Projections of meteorological and snow conditions at Col de Porte (French Alps) using downscaled and adjusted EURO-CORDEX climate projections

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Current and future availability of seasonal snow is a recurring topic in mountain regions such as the French Alps, where winter tourism and hydropower production are large contributors to the regional revenue. Associated changes in river discharges, their consequences on water storage management, the future vulnerability of alpine ecosystems as well as the occurrence of climate-related hazards such as debris flows and avalanches is also under consideration.

However, to obtain projections of snow conditions, a traditional dynamical downscaling approach featuring spatial resolutions typically between 10 and 50 km is not sufficient to capture the fine-scale processes and thresholds at play. Indeed, the altitudinal resolution matters, since the phase of precipitation is mainly controlled by the temperature which is altitude-dependent. Moreover, simulations from general circulation models (GCMs) and regional climate models (RCMs) suffer from biases compared to local observations, and often provide outputs at too coarse time resolution to drive impact models. RCM simulations must therefore be adjusted and further downscaled before they can be used to drive specific models such as land surface models.

In this study, time series of hourly temperature, precipitation, wind speed, humidity, and short- and longwave radiation were generated over the French Alps for the period 1950-2100, by using a new approach (named ADAMONT for ADAptation of RCM outputs to MOuNTain regions) based on quantile mapping applied to daily data, followed by time disaggregation accounting for weather patterns selection. Outputs from EURO-CORDEX simulations spanning 6 different RCMs forced by 6 different GCMs under 3 representative concentration pathways scenarios (RCP 2.6, 4.5 and 8.5) over Europe were downscaled at the massif scale and for 300 m elevation bands and statistically adjusted against the extensive SAFRAN reanalysis (1958-2015). These corrected fields were then used to force the SURFEX/ISBA-Crocus land surface model over the French Alps. Here we present as an example a reanalysis and future projections (using adjusted EURO-CORDEX data) of meteorological and snow conditions obtained using this method at the INARCH site Col de Porte in the French Alps, which we compare to in-situ observations carried out since the 1960s. These results further enable us to identify and apportion the main drivers for changes in snow conditions at the site, and the various uncertainty components at play.