

Principal Research Results

Development of the Mercury Transport Model for East Asia

Background

Since mercury has a bad influence on human health, concern about its dynamics in the environment is increasing internationally. The mercury discharged by combustion of a fossil fuel, incineration of waste, discharge of waste waters, etc. in environment reaches humans not only in breathing but in various pathways. Although monitoring of concentration in the air is performed in Japan, the air quality model incorporating the chemical reaction of mercury for evaluating the quantity of deposition to the ground has not been developed yet. The life time of mercury in the atmosphere is long, therefore in order to grasp the deposition of mercury, a long-range transport model for East Asia is necessary.

Objectives

In this study, a transport model of mercury for East Asia is developed. Furthermore, in order to evaluate the performance of the model, the calculation result and measurement result of deposition of mercury are compared and the amount of deposition of mercury in Japan is estimated.

Principal Results

1. Development of the transport model

In order to estimate the quantity of wet and dry deposition, the chemistry scheme of mercury was incorporated in air quality model CMAQ^{*1} (Fig.1). The oxidation-reduction reaction in gaseous and aqueous phase and the adsorption to the suspended substance in aqueous phase are included in the chemistry scheme of mercury. The emission data of mercury that Arctic Monitoring and Assessment Programme (AMAP) created was used. Meteorological data, such as wind direction wind velocity and precipitation, were calculated by mesoscale meteorological model MM5^{*2}. Using the developed transport model, mercury concentration and deposition were calculated for East Asia in the horizontal resolution of 45km, and 11 layers of vertical directions ranging from surface to 100hPa, and the results were outputted for every hour. The examples of the calculation result of the wet and dry deposition in June 2003 were shown in Fig.2 and Fig.3.

2. Performance evaluation of the transport model

The annual (Dec., 2002 - Nov., 2003) mercury deposition was calculated, and compared with the observed value at 10 sites in Japan (Fig.4). The comparison result of the calculated value and observed value of the wet deposition is shown in Fig.5. The calculated value of the wet deposition became 0.5 to 2.2 times of the observed value (except for the Komae site), and the calculated value of the dry deposition became 0.6 to 3.0 times of the observed value. Therefore, the model reproduced the observed value in the range of factor 2 in general.

3. Estimation of the amount of mercury deposition in Japan

As a result of model calculation, the amount of deposition of mercury in Japan was 21t y^{-1} , and particulate mercury was the main component. The contribution of foreign emission sources to the deposition in Japan was as high as about 50%. From these results, it was shown in the deposition process of mercury that the deposition of particulate matter generated by reaction during long-range transport was important.

Future Developments

Detailed calculation will be performed for the local area near emission source using the model developed by this research.

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Reference

M.Tsuzaki, H.Hayami, K.Asakura, 2006, "Development of Mercury Transport Model in East ASIA", CRIEPI Report V05014 (in Japanese)

* 1 : An eulerian multiscale and multi-pollutant chemistry-transport model developed by U.S.EPA.

* 2 : A nonhydrostatic, sigma-coordinate mesoscale atmospheric simulation model developed by PSU/NCAR.

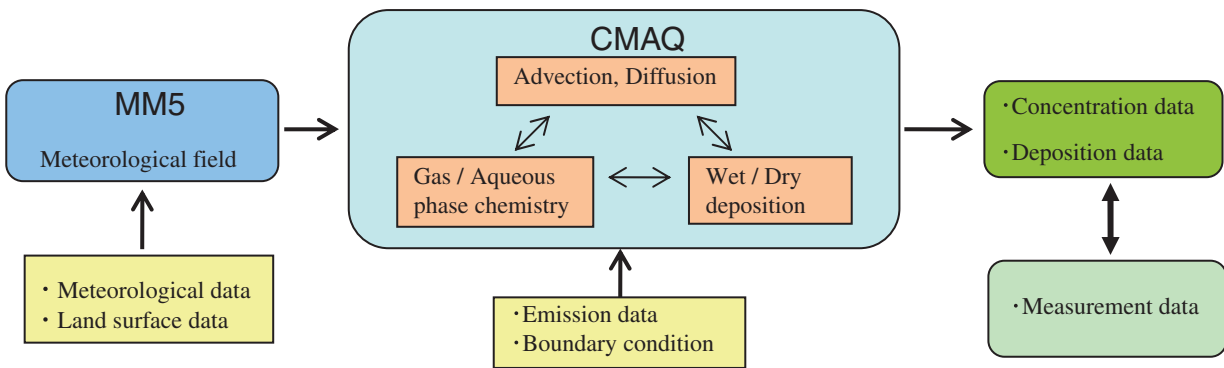


Fig.1 Outline of the mercury transport

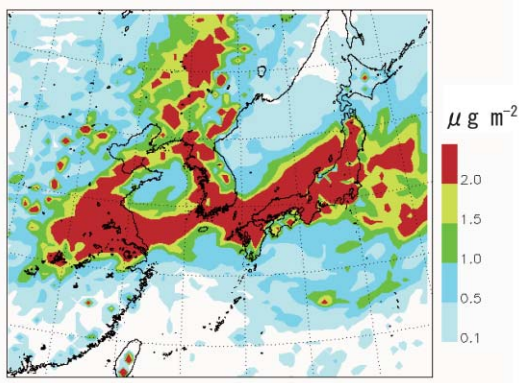


Fig.2 Model calculation result of the wet depositions

The influence of a seasonal rain front is seen near Japan from the continent.

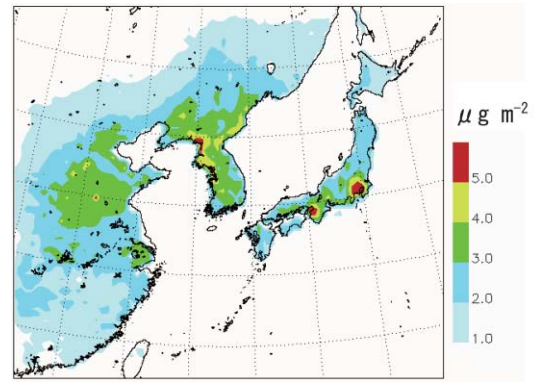


Fig.3 Model calculation result of the dry depositions

Since many emission sources of mercury exist in the Kanto area or the Korean Peninsula, the dry depositions have increased in these areas.

