APPLICATION OF CMAQ WITH RAMS TO AIR QUALITY IN THE OSAKA AREA IN JAPAN

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1. INTRODUCTION

Vertical and horizontal profiles of concentration of air pollutants, such as particulate matters and ozone, and meteorological elements have been observed in Osaka, the second largest city in terms of population and economy in Japan, in March 2001 by using an aircraft and some observational sites. An aircraft measurement was performed three times a day on 19th, 20th, 21st, and 23rd in the month and surface measurements were for the month. We apply the CMAQ (Community Multiscale Air Quality) modeling system with meteorological fields obtained by RAMS (Regional Atmospheric Modeling System) to simulate air quality in the area in order to understand observed spatial and temporal variations.

2. DEVELOPMENT OF AN INTERFACE FROM RAMS TO CMAQ

An interface of RAMS-to-CMAQ has been being developed by our group (Sugata et. al., 2001). It is mainly developed with a combination of RAMS 4.3 and CMAQ 1999 release version. RAMS 3b and CMAQ 2001 are also possible.

The interface works through three steps to use RAMS meteorological data in MCIP in CMAQ; (1) modified REVU (post-processing utility of RAMS) to output data in gtool format, (2) data converter from gtool format to IO/API format, and (3) modified MCIP to use the converted RAMS meteorological data. Gtool is a name of a utility for visualization and analysis of meteorological data, which is very popular in Japanese meteorologist. The gtool uses GrADS like format. We are now planning to update these utilities to use GrADS format, where you needs only two steps to use RAMS data in MCIP; (1) data converter of RAMS output from GrADS to IO/API, and (2) modified MCIP. These tools will be available in October. Contact to one of the authors (sugatas@nies.go.jp) if you are interested in using them. They cover RAMS 4.3, CMAQ 2001, and, hopefully, CMAQ 2002

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3.0 DESCRIPTION OF MODELS AND SIMULATION

3.1 CONFIGURATON OF CALCULATIONS

Simulation is performed for 10 days from 15th to 24th in March 2001. Calculation domain was 300km X 300km for RAMS (shown in Fig. 1) and 200km X 200km for CMAQ (shown in Fig. 2), both of whose centers are located at the bay area of Osaka prefecture. Horizontal resolution is 5 km mesh. The number of vertical layers in RAMS is 22 up to 19km and the lowest 5 levels are 23.3m, 80.4m, 154.5m, 250.8m, and 376.1m.

The RAMS options used for this study were nonhydrostatic dynamics, simplified Kuo for cumulus cloud parameterization and RAMS microphysics model for resolved cloud parameterization, Mellor-Yamada 2.5 for vertical diffusion, and Louis surface flux parameterizations. The RAMS output was fed into the MCIP by using the interface described in the previous section.

European Center for Medium-Range Weather Forecasts (ECMWF) meteorological data were used for assimilation in RAMS. The resolution of the data was 6-hour intervals temporally and 2.5°

$\times$ 2.5° latitude and longitude and 15 pressure levels (10–1000 hPa) spatially. Horizontal winds and temperature were nudged with the lateral Davies-type nudging (Newtonian relaxation) method. The strongest nudging, with a relaxation (e-folding) timescale of one hour, was set at each side boundary and at the top of the domain. Weak nudging, with a relaxation time of two days, was used in an inside region with boundaries 5 grid squares in from each side boundary and below 10 km.

Options used in CMAQ are the piece-wise parabolic method (PPM) for advection, K-theory parameterization for vertical diffusion, Carbon Bond 4 (CB-4) chemistry mechanism, and quasi-steady state approximation (QSSA) gas-phase reaction solver.

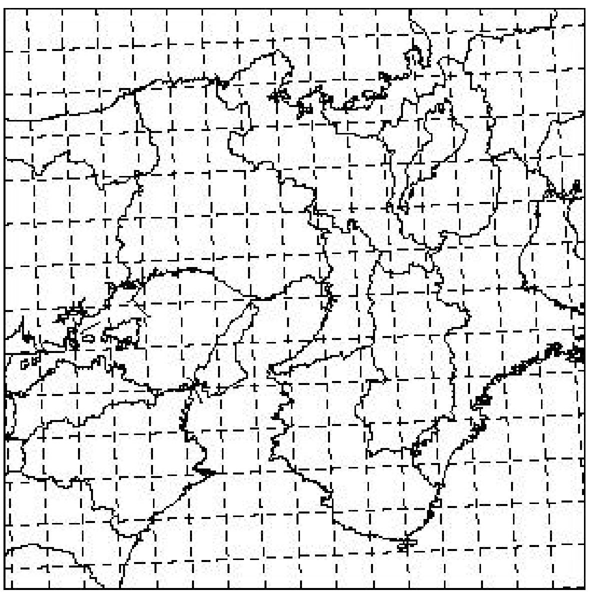

Fig.1 Area used for RAMS calculation. The center of the figure is Osaka Bay, which locates to the west of Osaka prefecture.

3.2 EMISSION

We used an emission inventory archived by the Ministry of the Environment (Japan), which covers whole Japan with 10km mesh. We developed a tool for converting data from the inventory to on a polar-stereo projection map with any location and resolution we specify.

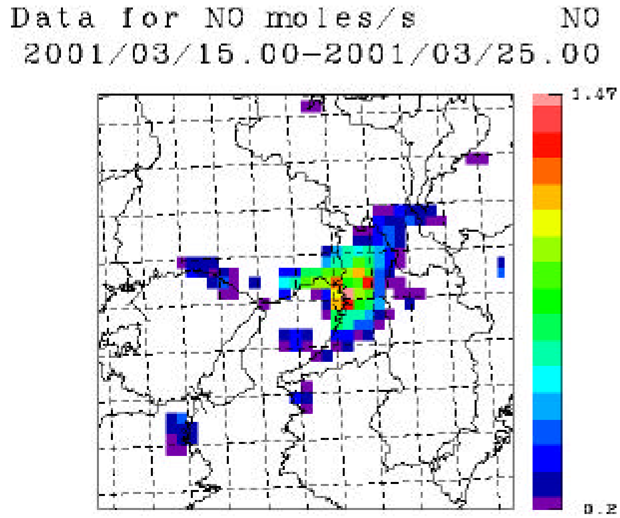

Fig.2 Area used for CMAQ calculation. Emission of NO is also shown by colors.

4.0 RESULTS

We compared concentrations of species, such as ozone, NOx, SO2, aerosols, between observations and calculations by the CMAQ, where temporal variations of them both at the observational surface sites and along flight paths of the aircraft are checked. Figure 3 shows comparison of temporal change of some gaseous species between the observation and simulation at the center of Osaka city. The model seems to reproduces orders of concentrations and essential daily variations of every species, although it shows qualitative difference in some cases, particularly in NOx.

Vertical profiles of concentrations along with flight paths are also compared between observation and calculation (figures not shown). Vertical profiles of the calculation show less concentration for every species in larger altitude. However ones of ozone show overestimated values in high layers, which suggests that a top boundary condition of ozone in CMAQ should be treated more carefully in this case.

In order to understand causes of difference of concentration between observation and calculation, meteorological data, such as wind velocity and direction, calculated by RAMS are investigated. Fig. 4 shows wind velocity and direction at a nearby meteorological observational site to compare RAMS data with observation. Calculated wind velocity and direction are essentially close to those of observations.

Other factors in the CMAQ are now being investigated to seek other causes for the difference.

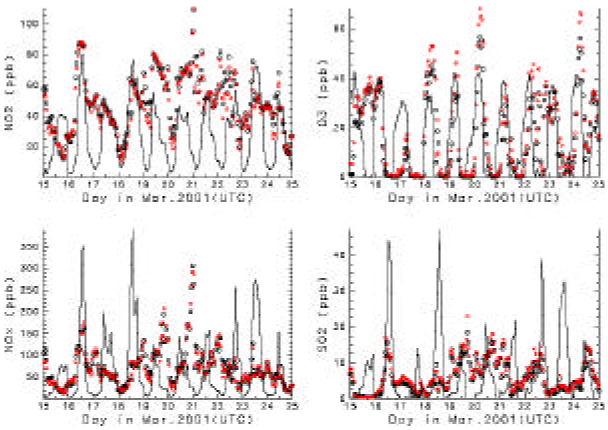

Fig.3 Time series of concentration of NO2 (upper-left), NOx (lower-left), ozone (upper-right), and SO2 (lower-right) for 10 days at the center of Osaka city. Red and black dots indicate observational data (black: surface, red: 60m above the surface), and solid lines do calculations at the grid corresponding to the observational site.

References

Sugata S., Byun D., and Uno I., 2001: Simulation of sulfate aerosol in East Asia using Models-3/CMAQ with RAMS meteorological data, *Air Pollution Modeling and Its Application XIV,* Gryning and Schiermeier eds., 267-275

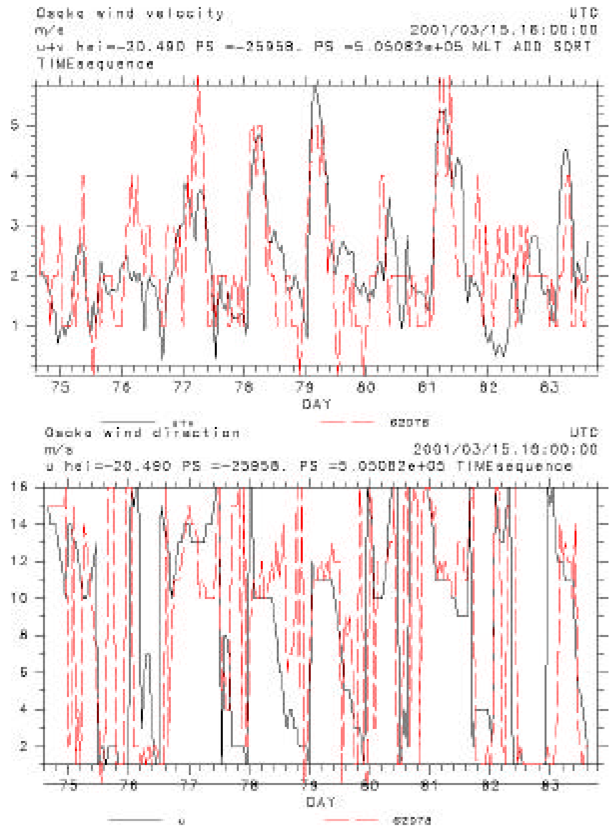

Fig. 4 Wind velocity (above) and wind direction (below). Red broken lines are observed at a meteorological observation site that is closest to the observational site for air quality and black solid lines are calculated by RAMS at a corresponding grid.

If you have any questions, please contact the Models-3 Users' Workshop, e-mail **m3workshop@emc.mcnc.org**, or telephone Kim Christmas (919) 248-4159.