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# Detecting and analyzing regional trends in sub-daily rainfall annual maxima by using the Meta-statistical Extreme Value Distribution

**Eleonora Dallan**[1], Mattia Zaramella[1], Marco Borga[1], and Francesco Marra[2]
[1]Department of Land Environment Agriculture and Forestry, University of Padova, Padova, Italy
[2]National Research Council of Italy - Institute of Atmospheric Sciences and Climate (CNR-ISAC), Bologna, Italy

Global warming is expected to modify the regime of extreme precipitation. Physical laws translate increasing atmospheric heat into increasing atmospheric water content that, together with changes in the atmospheric dynamics, drive precipitation changes. The literature generally agrees that extreme precipitation is changing. However, the study of observed annual maximum time series suggests that trends are highly variable in space and uncertain, also as a result of the inherent large stochastic uncertainty of rainfall maxima. In the present work, we exploit the Meta-statistical Extreme Value (MEV) Distribution to investigate the statistical processes behind these trends and understand how they can be related to changing meteorological conditions. The MEV framework was recently proposed for the frequency analyses of extremes under pre-asymptotic conditions and was shown to significantly improve estimation uncertainty for extreme events by using ordinary events. The narrow confidence interval characterizing MEV is a clear advantage for trend analysis, and its ability to separate storm intensity and yearly occurrence permits to better understand the statistical processes underlying extremes. We gathered data from 33 stations in the Trentino region (Eastern Italian Alps) with at least 25 years of 5-minute resolution records (average density 1/190 $km^{-2}$) and computed the parameters describing the yearly intensity distribution of events at multiple durations ranging from 15 minutes to 24 hours as well as their yearly number. The Regional Mann-Kendall test is used for evaluating the presence of trend in the distribution parameters, number of events per year, estimated quantiles and recorded annual maxima. Results confirm the presence of significant trends in the annual maxima. Trends in the 2-year quantiles estimated yearly using MEV are consistent with the observed trends in annual maxima, which are more marked for 15min to 1 hr duration and less marked for 3hr to 24 hr duration. Conversely, trends in rare quantiles (10-year, 100-year) are significant for durations up to 1 hour and become not significant for longer durations. Analysis of the parameters shows that these trends are likely due to a combination of (i) increasing number of storm events per year and increasing intensity of the storms, and (ii) changes in the tail properties of the storms.