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Disentangeling key drivers of high alpine hydrology with analytic streamflow distribution models

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Streamflow distributions represent a powerful tool for water resources and ecological habitat management and have been shown in the past to be predictable with relatively simple analytic models. Such analytic models derive streamflow distributions from fundamental stochastic properties of the rainfall forcing and the filtering effect of the landscape and offer thereby a theoretical basis to compare the hydrologic behavior across climates and landscapes.

This contribution proposes an extension of the streamflow distribution model originally developed by Botter et al. (2007) to alpine streamflow regimes where the hydrological forcing is strongly influenced by snow and ice melt, i.e. to streamflow regimes that have major relevance for water supply in many world regions. We developed and tested the approach for 10 Swiss high elevation catchments covering a wide range of glacier covers (from 0% to 60%) and obtained good model performances for all test cases, which opens interesting perspectives for the quantification of alpine water resources under climate change. Based on these results, we will also discuss how the presented modeling framework offers new insights into the interplay of snow and ice storage, subsurface storage and precipitation forcing, i.e. into the key drivers of alpine streamflow regimes across elevation gradients