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Probabilistic Deep Learning for Postprocessing Wind Forecasts in Complex Terrain

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The numerical weather predictions (NWPs) approach to forecasting of surface winds and their corresponding uncertainty in complex terrain remains an important challenge. Even for kilometer-scale NWP, many local topographical features remain unaccounted, often resulting in biased forecasts with respect to local weather conditions.

Through statistical postprocessing of NWP, such systematic biases can be adjusted a posteriori using wind measurements. However, for unobserved locations, these approaches fail to give satisfying results. Indeed, the complex and nonlinear relationship between model error and topography calls for more advanced techniques such neural networks (NN).

In addition, the prevalence of aleatoric uncertainties in wind forecasts demands the adoption of a probabilistic approach where the statistical model is not only trained to predict an error expectation (the bias), but also its scale (standard deviation). In this context, the model must be trained and evaluated using a proper scoring rule.

To this end, we developed a machine learning application to efficiently handle very large datasets, train probabilistic NN architectures, and test multiple combinations of predictors. This enabled us to improve the quality of the model direct output not only at the location of reference measurements, but also at any given point in space, and for forecasts up to 5 days. More importantly, the results underline that the combination of physical models with a data-driven approach opens new opportunities to improve weather forecasts.

Thematic area

1. Machine Learning for Product development - Including NWP Post-processing, Non-linear Ensemble Averaging, Development of new NWP Products

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