B-1.4 Study on atmospheric circulation and mass transport model for the tropospheric atmospheric system

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Abstract To have a comprehensive description of tropospheric atmospheric system, a chemical transport model (on-line transport model) coupled with Regional Atmospheric Modeling System (RAMS, Pielke *et al.*, 1992) are developed. To study a performance of this on-line transport model, numerical case study during the Baiu season was conducted. Model study was compared with extensive field observation. It was found that the location of rainy meso-front plays an important role for sulfate concentration level in Japan and Korea. Numerical results also indicates the importance of wet removal processes near rainy meso-front region.

Key Words atmospheric circulation model, chemical transport model, sulfate, wet/dry deposition

1. Introduction

Numerical models are very efficient tools to study environmental issues such as circulation of greenhouse effect gases, transport of precursors of acid depositions, and exchange of materials (ozone etc.) between the troposphere and stratosphere. Every physical and chemical processes are related complicatedly to one another in these issues. We need to develop comprehensive models to deal with the issues and to clarify contribution of each process.

In this study, starting from a material circulation model closely linked with meteorological models that we have developed in previous studies, we will establish the basis of developing a comprehensive tropospheric atmospheric system model.

What we have done in this study are:

- increasing spatial resolution by using multi-nesting method,
- developing assimilation method using satellite data,
- parameterizing uptake process of sulfate into cloud, and
- analyzing wet and dry deposition.

2. Development of tropospheric atmospheric system model

Regional Atmospheric Modeling System developed by US Colorado State University (CSU-RAMS, Pielke, 1992) was used as a meteorological model. Turbulence closure of Mellor and Yamada level 2.5 was used for turbulence. Observational sea surface temperature was used for

the lower boundary condition for sea area.

We have developed on-line long-range material transport model linked with the meteorological model. Conversion from gaseous SO2 to sulfate aerosol is considered in the transport model, whose reaction rate is according to photolysis rate, and aqueous phase conversion is also considered. Dry deposition is calculated for each species according to whether the surface is land or water. Wet deposition is calculated by considering both washout process, which depends on RAMS precipitation, and rainout process, which depends on RAMS cloud water.

Two cases were simulated from June 8 to June 28, 1991; one is with wet process and the other is without it.

3. Results and discussion

Precipitation is well reproduced by the meteorological model, particularly its temporal variation pattern at each point. It is shown that high concentration of sulfate is located on the northern side of the Baiu front and high sulfate concentration hits southern part of Japan according to movement of the front (Fig. 1).

By comparing time series of sulfate concentration at some points between observation and model, simulation with wet process is much better than that without the process (Fig. 2). This shows the importance of the wet process.

The coefficient factor used in four dimensional data assimilation change the result of simulation much: concentration of sulfate changes ± 20 % depending on the strength of nudging.

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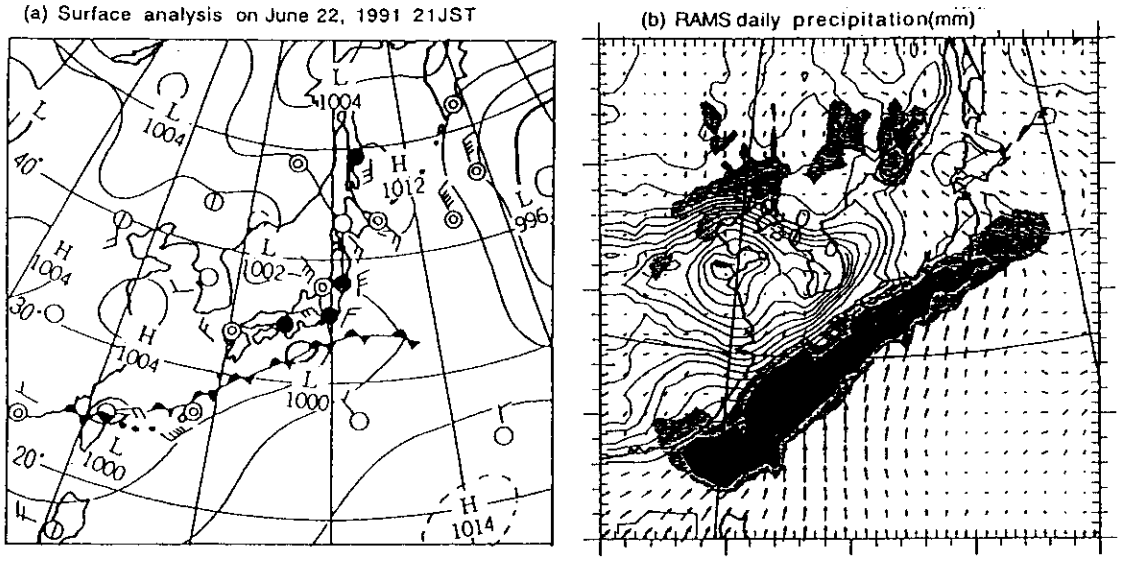

Fig. 1 (a) Weather chart at the surface level on Jun. 22, 1991. (b) Daily precipitation (hatched) and sulfate concentration (contour) on the same day.

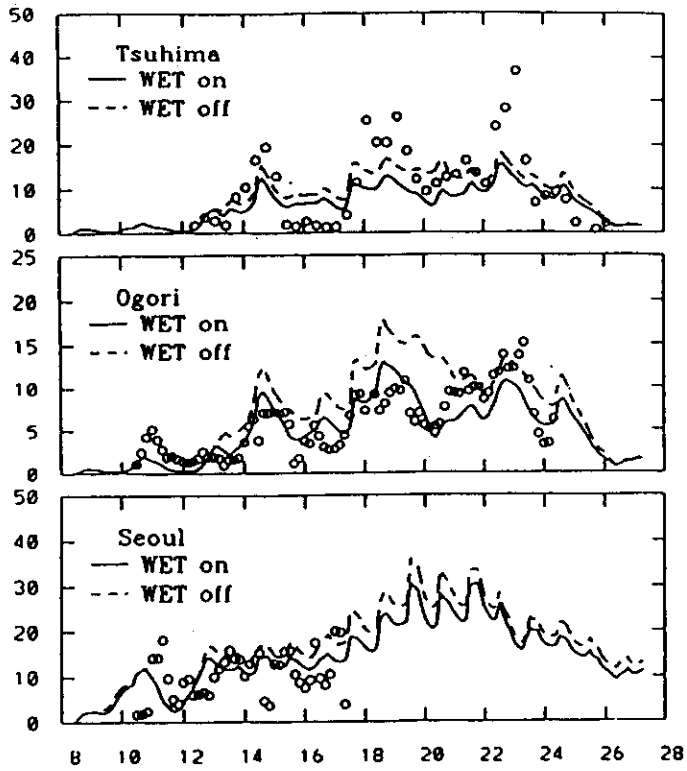

Fig. 2 Time series of sulfate concentration from observation and the material transport model at three points (Seoul, Tsushima, Tikugo-Ogori) in Jun. 1991. Solid lines show wet-on and dot lines show wet-off. Unit is $\mu g/m^3$.