes on water 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 all the available data, data points were selected with the following criteria: (1) at least one year of monitoring, (2) isotopic data should be associated to the rain amount, (3) when two points are close, only the longest and more recent monitoring is selected. A total of 44 rain data were selected. Some regions are poorly documented and complementary data were selected: (1) lakes considered as natural pluviometers in defined conditions (upper part of watershed to limit runoff, pristine environment), are used after correction from evaporation process. (2) young groundwaters were used as they were demonstrated to be often reasonably representative of long term rainfall. (3) landsnail shell. Finally, and to better constrain the isotopic signature at the limits of the French territory, we selected some data from the bibliography or long term rain monitoring in the GNIP database in the neighbouring countries.

The contour map of δ^{18}O values reflects well the main effects that could affect the isotopic signature of precipitations, the continental and altitude effects are clearly visible. This map constitutes a unique tool to assess the stable isotopic signature of the recharge of the aquifers for oxygen isotopes. Nevertheless, it is worth noting that the rainwater data used often integrate only one year of precipitations and it was evidenced that the mean annual weighted δ^{18}O values may vary from 1 to 2‰: In these conditions this map can constitute a good complement to a local rain monitoring when studying a specific aquifer.