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Analytic probability distributions for snow-dominated streamflow

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We propose a novel analytical description of the streamflow probability distribution functions (pdfs) in mountain catchments that are characterized by pronounced, snow-dominated winter low flows. In this stochastic framework linking precipitation (rain and snow) and streamflow dynamics, the effect of snow dynamics on the flow regime is included through two key concepts: i) the temporary disconnection of high elevation areas that experience freezing conditions over the entire winter season, and ii) the delay produced on streamflow formation by the temporary accumulation (and later melting) of snow at lower elevations.

In its current form, the analytical model has only five parameters, of which four can be directly estimated from observed discharge, precipitation and air temperatures; the remaining calibration parameter represents an elevation threshold that delimits "non-responsive" catchment areas that have a permanent seasonal snow cover and do not release any significant melt water during winter. We tested the developed tools with hydrologic data from 14 catchments located in the Swiss and the Italian Alps. Overall, the proposed analytic model reproduces the observed snow-dominated streamflow pdfs remarkably well. The analytical framework thus represents a progress towards the general statistical characterization of snow-dominated streamflow variability.