

# RAINFALL REGIMES IN A MEDITERRANEAN MOUNTAINOUS REGION

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## 1 Introduction

### 1.1 Motivation

Rainfall climatology in a mountainous region  $\equiv$  what about rainfall-altitude relationships.

### 1.3 Data sets

- Daily raingauges :
  - period of observations : 1958-2000;
  - More than 350 functioning at a time (blue crosses in daily maps);
  - Distance between sensors : between 5 and 10 km.
- Hourly raingauges :
  - period of observations : 1993-2005;
  - More than 150 functioning at a time (blue crosses in hourly maps);
  - Distance between sensors : between 5 and 12 km.

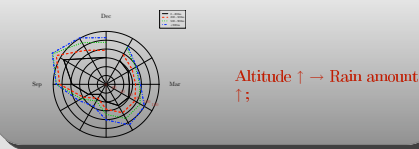
### 1.2 Studied Region

The Cévennes-Vivarais region.

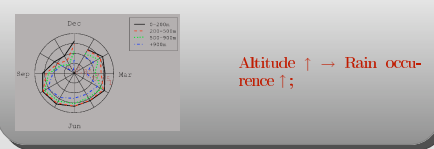


## 2 Seasonal rainfall regimes

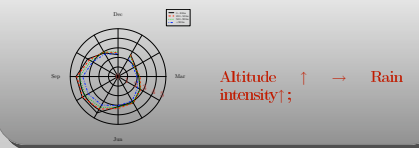
Monthly rainfall amounts (mm) averaged over 42 years in four altitude ranges



Monthly average of the hourly rainfall intermittence during rainfall events



Monthly average of the hourly non-null rainfall intensity (expressed in mm/hour) in 4 altitude ranges

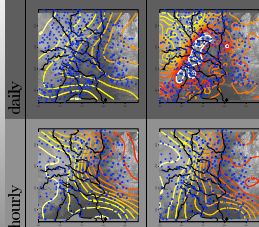


- Yearly rainfall amounts are higher over the mountain than anywhere else but the hourly rainfall intensity decrease with relief elevation.
- Focus on the rainfall of Sept., Oct. and Nov. in the following.

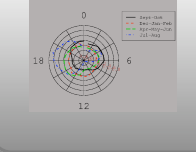
## 3 Regular-rainfall regimes

- Focus on the non-null rain intensity occurring during rain events;
- A rainfall events correspond to a daily rainfall intensity > 25 mm (median daily rainfall rate);
- Focus on the fall season where the highest amounts are observed and known to be prone to flood events;
- Identification of the fall rainfall regimes thanks to the signature of July intra-mass storms.

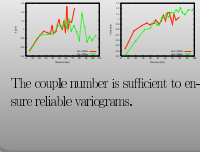
Median rainfall rate July Sept.-Oct.



Hourly rainfall rate diurnal cycle



Hourly rainfall rate climatological variograms



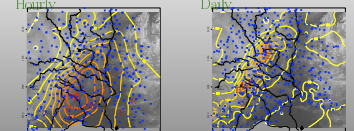
The couple number is sufficient to ensure reliable variograms.

- In July, infra-hourly convective storms involve both the hourly and daily rainfall rates (see median rain rate maps);
- In Sept.-Oct., hourly rainfall rates display the same spatial patterns as in July (see median rain rate maps)
- But a different diurnal cycle (see the diurnal cycle diagram) and a larger variogram range in the plain (see the variogram diagrams). Over the mountain, the hourly rainfall rate variogram range is similar to this of the relief elevation.
- Daily rainfall rates include the spatial pattern due to hourly rainfall in the plain and display a **prominent mountainous pattern** (see median rain rate maps)

## 4 Maximum rainfall regimes

- 2 maxima sample set  $\leftarrow$  one maximum per year in either the hourly and the daily databases.
- Hourly maxima occur preferentially from July to Spet.
- Daily maxima, from August to October.

Maps of the median hourly and daily annual maximum rainfall intensities (iso-contours). The terrain elevation is displayed by shaded areas. The letters A to I are the indexes of the top 10 rainfall maximums at the hourly or the daily durations.



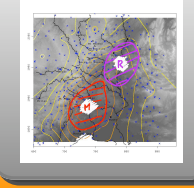
- Hourly maxima scattered over the South-West foothill;
- Daily maxima over localized around Mont-Aigoual & Serre de la Cx de Beaton.

## 5 From regular to extreme rainfall : What are the differences between "storms" producing regular and extreme rainfall at each time steps?

### Hourly time step

- Locations of highest regular rainfall and extreme rainfall change  $\rightarrow$
- Regular hourly rainfall are due to intra-mass infra-hourly storms over the Rhône river valley;
- Several cases studies (Senesi et al., 1996; Weat, For., Ducroq et al., 2008 QJRMIS; Nuissier et al. 2008 QJRMIS) described storms producing flash floods and depict the genesis mechanisms :
  - Mid level through + warm and moist low level air incoming flow;
  - Synergy between relief elevation and thermodynamical processes  $\rightarrow$  low level flow blockage  $\rightarrow$  long lasting MCSs over the foothill;

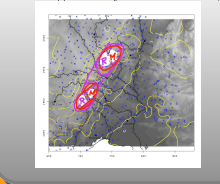
- M : highest hourly rainfall maxima;
- R : highest hourly median rainfall;



### Daily time step

- Co-located Regular and Maximum rainfall over the Cévennes mountain ridge (map below);
- Comparing the orographic rainbands daily intensity and the maxima daily rainfall intensities tells that orographic rainbands could play a significant role in daily maxima rainfall intensities.

- M : highest daily rainfall maxima;
- R : highest daily median rainfall;



### Orographic rainband genesis

- As schematized in Yates (2006), following the low level wind incidence on the relief, the relief involved lifting can interplay with the dynamical convergence to yield long lasting rainbands able to yield high daily rainfall amounts.

