Geophysical Research Abstracts
Vol. 14, EGU2012-8308, 2012
EGU General Assembly 2012

Probability-weighted historical patterns for downscaling seasonal forecasts using minimum relative entropy

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Seasonal forecasts based on large scale circulation patterns provide weak predictive power for climatic deviations with lead times of several months. For example, the ENSO and PDO indices from November to February contain some information about the climate in the Pacific Northwest of the USA from April to August. These forecasts are probabilistic and large scale, often concerning regional averages over several months.

To be useful in planning for, for example, management of hydropower reservoirs, these forecasts need to be downscaled to finer space and time resolution, providing reasonable realizations of spatial and temporal variability and correlations. Especially for planning of multiple-reservoir systems, which are interconnected through both the hydrological network and the power-grid, it is important to have correct statistical properties at smaller scales, while still benefitting from the information about the large scales.

One method to achieve this is to use the forecast to obtain a probability weighted ensemble of historical patterns, e.g. fields or time series of observations. These ensembles, having non-uniform weights, can be used in weighted Monte-Carlo simulations for risk analysis and planning of reservoir operations.

We present a method to determine the weights based on moments of the large-scale forecast, while ensuring the deviations from uniform weights do not introduce more information than is warranted by the forecast. This is ensured by minimizing the relative entropy from the original uniform distribution of weights to the new weights, while simultaneously satisfying the constraints posed by the moments of the large-scale forecast information.

We analyze the results of the minimum relative entropy update and compare it to other methods for obtaining weighted ensemble forecasts. This analysis from an information-theoretical perspective shows how the new method balances information and lost uncertainty, while other methods may not use all information or create false certainty.