



ENSO and extreme events of rainfall and streamflow in South America

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The influence of the opposite phases of ENSO (El Niño and La Niña episodes) on the frequency of extreme rainfall events over South America is analyzed for each month of the ENSO cycle on the basis of a large set of daily station rainfall data (from about 9000 stations) in the period 1956-2002, and compared with the influence of ENSO on the monthly total rainfall. 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 (El Niño, La Niña, and neutral), and the differences between El Niño and neutral years, and La Niña and neutral years are computed for each month. Changes in the mean intensity of extreme events are also investigated.

The ENSO-related changes in the frequency of extreme rainfall events are generally coherent with changes in total monthly rainfall quantities. However, significant changes in extremes are much more extensive than the corresponding changes in monthly rainfall, because the highest sensitivity to ENSO seems to be in the extreme range of daily precipitation.

The ENSO-related changes in the intensity of extreme events do not show as much consistency and spatial coherence as the changes in the frequency of extreme events. The most outstanding example of combined increase (reduction) in frequency and intensity of extreme events occurs over southeastern South America in all seasons, especially during austral spring. This region is location of the most intense storms on Earth, according to the TRMM data and even the champion thunderstorm of the 7 years sample of TRMM data was observed in southeastern South America during an El Niño episode.

In order to test the highest sensitivity of the extreme range of daily precipitation to ENSO episodes, we examined the differences of daily rainfall frequency distributions during EN and LN episodes with respect to neutral years for some regions with significant changes in the frequency of extreme events between these categories of years. The largest relative differences reside in the heavy tail of the frequency distributions.

Reasons for the significant variations in the frequency of extreme precipitation events in some regions during certain phases of ENSO episodes are sought through the analysis of the predominant conditions during extreme events in these regions and their relationship with large-scale monthly perturbations produced by ENSO. The results show how those conditions are favored or hampered by El Niño or La Niña episodes.

The ENSO-related changes in the frequency of extreme rainfall are important, since the most dramatic consequences of climate variability result from changes in extreme events. Their impact on stream flows is stronger than the effect of total monthly or seasonal rainfall. Here we show that there is more coherence between changes in the frequencies of extreme events of rainfall and streamflow than between changes in total monthly rainfall and extreme streamflow events for important river basins in South America, such as the Parana/La Plata basin.