Abstract

[Research Title]

Development and test experiment of a new air pollution prediction system integrated with observational data by machine learning

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Air pollutants (aerosols (PM2.5) and photochemical oxidants) emitted into the atmosphere by natural phenomena and human activities have a significant impact on people's lives, including deterioration of the air environment and human health. The National Institute for Environmental Studies (NIES) operates an air pollution forecasting system (VENUS) to provide early warning of photochemical oxidants and PM2.5, thereby contributing to reducing their impact on social life and health. Air pollution forecasting is increasingly recognized as an important part of social infrastructure in the context of public concern about health effects. However, its prediction accuracy is quantitatively insufficient. In this project, we applied machine learning techniques to develop a post-process (guidance) that corrects the prediction results of the air pollution forecasting system by learning from observational data collected by the Atmospheric Environmental Regional Observation System (AEROS). In addition, we developed a guidance implementation version of VENUS and conducted pre-operational experiments to study the actual operation of the guidance implementation version of VENUS.

In the current VENUS forecasts by concentration category, the guidance increased the accuracy rate by 10.8-21.1 percentage points for PM2.5 concentrations and by 7.3-33.6 percentage points for ozone concentrations. The confidence level of the forecast was derived by statistically processing the amount of revision of the guidance. A clear correlation was observed between the confidence level obtained and the accuracy of the PM2.5 concentration forecast, confirming that the confidence level was appropriately estimated.

To develop the guidance implementation version of VENUS, we divided Japan into 144 regions, created guidance in each region, and evaluated its performance. In predicting PM2.5 concentrations, both the correlation coefficient (R) and the root mean square error (RMSD) were improved in all grids by applying the guidance. The correlation coefficient (R) exceeded 0.7 for 67 grids (46.5% of the total), and the mean squared error (RMSD) achieved the target reduction of more than 30% for 137 grids (95.1% of all grids) (the overall mean reduction was 27.8%).

Based on VENUS in operation, we developed a guidance implementation version of VENUS by developing two processes for input and output to and from guidance. Through pre-operational experiments and web display experiments using the guidance implementation version of VENUS, we identified points for improvement of the guidance and explored its actual operation. The VENUS guidance implementation version was prepared to the stage just before the actual operation.

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