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Seasonal compartmentalisation of water in a grassland at 2600 m a.s.l.

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High Alpine catchments are precious water-resources since they act as natural storage reservoirs, storing water in the snow cover and in the subsurface and thereby providing water during the dry seasons. Thus, a deeper knowledge of the hydrological functioning of these systems is necessary, in particular to make climate change projections. The role of seasonality is crucial in these catchments that generally exhibit a snow-dominated hydro-climatic regime.

Here we use high-frequency observations of stable isotopes of water to identify the seasonal origin of streamwater in a high-elevation Alpine catchment located in the Valle d'Aosta Region, Italy. We quantify the relative contribution of winter and summer precipitation reaching the stream through the Seasonal Origin Index (SOI_Q), calculated using the $\delta^{18}O$ values and the volumes of precipitation and streamflow. Highly negative SOI_Q values are obtained suggesting that streamwater is mainly composed of winter precipitation. Conversely, the Seasonal Origin Index for evapotranspiration (SOI_{ET}), which can be directly inferred from SOI_Q, returns a positive value reflecting that plants preferentially take up water deriving from summer precipitation.

These findings allow us to develop a conceptual model of this Alpine system. This conceptual model suggests:

- a deep infiltration component, mainly composed by snowmelt water, reaching the stream through a preferential flow.
- a shallow infiltration component, predominantly represented by summer rainfall, that dominates the shallow soils and that is used by plants.

Therefore, we presume a seasonal compartmentalisation of water in this high-elevation catchment.

Nevertheless, a previous study in Switzerland revealed $SOI_Q \approx 0$ for the Allenbach and Dischmabach snow-dominated catchments, indicating that similar fractions of summer and winter precipitation become streamflow. This different result achieved in systems with an apparently similar functioning highlights the need for a deep insight into the flow paths governing high-elevation catchments and it opens the way for new challenges to understand the hydrological processes hidden behind this difference.