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Multivariate – Intervariable, Spatial, and Temporal – Bias Correction

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Statistical methods to bias correct global or regional climate model output are now common to get data closer to observations in distribution. However, most bias correction (BC) methods work for one variable and one location at a time and basically reproduce the temporal structure of the models. The intervariable, spatial, and temporal dependencies of the corrected data are usually poor compared to observations. Here, we propose a novel method for multivariate BC. The empirical copula–bias correction (EC–BC) combines a one-dimensional BC with a shuffling technique that restores an empirical multidimensional copula. Several BC methods are investigated and compared to high-resolution reference data over the French Mediterranean basin: notably, (i) a 1D BC method applied independently to precipitation and temperature fields, (ii) a recent conditional correction approach developed for producing correct two-dimensional intervariable structures, and (iii) the EC–BC method.

Assessments are realized in terms of intervariable, spatial, and temporal dependencies, and an objective evaluation using the integrated quadratic distance (IQD) is presented. As expected, the 1D methods cannot produce correct multidimensional properties. The conditional technique appears efficient for intervariable properties but not for spatial and temporal dependencies. EC–BC provides realistic dependencies in all respects: intervariable, spatial, and temporal. The IQD results are clearly in favor of EC–BC. As many BC methods, EC–BC relies on a stationarity assumption and is only able to reproduce patterns inherited from historical data. However, because of its ease of coding, its speed of application, and the quality of its results, the EC–BC method is a very good candidate for all needs in multivariate bias correction.