Priority Subjects — **Further Improvement of Facility Operations and Maintenance Technologies**

Development of Techniques for Comprehensive Impact Assessment of Thermal Power on Atmospheric Environment

Background and Objective

The importance of thermal power generation is increasing in Japan due to long-term shutdown of most nuclear power plants, and the renewal of old facilities as well as ongoing operation of existing thermal power plants are required for the stable supply of electricity. The Japanese government recognizes that the environmental impact assessment may be simplified under certain conditions in order to encourage the swift renewal and new/additional construction of thermal power plants. On the other hand, the effect of fine particulate matter ($PM_{2.5}$) and photochemical oxidant (Ox), which are major secondary air pollutants, on atmospheric environment should be estimated for successive operation of plants.

In this project, we aim to develop software tools for making atmospheric environmental impact assessments easier, quicker and less expensive, and also to contribute to the establishment of rational control measures through development of assessment methods for secondary air pollution.

Main results

1 Development of software tools to support atmospheric environmental impact assessments of thermal power generation

We have developed a prototype software tool to support atmospheric environmental impact assessments of replacements and new/additional construction of thermal power plants. The tool, coupled with the Geophysical Information System (GIS), allows computing dispersion and drawing contour maps of exhaust gas calculated from inputs of time and source conditions including location, stack height, and gas specifications (Fig. 1). Monitored atmospheric concentration data are automatically drawn on the map and summarized in a table in order to compare the source contributed concentrations. In the fiscal year of 2013, we will add functions such as dispersion simulations of multiple sources and self-judgment of meteorological and topographical conditions for downdraft, downwash and fumigation.

2 Establishment of an atmospheric monitoring system for secondary air pollution assessment

We have been developing an air quality model, a numerical model that accounts for detailed processes of emission, transport and chemical reactions of pollutants in order to assess the secondary air pollution. A particulate carbon monitor was added to our atmospheric monitoring system in Komae, Tokyo, to obtain monitoring data of $PM_{2.5}$ major components throughout of years for validation of the air quality model. Surface concentrations are related to upper-air concentrations. We established an observatory at an elevated site on the Tokyo Skytree to obtain urban upper-air quality (Fig. 2).

3 Improvement of modeling of $PM_{2.5}$*

Present air quality models seem to predict observed $PM_{2.5}$ mass concentrations well. However, the models considerably overestimate nitrate and underestimate organics concentrations among major components of $PM_{2.5}$. It is necessary to remediate these discrepancies for the establishment of adequate controls based on source apportionment estimates. We improved model predictions of nitrate concentrations by considering model configuration and conditions and changing temporal profiles of emissions to adjust discrepancies. The organics concentration was also revised. These findings may be useful in the estimation of impacts of thermal power on secondary air pollution.

* This work was performed as contract research with the Ministry of the Environment (the Environment Research and Technology Development Fund C-1001).

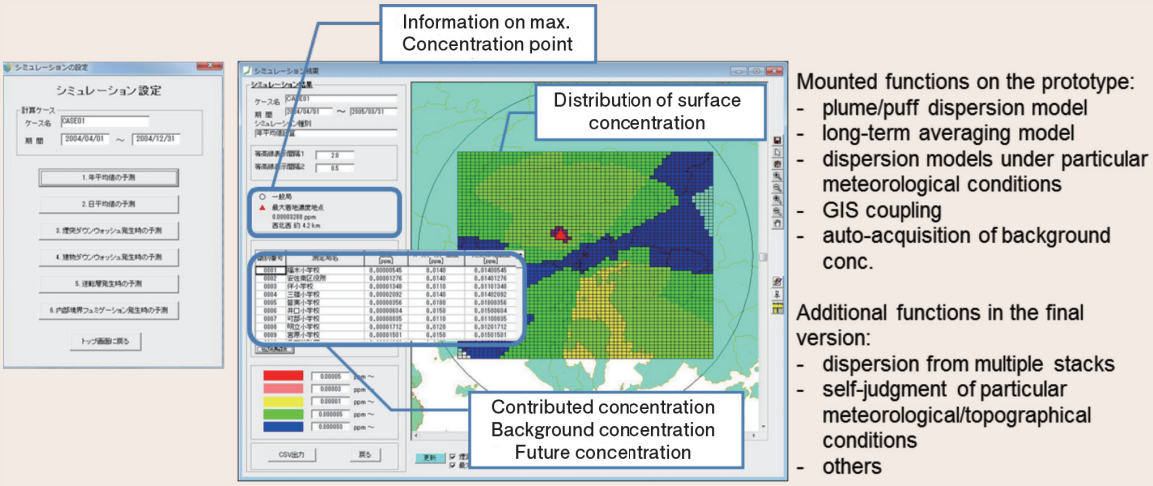

Fig. 1: A Screenshot of the prototype of the atmospheric environmental impact assessment support tool

In the right window panel, provide source information and computational period in the left column and, then, the source point (red triangle) is shown on a map (light aqua: land; white: sea). Select a dispersion scheme in the left window panel and, then, calculated concentrations are drawn with filled colors given in the legend box on the map in the right window panel. The table summarizes source-contributed, background and future concentrations at given locations.

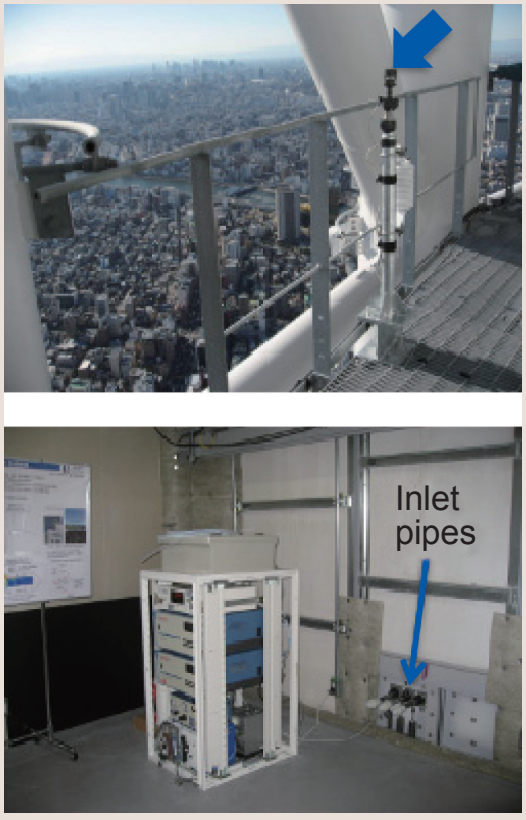

Fig. 2: Urban upper air quality monitoring station

Meteorological monitors outside (upper picture) and air quality monitors inside (lower picture) the Tokyo Skytree. Rare data regarding air quality over a megacity are accumulated for use in the development of a secondary air pollution evaluation method.

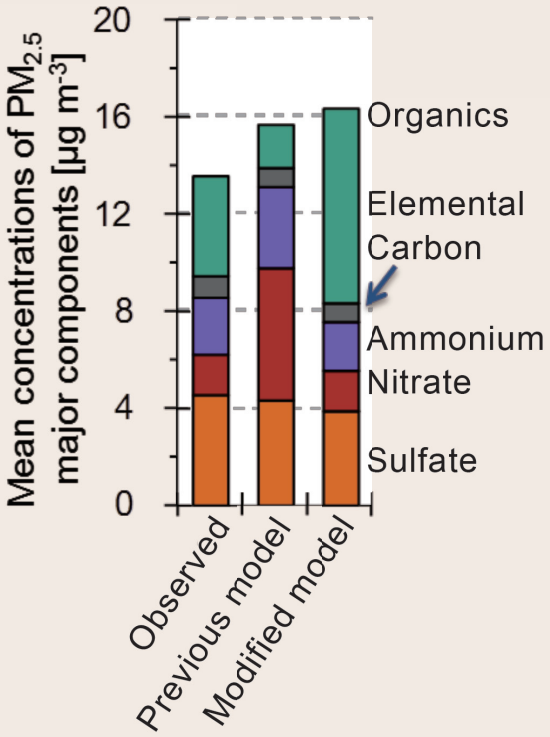

Fig. 3: Comparison of observed $PM_{2.5}$ components with calculated results of previous and modified models

The previous model (center column) overestimates the nitrate concentration and underestimates the organic concentration. The modified model gives much better results. Further studies are necessary for better performance on the organics.