

Short Range Hourly Temperature Forecasting in Relation to National Weather Prediction Models: A Breakthrough

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Accurate weather predictions are crucial to infrastructure, economic security, and disaster prevention. Short-range hourly temperature forecasting has been the purview of statistical numerical weather prediction (NWP) models. Recently, neural networks have shown promise, but not been sufficiently evaluated in temperature forecasting. This study explores optimal preprocessing methods, training, models, losses, metrics, and reproducibility for hourly temperature forecasting up to 48 hours. 2010-2020 ERA5 reanalysis data for Indianapolis with a large number of features were trained, validated against 2021, and tested on the first half of 2022, in comparison to state-of-the-art HRRR (High-Resolution Rapid Refresh Forecast). MSE and MAE metrics were inconsistent in correlation to ground truth; these losses were outperformed by a custom threshold-weighted loss. An ensemble shallow bidirectional LSTM with the custom loss outperformed other models, including HRRR, statistical models, and deeper and more complex neural network models such as different types of transformers. Results were 2-3 times more correlated to ground truth than HRRR, and reproducible in other cities. These models and processes can be trained on a laptop, one time, and used for predictions for every hour in under a second, indefinitely; making them especially useful for local county-specific weather predictions and resource-poor nations. They are applicable to further research in all other weather parameters and for longer-range weekly and monthly forecasting. These more accurate, skillful, longer-range forecasts of hourly temperature can markedly improve load forecasts, and thereby proper management of infrastructure grids, preventing deaths and economic destruction.