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The 21st century climate of the Alps: What can we learn from the latest generation of regional climate scenarios?

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The European Alps are a hot spot of climate change and related impacts. Due to their physiographic complexity and their location between distinct climatic zones, climate change and climate impact assessments in this region are challenging and often associated with substantial uncertainties. In particular, previous studies have highlighted the added value of high-resolution regional climate models (RCMs) to capture fine scale spatio-temporal Alpine climate variability and to assess climate change impacts for high elevation regions.

We here exploit state-of-the-art regional climate scenarios available through the CORDEX initiative to assess 21st century climate change over the European Alps. The analyzed model ensemble consists of both high (12 km) and low resolution (50 km) experiments carried out by multiple RCMs which are, in turn, driven by multiple global climate models. Obvious RCM deficiencies in the Alpine area are identified. For instance, several RCMs tend to constantly accumulate snow cover at some isolated grid cells resulting in a distortion of the temperature change signal. Our analysis considers two different emission scenarios (RCP4.5 and RCP8.5). Besides seasonal mean changes in temperature and precipitation we particularly focus on changes in precipitation and temperature extremes as well as changes in parameters related to snow cover and snowfall. A dedicated spatial analysis combined with the assessment of elevation dependencies of climate change signals identifies regional hot spots of change. Robust and reliable aspects of projected climate change in the Alps are highlighted, and more uncertain but nevertheless important possible further changes are discussed in addition.

The results largely confirm the findings of previous studies based on the ENSEMBLES experiments, but also yield a number of new insights. The projected increase of winter precipitation, for instance, appears to be stronger and more robust than previously known while potential summer drying is less pronounced and more uncertain. Depending on the region and the specific index considered, extreme precipitation could increase during most parts of the year. Snow cover and snowfall are importantly reduced at low and mid elevations. High elevation regions, however, can show snowfall increases in mid-winter as a consequence of higher winter precipitation combined with an increased snowfall intensity. Elevation dependencies of the near-surface temperature change can be substantial. In springtime, strongest warming occurs at medium elevations where snow cover changes are largest, indicating a contribution of the snow albedo feedback to the vertical profile of near-surface warming.