Mesoscale aerosol numerical system developed in NMC, China

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Mesoscale Aerosol Numerical System Developed in NMC, China

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Abstract - Abstract: An online aerosol numerical system MM5-CAM was developed in National Meteorological Center with the weather model MM5 and Canadian Aerosol Module. The advection scheme MPDATA was also introduced into the coupled system to make tracer's simulation positive. The coupled system can deal with several kinds of aerosol such as dust, sea-salt, BC, OC and sulfate. With the domain covering most of the middle and east Asia, A ten-days test, from 15th March to 25th March 2002, was conducted in order to verify whether the model can work out smoothly for dust emission and transportation or not. The model input was the analysis from T213, a global operational model in NMC, and the snow cover observation from satellite. The result of the 10-days test showed that MM5-CAM can catch the 18-21 dust event, a quite strong dust storm, life circle in a relative correct way, not only the magnitude but the dust areas.

Key words: aerosol simulation, MM5-CAM, dust storm, transportation, emission

I. Introduction

The significance of aerosol particles in the atmosphere has been recognized in two major environmental issues: Climate changes and human health effects. Tempera and spatial variation of aerosol particles should be clearfied first in order to know the effects. One way to do these is to integrate the efforts of modeling and observation. A lot of scientists groups pay a lot of attention into this area such as AEROCOM in Europe for modeling comparison, IGAC for global atmospheric Chemistry research, and EDGAR, an Emission Database for Global Atmospheric Research. There are plenty of things to conduct the aerosol research because of the great variation and changes over East Asia, not only for vast areas but also for different kinds of landuse together with the changing weather patterns and global circulations. The most effective way to do this is utilizing a relative complicated aerosol modeling to map the aerosol emission, transportation and modification. That is what we try to figure out the aerosol picture over East Asia.

II. Method

There should be a weather modele that can interpret the weather background in which the aerosol's emission, transportation and microphysics and chemistry, what an aerosol module depicts, happen. Here an aerosol module CAM developed by Gong [1] in MSC was coupled into a meso-scale model MM5 [2, 3]. For the transport of tracer we follow the parameterization for the turbulence transport of heat and moisture. Because MM5 uses second-order centered differencing with a leap-frog time integration scheme which is fairly diffusive and not positive definite. Here a monotonic, positive-definite form of the Smolarkiewicz and Grabowski [4, 5] scheme in its fully three-dimensional form was introduced for tracer advection. The coupled system consumes a lot of wall time to run when the programs for tracers are not paralleled as what MM5 dose. So a lot of work has been done to tune those files for tracers into a more effective paralleling style.

III. Tests

The coupled modeling system MM5-CAM can depicts the changes, movements and transportation for several kinds of aerosols like sea salt, sulfate, BC, dust. For the first step we chose dust whose sources can be parameterized with quite correct schemes [6] to test the coupled system to see whether it can work out positive for tracers dynamics and physics together with transportation in east Asia where are close to the boundary between China and Mongolia. The model was set to run 10 days during which there was a quite great dust storm from the day of 18th. to the day of 21th. in the March with the emission scheme of Marticorena [6] which set a critical friction wind to judge whether dust can flow out into the air in those dry lands and with only in-cloud and below-cloud removal and dry-wet deposition without considering the chemical changes. The weather initials for boundary and lateral conditions are model analysis output from global operational model T213 in NMC.

The model run smoothly for the ten days dust simulation. For the heavy dust storm described above it works out well for dust emission and transportation and the storm center just as the figs bellowing showing (fig.1, fig.2, fig.3). As time goes by, this kind of harmony pattern didn't change much as for model output, satellite imagines and surface observation.

IV. Summary and conclusion

1. MM5-CAM is an on line mesoscale numerical aerosol model with complex atmosphere and aerosol dynamics and physics. It can deal with several aerosol such as dust,sulfate, BC and nitrate etc.
2. There are several dust events during these 10 days from the satellite images, the one from 18 to 21 is the most striking one. MM5-CAM can catch the 18-21 dust event life circle in a relative correct way, not only the magnitude but the areas.
3. But for those relatively small dust activities, the location and the time series are both not so consistent with the satellite image maybe due to the pretty large grid space which can not keep the small scale dust events.

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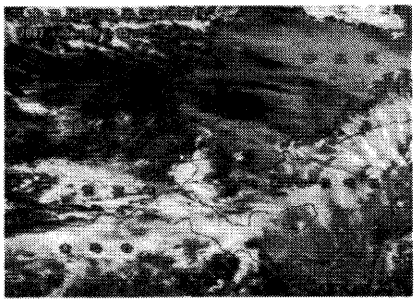

Fig.1 Sataellite observation for dust storm

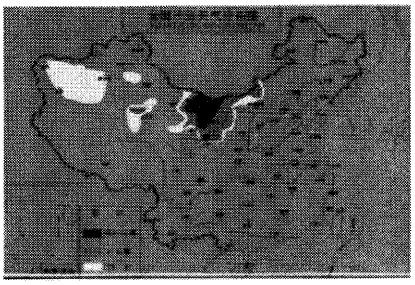

Fig.2 surfaceweather station observation

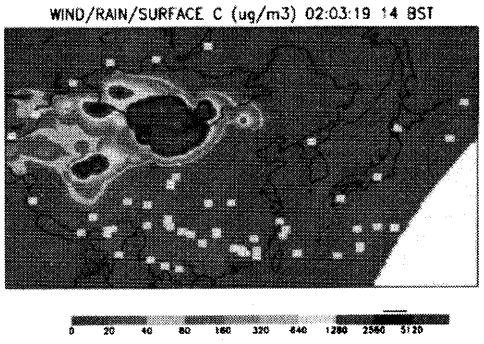

Fig 3 model output for surface dust concentration

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Health Effects of Asian Dust in Korea

- A case study from a health questionnaire survey of school children -

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Abstract - Recently frequent occurrence of Asian Dust phenomenon in East Asia has been observed. We conducted a questionnaire survey for the self-administration of respiratory symptoms for 1,050 school children aged 12-14 years in four major cities in Korea from 1 April to 26 May, 2003. In conclusion, the prevalences of the knowledge on Asian Dust and the use of protective gear between two distinctive areas were significantly different by the degree of Asian Dust events. In further analysis, we will provide the relative risk of time-series study on ambient air pollution in relation to daily respiratory symptoms in four cities, and from these results we will compare health status of schoolchildren between more frequently occurred area and less frequently occurred areas for Asian Dust event in Korea.

I. Introduction

The storms, known as 'Asian Dust phenomenon ', are originated from in the inland deserts in the northwestern China during dry spring weather, by strong convection currents of warm and cold air that sweeps soil particles up to a high altitude [1]. Together with air pollutants originating from the industrial area in the east China, the Asian Dust has been a serious environmental issue and has drawn health concern between Korea and Japan, as the dust masses carry many hazardous pollutants. Even though the dust of crustal origin such as the Asian Dust is not considered as harmful as the dust from the exhaust gas, many people have experience the respiratory symptoms during the dust period. This may lead to increased risk of hospitalization or mortality [2].

Recently frequent occurrence for Asian Dust phenomenon in East Asia has been observed. Especially in April 8, 2002 most primary schools in Seoul were closed, flights were canceled and clinics were filled with residents suffering from breathing problems due to severe dust events (MOE, 2002).

Researches on Asian Dust can be broadly classified into epidemiological study or clinical experience. There is also a report on health effects of school children using a health questionnaire during Asian Dust periods [3]. Therefore this study was conducted to examine relationship between respiratory symptoms and occurrence of Asian Dust in primary school children about four cities of Korea.

This study has too distinct objectives; one is to compare the daily variations of health symptoms reported by schoolchildren between Asian Dust (AD) and non-AD periods; and the other is to compare difference (variety) about the respiratory symptoms, the consciousness about Asian dust phenomenon for schoolchildren between two areas separated by their frequency rate for Asian Dust event.

II. Materials and Methods

The survey was conducted in 4 cities such as Seoul, Incheon, Busan, and Cheju during 56 days from 1 April to 26 May 2003. We made a choice of the survey regions by the frequency on occurrence of Asian Dust. The frequency of AD in Seoul city and Incheon city was higher.

A total of 1,050 children lived nearby the air pollution monitoring station in the survey area were

selected and the numbers of participants in each survey area are 300 in Soul, 300 in Incheon, 200 in Busan, 250 in Cheju.

This study used the modified version of questionnaire drawn form ATS-'DLD-78-C, Children's questionnaire (for those under 13 years of age) on respiratory symptoms. Two types of questionnaires were applied; one is a baseline questionnaire asking usual health status of children, the disease history of parents and siblings, and consciousness about the air pollution and Asian dust phenomenon; the other is a daily questionnaire asking the questions on respiratory symptoms, outdoor activity, and sanitary activity on that day. PM10 data was obtained in hourly level. All four monitoring stations in each of four cities were provided the air pollution data.

The descriptive analysis and $\chi 2$ –test were conducted to compare health symptoms rates and degree of perception of Asian dust using SAS software (version 8.0) and SPSS software (version 11.0).

III. Results

The response rate of baseline questionnaires survey in Seoul, Incheon, Busan, and Cheju were 86%, 85%, 31% and 90%, respectively. And the reply rate of daily questionnaires by self-administrated in Seoul, Incheon, Busan, and Cheju were 50%, 84%, 59% and 92%, respectively.

Prevalence of allergic rhinitis was the highest (11%) followed by pneumonia (7%) and influenza (4.8%). Prevalence of allergic rhinitis in Incheon was found to be highest (11%). In Table 1, prevalence of the respiratory symptoms was higher in more (18.5%) than that in less frequently occurred area. Table 2 showed the recognition on Asian Dust and the use of protective gear between more and fewer Asian dust days. We observed that those practice & recognition on AD were difference in two areas.

In Table 3 showed the result of daily questionnaires for health self-administration and behavior of schoolchildren from 3rd, April to 12th, May. We divided each case with severely and slightly as well as compared the average between total survey period and Asian Dust events (12th and 13th, April). And most cases were reported higher point in Asian Dust events but lower point in total survey period (Table 3). Especially the response rates of schoolchildren for nose (snivel) were 10.5% (severely) and 33.8% (slightly). The rate of children who use of the mask was 'always' 2.8%, sometime 10.6% in whole. Most children seemed not to use mask.

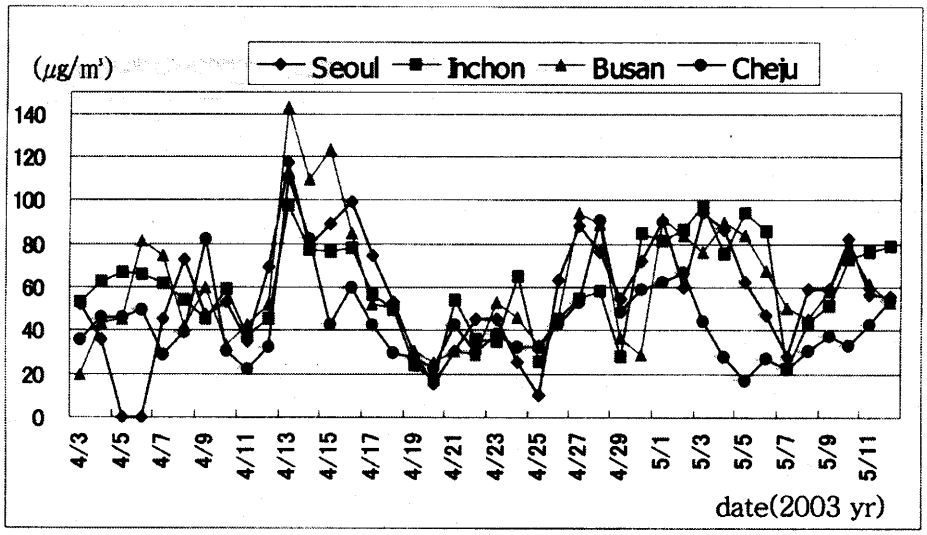

Fig.1. Concentration of PM10 by each city.

Table I

Prevalence of reported respiratory health status and the existence of smoker on family during the past on year between more frequently occurred cities and less frequently occurred cities for Asian Dust

(Unit; person)

		More (Seoul, Incheon)		Less (Busan, Cheju)		
	Total	Yes	Sub-Total	Yes	Sub-Total	X^2
1. Incidence of disease	725	134(18.5)	466 (64.3)	69(9.5)	259 (35.7)	0.369
Pneumonia	802	31(3.9)	512 (63.8)	15(1.9)	290 (36.2)	0.267
Allergic rhinitis	802	56(7)	512 (63.8)	22(2.7)	290 (36.2)	2.36
Pulmonary emphysema	802		512 (63.8)		290 (36.2)	
Bronchial asthma	802	15(1.9)	512 (63.8)	11(1.4)	290 (36.2)	0.44
Chronic bronchitis	802	2(0.2)	512 (63.8)	2(0.2)	290 (36.2)	0.334
Heart disease	802		512 (63.8)		290 (36.2)	
Hypertension	802	8(1)	512 (63.8)	4(0.5)	290 (36.2)	0.042
Influenza	802	14(1.7)	512 (63.8)	8(1)	290 (36.2)	
Other fever	799	70(8.8)	509 (63.7)	38(4.8)	290 (36.3)	0.067
2. Existence of smoker	794	325(40.9)	507(63.9)	189(23.8)	287(36.1)	0.246

Note; parenthesis is percentage

1. Incidence of disease; Did you children had been sick during the past on year?
2. Existence of smoker; Does any of your family member smoke?

Table II

Prevalence of the knowledge on Asian Dust and the use of between more and Less Asian Dust days

(Unit: person)

			More (Seoul, Inchon)		Less (Busan, Cheju)		
		Total	Yes	Sub-Total	Yes	Sub-Total	χ^2
1. Perception		786	492 (62.6)	507(64.5)	272(34.6)	279 (35.5)	0.134
Seasonally	Spring		483 (61)		269(34.0)		
	Summer	791	19 (2.4)	510(64.5)	6(0.8)	281 (35.5)	1.798
	Fall		8 (1.0)		6(0.8)		
Health effects		777	430(55.3)	501(64.5)	216(27.8)	276 (35.5)	7.271*
2. Protective behavior	Wearing of mask	802	127(15.8)	512(63.8)	40(5.0)	290 (36.2)	13.616*
	Stay indoors		269(33.5)	512(63.8)	101(12.6)	290 (36.2)	23.370*
	Not protect.		197(24.5)	512(63.8)	154(19.2)	290 (36.2)	16.094*

Note; * $P< 0.05$; parenthesis is percentage

1. Perception 1) Are you aware of the Asian Dust phenomenon ?
   2) Which season do you think that the sandy dust phenomenon mainly happen?
   3) Do you think the occurrence of the Asian Dust phenomenon will influence your health?
2. How do you protect your body when the Asian Dust break out?

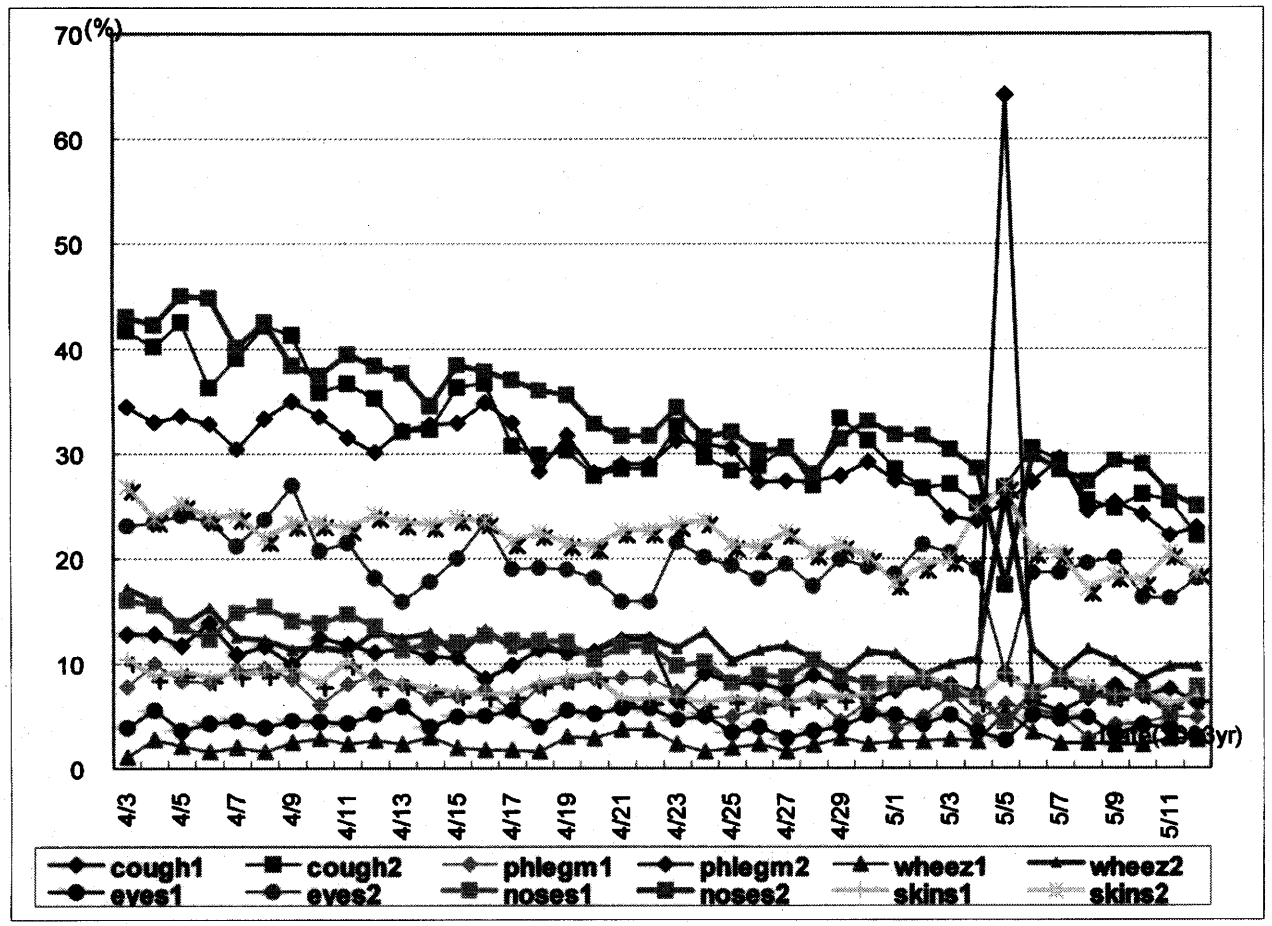

Fig. 2. Daily prevalence of respiratory health symptoms of total areas.

Table III
The prevalence of respiratory health symptoms at AD (Asian Dust) days and Total survey period

Unit;(%)

		C1	C2	P1	P2	W1	W2	E1	E2	N1	N2	S1	S2	M1	M2	G1
Seoul	S.T	8.8	34.5	7.8	30.3	3.0	13.3	5.8	29.3	12.3	39.0	5.6	25.2	3.9	19.8	70.1
	A.D	4.7	38.6	8.8	33.8	4.1	13.7	7.5	26.5	15.0	40.1	5.5	28.1	4.1	20.9	71.9
Incheon	S.T	10.0	37.5	7.0	32.5	3.1	12.0	3.9	17.3	11.6	35.4	9.6	25.9	2.6	10.7	61.7
	AD	12.0	37.0	10.5	31.2	2.4	10.8	3.9	15.6	12.1	36.2	9.3	27.0	2.1	8.9	63.9
Busan	S.T	9.9	27.4	4.1	23.8	2.8	11.9	5.4	16.9	8.5	32.8	7.1	20.4	2.9	9.1	67.2
	AD	7.6	27.5	1.7	27.6	3.8	11.5	8.0	12.7	7.2	40.4	6.0	21.7	1.7	8.8	65.6
Cheju	S.T	12.8	27.8	7.8	29.7	1.6	11.8	3.8	19.0	10.1	31.3	7.7	18.8	2.4	8.0	76.3
	AD	15.2	32.8	10.7	32.3	1.2	14.7	4.7	17.4	14.8	37.6	9.5	21.0	1.3	6.3	80.9
Total		10.8	31.6	6.7	29.4	2.5	12.0	4.4	19.6	10.5	33.8	7.9	22.1	2.8	10.6	69.4
AD		11.3	33.7	8.5	31.2	2.5	12.7	5.5	17.1	12.4	38.1	8.2	23.9	2.0	9.5	71.5

Note; S. T : Sub Total , AD : Asian Dust events(12^{th} and 13^{th}, April)
C(cough)1 : severely, C2 : slightly, P(phlegm)1: severely, P2 : slightly, W(wheeze)1 : severely, W2 : slightly,
E(eye)1 : severely, E2 : slightly, N(nose)1 : severely, N2 : slightly , S(Skin)1 : severely, S2 : slightly
M(mask)1 : always, M2 : sometimes, G(gargle)1 :yes, G2 : no

IV. Summary

This study showed that health effects of primary school children during Asian Dust (AD) phenomenon seems to be associated with the prevalence of respiratory symptoms and perception of Asian dust phenomenon, whereas no clear associations is found between Asian dust in Spring 2003 and respiratory symptoms.

However, it seems that prevalences of the knowledge on Asian Dust and the use of protective gear between are AD and Non AD significantly different. In further analysis, we provide the relative risk of time-series study on ambient air pollution in relation to daily respiratory symptoms in four cities, and from these results we will have an opportunity to compared health status of schoolchildren between more frequently occurred area and less frequently occurred areas for Asian Dust event in Korea

Acknowledgements

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