EGU21-12582
https://doi.org/10.5194/egusphere-egu21-12582
EGU General Assembly 2021

Precipitation extremes over southern South America and their synoptic environment in a set of CORDEX regional climate models

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Southern South America (SSA) is a wide populated region exposed to extreme rainfall events, which are recognised as some of the major threats in a warming climate. These events produce large impacts on socio-economic activities, energy demand and health systems. Hence, studying this phenomena requires high-quality and high-resolution observational data and model simulations. In this work, the main features of daily extreme precipitation and circulation types over SSA were evaluated using a 4-model set of CORDEX regional climate models (RCMs) driven by ERA-Interim during 1980-2010: RCA4 and WRF from CORDEX Phase 1 and RegCM4v7 and REMO2015 from the brand-new CORDEX-CORE simulations. Observational uncertainty was assessed by comparing model outputs with multiple observational datasets (rain gauges, CHIRPS, CPC and MSWEP).

The inter-comparison of extreme events, characterized in terms of their intensity, frequency and spatial coverage, varied across SSA exhibiting large differences among observational datasets and RCMs, pointing out the current observational uncertainty when evaluating precipitation extremes, particularly at a daily scale. The spread between observational datasets was smaller than for the RCMs. Most of the RCMs successfully captured the spatial pattern of extreme rainfall across SSA, reproducing the maximum intensities in southeastern South America (SESA) and central and southern Chile during the austral warm (October to March) and cold (April to September) seasons, respectively. However, they often presented overestimations over central and southern Chile, and more variable results in SESA. RegCM4 and WRF seemed to well represent the maximum precipitation amounts over SESA, while REMO showed strong overestimations and RCA4 had more difficulties in representing the spatial distribution of heavy rainfall intensities. Focusing over SESA, differences were detected in the timing and location of extremes (including the areal coverage) among both observational datasets and RCMs, which poses a particular challenge when performing impact studies in the region. Thus, stressing that the use of multiple datasets is of key importance when carrying out regional climate studies and model evaluations, particularly for extremes.

The synoptic environment was described by a classification of circulation types (CTs) using Self-

Organizing Maps (SOM) considering geopotential height anomalies at 500 hPa (Z500). Specific CTs were identified as they significantly enhanced the occurrence of extreme rainfall events in sectorized areas of SESA. In particular, a dipolar structure of Z500 anomalies that produced a marked trough at the mid-level atmosphere, usually located east of the Andes, significantly favoured the occurrence of extreme precipitation events in the warm season. The RCMs were able to adequately reproduce the SOM frequencies, although simplifying the predominant CTs into a reduced number of configurations. They appropriately reproduced the observed extreme precipitation frequencies conditioned by the CTs and their atmospheric configurations, but exhibiting some limitations in the location and intensity of the resulting precipitation systems.

In this sense, continuous evaluations of observational datasets and model simulations become necessary for a better understanding of the physical mechanisms behind extreme precipitation over the region, as well as for its past and future changes in a climate change scenario.