Heavy rainfall events in the Languedoc region (France): relationships with synoptic patterns and frequency analysis

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High intensity rainfall events often occur in the south of the Cevennes mountainous region (France), leading to catastrophic flash floods which are the main destructive natural hazard in this region. A good knowledge of these extreme events is necessary to better predict their occurrence, in particular for forecasting and to produce future scenarios. The goal of this study is to analyze the synoptic circulation patterns associated with heavy rainfall events, in order to describe their magnitude and frequency. 45 meteorological stations with 50 years of daily records (1958-2008) constituted the database for this project. A regional sample with 24-hour rainfall events exceeding a threshold of 80 mm was built, including a total of 455 events. A regional sampling was chosen in order to avoid the spatial and temporal correlations between the records. Most of the heavy rainfall events (75%) were observed during the months of September to December, associated with the highest rainfall intensity. The relationships between synoptic weather patterns and extreme rainfall events were analyzed using a classification of daily atmospheric circulation. The Western Mediterranean Oscillation Index (WeMOi), the Mediterranean Oscillation Index (MOI) and the sea-surface temperatures (SST) were also considered. Results indicated a positive trend in the magnitude of rainfall events in fall and winter seasons during the period 1958-2008 while a similar upward trend is observed for the coastal SST in the north-west of the Mediterranean Sea. The number of threshold exceedances per year is related to the annual occurrence of a south-eastern circulation pattern. There is also a clear association of the heavy rainfall events with negative values of the WeMOI and MOI indices. Finally, a non-stationary model using a Generalized Pareto distribution with climatic co-variables is proposed to model the frequency of occurrence and the magnitude of extreme rainfall events in the fall season.