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Proposal for transformation of fixed threshold to percentile based climate indices and implications on their changes in the future

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Climate indices, calculated from observations or model simulations, have become a common source of information for many climate impact studies. On the other hand, systematic errors in climate model results often present a barrier for wider use of indices, especially when calculated using the fixed threshold value. We propose and test a method of transformation of fixed threshold indices to percentile threshold indices, that can help to bypass a problem of model biases. To demonstrate the proposed method over Europe, we chose three fixed threshold indices: summer days (SU, $TX > 25$ °C), ice days (ID, $TX < 0$ °C) and number of days with daily rainfall greater than 10 mm (RR10, $RR \geq 10$ mm), and two datasets: E-OBS gridded data and outputs from two regional climate models' (RCMs) simulations from the EURO-CORDEX database. We selected these indices and datasets, after more detailed analysis over Serbia [1], as a convenient subset to test proposed method over wider region.

The initial step in our method is to find corresponding percentile value for each fixed threshold of selected indices, within the historical period 1986-2005, for each grid point of E-OBS data. Then using these percentile values, and model results for the same time period, we set a unique new threshold for each model grid point such that the model-based frequency of events that defines SU, ID, and RR10 is equal to the observed one. The difference between original fixed threshold and the new calculated threshold for each model grid point could be considered as an estimate of the systematic model error, and potentially could be used as additional information for model verification. Finally, we calculated future changes of the indices for the RCP8.5 scenario, using redefined thresholds and applying them for indices calculation over three future periods: 2016-2035, 2046-2065 and 2081-2100. To verify the proposed method, we compared our results of future changes of the indices with changes obtained from results of the same model which are bias corrected (i.e. bias-adjusted EURO-CORDEX) before calculation of the indices. Considering that bias-adjusted data are available just for limited number of all models in EURO-CORDEX ensemble, this method could help to increase number of ensemble members that could be used for analysis of future changes of climate indices, without bias correction of temperature and precipitation.

[1] Tasic, M., Djurdjevic, V., 2019: Transformation of fixed threshold to percentile based climate indices and implication on their change in the future, Book of abstracts, 5th PannEx Workshop: Building PannEx Task Teams to address environmental needs in the Pannonian basin, 3-5. june

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