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High resolution climatology
- towards climate change services

Understanding climate change-induced variations in daily temperature distributions over Italy

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Changes in the variability and the distributional shape of daily temperatures are expected to play a prominent role in explaining the enhanced occurrence of extremely warm events, either on a global or local scale. Variations in the probabilities of warm and cold extremes, indeed, may result from non-trivial variations in the underlying temperature distribution, e.g. the interplay between a simple shift in the mean and more complicated changes in scale or shape. In this context, we investigate variations of daily maximum (TX) and minimum (TN) temperature in Italy during the last 60 years, with the aim of identifying the nature of changes in the probability density functions and the probability of moderate extremes, induced by a warming climate.

We use a set of high-quality, homogenized TX and TN daily records to create complete spatial averages which represent two climatically homogeneous areas defined by a Principal Component Analysis. First, we empirically analyze rates of change from all the portions of TX and TN anomaly distributions by evaluating trends in time-varying percentiles -from the 1st up to the 99th-. Further, we outline the basic properties of the probability density functions and changes in the first and higher moments using the so-called L-moment shape statistics. Results give no evidence for long-term changes in scale or shape of daily anomaly distributions, their temporal evolution being essentially controlled by a forward, non-uniform shift in the mean. Subsequently, we determine changes in the probability of moderate warm and cold extremes -events pertaining to the outermost 10% and 5% tails of the distribution- by studying long-term behavior of a set of percentile-based indices. Then, based on a proper theoretical model for daily anomalies, we provide a realistic representation of the temporal evolution of exceedance probabilities, and show that observed changes can be well understood in the light of the above results. Specifically, consistency between expected and observed exceedance probabilities highlights the role of the inherent non-linearity between variation in the mean and probability of extremes, and demonstrates that the observed temporal evolution of the warm and cold moderate extremes can indeed be explained by a simple rigid translation of the anomaly density functions.