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Partitioning of rainfall and snowmelt between trees and streams in the Swiss Alps

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The hydrologic cycle in Switzerland relies heavily on snowmelt sustaining streamflows during spring and summer. Climate warming will shrink the regional coverage of seasonal snowpacks thereby leading to an earlier onset of snowmelt, which in turn will alter streamflow regimes. However, the effects of changes in snow regimes on Alpine vegetation are largely unknown. In this context, it is imperative to understand how much streamflow and vegetation water uptake depend on different precipitation phases (rainfall versus snowfall), and what factors control the relative proportion of rainfall and snowfall that are ultimately used by vegetation (versus that flow to streams).

In this presentation, we use stable water isotopes to assess seasonal origin of waters used by Alpine trees vs water flowing into the nearby stream across different sites in Switzerland. We then correlate remote sensing based plant water abundance indicators (NDVI, NDWI, VOD) against long term streamflow records to assess how strongly waters flowing into streams are decoupled from waters taken up by vegetation, and how this decoupling varies across space and time. Using these results, we propose a theoretical framework that explains the phenomenon of “drought paradox”, where precipitation deficits during periods of drought disproportionally impact streamflow generation over vegetation in the Swiss Alps.