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Different sensitivity of streamflow components to spatial variability in complex topography

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A complex field experiment was conducted in a 20 km^2 Alpine catchment to investigate the impact of spatial variability on stream flow generation. 10 Sensorscope stations were installed over a wide range of elevations and aspects to capture the spatial variability of different hydrological forcing parameters including: precipitation, air temperature, relative humidity, wind speed and direction, solar radiation and skin temperature, among other soil-atmosphere variables. Streamflow at the exit of the catchment was also monitored with high temporal resolution.

Data analysis revealed different degrees of sensitivity to spatial variability. Snow and ice melt streamflow components, showing a diurnal trend of different amplitudes and duration declining to ward the summer, were practically unaffected by the spatial variability in their forcing, as air diurnal temperature was adequately described regardless of the complex topography. On the contrary, rainfall-run off resulted to be dominated by the highly random spatial occurrence of convective rainfall events. Similarly, the long-term seasonal decreasing trend of the groundwater drainage appeared to be strongly affected by spatial variability in precipitation and topography.

To complement the data analysis, streamflow was also modeled with two models of different complexity: a 3D-physically based model (GEOtop) proved to be more suitable for reproducing rainfall-run off response, whereas a simple lumped degree-day type of model reproduced the snow melt more accurately than the 3D model. This is likely due to a lack of information on the initial conditions on snow depth over the catchment and the fact that the snow melt for this watershed was mainly controlled by the average daily temperature which did no vary significantly over the study area.