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Linking variations of meteorological and snow conditions in the French mountain regions to global temperature levels

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Long term records of Alpine meteorological and snow conditions are prominent indicators of ongoing climate change. However, there has been limited assessments of the impact of global air temperature levels on their local variations. Such approaches are particularly required at present time, because international scientific assessments, forming the basis of climate negotiations, have shifted into an era of global temperature targets rather than the traditional scenario based approach. Addressing local impacts of global temperature variations may better inform policy makers than scenario-based vizualisations, because of the direct relationship, regardless of the lead time, between local climate impacts (required for local climate adaptation planning) and the global temperature targets (largely discussed and showcased in national and international public debates and negotiations).

This contribution introduces a method addressing the links between variations of global temperature and local indicators of meteorological (temperature, precipitation, snow/rain partitioning) and snow on the ground (mean snow depth, peak snow water equivalent, onset/melt-out date of the snowpack, number of days above selected snow threshold values) in mountainous areas. Past and future variations of these indicators were computed based on the SAFRAN reanalysis from 1958 to 2016, and using CMIP5/EURO-CORDEX GCM/RCM pairs spanning historical (1950-2005) and RCP2.6 (4), RCP4.5 and RCP8.5 (13 each) future scenarios (2006-2100). The adjusted climate model runs were used to drive the detailed snowpack model Crocus. While such an approach makes it possible to generate continuous scenarios of meteorological and snow conditions for the time period from 1950 to 2100, we specifically process the obtained results in order to highlight the local impacts of 1.5°C, 2°C, 3°C etc. global temperature increases since pre-industrial levels, based on 30 years average values of the indicators selected.

The method will be introduced and illustrated for a representative location of the Northern French Alps, the Chartreuse massif (near Grenoble) at an altitude of 1500 m. In this case, regardless of the time period into the future, variations of local meteorological and snow conditions generally show significant linear correlation with global temperature variations, except total winter precipitation which does not show any significant trend. Global temperature levels on the order of 1.5°C above pre-industrial levels correspond to a 25 % reduction of winter mean snow depth (reference 1986-2005). Even larger reduction is expected for global temperature increase levels exceeding 2°C.

Beyond this illustrative example, the presentation will provide in-depth analysis of the obtained results in the French Alps and in the Pyrenees and discuss how the method can address other sectorial indicators, in the field of hydropower, mountain tourism or natural hazards.