EGU2020-19981
https://doi.org/10.5194/egusphere-egu2020-19981
EGU General Assembly 2020

Observed local drivers of rainfall variability and changes in the Rio Santa Basin, Tropical Andes of Peru

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The climate in the Rio Santa basin (Peruvian Andes) is characterized by a strong seasonality, with a wet season reaching its maximum intensity from December to March. Understanding the characteristics and variability of rainfall during the wet season is fundamental for small-scale farmers based on rain-fed agriculture, and is one of the main objectives of the recently started AgroClim-Huaraz project (http://agroclima-huaraz.info). Based on a combination of rain gauge observations and ERA5 reanalysis data, we demonstrate that the occurrence of local wet and dry spells in the Rio Santa basin is strongly connected to large scale circulation patterns that are known to drive such rainfall variability in the wider tropical Andes. Changes in upper-tropospheric zonal wind and the location of the Bolivian High pressure system therefore crucially affect the local water availability.

On large spatio-temporal scales, this connection was claimed to have already caused a decrease in precipitation in the Central Andes in response to global warming and could be associated with a projected four-fold increase of dry years by 2100. Consequently, it is of great importance to (i) evaluate the validity of this drying by trend analyses from different sources and (ii) understand the implications of a potential large-scale trend from a local perspective that takes into account the heterogeneity of rainfall distributions in complex terrain.

We therefore use ERA5 to evaluate whether and how observed changes in this teleconnection affect local atmospheric conditions and convective environments. In addition, we infer associated potential trends in rainfall frequency and extremes, cloud cover and convective intensity for the Rio Santa Basin from CHIRPS rainfall estimates and GRIDSAT brightness temperatures down to a resolution of 4-7km for 1983-2019.

Based on observations, our results illustrate how large-scale climatic changes may translate into smaller scales. This will in further steps not only help to validate and constrain regional dynamical downscaling attempts but also inform about the representativeness of coarser-scale climate projections for local conditions in Andean valleys.