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The role of snow in the spatio-temporal dynamics of Alpine catchment water storage sources and supply

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Seasonal snow cover plays an important role in Alpine catchments, with the melt period generating a high flow regime for the river, but also replenishing subsurface storages that will be increasingly relied upon during summer low flow periods. However, tracing where and when these storages are supplying Alpine river catchments remains difficult. Using a 2.5 yr high temporal resolution database of isotopes in streamflow from an Apline catchment in Switzerland (Vallon de Nant), we characterise the seasonal changes in the subsurface storages supplying streamflow. These dynamics shift according to the influence of snow vs rain, but there is nonetheless a marked persistence of snow melt signatures from subsurface storages long after most snow has melted. Our work highlights the outsized influence that snow storage and melt may have on replenishing subsurface storages, especially compared to rainfall. These results also shed light on the applicability of catchment residence time or young water fraction estimation methods using tracers in Alpine catchments. Under the common assumption of a single storage reservoir, our data shows such methods will yield considerable bias in the age estimation of water leaving the catchment. This is due to the often large delay between snowfall and snowmelt, as well as the disproportionate influence of snowmelt on supplying subsurface storages that subsequently provide streamflow throughout the year.