Statistical Forecasting of Ozone in Beijing: Evaluating Multiple Time Series Models and the Impact of Meteorological Factors

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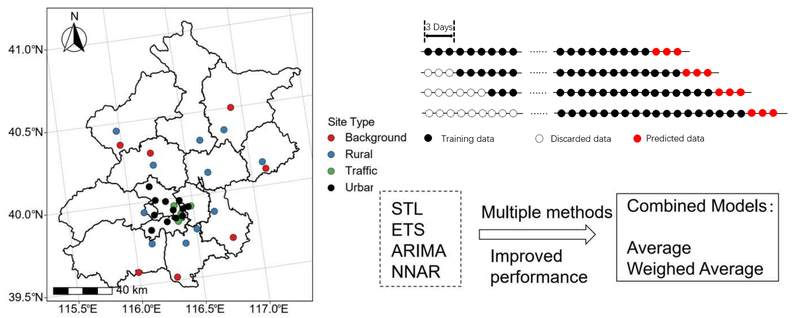
Introduction

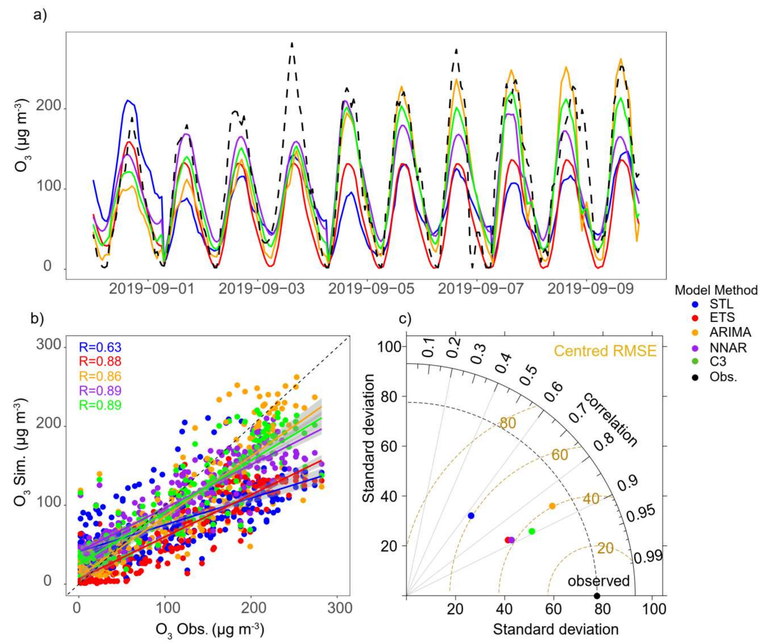
Ozone pollution has emerged as a critical air quality concern in China, especially in megacity area such as Beijing in recent years. Characterized by its complex, nonlinear interactions among precursor pollutants and significant spatiotemporal variations, ozone poses challenges for numerical models in terms of forecasting accuracy. In contrast, statistical forecasting models offer several advantages, including reduced data requirements, lower computational costs, and enhanced predictive accuracy, making them a viable option for practical ozone forecasting applications. In this study, we evaluate multiple time series models (such as ARIMA, NNAR, STLF, ETS etc.) for ozone concentration forecasts in Beijing.

Data and Methods

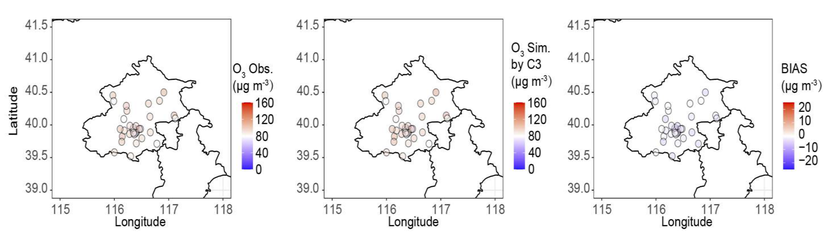


- Ozone observation data obtained from the China National Environmental Monitoring Centre and the meteorological observation data of Nanjiao site are obtained from the Meteorological Observation Center of the China Meteorological Administration.
- For each step of prediction, 3 months of historical data is input as training data to give prediction of hourly ozone concentration for the next 72hr. A 72hr rolling forecast method is adopted.
- Multiple methods were combined to improve model performance.

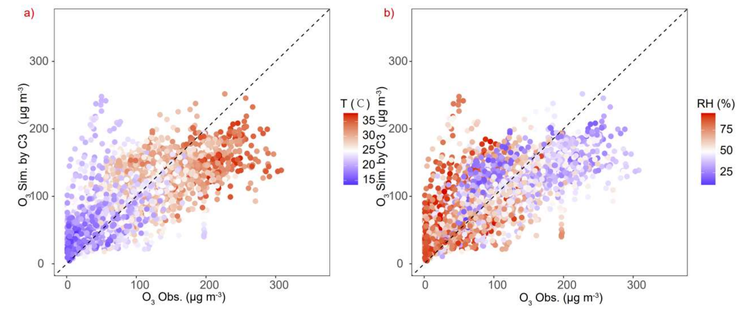
Results and Conclusions



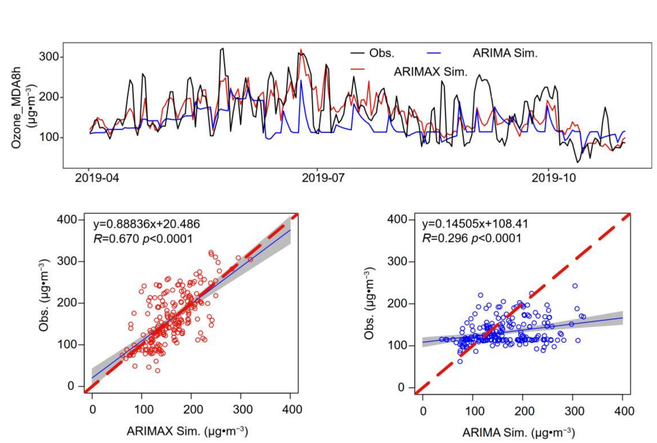
- Time series models such as ARIMA, ETS etc. can be used for short-term forecasting of ozone concentration.
- The ensemble model, which leverages multiple time series analysis methods, demonstrates the potential to enhance the performance of ozone forecasting.



- Both the time series and ensemble approaches, have proven to be highly effective in forecasting ozone levels during severe pollution episodes, offering high accuracy, temporal resolution, and spatial universality.



- Low temperature with high humidity leads to model overestimation of ozone, while high temperature with low humidity leads to underestimation of ozone peaks.



- Daily maximum temperature, radiation precipitation are key meteorological factors that significantly influence ozone concentration. Incorporating maximum temperature into a dynamic ARIMA model significantly improved ozone forecasts, raising the correlation coefficient to about 0.7 and reducing RMSE.
- Future improvements could integrate the meteorological covariates to improve the performance of short-term hourly ozone concentration forecasts.

Acknowledgement

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