EGU26-9757, updated on 13 Jun 2026
https://doi.org/10.5194/egusphere-egu26-9757
EGU General Assembly 2026

Analysis of thermo-pluviometric long-period trends for an ultra-centenary urban data series

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Global warming has been an ongoing phenomenon since the mid-20th century, with the Mediterranean basin identified as one of the major climate change hotspots.

To identify climate variability at the local, regional and global scales the scientific community has prompted to intensify the analysis of long, reliable and high quality historical meteorological data.

Here we present a comprehensive climatic analysis of the 190-year-long thermo-pluviometric dataset (1833–2022) recorded at the Historical Meteorological Observatory of the University of Genoa (NW Italy), one of the longest continuous series in the country and part of the global network of 388 weather stations recognized by the World Meteorological Organization (WMO), of which only 22 have a greater or equally long series.

Genoa is a very interesting urban study site which exhibits a peculiar climatic setting within the Italian context, due to its geographic position within the Mediterranean basin and the complex morphology of the surrounding terrain, consisting of slopes degrading steeply towards the sea.

From a meteorological point of view, this sector of Italy is often affected by the convergence between southern warm air masses coming from the Ligurian Sea and colder air masses coming from the northern Po basin. This, combined with exposure to moist southerly air flows carrying important sensible and latent heat fluxes, can trigger the development of convective systems and storm supercells, whose magnitude can be enhanced by orography.

The combined action of atmospheric circulation, geomorphological and orographic factors along with urbanization (e.g., culverted streams and channels) plays a crucial role in causing the occurrence of severe urban floods and mass-wasting processes along slopes that have significant effects on the population, the territory, and the infrastructures.

The aim of the study is to analyse the thermo-pluviometric dataset of this historic station and to explore the temporal variability of its climate extremes, identifying possible statistically significant trends (Mann-Kendall test, 95% confidence-level).

To evaluate variations in extreme events, a set of 8 ETCCDI-defined climatic indices was selected. Annual anomaly values were calculated with respect to the 1991-2020 climatological average, while the analysis of extreme precipitation at the daily and 5-days scales using GEV distribution

was performed. Results reveal a clear and consistent warming pattern, particularly in minimum temperatures during the cold season (November–March), with rates ranging from 0.005 to 0.010 °C/year. The warming trend has intensified since the mid-1980s, testified by 49% of positive thermal annual anomaly for minimum temperatures occurring since 1988, confirming local alignment with broader Mediterranean and global-scale temperature accelerations. Conversely, precipitation analysis indicates a general decrease in rainfall (~200 mm in annual precipitation lost) and rainy days, suggesting a tendency toward longer dry periods and shorter wet spells. Three 1-day extreme rainfall events with return periods exceeding 200 years were identified but no significant trend was observed. Overall, the findings provide robust evidence of significant local climatic change in Genoa, consistent with Mediterranean trends, and offer valuable insights for developing future adaptation and resilience strategies at regional and urban scales.