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심포지움 1) Characteristics and Environmental Impact of Atmospheric Aerosols

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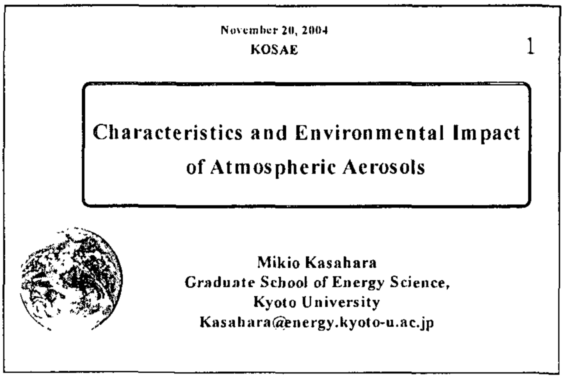
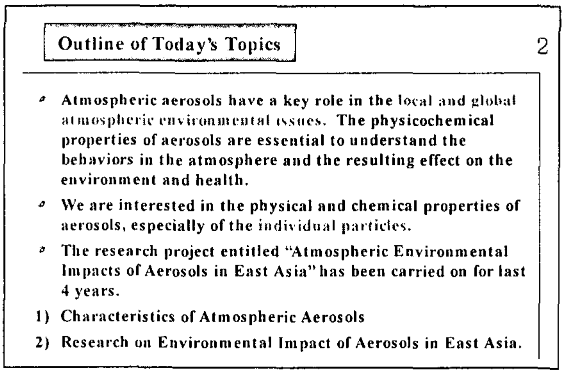
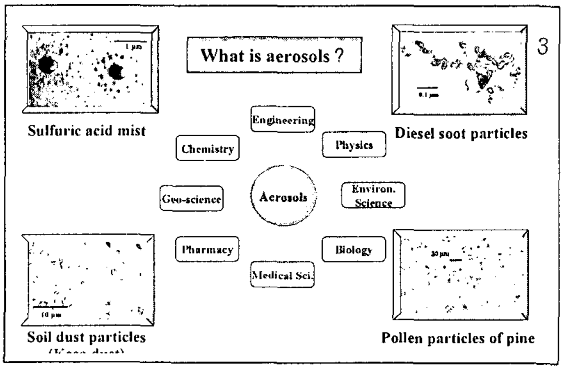
The importance of global environmental issues such as global warming, acid rain and ozone depletion has been recognized worldwide, especially over the last decade.



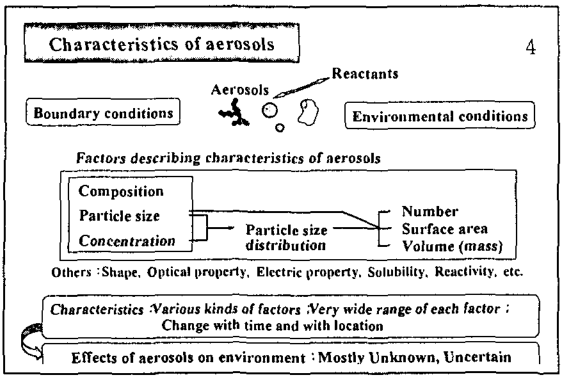


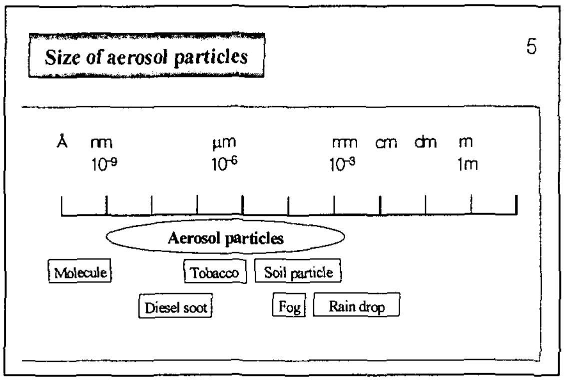


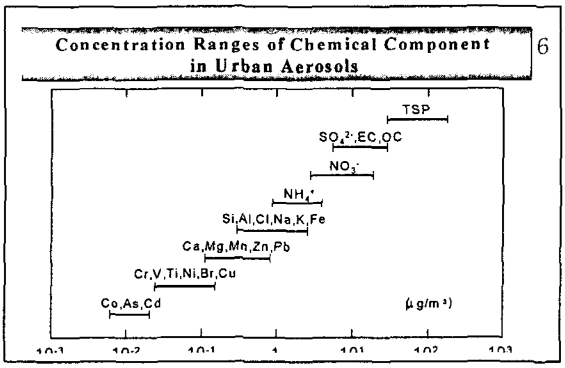
Atmospheric aerosols play an important role in the global environmental issues as well as the local pollution problems. The physical and chemical properties of aerosols are essential to understand the behavior in the atmosphere and resulting effects of aerosols on the environment and human health. The information of physical and chemical properties of aerosols allows estimating the original source of each particle, understanding the behavior of aerosols and evaluating the effects of aerosols on health and atmospheric environment.

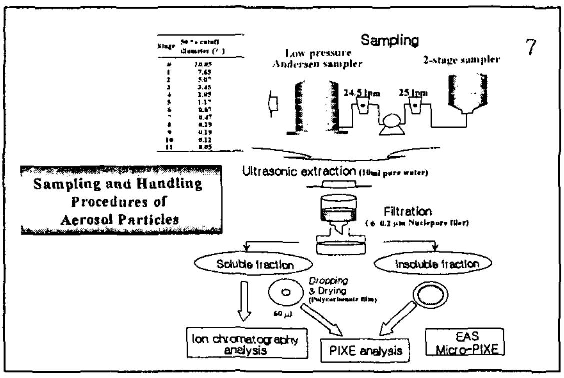
In this paper, the physical and chemical characteristics of aerosols are reviewed first, and then the outline of research project entitled "Characteristics and environmental impacts of atmospheric aerosols in East Asia" is introduced.

Figure 3. shows typical examples of the photograph of atmospheric aerosol particles. In real urban air, many kinds of aerosols exist as the mixtures. The characteristics of aerosol particles are described by a number of physical and chemical factors as shown Fig. 4. Generally, the most important factors are concentration, particle size and chemical composition. And so, simultaneous information of three factors, i.e. particle size distribution of every chemical component is very important. Other factors such as shape, density, reactivity and optical properties become important in some specific problems. For example, the optical property is essential on climate









change, and solubility and reactivity are on acid rain.

Characteristics of aerosol particles change momentarily, and differ from site to site. Such complicated properties of aerosols lead to the insufficient knowledge of aerosol effects on environment.

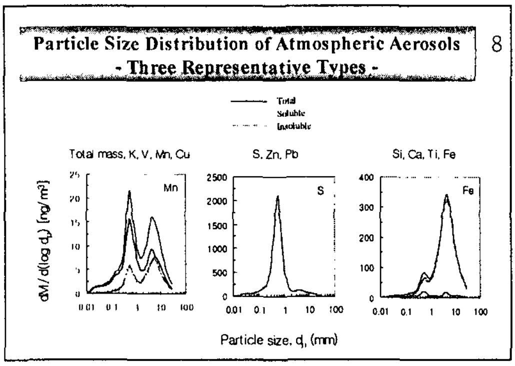
Furthermore, the objective ranges of each factor are very wide, as shown in Fig. 5 as an example of size and in Fig. 6 as an example of mass concentration of various kinds of chemical components.

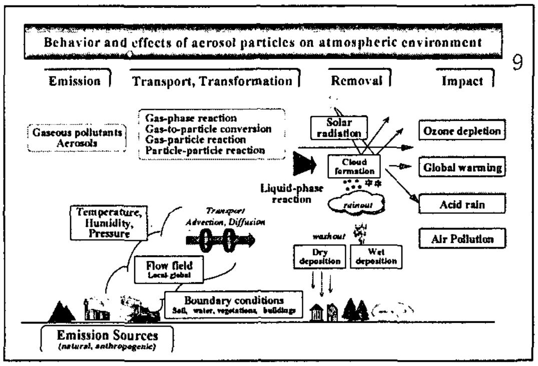
Figure 7 shows the sampling and handling procedures to provide the PIXE and ion chromatograph samples. We collected aerosol particles in two different ways. One is with classifying into 13 size ranges between about 0.01(m and 30(m using a low pressure Andersen air sampler. Another is with classifying into just fine and coarse fractions using a two stacked filter sampler.

The aerosol particles were extracted into the pure water and separated into the soluble and insoluble components.

The particle size distributions are classified into three types as shown in Fig. 8. In general, S, Zn and Pb had only one peak in the fine particle region. On the other hand, Si, Ca, Fe and Ti had nearly one peak in the coarse particle region. Mn, K, V and Cu were represented as the bimodal distribution. And the total mass is also always represented by the bimodal distribution.

Behavior and effects of atmospheric aerosols are summarized in Fig. 9. The figure shows the characteristics of aerosol, main sources including secondary particles and effects of aerosols on the atmospheric environment such as local pollution, acid rain, global warming and/or cooling and ozone depletion. The secondary particle





SCIENTIFIC RESEARCH
OF PRIORITY AREAS 10

Supported by Ministry of Education, Culture, Sport, Science and technology

April 2001 – March 2005

Project :

Atmospheric Environmental Impact of Aerosols in East Asia

Project Leader

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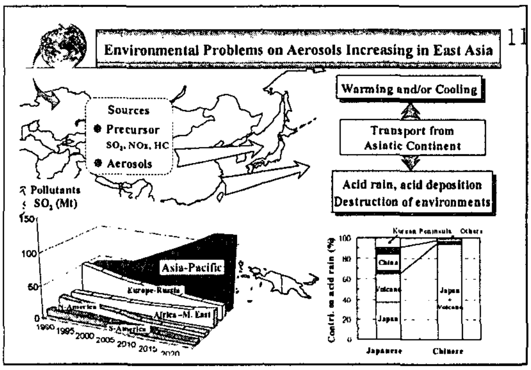

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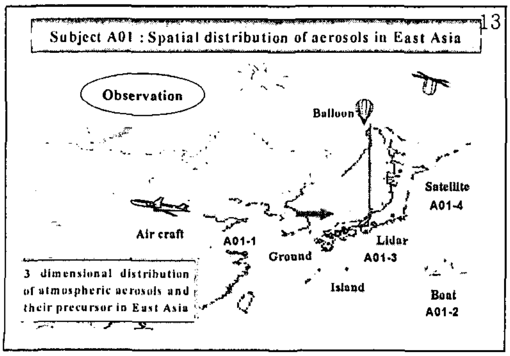
Outline of Research Project

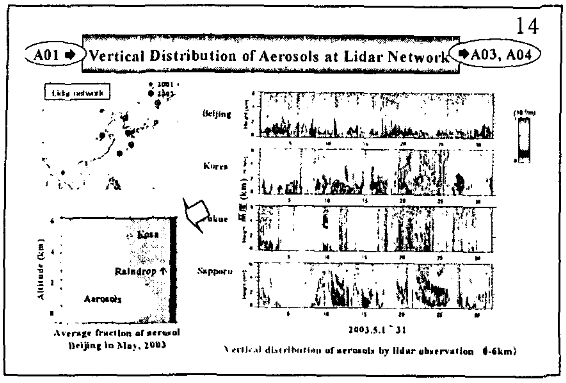
Item	Contents
Title of research project	*Atmospheric Environmental Impacts of Aerosols in East Asia*
Abbreviated title	Environmental Effects of Aerosols
Category	Grand-in-Aid for Scientific Research on Priority Areas (A)
Term of project	2001-2005 (5 years)
Head investigator of research project	Mikio Kasahara, Graduate School of Energy Science, Kyoto University Tel, Fax: +81-75-753-9127, E-mail: kasahara@energy.kyoto-u.ac.jp
Title and (leader) of subject	Subject A01: Spatial distribution of atmospheric aerosol in East Asia (S. Hatakeyama) Subject A02: Properties of atmospheric aerosols and secondary particle formation (K. Okuyama) Subject A03: Transportation, acid rain and acid deposition of atmospheric aerosols in East Asia Subject (T. Ohara) A04: Global warming/cooling effects of atmospheric aerosols (Y. Ohta)
Number of sub-subject	15 sub-subjects by Planed Research and 16 sub-subjects by Invited Research

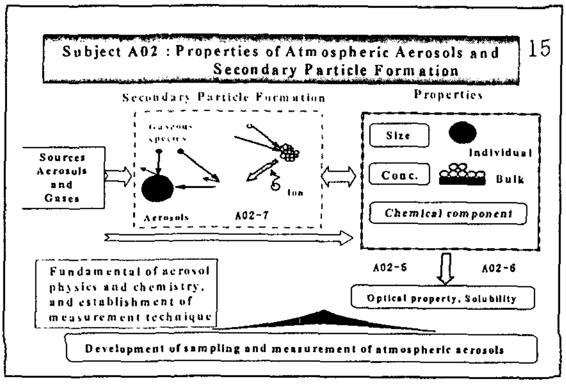


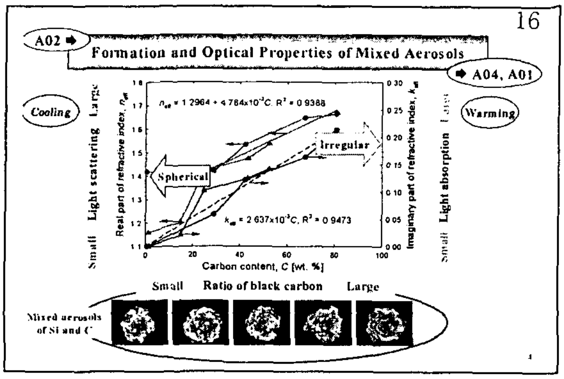
formation including cloud formation is very important. With the remarkable growth of East Asian industries, this area becomes a growing contributor to both local and global environmental issues (see Fig. 11). Therefore, it is very important to study the effects of *aerosol particles on atmospheric environment in* East Asia.

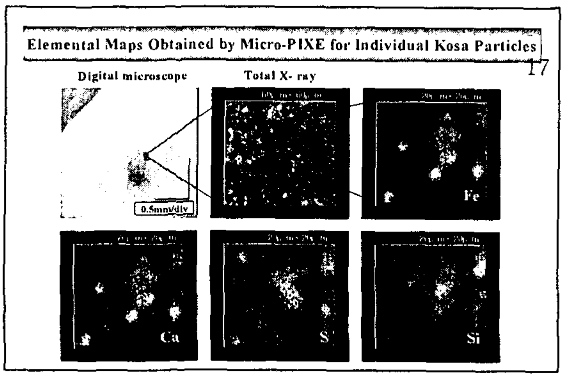
Research project titled "Atmospheric Environmental Impacts of Aerosols in East Asia" was started in 2001 and will continue until March 2005. It is supported by the Ministry of Education, Culture, Sports, Science and Technology in Japan. The outline of the research project is summarized in Fig. 12.

The research project consists of four research topics, Subjects A01-A04. Subject A01, "Spatial distribution of aerosols in East Asia", group studies on the three dimensional distribution of physical and chemi- cal atmospheric aerosols properties and their precursor in East Asia.









They measure the aerosols at the ground, island, on the boat and aircraft and also using lidar, balloon and satellite as shown in Fig. 13 and finally estimate the spatial *distribution of aerosols.*

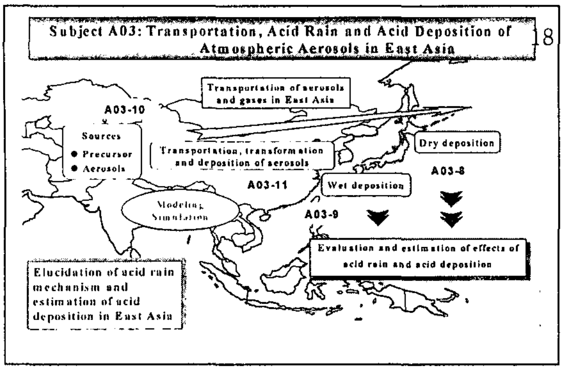
An example of observational data obtained from the continuous lidar network is illustrated in Fig. 14. It shows one month time variations of the vertical distribution of aerosol layer (0-6km) at 4 sites including Korean site (Suwon) and estimated aerosol fraction divided into 4 categories of rain drop, ice cloud, Kosa (dust) and spherical aerosols from extinction coefficient and depolarization ratio.

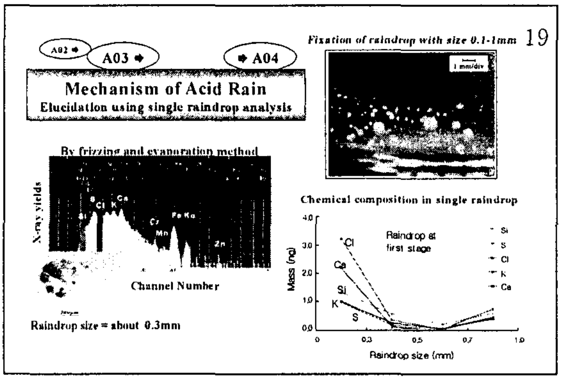
Subject A02, "Properties of atmos- pheric aerosols and secondary particle formation", group is carrying out the modification and development of aerosol sampling, measurement and analytical tech- niques and also the elucidation of the mechanism of nucleation and growth processes including cloud formation as shown Fig. 15. The physical and chemical properties of individual particles are especially focused in this project.

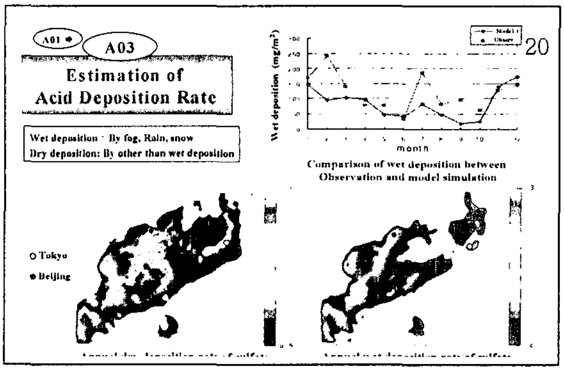
For example, spheroidal particles with various mixing ratio of silica and carbon were prepared and their optical properties were determined. Refractive index (light scattering and light absorption) of each particle are plotted in Fig. 16 as a *function of mixing ratio and shape* (spherical or irregular).

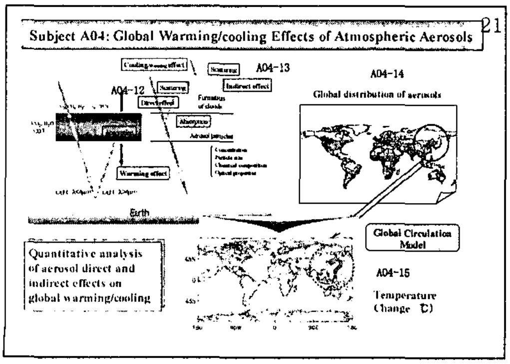
Figure 17 shows the elemental maps in the individual Kosa particle which were obtained by Micro-PIXE analysis.

Subject A03, "Transportation, acid rain and acid deposition of atmospheric aerosols in East Asia", *group is studying on elucidation* of mechanisms of acid fog/acid rain and estimation of acid deposition rate in East









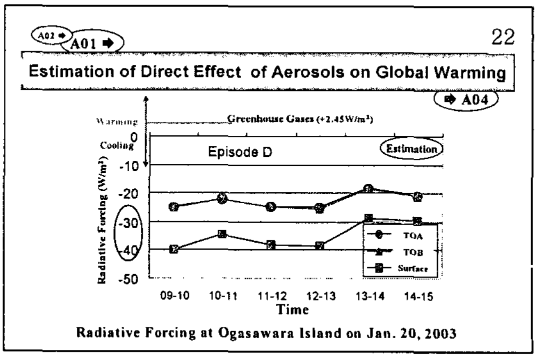
Asia by developing a detailed simulation model including transportation, transformation and deposition.

Chemical analysis of liquid particles is normally extremely difficult in the form of a single particle. In order to characterize the individually liquid particles, four fixation techniques were tested and applied. A photograph of fixed raindrops and PIXE spectrum of a single raindrop are shown in Fig. 19. The mass concentration of each chemical species in single raindrops is plotted as a function of raindrop diameter. The smaller raindrops collect more effectively aerosols during rainfall.

Figure 20 shows the map of acid deposition rate in East Asia obtained using the simulation model. It is assumed that the main source region of acid deposition is China.

Subject A04, "Global warming/ cooling effects of atmospheric aerosols", group urges the qualitative evaluation of direct and indirect effects of atmospheric aerosols on climate change and estimate finally as the temperature changes on the earth.

The radiative forcing is a very important parameter by which the warming or cooling effect can be evaluated. The radiative forcing estimated at Ogasawara Island during the campaign study in January 2003 is plotted in Fig. 22. On January 23, 2003,



the very high absorption coefficient was observed and the radiative forcing reached $-20 \sim -25 w/m^2$ on the top of the atmosphere.

Summary

Atmospheric aerosols have a key role in both local and global environmental problems. The physicochemical properties of aerosols and their spatial distribution are essential to understand their effects on the environment and health.