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Characterizing different spring systems in the Berchtesgaden Alps using stable water isotopes

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An extensive sampling campaign was started in January 2012 in the Berchtesgaden Alps located in the southeast of Germany. Monthly samples at 8 springs, 5 stream gauges and bulk samples of precipitation at 7 sites were collected since then. The samples were analyzed for the stable water isotopes oxygen-18 and deuterium. The sampled water systems are characterized by very different dynamics of the stable isotope signatures. Time series of precipitation stable isotope signatures were derived from the GNIP dataset in order to extend the dataset beyond the start of the sampling campaign. Mean residence times (MRT) of the spring systems and surface water streams were calculated using the exponential model and the sine curve approach.
Both approaches yield very similar MRT for the studied water systems. Based on this analysis two groups of spring systems could be identified. One group with relatively short MRT of 1-2 years and another group with longer MRT of about 10-12 years. Those results were consequently discussed and interpreted in the context of a large body of literature existing on the hydrogeology in the Berchtesgaden Alps area. The springs characterized by short MRT are located in geological situations with karstified limestone, dolomite or shell limestone. Previous dye tracer experiments in those areas revealed very efficient drainage systems with fast flowpaths. The spring systems with longer MRT are located in areas with large bodies consisting of quaternary debris and talus material and can be considered as porous aquifers with relatively long flow paths with low flow velocities. The influence of the stable isotope signature and hence the MRT observed at the springs is also reflected in the downstream surface water stable isotope signatures showing the importance of the spring water for river discharge in the study area.
The results of the study provide interesting insights into the different dynamics of spring systems and surface water bodies controlled by the respective geological settings over a relatively small study area in the alpine terrain of the Berchtesgaden Alps.