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Università degli Studi di Palermo
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INVESTIGATING THE CHANGES IN EXTREME RAINFALL IN SICILY

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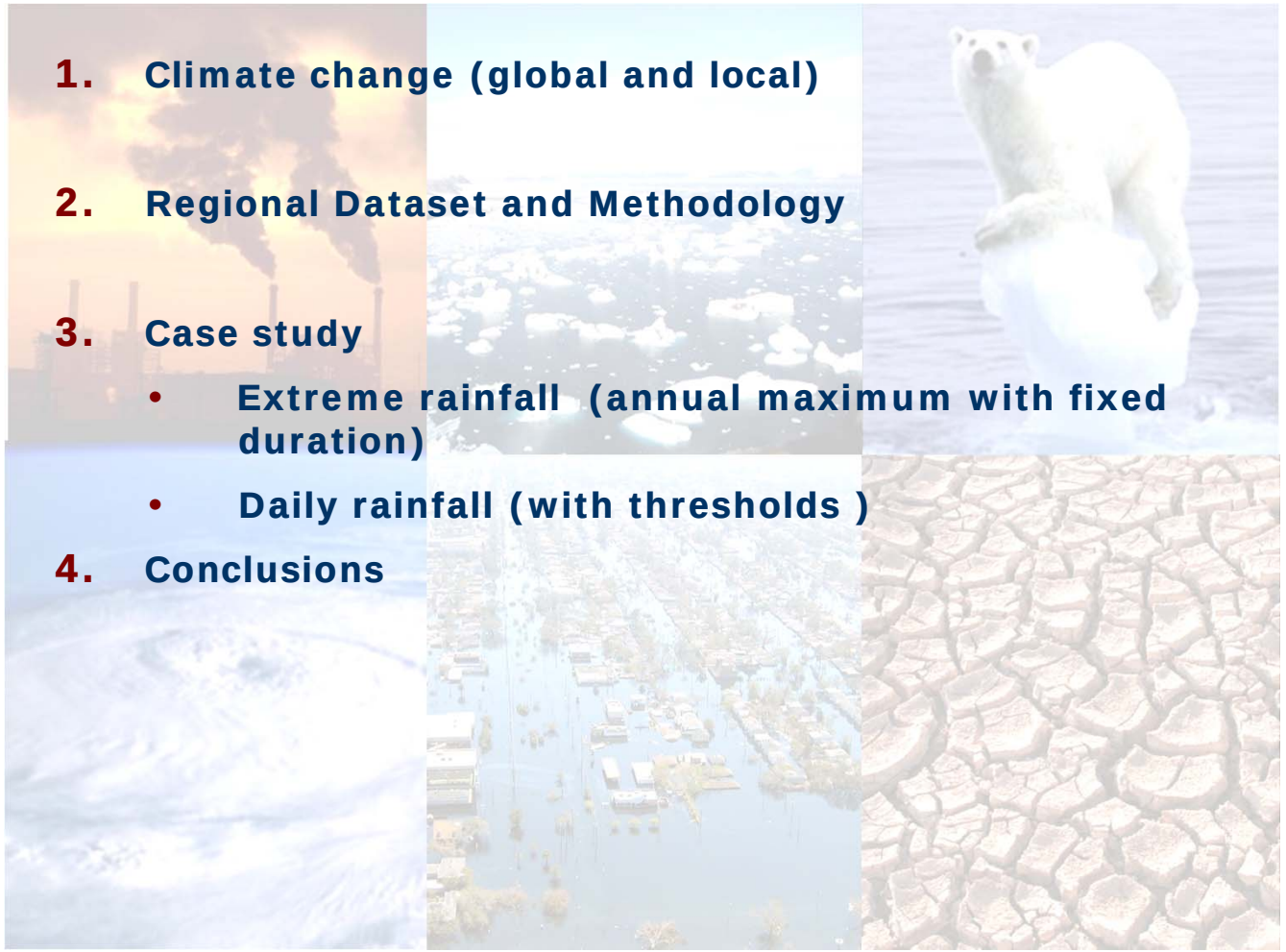
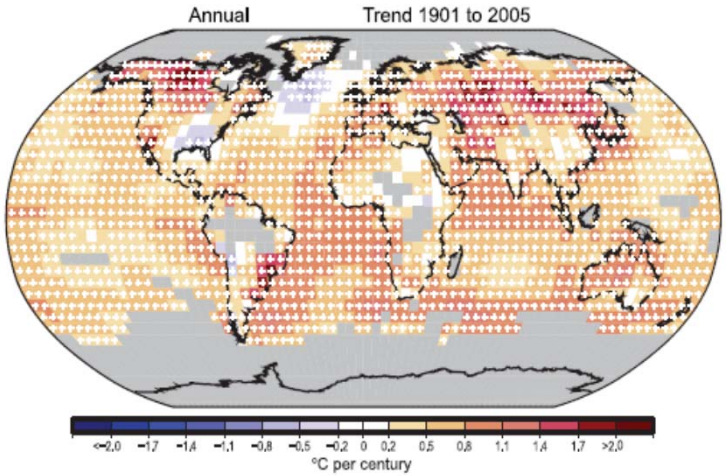
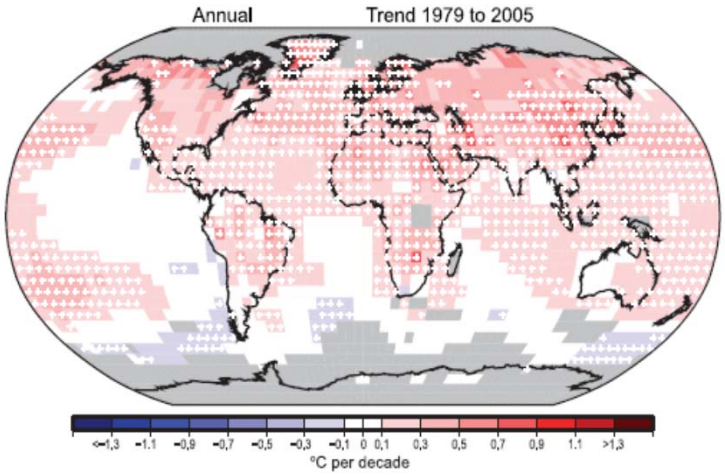
Introduction

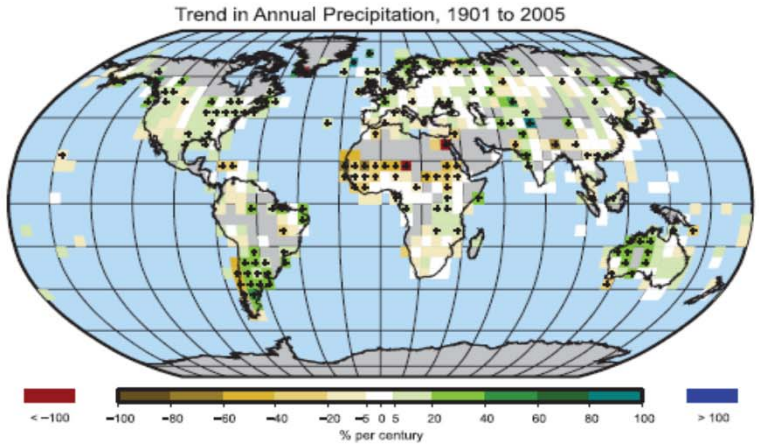


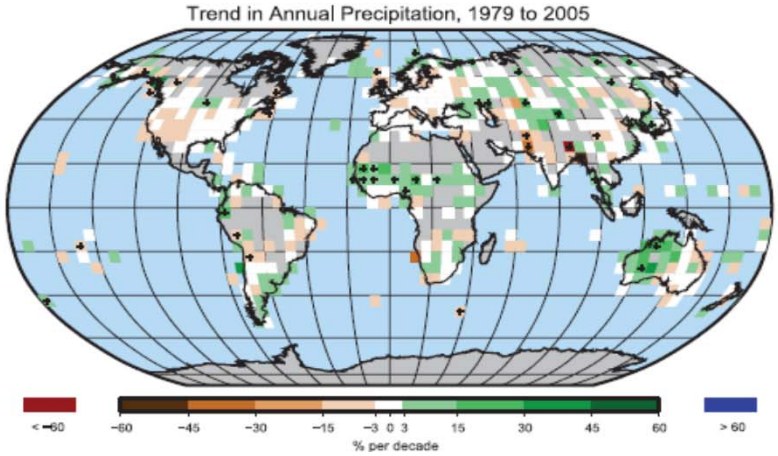
1. Climate change (global and local)
2. Regional Dataset and Methodology
3. Case study
   - Extreme rainfall (annual maximum with fixed duration)
   - Daily rainfall (with thresholds)
4. Conclusions

Climate change (IPCC Reports, 2007).

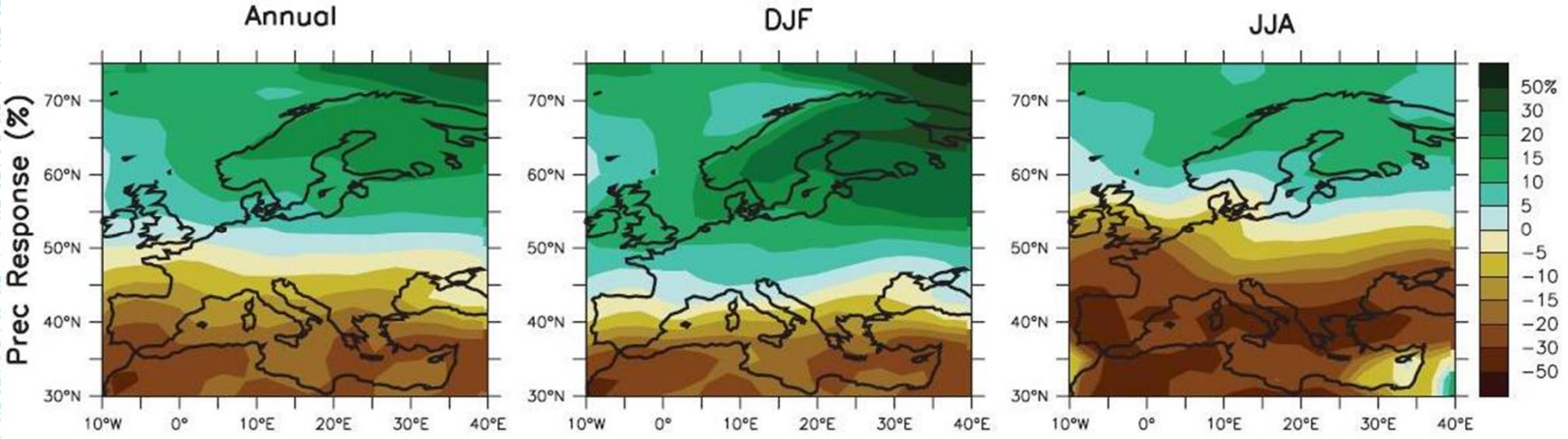


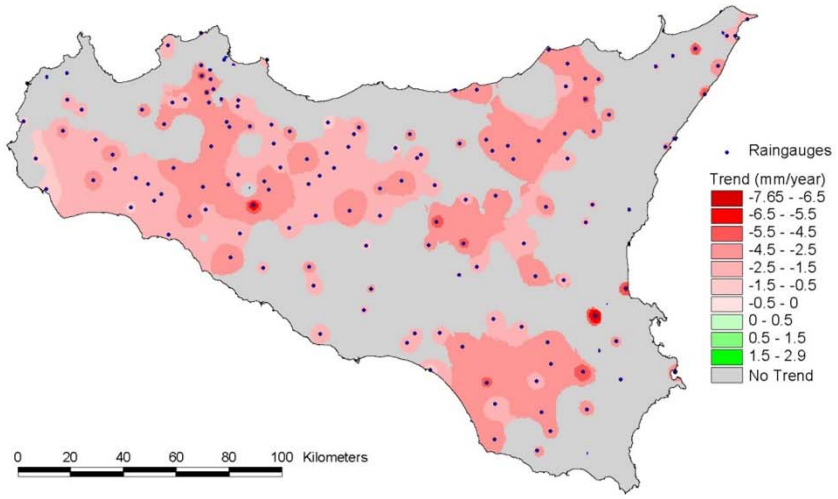




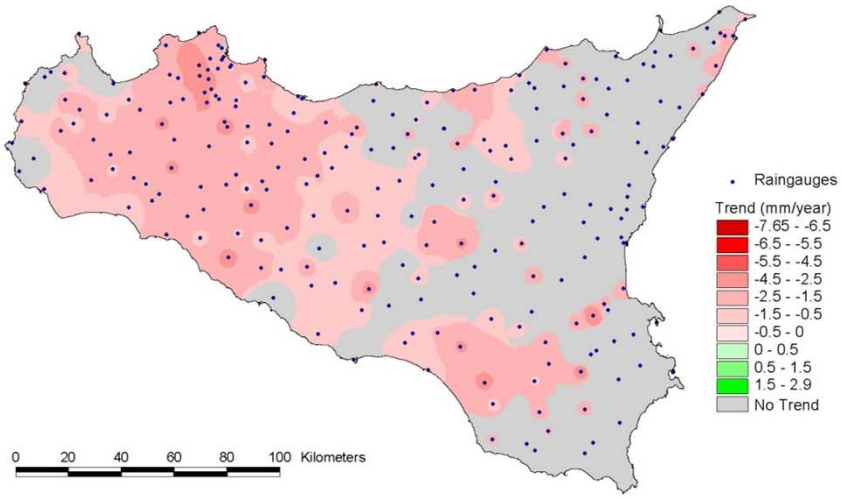


Regional Climate change (Christensen, 2007; Cannarozzo, 2006).





Annual precipitation trend at 95% confidence level



Winter precipitation trend at 95% confidence level

Climate change: main expected (likely) changes

Climate change

↓

Intensification hydrological cycle

Theoretical basis:
Clausius-Clapeyron

exponential increase in specific humidity with temperature

- ✓ ***Del Genio et al.* 1991**
- ✓ ***IPCC* 1996**
- ✓ ***Loaciga et al.* 1996**
- ✓ ***Held and Soden*, 2000**
- ✓ ***Arnell et al.* 2001**
- ✓ ***Huntington et al.* 2005**

Increased evaporation

↓

Increased precipitation

↓

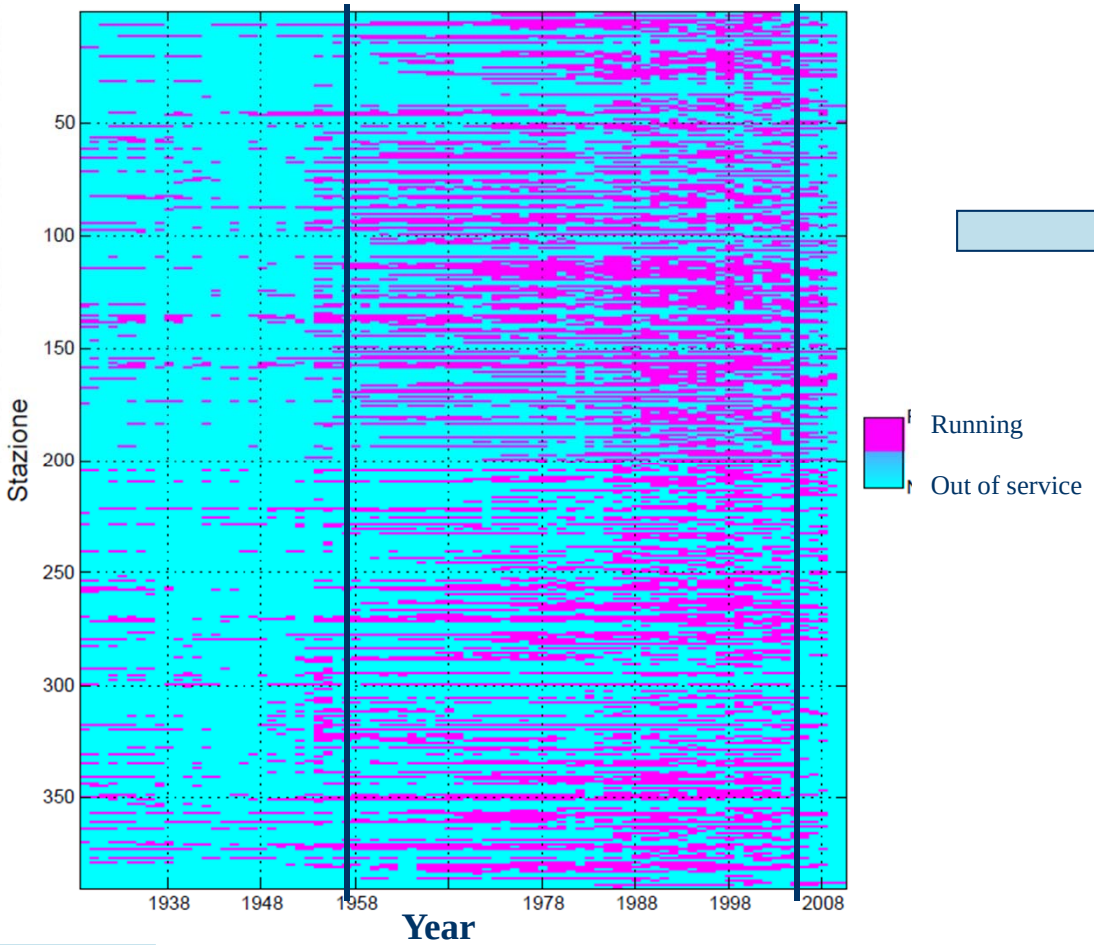
Uneven distribution of precipitation on the surface of the Earth

Main expected (likely) changes:

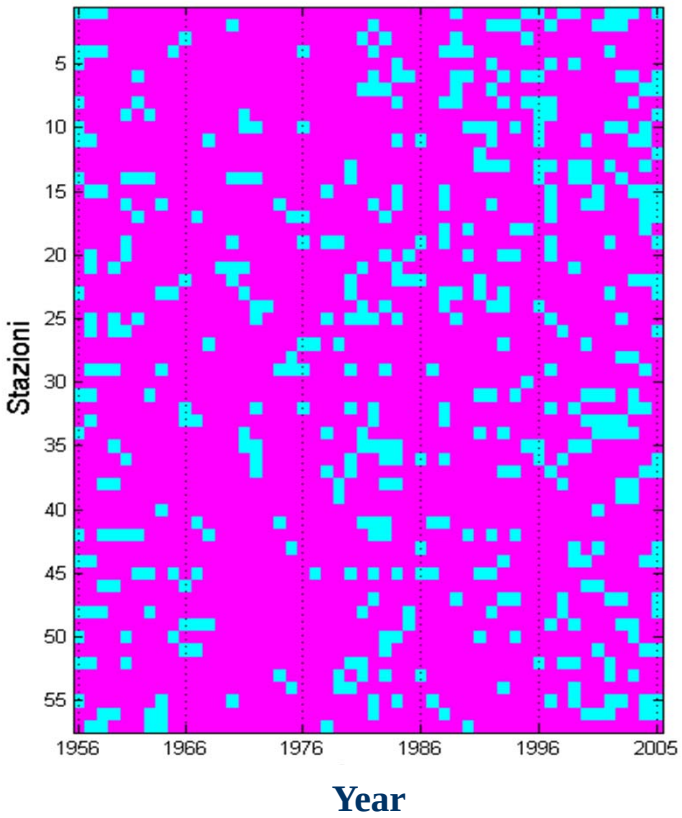
- changes in the characteristics of precipitation (amount, intensity, frequency, duration and type)
- increased frequency of extreme events like droughts and floods
- seasonal and annual changes in river regimes

Dataset

Entire database



Selected subsample
Stations= 57
Years= 50 (1956 - 2005)



Methodology

Mann-Kendall test

Mann-Kendall test allows to inquire on the presence of a tendency of long period in rainfall data, without having to make an assumption on its shape. Mann Kendall test was applied to the series of annual maximum with fixed duration (1, 3, 6, 12, 24h) and to daily rainfall. The Mann Kendall S statistic is calculated as:

$$S=\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}\operatorname{sgn}\left(y_j-y_i\right) \qquad \operatorname{sgn}(y)=\begin{cases}1 & \text{if } y>0\\ 0 & \text{if } y=0\\ -1 & \text{if } y<0\end{cases}$$

Under the null hypothesis that y_i are independent and randomly ordered the statistic S is approximately normally distributed when $n \geq 8$

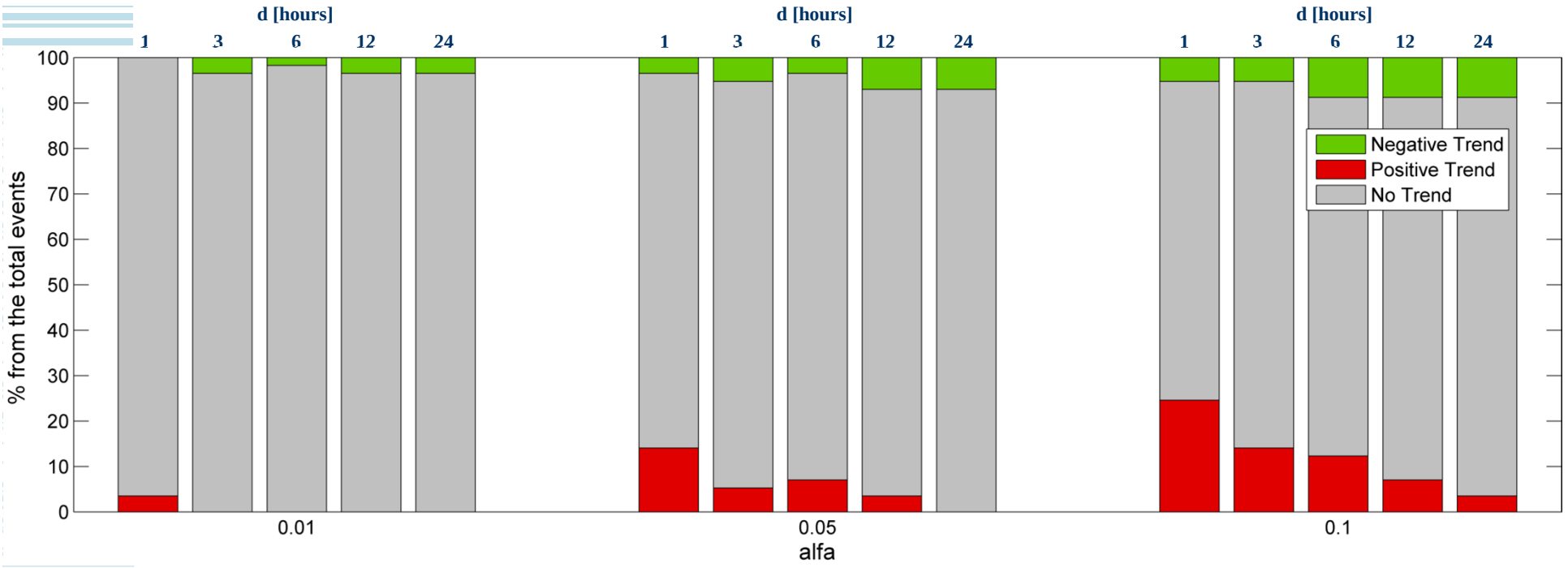
Standardized test statistic Z

$$Z=\begin{cases}(S-1)/\sigma & \text{if } S>0\\ 0 & \text{if } S=0\\ (S+1)/\sigma & \text{if } S<0\end{cases}$$

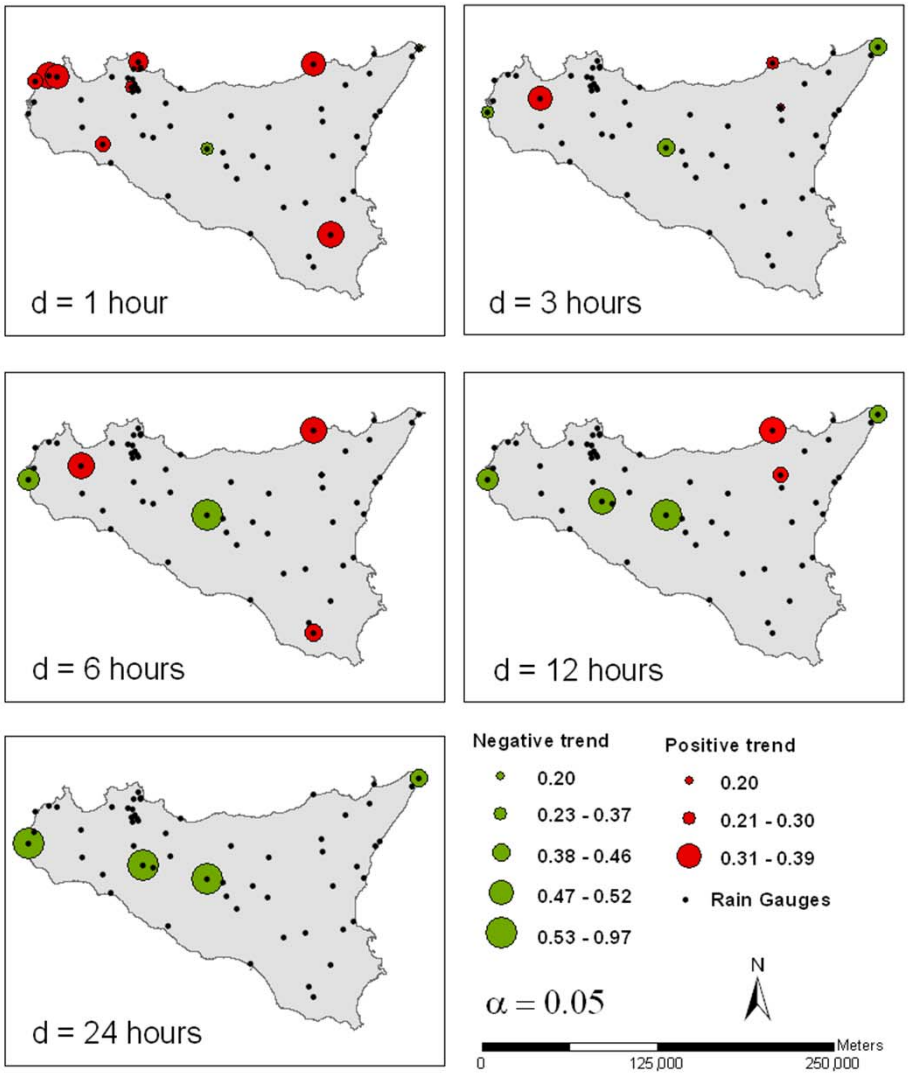
The statistic Z is compared with a standard normal distribution at the required level of significance.. The at-site *significance level p* was obtained by:

$$p=2\left[1-\Phi\left(Z\right)\right]$$

Extreme rainfall (annual maximum with fixed duration)



Extreme rainfall (annual maximum with fixed duration)



Trend magnitude (circles radius) for each station (black dots) and for each duration (left bottom label)

$\alpha = 0.05$

Daily rainfall (with thresholds)

Two different rainfall categories have been used

1	0.1≤ x < 4	Light
2	4 ≤ x < 16	Light-Moderate
3	16 ≤ x < 32	Moderate-Heavy
4	32 ≤ x < 64	Heavy
5	64 ≤ x < 128	Heavy-Torrential
6	128 ≤ x < inf	Torrential

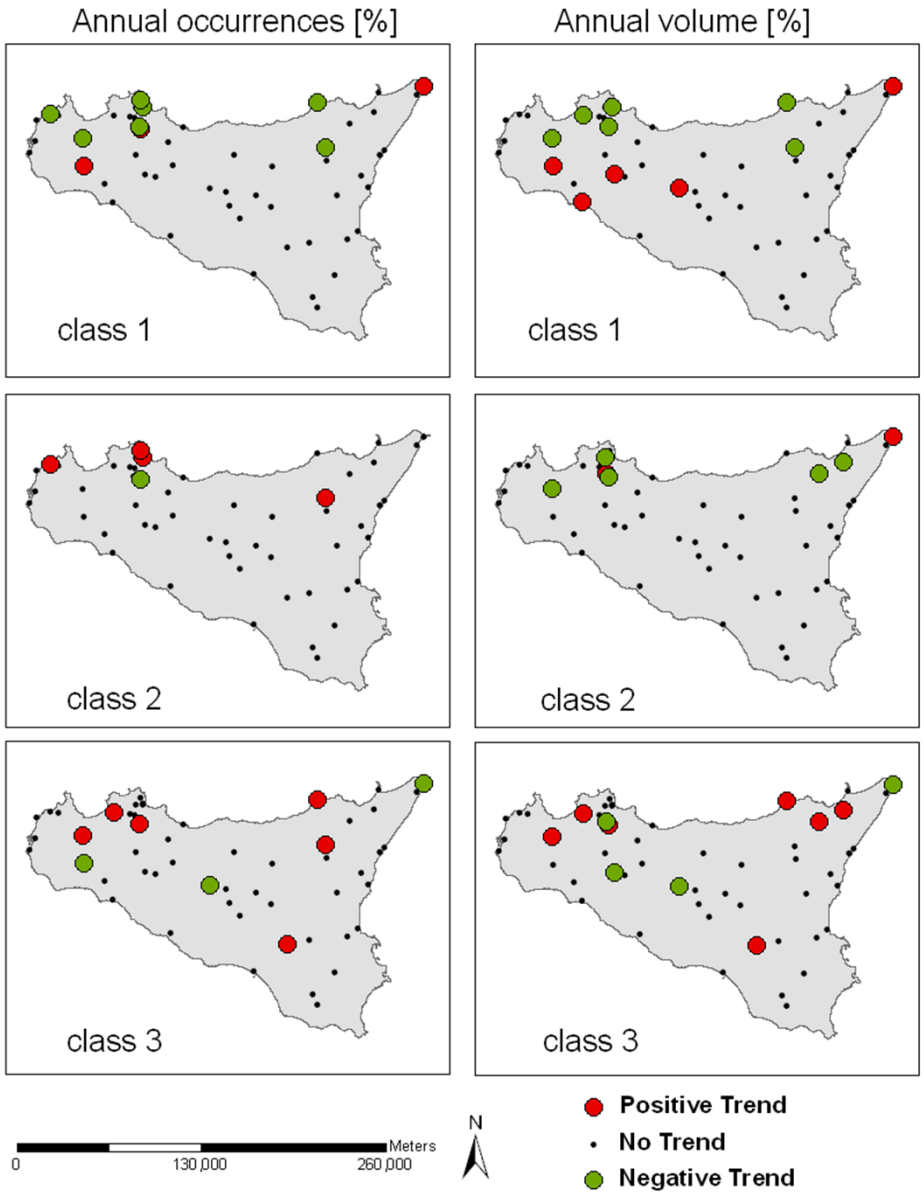
Alpert et al., 2002

1	0.1≤ x < 4	Light
2	4 ≤ x < 20	Moderate
3	20 ≤ x < inf	Heavy-Torrential

Stochastic variables analyzed

- Contribution to annual occurrences [%] from each class;
- Rainfall contribution [%] to the total annual volume from each class.

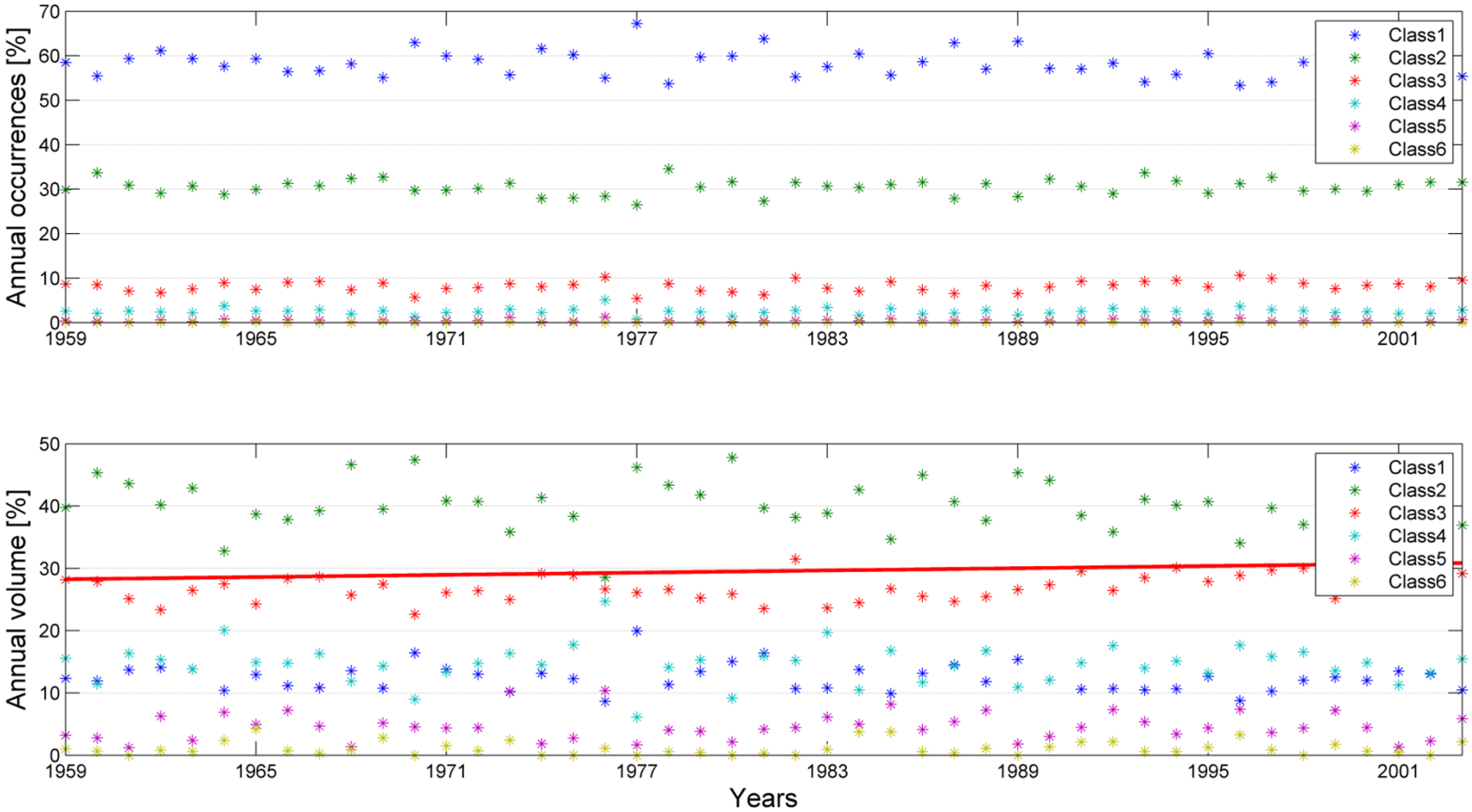
Daily rainfall (with thresholds)



Trend analisys at site.

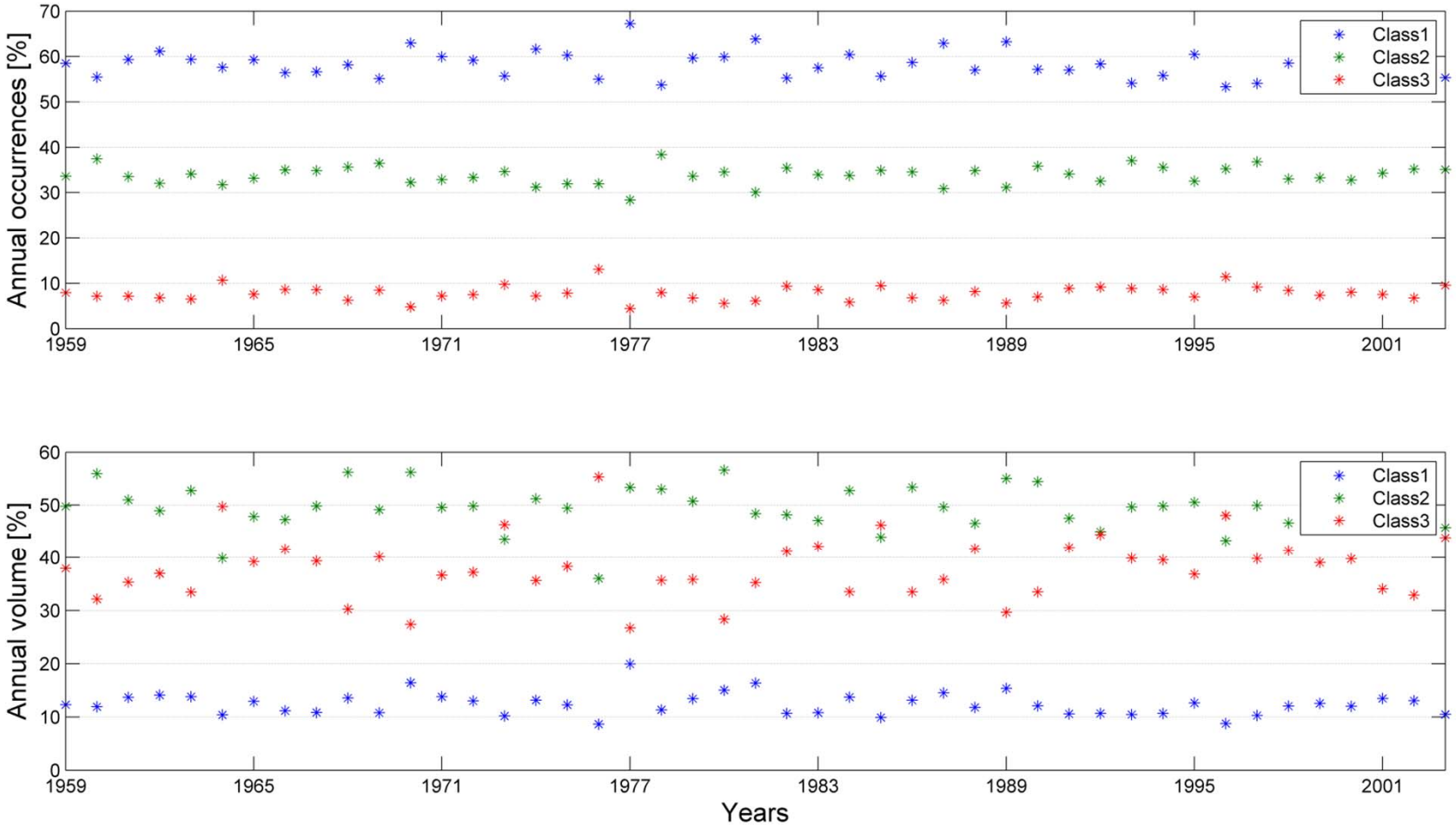
- ✓Dots indicate rainfall stations;
- ✓Circles indicate the presence of a statistical significant trend (α=0.05)
- ✓Circle colors indicate the trend sign.

Daily rainfall (with thresholds)



Regional trend analysis. Each point is the average of the values registered at site.

Daily rainfall (with thresholds)



Regional trend analysis. Each point is the average of the values registered at site.

Conclusions

✓ Earlier reports indicated a *paradoxical* increase of extreme rainfall in spite of decrease in the totals. Here, we analyzed a large Mediterranean region (Sicily island) in order to assess whether this behavior is real and its extent.

✓ Annual maximum rainfall with 1 h duration is going to increase in 15%-20% of the selected stations. No spatial pattern.

✓ The annual occurrences and the volume of light rainfall events is going to decrease in the North.

✓ The annual occurrences and the volume of heavy-torrential rainfall events is going to increase.

✓ Regional analysis, because of the average, hides any tendency.

Thanks!

Cambia lo superficial
cambia también lo profundo
cambia el modo de pensar
cambia todo en este mundo
Cambia el clima con los años
cambia el pastor su rebaño
y así como todo cambia
que yo cambie no es extraño...

Mercedes Sosa.