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Integrating drip-water chemistry and speleothem proxy data in a ventilated cave system, Bärenhöhle, Austria

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Despite speleothems being increasingly recognized as reliable palaeo-environmental archives quantitative reconstructions remain challenging. Experimental studies and modelling efforts represent solid options to address processes controlling speleothem growth but typically face non-linear responses when confronted with natural karst systems. Here, we present results of a 3-year monitoring period from Bärenhöhle, a cave site in western Austria. Artificial dye tracing performed on a rainy day of April 2011 by injecting 100 g of uranine dissolved in 40 l of water over an area of 2000 m^2 confirms that the hydrological transport to the speleothem drip sites takes place within a couple of weeks only. Drip rates, air flow, temperature, CO_2, CH_4, radon and air pressure have been recorded at hourly intervals, whereas drip water was sampled at monthly resolution for chemical and isotopic analyses. Results show a marked seasonality in the drip rate which is controlled by aquifer recharge during the summer half-year. Seasonal fluctuations in drip-water chemistry are additionally modulated by cave air circulation, which depends on the pressure difference between the cave and the external atmosphere. High-resolution analyses of speleothem proxy data, including stable isotopes and trace elements, confirm the transfer of this signal to the stalagmites. Results are being evaluated with respect to changing environmental conditions based on a replicated 500-year speleothem record from Bärenhöhle and compared to available proxy data from the northern Alps.