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Relative Role of Global and Regional Climate Models in Precipitation Projections over Switzerland

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Global warming and corresponding climatic changes are expected to continue well into the 21st century, leaving major impacts on society and ecosystems. Of particular importance for adaptation strategies is the response in precipitation, where model projections are still associated with large uncertainties. This is even exacerbated over complex terrain such as the Alps, where regional climate model (RCM) projections with a detailed topography are essential. The Alps represent also a region which is located at or near a transition zone between two larger-scale European regimes of precipitation change of different sign: an increase of precipitation in northern Europe and drying conditions over southern Europe. This further complication makes a robust prediction over Switzerland even more challenging. It is thus of great relevance to further investigate (i) how the spatial pattern of European precipitation change diverges temporally among different global climate models (GCMs), and (ii) how these large-scale projections map onto the local scale of the Alpine region within different RCMs.
Here, we analyse RCM simulations of precipitation (at 25 km horizontal resolution) from the FP6-ENSEMBLES project that were driven by different GCMs and run in transient mode over the period 1950 to 2050 and beyond based on the A1B emission scenario. Some of the RCMs were forced by the same GCM, hence allowing to compare the climatic response of different RCMs under the same boundary conditions. Seasonal precipitation change and corresponding uncertainties are assessed for three scenario periods over the 21st century and, in greater detail, for three climatologically homogeneous regions north and south of the Alps.
The multimodel-mean response shows that the transition zone of precipitation increase in northern Europe and decrease in southern Europe is located right over Switzerland for spring, autumn and winter throughout the 21st century. This is also the case for summer in the upcoming decades. Yet, towards the end of the century, summer drying becomes dominant over much of continental Europe and hence also Switzerland. In general, the patterns of precipitation change over Central Europe during wintertime are largely dominated by the global model projections. While in summer all RCM-GCM-chains project drier conditions over the Iberian Peninsula, France, and Switzerland, the response on the local scale can markedly deviate within the group of RCMs driven by the same GCM. Separating the projection uncertainty over Switzerland into the relative contributions of (i) the global models, (ii) the regional model, and (iii) internal decadal variability, it is revealed that the role of the GCMs dominates at the end of the century with about 80% in winter, spring and autumn. However, during summer only around 50% of the projection uncertainty are explained by the GCMs, while RCM uncertainty and internal variability contribute with around 40% and 10%, respectively