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Contribution of rainfall, snow and ice melt to the hydrological regime of the Arve upper catchment and to severe flood events

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In Alpine catchments, the hydrological response to meteorological events is highly influenced by the precipitation phase (liquid or solid) and by snow and ice melt. It is thus necessary to simulate accurately the snowpack evolution and its spatial distribution to perform relevant hydrological simulations.

This work is focused on the upper Arve Valley (Western Alps). This 205 km2 catchment has large glaciated areas (roughly 32% of the study area) and covers a large range of elevations (1000-4500 m a.s.l.). Snow presence is significant year-round. The area is also characterized by steep terrain and strong vegetation heterogeneity. Modelling hydrological processes in such a complex catchment is therefore challenging.

The detailed ISBA land surface model (including the Crocus snowpack scheme) has been applied to the study area using a topography based discretization (classifying terrain by aspect, elevation, slope and presence of glacier). The meteorological forcing used to run the simulations is the reanalysis issued from the SAFRAN model which assimilates meteorological observations from the Meteo-France networks. Conceptual reservoirs with calibrated values of emptying parameters are used to represent the underground water storage.

This approach has been tested to simulate the discharge on the Arve catchment and three sub-catchments over 1990-2015. The simulations were evaluated with respect to observed water discharges for several headwaters with varying glaciated areas. They allow to quantify the relative contribution of rainfall, snow and ice melt to the hydrological regime of the basin.

Additionally, we present a detailed analysis of several particular flood events. For these events, the ability of the model to correctly represent the catchment behaviour is investigated, looking particularly to the relevance of the simulated snowpack. Particularly, its spatial distribution is evaluated using MODIS snow cover maps, punctual snowpack observations and summer glacier mass balance estimations.