THE EFFECT OF TEMPORAL OBSERVATION SCALE ON EXTREME RAINFALL ANALYSIS

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ABSTRACT

Mediterranean storms usually show high intensity and irregularity of rainfall. A single torrential event can double, even triplicate, the average annual rainfall. These features, in turn, influence flash-floods and hydrological behaviour of ephemeral streams. However the internal structure of storms varies according to the time scale at which data are collected. As the observation interval is reduced, intensity becomes more significant and emphasizes the concentrated character of the precipitation.

This paper analyses the temporal and spatial variations of rainfall pattern, associated with different time scales in data collection. The study area involves the whole territory of the River Júcar Water Authority (43.000 km^2). Rainfall data are collected every five minutes by the Automatic Hydrological Information System (SAIH) from 147 rain gauges, covering a 13 years continuous period (1994-2007). Precipitation data have been rescaling in order to obtain rainfall parameters every five minutes, 15 minutes, 30 minutes, 1 hour, 6 hours, 12 hours and 24 hours. Indicators of *cumulative rainfall, maximum intensity, irregularity, probability of rain* and *persistence of rain* have been estimated for every time scale.

From a time scale perspective, results show that there are two variables - "*cumulative rainfall*" and "*probability of rain*" - that follow a positive logarithmic trend, time-dependent. "*Cumulative rainfall*" shows a change of trend at 6 hours time scale, while the variable "*probability of rain*" changes its trend after 1 hour. Variables of "*maximum intensity*", "*irregularity*" and "*persistence of rain*" show negative trends, fitting power curves functions time-dependent. All of these variables show a change of trend after 1 hour.

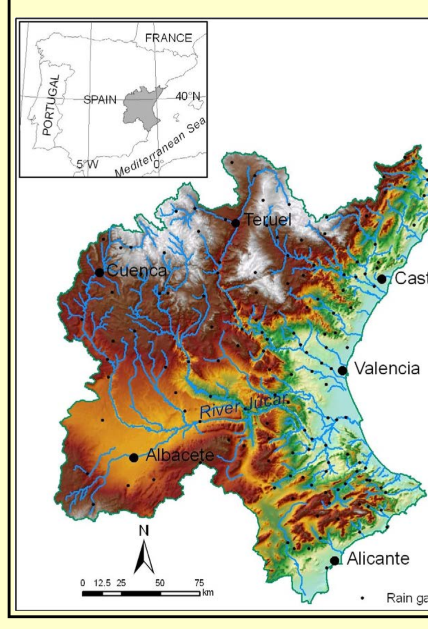
Regarding the **spatial pattern,** results show changes in the factors influencing this pattern, depending on the observation scale. Thus, for the variables of "*cumulative rainfall*" and "*maximum intensity*", increasing time interval implies a reduction of the area affected by the maximum values. The "*irregularity*" shows, for 5 minutes, the highest values in the plains near the sea and in the first line of relief. As the time interval increases, other factors, as distance to the sea, the effect of a second inland alignment of relief, and the exposure to wet wind of component NE, become important.

The "*persistence of rain*" is related to the distance to the sea from the first mountainous alignments and to the exposure to winds of components NE and SE.

Finally, although the results are preliminary, authors would remark their great applicability to detect thresholds in order to estimate indicators for water management.

STUDY AREA

River Júcar Water Authority (CHJ)



- Area: 43.000 km^2
- 147 rain gauges of SAIH
- Data collected every 5 minutes
- Period: 13 years (1994-2007)

METHODOLOGY

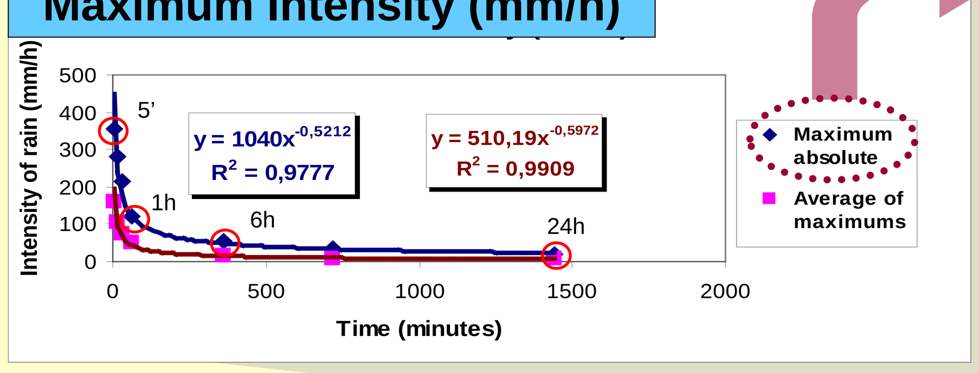
1. **Data of precipitation**, originally registered every 5 minutes, **have been rescaling** every 15 minutes, 30 minutes, 1 hour, 6 hours, 12 hours and 24 hours, in order to simulate different temporal scales of observation.
2. The following **indicators** of rainfall has been estimated **for every time scale**:
   - **Maximum intensity:** mm/h (this indicator covers a longer period of time than the rest of the study, 1989-2007).
   - **Cumulative rainfall**: mm
   - **Irregularity:** The *Concentration Index of Precipitation (CI)*, based on *Gini Coefficient*, has been estimated following the methodology proposed by Martin Vide (2004). According to this method, the statistical structure of precipitation can be analysed by means of concentration curves that relate the accumulated percentages of precipitation contributed by the accumulated percentages of time intervals on which it took place. The *Concentration Index* enables to compare data from different rain gauges and observation time intervals. Values rank from 0 (minimum) to 1 (maximum irregularity).
   - **Probability of rain:** values rank from 0 to 1.
   - **Persistence of rain:** probability of rain in consecutive time intervals.
3. For each indicator, the **maximum values** have been selected at each rain gauge. Then, the average of these values and the absolute maximum for each time observation scale were estimated. **Trends curves** have been fitted.
4. In order to provide the **spatial distribution** of indicators, the absolute maximum values have been mapped, as well as the percentages of change of these values between the main scales of observation.

INDICATOR		TIME OBSERVATION SCALE						
		5 min.	15 min.	30 min.	1 h	6 h	12 h	24 h
Maximum Intensity* (mm/h)	Absolute maximum	355	280	214	119.8	56.3	34.5	19.2
	Average of maximums	159.6	105.9	76	50.6	15.6	9.7	6
Cumulative rainfall (mm)	Absolute maximum	22.8	50	66	94.4	355.58	372.38	423.38
	Average of maximums	13.71	23.54	32.62	43.55	81	98.91	127.83
Irregularity CI (*Concentration Index*)	Absolute maximum	0.5	0.42	0.37	0.32	0.15	0.01	0.05
	Average of maximums	0.37	0.27	0.21	0.16	0.05	0.02	0.01
Probability of rain	Absolute maximum	0.035	0.046	0.055	0.075	0.170	0.243	0.347
	Average of maximums	0.012	0.022	0.030	0.040	0.096	0.142	0.210
Persistence of rain	Absolute maximum	0.0989	0.0558	0.0380	0.0262	0.0079	0.0034	0.0019
	Average of maximums	0.0408	0.0190	0.0118	0.0068	0.0007	0.0002	0.0001

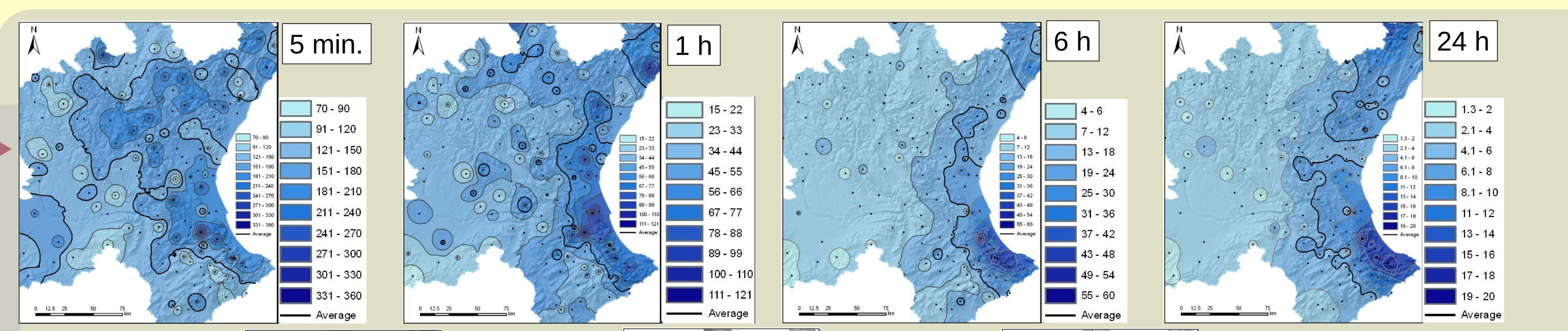
(*) This indicator refers to a longer period of time than the rest of the study(1989-2007)

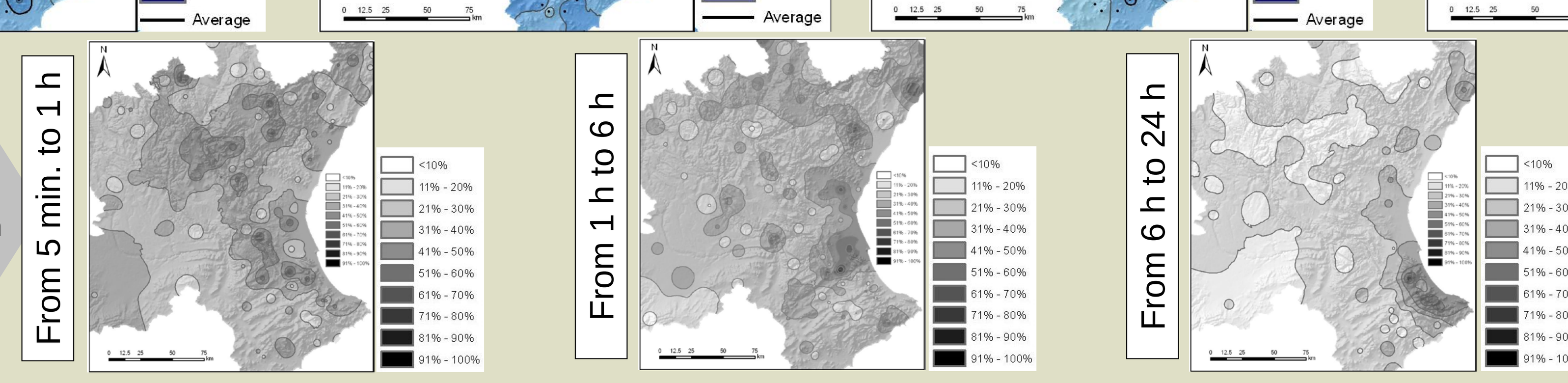
RESULTS AND CONCLUSIONS

Maximum Intensity (mm/h)



Negative power function time-dependant

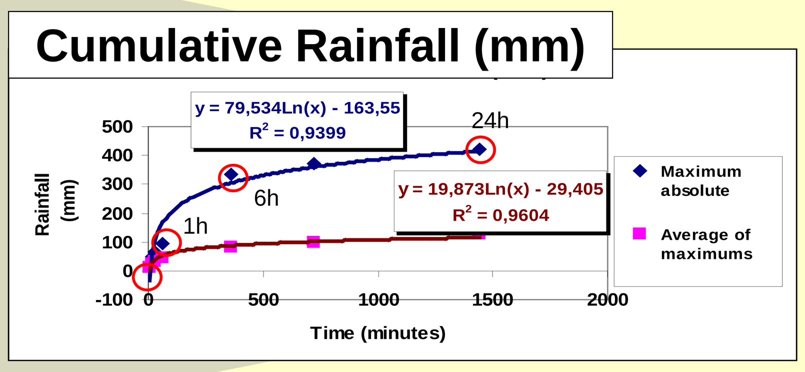




Ratio of change: reduction percentage of **Intensity** between time scale of observations

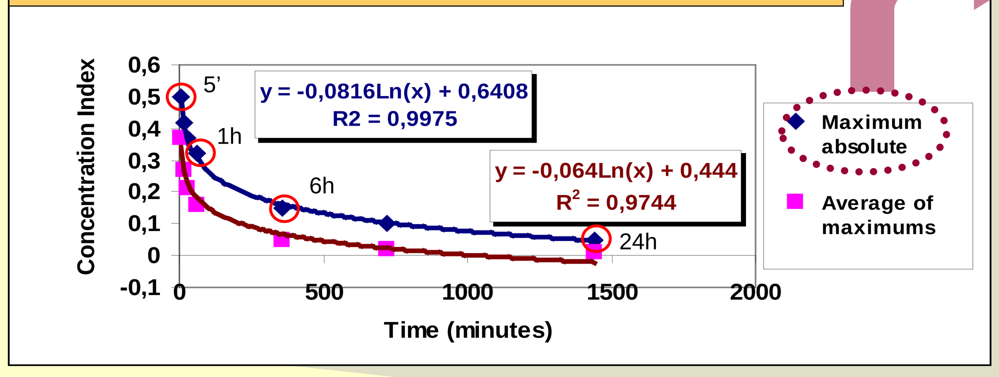
The main reductions of rainfall intensity move from inland relief (factor: altitude) to the coast (factor: altitude and exposure to wet winds) as time scale increases.

Cumulative Rainfall (mm)

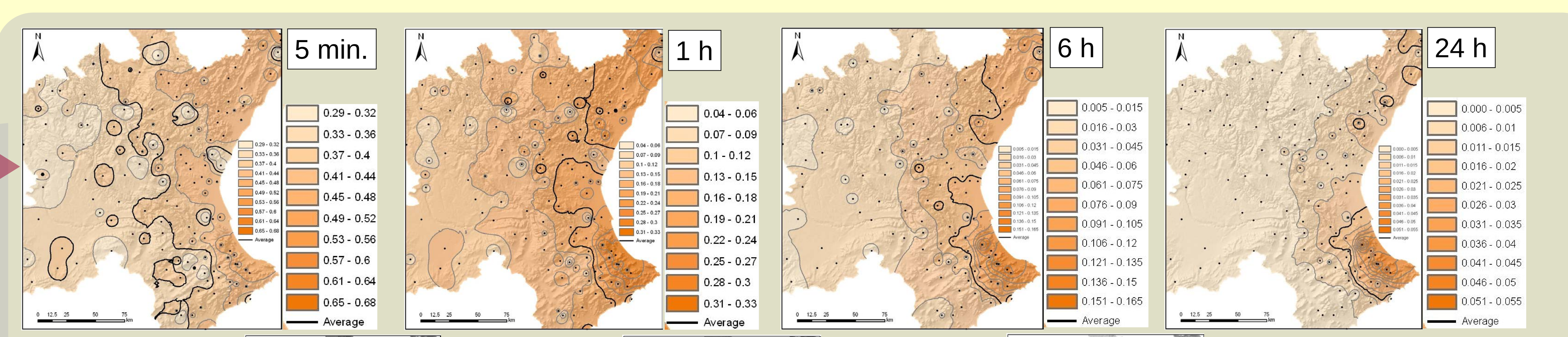


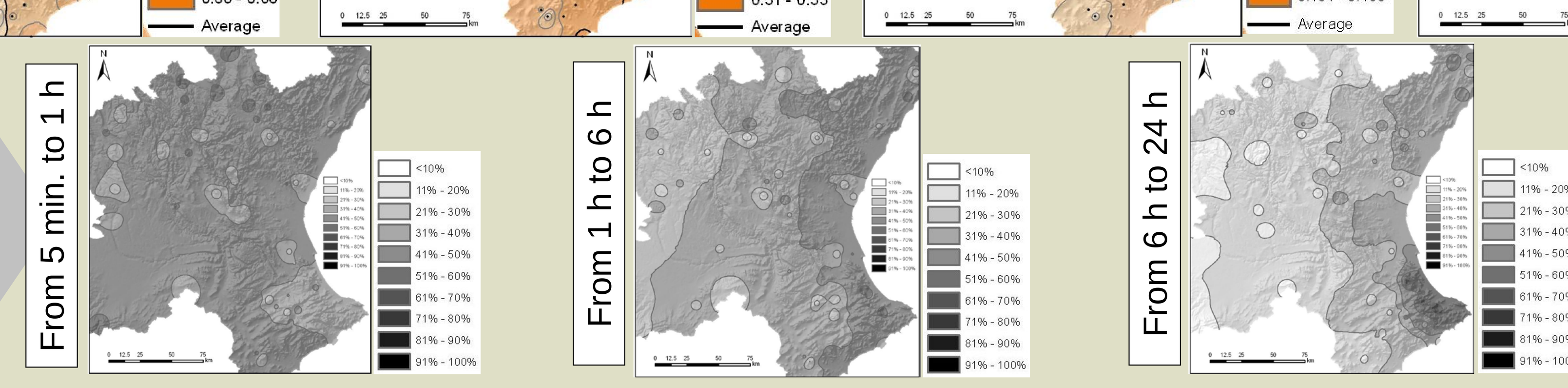
Positive logarithmic trend time-dependant

Irregularity (Concentration Index)



Negative logarithmic trend time-dependant

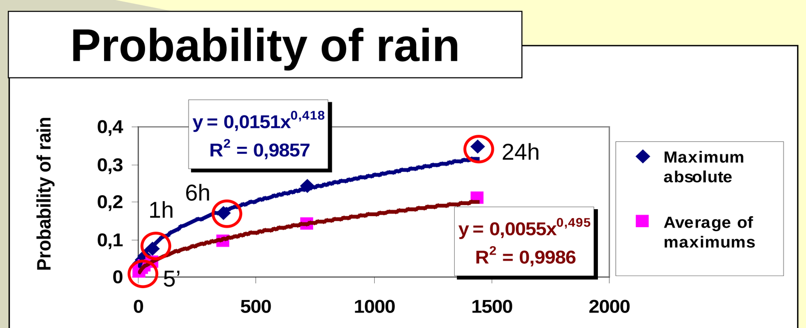




Ratio of change: reduction percentage of **Irregularity** between time scale of observations

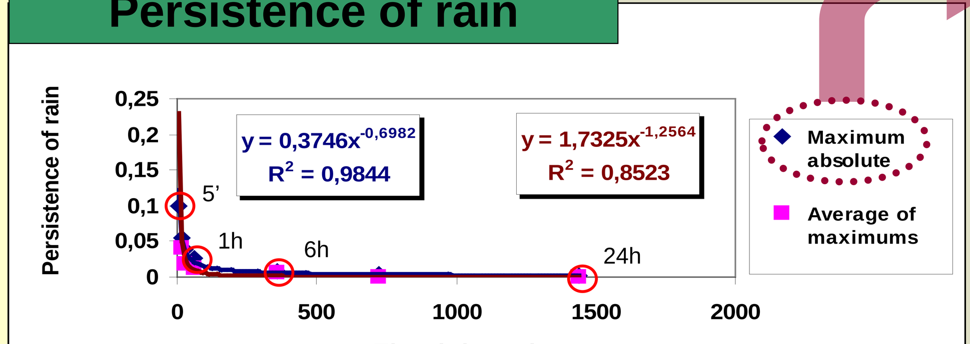
From 5 minutes to 1 hour the main reductions of irregularity take place inland. After 1 hour, mains reductions occur on the coast in relation to the exposure to the dominant wet East winds and the distance to the Sea

Probability of rain

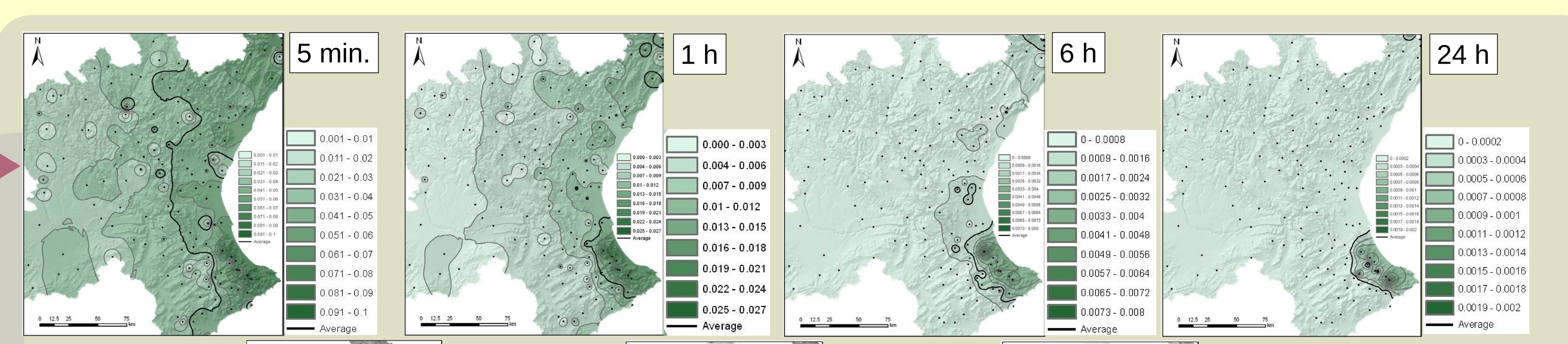


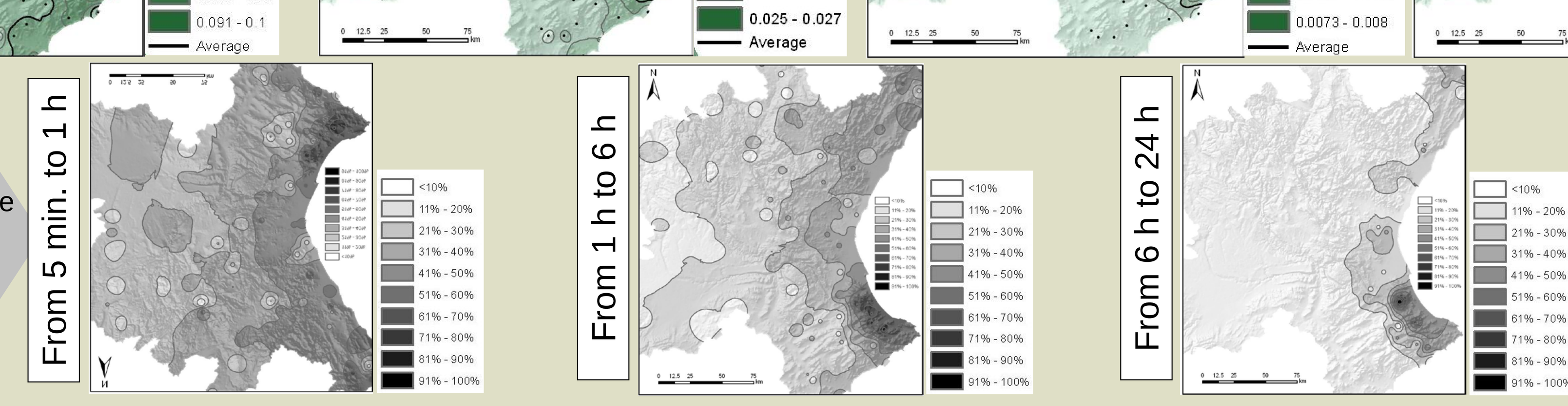
Positive power function time-dependant

Persistence of rain



Negative power function time-dependant





Ratio of change: reduction percentage of **Persistence** between time scale of observations

The persistence is related to the distance to the sea from the first mountainous alignments and to the exposure to winds of components NE and SE. As the time interval increases rain only persists in the mountainous coastal area, exposed to winds of component NE.