8. Aerosol Observations

8.1 Background of ACE-Asia

Kazuhiko Miura (Department of Physics, Science University of Tokyo)

Atmospheric aerosol particles affect the Earth's radiative balance directly by scattering or absorbing light, and indirectly by acting as cloud condensation nuclei (CCN), thereby influencing the albedo and life-time of clouds. The natural aerosol has been substantially perturbed by anthropogenic activities, particularly by increases of sulfates, nitrates, organic condensates, soot, and soil dust. The present day global mean radiative forcing due to anthropogenic aerosol particles is estimated to be between - 0.3 and -3.5 Wm^{-2}, which must be compared with the present day forcing by greenhouse gases of between +2.0 and +2.8 Wm^{-2} (IPCC, 1995).

Although aerosol particles have this potential climatic importance, they are poorly characterized in global climate models. This is a result of a lack of both comprehensive global data and a clear understanding of the processes linking aerosol particles, aerosol precursor emissions, and radiative effects. At this time, tropospheric aerosols pose the largest uncertainty in model calculations of the climate forcing due to man-made changes in the composition of the atmosphere. Clearly there is an urgent need to quantify the processes controlling the natural and anthropogenic aerosol, and to define and minimize the uncertainties in the calculated climate forcings. Among the largest sources of uncertainty is the climate forcing by Asian aerosols.

The Aerosol Characterization Experiments (ACE) , which are sponsored by the International Global Atmospheric Chemistry Program (IGAC), are envisioned as a series of international field studies aimed at understanding the combined chemical and physical processes that control the evolution of those aerosol properties that are relevant to radiative forcing and climate. The ultimate goal of this series of studies is to provide the necessary data to incorporate aerosols into global climate models and to reduce the overall uncertainty in the climate forcing by aerosols.

The strategy of ACE is to investigate the multiphase atmospheric system in key areas of the globe. ACE-1, conducted in late 1995, was aimed at the minimally polluted marine troposphere in the Southern Ocean near Tasmania. TARFOX, conducted in June of 1996, studied continental aerosol off the eastern coast of North America. ACE-2, conducted in June of 1997, focused on anthropogenic aerosols from the European continent and desert dust from the African continent as they move over the North Atlantic Ocean.

ACE Asia, of which intensive observations are planned in spring 2001 and 2003, will focus on the outflow of both desert dust and anthropogenic aerosol from Eastern Asia to the Pacific Ocean. The goal of ACE Asia is to determine and understand the properties and controlling factors of the aerosol in the anthropogenically modified atmosphere of Eastern Asian and the Northwest Pacific and to assess their relevance for radiative forcing.

The R/V Mirai is elected as the platform of Japanese shipboard observation. The MR00-K04 cruise was regarded as the pre-ACE Asia cruise by all Japan researchers. PIs and on board members of the pre-ACE Asia group were shown in Tables 1 and 2, respectively. The MR01-K02 cruise was regarded as the ACE Asia cruise. Pis and on board members of the ACE Asia group were shown in Tables 3 and 4, respectively.

Table 1 Participating Organizations of pre-ACE Asia group

Participating Organizations	PI
Institute of Low Temperature Science, Hokkaido University (ILTSa)	Kimitaka Kawamura
Institute of Low Temperature Science, Hokkaido University (ILTSb)	Tatsuo Endo
Faculty of Engineering, Hokkaido University (HU)	Sachio Ohta
Ocean Research Institute, University of Tokyo (ORI)	Mitsuo Uematsu
Faculty of Science, Science University of Tokyo (SUT)	Kazuhiko Miura
National Institute for Environmental Studies (NIES)	Nobuo Sugimoto
Japan Ocean Science and Technical Center (JAMSTEC)	Kunio Yoneyama

Table 2 On Board members of pre-ACE Asia group

Scientists

Mutsuhiro Mochida (ILTSa), Kiyoshi Matsumoto (ORI), Kazuhiko Miura (SUT),

Technicians

Ichiro Matsui (NIES)

Students

Masahiro Narukawa (ILTSa), Yuji Fujitani (HU), Takeshi Hara (SUT), Takeshi Ui (SUT), Takeshi Kishida (SUT)

Table 3 Participating Organizations of ACE Asia group

Participating Organizations	PI
Institute of Low Temperature Science, Hokkaido University (ILTSa)	Kimitaka Kawamura
Institute of Low Temperature Science, Hokkaido University (ILTSb)	Tatsuo Endo
Faculty of Engineering, Hokkaido University (HU)	Sachio Ohta
Ocean Research Institute, University of Tokyo (ORI)	Mitsuo Uematsu
Research Center for Advanced Science and Technology, University of Tokyo (RCAST)	Yoshizumi Kajii
Faculty of Science, Science University of Tokyo (SUT)	Kazuhiko Miura
Faculty of Environment, Nagoya University (NU)	Ippei Nagao
National Institute for Environmental Studies (NIES)	Nobuo Sugimoto
Communications Research Laboratory (CRL)	Hiroshi Kumagai
Japan Ocean Science and Technical Center (JAMSTEC)	Kunio Yoneyama

Table 4 On Board members of ACE Asia group

On Board (12 persons)
Scientists
Kazuhiko Miura (SUT), Shungo Kato (RCAST), Ippei Nagao (NU), Nobuo Sugimoto (NIES), Akihide Kamei (CRL)
Technicians
Kazutake Ohta (ORI), Ichiro Matsui (NIES)
Students
Sou Matsunaga (ILTSa), Yuji Fujitani (HU), Atsushi Ooki (ORI), Ryo Ashikawa (SUT), Takahito Inaba (SUT)

8.7 Study on the transport process and the modification of aerosols

(1) personnel

Kazuhiko Miura , Ryo Ashikawa, Takahito Inaba (Department of Physics, Science University of Tokyo)

(2) objectives

It is important to know aerosol profile in the lower troposphere for the process study of aerosol transport from continental to the remote ocean. There is no observation in the the planetary boundary layer (PBL), however there are a few observations in the free troposphere (FT). In this work, we observed aerosol behaviors in the PBL by using kytoon system over the ocean.

Main purposes of our observation are as follows:

(a) Measuring the entire size distribution with three instruments
(b) Obtaining the residence time of aerosols with radon and thoron measurements
(c) Investigating the mixing condition of individual particles with TEM/EDX analysis
(d) Simultaneous sampling on surface and by kytoon system

(3) measured parameters

- size distribution

scanning mobility particle sizer : 3936N25 (3085 + 3025A), TSI Inc. (44<d<168nm)

optical particle counters : KC18 and KC01, Rion Co. Ltd.

(d>100, 150, 200, 250, 300, 500, 1000, 2000, 5000 nm)

- total concentration of particles

condensation nuclei counter : 3022A, TSI Inc.

- radon daughter concentration

radon daughter monitor : ES-7269, JREC Co. Ltd.

- particle concentration profile with kytoon system

kytoon : 10 m^3 in volume

optical particle counter (d>300, 500, 700, 1000, 2000, 5000 nm) : KR12, Rion Co. Ltd.

- solar radiation

portable sunphotometer (λ: 368, 500, 675, 778, and 862 nm) : MS-120(S), Eko Co.

- shape and elemental composition of aerosols

sampling : cascade impactor : Model I-1L, PIXE Int. Corp.

carbon-covered nitrocellulose film supported on an electron microscopic grid

analysis : an energy dispersive X-ray spectrometer : Kevex Sigma

(4) method

In order to examine the transport process and the modification of aerosols, we measured the complete size distribution from 4.4 to 5000 nm in diameter with scanning mobility particle sizer (3936N, TSI Inc.) and two optical particle counters (KC18 and KC01D, RION Co. Ltd.) every five minutes. We also measured radon daughter concentration with radon daughter monitor (ES-7269, JREC Co. Ltd.) every four hours.

We also performed the kytoon observation up to 1000 m at eight stations (Table 8.7.1). Aerosol particles larger than 0.15 μm in radius were counted with the KR12 and temperature and relative humidity were measured for 1 min at every 50 m. Aerosol particles were collected directly on a carbon-covered nitrocellulose grid with two impactors for 10 min at the highest level and on the compass deck at the same time (Table 8.7.2). The electron micrograph will be obtained using a scanning electron microscope (Hitachi Co., H-9000). The elemental compositions in individual particles larger than 0.1 μm in radius will be analyzed with an energy dispersive X-ray spectrometer (Kevex Sigma).

(5) results

Variations of radon concentration (shown as peak counts) and total particle concentration are shown in Figs. 8.7.1 and 8.7.2, respectively. Radon and total particle concentration decreased as leaving the Japan Islands. The decreasing rate of particle was greater than that of radon.

An example of aerosol profile on 26 May 2001 with optical sonde on the kytoon system is shown in Fig. 8.7.3. This shows that there is a boundary at about 600 m in length and the concentration of smaller particles in the upper layer is higher than that in the under layer. The further analyses are in future work.

(6) data archive

The original data will be archived at Department of Physics, Science University of Tokyo (Contact Kazuhiko Miura [e-mail: miura@rs.kagu.sut.ac.jp]).

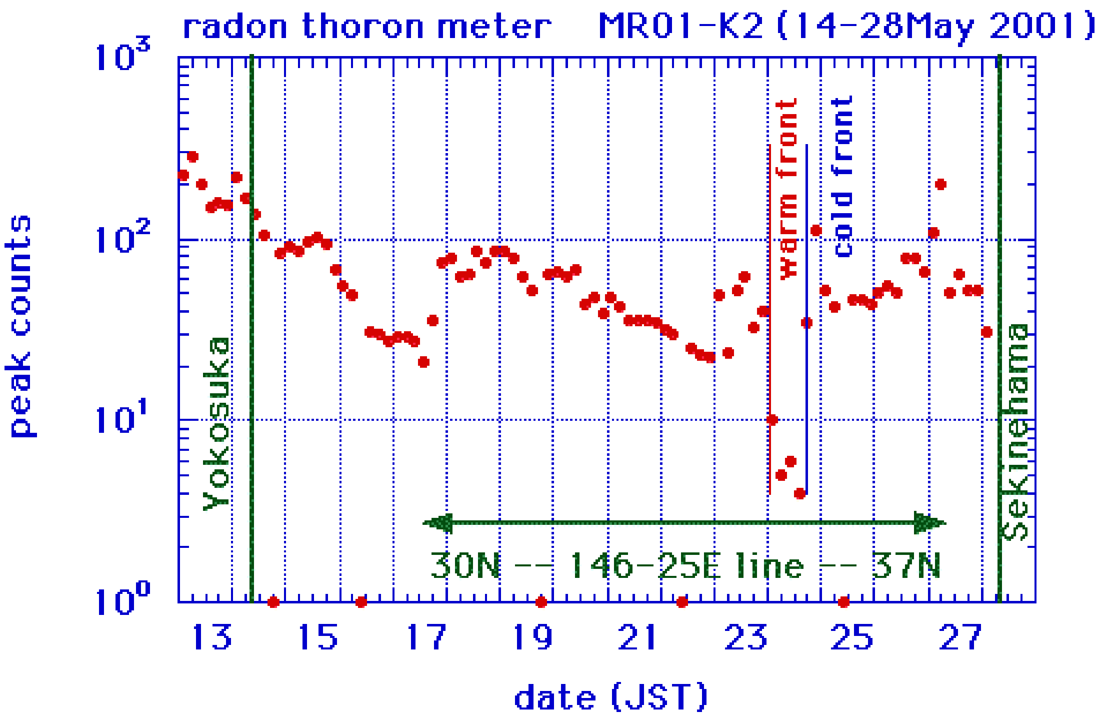


Fig. 8.7.1 Variation of radon concentration (peak counts).

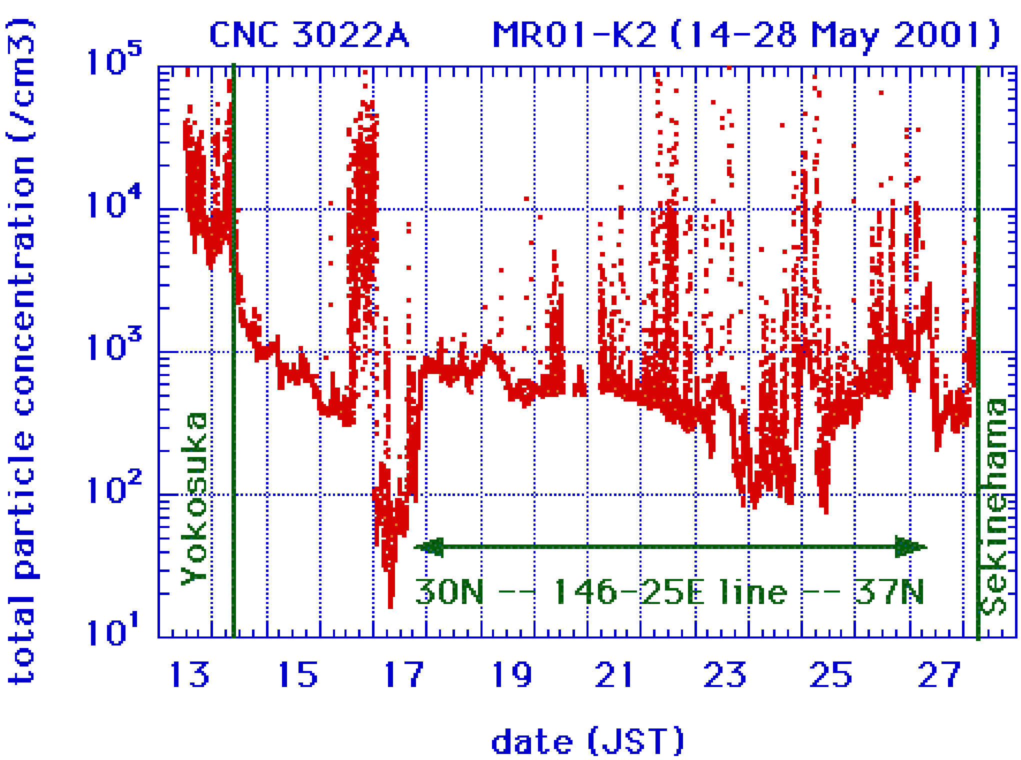
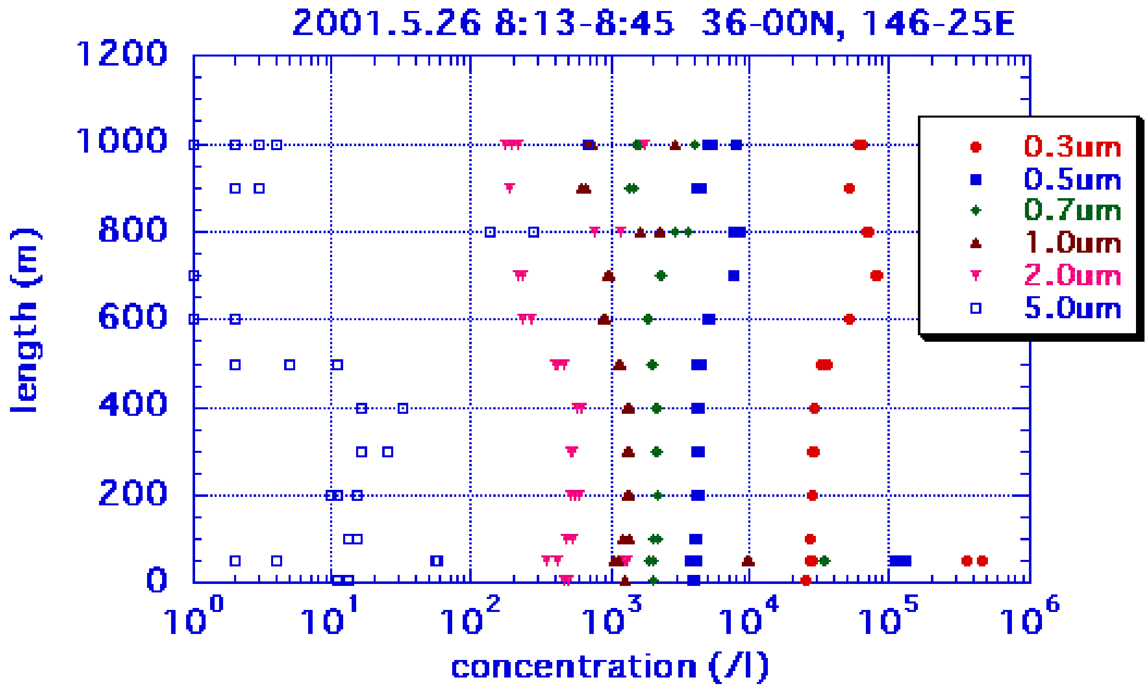


Fig. 8.7.2 Variation of total particle concentration.



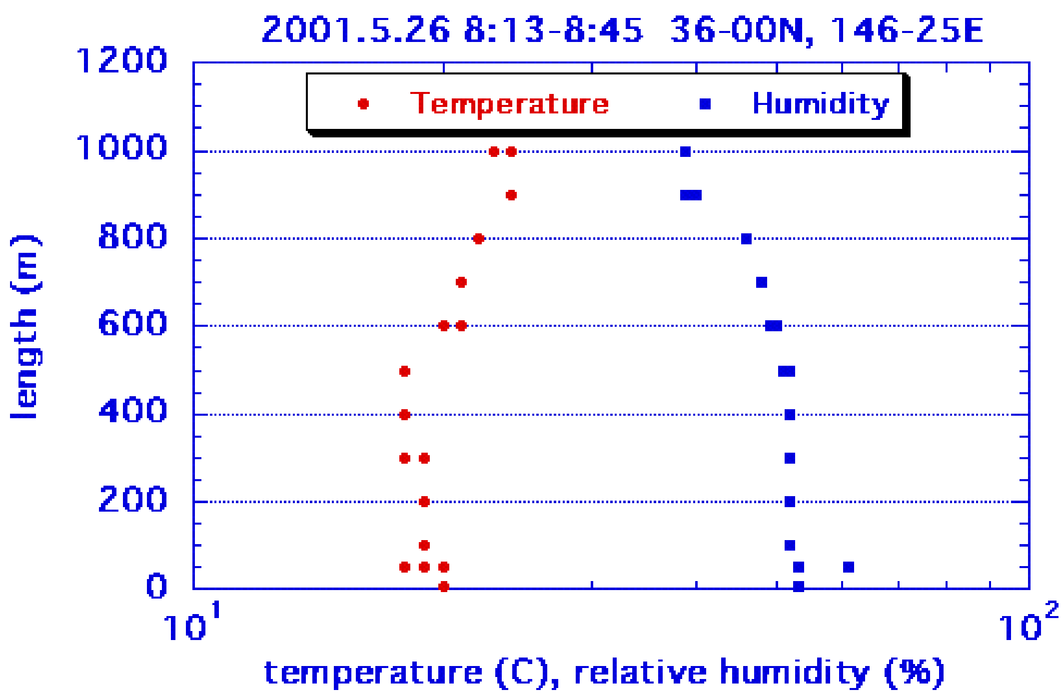


Fig. 8.7.3 Upper : An example of aerosol profile at 0813 to 0845 JST on 26 May 2001, at (36N, 146-25E) with optical sonde on the kytoon system.

Lower : Temperature and relative humidity profile measured at the same time.

Table 8.7.1 Measuring list of the number concentration profile with OPC on the kytoon.

No.	date	start time	stop time	max. length (m)	latitude	longitude
1	2001.5.18	8:35	8:56	600	30-45N	146-25E
2	2001.5.18	12:40	13:02	600	31-00N	146-25E
3	2001.5.19	5:04	5:24	600	31-45N	146-25E
4	2001.5.19	8:41	9:14	1050	32-00N	146-25E
5	2001.5.19	14:23	14:53	1000	32-15N	146-25E
6	2001.5.20	5:35	6:06	1000	33-00N	146-25E
7	2001.5.20	10:26	10:57	1000	33-15N	146-25E
8	2001.5.26	8:13	8:45	1000	36-00N	146-25E

Table 8.7.2 Sampling list of the grid with two impactors.

No.	date(JST)	start time	stop time	latitude(N)	longitude(E)	place	case No.
1	2001.5.13	11:05	11:15	35-16	139-40	compass	1,31
2	2001.5.14	12:40	12:50	34-43	140-15	compass	2,32
3	2001.5.14	20:09	20:19	34-08	142-30	compass	3,33
4	2001.5.15	8:15	8:15	33-20	146-29	compass	4,34
5	2001.5.15	13:22	13:32	33-01	148-07	compass	5,35
6	2001.5.15	20:15	20:25	32-34	150-06	compass	6,36
7	2001.5.16	7:03	7:13	32-07	152-28	compass	7,37
8	2001.5.16	17:47	17:57	31-50	151-04	compass	8,38
9	2001.5.17	8:32	8:42	30-20	147-16	compass	9,39
10	2001.5.18	9:30	9:40	30-44	146-24	compass	10,40
11	2001.5.18	9:30	9:40	30-44	146-24	600m	11,41
12	2001.5.18	13:38	13:48	31-00	146-24	compass	12,42
13	2001.5.18	13:38	13:48	31-00	146-24	600m	13,43
14	2001.5.19	5:55	6:05	31-45	146-24	compass	14,44
15	2001.5.19	5:55	6:05	31-45	146-24	600m	15,45
16	2001.5.19	10:07	10:17	31-59	146-24	compass	16,46
17	2001.5.19	10:07	10:17	31-59	146-24	1050m	17,47
18	2001.5.19	15:50	16:00	32-15	146-23	compass	18,48
19	2001.5.19	15:50	16:00	32-15	146-23	1050m	19,49
20	2001.5.20	6:55	7:05	32-59	146-30	compass	20,50
21	2001.5.20	6:55	7:05	32-59	146-30	1000m	21,51
22	2001.5.20	11:45	11:55	33-15	146-27	compass	22,52
23	2001.5.20	11:45	11:55	33-15	146-27	1000m	23,53
24	2001.5.23	8:47	8:57	34-31	146-22	compass	24,54
25	2001.5.24	15:45	15:55	34-05	146-28	compass	25,55
26	2001.5.25	15:25	15:35	35-05	146-21	compass	26,56
27	2001.5.26	9:30	9:40	35-59	146-25	compass	27,57
28	2001.5.26	9:30	9:40	35-59	146-25	1000m	28,58
29	2001.5.26	18:12	18:22	36-30	146-25	compass	29,59
30	2001.5.27	8:20	8:30	37-59	146-24	compass	30,60
31	2001.5.27	15:35	15:45	39-15	144-59	compass	61,62