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Improving the Analog Ensemble Wind and Solar Power Forecasts for Rare Events

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The analog ensemble (AnEn) technique has been developed by the National Center for Atmospheric Research (NCAR) to generate probabilistic predictions of meteorological variables, the wind and solar power, and load. Its adaptability to a wide range of energy-related applications is documented by several papers focused on the wind (Alessandrini et al., 2015, Junk et al., 2014) and solar power (Davo et al., 2016) forecasting, and the optimal bidding in the day-ahead energy market (Alessandrini et al., 2014).

The AnEn method is built using a historical time series of past forecasts (past runs) from a meteorological model and observations. For each forecast lead time, the ensemble set of predictions is constituted by a set of observations from the past. These observations are those concurrent with the past forecasts at the same lead time, chosen across the past runs most similar to the current forecast. Recent applications have demonstrated that the AnEn introduces a conditional negative bias when predicting events in the right tail of the forecast probability density function (PDF). Also, the AnEn error (underestimation) increases as the predicted event is rarer. This error is found to be dependent on the difference between the analog forecasts mean $< f_{an} >$ and the current forecast f .

The simplest proposed approach is to add the adjustment factor ($f - < f_{an} >$) to each analog member obs_{an} which are the past observations corresponding to the past analog forecasts. This method works under the assumption that a linear relationship between the forecast and the observations holds. But, in the case of wind power, for instance, a power curve must be used to properly compute the adjustment factor.

We will apply the AnEn with the proposed bias correction method to three datasets. One consists of wind observations over the US from more than 500 stations. The second dataset is made of wind power data from a wind farm located in in the South of Italy. The third dataset consists of solar power data from the Shagaya farm located in Kuwait. In all cases, we will show that the conditional negative bias introduced by the AnEn in its standard application is significantly reduced by our novel approach.

This new feature of the AnEn algorithm is demonstrated not only to reduce the conditional bias but also to improve other probabilistic attributes such as the reliability and resolution.