A Deep Learning Bias Correction Approach for Rainfall Numerical Prediction

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Numerical weather prediction (NWP) models are currently popularly used for operational weather forecast in meteorological centers. The NWP models describe the flow of fluids by employing a set of governing equations, physical parameterization schemes and initial and boundary conditions. Thus, it often face bias of prediction due to insufficient data assimilation, assumptions or approximations of dynamical and physical processes. To make gridded forecast of rainfall with high confidence, in this study, we present a data-driven deep learning model for correction of rainfall from NWP model, which mainly includes a confidence network and a combinatorial network. Meanwhile, a focal loss is introduced to deal with the characteristics of longtail-distribution of rainfall. It is expected to alleviate the impact of the large span of rainfall magnitude by transferring the regression problem into several binary classification problems. The deep learning model is used to correct the gridded forecasts of rainfall from the European Centre for Medium-Range Weather Forecast Integrated Forecasting System global model (ECMWF-IFS) with a forecast lead time of 24 h to 240 h in Eastern China. First, the rainfall forecast correction problem is treated as an image-to-image translation problem in deep learning under the neural networks. Second, the ECMWF-IFS forecasts and rainfall observations in recent years are used as training, validation, and testing datasets. Finally, the correction performance of the new machine learning model is evaluated and compared to several classical machine learning algorithms. By performing a set of experiments for rainfall forecast error correction, it is found that the new model can effectively forecast rainfall over East China region during the flood season of the year 2020. Experiments also demonstrate that the proposed approach generally performs better in bias correction of rainfall prediction than most of the classical machine learning approaches .