Author Response to Topic Editor

We thank the topic editor for the time and effort put in towards the review of this manuscript. The detailed comments have helped improve the manuscript significantly. The detailed responses to the topic editor comments are given below.

Minor comments.

Comment. Could you revise abstract for better transfer of results and implications?

Response. We revised the abstract.

Abstract. Despite recent progress of numerical air quality models, accurate prediction of fine particulate matter ($PM_{2.5}$) is still challenging because of uncertainties in physical and chemical parameterizations, meteorological data, and emission inventory database. Recent advances in artificial neural network can be used to overcome limitations in numerical air quality models. In this study, a deep neural network (DNN) model was developed for a 3-day forecasting of 6-hour average $PM_{2.5}$ concentrations - the day of prediction (D+0), one day after prediction (D+1) and two days after prediction (D+2). The DNN model was evaluated against the currently operational Community Multiscale Air Quality (CMAQ) modelling system in South Korea. Our study demonstrated that the DNN model outperformed the CMAQ modelling results. The DNN model provided better forecasting skills by reducing the root-mean-squared error (RMSE) by 4.1 μgm^{-3}, 2.2 μgm^{-3} and 3.0 μgm^{-3} for the 3 consecutive days, respectively, compared to the CMAQ. Also, the false-alarm rate (FAR) also decreased by 16.9 %p (D+0), 7.5 %p (D+1), and 7.6 %p (D+2), indicating that the DNN model substantially mitigated the overprediction of the CMAQ in high $PM_{2.5}$ concentrations. These results showed that the DNN model outperformed the CMAQ model when it was simultaneously trained by using the observation and forecasting data from the numerical air quality models. Notably, the forecasting data provided more benefits to the DNN modelling results as the forecasting days increased. Our results suggest that our data-driven machine learning approach can be a useful tool for air quality forecasting when it is implemented with air quality models together by reducing model-oriented systematic biases.

Comment. We also found out a type such as YUS which may be YSU.

Response. We modified YUS to YSU.