Observed changes in extreme minimum and maximum temperature and precipitation in Emilia-Romagna (1958-2000)

ARPA-SMR (D9)

Introduction

Most studies concerning the climate variability in Italy are focused on precipitation. A general view of spatial and temporal variability of seasonal and annual precipitation in *Italy* was made by Buffoni et al.(1999) using historical records, and for *different areas* and *time scales* by Cacciamani et al. (1994),Quadrelli et al.(2001b),Tomozeiu et al. (2002). These studies have focused only on trends and changes in total precipitation for specific seasons, not covering with their analyses changes in frequency or intensity of extreme events.
Brunetti et al.(2001) presented an analysis on the frequency of rainy days occurred at selected stations located in the north-east of Italy. This study has shown the presence of stronger and more significant negative trends in the frequency of extremes than in the total precipitation amount, both on yearly and seasonal scale. Unfortunately, the number of stations considered by this study is very small, and this limits the strength of the results.
In the present work we have investigated trends in extremes of precipitation and temperature, as derived from observed station data from Emilia-Romagna. This is a region situated in Northern Italy. The presence of both mountains and sea strongly influences the climate of this region, leading to high spatial variability in most climate indices.

Data and method

The data set used consists of the time series of observed daily minimum and maximum temperature (44 stations) and daily precipitation (62 stations) from Emilia-Romagna (Fig.1) .The data have been provided by the Bologna and Parma offices of the Italian Hydrographic Service and cover the period 1950-2000.

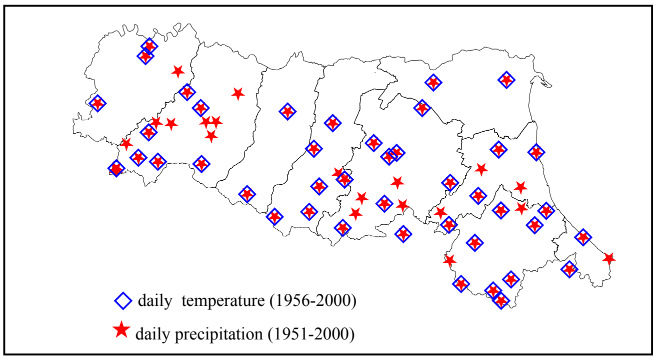

Figure 1: Map of stations used in this study

The extreme events are described using the 10 indices listed in Table 1.

Table 1: STARDEX Diagnostic Extreme Indices

Name	Indices
Prec90	90th percentile of rainday amounts
644R5d	Greatest 5-days total precipitation
646SDII	Simple Daily Intensity
641CDD	Maximum number of consecutive dry days
691R90T	% of total rainfall from events>long-term P90
692R90N	No.of events >long-term 90th percentile of raindays
Tmax90p	90th percentile of maximum temperature
Tmin10p	10th percentile of minimum temperature
125Fd	No. of frost days
144HWD	Heat Wave Duration

These indices are computed starting from daily data of temperature and precipitation and using the official STARDEX extreme index software.
We have made the following set-up in the software:

- rainday threshold = 1mm
- base period for calculation of normals = 1961-1990
- minimum number of days for percentile calculation = 10

Seasonal and annual indices were calculated for every year, and for each station where less than 20% of data were missing. The presence of missing data has reduced the number of stations for which the indices were computed to 30 stations for temperature and 55 for precipitation. The magnitude of seasonal/annual trends was estimated using linear regression while its statistical significance was evaluated by Kendall-Tau test.

Results

In the following, a schematic description of the temporal variability of the above indices is given:

prec90p
Negative trends are detected in *winter* and *spring*, significant only for a small number of stations: 4 for winter and 7 for spring. In general, summer is characterised by positive trends (up to 0.5mm/yr) statistically significant over the Apennines (Fig.2). No significant trend is found in Autumn. Annual trends present a pattern similar to those for winter.

644R5D
Negative and significant trends are obtained for *spring* (1.2mm/yr) while *summer* is characterised by *positive* trends (up to 1.2 mm /yr), statistically significant over the mountains. A *decrease* is noted in *winter* and *autumn*, except for small areas located in the north-east and north-west of Emilia-Romagna. Positive trends, not significant from the statistical point of view, are detected in the time series of annual values.

646SDII
Negative and significant trends are present in *spring* (up to 0.3 mm) while *summer* maintains a *positive* trends (up to 0.12 mm), significant in the mountain and hill area. Winter and autumn do not present significant results, only a slightly positive trend in autumn. Annual trends of simple daily intensity index present positive and significant values especially over the mountain area, while the other areas present slightly negative values.

641CDD
Winter is characterised by a *positive* tendency in the consecutive number of dry days, significant in the plain and hill area(up to 0.6 days/yr). The other seasons do not present significant trends. The annual values are influenced by winter, so that a positive and significant trend is present in most parts of Emilia –Romagna.

691R90T
Generally, this index has *decreased* in *spring* up to 0.6 %/yr and *increased* in *summer* up to 0.7%/yr.The results are less significant in the North and North-eastern parts of the region. Winter and autumn do not present significant results. The annual trend is similar to the summer one, positive in almost all parts of the region.

692R90N
Negative and significant trends are detected in *winter* and *spring* (up to 0.06 events/yr) while *summer* presents a *positive* trends up to 0.05 events/yr, significant especially over the Apennine area. Winter and spring influence the annual trends so that a negative pattern appears in the annual values of 692R90N.

Tmax90p
The 90th percentile of *maximum temperature* has *increased* in all seasons, significant results being observed in winter, spring and summer (up to 0.09°C/yr-Figure 3). The annual Tmax90p presents also a positive trend, significant at almost all stations, with a pattern similar to that obtained for summer.

Tmin10p

Positive and significant trends are obtained in *winter* and *summer* (up to 0.08°C/yr), while spring and autumn are characterized by a slightly positive trend. Positive trends are present also in the annual values, their pattern being close to the summer one.

125Fd

This index has generally *decreased* in *winter* and *spring* (up to 0.7 days/yr), the results being significant at a small number of stations: 7 in winter and 3 in spring. Autumn does not show significant results. Annual values are influenced by winter, so that a decreasing trend appears in almost all parts of the region.

144HWD

The pattern of seasonal trends of HWD are similar to those obtained for Tmax90p. Thus, *positive* and *significant trends* are obtained in *winter*, *spring* and *summer*, more intense in summer when it reaches a value of 0.5 days/yr. Summer influences the annual trends, so that a positive and significant trend is detected, the increase reaching values up to 1.3 days/yr.

Summary

The analysis of extreme precipitation and temperature events shows the presence of significant trends especially in winter, spring and summer in most of the climate indices considered, with a general tendency for a decrease in precipitation and increase in temperature indices.

References

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Appendix1

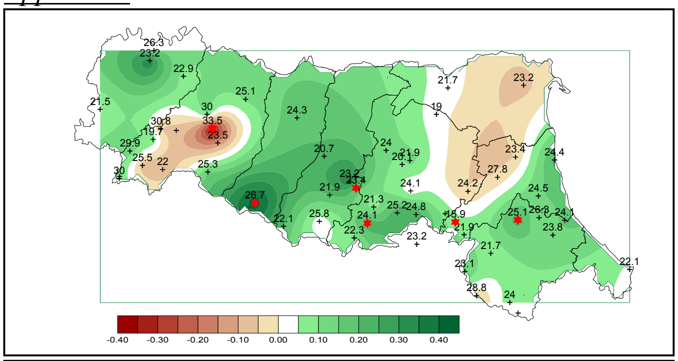

Figure 2: 90th percentile in JJA precipitation with the associated trends (shaded area in mm/winter) 1958-2000. Red dots indicate significant results. Mean values for the index are reported at each station.

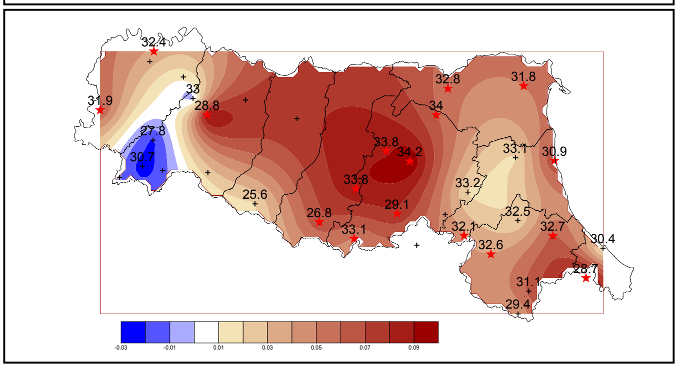

Figure 3: 90th percentile in JJA T_{max} with the associated trend (shaded area in mm/winter) 1958-2000. Red dots indicate significant results. Mean values for the index are reported at each station.