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Influence of temperature on extreme rainfall intensity in Sicily (Italy)

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Some climate model experiments suggest an intensification of short-duration extreme precipitation in many parts of the world associated with a warming climate. This behavior could have a physical motivation due to the fact that warmer air has the potential to hold more atmospheric moisture and, then, to provide more water to rainfall events. The theoretical basis of the relationship that links air temperature and atmospheric humidity is provided by the Clausius-Clapeyron relation, according to which, if the relative humidity remains constant, then atmospheric humidity will increase with temperature at a rate (often referred to as CC-rate) in the order of 6-7% °C-1, following the saturation vapour pressure curve as a function of temperature. The study of the relationship between extreme rainfall events and surface temperature could be of capital importance for evaluating the effects of global warming on future precipitation, since it may have important impacts on society with relevant fallouts on several aspects (e.g. flooding, risk protection, etc.).
Different approaches have been proposed for the study at different locations of the scaling relationship between extreme rainfall intensity and surface temperature. In some cases, it has been observed a rate consistent with the thermodynamic Clausius-Clapeyron relation (CC-rate). Nevertheless, in many cases, the existence of scaling rate between temperature and extreme precipitation has been demonstrated with significantly different values with respect to the theoretical CC-rate, being in some cases sensibly higher (super-CC) and in other relevantly lower (sub-CC).
In this work, an analysis of the scaling relationship between sub-daily extreme rainfall and surface temperature in a semi-arid region (Sicily, Italy) is carried out, also investigating the role of different factors, such as the duration of maximum rainfall depths for fixed duration (i.e. 10, 30 and 60 minutes), the type of adopted regression models (exponential regression, two-segments piecewise regression and LOESS - Locally-weighted scatterplot smoothing - regression), and the climate seasonality (unique season for the entire hydrological year; dry season from April to September and wet season for the remaining part of the year). The original dataset is constituted by hourly temperature and 10-minutes rainfall data collected from 2003 to 2015 by the regional agency SIAS (Servizio Informativo Agrometeorologico Siciliano) through 107 weather stations spread over the region.
The results demonstrate that in Sicily the scaling rates are generally lower than the CC-rate; however, the observed tendency towards sub-CC rates is smoothed by the consideration of shorter duration for rainfall maximum depths (higher rates for 10-minutes durations) and under wetter periods (higher rates considering only wet season values), demonstrating how such factors play a fundamental role.