Analysis of the dynamics of extreme rainfall events in summer in southern Uruguay

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Objective

The objective of this research is to explore the nature and understand the dynamics of extreme rainfall events in summer in southern Uruguay

Introduction

- Uruguay is an agricultural country, whose economy is greatly affected by the accumulation and distribution of rainfall
- Extreme rainfall events generate social damages such as population displacement and road closures
- There is no investigation on extreme rainfall events in Uruguay
- The nature and variability of these events makes its study a challenge
- Extreme events were defined as days in which the accumulated rainfall exceeds the 90th percentile

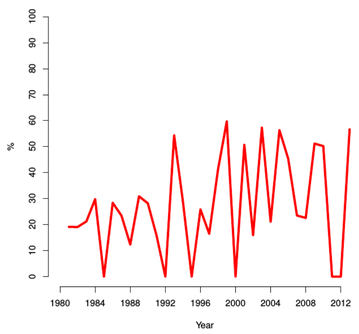


Figure 1: Percentage of accumulated seasonal rainfall in extreme events

Data

- 49 pluviometers registering daily accumulated rainfall located along the country
- NCEP-DOE reanalysis2 (NOAA):200 and 1000 hPa geopotential height, 2m temperature, and specific humidity

Methodology

- Clustering analysis in order to define the southern area as a dynamically consistent region to study
- EOF decomposition as a way of grouping together the extremes according to their characteristics
- Composite analysis of the variables that may influence the occurrence of the extremes

Results

Clustering

- We performed partitioning and hierarchical clustering analysis with different amount of groups
- The best division is composed of 4 groups that represent the characteristics of Uruguay's rainfall
- The southern region is composed of 15 points (green in Fig.2)

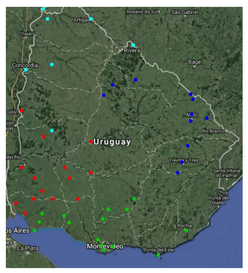


Figure 2: Clustering of rainfall

EOF

- The EOF was calculated considering 2m temperature
- They repesent 48% and 17% of variability
- We studied the red, blue and violet cases of the scatterplot (Fig.3 right)

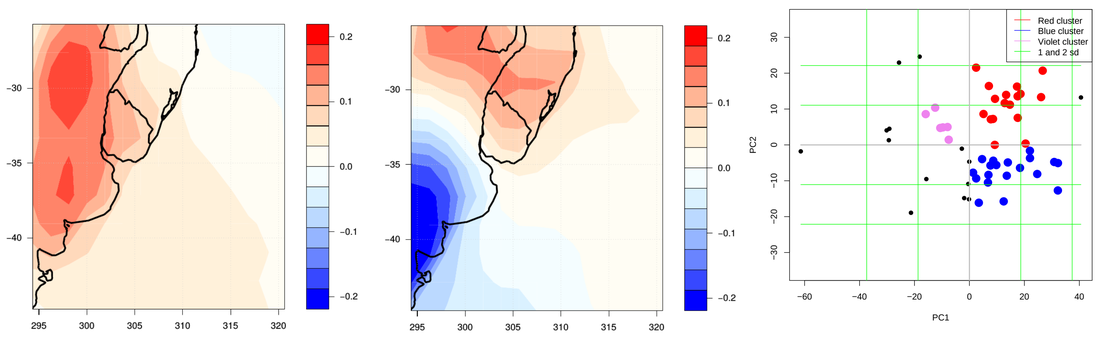


Figure 3: First EOF (L), second EOF (M), scatterplot PC1 vs. PC2 (R)

Red group

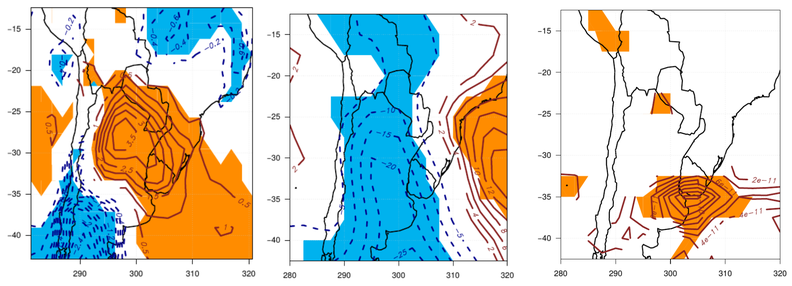


Figure 4: 2m temperature anomaly (L), 1000hPa geopotential anomaly (M), Frontal index anomaly (Solman and Orlanski,2010) (R), anomalies, 90%

- Positive temperature anomaly in Uruguay and the area adjacent to its western border (left), generating atmospheric instability and convection
- Low pressure in Uruguay and the area adjacent to its western border (middle), that favours humidity advection
- Frontal activity (right), that triggers the rainfall initiation

Blue group

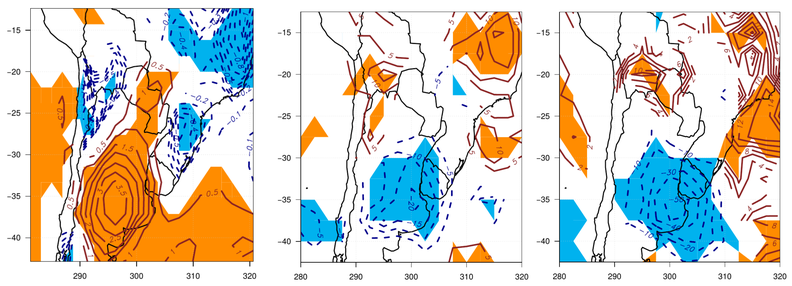
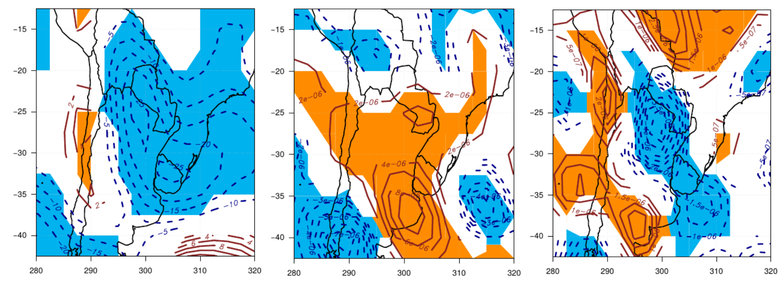


Figure 5: 2m temperature (L), OLR previous day (M), OLR event day (R), anomalies 90%

- Positive temperature anomalies in Uruguay and the area adjacent to its western border (left), generating atmospheric instability and convection
- Negative OLR anomaly west to Uruguay the previous day, representing rainfall (middle)
- Negative OLR anomaly in Uruguay in day 0, representing convecting rainfall coming from the west (right)

Violet group



(a) caption **(b)** caption **(c)** caption

Figure 6: 1000hPa geopotential anomaly (L), 200hPa divergence anomaly (M), 850 hPa divergence anomaly (R), 90%

- Surface low pressure in Uruguay, favouring upward movements
- Positive divergence in 200 hPa level, intensifying the surface low level pressure
- Negative divergence in 850 hPa level, advecting humidity to Uruguay

Conclusions

We found three different configurations for extreme rainfall events in summer:

- **Red extremes are characterized by convection and triggered by frontal activity**
- **Blue extremes are consequence of atmospheric instability that generates convective activity in the west, that travels to southern Uruguay, agreeing with Salio et.al (2007)**
- **Violet extremes are favoured by 200 hPa circulation that generates surface ciclogenesis and also by humidity advection in 850 hPa**