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Bootstrapping in Recurrence Quantification Analysis for Comparing Different Patterns of Extreme Temperatures

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There are various different approaches for comparing time series usually based on distributional characteristics of data in phase-space or not and/ or with the help of specific classes of models – for example linear or low dimensional chaotic models – that are constrained by various assumptions. Even, the spatial comparison metrics of multiple climate field reconstructions (CFR) methods have not fully quantified the spatial skill of the CFRs and moreover their statistical analysis indicated the need for significant rigorous statistical assessments. For establishing comparisons between two different patterns of time series in Recurrence Quantification Analysis (RQA), a quantitative judgment such as a confidence interval should be established. We adopted the Schinkel et al., (2009) bootstrap method to calculate the confidence bounds of RQA parameters based on a structural preserving resampling that does not require a specific probability distribution. The process was as follows: for a given sample xi (i=1,..,n), n elements were randomly drawn with replacement from the xi and this results to a new distribution xi*. This procedure was repeated for an adequately large number of times and the empirical distribution of the variable was produced. Using this approach, we could resample the distribution of the diagonal or vertical lines and, thus, obtained a new distribution that would be used to compute the bootstrapped values of the RQA parameters. The empirical distributions of the RQA parameters were obtained by repeating the above procedure nbs times. From the empirical distributions, the two-sided $(100-\alpha)$ % confidence interval was then defined as the range between percentiles $\alpha/2$ and $1-\alpha/2$, where the value α determines the spread of the interval (smaller α indicating a broader interval) (Schinkel et al., 2009). The above approach helped to determine whether the changes observed in the RQA patterns are statistically significant when compared to another system patterns. This approach has been applied to comparing extreme maximum/minimum patterns under historical, present and future 1xCO_2 and 2xCO_2 scenarios of a mountainous region in Greece. The confidence intervals of the historical minimum and maximum temperature patterns exhibited strong similarities, while those of the 1xCO_2 and 2xCO_2 climate scenarios portrayed strong divergences.