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Daily and hourly statistical downscaling of CMIP6 climate scenarios for DISTENDER case studies

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Downscaling approaches are a key to translate global climate change projections to regional and local climate scenarios required in adaptation planning. A cutting-edge statistical method was developed under the framework of the European DISTENDER project to produce climate scenarios (1981-2050) of a large number of variables, including precipitation and temperature, at a daily scale for two extensive regions (Austria and the Spanish-Portuguese EURAF region) and at a hourly scale for three small regions: Guimaraes (Portugal), Metropolitan City of Turin (CMTo, Italy) and The North-east of The Netherlands (HUAS). Our method consisted of three steps: 1) Parametric quantile mapping; 2) hourly transfer function; and 3) Geostatistical downscaling. In the first step, a parametric quantile mapping (Monjo et al. 2014) was used to locally transfer reference probability distribution to the Historical and the four main SSP experiments (SSP1-2.6, SSP2-4.5, SSP3-6.0, SSP5-8.5) of three CMIP6 Earth System Models at a daily scale. To make this, ERA5-Land reanalysis data (0.073°×0.073°) was used as a reference. In the second step, for each modeled (targeted) day, the most analogous past day was selected from the reanalysis by comparing their spatial thermal patterns to each targeted day of every climate projection (from the first step) and then linear transfer functions were applied from the maximum/minimum values of each projected day to the hourly curve of its analogous day, so producing a hourly climate projection of that targeted day at the reference 0.073°×0.073° grid. The third step is a purely geostatistical technique with multi-linear AIC-based stepwise regression, fitting high-resolution predictors (land-use, geographical and topographical parameters), with a final bilinear interpolation for the residual errors. The generated climate simulations adequately passed the Kolmogorov-Smirnov test for the historical period. Projections showed a reduction of total precipitation amount in summer (CMTo) and autumn (HUAS and Austria) between 10 and 20%, even decreasing more than 40% during the warmest months in Guimaraes and EURAF. Spring will experience an increase of precipitation up to 20% in CMo, while winter will be 10-30% wettest during the winter season in Guimaraes and HUAS. Maximum temperature will increase up to +3.5ºC in Guimaraes and Austria, and up to +5ºC in CMTo, HUAS and Euraf during summer under the SSP5-8.5 scenario. The developed techniques are ready to be transferred to future projects on climate modeling and environmental applications.