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Studying the relationships between hourly precipitation extremes and dew point temperature in Sicily

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According to the well-known Clausius-Clapeyron relation, the maximum moisture content of the atmosphere increases with approximately 7% per degree temperature raise (CC-scaling rate). Under the hypothesis that relative humidity does not change, an increase in the water vapor should occur at the same rate. For this reason we could expect for the coming years an increase in the intensity of extreme precipitation as a consequence of the global climate warming.

Trend on precipitation extremes and possible links to changes in atmospheric temperature and moisture are investigated in different parts of the world, and a number of observational studies has exhibited scaling rates that are either higher (super-CC) or lower (sub-CC) than CC scaling rate depending on the climatic areas under analysis. One of the most common approaches consists in a regression analysis to interpret the relationships between extreme percentiles of rainfall and surface temperature, and this is often due to the lack of availability of consistent historical data series for other variables of interest, such as the relative air humidity. In some applications, combined temperature-humidity measures, such as the dew point temperature, have been used as proxy measures.

In this study we investigate, at the regional scale (Sicily, Italy), the scaling rate between hourly precipitation extremes and dew point temperature. This last is then used as a measure of near surface absolute humidity and is computed for each rainfall event at the same time (T_0) and, 2 (T_2) and 4 (T_4) hours before the event occurrence. The scaling rate is studied at both the level of entire hydrological year and the seasonal level, dividing the calendar year in a wet, colder and more rainy, season and a dry warmer season.

The high-resolution dataset from the regional agency SIAS (Agro-meteorological Information Service of Sicily) has been used and it is constituted by data of 10-min rainfall, hourly temperature and maximum hourly relative air humidity, collected by 107 gauges from 2003 to 2015. The hourly temperature and maximum hourly relative air humidity data are combined to provide hourly time-series of dew-point temperature at each gauge. The samples from the different gauges are pooled together forming six different samples relative to six different sub-regions defined within the Sicilian island and at the level of entire region (unique regional sample). At the level of single sub-region a binning procedure is used, investigating the suitability of exponential regression models for interpreting the relationships between dew point temperature (median for bin) and extreme rainfall intensity (95^{th} percentile for bin). A LOESS (LOcally-wEighted Scatter-plot Smoothing) regression analysis is considered for the study of the regional sample.

Similar results are obtained from the analysis at the annual level and for the wet season, with high coefficients of determination (R^2 >0.94) for all the sub-regions, demonstrating the appropriateness of the used regression models, and with sub-CC scaling rate (4-5%$^{\circ}C^{-1}$). For the dry season, both the R^2 and the rates (especially for T_2 and T_4) are lower; moreover, the LOESS analysis highlights a decreasing scaling rate at higher dew point temperatures.