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A continuous high resolution water isotope dataset to constrain Alpine water balance estimates

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Water delivered from Alpine environments is a crucial resource for many countries around the world. Precipitation accumulated during cold seasons as snowpack or glaciers is often an important source of water during warm (dry) season but also a dominant contributor to the annual water balance. In Switzerland, water from high Alpine, glacier-fed catchments provides a large portion of both the hydroelectric power and water supply. However, large uncertainties regarding changes in glacier volume and snow accumulation can have significant impacts on hydrologic, biologic, physical and economic understanding, modeling, and predictions. Accurately quantifying these water resources is therefore an on-going challenge.

Given the well-known difficulty observing solid precipitation (snowfall), it can be assumed that most of the uncertainty in water balance estimates for snow-dominated environments is due to: 1) Poor measurement of winter precipitation and 2) A poor estimation of timing and amount of snow melt. It is noteworthy that the timing of melt plays a crucial role even for annual water balance estimates since it might significantly influence melt runoff flow paths and thereby groundwater recharge.

We use continuous monitoring of water stable isotopes over the entire annual cycle in an Alpine catchment to shed light on how such observations can constrain water balance estimates. The selected catchment is the experimental Vallon de Nant catchment in the Vaud Alps of Switzerland, where detailed hydrologic observations have recently started in addition to the existing vegetation and soil investigations. The Vallon de Nant (14 km^2, and an altitude ranging from 1200 to 3051 m) is a narrow valley that accumulates large amounts of snow during winter. In spring and summer, the river discharge is mainly supplied by snowmelt, with additional inputs from a small glacier and rainfall. Continuous monitoring of water stable isotopes (δO18 and δD) is combined with measurements of climatic and hydrological parameters to quantify water fluxes. Measurements and sampling in such an environment is challenging and has rarely been done at such a high temporal resolution for a full annual cycle. We will discuss the advantage of our approach for 1) evaluating the dominant hydrological processes and pathways in Alpine environments and 2) for reducing the uncertainties of water resource estimation in Alpine catchments.