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

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

Background and Objective

Japan's dependence on thermal power generation and interest in the generation of geothermal power have been increasing with the long-term stoppage of nuclear power plants. In the environmental impact assessment (EIA) of the construction, extension, and replacement of thermal and geothermal power plants, prompt and low-cost assessment is also required as part of national policy. Thermal power plants are suspected to be the emission sources of particles with a diameter of 2.5 μm or less ($PM_{2.5}$). Thus, measures to reduce their emission are likely to be required in the future. The objective of this research is to develop a method and a tool (software) for the simple, rapid, and inexpensive assessment of atmospheric environments. In addition, an assessment method for agents causing secondary air pollution is developed to clarify the impact of their emission sources and to contribute to the formulation of rational measures to reduce the emission of these agents.

Main results

1 Development of an atmospheric EIA support tool for thermal power generation

We have been developing an atmospheric EIA support tool for the simple and rapid assessment of the construction, extension, and replacement of thermal power plants. A function to predict the factors related to sulfur dioxide and dust was added to the tool in consideration of coal-fired power plants. Additionally, a function that can easily compare the ground concentrations measured before and after the replacement and the results of sensitivity analysis under various conditions was added. As a result of adding these functions, the atmospheric EIA support tool almost complies with the dispersion prediction of exhaust gas in the Guidelines for the EIA of Power Plants established by the Ministry of Economy, Trade and Industry (revised in 2007). Furthermore, the support tool enables the evaluation of predictions while complying with the Guideline for Streamlining EIA Methods on Thermal Power Plant Replacements established by the Ministry of the Environment (revised in 2013)*1 (Fig. 1) (V14017).

2 Development of dispersion prediction numerical models for atmospheric EIA of geothermal power generation*2

The research team constructed two types of atmospheric dispersion numerical models, one of which was simplified and one which was detailed*3. For the simplified model, a test calculation of the model considering the effects of reactor buildings and the local geography was carried out and a function to predict the dispersion of white smoke was also incorporated. For the detailed model, it was confirmed that it reproduces the results of wind tunnel experiments reasonably well for a simple geography (Fig. 2).

3 Development of a method for assessing impact of domestic thermal power plants on $PM_{2.5}$ concentration

The research team carried out a simulation of $PM_{2.5}$ concentration over a wide area using the latest publicly available data (FY2005) on the amount of emission of precursors causing air pollution. The team confirmed that the concentrations of the major $PM_{2.5}$ components, except carbon compounds, are reproduced reasonably well. The impact of domestic and overseas emission sources on the $PM_{2.5}$ concentration in Japan was assessed using a tagged tracer method.*4 The results indicated that overseas emission sources account for 47% of the $PM_{2.5}$ concentration observed in Japan and that domestic thermal power plants account for 3% (Fig. 3) (V14005).

*1 Guidelines that specify the rationalization of procedures, such as the shortening of the duration of assessment, when the environmental load can be reduced by the renewal of facilities.
*2 Jointly developed with New Energy and Industrial Technology Development Organization (NEDO).
*3 The simplified model operates on a PC and is applicable to a relatively simple geography, whereas the detailed model considers the effects of a complex geography and buildings and exhibits high accuracy.
*4 A method of calculating the impact by tagging emitted precursors (emission source information) and tracing their behavior.

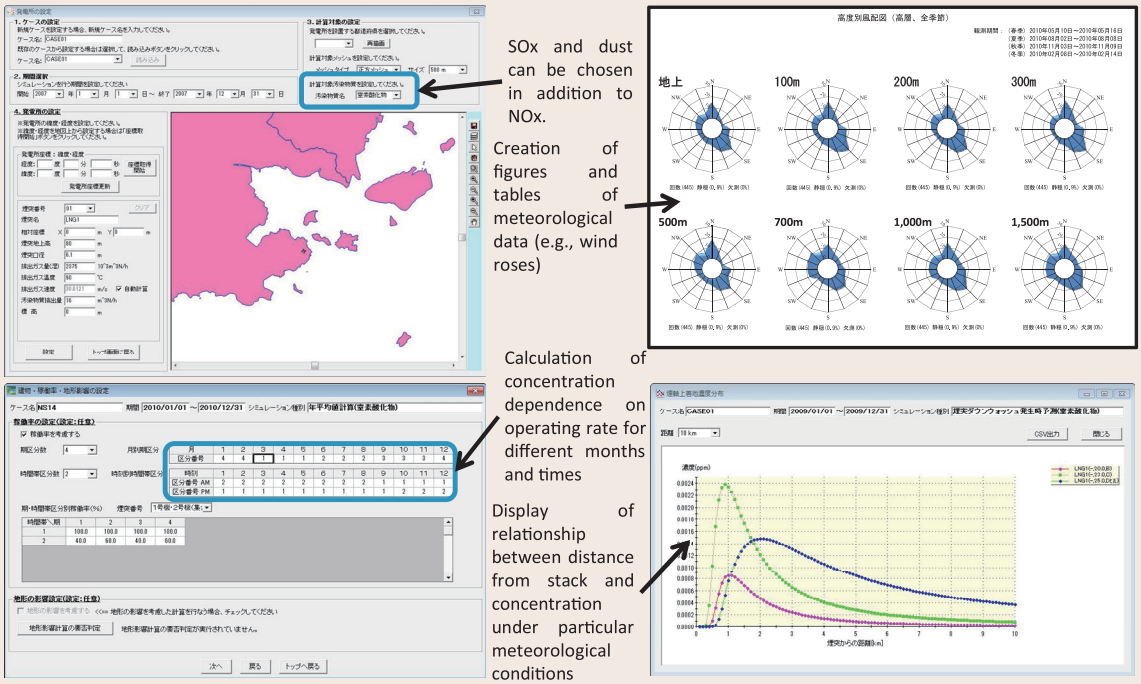
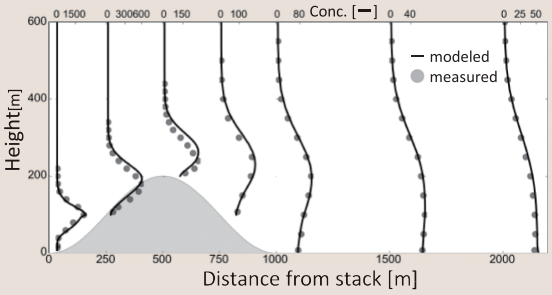


Fig. 1: Main improvements to atmospheric environmental assessment support tool

Upper left: Screen for inputting target point, target period, and specifications of emission gas / Lower left: Screen for inputting operating rate / Upper right: Screen for outputting wind roses for different heights / Lower right: Screen for outputting results calculated under particular meteorological conditions.

Wind tunnel experiments for three-dimensional hilly geography



Standardized concentration distribution along with leeward distances

Fig. 2: Wind tunnel experiments (upper) and comparison of results obtained by detailed model and wind tunnel experiments (lower)

Wind tunnel experiments were carried out considering the surface roughness of a geographical model and the combined effects of the geography and buildings to obtain data used to verify the numerical model.

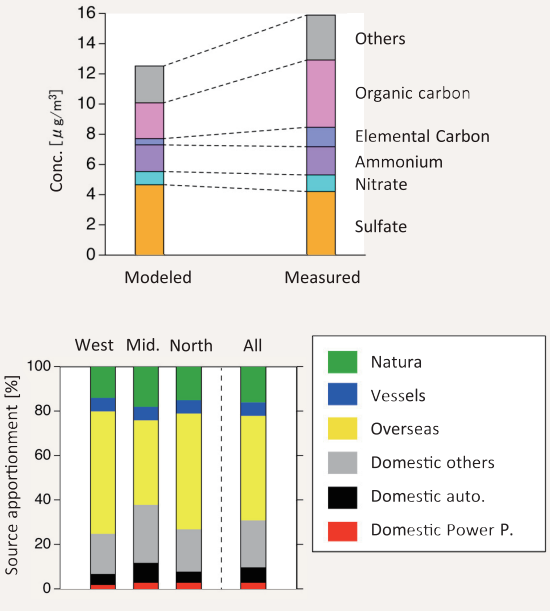


Fig. 3: Modeled and observed $PM_{2.5}$ compositions (upper) and calculated impact of various emission sources on $PM_{2.5}$ (lower)

The calculated results accurately predict the concentrations of sulfate and nitrate emitted from power plants, although the concentration of the carbonaceous compound is lower (upper). The percentage impact of power plants on the $PM_{2.5}$ concentration is smaller than that of other emission sources (lower).