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Kalman Filter Post-Processing of the Wind Speed and Gusts NWP and Analog-Based Forecasts: Performing Sensitivity Tests

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Weather forecasting is based on the NWP models for a long time. Although their skill is constantly improving, their limitations are still substantial. This is especially the case in the complex terrain, even when referring to the high-resolution mesoscale models. Besides, NWP models require massive computational resources, and their requirements grow excessively with the refinement of the spatiotemporal scale. Thus, in addition to the further model development, the forecast improvement can be obtained by statistical post-processing of raw NWP forecasts for the locations where measurements are available. The post-processing methods analyzed in this work are based on the analog and Kalman filter (KF) approach.

The focus of this study is to perform a sensitivity test to find the optimal value of the variance ratio *r* in the KF algorithm for different forecasts. The KF algorithm is applied to generate four different forecasts: KF (KF applied to the raw NWP time-series), KFAN (KF applied to the analog-method time-series), KFAS (KF applied to NWP forecasts in analog space), and KF-KFAS (KF applied to the KFAS time-series). The post-processing is applied to the point-based predictions of wind speed and wind gust. The forecasting range is 72 hours, and the measurements include 61 locations across the Republic of Croatia.

The wind forecasts are analyzed considering the variables as both continuous and categorical. The continuous verification relies on RMSE decomposition, spectral analysis, and quantile-quantile plot. The categorical verification includes the equitable threat score, frequency bias measure, extremal dependence index, and frequency measure. The verification is conducted to assess the improvement for both the overall data and for the relatively extreme events. The results suggest that for the KF and KFAS forecasts the *r*-value of 0.01 is recommended, whereas for the KFAN and KF-KFAS forecasts the *r*-value should be set to 0.001. Even though different r-value implementations yield certain trade-offs, the proposed *r*-values are considered optimal since they lead to excellent results for the overall data, and the results remain adequate even for strong wind.