Geophysical Research Abstracts
Vol. 21, EGU2019-2272, 2019
EGU General Assembly 2019

Neural networks for post-processing ensemble weather forecasts

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Ensemble weather predictions require statistical post-processing of systematic errors to obtain reliable and accurate probabilistic forecasts. Traditionally, this is accomplished with distributional regression models in which the parameters of a predictive distribution are estimated from a training period. We propose a flexible alternative based on neural networks that can incorporate nonlinear relationships between arbitrary predictor variables and forecast distribution parameters that are automatically learned in a data-driven way rather than requiring pre-specified link functions. In a case study of 2-meter temperature forecasts at surface stations in Germany, the neural network approach significantly outperforms benchmark post-processing methods while being computationally more affordable. Key components to this improvement are the use of auxiliary predictor variables and station-specific information with the help of embeddings. Furthermore, the trained neural network can be used to gain insight into the importance of meteorological variables thereby challenging the notion of neural networks as uninterpretable black boxes. Our approach can easily be extended to other statistical post-processing and forecasting problems. We anticipate that recent advances in deep learning combined with the ever-increasing amounts of model and observation data will transform the post-processing of numerical weather forecasts in the coming decade.