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Precipitation variability in the Peruvian Andes under future climatic conditions – Assessment and implications

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The Peruvian Andes are characterized by pronounced dry and wet seasons. Agriculture but also other economic sectors such as hydropower production strongly depend on water availability, and are therefore sensitive to changes in precipitation regime at the local and regional scale. Future changes in rainfall amounts and variability may have severe consequences for society and need to be assessed in order to develop adequate strategies for adaptation.

The precipitation regime of the high Peruvian Andes is characterized by a complex interplay of local orographic effects with large-scale circulation. A main moisture source for the region is the Amazon Basin and the amount of moisture received in the Central Andes is influenced by the strength of zonal winds in the upper troposphere. As a result, variations in seasonal precipitation amounts can be associated to the South American Monsoon and large-scale teleconnections with the oceans surrounding the South American continent. Notably, however, direct correlations of local precipitation with ENSO, the main driver of tropical Pacific variability, are mostly weak and unstable over the short instrumental period.

In this contribution we provide an assessment of future changes in precipitation amounts and variability of the southern Peruvian Andes in relation to changes in the large-scale atmospheric circulation, quantify the associated uncertainties and discuss some of the implications for society. The analysis relies on climate change projections from the CMIP5 initiative. We show that owing to the complex dynamic influence on local climate and the distinct, small-scaled topographic features of the Andes, Global Climate Models (GCMs) have limited ability to adequately simulate precipitation variability at the local scale. Accordingly, uncertainties in simulated precipitation patterns are considerable.

More reliable is the simulation of the mid and upper tropospheric flow, as shown by comparing the model output with global re-analyses. We therefore apply a statistical downscaling to constrain the GCM simulations and identify robust 21st century projections of inter-annual to decadal precipitation variability for the Peruvian Andes. Preliminary results indicate a decline of precipitation in the coming decades, leading to unusually low precipitation amounts. These results are put in the context of changes in teleconnection patterns. The projected precipitation distributions and resulting changes in means and extremes are used to discuss possible implications for local societies and economy.