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Assessing climate change over the Marche Region (central Italy) from 1961 to 2100: projected changes in mean temperature and future heat waves characterization (with a statistical evaluation of RCMs local performance)

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Marche region (central Italy, facing the Adriatic Sea) climate dynamics are connected to the Mediterranean basin, identified as one of the most sensitive areas to ongoing climate change. Taken into account difficulties to carry out an overarching assessment over the heterogeneous Mediterranean climate-change issues frame, we opted toward a consistent regional bordered study. Projected changes in mean seasonal temperature, with an introductory multi-statistical model performance evaluation and a future heat waves intensity and duration characterization, are here presented. Multi-model projections over Marche Region, on daily mean, minimum and maximum temperature, have been extracted from the outputs of a set of 7 Regional Climate Models (RCMs) over Europe run by several research Institutes participating to the EU ENSEMBLE project. These climate simulations from 1961 to 2100 refer to the boundary conditions of the IPCC A1B emission scenario, and have a horizontal resolution of 25km $\times$ 25km. Furthermore, two RCMs outputs from Med-CORDEX project, with a higher horizontal resolution (12km x 12km) and boundary conditions provided by the new Representative Concentration Pathway (RCP) 4.5 and 8.5, are considered. Observed daily mean, minimum and maximum temperature over Marche region domain have been extracted from E-OBS gridded data set (Version 9.0) referring to the period 1970-2004. This twofold work firstly provides a concise statistical summary of how well employed RCMs reproduce observed (1970-2004) mean temperature over Marche region in term of correlation, root-mean-square difference, and ratio of their variances, graphically displayed on a 2D-Taylor diagram. This multi-statistical model performance evaluation easily allows:
- to compare the agreement with observation of the 9 individual RCMs
- to compare RCMs with different horizontal resolution (12 km and 25 km)
- to evaluate the improvement provided by the RCMs ensemble.
Results indicate that the 9 RCMs ensemble provides the statistically best reproduction of the observed interannual mean temperature distribution. Secondly, we assessed projected seasonal ensemble average change in mean temperature referring to the ending 21st century obtained by comparison between 2071-2100 and 1961-1990 time slice modeled mean value over Marche region. Results emphasize summer as the season most affected by projected temperature increase (+4.5°C / +5.0°C), followed by spring season temperature increase (+3.5°C / +4.0°C). Finally, considering that some of the most severe health hazards arise from multi-day heat-waves, associated with both hot day-time and warm night-time temperatures, we assessed modeled trend (1961-2100) of the heat waves intensity and duration: intensity through the temporal evolution of the summer (J J A months) maximum and minimum temperature 90th percentile, heat waves length by temporal evolution of two detected threshold-based indices (annual maximum number of consecutive days characterized by Tmin >= 24°C and annual maximum number of consecutive days characterized by Tmax > = 32°C). Same analysis for both coastal and mountainous areas has been conducted.
Future research plans aim to involve ensemble RCMs simulation, processed with bias correction methods, in forcing climate change impacts models, to provide a detailed regional heat waves impacts scenario, mainly over agriculture and health sectors.