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# Deterministic and probabilistic optimization of analogs and weather-regimes downscaling algorithms for seasonal precipitation

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We present two statistical-downscaling methods to estimate seasonal precipitation at predetermined stations that rely on global forecasts, using a technique to find past-analog synoptic-weather patterns and their connection to local precipitation. One of the methods utilizes a classification of the large-scale weather patterns into regimes (weather-regimes downscaling) and the other is based on the identification of closest past analogs without grouping the weather events into defined regimes (a “pure analogs” approach, analogs downscaling).
Determining the closest past synoptic pattern requires the definition of a distance between the present and past states. We have chosen to work with a general definition of distance following the Minkowski metric of order p (p-norm distance). In an attempt to explain the uncertainty associated with the determination of past analogs, not only the closest state to the actual event is identified, but also the following ones, up to n, and their contributions are weighted in inverse proportion to their squared distances.
The sensitivity to n and p was objectively analyzed using deterministic and probabilistic verification procedures with the aim of optimizing the algorithms. Two types of information are relevant to the end users in this study: (1) the absolute seasonal precipitation amount and (2) whether a given precipitation threshold of the climatology distribution is exceeded or not.
We analyzed the ability of the downscaling algorithms to reproduce the seasonal amount by deterministically evaluating the linear relationship between the downscaled and observed seasonal precipitation amounts. Next, we checked the improvement by the downscaling method over an existing reference forecast in providing threshold exceedance information. In the absence of a downscaling algorithm, the only gauge-specific available seasonal forecast was the seasonal climatological mean of the precipitation at the site. The skill of the downscaling estimations was assessed in terms of four attributes relevant to the end user: accuracy, reliability, resolution, and discrimination relative to the observed climatological mean. To analyze these attributes we calculated Brier skill scores, their decomposition into reliability and resolution terms, and the area under the relative-operating curve. These are calculated for the probability of exceeding the 66th percentile and of not reaching the 33rd percentile.
Results show that skill full deterministic and probabilistic estimates of seasonal precipitation at each site are obtained with our downscaling methods. Our analysis shows that weighting n=2,3 analogs/weather regimes results in significant improvement as compared to relying on the closest past state only, but no further improvement is attained for n>3. The sensitivity of the downscaling algorithm to p-norm is different whether the algorithm is verified deterministically or probabilistically.