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Investigating future climate change impacts on drougt patterns over the Euro-Mediterranean area based on a probabilistic approach

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As extensively documented by the IPCC assessment reports, impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones and wildfires, reveal significant vulnerability of many environmental and anthropic systems to climate change. Compared to other extreme weather events, droughts evolve slowly in time. Based on this feature, effective drought preparedness and mitigation strategies could be implemented by decision makers, if appropriate tools, able to anticipate drought evolution in time and space, were available.
Climate models' projections combined with probabilistic tools for drought characterization could help in understanding the time evolution of drought hazard in the future. Within the delineated context, the aim of the present study is to investigate potential scenarios of space-time variability of drought occurrences over Europe, by comparing the return periods of design drought events for different future time intervals. More specifically, annual precipitation data from Regional Climate Models (RCMs) of the Med-CORDEX initiative, covering the Euro-Mediterranean area (Northern Africa and Southern and Central Europe) at a grid resolution of about 50 km, are used to assess drought characteristics for three future periods (i.e. 2011-2040, 2041-2070 and 2071-2100), and compared to those in the baseline period (1971-2000). Specifically, three precipitation RCM datasets – produced by the CMMC (Euro-Mediterranean Center on Climate Change, IT), the LMD (Laboratorie del Météorologie Dynamique, FR) and the GUF (Goethe University Frankfurt, DE) – for two Representative Concentration Pathways, RCP 4.5 (intermediate) and RCP8.5 (high emissions), are considered for multi-year drought identification and characterization.
First, the goodness of fit of several probability distributions to the considered precipitation gridded dataset is examined cell by cell by the Lilliefors test, and the best distribution is chosen for each cell based on the lowest value of the test statistic. Then, the marginal and multivariate probability distributions of drought characteristics (duration and accumulated deficit) are derived as functions of the parameters of the probability distribution of precipitation and the threshold level selected to identify droughts as negative runs. Finally, the return periods of design drought events are computed as the expected value of the interarrival time between consecutive critical droughts, and the possible spatial patterns are investigated.
In general, results confirm an increasing occurrence of severe drought episodes in several regions of the investigated area in the future, although some discordances arise with respect to the different projections over the considered future periods. Apparently, Central Eastern regions of the Mediterranean are likely to become more drought prone, as low values of return periods are obtained.