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(Article begins on next page)

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How landscape and climate affect the spatial variability of the Italian rainfall extremes? Some initial clues based on I^2-RED

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The intensity and the spatial distribution of precipitation depths are known to be highly dependent on relief and geomorphological parameters. Complex environments like mountainous regions are prone to intense and frequent precipitation events, especially if located near the coastline. Although the link between the mean annual rainfall and geomorphological parameters has received substantial attention, few literature studies investigate the relationship between the sub-daily maximum annual rainfall depth and geographical or morphological landscape features.

In this study, the mean of the rainfall extremes in Italy, recently revised in the so-called I^2-RED dataset, are investigated in their spatial variability in comparison with some landscape and also some broad climatic characteristics. The database includes all sub-daily rainfall extremes recorded in Italy from 1916 until 2019 and this analysis considers their mean values (from 1 to 24 hours) in stations with at least 10 years of records, involving more than 3700 stations.

The geo-morpho-climatic factors considered range from latitude, longitude and minimum distance from the coastline on the geographic side, to elevation, slope, openness and obstruction morphological indices, and also include an often-neglected robust climatological information, as the local mean annual rainfall.

Obtained results highlight that the relationship between the annual maximum rainfall depths and the hydro-geomorphological parameters is not univocal over the entire Italian territory and over different time intervals. Considering the whole of Italy, the highest correlation is reached between the mean values of the 24-hours records and the mean annual precipitation (correlation coefficient greater than 0.75). This predominance remains also in sub-areas of the Italian territory (i.e., the Alpine region, the Apennines or the coastal areas) but correlation decreases as the time interval decreases, except for the Alpine region (0.73 for the 1-hour maximum). The other geomorphological parameters seem to act in conjunction, making it difficult to evaluate, with a simple linear regression analysis, their impact. As an example, the absolute value of the correlation coefficient between the elevation and the 1-hour extremes is greater than 0.35 for the Italian and the Alpine regions, while for the 24-hours interval it is greater than 0.35 over the coastal areas.

To further investigate the spatial variability of the relationship between rainfall and elevation, a spatial linear regression analysis has been undertaken. Local linear relationships have been fitted in circles centered on any of the 0.5-km size pixels in Italy, with 1 to 30 km radius and at least 5 stations included. Results indicate the need of more comprehensive terrain analysis to better understand the causes of local increasing or decreasing relations, poorly described in the available literature.