PF10) Comparison Study of Numerical Simulations Associated with Emission Conditions during Asian Dust Events

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1. Introduction

Many studies of Asian dust have been undertaken to investigate dust sources, their transport and deposition mechanisms, their optical and chemical properties, and their physical characteristics. These studies have used meteorological parameters, optical thickness, and mineral compositions derived from satellite images, lidar, sunphotometer, and other ground-based instruments in East Asia (Chun et al., 2001; Murayama et al., 2001). Recent studies are progressing not only the analysis of the dust characteristics but also the simulation of transport models related to outbreak, transport, and deposition processes of dust, but they are still a basic step. Understanding and predicting the overall dust impacts in East Asia depends on the knowledge of dust sources and emission rates. In particular, one of the largest uncertainties in the modeling for the long-range transport of dust is the source strength in emission regions because dust emission into the atmosphere varies highly with space and time.

Therefore we are to estimate more correct dust emission of the source regions using two formulas that are presented by the previous studies (Westphal et al., 1988; Wang et al., 2000), and are to simulate a transport model, HYbrid Particle And Concentration Transport (HYPACT) Model, based on the estimated emission data. Further we are to compare with the results of numerical simulation associated with two emission conditions. These will be contributed as a fundamental and significant data to simulate the transport models and to better understand the dust outflow transported to Korea.

2. Methodology

We estimated emissions of Asian dust on episode days observed over Korea for 21-23 on March 2002 and this case was the biggest Asian dust event over 1000 ㎍/㎥. Fig. 1 shows the vegetation categories of domain to estimate dust emission and classified into 4 regions using USGS landuse data. The gray color except for it in South China denotes Grassland type in Inner Mongolian and Loess Plateau, the black one means Shrubland type in near Gobi desert, the dark gray one means Bar. sparse vegetation type in near Taklamakan desert, and the white one means non-emission region. We applied different threshold friction velocity according to each region. The value is 0.5 m/s, 0.45 m/s, 0.35 m/s, and 0.6 m/s in the Gobi, Sand, Loess region, and the non-emission region, respectively. Thereafter we compared the horizontal distribution of dust emission after estimating the dust emissions using two formulas based on the classified landuse data, and simulated the RAMS HYPACT model during the study period.

Formula (1) is the total emission amounts of uplifted dust whose radius in the range of 0.1~30 ㎛ as F_a (Westphal et al., 1987; 1988). Formula (2) is emission intensity developed by Wang et al. (2000). C_1 is the weighting factor for different land types, C_2 is an empirical constant set as 2.9×10^{-11}, and $R_{i,j,l}$ is the fraction of the size distribution of floating dust in source area. Formula (3) is the humidity factor $W_{i,j,l}$ which is assumed to be

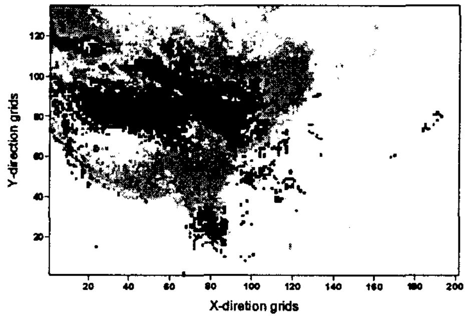


Fig. 1. Vegetation categories of domain.

linearly dependent on the relative humidity(RH). RH and RH_0 are the surface relative humidity and its critical value (set as 40%).

u_* is the friction velocity and u_{*t} is the threshold friction velocity in all cases of formula (1) and (2).

$$F_a = 2.3 \times 10^{-13} u_*^4 \quad \text{if} \quad u_* \geq u_{*t} \qquad (1)$$

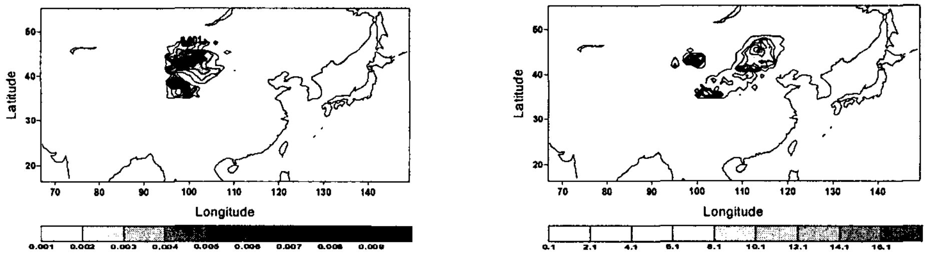
$$Q_{i,j,l} = C_1 C_2 \, u_*^2 (1 - u_{*t}/u_*) \, W_{i,j,l} R_{i,j,l} \qquad (2)$$

$$W_{i,j,l} = \begin{pmatrix} (1 - RH/RH_0) & \text{for} & RH < RH_0 \\ 0 & \text{for} & RH \geq RH_0 \end{pmatrix} \qquad (3)$$

The RAMS data set has a input data (202 grids×135 grids), a horizontal resolution of 30 km and vertical terrain-influenced coordinates. A vertical stretched grid with 40 levels was utilized on each grid. The resolution was of 100 m close to the surface and increased to a maximum of 1000 m. The simulation time step was set to 30 sec by each grid. RAMS was initialized with NCEP/GDAS. Simulation started at 0000 UTC on 17 March and ended at 1800 UTC on 24 March, thus lasting 186h.

3. Results

Fig. 2 shows the spatial distribution of dust emission estimated by two formula at 0500 UTC on 19 March 2002. Fig. 2a illustrates that the dusts generated at Gobi desert, however the dust outbreaks were shown at Gobi desert, Loess Plateau, and Inner Mongolia in Fig 2b.



(a) (b)

Fig. 2. Spatial distribution of estimated dust emission using (a) formula (1) and (b) formula (2) at 0500 UTC on 19 March 2002.

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