SOME RESULTS ABOUT A FIRST STATISTICAL ANALYSIS ON THE LONG-TERM THERMOMETRIC SERIES OF ROME COLLEGIO ROMANO

PRIMI RISULTATI CIRCA L'ANALISI STATISTICA SULLA LUNGA SERIE TERMOMETRICA DI ROMA COLLEGIO ROMANO

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Abstract
We present some results about a study carried out on the historical thermometric series recorded at the "Collegio Romano Observatory" in Rome between 1862 and 2010.
From raw daily data extracted from the original bulletins, we calculated and explored the annual series of the minimum and maximum temperatures, to identify trends and discontinuities. We have examined break-point also with the help of metadata. For each subseries defined by the break-points we calculated several climatic indices, among those suggested by the ETCCDI and some results are shown. In the last sub-period we observe a strong increase of annual both minimum and maximum mean temperatures. In the more recent sub-period the number of warm spells and Summer days is increased compared to the first one. It is increased also the interannual variability of the events.

Keywords: historical temperature series, metadata, breakpoint, urban climate, climate index.
Parole chiave: Serie storiche di temperature, metadata, discontinuità, clima urbano, indici climatici.

Introduction

In the last decades scientific community has become more aware of the fact that the climate change signals in series of meteorological data, even more in the urban environment, generally are hidden behind non-climatic noise due to several causes: station relocation, changes in instruments and instrument screens, changes in observation times, in observers and observing routines, in algorithms, change in surrounding area, urban growth and so on. Regarding the Collegio Romano Observatory, to have the headquarter of the office designated to collect, store, process and publish meteorological data recorded on the whole Italian territory in the same location of the observatory, has been a lucky coincidence which allowed us to have a great deal of metadata, like information on the history, instruments and methods of observation performed at the observatory and on data processing.

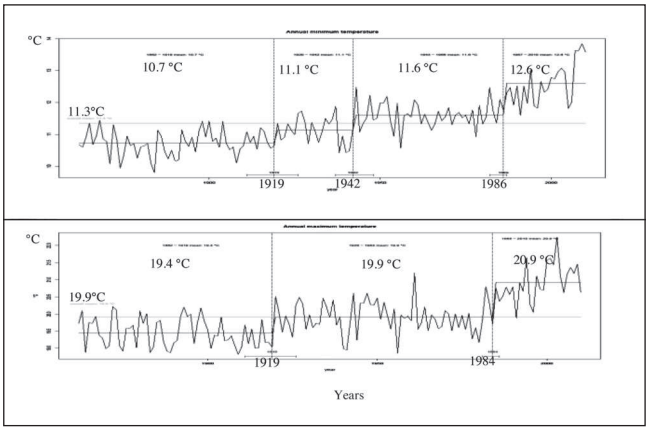

Fig. 1 - Annual mean temperatures (1862-2010) and break points. Top: TN. Bottom: TX.
Fig. 1 - Temperature medie annuali (1862-2010) e break-points. Sopra: TN. Sotto: TX.

Materials and Methods

We present some results about the analysis of annual maximum (TX) and minimum (TN) temperature recorded during 150 years in the centre of Rome, starting from the raw daily measures are recorded between 1862 and 2010 at the Collegio Romano Observatory (CRO) by comparable liquid-in-glass minimum and maximum thermometers. Such daily measures were extracted from original documents gathered at the CRA-CMA seat and transferred into the National Agrometeorological Data Base (BDAN), the computerized archive of the CRA-CMA. They were submitted to several automatic quality control procedures of internal, climatic and spatial consistency. However, once extracted from the BDAN, we submitted data at further tests. Outliers are been verified checking original papers.
The first step has been to elaborate the TX and TN annual average and analyse series to check discontinuities. We adopted analysis by flat step regression using the "STRUCCHANGE" package in the R software (Zeleis *et al.* 2002). Specific advantage of discontinuities analysis is to attract attention about, climatic and non, causes, that are the origin of the climate behavior. In a second time for each sub-period identified by break-points analysis, we have elaborated several climatic indices, among those ones suggested by the Expert Team on Climate Change Detection and Indices (Klein *et al.*, 2009). We present results about warm spells and Summer days analysis.

Results and Discussion

Graphs show some results. Both annual TN and TX series show discontinuities (Fig. 1). About those ones in 1919, they can explain by astronomical factors. In support of this hypothesis, astronomical studies have described (Chernosky, 1966) a minimum in the solar activity in 1912 and the start of a new cycle from this year. About discontinuities observed in mid-eighties, numerous studies have demonstrated in that period a change in the global

Tab. 1 - 90th P TX value per sub-period.
Tab. 1 - Valore del 90° P di TX per sub-periodo.

Subperiod	[1862 - 1919]	[1920 - 1984]	[1985 - 2010]
90th p value (°C)	30,1	30,6	31

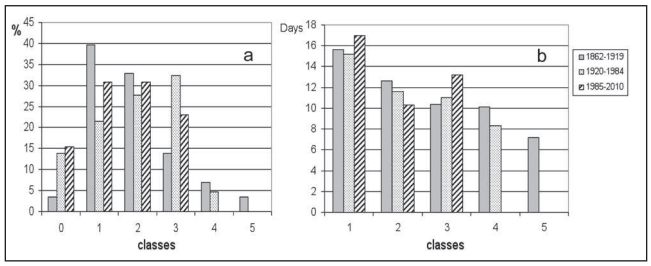

Fig. 2 - a) Frequency of the WS occurrences per year and per sub-period; b) Mean length in days of the WS per classes of occurrence / year and per sub-period.
Fig. 2 - a) Frequenza delle occorrenze di WS per anno e sottoperiodo; b) lunghezza media in giorni delle WS per classe di occorrenza/anno e sottoperiodo.

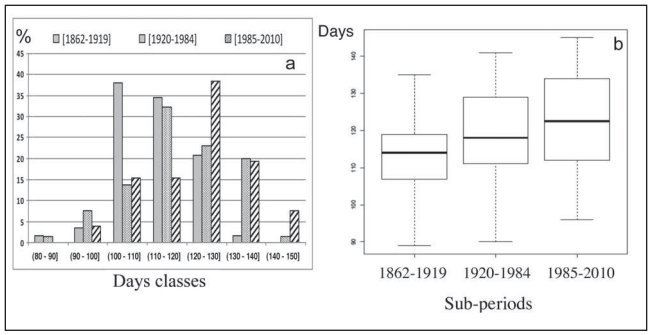

Fig. 3 - a) Yearly frequency and b)distribution in sub-periods of SD (TX>25°C).
Fig. 3 - a) Frequenza annua e b) distribuzione nei sub-periodi dei SD (TX>25°C).

atmospheric circulation which determined a global increase of temperature in Europe (Werner, 2000). Regarding TN discontinuity in 1942 we found information about the movement of the station.
In each TX sub-period, we counted Warm Spells (WS), namely the days in a span of at least six days where TX > 90th percentile. About WS frequencies and the number of occurrences per year, Figure 2a, b summarizes results.
The 90th percentile threshold value is increased from the first to the last sub-period and the mean length of each heat wave, both in the cases of one or three occurrences per year: the consequence is a stronger discomfort. In the most recent period, one or two events occur in 30% and three in 20% of years and the mean length is raised, in case of one and three occurrences. The frequency of years without warm spells is increased from the first period to the last one, evidence of higher variability of the event.
For each TX sub-period, we counted Summer Days (SD), namely the number of days where daily TX > 25 °C.
Over 66% of the years of the last period had more than 120 SD (Fig. 3a). Box-plots graph (Fig. 3b) shows a general shift in high of the number of days (median, 1st and 3rd Q.le) in the more recent SP; at the same time we observe a higher inter annual symmetric variability of occurrences.

Conclusions

The results of the analysis show an increase of maximum and minimum temperature observed in Rome. Particularly, extreme TX have increased in term of values and length. Furthermore we observe an increase of the inter-annual variability of the severe thermal occurrences.
Under the point of view of the evolution of temperature in the heart of the town, a single urban secular thermometric series of observations can be interesting. However, it is not possible to assess the effect of climate change without knowing the true impact of the heat added by overall citizen context. We should not forget that the analyzed thermometric series begins at the end of the the well documented Little Ice Age. The increase of temperature could have a natural origin, in which human activities can contribute in terms non easily quantifiable. In effect, building materials retain heat, the heat coming from the production of energy (i.e.: warming buildings systems, cooling ones -air conditioners give off the warm air-) adds to the natural heat; emissions of greenhouse gases and pollutants due to the traffic have consequence not negligible on the urban climate; in particular smog operates as a cover on the town so that the ability to absorb solar radiation increases, avoids the turnover and the cooling air, modifying the atmospheric cycles and the citizen microclimate (Mariani *et al.*, 2005).

References

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