A novel statistical method for the study of short-duration extreme rainfall in a changing climate

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Sub-daily extreme precipitation represents the main trigger of severe hazards such as flash floods and debris flows, which cause fatalities and large damage. Under global warming, the regime of extreme precipitations is expected to change, and understanding these changes is crucial for improving our ability to predict their future dynamics. In particular, a robust estimate of extreme storm occurrence probability that accounts for recent and projected changes in extreme precipitation at different durations is crucial for adapting our risk management strategies.

The Simplified Metastatistical Extreme Value (SMEV) framework is a novel approach for the frequency analyses of extreme precipitation of multiple durations. The method is non-asymptotic, meaning that the occurrence frequency of the storms, and thus its possible change, is explicitly accounted for. This separation between occurrence frequency and storm intensity allows to investigate the statistical processes underlying extremes. Additionally, the approach is based on many "ordinary" events rather than just yearly maxima or a few values over a high threshold, and thus is characterised by narrower confidence intervals, which can be of great advantage for the detection of trends or for applications based on short records such as the climate model runs often available.

We present here two examples in which SMEV has been used for the study of changes in short-duration extreme rainfall in a complex-orographic region: i) the analysis and attribution of recent trends in rare return levels (up to 100 years) based on long observational records; and ii) the analysis of projected changes in extremes based on 10-year time slices from a recently developed high-resolution convection-permitting climate model.

We demonstrate the complexity of the ongoing and future changes of short-duration extreme precipitation in a complex orography region that extends from coastal floodplains to high mountains, and we illustrate the benefits of using this non-asymptotic approach based on ordinary-events for having reliable estimates of these changes from short CPM runs.