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Prediction of $PM_{2.5}$ Concentration in Ulaanbaatar with Deep Learning Models

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Abstract : Rapid socio-economic development and urbanization have led to an increasingly serious air pollution problem in Ulaanbaatar (UB), the capital of Mongolia. $PM_{2.5}$ pollution has become the most pressing aspect of UB air pollution. Therefore, monitoring and predicting $PM_{2.5}$ concentration in UB is of great significance for the health of the local people and environmental management. As of yet, very few studies have used models to predict $PM_{2.5}$ concentrations in UB. Using data from 0:00 on June 1, 2018, to 23:00 on April 30, 2020, we proposed two deep learning models based on Bayesian-optimized LSTM (Bayes-LSTM) and CNN-LSTM. We utilized hourly observed data, including Himawari8 (H8) aerosol optical depth (AOD), meteorology, and $PM_{2.5}$ concentration, as input for the prediction of $PM_{2.5}$ concentrations. The correlation strengths between meteorology, AOD, and $PM_{2.5}$ were analyzed using the gray correlation analysis method; the comparison of the performance improvement of the model by using the AOD input value was tested, and the performance of these models was evaluated using mean absolute error (MAE) and root mean square error (RMSE). The prediction accuracies of Bayes-LSTM and CNN-LSTM deep learning models were both improved when AOD was included as an input parameter. Improvement of the prediction accuracy of the CNN-LSTM model was particularly enhanced in the non-heating season; in the heating season, the prediction accuracy of the Bayes-LSTM model slightly improved, while the prediction accuracy of the CNN-LSTM model slightly decreased. We propose two novel deep learning models for $PM_{2.5}$ concentration prediction in UB, Bayes-LSTM, and CNN-LSTM deep learning models. Pioneering the use of AOD data from H8 and demonstrating the inclusion of AOD input data improves the performance of our two proposed deep learning models.

Keywords : deep learning, AOD, PM2.5, prediction, Ulaanbaatar
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