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The influence of ENSO on the frequency of extreme rainfall events in present and future climate in South America

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Previous analysis of observed data has shown a clear association between ENSO episodes (El Niño, EN / La Niña, LN) and the frequency of extreme rainfall events over South America. ENSO is the main source of interannual variability in the continent, and its influence varies throughout the annual cycle. For instance, in austral spring (November) it is very significant in Southeastern South America, producing increase (decrease) of extreme events in the La Plata Basin during EN (LN) episodes. In peak summer monsoon season (January), the extreme events in Central-East South America, in the South Atlantic Convergence Zone and in the core monsoon region are enhanced (hampered) during EN (LN) episodes. In austral autumn (April), there is significant enhancement of extreme events in the La Plata Basin during EN episodes, and in Northeast Brazil during LN episodes. These significant changes in extreme events are much more extensive than the corresponding changes in monthly rainfall, because the highest sensitivity to ENSO is in the extreme range of daily precipitation. As the most dramatic consequences of climate variability result from changes in extreme events, it is important to assess the impact of global anthropogenic climate change on the ENSO influence over extreme rainfall in South America.
The present study examines the influence of ENSO episodes as simulated by the atmosphere-ocean coupled model ECHAM5-OM in the twentieth century climate (1960-2000) (comparing it with the observed influence), and in a future scenario (SRES-A2, 2060-2100).
Extreme events are defined as three-day mean precipitation above the 90th percentile. The mean frequencies of extreme events are determined for each category of year (EN, LN, and neutral), and the differences between EN and neutral years, and LN and neutral years are computed for each month, and their significance assessed. The EN and LN years in the model output are determined from the Niño 3 SST anomalies, as in the observations, and verified against the extreme phases of the ENSO mode of SST variability (first mode). It is not expected that the ENSO episodes in the model coincide with the dates of the observed episodes in the present climate (1960-2000), but the statistical characteristics are very similar, and the ENSO cycle is reasonably simulated.
The model reproduces well the strongest impacts of ENSO in the South American present climate, although not all their features. The areas with consistent impact on the frequency of extreme events are generally greater in the future climate, and the ENSO-related frequency is enhanced with respect to the present in several instances, such as in Southeastern South America (La Plata Basin) in spring, and in Northeast Brazil in autumn.
Besides the climate change impact on the influence of ENSO over the frequency of extreme rainfall events, also the shifts produced in the daily rainfall distributions, with respect to present climate during EN, LN and all years, are examined. The frequency tends to decrease for light rainfall, and increase in the heavy tail of the distributions.
Physical mechanisms underlying the influence of ENSO on the frequency of extreme precipitation events in certain regions are sought through the analysis of the conditions during extreme events in these regions and their relationship with large-scale perturbations produced by ENSO. Possible reasons for future changes in that influence are proposed.

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