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NIES Annual Report 1996/97

National Institute for Environmental Studies

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Foreword

Human development while preserving the natural environment is no easy task because environmental degradation itself is deeply rooted in the human desire for better and more convenient lives. The drive to satisfy these desires has created a human process requiring huge material flows, which will eventually exhaust our energy base, natural resources, and natural environment.

Accordingly, our common belief in endless economic growth is now being questioned. People have now begun to consider our present environmental problems to be fundamentally inherent in our industrialized society. That is, a society characterized by huge material flows from production, through consumption, and onward to final disposal into the surroundings, is, in essence, a one way process without feedbacks.

Needless to say, our Earth is limited. Thus, if human activities should expand endlessly with explosive population growth, our Earth would eventually be overwhelmed, thus threatening our very existence. To sustain human society, and avoid such an outcome, we should use energy more efficiently and natural resources more sparingly. Recycling materials and life cycle assessment, for which acceptance is gradually increasing in Japanese society, are also important. As a concept, sustainable development is more comprehensive than just recycling, and it is accordingly emphasized in Japan's Basic Environment Law and Plans. Henceforth, Japanese society will seek practical ways to achieve sustainable development.

As Japan's foremost center for environmental sciences and technologies, the National Institute for Environmental Studies (NIES) is doing its utmost to promote international cooperation. So, in addition to the original Japanese annual report, NIES decided in 1995 to publish a new one in English. I hope that NIES's 1996/97 English annual report will help promote deeper understanding of our activities and strengthen international ties on environmental studies.

石井吉徳

Yoshinori Ishii
Director General

Contents

During the 1950s and 1960s, Japan experienced serious environmental pollution problems accompanying the rapid economic growth which followed World War II. Among these problems were Minamata disease caused by poisoning with organic mercury contained in the waste water of some factories and chronic bronchitis and asthma caused by sulfur oxides emitted from the factories of large industrial complexes. The Environment Agency of Japan was established in 1971 to develop countermeasures to serious environmental pollution problems such as these. Since the promotion of basic research on environmental sciences was very necessary and could address public needs, the National Institute for Environmental Studies (NIES) was established in 1974 at Tsukuba Science City, about 50 km north of Tokyo as a branch of the Environment Agency of Japan. NIES is the sole national institute for comprehensive research in the environmental sciences.

Since its establishment, NIES has conducted basic studies to reveal the nature of and to provide countermeasures to the so called seven common public nuisances; i.e. air pollution, water pollution, soil contamination, noise, vibration, offensive odor and ground subsidence. Researchers at NIES are of various specialties including physics, chemistry, biology, health sciences, engineering, economics, etc. Interdisciplinary joint studies have been carried out, particularly in project research studies. There are various types of specially designed experimental facilities as well as remote research stations like the Lake Kasumigaura Water Research Station, the Okunikkou Field Monitoring Station and Monitoring Station-Hateruma.

Recent, rapid, technological progress, structural changes in industries and changes in the styles of our daily lives have added new problems for environmental science to deal with. Moreover, global environmental problems, such as global warming, depletion of the stratospheric ozone layer, acid rain, destruction of tropical rain forests, desertification, etc., have recently given rise to deep concern worldwide. NIES underwent a major reorganization (Fig. 1) on July 1, 1990 to elucidate the adverse effects of environmental pollution on human health, to search for countermeasures to these threats, to conduct more intensive research both on global environmental changes and their effects, and on conservation of the natural environment. The research functions of the new organization are conducted within two project research divisions, six fundamental research divisions and the Center for Global Environmental Research. The Senior Research Coordinator, the General Affair Division and the Environmental Information Center facilitate the research activities. The Environmental Information Center has the additional functions at preparing and providing access to both research publications and environment related data bases. The Environmental Training Institute, located in Tokorozawa, enhances the capabilities of officials from all levels of government.

As of the end of FY 1996, the total number of NIES regular personnel was 272 (Table 1). In FY 1996, NIES invited 394 scientists to carry out the research programs as occasion demanded and also 165 researchers (62 foreigners included) joined NIES's research activities. The total budget of FY 1996 was 9,819 million yen (Table 2).

Table 1
Full Number of Personnel

Research	178	65.4%
Management	47	17.3%
Env. Information Center	18	6.6%
Center for Global Env. Research	10	3.7%
Env. Training Institute	19	7.0%
Total	272	100%

(as of the end of FY1996)

Table 2
Budget in Millions of Yen

Item	FY1994	FY1995	FY1996	
1. Primary budget				(% of total)
Personnel	2,115	2,199	2,267	(28.6%)
Research	587	1,637	694	(8.8%)
Facilities operations & maintenance	1,290	1,457	1,418	(17.9%)
Info. & related research	412	509	509	(6.4%)
Center for Global Env. Research	1,668	1,928	2,091	(26.4%)
Env. Training Institute	100	108	121	(1.5%)
Administration	338	354	356	(4.5%)
Facilities maintenance and repairs	205	2,005	463	(5.9%)
Total	6,715	10,197	7,919	(100%)
2. Additional resources from external research funds				
EA Research Funds	1,041	1,066	1,217	
STA Research Funds	316	588	683	
Total	1,357	1,654	1,900	

(EA=Environment Agency, STA=Science and Technology Agency)

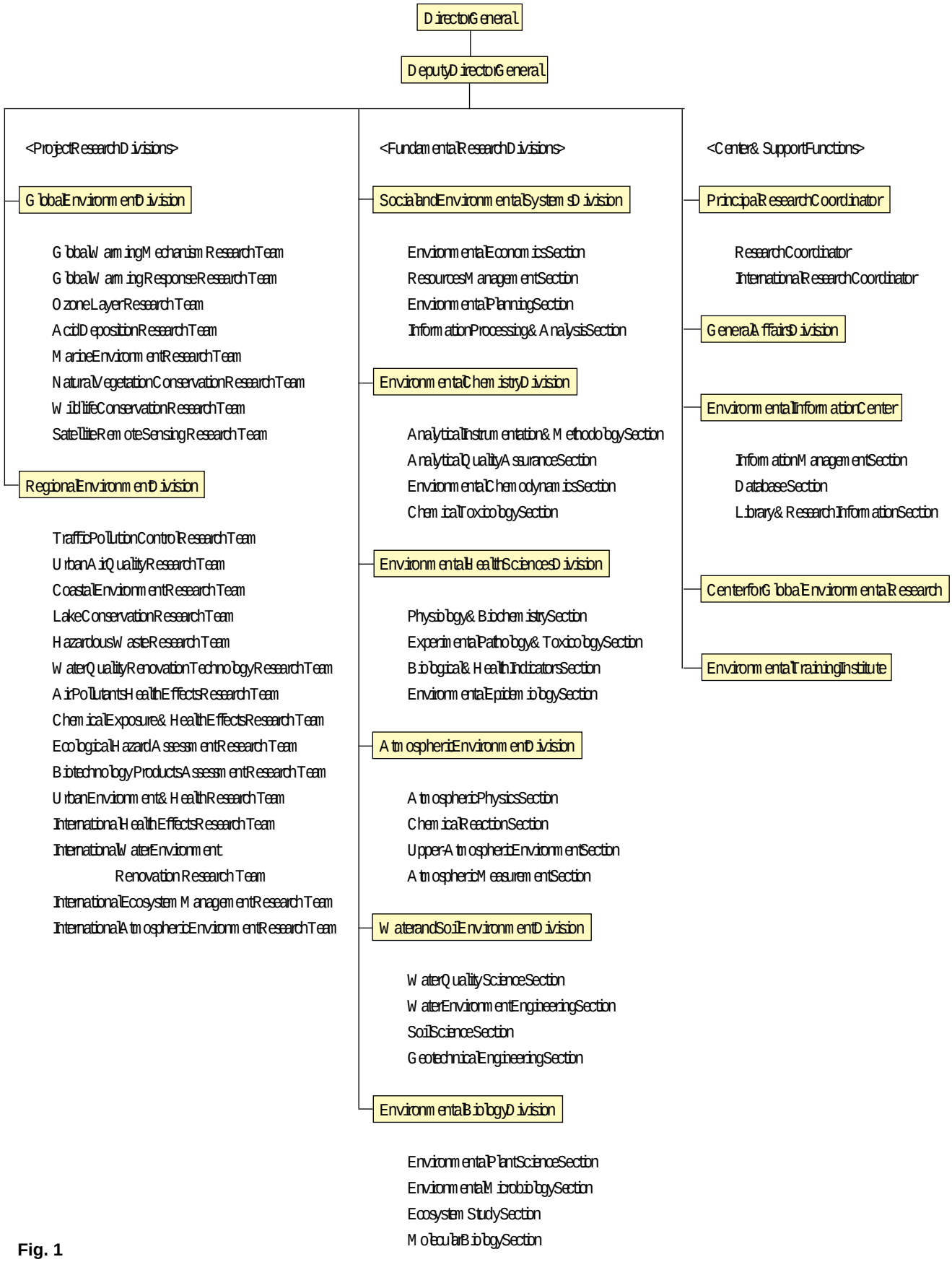
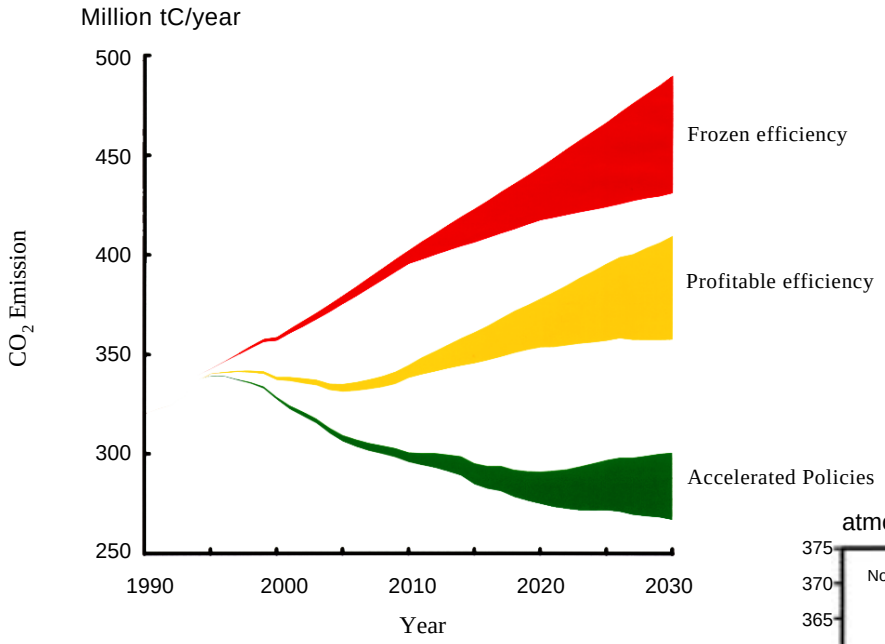


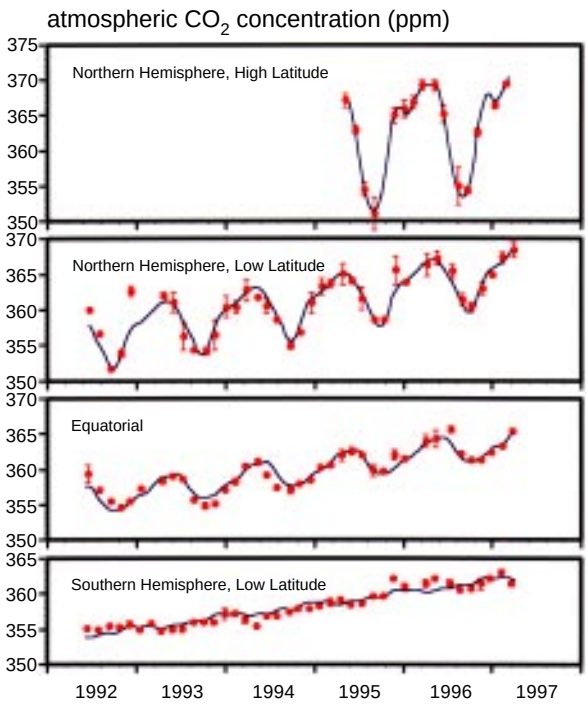
Fig. 1
Organization of the National Institute for Environmental Studies

Global Environment Division

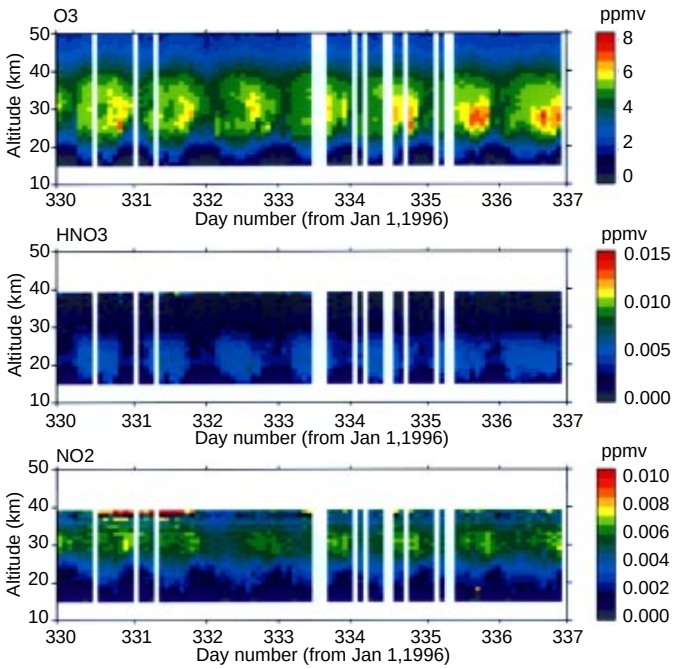


Forecasts of Japanese CO_2 emissions

Atmospheric CO_2 increase observed by CGER/NIES monitoring utilizing transpacific commercial vessels



ADEOS/ILAS Level 2 (ver.02.00) Product, S.H.,1996/11/25-1996/12/01



The mission of the Global Environment Research Division is to tackle contemporary global environmental issues with interdisciplinary and integrated approaches; with these approaches, we analyze, evaluate, and understand the issues. Based on the new insights so generated, we hope to propose technical and policy measures to solve the problems. In this section, the scope of the activities of the eight teams in the group is introduced and three major recent research topics are described in depth.

Global Warming

The **Global Warming Mechanism Research Team** is measuring greenhouse gases in the troposphere and the hydrosphere, utilizing the NIES monitoring network with various platforms established by CGER/NIES, including ground based stations, ships-of-opportunity, and aircraft. The steadily increasing atmospheric concentration of CO_2 has been observed at our two background air monitoring stations, located at Hateruma Island in Okinawa Prefecture and at Cape Ochiishi in Hokkaido Prefecture, since 1993 and 1995, respectively.

Latitudinal distributions of atmospheric CO_2, CH_4, and N_2O have been precisely measured since 1992 from a ship-of-opportunity that sails regularly between Japan and Australia. Bottles of marine air are sampled automatically from lat. 25°S to 35°N every 6 weeks. Additional sampling from another ship-of-opportunity sailing regularly between Canada and Japan started in 1995; atmospheric samples from lat. 54°N to 36°N are collected to extend the latitudinal coverage. The results provide a unique data set of the latitudinal distribution of N_2O, and show a small inter-hemispheric difference of 0.8 ppb. We observed seasonal variation of atmospheric N_2O, with slightly higher concentrations in the northern hemispheric winter.

Air sampling for the measurement of vertical profiles of greenhouse gases has been carried out once per month over Surgut, West Siberia using a chartered aircraft since July 1993. Air samples were collected at 8 different heights between 500 and 7000 m. CO_2 concentrations in the profile reached a maximum in late March or late April and a minimum in late July or late August. The seasonal amplitudes of variation observed at 500 m have been significantly larger than those observed at similar latitudes at the surface, due to the fact that our air sampling was made in an inland area of the Eurasian Continent with highly active terrestrial biomass, whereas other sites are located remote from the continents or near their coasts. CH_4 below 1000 m reached maxima both in summer and winter. Extremely large amounts of CH_4 were released from wetlands around West Siberia, thus creating the concentration maximum observed in summer. The CH_4 maximum in winter suggests venting or leakage of natural gas and its accumulation under the inversion layer.

The **Global Warming Response Research Team** has been developing the Asian-Pacific Integrated Model (AIM) with Nagoya University and collaborating institutes in China, India, Korea, and Indonesia. This model assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and preventing the impacts of climate change.

The AIM comprises three main models - the greenhouse gas emission model (AIM/emission), the global climate change model (AIM/climate), and the climate change impact model (AIM/impact). The AIM/emission model has been extended to analyze systematically the effects of countermeasures and projected national CO_2 emissions out to 2030. The AIM/climate model was improved to analyze a safe emission corridor, a range of emissions that is acceptable. The AIM/impact model has been linked to an economic model for assessing climate change damage.

The research program has made major contributions to policy deliberations at the national, regional, and global levels. The AIM model has been used to provide global and regional emission scenarios and regional impact assessments to the IPCC. The AIM model has been evaluated at the Stanford Energy Modeling Forum for the international comparison of emission scenarios and impact assessment. Other uses have included contributions to Eco Asia (the Congress of Asian Ministers for the Environment), the Global Environmental Outlook Program of UNEP, the UN Global Modeling Forum, and the Asian-Pacific Network Program.

Ozone Depletion

Ozone depletions in the middle and high latitudes of the Northern Hemisphere during the winters of 1994/1995, 1995/1996, and 1996/1997 were extraordinarily large, especially those inside the polar vortex. The **Ozone Layer Research Team** has been developing ground-based remote sensing instruments and balloon-borne instruments to measure trace species related to ozone depletion as well as participating in national and international research campaigns, such as Ozone Sounding as a tool for Detection of Ozone Change (OSDOC), in cooperation with national institutes, universities, and foreign institutions. The team is also in charge of the ozone layer monitoring effort supported by CGER. Ozone at altitudes from 15 to 45 km has been monitored for more than 7 years with a laser radar, as a component of the Network for the Detection of Stratospheric Change (NDSC). In September 1995 we installed a millimeter radiometer to continuously measure vertical profiles of ozone from 30 to 70 km to extend our ozone measurement capabilities in both time and space.

From January 1996, ozone sonde observations were carried out to examine the influences of the polar vortex on ozone depletion at Moshiri Station (lat. 44°N, long. 14°E), operated by the Solar Terrestrial Environment Laboratory (STEL) of Nagoya University. These observations were complemented by visible spectrometer and Fourier transform-infrared spectrometer (FTIR) observations from STEL. In April 1996, the effects of ozone depletion in the polar vortex were observed by these methods.

Modeling of ozone depletion, laboratory experiments, and studies to evaluate the impacts of UV-B on human and plant health were carried out. The behavior of and countermeasures against methyl bromide were also studied.

The **Satellite Remote Sensing Research Team** has taken the lead in promoting the Improved Limb Atmospheric Spectrometer (ILAS), Retroreflector In-Space (RIS), and ILAS-II projects for atmospheric monitoring from space. The ILAS and RIS instruments have been in orbit on the satellite “Midori” renamed from the Advanced

Earth Observing Satellite (ADEOS) since 17 August 1996.

As one of the ILAS project activities, the team has developed and then revised ILAS Data Processing Software for daily use at the ILAS & RIS Data Handling Facility, which was built in cooperation with the CGER (Center for Global Environmental Research). The revised software reflects the results of the algorithm studies and instrumental function evaluation conducted in 1996 after the start of acquisition of real ILAS data.

The team also organizes a researchers' group to conduct studies and provide scientific guidance for the ILAS project. This group consists of researchers from universities and research institutes both inside and outside of Japan. The members have been studying revisions of the algorithms for data processing, and conducting validation experiments and analysis for ILAS. Preliminary results indicate that the ILAS instrument and the data processing software have been working normally without problems and have produced valuable data on ozone layer chemistry and dynamics. The ILAS-II instrument will add new capabilities to the first ILAS instrument to better characterize stratospheric ozone layer chemistry and polar stratospheric clouds. The team has also been involved in algorithm studies and development of the ILAS-II Data Processing System. [Unfortunately, the satellite "Midori" stopped its operation due to a fatal problem in its solar battery panel on 30 June 1997 when the editing work on this Annual Report was on-going.]

Acid Deposition

Acidic deposition is one of the most interdisciplinary environmental problems we are now facing. East Asia will soon become the largest source region for acidic pollutants in the world because of the increase in fossil fuel consumption accompanying rapid population growth and development of industrial activity. The **Acid Deposition Research Team** is researching the estimation of emissions, transport, deposition, and impacts of acidic pollutants on life-environment systems in East Asia including China, Korea, and Japan.

1. Studies on the development of a comprehensive model of atmosphere-soil and an international cooperative field survey to clarify the budget of environment-acidifying substances in East Asia.
The gridded emissions of volatile organic compounds from natural and anthropogenic sources were compiled. International cooperation among China, Korea, and Japan on aerial and ground-based observation of air pollutants over the East China Sea and the Yellow Sea began in FY 1996. Observation flights were made on 11 and 13 January 1997. High concentrations of SO_2 were observed over those seas when northwest winds prevailed. In addition, long and short term field observations were conducted from a remote island and a semiurban site to obtain data with which to evaluate a long range air pollutant transport model.

2. Impacts of acidic pollutants on life-environment systems
Chemical forms of Al were studied in the aquatic plant and soils collected from neutral and acidic environments. The cellular distribution of Al in an aquatic plant showed

that almost all Al is distributed in the cell wall as Al-compounds combined with organic polymers.

The acid neutralization capacity of river water collected from the island of Yakushima were measured through the seasons with a newly devised flow-type pH meter after the addition of 0.001 N, 0.01, N and 0.1 N sulfuric acid solution, as a simple and effective method.

Marine Environment

The marine environment has been affected by anthropogenic disturbance of the elemental cycles of C, N, and P and the anthropogenic discharge of hazardous materials. Also, the ocean plays a primary role in stabilizing the Earth's climate and environment. These two issues are strongly related to the functions of marine ecosystems . The following results were obtained by the **Marine Environment Research Team** under four research projects. A Japan-China collaborative study on the impact on marine ecosystems of anthropogenic perturbations of C, N, P, and Si cycles and input of hazardous chemicals in the Changjiang (Yangtze) River Basin has been established based on a field survey and floating mesocosm experiments. A continuous sampling system with extraction and concentration for monitoring hazardous trace chemicals was developed and deployed on a ferry sailing regularly between Osaka and Okinawa. Furthermore, a new marine monitoring program using a container ship that sails the route (Japan - Hong Kong - Singapore - Malacca Strait - Kuala Lumpur) was designed and the seawater intake system was equipped. To interpret the anticipated results of this monitoring, a hydrodynamic model for the South China Sea was developed and the results demonstrated that the sea surface temperature and flow depend on the Monsoon cycle. Because of the importance of the Asian coastal seas, a method for monitoring coral reef changes by archiving of underwater images was established and further developed, mainly by introducing an underwater stereo photographic system.

Nature Conservation

The **Natural Vegetation Conservation Research Team**, studied the differences in herbivore influences on seeds and seedling establishment between the disturbed and undisturbed patches of the Pasoh Forest Reserve in Peninsular Malaysia. The plots in the disturbed patches were under canopy gaps while the undisturbed patches were under closed canopy. At the same time, we conducted a defoliation experiment on some seedlings of canopy forming species; the effects of herbivore in the canopy gaps and closed understory were compared. To understand the defense mechanisms of trees to herbivores, we measured the tannin, starch, glucose, and lipid contents in some dipterocarp seedlings. Tolerance to the herbivore grazing (mechanical disturbance) was also studied by measuring leaf toughness. Microenvironmental factors (light intensity, atmospheric vapor pressure, surface temperature, soil moisture content, etc.) were measured both in the canopy gap and closed canopy sites. To clarify the role of canopy gap formation as a mechanism for maintaining forest structure and composition, a three-dimensional model of a canopy was constructed using aerial photographs. Based on this model, the size and distribution patterns of canopy gaps were analyzed.

The **Wildlife Conservation Research Team** has been developing techniques to evaluate the vulnerability of wildlife populations to extinction. In the process of population decrease, populations may suffer significant genetic deterioration, namely decrease in genetic variability, which may lead to corresponding decreases in fitness (survival and reproduction). The team we analyzed fluctuating asymmetry (FA: minor non-directional deviations from bilateral symmetry in morphological characters), genetic variability, and the relationship between them, for cases in which both terms could be calculated as measures of fitness for several species (butterflies, dragonflies, fruit flies, sticklebacks, Sylvid and Emberizid birds).

We investigated the influence on FA of the eradication program that attempted to annihilate the oriental fruit fly *Dacus dorsalis*, from the islands of Okinawa. The FA of two veins of the fruit fly showed a significant increase during the process of extinction. Reduced genetic variability is more likely to explain the increase of FA in the nearly extinct population than is stress from the toxicant used in the eradication program. In a Papilionid butterfly *Parnassius glacialis*, on the other hand, we found a substantial genetic variability measured as heterozygosity rates of Glucose Phosphate Isomerase (GPI), Esterase (EST) and Glucose-6-Phosphate Dehydrogenase (G6PD) between populations. FA was negatively correlated with the average heterozygosity of this butterfly population, indicating that FA is a reliable measure of genetic variability of populations.

In addition to FA measurements, the team is analyzing the effects of decreased genetic variability on disease resistance in the wildlife populations, using DNA analysis of major histocompatibility complex (MHC) polymorphism and/or bioassay for immune response of animals.

Human Dimensions of Global Environment Change

In light of the increasing importance of the human dimensions of global environmental issues, this group started in FY 1995 to organize Global Environment Research Program researchers whose interests are related to the Human Dimensions of Global Environmental Change Programme (HDP). Those interests cover 1) effects of land use/cover change on global environmental change (Land Use for Global Environmental Conservation: LU/GEC), 2) urban structure and life style changes necessary for sustainable development, 3) human activity and its impacts on the environment and socio-economic system, and 4) quality of life and risk assessment.

The purpose and major result of our initial research, i.e. LU/GEC, is briefly introduced below. The purpose of LU/GEC is to develop a comprehensive land use model that can predict future change in land use in Asia between 2025 and 2050. The project is divided into 4 major model parts: 1) Basic Model, 2) China Model, 3) East Asia Model, and 4) Comprehensive Model. Simultaneous with model development, our international cooperating researchers from China, Indonesia, and Thailand collected and stored environmental and socio-economic data in geographically referenced form that will be used as a database for verification and prediction of the models.

The China model was applied assuming four different socio-economic scenarios

describing changes in population, GDP, and so on. The model can predict changes in 5 categorized land uses (agricultural land, forest, grassland, urban area, and other uses). The model predicts dramatic changes in land use in China by 2050. Grassland in China decreased by more than 100 million ha and in its place, arable land will increase by about 70 million ha. This significant change in land use will occur mainly due to continuing population growth and industrialization in China.

Study of CO_2 gas exchange in the subarctic Pacific from a ship-of-opportunity

Almost the half of the anthropogenically emitted CO_2 is accumulating in the atmosphere. The other half is absorbed by processes involved in the global carbon cycle, mainly due to exchange between the atmosphere and both the surface ocean and the land biota. The extent of the oceanic uptake of anthropogenically emitted CO_2 is a matter of great contention. One of the various approaches to evaluate oceanic uptake is measurement of gas exchange at the ocean surface.

The CO_2 partial pressure (pCO_2) of the surface ocean has been measured at various locations in the world ocean for estimations of oceanic CO_2 uptake. Higher pCO_2 in the surface ocean than that in the atmosphere indicates evasion of CO_2 from the ocean, and, conversely, lower pCO_2 indicates invasion of CO_2 into the ocean. Since the oceanic pCO_2 shows large spatial and seasonal variability, the estimation of a truly representative average of oceanic invasion and evasion of CO_2 requires intensive observations. Obtaining sufficient time series coverage with measurements from conventional research vessels is very difficult. The use of ships-of-opportunity is an effective way to obtain pCO_2 data with complete seasonal coverage along a fixed transect of the ocean.

In March 1995 we started monitoring pCO_2 in the northern North Pacific from the cargo vessel “M/S Skaugran” (owned by Seaboard Co., Canada) with cooperation from the captain, crew, and owners. This is a joint research program of NIES with the Institute of Ocean Sciences, Fisheries and Ocean, Government of Canada; it is also a CGER/NIES monitoring program.

The ship sails between Vancouver and several Japanese ports at intervals of around 6 to 8 weeks. Usually she transports Canadian lumber to Japan and returns either without cargo or with Japanese and/or Korean cars bound for the United States and Canada. Figure 1 shows all of the ship routes from the start of this monitoring program through April 1997. The ship route from Japan to Canada ranges in a latitudinal band between lat. 35°N and 52°N. When cars are loaded, the ship route shifts southward. The route from Canada to Japan is close to the great circle route crossing the Bering Sea. The route in the Gulf of Alaska and in the Bering Sea is a constant one. In the Western Subarctic Pacific, the route varies according to the port of destination in Japan. About 8 round trips per year provide 8 sets of measurements for complete seasonal coverage.

A water intake line from the bottom of the ship was installed. The depth of the intake from the sea surface changes between 8 and 12 m with changes in the load. Two types of pCO_2 measurement systems were installed in a space in the engine room.

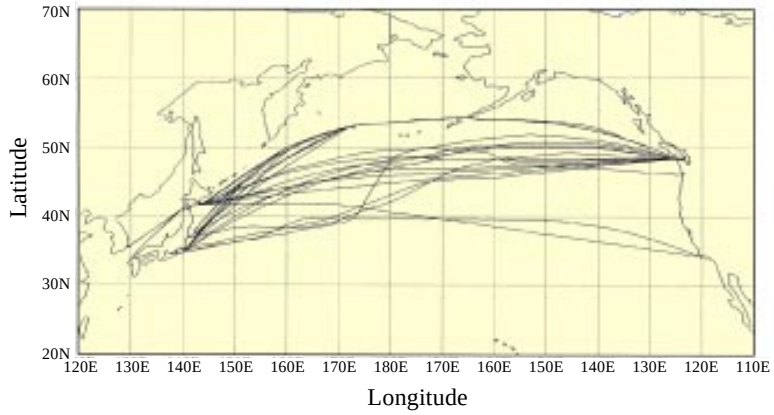


Fig. 1
Cruise track of the M/S Skaugran during the oceanic pCO_2 monitoring study initiated in March 1995. By April 1997, measurements on 17 round trips had been completed.

One has a conventional shower head type equilibrator with a circulating airflow. The concentration of CO_2 in the equilibrated air is measured by a non-dispersive infra-red analyzer (NDIR), which gives hourly data for pCO_2 in surface seawater. The other system has a newly designed bubbling equilibrator with an open airflow. The concentration of CO_2 in the equilibrated air is also monitored by another NDIR, which facilitates continuous pCO_2 data acquisition with a very quick response time. The standard CO_2 gas used is carefully calibrated against the NIES CO_2 scale standard gases. Data for pCO_2, temperature, salinity, and other parameters are logged in a computer system every minute. The atmospheric concentration of CO_2 is also monitored on board. The on-board monitorring personnel operate the system and also take water samples for analysis of nutrients, dissolved inorganic carbon species, phytoplankton pigments, and so forth. A global positioning satellite receiver (GPS) and sensors for air temperature, humidity, and wind, along with a data logger are installed on a container laboratory deployed on the top deck.

By April 1997 we had already obtained pCO_2 records of 17 round trips. The oceanic invasion and evasion of CO_2 is controlled by the difference in pCO_2 between the surface seawater and the atmosphere ($\Delta\ pCO_2$) and by the wind velocity at the ocean surface. A $\Delta\ pCO_2$ contour plot for the data set of transects from Canada to Japan is shown in Fig. 2. The positive and negative $\Delta\ pCO_2$ areas indicate evasion and invasion of CO_2, respectively. In late spring and summer, a low oceanic pCO_2 area was observed in the western Gulf of Alaska and in the eastern Bering Sea. Highly variable oceanic pCO_2 was observed in the Western Subarctic Pacific (off the Kamchatka Peninsula and Kuril Islands); but $\Delta\ pCO_2$ was generally negative. The negative $\Delta\ pCO_2$, namely the oceanic uptake of CO_2, usually relates to primary production by the phytoplankton. In contrast, the highest $\Delta\ pCO_2$ observed in the Bering Sea occurred in winter. Positive $\Delta\ pCO_2$ was also observed in the Western Subarctic Pacific in winter. The evasion of CO_2 from the ocean relates to the vertical mixing due to the surface cooling of the surface ocean in winter. The Gulf of Alaska is a generally weak sink throughout the year.

The annual average of the data confirm that the Western Subarctic Pacific is an important sink area for CO_2, an area of high oceanic primary production. On the ship route from Japan to Canada, usually located south of the subarctic front, a small negative $\Delta\ pCO_2$ was observed throughout the year. This result indicates that atmospheric CO_2 is absorbed into the ocean in this area. This data set, combined with

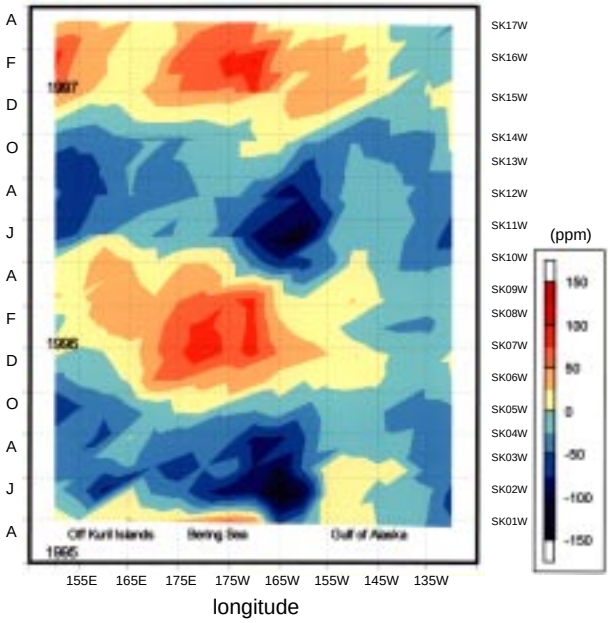


Fig. 2
Δ pCO_2 (difference between the oceanic pCO_2 and the atmospheric pCO_2 in ppm) on the westbound legs of M/S Skaugran cruises. Green and blue colors indicate oceanic invasion of CO_2 and yellow and red colors, oceanic evasion. Tick labels on the right ordinate indicate the leg number of the monitoring cruise.

the analysis of the ocean wind data sets, can contribute to accurate estimation of the CO_2 exchange flux in the North Pacific.

Projection of the Asian-Pacific Integrated Model (AIM)

The Asian-Pacific Integrated Model (AIM) is a large-scale model for scenario analyses of greenhouse gas emissions and the impacts of global warming in the Asian-Pacific region. This model is being developed mainly to examine global warming response countermeasures in the Asian-Pacific region, but it is linked to a world model, making global estimates possible. AIM is unique in that it integrates emissions, climate, and impact models to facilitate policy assessment.

A submodel of AIM/emission, an end-use model, can evaluate the effects of introducing new technologies. It accounts for final energy consumption and CO_2 emissions in end-use sectors, based on actual energy use and the way energy services are performed by energy devices. Figure 3 shows the Japanese CO_2 emission projections simulated in three cases: business-as-usual, introduction of a 30,000 ¥/t C tax, and introduction of 3,000 ¥/t C tax plus subsidy. In order to reduce emissions to the 1990 level with a single carbon tax, the high tax rate of 30,000 ¥/t C is required.

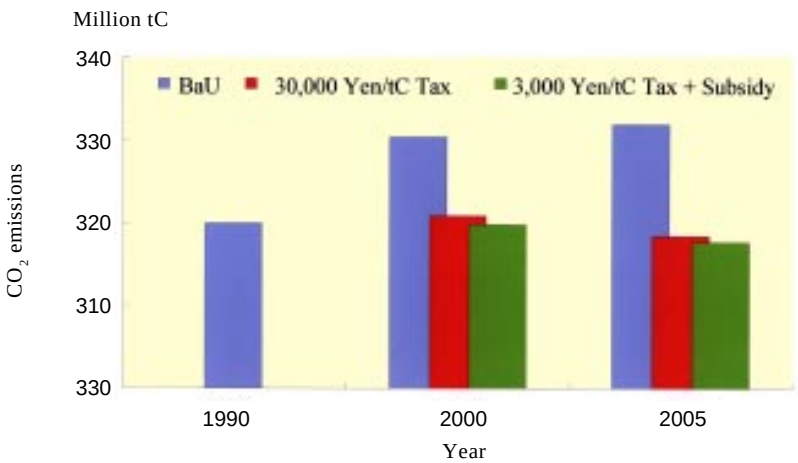


Fig. 3
CO_2 emission stabilization scenarios for Japan.

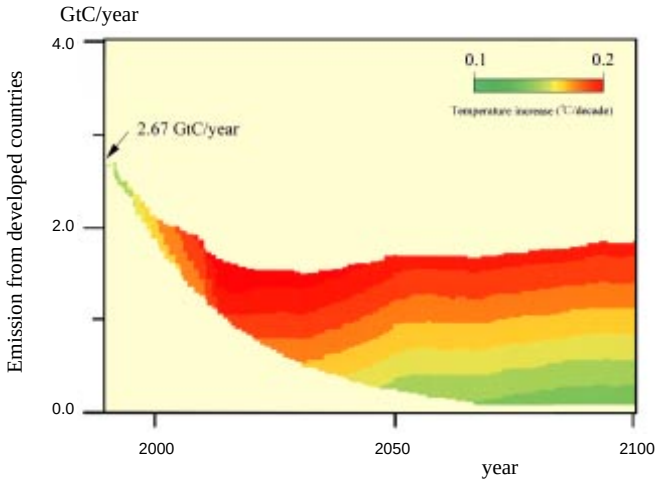


Fig. 4
Emission corridor for developed countries (maximum CO_2 reduction rate of 4% and maximum temperature increase of 0.2°C/decade).

However, the introduction of such a high tax rate would be politically difficult. An alternative would be to use the revenue from the tax to subsidize investment in energy efficient technologies. In this case, the tax rate would only need to be 3,000 ¥/t C. This combination of tax and subsidy policies has been evaluated with a two level optimization technique.

Another important result was the calculation of a safe emission corridor. The most cost-effective emission trajectory was calculated within several constraints. For example, two types of constraints were used to calculate the corridor: the upper limit on the rate of temperature increase and the upper limit on the rate of emission reduction. If the maximum temperature increase is assumed to be 0.2°C/decade and the maximum annual rate of CO_2 emission reduction is to be 2% for developed countries, then the emission corridor would disappear at the beginning of the next century. To make a corridor for developed countries, the maximum annual rate of CO_2 emission reductions needs to be increased to 4% (Fig. 4). The corridor resulting from this increase in the rate of emission reductions demonstrates that a 0.2°C/decade maximum temperature increase creates a very severe constraint for the developed countries in controlling their CO_2 emissions.

Climate impacts on water resources, crop production, and spatial changes in natural ecosystems have also been studied. Crop production changes are shown in Fig. 5 under a 2°C-temperature increase scenario. The range of values is caused by the eleven general circulation models (CCC, GISS84, GFDL, GFDLR30, GFDLQ-flux, OSU, UKmet, UIUC, GISS95, MRI, GFDL100) used. A small decrease in rice production is expected in most countries, except Bhutan and Taiwan. The productivity of wheat will decrease significantly in many countries.

Figure 6 shows the spatial changes of potential productivity of winter wheat, if the global temperature increase is assumed to be 2.0°C. Potential productivity in northeastern China and northern India will greatly decrease. However, in several areas, such as central China and Russia, potential productivity is expected to increase. This uneven impact of global climate change can be calculated with the AIM model for policy evaluation.

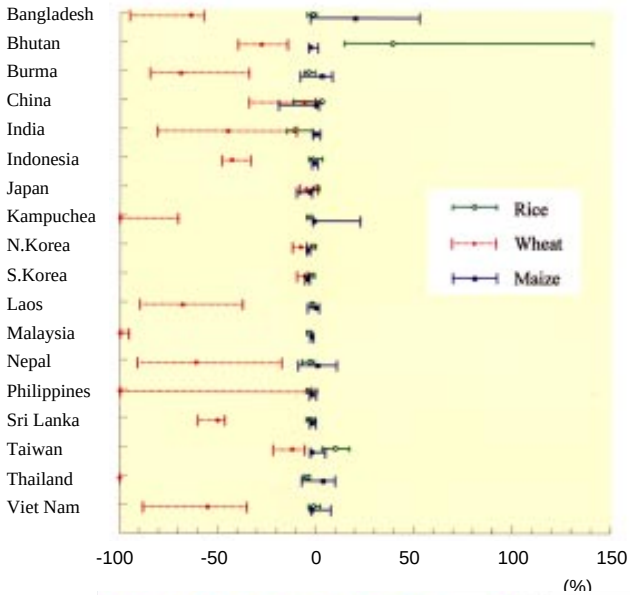


Fig. 5
Potential crop production changes under a 2°C-global temperature increase scenario.

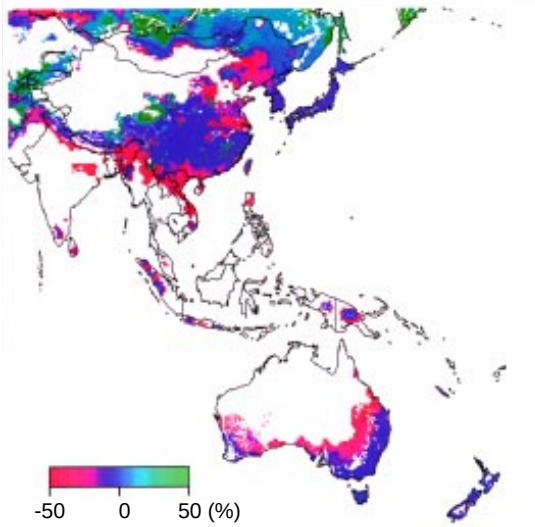


Fig. 6
Change of potential productivity of winter wheat under a 2°C-global temperature increase scenario.

ILAS providing ozone layer data from space
— The first instrument in space developed by the Environment Agency

The Improved Limb Atmospheric Spectrometer (ILAS) developed by the Environment Agency (EA) for monitoring the stratospheric ozone layer was launched on the satellite "Midori" (renamed from ADEOS) on 17 August 1996. Every day this instrument is providing much valuable data on the chemical and physical conditions of the ozone layer. [This article had been prepared before the extremely unfortunate failure of Midori's power system happened. The ILAS on board Midori is producing no more data on the time of editing this article.] The Satellite Remote Sensing Research Team has been playing a leading role in promoting the ILAS project and supporting the EA in designing and manufacturing the ILAS instrument; the team has organized the scientists group and established a data center for the ILAS.

The principle of ILAS measurements is based on the solar occultation technique, which has been proven to be quite effective and stable for measurements of stratospheric trace species. The goals of ILAS measurements were to obtain data to improve our understanding of the mechanisms of ozone layer destruction and to

monitor the behavior of the ozone layer in response to the restrictions on production and use of artificial clorofluorocarbons (CFCs).

The ILAS instrument has infrared (IR) and visible spectrometers. The main targets of the ILAS measurements using the IR channel data were vertical profiles of ozone (O_3) and ozone-related species such as nitric acid (HNO_3), nitrogen dioxide (NO_2), nitrous oxide (N_2O), methane (CH_4), and water vapor (H_2O). We will also try to derive the profiles of other minor gases, such as CFC11, CFC12, and N_2O_5. Profiles of aerosol extinction coefficients at some IR wavelengths were also being derived. From the visible channel data, which give absorption spectra due to oxygen molecules, temperature and pressure profiles were obtained. Aerosol extinction profiles were also derived from the visible channel signal in the wavelength range of no absorption due to oxygen molecules.

The altitude range for data analysis was from cloud-tops to about 60 km, depending on the retrieved parameters. The instantaneous field of view had a 2 km height resolution. Since the solar occultation technique was employed as the measurement principle and the Midori satellite had a sun-synchronous polar orbit (the inclination angle was 98° and the altitude was about 800 km), the measurement region of the ILAS was over high latitude regions (58°N to 73°N and 65°S to 90°S) and changed with the season. The ILAS gave quite unique measurement opportunities and generated daily height-longitude cross sectional maps of atmospheric parameters.

We have been working in collaboration with CGER on the ILAS Project to establish the ILAS Data Handling Facility (DHF) and also working together with research groups (ILAS Science Team and Validation Experiment Team) to support the project scientifically. The ILAS DHF functions as a data center for the ILAS project, generating request commands for ILAS sensor operation, exchanging various operational information with the Earth Observation Center (EOC) of the National Space Development Agency of Japan, acquiring ILAS data from EOC, processing ILAS data to higher level products, archiving them, and distributing them to EOC and data users. The Science Team activities include development of algorithms for data processing, planning of data use, data quality check, validation analysis, and data use.

As a result of initial activities, we confirmed that the ILAS instruments were working normally as designed and that the ILAS DHF software for processing data to derive geophysical quantities from ILAS data was also functioning well. The first data obtained from the initial checkouts of the instrument on 18 and 19 September 1996 provided quite reasonable ozone profiles. From the commencement of routine operation of the satellite Midori and the ILAS instrument in November 1996 until the end of March 1997, more than 3000 measurements had been made.

Validation experiments were conducted at several sites, including Esrange, near Kiruna in Sweden. The Kiruna balloon campaign, carried out in cooperation with Centre National d'Études Spatiales (CNES, the French Space Agency), was the biggest

validation experiment conducted by the ILAS Project. About 20 large balloons were launched during the period of February and March 1997 with the collaboration of more than 100 scientists and engineers who gathered from several countries. All the target parameters of the ILAS instrument were measured with the instruments on board the balloons. Analysis of data collected through this validation experiment is now proceeding. Some preliminary comparisons show that the ILAS-derived ozone profiles look very reasonable. We are still working on some problems in data processing to provide scientifically valid data. One of the problems is the uncertainty in tangential height determination from the ILAS sun-edge sensor data. Another is the discrepancies between ILAS-derived temperature and temperature from the UK Meteorological Office assimilation data. Validation analysis is still on-going. When all the validation analysis is completed, the ILAS data will be labeled as "Verified" and made available to general users. Until then, the ILAS Science Team members and Principal Investigators selected through Research Announcement activity will continue to work hard on validation analysis and algorithm improvement.

Here we present some preliminary data. Due to the problem of tangential height determination, UK Meteorological Office assimilation data were used to calculate tangential heights for all data processing. UKMO temperature was also used in calculating infrared spectroscopic parameters. Figure 7 depicts a vertical profile of ozone mixing ratio derived from ILAS with that from simultaneous ozone sonde measurements made at Syowa station in the Antarctic for the same location as the ILAS measurement; agreement is quite reasonable. The ILAS makes about 14 measurements over a certain latitudinal circle in a day in both the Southern and Northern Hemispheres, respectively. Therefore, it is possible to draw a height-longitude cross sectional map for each target parameter each day in both the Southern

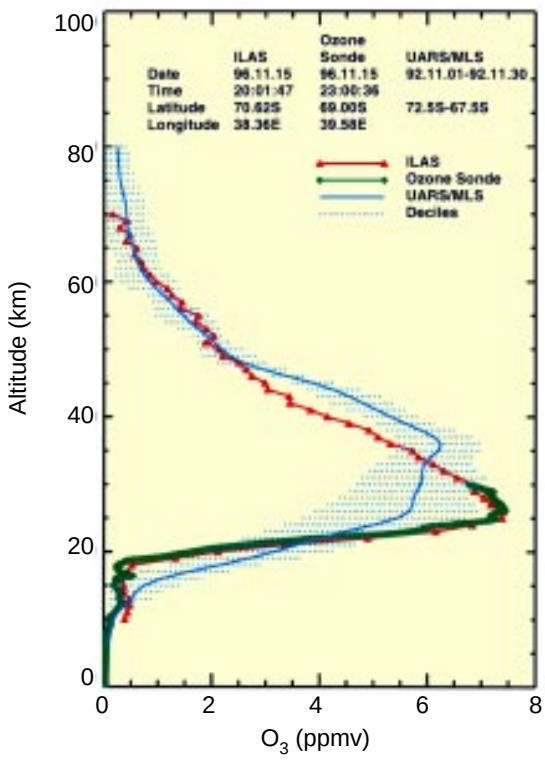


Fig. 7
Comparison of ozone profiles derived from ILAS data and from ozone sonde data collected over Syowa station in the Antarctic for 15 November 1996.

and the Northern Hemisphere. For example, the ozone hole over the Antarctic was still present in the middle of November 1996 and its structure is quite apparent in the cross sectional maps derived from the ILAS data (Fig. 8). Nitric acid is one of the key species involved in ozone destruction. Nitrous oxide can be regarded as a tracer of tropospheric air. In the ozone hole, downward movement of air could explain the low concentrations of nitrous oxide. Detailed analysis should wait until verified data become available.

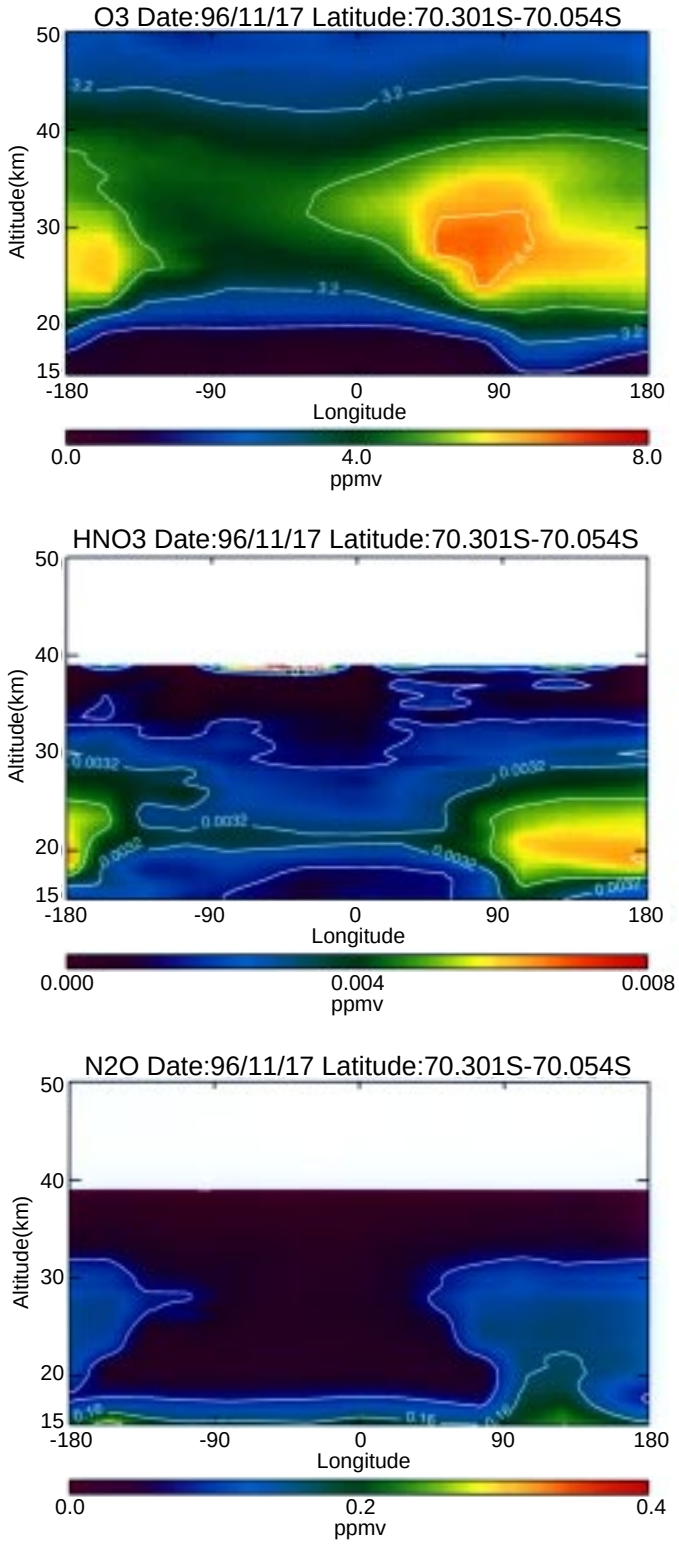


Fig. 8
Height and longitude cross sectional map for ozone (a), nitric acid (b), and nitrous oxide (c) concentrations derived from ILAS data collected on 17 November 1996 along the latitude circle at 70°S.

Regional Environment Division

This division is a project research unit dealing with both national environmental issues and overseas environmental pollution problems. The unit is composed of 15 research teams. Our members have worked in cooperation with members of other NIES divisions and visiting scientists from both domestic and overseas institutions. Major target areas include environmental risk assessment and pollution mechanisms and countermeasures. Since 1993, our environmental risk studies in developing countries have also started to promote the transfer of environmental technology. Following is a summary of the current studies of our respective teams. Not all of the Regional Environment Division's research projects are included in the present report. Research reports from our respective teams have also been published separately and are available upon request.

Traffic Pollution Control Research Team

This team primarily studies: 1) methodology for environmental impact assessment of traffic systems, in particular motor vehicles and 2) technology assessment of environmentally friendly alternative transport systems, in particular electric vehicles. As a part of a special research project entitled, "Air and water pollution in an urban area caused by changes in the environmental load and countermeasures against it", the team has developed two kinds of motor vehicle air pollution simulation programs. The first of these programs is a microscale model for predicting the dispersion of automotive exhaust gases near complex urban roadways using numerical solutions of advection-diffusion equations by the finite difference method. During FY 1996, the team succeeded in improving calculation speed and convergence of the model by adopting new algorithms. The second of these simulation programs, the Regional Traffic Pollution Simulation System (RTPSS), is designed to assess countermeasures that mitigate traffic pollution on an urban scale. By combining traffic volume assignment simulation with air pollutant dispersion simulation, this system predicts the impacts of various alternatives including modal shifts, changes in road network design, traffic flow control, and so on. The system was first applied to the Tokyo metropolitan area, and preparations for its application to the Osaka metropolitan area, for which a variety of air pollution field survey data are available, are proceeding.

A new project entitled "Research on Motor Vehicles to Mitigate Related Aspects of Environmental Pollution" such as environmental damage, energy consumption, accidents and congestion, began in 1994. This Eco-Vehicle Project has now completed development of an Eco-Vehicle, which is a reduced size electric vehicle incorporating solar cell technologies. Now underway are efforts to develop 1) a traffic collision prevention system that controls vehicles in response to driver commands and sensor inputs and 2) a multi-layered road design for decreasing traffic congestion.

In addition, the life cycle amounts of energy consumption and CO_2 emission required per unit of production of each good or service have been estimated by the input-output analysis and summing-up approaches. Environmental burdens for goods, services or facilities, including motor vehicles, have been evaluated by life cycle assessment (LCA).

Urban Air Quality Research Team

Due to the rapid development of the Kanto and Kansai areas and changes in emission source structure, widely distributed air pollution has become an environmental problem. Secondary air pollutants, such as nitrogen oxides, photochemical ozone, and aerosols in particular, are a serious problem. The major purposes of this research team's efforts were to investigate the formation mechanisms of NO_2, photochemical O_3, and aerosols in the urban atmosphere and to understand the relationship between changes in the relative importance of various air pollution sources and the spatial and temporal patterns of urban air pollution distribution. The team's program includes the following topics: 1) air pollution trend analysis related to changes in pollutant loading from various sources, 2) field and wind tunnel studies of the dynamic behavior of urban air pollution, 3) studies of an air pollution model and its application to urban areas and 4) technology assessment for the development of an Eco-House.

High concentrations of NO_2 are often observed in winter under stable atmospheric conditions, but in the Kansai area, NO_2 concentrations also increase in spring. Analysis based on the three-dimensional simulation model revealed the importance of a photochemical reaction in spring. Air pollution trend analysis suggested a change in the mechanism of O_3 formation in summer in both the Kanto and Kansai areas. Recently regional O_3 maxima have been observed outside of the central Kanto and Kansai areas. This trend of geographic widening of the urban oxidant concentration maxima might be a reflection of the increases in NO_x emissions and decreases in the ratio of the concentrations of volatile organic compounds (VOC) to those of NO_x, indicating an increase in O_3 formation potential and a decrease in photochemical reactivity, respectively.

To clarify the formation mechanisms of high concentrations of these widely distributed air pollutants in and around the Tokyo metropolitan area, three-dimensional observations covering the nearby marine and mountainous regions are necessary. In August 1995 an intensive field survey using aircraft was conducted. High concentrations of photochemical O_3 were observed above the southern marine area and the western mountainous region. Photochemical O_3 observed over the Pacific Ocean is transported from the inner city area due to the upper general geostrophic wind. The processes by which photochemical O_3 intrudes into the mountainous region were also clarified.

Coastal Environment Research Team

The coastal zone, especially in enclosed-sea areas of Japan, may be under actual pressure, from results of human activities such as eutrophication, pollution, or overcrowding, or it may be under threat of pressure from some proposed developments. Shallow areas there have been reclaimed without appropriate consideration of marine ecosystems. This team aims to prepare a precise scientific method to evaluate the vulnerability of the ecosystems of shallow areas through a special research project entitled "Studies on biogeochemical cycles and self-purification in shallow coastal areas for preservation of the marine environment". As a part of the project, we conducted field surveys of a shallow area Sanban-se at the head of Tokyo Bay in the summer and winter seasons, monitoring water quality, phytoplankton, and macro- and meiobenthos. Plenty of macrobenthos were observed in the shallow area (Stns. 1

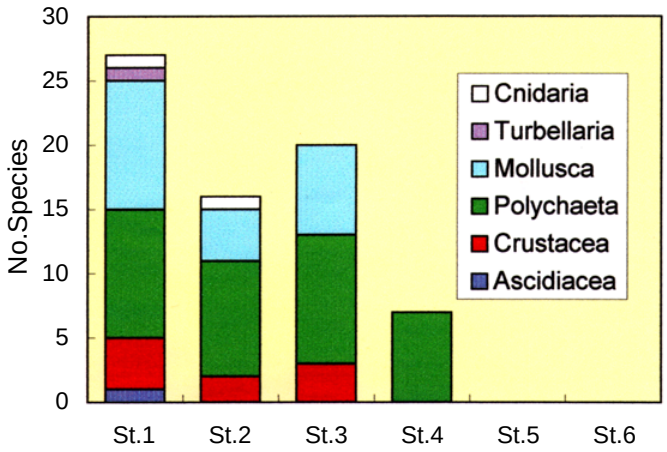


Fig. 1
Numbers of benthic macroinvertebrate species observed at a northern part of Tokyo Bay on 11 Sept. 1996. Stations No. 1 to 3 were in a shallow area where dissolved oxygen in the bottom layer was greater than 3 mg l^{-1}. No living animals were observed at Stations 5 and 6, where the water depths were 15 to 18 m, and dissolved oxygen in the bottom layer was less than 1 mg l^{-1}.

to 3; Fig. 1) during the summer sampling period; macrobenthos biomass (wet weight) ranged from 1.26 to 3.41 kg m^{-2}. Bivalves were the dominant animals, accounting for more than 98% of the total biomass, and they seem to play a significant role in biogeochemical cycles there. Dissolved oxygen was almost deficient on the bottom at Stns. 5 and 6, where no living animals were observed, in a deeper area adjacent to the shallow area. Our results suggest that shallow areas play an important role in biogeochemical cycles in the bay during the stratified seasons.

Although the primary production in coastal areas has long been believed to be consumed by mesozooplankters such as copepods, recent studies indicate that a significant fraction of primary production is channeled into microprotozooplankters (MPZ) such as heterotrophic dinoflagellates and ciliates; thus, the fate of MPZ is of great interest. In this context, we examined the feeding of MPZ by a small cyclopoid copepod *Oithona similis* — whose feeding ecology has long been ignored in spite of their ubiquitous distribution and abundance — in Buzzards Bay, Massachusetts, USA. Our experimental results indicated that *O. similis* can grow by feeding on MPZ as its main food source, thus, controlling the abundance and production of MPZ in Buzzards Bay during warm seasons and acting as a 'retriever' of primary production.

Lake Conservation Research Team

The main objectives of this research project have been the development of new indices for assessing Japanese lakes and their watersheds and investigation of the regulation of phytoplankton succession in lakes. We sought indices of 3 aspects of lake and watershed dynamics: 1) the organic matter and nutrient load generation potential of watersheds, 2) lake water quality, particularly with respect to the origin and biodegradation of organic matter, and 3) lake ecology, particularly the metabolic state of lake water and sediments, and the degree of anthropogenic perturbation. The main FY 1996 results were:

(1) Watershed information regarding load generation potentials, e.g. land use, population, etc., was gathered for a small town and analyzed with a PC-based geographical information systems (GIS). This system can predict the aquatic environment in the future and support basin management decision-making.

(2) Chemical oxygen demand (COD) measured with potassium permanganate (COD(Mn)) seemed an inappropriate index of organic matter due to rather low and

variable percentages of oxidation in various water regions and also due to the lack of any proportional relationship with biological degradability. In order to utilize the already measured COD (Mn) data, we confirmed that they could predict the concentration of total organic carbon (TOC) when there were simultaneously measured COD (Mn) and TOC data for several years.

(3) Based on the data measured in 30 Japanese lakes, we found that the UV absorbance:DOC ratio was inversely proportional to the water retention time (Fig. 2). This finding indicates that the percentage of autochthonous dissolved organic matter in the lakes increases with retention time.

(4) The metabolic characteristics of Lake Hinuma were determined by continuous measurements of dissolved oxygen and pH in open (uncontained) water and in light and dark boxes in which lakewater was exchanged at regular intervals.

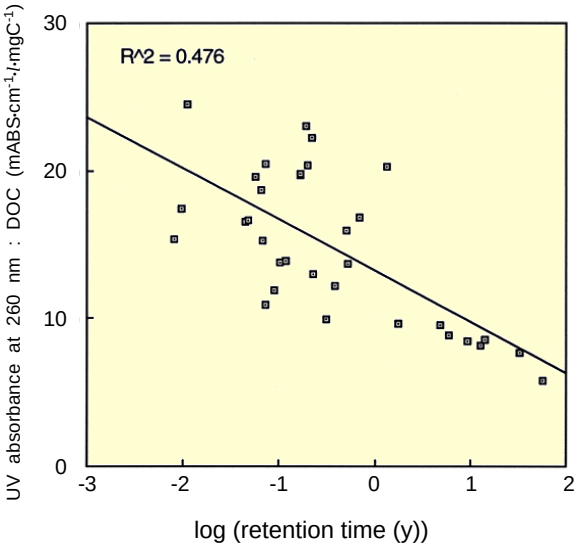


Fig. 2
Retention time (y) vs. the UV absorbance:DOC ratio of the filtrates of water from 30 Japanese lakes.

Hazardous Waste Research Team

This team has been developing methodology to assess exposure to hazardous chemicals from waste landfills. Little is actually known about the environmental impacts of waste landfills in Japan. Our team, coordinated by the National Institutes for Environmental Studies and including fourteen local government environmental research institutes, has been analyzing landfill exudates since 1994. Ten exudates and treated drainage fluids were sampled from different sites during late July and early August 1996. The samples were brought together and homogenized in the National Institute for Environmental Studies and then distributed to the local government institutes for chemical analysis.

Measured items were general water quality variables such as pH, dissolved oxygen (DO), COD, biological oxygen demand (BOD), suspended solids (SS), nutrients such as total phosphate, reactive phosphate, nitrate, nitrite, ammonium, inorganic elements including both metallic and non-metallic elements, and organic chemicals such as polychlorinated biphenyls (PCB), polychlorinated naphthalenes (PCN), pesticides, herbicides, plastic-additives including phosphate and phthalate esters, polycyclic aromatic hydrocarbons (PAH), and volatile organic compounds (VOC). Over 400 organic compounds were determined mainly by GC/MS. The results of leachate analyses in FY1996 are very similar to those obtained in FY1994 -1995. The findings include: 1) very low concentrations of highly hydrophobic compounds such as PCB

and some chlorine-containing pesticides, 2) high concentrations of compounds related to plastics, such as phthalate esters, phosphate esters, and bisphenol A, in some samples, 3) high concentrations of boron in some samples, and 4) high concentrations of dioxane in some samples.

In FY 1996, VOC in gases from several landfill sites were measured (Fig. 3). Figure 3 shows the concentration of chlorinated aliphatic hydrocarbons in landfill gases and in the indoor air of individual Japanese houses. The preliminary results show that 1) the concentrations of VOC exceeded 100 ppbv in some landfill gases and 2) higher concentrations of chlorinated ethane and ethene than other chlorinated aliphatic compounds in some landfill gases.

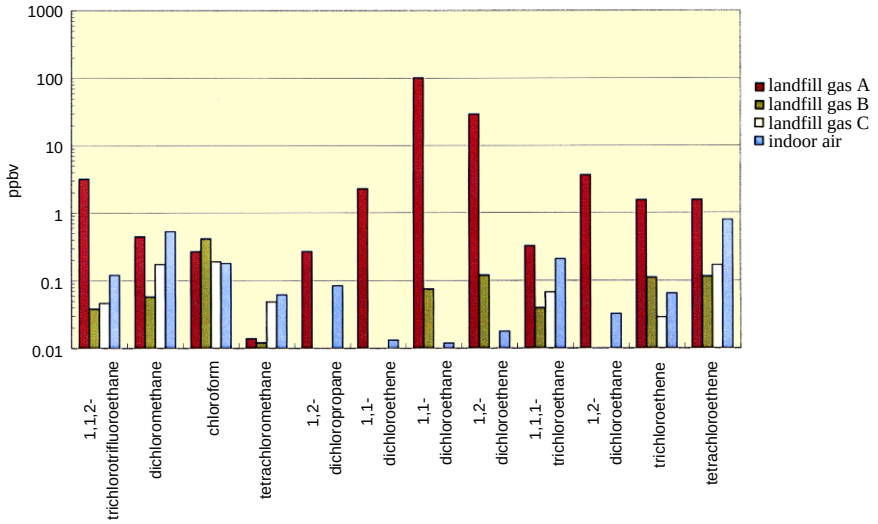


Fig. 3
Concentrations of chlorinated aliphatic hydrocarbons in landfill gases and in the indoor air of individual Japanese houses.

Interdisciplinary Impact Assessment Research Project

The Water Quality Renovation Technology Research Team used to study soil and groundwater contamination with hazardous chemicals. Since 1996 FY, the Team has filled the role of an ad-hoc project team to manage a new interdisciplinary area, entitled "Life cycle assessment (LCA) of environmental burdens and impacts originating from transportation and waste management systems". This study works toward the development of comprehensive environmental impact assessment methodology from the life-cycle point of view. The study consists of two areas of concern: fundamental methodologies for so-called Life Cycle Impacts Assessment (LCIA) and the application of such methodologies to case studies of transportation and waste management systems. The object of assessment is a system of included products, services, and infrastructures, as well as institutional arrangements, rather than a single product or service unit, for example, the road transportation system rather than a motor vehicle as a product, or a recycling system rather than cans and bottles as recyclable containers.

Emphasis was put on methodologies for LCIA in the first year of this 3-year project. A range of environmental issues to be covered by LCIA and ways to aggregate different environmental burdens and impacts into smaller numbers of indices were investigated by reviewing existing LCIA studies, environmental indicator studies, as well as by a trial of Comparative Risk Assessment (CRA) among experts. Linkage of LCIA and Risk Assessment (RA) was also investigated to assess real impacts of environmental burdens as manifested locally, rather than potential impacts. To achieve this goal, a

computer system was designed to include emission inventory, a cross-media fate prediction model of pollutants, and an exposure assessment model on a geographical information systems (GIS). The system will also be linked with databases on chemical toxicity. The system will be tested initially at the prefectural level to assess the impact of conventional and hazardous air pollutants.

Air Pollutants Health Effects Research Team

This team has experimentally studied the mechanism of pathogenesis and evaluated the risk of chronic pulmonary diseases due to diesel exhaust particles (DEP) and diesel exhaust (DE).

Subthemes include the following topics: 1) clarification of mechanisms of asthma pathogenesis and examination of the dose-response relationship between diesel exhaust and asthma, 2) evaluation of the risk of pulmonary tumor formation due to diesel exhaust, 3) evaluation of suspended particulate matter (SPM) exposure levels from diesel exhaust and associated risks, and 4) evaluation of the overall risk posed by diesel exhaust to human health.

FY 1996 research clarified the mechanisms of asthma pathogenesis caused by the combined inhalation of both diesel exhaust (DE) and ovalbumin (OA) as allergens. DE inhalation by mice increased the concentrations of interleukin-5 (IL-5) and IL-2 in the lungs, and IgG1 antibody in the serum, but not IgE antibody. IL-5, which is produced by Th2 lymphocytes, is the most important cytokine that induces the infiltration of eosinophils into the lungs. IgG1 may bind to the FcγRII receptor on eosinophils, stimulating the eosinophils to release toxic proteins such as major basic protein (MBP), eosinophil peroxidase (EPO), and eosinophil cationic protein (ECP). These toxic proteins may cause airway epithelial cell damage and chronic airway inflammation, thereby inducing airway hyperresponsiveness.

Human exposure levels to suspended particulate matter (SPM) including diesel exhaust particles (DEP) have been surveyed in Osaka Prefecture. This year, the relationship between SPM sizes and exposure levels was analyzed. All combinations (SPM level in outdoor vs. that in indoor, outdoor vs. individual, and indoor vs. individuals) were correlated highly with the level of < 2 μm SPM, accompanied by PM10 (Table 1). Total SPM was not related to any exposure levels. Furthermore, it was clear that nitrogen dioxide did not correlate with individual human exposure levels.

Table 1 Correlations between individual human exposure level and different sizes of SPM.

SPM size	outdoor vs indoor	outdoor vs individual	indoor vs individual
10 μm (a)	0.15	0.05	0.18
2 - 10 μm (b)	0.800*	0.343*	0.375*
< 2 μm (c)	0.892*	0.741*	0.806*
PM10 (b+c)	0.884*	0.672*	0.727*
Total SP (a+b+c)	0.679*	0.307*	0.350*

Values are correlation coefficients (r)

* significant differences between groups at the level of $p < 0.05$

These results show that SPM < 2 μm is the most suitable marker for the estimation of individual exposure level to SPM.

Chemical Exposure and Health Effects Research Team

This team is systematically studying human exposure to halogenated organic compounds that have been released into the environment and assessing the associated health risks.

The primary FY 1996 research topic was "exposure of individuals to volatile organic compounds in air". Personal exposures to 18 volatile and toxic organic compounds were monitored for residents of Tsukuba and Tokyo, and for university students in Tokyo. The target compounds were 8 chlorinated hydrocarbons (dichloromethane, chloroform, carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, chlorobenzene, and p-dichlorobenzene), 2 Freons (Freon 11 and Freon 113), and 8 aromatic compounds (benzene, toluene, ethylbenzene, p-xylene, o-xylene, styrene, 1,3,5-trimethylbenzene, and 1,2,4-trimethylbenzene).

A passive sampler was used to monitor individual exposure. The passive sampler is light, simple, and inexpensive, however, environmental conditions affect the precision and accuracy of the measurement because it relies on molecular diffusion. To validate its use, uptake rates of the sampler for 18 target compounds were evaluated.

The results demonstrated that the compounds could be classified into three groups.

(1) Personal exposures and outdoor levels were similar. Carbon tetrachloride and Freon 11 were included in this group, and sources of these compounds are far from the sampling places.

(2) Personal exposures exceed outdoor levels, and personal exposures in Tsukuba and in Tokyo were similar. Xylenes and p-dichlorobenzene were included in this group. Indoor air concentrations correlated highly with personal exposure.

(3) Exposures for residents in Tokyo were higher than for those in Tsukuba. Benzene and 1,1,1-trichloroethane were included in this group, and effects from industry and mobile sources were considered.

We attempted to estimate the cancer risks. The measured median value of personal exposure for each compound was assumed to be the lifetime average exposure, and the lifetime probability of cancer was estimated from U.S. EPA data, the Integrated Risk Information System (IRIS). Chloroform, benzene, and tetrachloroethylene posed relatively high risks of causing cancer among the measured compounds that are probable carcinogens.

Ecological Hazard Assessment Research Team

This team has studied overall pesticide effects on river ecosystems using several biomonitoring methods. Two species of duckweed (*Lemna* sp. and *Spirodela polyrhiza*) were selected as appropriate organisms for assessing the effects of herbicides on aquatic plants. Ten duckweed individuals were floated on the water surface of an aquarium through which Sakura River water flowed. This river was polluted with herbicides from the end of April to June. Biomonitoring (2-week test) using the duckweed was conducted weekly or biweekly under continuous fluorescent

illumination (water temp., 22-23°C), concurrently with a *Selenastrum* growth test (3-days) in the river samples (3 times per week). Growth of duckweed (n = 10) introduced into the aquaria in May and June was severely suppressed, although high growth was observed after June, when herbicide pollution had almost cleared from the river. Growth of *Selenastrum* had already recovered in June although its growth was severely supressed in mid-May, suggesting that the duckweed bioassay may be more sensitive to herbicide pollution than is the *Selenastrum* bioassay.

An image analyzer apparatus was developed for assessment of overall pesticide effects on behavior of aquatic organisms. Five freshwater shrimp (one month old), *Paratya compressa improvisa*, were introduced into a flow-through aquarium carrying the river water under a continuous light (water temp., 22-23°C). Mean swimming velocity (V, n=5) and mean number (N) of individuals showing extraordinary position (over 7 mm from the bottom) were monitored continuously. As an indicator for behavioral response to pesticides, relative mobility (V × N, mean-value/d) was followed through a year, although frequencies of the data records were not always constant (Fig. 4). The relative mobility in the pesticide application season, from April to August, was generally higher than that in autumn and winter. However, high relative mobility was also recorded in mid-November, although causal substances have not been analyzed at the present time.

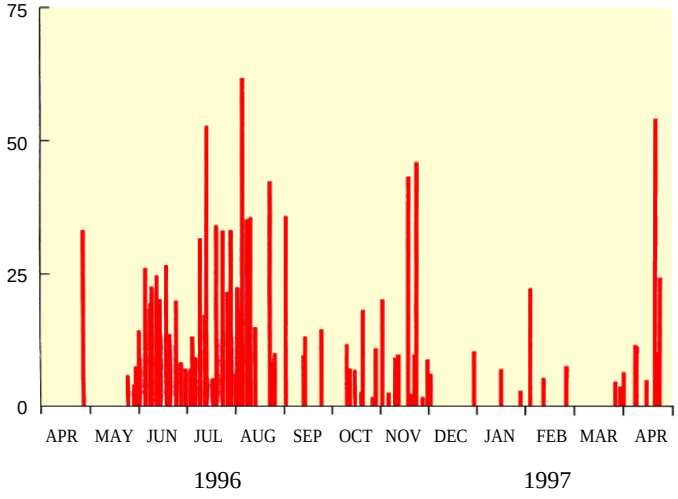


Fig. 4
Relative mobility (mean values/d of five individuals) of shrimps continuously exposed to water in a flow through aquarium carrying water from the Sakura River.

Biotechnology Products Assessment Research Team

This team studies the application of biotechnology to the preservation and clean-up of the environment and the risks entailed by this approach. Our approach is to produce genetically modified organisms useful for preservation or clean-up of the environment and then to evaluate their impacts.

Mercury resistance occurs widely in gram-negative and gram-positive bacteria that transform mercuric ion (Hg^{2+}) into the less toxic elemental form (Hg^{0}). The plasmid pSUPmer2 was constructed by inserting tandem copies of the mercury resistance (mer) operon into a broad host range-vector, and introduced into *Esherichia coli* HB101 and *Pseudomonas putida* PpY101 to increase their mercury resistance. Strains harboring plasmid pSUPmer2 had higher mercury resistance and mercuric reductase activity than did those strains harboring the plasmid pSUPmer which had only a single

copy of the mer operon. The mercury resistance of *P. putida* PpY101 was significantly increased by tandem insertion of the mer operon.

It is very important to determine the fate of microorganisms introduced into environment to clean up contaminated soil. The sensitivity of the polymerase chain reaction (PCR) method for the determination of *P. putida* PpY101/per134 with the mercury resistance gene was determined. Under the optimal conditions for the PCR method studied, even a single cell of *P. putida* could be detected.

A pilot-scale field test of bioremediation for trichloroethylene (TCE) contaminated groundwater was conducted by injecting methane, oxygen, nitrogen, and phosphorus to evaluate the efficacy and risks of this technology. The TCE concentration in groundwater before bioremediation was 6.7 mg l^{-1}. During the bioremediation period, 99.6% of the TCE was removed from the layer of soil from 14 m to 23 m depth. Clearly biostimulation was an effective way to clean up this contaminated soil.

Ozone and sulfur dioxide are typical industrial air pollutants. As components of acid rain and photochemical oxidants, they cause visible damage to the leaves of many plant species. We found that the rate of ethylene evolution in leaves of tomato plants exposed to these pollutants increased significantly before any appearance of visible injury. In plants exposed to 0.2 ppm ozone, the activity of 1-aminocyclopropane-1-carboxylate synthase (ACS) — the rate limiting enzyme in the ethylene biosynthesis pathway — was induced after one hour, while visible injury was observed 12 hours later. After ozone exposure, application of aminoethoxyvinylglycine and 2,5-norbornadiene — inhibitors of ethylene biosynthesis and ethylene action, respectively — protected plants against damage. These results suggest that ethylene acts as a hormone triggering a cascade of reactions leading to irreversible leaf damage.

We isolated cDNAs encoding ACS and 1-aminocyclopropane-1-carboxylate oxidase (ACO) from ozone-exposed tomato plants. Northern hybridization showed that levels of ACS mRNA increased immediately after one hour of ozone exposure, then gradually decreased. The level of ACO mRNA remained at the initial level during ozone exposure. Exposure of plants to 1.0 ppm sulfur dioxide did not affect mRNA levels of either enzyme, suggesting that different forms of ACS may participate in plant responses to ozone and sulfur dioxide.

Urban Environment and Health Research Team

This team studies the human health effects of various urban environmental factors, such as traffic noise, air pollution, and electromagnetic fields (EMF). A special research project entitled “Environmental health studies on stress and health effects due to environmental sounds and air pollution in highly urbanized areas” was completed in FY 1995. The major findings of the research were the following: The relationship between insomnia and chronic sleep disturbances to indoor noise levels from nighttime road traffic has been investigated with a survey of 3,600 randomly selected middle-aged women (20-80 years of age) from 8 areas where major roads pass with various traffic volumes, in Tokyo, Gunma, Nagasaki, and Okinawa. Of those surveyed, 403 (11%) experienced insomnia —defined as a state with 1) difficulty

falling asleep, 2) waking during sleep, 3) waking early, and 4) feeling insufficiently rested in the morning — that lasted for the previous one month or longer. When the confounding factors were adjusted for, the odds of insomnia in roadside zones of the all areas were well correlated with nighttime traffic volumes. The highest prevalence rate, 21%, was observed in one of two Tokyo areas with nighttime traffic volume of around 1800 vehicles hr^{-1}. In contrast, the prevalence rates in reference zones 20 m or more away from roadways were fairly consistent at around 9%. Epidemiological surveys have been were conducted in five areas in and around Tokyo to investigate the relationship between Japanese cedar pollinosis and diesel exhaust particles. Annual changes and areal differences in the rates of the prevalence were largely dependent on cedar pollen exposure. It seems unlikely that the prevalence of cedar pollinosis was associated with the levels of air pollutants such as suspended particulate matter, adjusted by cedar pollen counts, age, sex, smoking habits, years at current residence, and family history of allergic diseases.

A new project entitled "Health risk assessments of exposure to extremely low frequency electromagnetic fields" will begin in FY 1997. In FY 1996, we developed a facility for exposing human volunteers to low levels of EMF. This facility has been built in the Homotron (Community Health and Noise Effects Laboratory). The exposure room (approximately 3 m × 3 m × 3 m) was designed to optimize EMF field uniformity, as well as to control room temperature and humidity. Using the facility, the effects of EMF exposure will be physiologically and endocrinologically evaluated.

International Water Environment Renovation Research Team

This team has studied eutrophication of lakes, reservoirs, and rivers, and countermeasures against it, especially nutrient removal from wastewater by specific microorganisms.

Increases in the total N/P ratio cause blooms of harmful, toxin-producing picoplankton and cyanobacteria in surface waters used for public water supply. Clearly, further nitrogen and phosphorus removal is important for maintaining water quality. A new, small-scale, advanced, on-site domestic wastewater treatment system that uses an anaerobic biofilm filtration process with flow-rate adjustment was developed to treat domestic wastewater. Another new treatment system, using an aerobic, thermophilic process, was developed to treat high strength organic wastewater from livestock farms, restaurants, etc.

The use of bio-films for water treatment has also been developed and applied to domestic water treatment in developed countries as well as in such developing countries such as Thailand and the Philippines. The use of such bio-films is expected to efficiently decompose anthropogenic contaminants, such as trichloroethylene, and naturally occurring toxicants, such as microcystins.

The effects of chemicals, microbial pesticides, and genetically engineered microorganisms in aquatic ecosystems have been estimated with a bioassay method using a flask-sized microcosm system consisting of decomposers (bacteria), producers (algae), and consumers (protozoa, metazoa).

Furthermore, it was demonstrated that ecoengineering wetland systems using aquatic plants such as cattail (Typha) can be very important to help remove nitrogen and phosphorus effectively from low strength domestic wastewater in Thailand and other tropical developing countries (Fig. 5).

(a)

(b)

Fig. 5
Domestic wastewater treatment using a wetland system.
(a) Co-researchers at the wetland site,
(b) Pilot-scale wetland system.

International Health Effects Research Team

This team has assessed the health risks associated with air pollution from coal burning in Asia-Pacific countries, such as China, and will evaluate possible risk reduction strategies. International cooperative research on exposure assessment for both indoor and outdoor air pollution from coal burning has been carried out in China. The results show elevated levels of atmospheric pollutants from coal combustion in both indoor and outdoor air.

Since suspended particulate fluoride and hazardous air pollutants have a potential toxicological significance in China, fluoride pollution in indoor air and the incidence of fluorosis has been analyzed in rural areas of China. In China, an estimated 18 million people are suffering from dental fluorosis and an estimated 330 thousand are suffering skeletal fluorosis, both caused by coal burning. In the rural area we studied, many farm families use coal from local mines; coal is the main energy source for heating, drying, and cooking. Since the local coal contains high concentrations of fluoride, indoor fluoride pollution is very serious in this rural area and the incidence of dental (Fig. 6 a) and skeletal fluorosis (Fig. 6 b) is extremely high here and in some other rural areas in China.

Fig. 6
(a) Dental fluorosis. This severity of this case was quantified with a score of 4.
(b) Osteosclerosis of the forearm of a fluorosis patient.

International Ecosystem Management Research Team

Nowadays, the problems of lake ecosystems are becoming far more complex than the problems conventional limnological studies have dealt with in the past. For instance, nutrient overloading from highly developed watersheds, inadvertent stocking of exotic fishes, and the intensive construction of dams, dikes, and other artificial structures are challenges to scientists in the field. We believe that better understanding of lake ecosystems based on modern limnological approaches is essential to solve these problems.

One of our research goals is to devise a lake management plan that maintains a sound aquatic environment in terms of water quality and ecosystem functions, while allowing sustainable use of lake resources such as commercially important fishes, hydroelectric power supply, and recreational value. We have been investigating long-term dynamics of biomass and densities of food web components both in eutrophic and oligotrophic lakes in Japan and China in cooperation with other research teams and agencies. In addition, to explore the mechanisms of relatively sudden community changes frequently observed in lake ecosystems, a set of enclosures (or mesocosms) was constructed at Lake Kasumigaura. Silver carp, *Hypophthalmichthys molitrix* — a planktivorous cyprinid, was used in our experiment in 1996 and found to be capable of dramatically changing the structure of the plankton community of a eutrophic lake. After silver carp were stocked into the enclosures at various densities, the biomass of phytoplankton larger than 10 μm decreased and remained at considerably lower levels than that in a reference enclosure without silver carp. As a result, water transparency in the enclosures increased with increasing silver carp density (Fig. 7).

International Atmospheric Environment Research Team

This team studied the origin of atmospheric aerosols with a chemical mass balance method, as well as aerosol surface chemical reaction mechanisms in highly polluted urban air in East Asia. Big cities in this region, for example Beijing, experience high atmospheric concentrations of both anthropogenic aerosols and soil aerosols originating from arid desert areas. One of our research topics is designed to increase basic understanding of the environmental behavior of the soil aerosols known as Kosa aerosol (Fig. 8). The calcite minerals present in Kosa aerosol may be a major

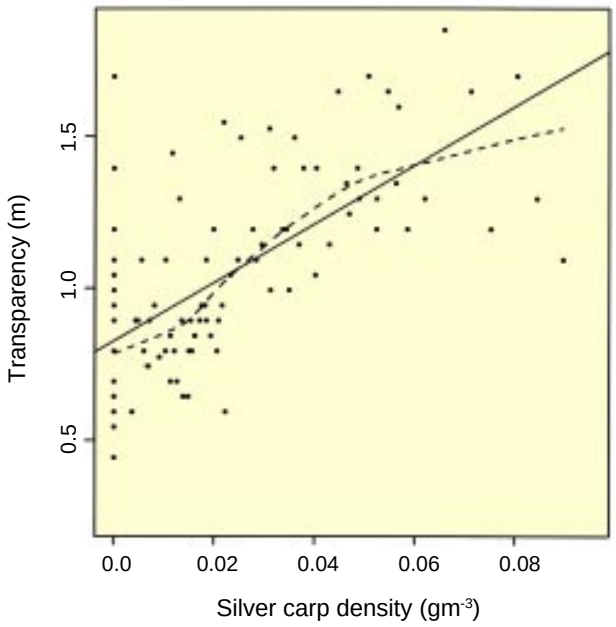


Fig. 7
Relationship between transparency and silver carp density in enclosures in Lake Kasumigaura. The linear regression (solid line) is $T=0.826 + 9.60 \times 10^{-3}D$ ($r^2=0.44$, $P<0.001$) where T is transparency (m) and D is fish density (gm^{-3}). The broken line is a LOWESS line with a window size f=2/3.

Fig. 8
Yellow loess dust (the source of Kosa aerosol) on a car bumper in the Lanzhou city area.

contributor to reactions with the acidic gases in urban air. Kosa aerosol is expected to play as a key role, whether hastening or restraining the environmental air pollution in the big cities of East Asia.

We started this year to collaborate with several foreign laboratories including the China-Japan Friendship Environmental Protection Centre in Beijing, China. Atmospheric aerosol monitoring in the cities of Beijing, Yinchuan, and Lanzhou will continue for several years with a cascade impactor-type sampler for size distribution, a high-volume sampler for chemical analysis, and a deposit-gage sampler for quantifying the coarse dust flux. Expeditionary investigations and sampling are being undertaken for basic research on the relationship between the chemical characteristics of Kosa aerosol and the soil from which it originates.

Independent Senior Researchers

In addition to the above-mentioned 15 research groups, 4 independent senior researchers are working in specialized areas including environmental statistics, diffusion process analysis, ecosystem preservation, and environmental policy-making in developing countries.

Social and Environmental Systems Division

Environmental problems may be defined as those resulting from environmental changes that are consequences of various human activities. Whether these changes are environmental pollution, physical degradation, or ecosystem destruction, they adversely affect or threaten our daily lives, well-being, and socio-economic activity. Therefore, the human and societal dimensions of environmental changes are of the utmost importance for environmental protection and conservation. In this context, the Social and Environmental Systems Division concerns itself primarily with present and future ways of interaction between social and environmental systems.

In FY 1996, the Division, with its Principal Researcher (PR) and its four research units, the Environmental Economics (EE), Resources Management (RM), Environmental Planning (EP) and Information Processing & Analysis (IP) Sections, conducted basic research on the following 14 topics.

Selected Basic Research Topics of the Social and Environmental Systems Division

	Research Theme	Responsible section
(1)	Some Fundamental Issues in Environmental Cognition and Perception	(PR)
(2)	Treatment of Qualitative Information Concerning Environmental Problems	(PR)
(3)	Socio-economic Analysis and Policy Assessment for Environmental Management	(EE)
(4)	Potentially Effective International Collaboration for Global Environmental Protection	(EE)
(5)	Economic Impact of Environmental Policies	(EE)
(6)	Environmental Impacts Associated with Water Resources Development	(RM)
(7)	Recovery, Reuse, and Recycling of Potential Resources for Waste Reduction and Their Impacts on Social and Environmental Systems	(RM)
(8)	Modeling and Policy Studies for Local and Regional Environmental Planning	(EP)
(9)	Information Processing Systems for Geographic and Image Data	(IP)
(10)	Modeling and Simulation Methodologies for Environmental Evaluation	(IP)
(11)	Landscape in Terms of Environmental Perception and Evaluation	(EP)
(12)	"International Political Costs" of Climate Change Policy Implementation	(EE)
(13)	Life Cycle Assessment of Asbestos as a Toxic Substance	(RM)
(14)	Development of the "Quicklook System" for the NOAA Image Databases	(IP)

The first 2 research topics, which were conducted primarily by the Principal Researcher and associates, dealt with some selected basic issues concerning people's awareness and perceptions of the environment, which are fundamental to the formulation of policy for environmental conservation. Research topic (1) produced some interpretations of people's cognition on "soundscape", while topic (2) was successful in dealing with various descriptions of respondents obtained in free association surveys.

Environmental Economics Section

Two selected issues were studied under research topic (3): using statistical data such as National Survey Data on Consumption, an analysis was made to relate energy consumption patterns of households to people's environmental conservation behaviors. Also, a survey of public environmental knowledge and perceptions was conducted to identify how they are affected by the media and how effective they are in promoting environment-friendly behavior among consumers. Industrial ecology studies were also performed under this research topic. Voluntary take-back programs of obsolete electrical appliances organized by producers based on the Waste Management Law and a mandatory recycling program based on the scheme of the Packaging Recycling Law were studied in the context of "extended producer responsibility (EPR)".

Research topic (4) deals with policy science analysis and assessment concerning the Framework Convention on Climate Change. The process of negotiations for the final agreement was analyzed in terms of the equity and interests of the participating nations that are taking measures to reduce CO_2 emissions. In addition, under research topic (12), selected participants of the first and second Meetings of the Convention were interviewed and surveyed; two different scenarios for international collaboration in taking different CO_2 reduction measures were performed to estimate costs, including the newly defined "international political cost".

The possibility of a modal shift in the transportation sector was used as a parameter to estimate and simulate the effects of a carbon tax on the macro-economy as a major component of research topic (5). The model was also used to determine the amount of CO_2 emission reduction; the cost to reduce CO_2 emissions from cargo transportation by 1 percent was 14,755 yen per ton of carbon.

Resources Management Section

Under research topic (6), data were collected to build a model to evaluate the environmental as well as socio-economic impacts of a water resource development project. Data on water quality changes in both drinking water and agricultural irrigation systems were collected in the Lake Kasumigaura watershed.

Research topic (7) deals with the development of LCA methodology to assess the life-cycle resource and environmental impacts of process equipment and products that should be recycled. Studies of several types of plastic and metal beverage containers were case studies, for which relevant data for inventory analysis were collected to improve our LCA method. An extended analysis of a refuse incinerator with power generation for its entire life-cycle was also performed. Asbestos was chosen under research topic (13) as a toxic substance for which to develop LCA methodology; wall-sprayed asbestos was the case studied. Life-cycle environmental impacts due to energy consumption of asbestos used as insulation and the health risk caused by airborne dust were calculated.

Environmental Planning Section

Improvement of local environmental plans is a central theme in research topic (8). Many regional and local authorities, prefectural as well as municipal, are now engaged in formulation of their own basic environment plans in conformity with the National Basic Environment Plan. Important, common issues arising from the planning process were carefully identified and analyzed in this study. In the planning process, public participation at venues such as public hearings and information provision are two key factors.

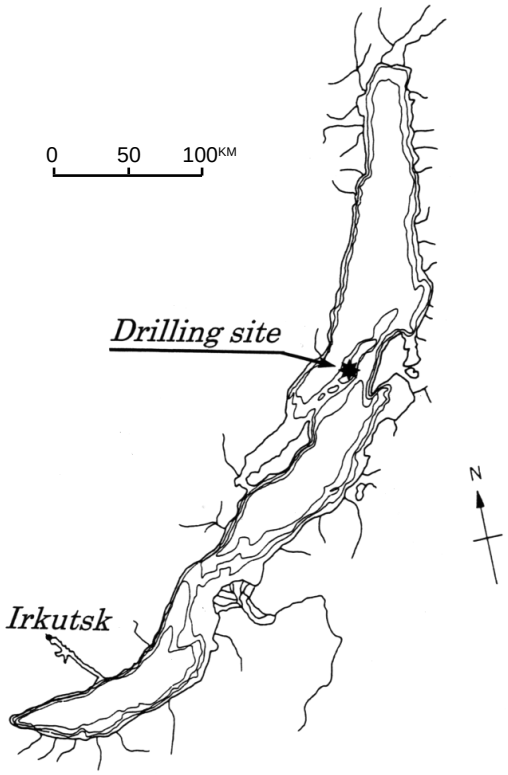
Under research topic (11), some descriptions of the local landscape from the diaries and travelogues of foreigners who visited during the Edo and Meiji Periods were confirmed and many factors have been identified to determine landscape value.

Information Processing and Analysis Section

Developments under research topic (9) have produced improved image data processing techniques for analysis of remotely sensed monitoring data such as the geographic and image data obtained from various earth observation satellites. Image data from the NOAA AVHRR have been obtained continuously from NIES's 2 NOAA Data Receiving Stations located in Kuroshima (Okinawa) and in Tsukuba, respectively. Data from these stations were used to develop a regional mosaic and vegetational index map for East Asia. Also techniques to merge satellite data and geographic information are being developed. As the volume of image data obtained from our 2 NOAA Data Receiving Stations increases, it becomes necessary to develop an efficient system for retrieval of specific image data. The goal of research topic (14) is to develop the Quicklook System.

Research topic (10) concentrates on both development of models to analyze and quantitatively evaluate environmental changes, and simulations based on these models to predict changes. An elaborate traffic noise propagation model was developed and the noise field was simulated with the boundary element method under various environmental conditions.

Environmental Chemistry Division



Lake Baikal

Drilling Complex working on the frozen Lake Baikal (below), and drilling site (left). A 200 m core (BDP96-2) obtained from Academician Ridge covers the history of last 5 million years.

Research in this division provides underpinning for analytical instrumentation, methodologies, and quality assurance for environmental measurements. The division also conducts research on the fate and toxicology of chemicals. In FY 1996, 14 basic research projects concerning a wide range of environmental problems were implemented. Members of the division also participated in 11 research projects organized by the project research divisions, and 7 special projects subsidized by the Science and Technology Agency.

In the **Analytical Instrumentation and Methodology Section**, studies on analytical methods and instrumentation for environmental analysis, especially those using mass spectrometric systems, have continued. The distributions of selected volatile halocarbons over the oceans were studied. A program to develop a system to detect DNA-toxic chemical adducts with high sensitivity was conducted.

Studies on standardization and quality assurance in environmental analysis continued in the **Analytical Quality Assurance Section**. Research on the mass balance of chlorine in chlorination of municipal wastewater started from this year. The structures of carbonyl compounds were investigated by derivatization and mass spectrometry.

The **Environmental Chemodynamics Section** focuses on chemical state analysis, chemical speciation analysis, isotope analysis, and their applications to elucidation of the environmental fates of chemicals. The establishment and application of accelerator mass spectrometry techniques has continued. The environmental fates and ecological effects of organotin compounds were investigated.

In the **Chemical Toxicology Section**, studies on chemical structure and toxicity of both natural and anthropogenic toxic compounds have continued. Toxins produced by blue-green algae and the mechanisms of their toxic action were evaluated. A bioassay system that evaluates the effects of compounds that cannot permeate the intact membranes of cultured mammalian cells has been developed.

Paleoenvironmental studies of Lake Baikal sediment cores continued as an international joint project. This project constitutes an important program of the Baikal International Center for Ecological Research established under the initiative of the Russian Academy of Science.

The environmental specimen-banking program has been carried out for 17 years with special emphasis on the monitoring of background pollution levels around Japan. Information on the monitoring and the analytical data for specimens stored in the bank were exchanged with the U. S. National Oceanic and Atmospheric Administration (NOAA).

By the end of 1996, 17 certified reference materials (CRMs) had been prepared and 11 of them were certified for metal composition under the Environmental Certified Reference Material Program. In 1996, the concentrations of polychlorinated dioxins/furans in NIES CRM No. 17, a toluene-extract of incinerator fly ash, were determined

and a human urine CRM, NIES CRM No. 18, was prepared as a new candidate for organo-selenium and organo-arsenic compound analysis.

Brief accounts of some of the important 1996 outcomes from the division are as follows:

Distribution of selected volatile halocarbons over the ocean

Ambient concentrations of four marine-derived halocarbons (methyl iodide, ethyl iodide, bromoform, and dibromomethane) and two man-made halocarbons (trichloroethylene and tetrachloroethylene) were measured during Western Pacific cruises and East and Southeast Asian cruises. Ethyl iodide was detected in the atmosphere for the first time, and was identified as an atmospheric iodine source compound. Bromoform concentrations were positively correlated with those of dibromomethane, and methyl iodide showed variations similar to those of ethyl iodide. However, there was no correlation between the bromocarbons and the iodocarbons. The concentrations of methyl iodide and ethyl iodide changed markedly, which might be due to higher rates of photodecomposition of the iodocarbons.

Sensitive/selective detection of DNA-adducts by LC/MS/MS

Micro HPLC/MS/MS using a frit-FAB interface has been investigated for sensitive/ selective detection of DNA-adducts. Survey of unknown adducts at the 10^{-9} g level and/or detection of known adducts at the 10^{-11} g level has been achieved by this method. Separation of adducts under conditions suitable for ESI (Electrospray Ionization) and modification of ESI to improve efficiency/stability have also been carried out to further improve sensitivity.

Chromatographic separation of all 209 PCB congeners on a capillary column

All 209 PCB congeners were successfully separated by GC or GC/MS on a capillary column coated with polysiloxane-carborane. Separation on this column has been improved substantially, compared with commonly used columns with coatings such as 5% phenyl methyl silicone. Neither peak tailing phenomena nor interference on the column were observed. We measured retention parameters for all PCB congeners. PCB congeners in several samples were analyzed with this capillary column in high resolution gas chromatography/high resolution mass spectrometry using the measured retention parameters.

Surface characterization of acid-leached olivines by X-ray photoelectron spectroscopy (XPS)

The chemical weathering of minerals is one of the most important factors affecting the geochemical behavior and cycling of various elements. To elucidate the dissolution mechanisms of silicate minerals, we used XPS to study the surface alteration of olivines, i.e., fayalite (Fe_2SiO_4) and forsterite (Mg_2SiO_4), during dissolution by acid. The abundances of Fe and Mg, relative to Si, near the surface of olivines decreased after acid dissolution. The divalent cations in the fayalite were removed more readily than were those in the forsterite. After acid dissolution, the Si 2s and O 1s spectra of fayalite were deconvoluted to contributions from unleached and leached phases (Fig. 1). The Si 2s and O 1s binding energies were higher for the leached phase relative to

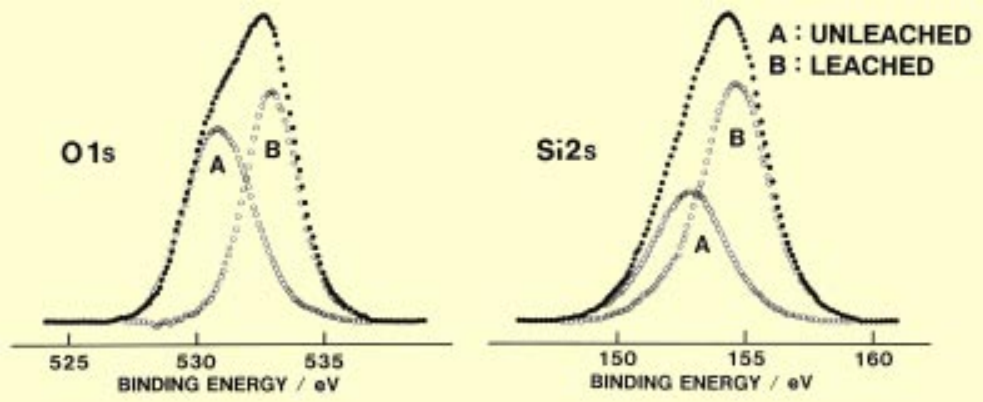


Fig. 1
O 1s and Si 2s spectra of fayalite after acid dissolution. A and B indicate unleached and leached phases, respectively.

the unleached phase, and were comparable to those of silicon dioxide. On the basis of this work, the following dissolution process in acidic solution is proposed. At the initial stage, divalent cations (Fe and Mg) in olivine are selectively leached resulting in the formation of surface leached layer ($SiO_2 \cdot nH_2O$), which dissolves slowly.

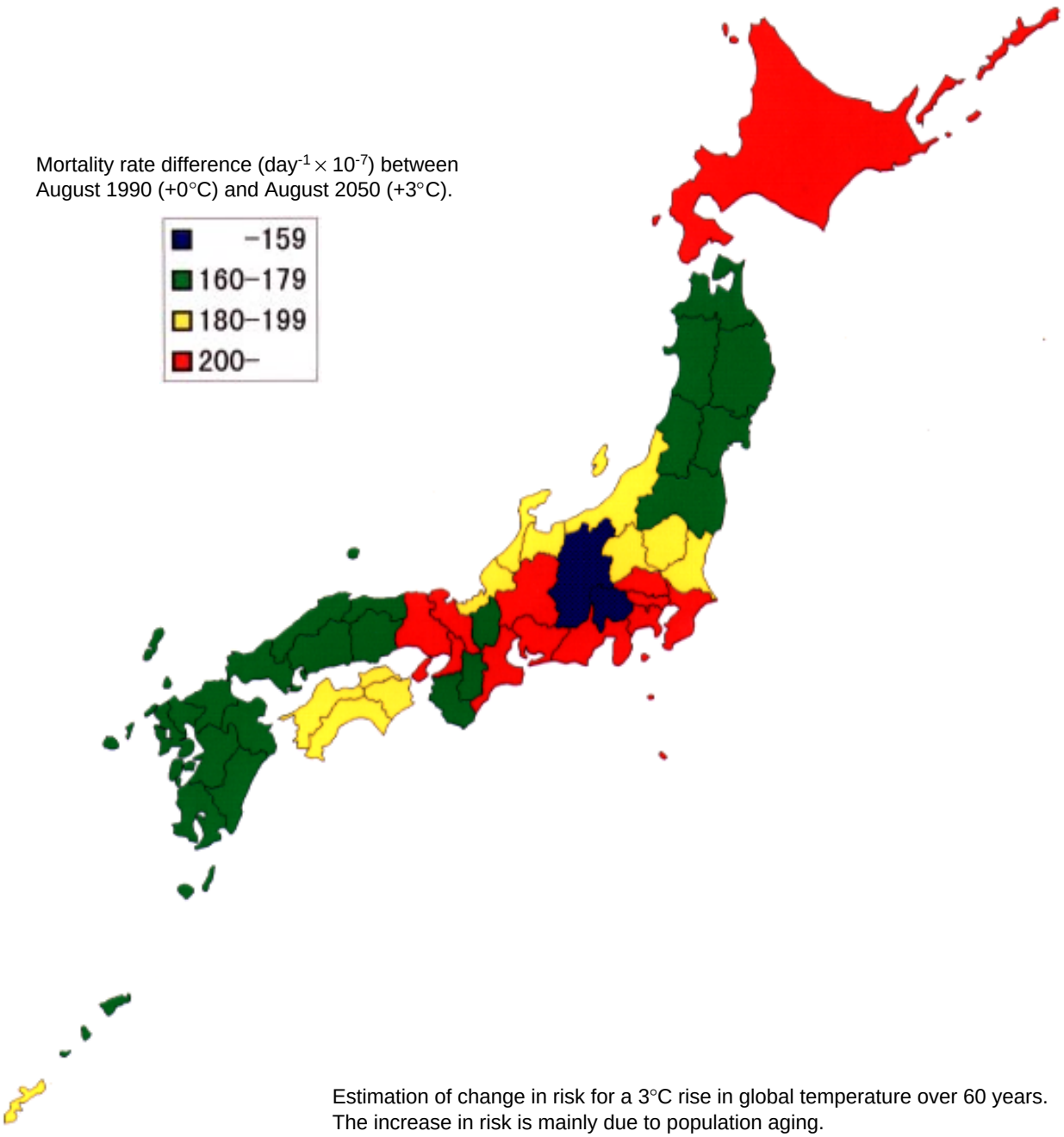
Development of a new cytotoxicity screening method

Some toxic compounds show toxicity to cultured cells in vivo, but not in vitro. The major reason for this difference is that some toxic compounds are unable to be permeate through cell membranes. We have developed a new cytotoxicity screening method for the impermeable compounds based on the combination of electroporation with the conventional incubation method using a cultured mammalian cell line, HL60. For example, the cyanobacterial microcystins Dhb-microcystin RR and microcystin LR cannot permeate intact cell membranes and did not show cytotoxicity in the previous HL60 incubation method. After optimizing the conditions for electroporation, cytotoxicity of these microcystins could be detected sensitively. On the other hand, a compound that can permeate a membrane, 2-(2-furyl)-3-(5-nitro-2-furyl) acrylamide (AF2), was equally inhibitory to the growth of HL60 with or without electroporation, indicating that the method facilitates permeation of the compounds into the cells without damaging them.

Northern Asia paleoenvironmental reconstruction with Baikal sediment cores

An international research collaboration focusing on global climate change and its effects on an ecological system and biodiversity has continued in the Baikal area of Russia. Two undisturbed sediment cores (200 and 100 m long) were successfully obtained with good recovery from the Academician Ridge in Lake Baikal. Geomagnetic measurements of the cores showed that the bottom of sediment core (200 m) were deposited more than 5 million years ago, and that the sedimentation rate has been almost constant since then at 3.8 cm/1000 years. Climatic and biological changes over the last 5 million years are being clarified by our results.

Environmental Health Sciences Division



Estimation of change in risk for a 3°C rise in global temperature over 60 years. The increase in risk is mainly due to population aging.

The main scope of this division's research activities covers experimental and epidemiological studies of risk assessment for environmental agents that are harmful to human health. Among the agents we study are nitrogen dioxide and diesel exhaust particles (DEP), toxic chemicals, heavy metals, Japanese cedar (sugi) pollen, ultraviolet radiation, and noise. The severity and manifestation of health effects as well as the development of detection and assessment methodology are the primary research themes of this division. Depending upon the distribution of a given agent in the environment and its possible health effects, research topics are classified into either domestic or global environmental issues. During fiscal 1996, we performed 14 regular research and 3 Special Encouragement Research programs. Experimental studies were performed in three sections; the Biochemistry and Physiology Section, the Experimental Pathology and Toxicology Section, and the Biological and Health Indicators Section. Studies that dealt with human populations were carried out in the Environmental Epidemiology Section. Research objectives which were considered to be both domestic and global environmental issues have been also pursued as research projects or programs supported by the Global Environment Research Programs or Special Research Programs, in collaboration with scientists belonging to the Global Environment Division and Regional Environment Division. In addition, research supported by the Science and Technology Agency and other funding bodies was also performed. In this year's report we describe, in greater detail, the results of epidemiological studies performed in recent years.

Indoor concentrations and personal exposure to particulate matter (PM) at roadside houses (results presented at Indoor Air 1996, Nagoya)

We conducted a field study in three areas of Osaka to obtain basic information on the relationship between three types of measurements: levels of personal exposure and indoor and outdoor concentrations. We measured indoor and outdoor concentrations of PM below 10 μm in aerodynamic diameter (PM10) for 24 hour periods as well as levels of personal exposure to PM10 in autumn for five years from 1990. The outdoor and indoor concentrations were measured with impactor-type air samplers, and levels of personal exposure were measured with personal samplers worn by subjects. Twenty-four houses were included in the study, and 77 combinations of the three types of measurement were available. The correlation coefficients between all combinations of these three variables were greater than 0.67 and statistically significant ($p<0.01$). We conclude that personal exposures can be estimated from outdoor measurements, provided that information on some confounding factors, such as the presence of smokers, is available.

Heart Rate Variability Index is Strongly Correlated with Delta Wave Activity during Sleep (Presented at the 26th annual meeting of the Society for Neuroscience in San Diego)

Electroencephalograms (EEG) and electrocardiograms (ECG) were continuously recorded for 13 healthy subjects throughout their sleep-time (23:00-08:00). We subjected R-R interval (between two heart bests) data to spectral analysis, and obtained

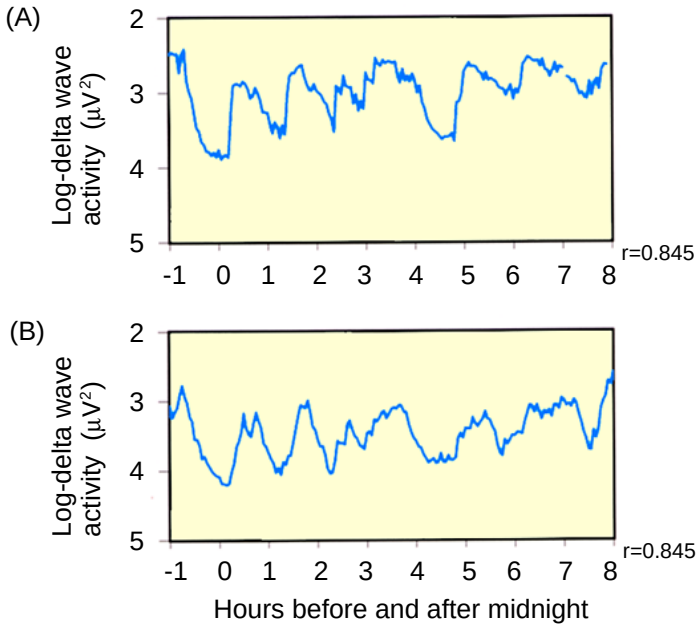


Fig. 1
Time-course of (A) log EEG delta wave activity (DWA) and (B) log-DWA estimated from heart rate variability for a typical subject from among the 13 participants.
The r-value at the bottom is the coefficient for the correlation between (A) and (B).

various indices of heart rate variability (HRV). The indices used were heart rate, total HRV power, coefficient of variation in R-R intervals (CV-RR), and spectral powers in six frequency ranges between 0.005 Hz and 0.5 Hz. By analyzing the correlation coefficients between these indices and EEG delta wave activity (DWA), we found that powers in the lowest range (0.005-0.01 Hz) calculated by spectral analysis were most strongly correlated to DWA and that the inter-individual variation of this correlation coefficient was the smallest. Using a moving average model, we obtained a formula for estimating DWA during sleep from R-R interval data. The formula fitted the data well (r^2=0.56); Fig. 1 shows a typical example from a subject. This method can be applied to field research for human sleep assessment in place of polysomnography, with which a field survey is essentially impractical.

Exposure assessment of ultraviolet radiation in four areas in Japan (Ono, M. (1997) Preliminary study on exposure measurement of ultraviolet radiation. Cataract Epidemiology. *Dev*. *Ophthalmol*. 27, 81-88, in Sasaki K., Hockwin O. (eds), Krager, Basel)

We started a research program entitled “Epidemiological study on ultraviolet radiation (UVR)-related cataract” and obtained long term measurements of residential UVR exposure.

For personal UVR exposure measurements, we used a simple, badge-like device (Model SUB-T, Toray Techno Institute) that can determine UVR in the wavelength range of 260-390 nm. We requested each participant to attach such a badge to her chest. Twenty outdoor workers (caddies at golf courses) were selected as participants in each of the four areas, Sapporo (lat. 43°N), Tsukuba (lat. 36°N), Noto (lat. 37°N), and Okinawa (lat. 26°N). Daily cumulative UVR exposure was monitored throughout the year, except for the periods during which the golf courses were closed. Each participant was requested to record the length of time that she spent outdoors each day.

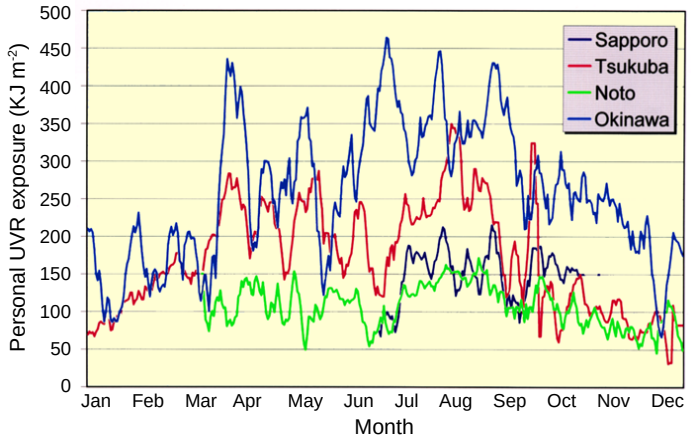


Fig. 2
Seasonal fluctuation of ultra-violet radiation (UVR) exposure by area (1993-4)

Results: the inter-individual variation of UVR exposure in each target area was very large. From the results (Figs. 2 and 3) we concluded the following four points: 1) Personal UVR exposure varied seasonally, 2) Day-to-day fluctuations were very large, due mainly to weather conditions, 3) The level of personal UVR exposure followed a north-south gradient, and 4) Cumulative exposure in Okinawa was nearly twice that in Sapporo.

Relationship between ambient temperature and mortality rate in Japan (Honda, Y., et al. (1995) Relationship between daily high temperature and mortality in Kyushu, Japan. *Jpn. J. Pub. Health.*, 42, 260-268)

The relationship between ambient temperature and mortality is reported to be V-shaped; i.e., mortality rate is lowest at a certain (optimum) temperature and higher when temperature is either higher or lower than the optimum temperature. Here, we evaluated this relationship using Japanese data for the period 1972-1990. The relationship between daily maximum temperature and mortality from all causes showed such a V-shaped pattern. Elderly people mainly formed the V-shape. Circulatory and respiratory diseases were found to contribute to the V-shape, whereas neoplasms were not. The proportion of deaths due to "excessive heat" was less than 1 percent of the total deaths in the +33°C category, although "excessive heat" included occupational hot environments in early years.

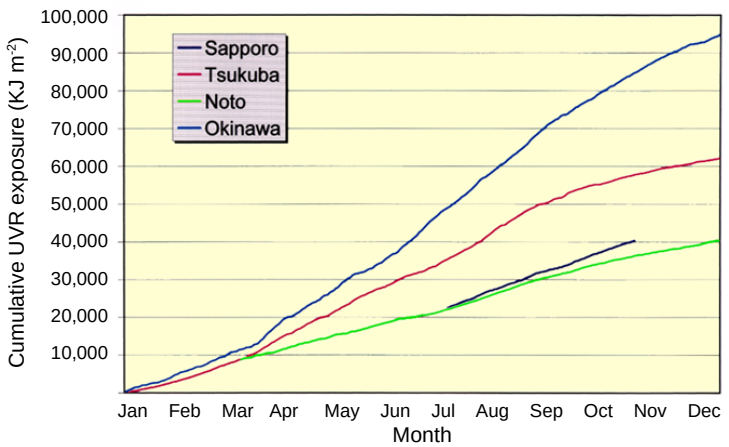


Fig. 3
Cumulative UVR exposure by area (1993-4)

Atmospheric Environment Division

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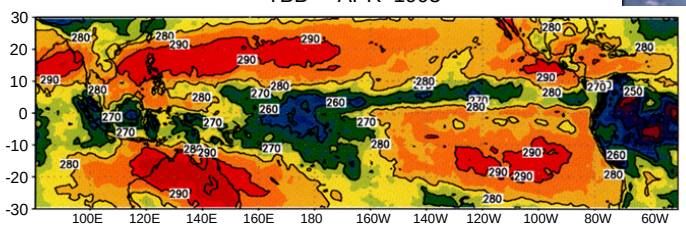

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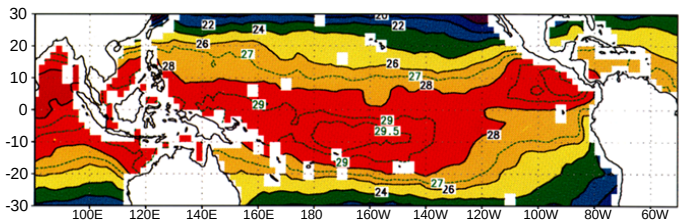

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The Atmospheric Environment Division conducts basic studies on the distributions, properties and reactions of atmospheric pollutants, as well as on related tropospheric and stratospheric chemistry and physics. The division consists of four sections, the Atmospheric Physics, Chemical Reaction, Upper-Atmospheric Environment, and Atmospheric Measurement Sections. Several facilities such as a photochemical reaction chamber, lidar (laser radar), ozone lidar, aerosol chamber, and wind tunnel are made available in cooperation with the Global Environment and Regional Environment Divisions.

Atmospheric Physics Section

The Atmospheric Physics Section focuses its research on the numerical analysis of atmospheric dynamics. Analysis of the global climate system, with a climate model (atmospheric general circulation model or GCM) and observational data, is a main research topic; the results facilitate study of both global (global warming, stratospheric ozone, acid rain, etc.) and regional-scale environmental issues (urban air pollution etc.). Improvements to and validations of our GCM focused, especially on stratospheric dynamics, gravity wave propagation, and land surface parametrization are in progress. The interaction processes between tropical cumulus activity and large-scale atmospheric dynamics were also studied by analyzing meteorological satellite data and numerical studies with the GCM. A model of long-range transport of pollutants in East Asia indicates that wind pattern variations associated with a synoptic scale pressure system are extremely important for the transport of pollutants (Fig. 1).

Chemical Reaction Section

The Chemical Reaction Section deals with the photochemical and thermal reactions of a relatively small number of reactive atmospheric constituents. Studies of the photochemistry and kinetics of free radicals related to photochemical smog, acid deposition, and the fates of airborne chemicals in both the troposphere and stratosphere have been carried out.

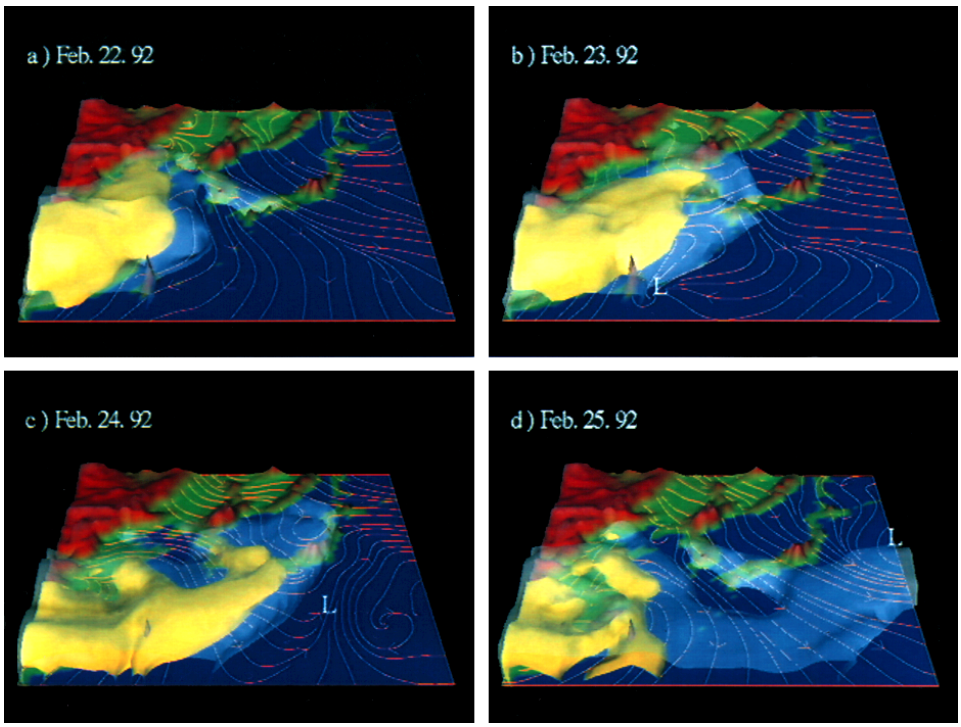


Fig. 1
Simulated sulfate isosurfaces for 6.5 μgm^{-3} (white) and 13.0 μgm^{-3} (yellow) and stream lines from Feb. 22 to 25, 1992. A low pressure system (denoted by L) located east of Taiwan (Feb. 23) moved to south of Tokyo (Feb. 24). Transport of pollutants from the Asian mainland (a), to the Yellow Sea (b), and the western part of Japan (c) after the passage of the low pressure system.

Ozone destruction by chlorofluorocarbons (CFCs; $CFCl_3$ and CF_2Cl_2), bromofluorocarbons (BFCs; CF_3Br and $C_2F_4Br_2$), hydrochlorofluorocarbons (HCFCs; CH_3CCl_2F, CF_3CHCl_2, and CF_3CHFCl), and CH_3Br was demonstrated in a 6-m^3 evacuable photochemical chamber equipped with UV-enhanced Xe arc lamps. The decay of ozone by a catalytic cycle involving Cl or Br atoms released from the photolysis of halocarbons by UV light was evident, although the chain length was far less than that in the real stratosphere; chain length was about 8 for $CFCl_3$ and 40 for CF_3Br. The rates of ozone decomposition were faster in the BFCs than in the CFCs. According to a box-model simulation, in the $CFCl_3$ system, 90% of the catalytic cycle proceeds from reactions of $Cl + O_3 \rightarrow ClO + O_2$ and $ClO + O \rightarrow Cl + O_2$. In the CF_3Br system, 90% of the catalytic cycle is governed by the following reactions: $Br + O_3 \rightarrow BrO + O_2$ and $BrO + BrO \rightarrow 2Br + O_2$. The HCFCs and CH_3Br can destroy ozone as well as CFCs and BFCs when they enter the stratosphere.

Laser induced fluorescence of the C_2H_2FO radical produced in reactions of fluoroethylenes with atomic oxygen. A new laser induced fluorescence spectrum was observed in reactions of $C_2H_3F + O$ and $C_2H_2F_2 + O$. Since the spectrum obtained was similar to that of vinoxy radical (C_2H_3O) which was reported previously, we concluded that it was the C_2H_2FO spectrum that was observed.

Upper-Atmospheric Environment Section

The Upper-Atmospheric Environment Section uses lidars and laser remote sensing methods to conduct observational studies of the upper atmosphere.

Lidar observations of stratospheric and tropospheric aerosols. Aerosols in the troposphere and stratosphere have been observed with the NIES Large Nd:YAG Lidar and a compact lidar (Fig. 2). Lidar methods for quantitative measurement of optical parameters and size distribution of aerosols are being studied.

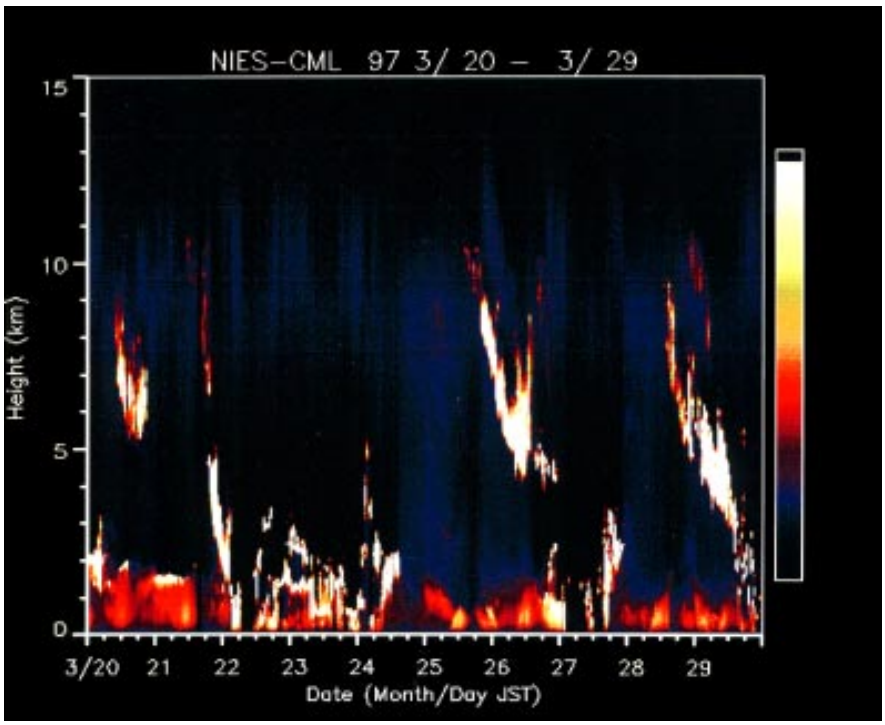


Fig. 2
Variation in the vertical profile of tropospheric aerosols measured with a compact lidar over 12 days. The structures of aerosol distribution and clouds, which are related to the structures of warm fronts, are apparent.

Retroreflector in Space (RIS) Experiment was examined. Preparations for earth-satellite-earth laser long-path absorption measurements of atmospheric trace species using the Retroreflector in Space (RIS) on the Advanced Earth Observing Satellite (ADEOS) are being carried out in cooperation with the Communications Research Laboratory. The spectra of ozone have been successfully measured in the round-trip optical path to the ADEOS with a pulsed CO_2 laser transmitter/receiver system. The experiment on the laser long-path absorption measurement of ozone, methane, CF_2Cl_2, HNO_3, etc. is being continued. A study on remote sensors for future satellite programs is also being conducted.

Atmospheric Measurement Section

This section's special emphasis is on field studies of atmospheric trace gases including greenhouse gases. The origins, distributions, and fates of greenhouse gases, reactive trace gases, aerosols, and stable and radioactive isotopes in the troposphere have been studied on a global and/or regional scale. Measurements of greenhouse gases and related species from ground base stations and aircraft have contributed to these efforts. One of the main activities in 1996 was airborne measurement of CO_2 uptake by vegetation by the eddy correlation method. Water vapor flux (latent heat flux) and CO_2 flux were calculated from aerodynamic data taken at about 100 m above the surface by fast response water and CO_2 sensors together with the vertical wind velocity. Fig. 3 shows the downward CO_2 flux and the upward latent heat flux over East Hokkaido averaged over every 2 min of a flight leg. The measurements have been repeated several times and the results are quite reproducible. The high flux is due to the upward thermal convection caused by heated roads or bare soil collecting the wet and low-CO_2 air from nearby in the scale of on the order of hundred meters.

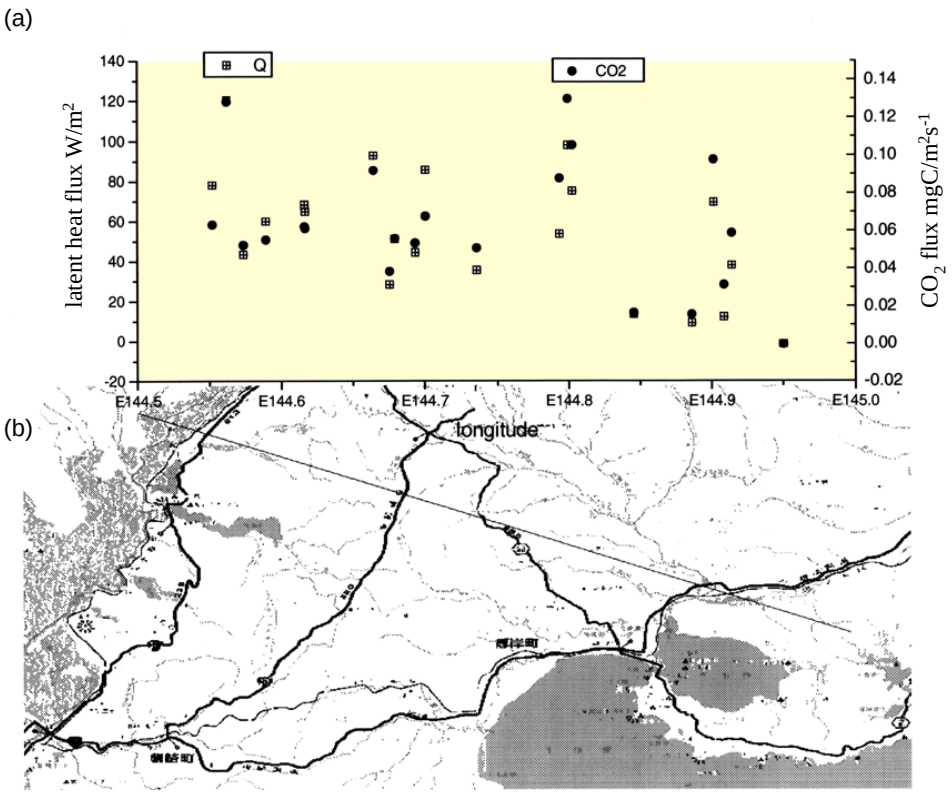


Fig. 3
The negative CO_2 flux and the latent heat flux (a) observed from an aircraft over East Hokkaido ((b) flight path map).

Water and Soil Environment Division

The Water and Soil Environment Division conducts both fundamental and applied research on transport, biological degradation, and chemical reactions of pesticides, organic matter, heavy metals, chlorinated aliphatic compounds, as well as biologically available nutrients in aquatic and soil systems. The results of these studies are integrated into biogeochemical models to contribute to the conservation and protection of the environmental quality of such systems.

The division consists of four sections, the Water Environment Engineering, Water Quality Science, Soil Science, and Geotechnical Engineering Sections. Experimental facilities such as a freshwater microcosm, a marine microcosm, lysimeters, the Environmental Biotechnology Laboratory, and the Kasumigaura Water Research Station are currently used in these studies in collaboration with members of the Global Environment and Regional Environment Divisions.

Water Environment Engineering Section

Development of comprehensive watershed management model for Chang Jiang River

There is increasing global interest in environmental and ecological issues of the East China Sea as a result of rapid economic development in the Chang Jiang (also known as the Yangtze) River catchment. This rapid development is causing increased sediments, nutrients, organic matters and so on; these are conveyed to the sea through the river. For this reason, we must understand the transport phenomena of them in this huge catchment, and describe them in order to carry out the environment quality management of the East China Sea.

The water movement is the fundamental agent which controls the transport of pollutant loading, and is characterized by the morphological, landuse, vegetation cover, social variables and so on. Because the Chang Jiang River is 6300 km long and drains an area of 1.8 million km^2 (three times as long as and five times as large as Japan), we need the advanced technology for remote sensing and geographic information system (GIS) in order to describe the properties of catchment. For example, the geometrical structure (i.e. gradient and dimension of the rivers and linked components of catchment) has been calculated based upon the detailed digital elevation model (DEM) and a pseudo-Chang Jiang River Network System have been generated. The various properties have been overlaid on this pseudo-catchment.

These databases give an objective description of the catchment at present, and we must develop a mathematical simulation model to predict environmental conditions there in the future. The hydrologic and associated water quality processes in the catchment consist of many subsystems, which are themselves quite complicated. Therefore, first of all we have tried to make the total system model which integrates the subsystems before investigating the mechanism of the subsystems in detail. Coupling a GIS with the simulation model is expected to enable us understand the catchment as a whole system comprehensively.

Water Quality Science Section

The fate and cleanup of pollutants in aquatic environments

A large amount of radioactive cesium was released during the nuclear reactor accident at Chernobyl and Chernobyl Cs remains in lake water now. Freshwater plants, green algae, mushrooms, and fishes all accumulated radioactive cesium. There is considerable interest in the potential of use of bacteria to remove metals and radioactive compounds from both wastewater and aqueous streams. We isolated a cesium-accumulating bacterium from soil and identified it as *Rhodococcus erythropolis* CS98. Strain CS98 accumulated cesium depending on its metabolism. As an initial step towards developing a radioactive cesium recovery method using bioaccumulation, we made a bioreactor model with strain CS98 using a semipermeable membrane. The semipermeable membrane was soaked in a 100 m*l* water sample in a glass column. The water sample contained buffer, a carbon source, and ^{137}Cs at a final activity of 37 kBql^{-1}. A cell suspension of strain CS98 was put inside the semipermeable membrane and incubated at 25°C (Fig. 1). The ^{137}Cs activity of the water sample incubated with cells had decreased to 3 kBql^{-1} after 24 h (Fig. 2). In another experiment, ^{137}Cs activities in cell suspension increased in proportion to initial ^{137}Cs activities in water samples (Fig. 3). Over 80% of the ^{137}Cs added to each water sample was collected in the cell suspensions, demonstrating that bioaccumulation can be used in the future to recover radio-cesium from fresh water.

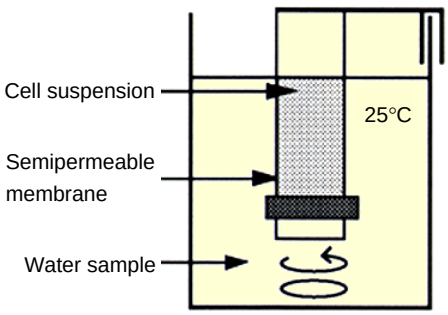


Fig. 1
Experimental conditions for concentration of ^{137}Cs by *Rhodococcus erythropolis* CS98.

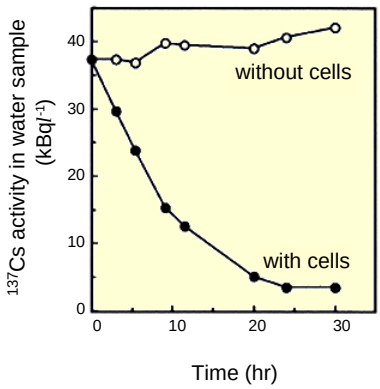


Fig. 2
Recovery of ^{137}Cs by *Rhodococcus erythropolis* CS98 in the bioreactor system.

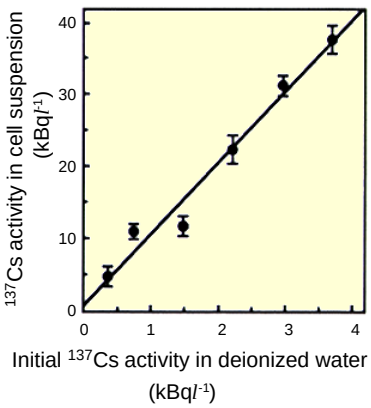


Fig. 3
Relationship between the ^{137}Cs activity in cell suspension and initial ^{137}Cs activity in deionized water.

Soil Science Section

Survival of *Sphingomonas paucimobilis* strain SS86 in soil

Beneficial microorganisms have received much attention for their possible use in bioremediation of polluted soil environments and for agricultural purposes. An aerobic bacterium, *Sphingomonas paucimobilis* strain SS86 isolated and identified by Senoo and Wada (1989), is able to decompose γ-hexachlorocyclohexane. We studied the survival of strain SS86 (short rod 0.7 by 1.3 μm) during a 20-week incubation period after inoculation (5.5×10^6 cells per g dry soil) into micro-capillary pores (=MiCP, 0.19-3.00 μm diameter pores) and macro-capillary pores (=MaCP, 3-48 μm diameter pores) of three sandy loam soils (PK fertilizer, NPK fertilizer, and NPK fertilizer + rice straw compost plots) of the long-term experimental paddy field (sandy loam) of the Yamaguchi Prefectural Agricultural Experiment Station. Viable cells were

quantified using the Most Probable Number (MPN) serial dilution method (Senoo and Wada, 1990). In all plot soils used, survival of strain SS86 was longer when inoculated into MiCP (5-15 weeks) than when inoculated into MaCP (4-10 weeks), although population density decreased at various rates with increasing incubation time. Furthermore, survival of strain SS86 varied widely with fertilizer type, which had been repeatedly applied to the plot soils; the order of increasing survival in plot soils was as follows: PK fertilizer > NPK fertilizer + rice straw compost > NPK fertilizer. The results indicate that MiCP is a more habitable pore space for survival of strain SS86 than is MaCP and that survival of strain SS86 in soil can be greatly influenced by the kind of fertilizer applied to the soil.

Geotechnical Engineering Section

Land subsidence of Joetsu, Niigata

Urban Takada, situated south of city of Joetsu in western Niigata Prefecture, is one of the typical heavy snowfall areas in Japan. The ground water level decreases greatly in winter due to excessive pumping of ground water to melt snow, resulting in subsidence caused by consolidation of Quaternary deposits. Recently severe decline of ground water level of a confined aquifer at about 50-m deep, known as “G1 bed”, has occurred due to increased pumping of ground water from wells there.

We developed a new observation system to monitor land subsidence. This observation system uses an aromatic polyamide wire to measure subsidence. We miniaturized the observation system to reduce the cost (Fig. 4). Accuracy was improved by reducing the influence of friction by reducing the amount of contact between component parts. The new land subsidence observation system was installed at the Takada branch public hall in Joetsu in 1993. Land subsidence there due to rapid decline of ground water level in winter was precisely observed (Fig. 5), demonstrating that this new and simple observation system is effective.

Fig. 4
A new observation system for land subsidence monitoring after boring observation at the Takada branch public hall in Joetsu.

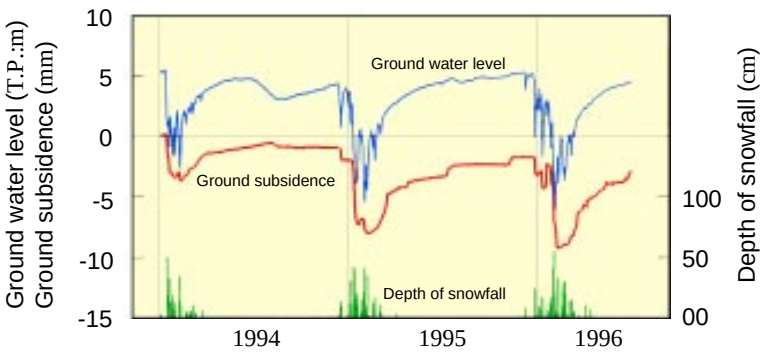
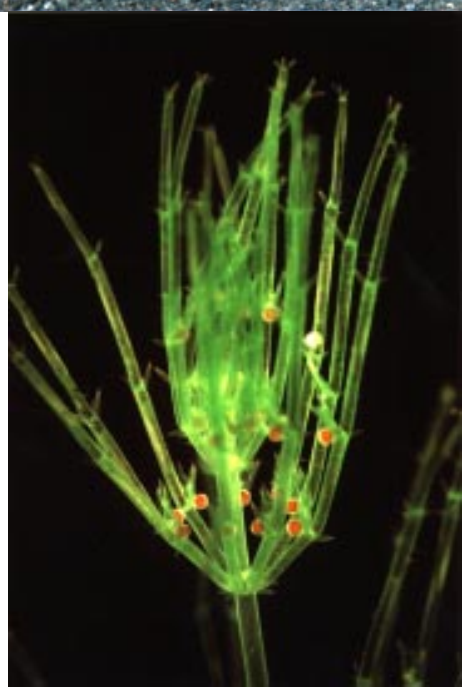


Fig. 5
Ground water level and subsidence measured with the new observation well at Takada in Joetsu.

Environmental Biology Division



The Environmental Biology Division consists of four sections: the Molecular Biology, Environmental Microbiology, Environmental Plant Science, and Ecosystem Study Sections. The division performs basic and applied research on the effects of various environmental stresses, both chemical and physical, on organisms at various levels, from molecules and cells to individuals, species, populations, and ecosystems. The division's work is also directed towards the conservation of genes, species, and ecosystems. In 1996 we performed 19 studies funded by NIES, three studies funded by the Science and Technology Agency, and two studies funded by the Ministry of Education, Science, and Culture.

In the **Molecular Biology Section**, we carried out physiological and molecular biological studies on the mechanisms of plant tolerance to stress caused by various environmental conditions.

APX is a component of the ascorbate-glutathione metabolic pathway and catalyzes the reduction of H_2O_2 to H_2O using ascorbate as an electron donor. We previously isolated a cDNA corresponding to the cytosolic isoform of APX from *Arabidopsis thaliana*. We connected this cDNA downstream of the promoter for the ribulose-1,5-bisphosphate carboxylase small subunit gene and introduced the resulting chimeric gene into tobacco. Leaves of the transgenic plants accumulated the transgene product (Fig. 1) and expressed APX activity at levels up to 10-fold higher than that in control non-transgenic plants. However, the sensitivity of these transgenic plants to an active-oxygen-generating herbicide, paraquat, did not significantly differ from that of control plants, as evaluated by electrolyte leakage from leaf discs. The ascorbate content and APX activity rapidly decreased in leaf discs of both transgenic and control plants during paraquat treatment in the light. At least under the present study conditions, the cytosolic APX activity appears not to be a limiting factor in the tolerance of plants to paraquat-induced oxidative stress.

In the **Environmental Microbiology Section**, studies have been carried out on 1) the diversity of microorganisms, 2) the distribution and culture of charophytes that are in urgent need of protection, 3) the enzymology of soil organic matter decomposition, and 4) the fate of algal toxins in a eutrophic lake.

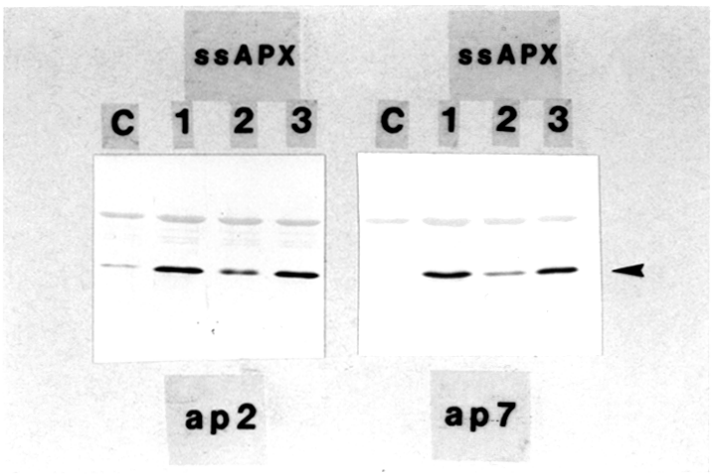


Fig. 1
Immunoblots indicating the accumulation of *Arabidopsis* cytosolic ascorbate peroxidase (APX) in transgenic tobacco leaves. Foliar extracts of control (C) and transgenic (ssAPX 1, 2, and 3) plants were electrophoresed and probed with anti-APX monoclonal antibodies. Antibody ap2, but not ap7, cross-reacts with the endogenous tobacco APX. The arrowhead indicates the position of cytosolic APX.

We implemented a laboratory study to determine the fate of microcystins (toxic, cyclic heptapeptides in cyanobacteria) after grazing by the mixotrophic flagellate *Poterioochromonas malhamensis* (Ochromonadales, Crysophyceae). When live cultures of the toxic *Microcystis viridis* (Chroococcales, Cyanobacteria) were inoculated as prey into cultures of *P. malhamensis*, the latter ingested and digested all of the prey cells within 5 days. At the end of the experiment, almost all of the microcystin was found in the filtered culture medium and none was detected in the harvested *P. malhamensis* cells (Fig. 2). Similar results were obtained when lyophilized samples of a natural toxic cyanobacterial bloom were added as a prey to *P. malhamensis* cultures. We conclude that almost all of the microcystins are eliminated from the chrysomonad cells immediately after release into the food vacuole. Microcystins may be released into lake water not only by bacterial decomposition of toxic cyanobacterial cells but also during grazing and digestion by mixotrophic chrysomonads.

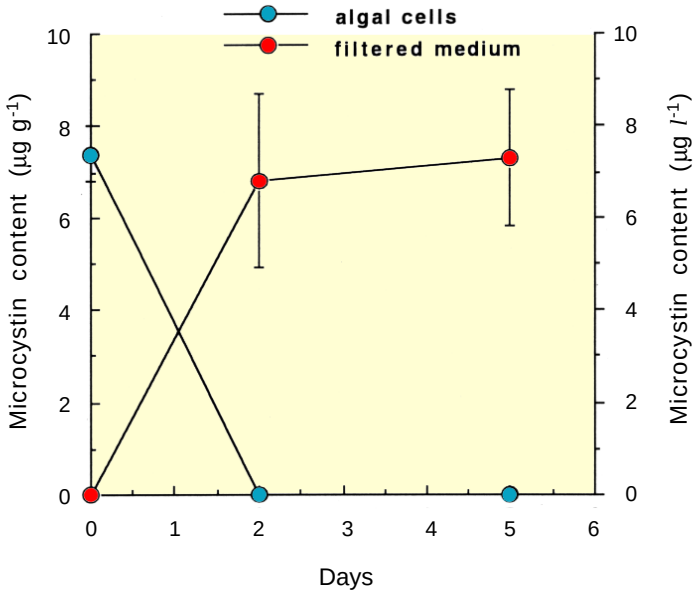


Fig. 2
Changes in microcystin content in algal cells (μg•g dry weight^{-1}) and filtered culture medium (μg l^{-1}) in mixed culture of *Poterioochromonas malhamensis* and *Microcystis viridis*. The points are means of two or three determinations and vertical bars indicate standard deviations of the means.

In the **Environmental Plant Science Section**, studies have been carried out on 1) the effects of desertification and global warming on plants and 2) the development of new techniques for diagnosing such effects.

To estimate the effects of global warming on plants growing in high mountains that will be seriously affected by global warming, we measured the daily change of leaf temperature of an alpine plant species, *Polygonum weyrichii* var. *alpinum* Maxim in August; this plant grows in a volcanic desert at an elevation of about 2600 m on Mt. Fuji. The August mean temperature here was estimated to be 11.9°C. The average leaf temperature gradually increased to 24.5°C in the morning. The maximum leaf temperature was 29.5°C, considerably higher than the temperature of the surrounding air. At about 11:00 a.m. a fog began to set in, a common phenomenon in high mountain areas of Japan, and the leaf temperature gradually decreased (Fig. 3). Therefore, the effect of fog on leaf temperature seems to be important for alpine plants.

The **Ecosystem Study Section** studied 1) the effects of environmental stress on plants

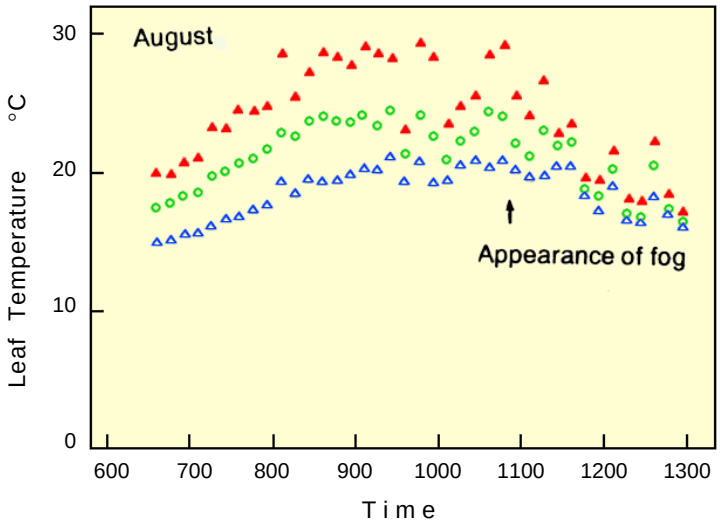


Fig. 3
Leaf temperatures (°C) of *Polygonum weyrichii* var. *alpinum* Maxim growing at about 2600 m in a volcanic desert on Mt. Fuji. ▲: maximum, ○ : average, and △: minimum.

in transitional zones of lakes and wetlands, 2) the habitat of littoral zoobenthos, 3) the food-web structure in stream benthic communities, and 4) the evaluation of modified river-beds for colonization by aquatic plants and animals.

The dynamics of benthic communities in the upper reaches of the Kozakura River (site 1) and in the lower reaches of the Kawamata River (site 2) were investigated with particular reference to species interactions. The population dynamics of larvae of one of the dominant Ephemerid species, *Baetis thermicus*, were similar at each site, but the larval densities of the other dominant species, *Ephemerella aurivillii*, peaked at site 1 in November 1996 and at site 2 in January 1997 (630 and 600 indiv. m^{-2}, respectively). Hydropsychidae (Trichoptera, net spinning caddis) were the most abundant caddis flies at both sites. Larvae of *Hydropsyche orientalis* decreased from May to June (emerging periods) 1996 at both sites. Their density in the Kawamata River (site 2) remained low from July to August, when pesticides were detected, and peaked (2480 indiv. m^{-2}) in September. In contrast, their density peaked at site 1 (3080 indiv. m^{-2}) in July (Fig. 4).

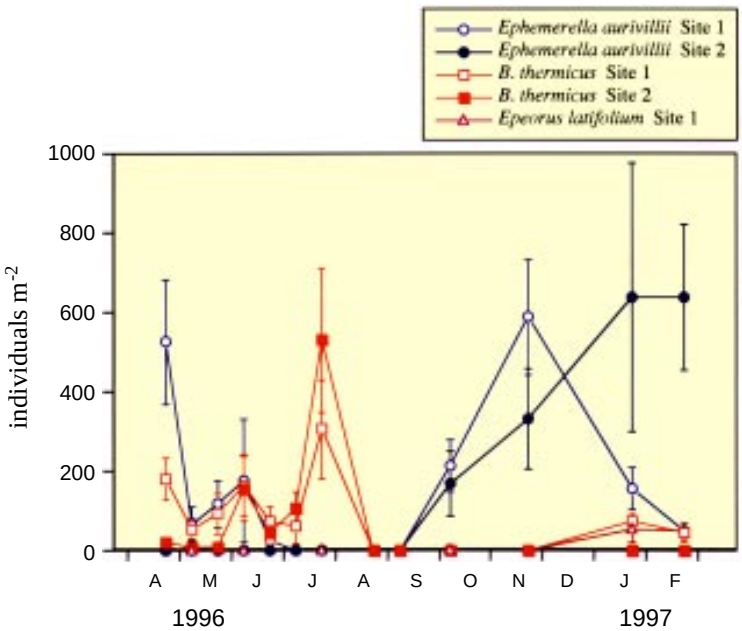
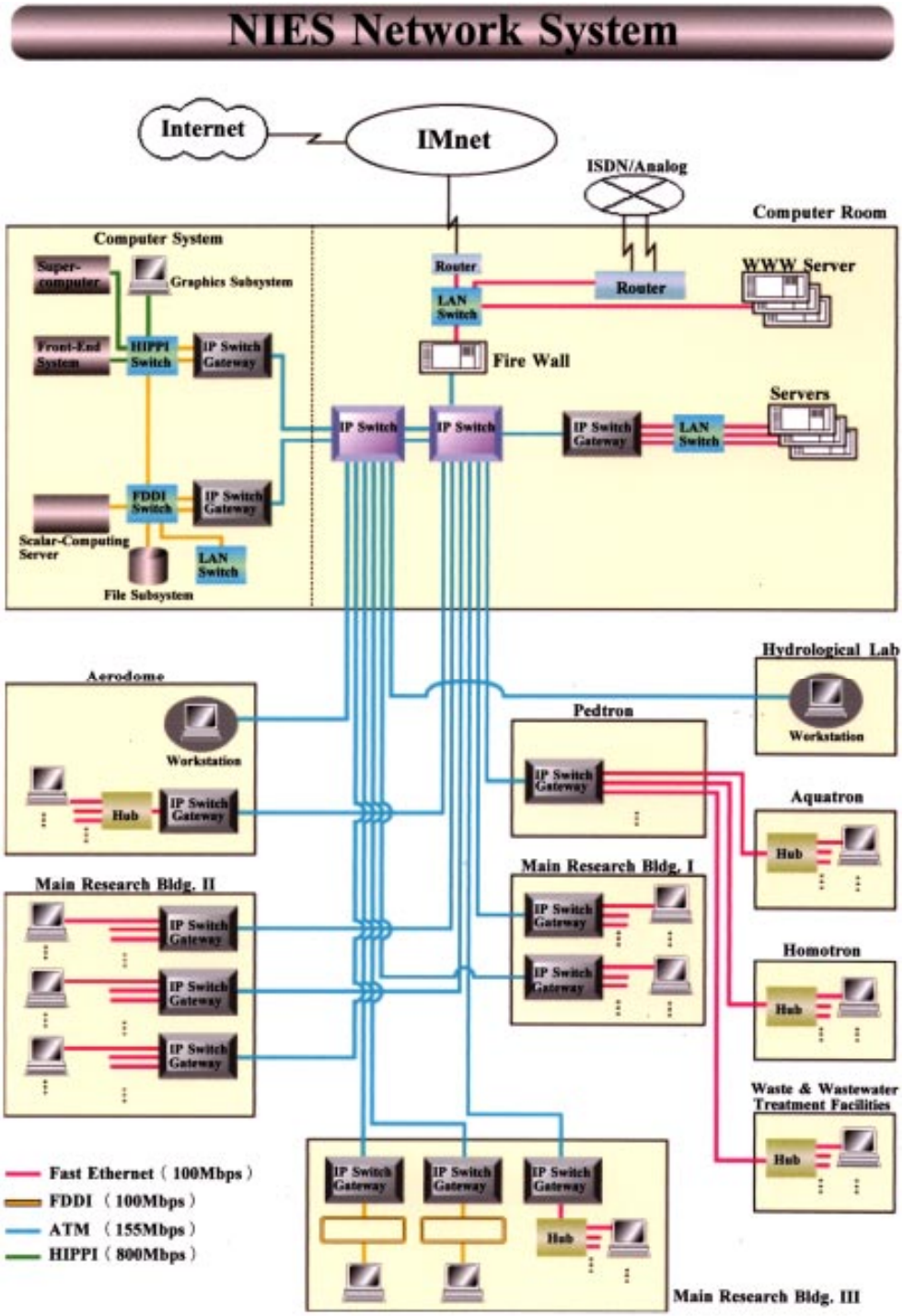


Fig. 4
Densities of three Ephemerid species at site 1 in the Kozakura River and site 2 in the Kawamata River.

Environmental Information Center



The Environmental Information Center is responsible for various functions and services related to collection and provision of environmental information. Databases, a library, and a computer system are operated and maintained, enabling the handling of a wide range of environmental information.

Database Section

Processing and provision of computer files of numerical environmental data

A wide range of numerical, environmental data is necessary for both environmental research and environmental policy development, implementation, and enforcement. The center has compiled, processed, stored, and provided access (in computer-accessible form) to data files of air and water quality monitoring data which are transmitted by local governments to the Environment Agency under the Air Pollution Control Law and the Water Pollution Control Law. These data files are provided to outside users including other governmental organizations and laboratories. Also a duplication service for use by the general public is available for some files. Data files are also exchanged with other governmental organizations.

Collection and processing of information

The General Reference System for the Natural Environment has been developed since FY 1991 to provide basic reference materials that facilitate both understanding of present conditions and forecasting of changes in the natural environment. A database system (GREEN) using a UNIX Database server, is available on NIESNET to enable searches for and display of environmental data from all over Japan. Since FY 1995, a system to provide database access by personal computers (P-GREEN) has been developed based on previously recorded results and data. P-GREEN is available on Windows PCs to enable graphical-display and user friendly operation.

NIES began in March 1996 to provide environmental information from NIES research activities and results (in English and in Japanese) to the world via the internet's World Wide Web (URL http://www.nies.go.jp/).

In March of 1996, the center established a computer communication system for the general public called the "Environmental Information & Communication Network" (EICnet) in accordance with the Basic Environment Law to promote national activities for conservation of the environment. This system is available only in Japanese via telephone, the internet, or the Value-Added Network (VAN). In January 1997, an EICnet WWW server was also established (URL http://www.eic.or.jp/).

Surveys of environmental information have been in progress since FY 1992 with the goal of providing a directory of information sources in a form widely accessible to the general public. The surveys — including information about where and in what mode environmental information is being accumulated (environmental information sources) and explanations of laws, treaties, and terms concerning the environment — were compiled on floppy disks and are being distributed to the general public through a public corporation and through NIES and EICnet WWW servers.

Library and Research Information Section

Compilation of documentary information concerning environmental research

Documentary information concerning the environment is essential for competent environmental research and management. Database systems containing informative documents about the environment have been created to meet such needs. In addition, access to other Japanese and foreign commercial databases has been provided to institute users.

Databases available off-line on CD-ROMs or floppy disks in the institute include NTIS, MEDLINE, Ei Energy and Environment, Environment Library, and Current Contents on Diskette (CCOD).

Access is also provided to several other on-line databases, JOIS, DIALOG, STN-International, G-Search, and NIFTY-Serve.

Library management and operations

As of March 1997, 36,358 books, 644 technical and scientific serials, 8,501 maps, 106,925 microfiches, and various other reports and reference materials were in the NIES library.

Library facilities include separate reading rooms for books, for journals, for indexes and abstracts, for reports, and for maps and microfiche as well as a database access room and a photocopying room.

Editing/publication

Reports concerning NIES research activities and results, an official newsletter (the NIES News, in Japanese), and other reference materials are edited by the center and distributed to many organizations.

Information Management Section

INFOTERRA

INFOTERRA, the Global Environmental Information Exchange Network has been designed by UNEP to stimulate and support the exchange of environmental information between partners. The system is operated at the national level by national focal points. The center is designated as the INFOTERRA National Focal Point of Japan. As of March 1997, 174 countries had participated in INFOTERRA, and information sources registered in INFOTERRA numbered about 8,000 (519 in Japan).

Management and operation of computer and related systems

A new computer system started operation in March 1997. The system is regarded as an integration of a general-purpose computer system and a supercomputer system to meet increasing demand for computing resources and a multiplicity of processing uses. This distributed computing environment runs under the UNIX operating system and consists of the comparatively large-scale supercomputer system (NEC SX-4/32(32CPU)) and various subsystems such as a scalar-computing server (IBM RS6000/SP2 (16 CPU)), database servers (SUN Enterprise 2/1200 (Oracle7, SAS) 3 sets, NEC Express 5800/160 Pro (Oracle7 Workgroup) 2 sets), and file servers (DEC Alpha Server 8400 5/440 (4 CPU), Alpha Server 4100 5/400 2 sets, a SONY File Bank

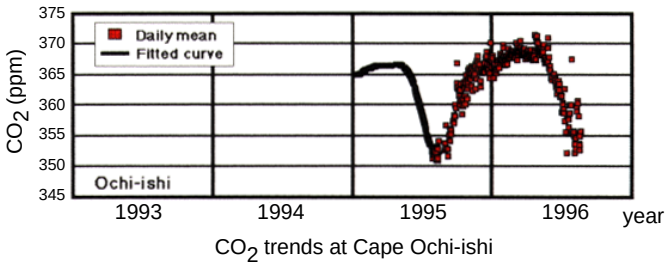
system, and a Peta Site system).

Our SX-4/32 vector-computing system, including a front-end system (SX-4/4C (4 CPU)), employs the SUPER-UX (UNIX-based) operating system. The system is equipped with a FORTRAN compiler (with high-level debugging, high-efficiency optimization, high-level vectorization, and various supportive tools for efficient compilation) and executes large-scale programs to handle global environmental problems. It is also equipped with a image processor and a 3-dimensional graphics processor (SGI Onyx MIPS R10000/R4400 (2 CPU)).

A LAN called the NIES Network (NIESNET) was established at our institute in 1992. The file transports in various computer systems, the IP Switch, and the IP Switch Gateway were upgraded in the present year. The network configuration was restructured and large-scale file transport performance was improved. Each institute researcher can access the computer system from their own desk through the LAN. Foreign as well as Japanese registered users outside the institute can remotely access the supercomputer system through NIESNET's connection to the Internet via the Inter-Ministry Network (IMnet).

Center for Global Environmental Research

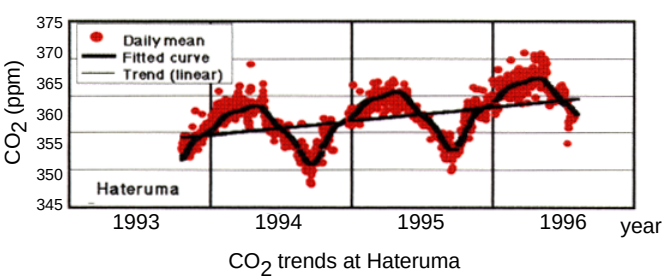
Global Monitoring Station-Cape Ochi-ishi



CO_2 trends at Cape Ochi-ishi

Cape Ochi-ishi

Hateruma



CO_2 trends at Hateruma

Global Monitoring Station - Hateruma

The Center for Global Environmental Research (CGER), was established in October 1990 to contribute broadly to scientific understanding of global change and the elucidation and solution of our pressing environmental problems. CGER has three major activities: integration of global environmental research, management of global environmental databases, and global environmental monitoring.

Research Integration

The objectives of research integration are: 1) to ensure communication and networking among researchers and decision-makers; 2) to cooperate with the Research & Information Office of the Global Environment Department of the Environment Agency in coordinating scientific and socio-economic research on global change; 3) to cooperate in international efforts to establish a research network for global change; 4) to manage research programs utilizing our supercomputer facilities, which are open to researchers at institutes and universities around the world; and 5) to conduct integrated research into policy options for coping with global environmental problems.

Enhancement of communication

CGER hosted several seminars, symposia, and conferences on research into global environmental change in FY 1996. Some, such as the annual Global Environment-Tsukuba, brought together researchers and decision-makers with the general aim of furthering communication. CGER also supported the efforts of groups seeking to organize workshops or symposia on specific research programs. In 1996, such groups included the International Symposium on Acidic Deposition and its Impacts, the Open IGBP/BAHC-LUCC Joint Inter-Core Projects Symposium, and the East Asia-Pacific Regional Conference of International Long-Term Ecological Research.

Cooperation to promote and coordinate global change research

CGER has advised the Research & Information Office, from a scientific point of view, on its effective promotion of the Global Environment Research Program. An international research network, involving scientists in both developed and developing countries, is indispensable to advance scientific understanding of global change. The Asia-Pacific Network for Global Change Research (APN) has been set up via an inter-governmental framework and efforts to establish three subregional networks in this region under the SysTem for Analysis, Research, and Training (START) have been launched via a non-governmental scientific framework. CGER supported the APN/START-TEACOM LUTEA Workshop in Kyoto in November 1996.

CGER is actively participating in the work of the Intergovernmental Panel on Climate Change (IPCC). Japan hosted the IPCC Asia-Pacific Workshop on Integrated Assessment Models in Tokyo in March, 1997. CGER has supported this workshop as a Secretariat Office to contribute to the Third Assessment Report of the IPCC, which is set for completion at the end of the year 2001 (Fig. 1).

Coordinating supercomputer-aided research programs

In March 1992, CGER installed a supercomputer system (NEC SX-3, model 14) and in March 1997, CGER replaced this model with a newer supercomputer (NEC model SX-4/32) to facilitate research on global change (Fig. 2). An annual supercomputer

Fig. 1
IPCC Asia-Pacific Workshop on Integrated Assessment Models.

Fig. 2
CGER's NEC Supercomputer SX-4/32.

activity report was published and the 4th Supercomputer Research Workshop was convened by CGER to disseminate the advanced knowledge obtained by the users of our supercomputer.

Integrated research on policy options

A special research category in the Environment Agency's Global Environment Research Program, Integrated Research, is research directed towards actual decision-making processes through the development of conceptual models and the generation of data used widely in interdisciplinary research. The following two research projects in this category were implemented in 1996: 1) Studies on Environment-Economic Integrated Assessment Methodologies for Sustainable Development, and 2) Design of a Global Environmental Information System for Sustainable Development.

Database management

CGER is establishing a global environmental database system as well as producing and distributing UNEP/GRID environmental data sets to support environmental research and decision-making. During FY 1996, metadata on outlines of monitoring or researches planned by various collaboration programs, whereabouts of the original data, and the ways to access to the original data sets were collected and the resulting metadata set was published as a handbook in order to reevaluate the method of gathering global environmental data.

Database

CGER is establishing databases field by field. An inventory of the sources of SO_2 discharge in China and India was made for elucidation of long-range transboundary air pollution in the East Asian region. Two data sets of field observations were arranged and processed: the results of the IGAC/APARE/PEACAMPOT survey (1991-1995) performed by the National Institute for Environmental Studies (NIES) and collaborating institutions, and the acid deposition monitoring data (1991-93) collected

by prefectural research institutes under an initiative of the Environmental Laboratories Association. A database on the distribution and characteristics of wetlands and related references was made from the viewpoints of wildlife protection under the Ramsar Convention and emissions of methane, a greenhouse gas. Digital map data of wetlands were prepared based on this database. The international data sets in physical term were collected to evaluate the burdens imposed on the environment by the various Asian countries with the export and import of natural resources. "Collected Data of High Temporal-Spatial Resolution Marine Biogeochemical Monitoring from Ferries in the East Asian Marginal Seas (April 1994-December 1995)" based on observations made by CGER/NIES was published as a CD-ROM.

GRID

The Global Resource Information Database (GRID) was established within UNEP in 1985 to provide timely and usable environmental data to the world community of researchers and policy-makers. GRID-Tsukuba was founded at CGER in May, 1991 as the 8th GRID Center. During FY 1996, 130 data sets were distributed to users in and outside of Japan in response to 33 requests. There were 22 inquiries concerning the activities of GRID-Tsukuba and other GRID centers. During FY1996, the network database software "Oracle" was introduced and the system to operate it was developed to facilitate access to the GRID metadata directory.

Global Environmental Monitoring

CGER has observed and recorded data of various global phenomena via long-term monitoring programs. These data are available through published data reports and through data set files provided by international data networks in which CGER participates. The following 10 projects are presently coordinated by CGER.

Ozone monitoring with ozone lidar (laser radar) and millimeter wave ozone radiometer systems

CGER measures the vertical profile of ozone in the lower stratosphere over Tsukuba with an ozone lidar that was installed in August 1988. Monitoring of the ozone layer commenced in October 1990. In FY 1996, the ozone lidar system was modified. The modified system extends the ozone measurement range to from 10 to 45 km. Millimeter wave measurements started in October 1995. Since then, vertical ozone profiles through the whole stratosphere have been determined. A comparison of the millimeter wave measurement results with those from a satellite and lidar data was made.

Monitoring of UV-B

To reveal trends in the urban ultraviolet-B (UV-B) intensity of solar radiation resulting from stratospheric ozone depletion, CGER installed a Brewer Spectroradiometer at the top of a building in Tokyo. Monitoring has been conducted since November 1993.

Japanese atmospheric monitoring stations (Hateruma and Cape Ochi-ishi)

The concentrations of greenhouse gases (GHGs) at two stations are continuously monitored to understand trends in background air quality in Japan. Atmospheric data from Monitoring Station-Hateruma, the southernmost inhabited island in Japan, should

be representative of the air quality in southern Japan. Monitoring at Hateruma Island started in October 1993. To obtain atmospheric background data for northern Japan, monitoring at Cape Ochi-ishi, Hokkaido, started in September 1995.

Monitoring of GHGs over Siberian Wetlands by airplane

The CO_2 sink of boreal forests and the CH_4 emissions from natural wetlands are among the factors that govern variations of carbon cycle in the Northern Hemisphere. The vertical concentration profiles of GHGs from 500 to 7000 m over Siberia were obtained monthly by an aircraft sampling method followed by laboratory analysis in Japan. These measurements have been made over Surgut in Western Siberia since 1993 and over Yakutsk in Eastern Siberia since 1996 at the same latitude of 60°N. The seasonal amplitude of CO_2 variations over Siberia were double those measured in marine air at the same latitude.

Monitoring of GHGs along a north-south transect by ships-of-opportunity in the Western Pacific

Routine sampling of background air along a north-south transect became possible by utilizing a cargo ship crossing regularly 8 times a year between Japan and Australia. Additional sampling of higher latitude air started from 1995 by utilizing another cargo ship sailing regularly between Canada and Japan. Samples are collected during every cruise and sent to a CGER laboratory for high precision determination of GHGs such as CO_2, CH_4, and N_2O. The resulting data are useful in the study of the global cycles of GHGs (Fig. 3).

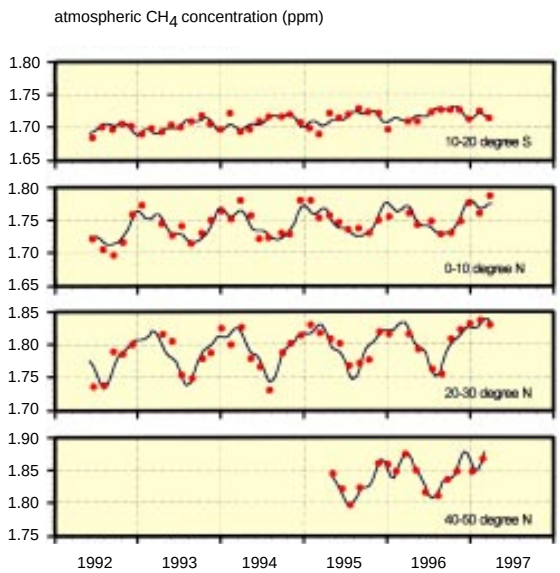


Fig. 3
Secular trends in atmospheric methane concentrations in various latitudinal zones of the Western Pacific. The samples were collected with the cooperation of the cargo ships, M/S Hakuba-maru from 1992 to 1995, M/S Southern-cross maru from 1996, and M/S Skaugran from 1995.

Monitoring of atmosphere-ocean carbon dioxide exchange from a ship-of-opportunity

CO_2 invasion from the atmosphere to the ocean is one of the most important sinks in the global carbon cycle. To estimate the net rate of atmosphere-ocean CO_2 exchange, CGER installed instruments on a cargo ship sailing between Canada and Japan (Fig. 4). The partial pressures of CO_2 in air and the surface ocean are automatically measured. CO_2 invasion into the ocean in spring and summer and evasion from the ocean in winter in the subarctic Western Pacific were clearly observed.

Fig. 4
The M/S Skaugran, belonging to Jahre-Wallem Management AS (Norway), is our ship-of-opportunity for regular cruises between Japan and Canada. CO_2 partial pressures in air and sea water are measured from this lumber transport ship.

High temporal-spatial resolution biogeochemical monitoring of the Western Pacific from a ship-of-opportunity

The cycles of elements such as C, N, P, and Si have been perturbed from those in pre-industrial and pre-agricultural times. These perturbations are thought to have impacted the ocean through the marginal seas. CGER has been measuring temperature, salinity, pH, fluorescence, dissolved nutrients, chlorophyll a, and pheopigments in the continuous water intake of ferry boats sailing regularly on two lines (Osaka-Naha and Osaka-Beppu) since March 1994.

Mapping the vegetation index with satellite data

The rapid destruction of tropical forests in Southeast Asia and elsewhere is a serious problem. Our vegetation index project uses data from a NOAA satellite to produce annually 1-km resolution vegetation maps of the Southeast Asia region. The resulting maps are distributed globally through the UNEP/GRID-Tsukuba Center.

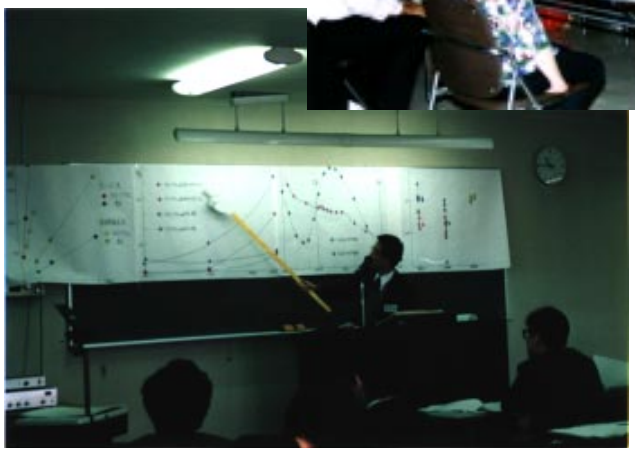
ILAS & RIS data handling facility

The ILAS and RIS instruments fly aboard the ADEOS satellite, which was launched on 17 August 1996. Establishment and operation of an ILAS & RIS Data Handling Facility (DHF) is the responsibility of CGER in cooperation with the Satellite Remote Sensing Research Team. The ILAS & RIS DHF processes the data obtained from the satellite instruments to prepare final atmospheric gas profiles for the ozone layer. These final products are distributed to interested parties. During FY 1996, the ILAS & RIS DHF was successfully operated.

GEMS/Water Programme

GEMS/Water, organized under UNEP and WHO, is a global environmental monitoring system for rivers and lakes. A network of 21 stations in Japan has been established for GEMS/Water Phase II activities. In particular, Lakes Mashu and Kasumigaura have been registered as network sites. CGER is responsible for coordinating GEMS/Water data transmissions, etc., as the Japanese National Center (focal point). CGER also participates in an Analytical Quality Control (AQC) Programme by providing certified reference materials (CRMs) of river water to laboratories analyzing samples from flux stations in Japan.

Environmental Training Institute



The Training Institute for Environmental Pollution Control was established under the jurisdiction of the Environment Agency in March 1973 to offer training courses in the environmental field to administrative and technical personnel. It was renamed the National Institute for Environmental Studies, National Environmental Training Institute (NETI) when it was united with the National Institute for Environmental Studies in July 1990 to strengthen the link between its training and research.

The structure of Japanese society, particularly with respect to lifestyle and industry, has been changing. Accordingly, new environmental issues have been raised and requests to develop skills with which these new issues can be tackled have been increasing. Consequently our range of training subjects must be broadened. Our training courses cover a range of subjects from administration and international cooperation to monitoring techniques, including laboratory analysis. In FY 1996, we provided 20 public policy courses, 12 laboratory analysis courses, and one international cooperation course (Table 1). A research-type training course, in which trainees comprehensively study policy formulation based on their own interests and using our facilities, was introduced in 1996. The institute has also strengthened its support for the training programs carried out in local governments, corresponding to substantial implementation of the Basic Environmental Law, which passed in 1993.

So far, NETI has provided training courses like these for about 26,000 participants, mainly from all levels of the Japanese government. According to the registration records, the number of trainees from prefectural, metropolitan, and city governmental organizations are largest, comprising about 70% of the total (Fig. 1). This is followed by trainees from the ministries and central governmental organizations, about 20% of

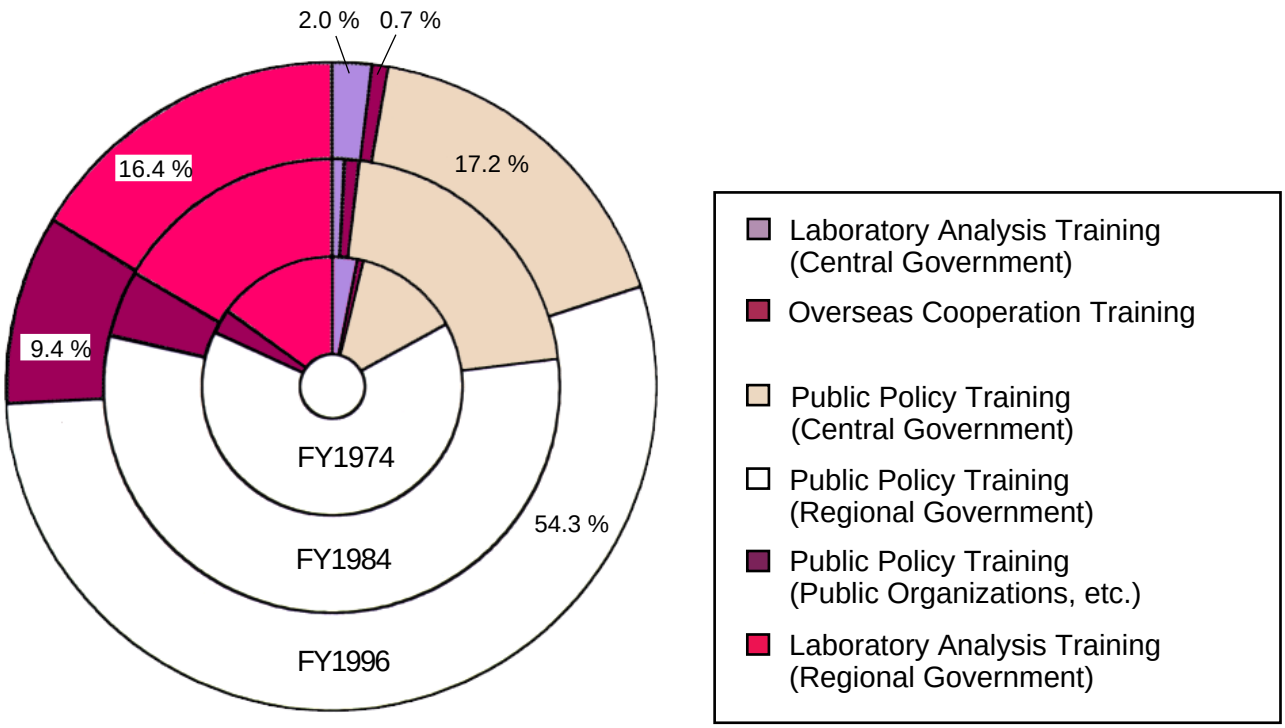


Fig. 1
Participation from Affiliated Organizations in 1974, 1984, and 1996.

the total, and public organizations with special status, 10%. Recently, we began accepting a few trainees from developing nations and elsewhere.

Table 1

Public Policy Courses

Course Name	Length (days)	Number of Participants
Seminar for Environmental Administration/Management	5	41
Local Environmental Training Course	6	62
Environmental Impact Assessment Training Course	6	117
Environmental Education Training Course (Government)	5	46
Environmental Education Training Course (Practical)	3	25
The Basic Environment Plan Training Course	5	75
Training Course for Leaders of Overseas Training Programs	5	11
Training Course for Global Environmental Conservation Technology	8	35
Nature Conservation Training Course	6	66
Wildlife Protection Training Course	5	55
National Park Management Training Course	5	40
Air Pollution Control Training Course	6	80
Noise and Vibration Control Training Course	5	102
Water Pollution Control Training Course	6	113
Information Management Training Course	8	38
Training Course for Environment Agency Employees (Section Chief Class)	5	15
Training Course for Environment Agency New Recruits (Class I Officials)	8	17
Training Course for Environment Agency New Recruits (Class II and Class III Officials)	4	19
Training Course for Newly Assigned Regional Environmental Intelligence Officers	4	19
Research Type Training Course	58	7
Sub Total	163	983

Laboratory Analysis Courses

Course Name	Length (days)	Number of Participants
Instrumental Analysis Training Course	13	43
General Analysis Training Course	8	19
Air Analysis Training Course	13	24
Water Analysis Training Course	13	38
Instrument Analysis Training Course (Special Program A1)	5	21
Instrument Analysis Training Course (Special Program A2)	5	10
Instrument Analysis Training Course (Special Program B)	5	9
Special Topic Analysis Training Course	59	1
Thematic Analysis Training Course (1) Adhering Algae	5	16
Thematic Analysis Training Course (2) Plankton	5	15
Thematic Analysis Training Course (3) Effluvia	5	12
Thematic Analysis Training Course (4) Bottom-Dwelling Fauna	5	16
Sub Total	141	224

International Cooperation Courses

Course Name	length (days)	Number of Participants
Environmental Monitoring (Water Quality) Training Course	32	9
Grand Total	336	1216

To comprehensively discuss the necessary functions of NETI from middle and long term perspectives, the Investigative Committee for the Future Status of the National Environmental Training Institute was commissioned by the Chief of the National Planning and Coordination Bureau of the Environment Agency and organized in February 1994. The committee pointed out that the institute should continue to endeavor to develop human resources. In particular, it is important to let personnel in the environmental sectors acquire intersectoral, international, and interdisciplinary perspectives. NETI recently decided to provide several training courses for experts who will collaborate to solve the environmental problems with people in developing nations. The institute is installing some facilities including multimedia equipment, an international conference room, and analytical laboratories where appropriate techniques for developing nations are studied. NETI started offering some of these training courses for developing country participants in 1997.

<Global Environment Research Projects>

Mechanisms of global warming caused by the increase of greenhouse gases , Nojiri, Y., 1990-1998

Impacts of global warming and responses for stabilizing global climate , Morita, T., 1990-1996

Depletion of the ozone layer , Nakane, H., 1996-1998

Acidic precipitation , Satake, K., 1996-1998

Role of ocean flux in variations of the global environment and marine pollution , Harashima, A., 1996-1998

Maintenance mechanisms of tropical forest ecosystems , Furukawa, A., 1996-1998

Effects of habitat fragmentation on biological diversity , Tsubaki, Y., 1991-1996

Human dimension of global environmental change , Nishioka, S., 1994-1997

Integrated studies for conserving the global environment , Nishioka, S., 1990-1997

Satellite remote sensing , Sasano, Y., 1989-2002

<Special Research Projects>

Biogeochemical cycles and self-purification in shallow coastal areas for preservation of the marine environment , Kohata, K., 1996-1998

Bioremediation mechanisms for contaminated soil and groundwater , Yagi, O., 1996-1998

Methodology for quantification of environmental loads and their environmental impact assessment regarding transport systems and material cycle systems , Moriguchi, Y., 1996-1998

Human exposure to halogenated organic compounds and its health effects , Soma, Y., 1992-1996

Lake environment indices and nuisance picoplankton blooms , Fukushima, T., 1992-1996

Air and water pollution in an urban area caused by changes in the environmental load and countermeasures against it , Wakamatsu, S., 1993-1996

Evaluation of the risk of chronic pulmonary diseases due to diesel exhaust exposure and mechanisms of pathogenesis , Sagai, M., 1993-1997

Methodology for assessment of exposure to hazardous chemicals from waste landfills , Shiraishi, H., 1994-1997

Biomonitoring methodology for ecological risk assessment of chemical substances , Hatakeyama, Shigehisa; 1995-1997

<International Joint Research Projects>

Collaboration on water pollution renovation technology in developing countries , Inamori, Y., 1994-1998

Health risks of air pollution from coal burning and risk reduction in developing countries , Ando, M., 1994-1998

Community change and ecosystem management of shallow, eutrophic lakes , Takamura, N., 1995-1999

Development and application of environmental analysis and evaluation methods for atmospheric aerosols in China , Nishikawa, M., 1996-2000

International collaborative research on environmental management of watershed , Watanabe, Masataka; 1996-2000

<Others>

Development of bioeffect sensors for environmental chemicals , Mochitate, K., 1995-1999

Paleoenvironmental studies of Baikal sediment cores , Kawai, T., 1995-1999

Vehicular research to mitigate environmental pollution , Shimizu, Hiroshi; 1994-1996

Path controls for bulk data transmission on the IMnet , Abe, S., 1994-1996

Development of advanced, sustainable water and wastewater treatment systems , Inamori, Y., 1995-1997

NIES Symposium: Contemporary Issues in Heavy-Metal Related Toxicology

April 4-8, 1996
NIES, Tsukuba, Japan

There is world-wide concern about the possible occurrence of serious poisoning in developing countries. In developed countries, low-level exposure to heavy metals in the general environment should gain more attention in terms of various health effects. In addition, background exposures to particular heavy metals like cadmium differ between people living in different countries due to differences in diet and lifestyle. Newly developed biomarkers may be used to understand the toxicity mechanisms of heavy metals. At this symposium the discussions focused on these aspects of heavy metal toxicology. This symposium was arranged as a part of the activities of the International Commission on Occupational Health. The invited papers were published in a special issue of Environmental Sciences (4:133-212, 1996, editors, H. Tsunoda and M.-H. Yu with a guest editor, C. Tohyama).

IIASA (International Institute for Applied Systems Analysis) Day in Tsukuba

April 25, 1996
NIES, Tsukuba, Japan

An interdisciplinary meeting was held at NIES to create opportunities for national institutes in Tsukuba to collaborate with the International Institute for Applied Systems Analysis (IIASA) in Austria. Forty researchers from seven institutes in Tsukuba participated, as did five researchers from IIASA, including Vice Director, Dr. Jill Jaeger. The discussions focused on three topics, acid rain, mathematical methodology, and land use changes. The meeting came off successfully and concluded that more cooperation between IIASA and institutes in Tsukuba is necessary.

IGBP-NES (Northern Eurasia Study) Far East Transect Workshop

October 9-12, 1996
Academy of Sciences, Sakha Republic, Yakutsk, Russia

Northern Eurasia, mainly Siberia, is one of the key areas to be studied to reduce the uncertainty of future climate forcing predictions, as the feedback to the greenhouse gases emission/sink in Siberia is poorly understood. Based on the prospectus for an Integrated Global Change Research Project of the International Geosphere-Biosphere Programme (IGBP) NES, IGBP Report No. 37, research programs for a Far East Transect Study have been proposed and discussed by international groups from Japan, Russia, Germany, UK, Austria, USA, Canada, and Australia. To enhance understanding of potential research sites and to promote the participation of Russian scientists, the workshop was held in Yakutsk. The topics discussed were i) Carbon Cycle in the larch forest over permafrost, ii) Water and Energy Cycles in both boreal forest and tundra, iii) Flux and Distribution of Greenhouse Gases, and iv) Scaleup by use of Satellite Data. The existing research programs for tundra, in Tiksi or Chersky, and for boreal forest, in Yakutsk, were intensively discussed to integrate the research activities of forestry, meteorology, hydrology, atmospheric chemistry, remote sensing, and criology groups, to facilitate comprehensive understanding of the feedback processes over permafrost area.

International Symposium on Acidic Deposition and its Impacts

December 10-12, 1996
NIES, Tsukuba, Japan

Acidification of the global environment is one of the most interdisciplinary environmental problems we are facing now. The aim of this international symposium was to exchange scientific information about acidic deposition and its impacts; "Looking back to the past and thinking of the future" was one of the main themes in the symposium. This symposium was supported by the Research & Information Office, Global Environment Department, Japan Environment Agency and the Center for Global Environmental Research, National Institute for Environmental Studies. There were 165 participants from 13 countries. One of the contributions of this symposium is mutual understanding of the historical background of this problem in the East and the West. This symposium was a prelude to the 6th International Conference on Acidic Deposition in 2000, which will be held in Tsukuba.

Application of in vitro Toxicity Assays to the Assessment of Environmental Hazards –Encouraging or Hopeless?–

February 13, 1997
NIES, Tsukuba, Japan

This international workshop was organized as part of the Bilateral International Joint Research between NIES and Uppsala University on "Development of risk assessment methodologies using in vitro toxicity testing" and was supported by Special Coordination Funds for Promoting Science and Technology. Topics discussed were "Basal cytotoxicity and Multicenter Evaluation of *in vitro* Cytotoxicity (MEIC) project", "Mutagenicity testing for environmental samples", "Present status of bioassays for environmental hazards in Japan", "Future bioassays for environmental hazards", and "Control of environmental hazards".

International Symposium on Asian Network on Microbial Researches

-Physiological Potency, Toxicology, Diversity, Systematics, and Culture Collection of Microalgae-

March 23-24, 1997
Congress Hall of the Sun Lake Tsuchiura, Tsuchiura, Japan

The International Collaborative Research Project, "Asian Network on Microbial Researches (ANMR)", has been operated from 1995 using the Japanese Government's Special Coordination Funds provided by the Science and Technology Agency, Japan. NIES participate in the microalgal research area on this project together with 7 institutes and universities from Japan, the People's Republic of China, Singapore, and Thailand. This symposium was organized by NIES in cooperation with the Institute of Physical and Chemical Research (RIKEN) and the Japanese Society of Phycology (JSP). The proceedings of this symposium will be published in a special issue of Phycological Research, the International Journal of JSP.

COUNTRY
No. Title
Collaborating Institution
NIES Partner

AUSTRALIA
1. Biogeochemical studies on the trace elements in marine environments
Western Australian Marine Research Lab.
Environmental Chemistry Div.
2. Development of new methodologies to assess physiological effects of environmental pollutants
Dept. Biochemistry, Univ. Tasmania
Environmental Health Sciences Div.
3. Cooperative research on global environmental monitoring
CSIRO
Atmospheric Environment Div.

CANADA
1. Monitoring of the atmosphere-ocean carbon dioxide exchange rate
Center for Ocean Climate Chemistry, Institute of Ocean Sciences
Global Environment Div.
2. Eco-physiological studies on picophytoplankton in lakes
West Vancouver Lab.
Regional Environment Div.
3. Arctic atmosphere under polar sunrise
Atmospheric Environment Service
Environmental Chemistry Div.
4. Elucidation of the cycling and transformation of chemical substances in the North Pacific Ocean
Dept. Chemistry, Univ. British Columbia
Environmental Chemistry Div.

CHINA
1. Biogeochemical studies on the acidic deposition and pollutions in the terrestrial and aquatic ecosystems
China-Japan Friendship Environmental Protection Center
Global Environment Div.
2. Cooperative research on acid rain in East Asia
Peking Univ.
Global Environment Div.
3. Identifying groundwater pollution sources by nitrogen isotopes
Zhongshan Univ.
Regional Environment Div.
4. Investigation on toxic chemicals in China
China-Japan Friendship Environmental Protection Center
Regional Environment Div.
5. Advanced wastewater treatment processes for China
Research Institute for Environmental Engineering/Dept. Environmental Engineering, Tsinghua Univ.
Regional Environment Div.
6. Industrial wastewater treatment processes and water quality renovation technology for eutrophied lakes in China
Wuhan Environmental Protection Agency
Regional Environment Div.
7. Development of advanced on-site domestic wastewater treatment systems for China
Chinese Research Academy of Environmental Sciences
Regional Environment Div.
8. Advanced sewage treatment processes by soil system applicable to China
Institute of Applied Ecology, Chinese Academy of Sciences
Regional Environment Div.
9. Development of wastewater and water resources treatment processes applicable to China
Chinese Research Academy of Environmental Sciences
Regional Environment Div.
10. Urban atmospheric pollution in China
China-Japan Friendship Environmental Protection Center
Regional Environment Div.
11. Remote sensing of forest vegetation dynamics in southwest China
Institute of Mouton Hazards and Environment
Social Environmental Systems Div.
12. Preparation and evaluation of environmental certified referencematerials
China-Japan Friendship Environmental Protection Center
Environmental Chemistry Div.
13. Stable isotope ratios of lead and sulfur in the atmosphere in Japan and China: Sources and cross-boundary transmission of air pollutants
Institute of Geochemistry
Environmental Chemistry Div.
14. Development of monitoring method and surveillance of dry deposition
China-Japan Friendship Environmental Protection Center
Atmospheric Environment Div.
15. Cooperating study of the East China Sea monitoring and preservation of the life species diversity
Dept. International Cooperation, State Oceanic Administration/East China Sea Fisheries Research Institute
Water and Soil Environment Div.
16. China-Japan cooperative research on natural resources and environmental accounting
Development Research Center
Center for Global Environmental Research
17. International joint research project on health effects of environmental pollution and their prevention in China
Institute of Environmental Health and Engineering
Regional Environment Div.
18. Molecular epidemiological study on clarification of risk factors of the increased lung cancers in China
China Medical University
Regional Environment Div.

FINLAND
1. Accumulation of heavy metals by bryophytes in acidic environments
Dept. Botany, Helsinki Univ.
Global Environment Div.

FRANCE
1. Ozone layer observation from satellite
Lab. Physique Moleculaire et Applications, CNRS/Univ. Pierre et Marie Curie
Global Environment Div.
2. Assessment of lung injury by air pollutants
Unite de Biologie Moleculaire, Hospital Armand Trousseau
Regional Environment Div.
3. Environmental noise control
Lab. Acoustique, Univ. Maine
Social Environmental Systems Div.

GERMANY
1. Monitoring of stratospheric ozone by laser radar
HohenpeissenbergMeteologicalObservatory
Global Environment Div.
2. Observational studies of the arctic ozone layer using satellite, airborne and other sensors
Div. Climate and Atmospheric Research, BMFT
Global Environment Div.
3. Comparative study on total material flow balance between JapanandGermany
Wuppertal Institute for Climate, Environment and Energy
Regional Environment Div.
4. Evaluation method of environmental burden
Federal Environmental Agency
Social Environmental Systems Div.
5. Research on the changing composition of the atmosphere
Univ. Bayreuth
Atmospheric Environment Div.
6. Studies on eutrophication and related problems in closed water bodies
Nuclear Research Center, Karlsruhe
Water and Soil Environment Div.

ISRAEL
1. Novel applications of supersonic free jet for environmental measurement
Sch. Chemistry, Tel Aviv Univ.
Environmental Chemistry Div.

KOREA
1. Aircraft and ground-based observations of acidic and/or oxidative pollution in East Asia
Environment Research Center, Korean Institute of Science and Technology
Global Environment Div.
2. Monitoring of ocean environmental parameters from a Japan-Korea ferry boat
Korea Ocean Research and Development Institute
Global Environment Div.
3. Cooperation for monitoring organochlorine pesticides and PCB in the Japan Sea
Korea Ocean Research and Development Institute
Environmental Chemistry Div.
4. Quantification of personal ultraviolet irradiation and its health effects
Gyeong-Sang National Univ.
Environmental Health Sciences Div.
5. Development of urban scale air pollution model
National Institute of Environmental Research
Atmospheric Environment Div.

NORWAY
1. Studies on analyses of observed data of the stratospheric ozone layer
Norwegian Institute for Air Research
Global Environment Div.
2. Trophic interactions in lake and wetland ecosystems in relation to their conservation and management
Norwegian Institute for Nature Research
Environmental Biology Div.
3. Global environmental database
GRID-Arendal
Center for Global Environmental Research

RUSSIA
1. Research programs under the Baikal International Center for Ecological Research
Limnological Institute, Russian Academy of Sciences
Environmental Chemistry Div.
2. Airborne measurement of greenhouse gases over Siberia
Central Aerological Observatory
Atmospheric Environment Div.
3. Modeling of methane emission rates from natural wetlands
Institute of Microbiology
Atmospheric Environment Div.
4. Measurement of methane emission rates from permafrost areas
Permafrost Institute
Atmospheric Environment Div.
5. Fundamental studies on the conservation of river, lake and wetland ecosystems in the Far East
Institute of Biology and Pedology, Far East Branch
Environmental Biology Div.
6. Comparative studies on the structure of fresh water ecosystems in the Far East
Institute of Biology and Pedology, Far East Branch
Environmental Biology Div.
7. Assessment of the effects of hazardous chemicals on aquatic ecosystems
Irkutsk State Univ.
Environmental Biology Div.

SPAIN
1. Development of new methodologies to assess physiological effects by environmental pollutants
Dept. Cellular Biology, Autonomous Univ. Barcelona
Environmental Health Sciences Div.

SWEDEN
1. Development of risk assessment methodologies using in vitro toxicity testing
Dept. Toxicology, Uppsala Univ.
Environmental Health Sciences Div.
2. Health risk assessment of heavy metal exposure: Effects of increase in human activity
Kalolinska Institute
Environmental Health Sciences Div.

U. K.

1. Quality assurance and international harmonization of marine environmental analysis
   - Dept. Agricultural and Fisheries for Scotland, Marine Lab.
   - Regional Environment Div.
2. Solubilization of toxic heavy metals from man-made objectives by acid rain
   - Dept. Earth Science, Univ. Sheffield
   - Regional Environment Div.
3. In vivo NMR spectroscopy method and its application to the field of environmental health
   - Dept. Biochemistry, Univ. Cambridge
   - Environmental Health Sciences Div.
4. Effects of environmental pollution on the metabolism of trace elements in man
   - Rowett Research Institute
   - Environmental Health Sciences Div.
5. Studies on the maintenance mechanism of biodiversity in aquatic ecosystems
   - Sch. Biological Science., Queen Mary and Westfield Coll., Univ. London
   - Environmental Biology Div.
6. Algae and Protozoa
   - CCAP, Institute of Freshwater Ecology
   - Environmental Biology Div.

U. S. A.

1. Monitoring long-term change in biodiversity
   - Dept. Biology, Univ. New Mexico
   - Global Environment Div.
2. Preparation and evaluation of certified reference materials for marine monitoring
   - NOAA
   - Regional Environment Div.
3. Development of simulation models for health risk assessment of toxic compounds
   - Sch. Hygiene and Public Health, Johns Hopkins Univ.
   - Regional Environment Div.
4. Ecological and physiological aspects of methanotrophs
   - Dept. Microbiology, Biochemistry and Molecular Biology, Univ. Maine
   - Water and Soil Environment Div.
5. Development of bioremediation technologies for cleanup of contaminated soil
   - Center for Environmental Biotechnology, Univ. Tennessee
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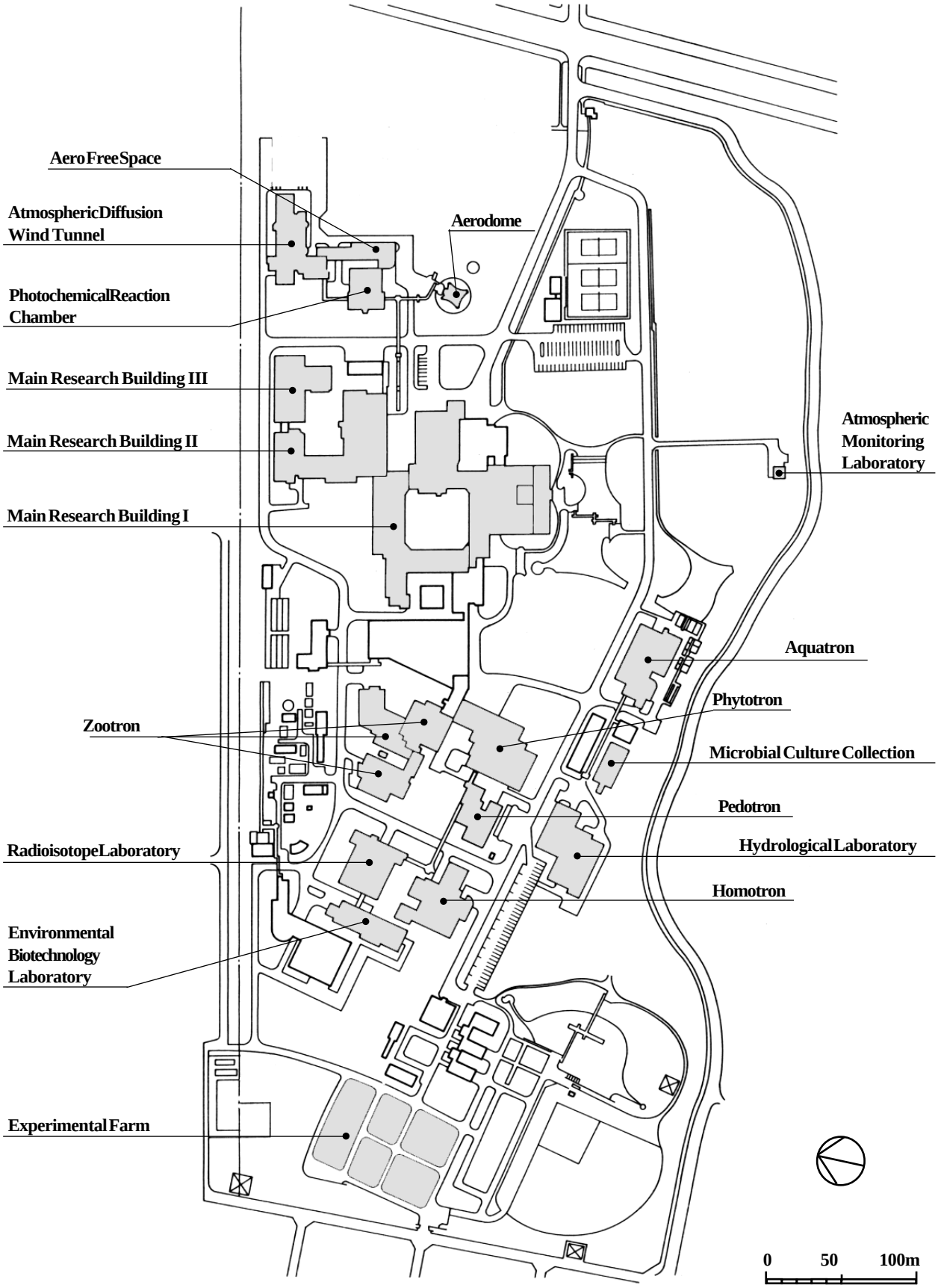
Aero Free Space
Atmospheric Diffusion Wind Tunnel
Photochemical Reaction Chamber
Main Research Building III
Main Research Building II
Main Research Building I
Zootron
Radioisotope Laboratory
Environmental Biotechnology Laboratory
Experimental Farm
Aerodome
Atmospheric Monitoring Laboratory
Aquatron
Phytotron
Microbial Culture Collection
Pedotron
Hydrological Laboratory
Homotron
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Aerodome
The aerodome is a facility both for remote monitoring of pollutant particles in the atmosphere (via a large-scale laser radar) and for study of the formation of secondary particulates from gaseous primary pollutants. The laser radar can rapidly and sensitively scan, with computer controlled pointing, both tropospheric and stratospheric aerosols at any angle above the horizon. The 4 m^3 aerosol chamber can be evacuated to 10^{-5} Torr.

Aero Free Space
The aero free space laboratory serves as the site for instrument calibrations for both lab and field experiments. It is also available for atmospheric research which can not be done in any of the other atmospheric research facilities.

The ozone laser radar is equipped with three lasers of different wavelengths and 56 and 200 cm caliber telescopes. Accurate ozone profiles up to an altitude of 45 km are being measured with this instrument.

Aquatron
This hydrobiological laboratory includes several related special facilities. The fresh water microcosm is particularly suitable for studies of the mechanisms of phytoplankton bloom formation and dynamics. The toxicity testing system is suitable for long term exposure studies. Other associated facilities include temperature controlled culture rooms, axenic culture rooms, large autoclaves and an outdoor experimental pond.

Atmospheric Diffusion Wind Tunnel
This wind tunnel is exceptional in that wind velocities (down to 0.2 m s^{-1}), air temperatures and floor temperatures can be independently controlled to create stratified flow fields. Temperature and wind velocity sensors are moved through the tunnel on a computer controlled traverse system gathering three dimensional data. These features, together with the use of models of buildings or mountains in the tunnel facilitate the accurate simulation of air flows and pollutant transport under a variety of atmospheric conditions.

Atmospheric Monitoring Laboratory
Automatic instruments to monitor the concentrations of seven atmospheric constituents (NO_x, SO_2, O_3, CO_2, non-methane hydrocarbons, suspended particulate matter and gaseous Hg) are operated in this facility. Wind speed, precipitation, atmospheric pressure, solar and UV radiation, earth surface (soil and air) temperature and other atmospheric characteristics are also measured and the results made available to NIES researchers. The stability and accuracy of the automated measurements and factors which interfere with them are studied.

Environmental Biotechnology Laboratory
The Environmental Biotechnology Laboratory develops applications of recombinant-DNA technology for environmental protection and studies the fate and effects of recombinant organisms in ecosystems. This laboratory was completed in FY 1993. The specialized instruments of this lab, including a peptide sequencer and a DNA sequencer, are used actively.

Experimental Farm
The institute's experimental farm is 4 km west of the main grounds. The farm's facilities include a cultivated field, an experimental field, lysimeters, a greenhouse, a tool storage shed, an observation tower, a remnant natural forest and offices. This farm serves to test results obtained in the indoor controlled-environment biological laboratories of the institute, to evaluate the environmental maintenance functions of plant and soil ecosystems and to supply plant material, particularly for use in bioassays or bioremediation, to researchers at the institute.

Homotron
This laboratory includes a variety of facilities to evaluate pollution effects on community health. The Noise Effects Laboratory has one anechoic room and three sound proof rooms to test the psycho-physiological effects of noise on health. The Community Health Laboratory conducts epidemiological studies on humans and experimental studies on animals to evaluate the effects of environmental pollutants.

Hydrological Laboratory
The facilities of this unit facilitate study of groundwater transport and coastal water quality. A large ocean microcosm is uniquely equipped to permit culture of marine algae and studies of CO_2 dynamics and elemental cycles.

Lake Kasumigaura Water Research Station
This field station, located on the shore of Lake Kasumigaura, is utilized as a common facility by many NIES researchers. The station's location allows *in situ* studies of pollution, water quality recovery, lake ecosystem dynamics and material cycles in this heavily eutrophied and polluted lake.

Main Research Building I
Main Research Building I houses analytical instrumentation and support facilities such as clean rooms. These instruments permit accurate, highly sensitive and selective detection of harmful substances in environmental samples. Stable isotope analysis facilitates research on global warming and the origins of pollutants. Among this building's instruments, listed below, are some which are used for research and development of new analytical methods.

Table of Analytical Instrumentation

Standard Instruments (Free Access to Institute Researchers)
Gas Chromatograph/Mass Spectrometer
Gas Chromatograph with Atomic Emission Detector
Scanning Electron Microscope
Transmission Electron Microscope
Ultraviolet-Visible Microscope Spectrophotometer
Inductively Coupled Plasma Emission Spectrometer
Atomic Absorption Spectrometer
X-ray Fluorescence Spectrometer
X-ray Photoelectron Spectrometer
Stable Isotope Mass Spectrometer (for Gas Samples)
Fourier Transform Infrared Spectrometer
Nuclear Magnetic Resonance Spectrometer
Flow Cytometer
High Speed Amino Acid Analyzer

Special Instruments (Restricted Access)
Gas Chromatograph/Mass Spectrometer
High Performance Liquid Chromatograph/Mass Spectrometer
Inductively Coupled Plasma Mass Spectrometer
Secondary Ion Mass Spectrometer
High Resolution Mass Spectrometer
High Precision Stable Isotope Mass Spectrometer (for Gas Samples)
Thermal (Surface) Ionization Mass Spectrometer (for Stable Isotopes)
Atmospheric Pressure Ionization Mass Spectrometer
Laser Raman Spectrometer
X-ray Diffractometer

Main Research Building II

1) Evaluation Laboratory of Man-Environmental Systems (ELMES) and Systems Analysis and Planning in Intelligent Environmental Information System (SAPIENS)

ELMES includes a medium size conference room which serves as a group laboratory, a multi-group laboratory for gaming simulations and minicomputer control devices for experiments, all to facilitate the experimental evaluation of human attitudes toward the environment, the environmental planning process and the effect of environmental information on these. SAPIENS is comprised of an environmental database, an image processing and display system and a minicomputer for presenting environmental information in ELMES. SAPIENS is also used to develop and study local environmental information systems.

2) Preservation Laboratory

This facility includes -20°C, 4°C and 25°C temperature-controlled rooms, a room for -100°C and -80°C freezers and a record room. Environmental specimens are stored here for long periods. Research on specimen preservation is also conducted.

3) Bay Density Flow Experiment

Density flows in a bay are investigated in this apparatus consisting of a water channel which simulates a bay and the ocean to which it is attached. A wind tunnel sits above the channel.

Main Research Building III

The third of NIES's main research buildings was completed during FY 1995 and includes advanced spectrometers, a hazardous chemicals area, satellite remote sensing equipment, an eco-office and so on.

1) Fourier-Transform Mass Spectrometer (FT-MS)

FT-MS has very high mass resolution of more than 10^6 at m/z=131 with a superconducting magnet rated at 3 Tesla. Ions are supplied to this instrument by electron impact ionization (EI) and chemical ionization (CI) and also from an external ionization chamber with an ion acceleration lens system. Cluster ions with high mass numbers, isotopes/isobars and reaction of radicals and ions can be measured with very high mass resolution.

2) Tandem Mass Spectrometer (Tandem-MS)

Two double-focus type mass spectrometers, each with a resolution of 65,000, are connected serially (in tandem). The ions selected by the first mass spectrometer are modified by electron impacts and other reactions in the interface area and the resulting ions are analyzed by the second mass spectrometer. The chemical structures of complex molecules can be analyzed with this technique.

3) Accelerator Mass Spectrometer (AMS)

An electrostatic tandem accelerator of 5,000,000 V (max.) terminal voltage is interfaced with two ion sources and an analytical mass spectrometer system. The AMS is installed and isolated in a radioactivity controlled area. Isobaric atomic ions, which have the same mass number but different atomic numbers, can be distinguished by the electric charges of their nuclei. The AMS is a very sensitive and selective method for atomic ion detection and it is used for measurements of long-lived radioisotopes such as ^{14}C and ^{36}Cl. These radioisotopes are used as tracers and time-makers (dating agents) in environmental research.

4) Hazardous Chemicals Area

Highly toxic substances, such as dioxins (chlorinated dibenzodioxins), polychlorinated biphenyls (PCBs) and poly-chlorinated dibenzofurans, are used in this area. The air pressure inside of this area is maintained below atmospheric pressure, which prevents toxic fumes from leaking out. Exhaust air is treated by high performance filters (HEPA) and charcoal filters and discharge water is also treated with a charcoal filter system. These filters and other wastes are destroyed by appropriate incineration facilities installed within this area, such as an electric oven and a plasma incinerator. The Hazardous Chemicals Area includes a gas chromatograph/mass spectrometer (GC/MS) and a microcosm, as well as facilities for microorganism related research, animal exposure experiments and measurements of the physical and chemical properties of substances.

5) Data Handling Facility for the Improved Limb Atmospheric Spectrometer (ILAS) and the Retroreflector in Space (RIS)

ILAS and RIS are satellite-borne sensors for measuring atmospheric constituents, such as ozone, which have been developed by the Environment Agency of Japan as components of the Advanced Earth Observing Satellite (ADEOS). In August 1996, ADEOS will be launched by an H-II rocket from the Tanegashima Space Center of Japan. Data obtained by ILAS/RIS will be processed, archived and distributed by NIES. The data handling facility includes a parallel processing computer system, a high speed network system and software, optimized for processing the data from these satellite sensors.

6) Millimeter-wave Spectrometer System for Observation of Atmospheric Ozone

The millimeter-wave spectrometer is widely and extensively used in the astronomical measurements of gaseous molecules in space. The ozone molecules in the stratosphere and mesosphere radiate millimeter-range radio waves. This spectrometer system was completed in October of FY 1995, and since then has continuously monitored the vertical distribution of ozone (35~75 km altitude), except on rainy or heavily overcast days.

7) Eco-Office

An office area for evaluating energy-saving/solar-energy-utilizing equipment such as wall insulation, solar cells and a solar hot water supply system. Several types of solar cells, such as single crystal, multi-crystal and amorphous types, are being compared under identical conditions. The generated hot water is used as the source for a heat pump type air conditioner as well as for hot water faucets.

8) Reception and Processing Facility for NOAA Satellite Data

The Advanced Very High Resolution Radiometer (AVHRR) orbits the earth on a National Oceanic and Atmospheric Administration (of the United States) satellite. This instrument monitors 5 electromagnetic radiation wavelength bands from the visible to the infrared region with high temporal resolution and a relatively medium spatial resolution (ca. 1×1 km). NIES's AVHRR facilities consist of 2 receiving station, one at NIES, Tsukuba and the other on Kuroshima Island, Okinawa, and a data processing center at NIES.

9) Information Processing Center for GRID-Tsukuba

GRID-Tsukuba is a part of the Center for Global Environmental Research (CGER). A GRID information processing system was introduced at NIES in 1994. This system, which consists of a remote-sensing image processing system and a geographic information system, is operated by NIES researchers to process GRID data and to produce original data sets. The workstations of this system are connected to a supercomputer, super-minicomputer and personal computers through a LAN. Several software packages, including ERDAS/IMAGINE, ARC/INFO and GRASS, are installed on these workstations. Image processing is done with IDRISI on an IBM/PC.

Microbial Culture Collection
This facility collects, characterizes, cultures and distributes strains of microorganisms. Many of the strains in the collection are important for the study of red tides and other phytoplankton blooms (including toxic algae), bioremediation, pollution bioassays and carbon cycling.

Oku-Nikko Field Monitoring Station
This field station in Oku-Nikko, Tochigi Prefecture consists of an observatory and a control building. These facilities are used to both monitor background forest pollution levels and study the effects of pollution on the forest.

Pedotron
This soil laboratory includes large lysimeters, special growth chambers for studies of pesticide and heavy metal effects and soil temperature-controlled chambers. Growth effects of pollutants and reclamation of contaminated soil are studied.

PhotochemicalReactionChamber
This 6 m^3 stainless steel chamber permits studies of atmospheric photochemistry at pressures as low as 10^{-7} Torr. This facility is essential to our research on the photochemistry of urban smog, stratospheric ozone depletion and other important atmospheric phenomena.

Phytotron
This botanical laboratory complex consists of two major facilities to evaluate the effects of various detailed environmental scenarios on plants and soils. Both facilities include experimental chambers in which light, temperature and humidity can be precisely controlled. Facility I also facilitates exposure of the experimental plants and soils to pollutant gases under these controlled conditions. Facility II's two simulators permit the creation of micro environments which are stratified from the soil up through the overlying atmosphere.

Radioisotope Laboratory
Here radioisotopes facilitate studies of the transport, accumulation, chemical conversion and toxicity of environmental pollutants in plants, animals, soil, water and the atmosphere. The use of 36 β and γ emitting isotopes is permitted but the use of α emitters is forbidden.

Zootron
This animal laboratory's facilities are subdivided into two sections. Facility I breeds conventional and specific pathogen free laboratory animals and has complex gas exposure chambers. Environmental conditions are controlled in both facilities. Facility II also has a conventional laboratory animal breeding unit and is useful for studies of the effects of heavy metals and residual chemical exposure. The Nuclear Magnetic Resonance Imager (NMR) for living organisms images living bodies and active metabolic functions of humans and animals.

Present Number of Personnel

Director General	1
Deputy Director General	1
Research Coordinators	5
General Affairs Division	41
Global Environment Division	25
Regional Environment Division	43
Social and Environmental Systems Division	15
Environmental Chemistry Division	18
Environmental Health Sciences Division	18
Atmospheric Environment Division	20
Water and Soil Environment Division	17
Environmental Biology Division	16
Environmental Information Center	19
Center for Global Environmental Research	8
Environmental Training Institute	18
Total	265

Field of Expertise

Basic Sciences	84
Engineering	47
Agricultural Sciences	20
Medical Science	16
Pharmacology	6
Fisheries Science	3
Economics	2
Total	178

Division / Section/Team	Position	Staff Member	Extension	E-mail (@nies.go.jp)
Director	Director General	ISHII, Yoshinori	2300	ishiiy
	Deputy Director General	OHI, Gen	2301	ohigen
Research Coordinators	Principal Research Coordinator	ONOGAWA, Kazunobu	2302	onogawa
	Research Coordinator	SASAOKA, Tatsuo	2303	tsasaoka
	Research Coordinator	TADAMI, Yasunobu	2304	tadami
	Research Coordinator (*)	SHIMIZU, Akira	2305	ashimizu
	Research Coordinator (*)	MOCHITATE, Katsumi	2306	mochitat
	Research Coordinator (*)	SUGIYAMA, Ken-ichiro	2307	kensugi
	International Research Coordinator	YAMAMURA, Mitsuru	2308	mitsury
General Affairs Division				
	Director	HORIUCHI, Eiju	2311	
General Affairs Section				
	Chief	TAKABATAKE, Rikkou	2312	
Accounting Section				
	Chief	ASANO, Noboru	2319	
Facility Section				
	Chief	FURUKAWA, Mitsunobu	2325	mfuru
Global Environment Division				
	Director	NISHIOKA, Shuzo	2331	snishiok
	Independent Senior Researcher	MURANO, Kentaro	2537	murano
Global Warming Mechanism Research Team				
	Leader	NOJIRI, Yukihiro	2499	nojiri
		TAKENAKA, Akio	2474	takenaka
		MUKAI, Hitoshi	2536	lnmukaih
		MACHIDA, Toshinobu	2525	tmachida
Global Warming Response Research Team				
	Leader	MORITA, Tsuneyuki	2541	t-morita
		KAINUMA, Mikiko	2422	mikiko
Ozone Layer Research Team				
	Leader	NAKANE, Hideaki	2491	nakane
		AKIYOSHI, Hideharu	2393	hakiyosi
Acid Deposition Research Team				
	Leader	SATAKE, Kenichi	2447	ksatake
Marine Environment Research Team				
	Leader	HARASHIMA, Akira	2508	harashim
		KUNUGI, Masayuki	2434	kunugi
		HARADA, Shigeki	2509	sharada
Natural Vegetation Conservation Research Team				
	Leader	OKUDA, Toshinori	2426	okuda
		TANG, Yanhong	2483	tangyh
		ADACHI, Naoki	2481	nadachi
Wildlife Conservation Research Team				
	Leader	TSUBAKI, Yoshitaka	2482	tsubaki
		TAKAMURA, Kenji	2470	takaken
		NAGATA, Hisashi	2493	hnagata
Satellite Remote Sensing Research Team				
	Leader	SASANO, Yasuhiro	2444	sasano
		SUZUKI, Makoto	2460	m-suzuki
	(*)	FURUKAWA, Akio	2519	afkawa
	(*)	INOUE, Gen	2402	inouegen
	(*)	HARASAWA, Hideo	2507	harasawa
	(*)	HATAKEYAMA, Shiro	2502	hatashir
Regional Environment Division				
	Director	MORITA, Masatoshi	2332	mmorita
	Deputy Director	KABUTO, Michinori	2333	kabuto
	Independent Senior Researcher	KASUGA, Seiichi	2425	skasuga
	Independent Senior Researcher	MATSUMOTO, Yukio	2529	y-matsu
	Independent Senior Researcher	NAKAJIMA, Koki	2346	knakajim

(*) Multiple roles

Traffic Pollution Control Research Team			
Leader	TANABE, Kiyoshi	2478	tanabe
	KONDO, Yoshinori	2441	kondos
Urban Air Quality Research Team			
Leader	WAKAMATSU, Shinji	2554	wakamatu
	UEHARA, Kiyoshi	2409	kuehara
Coastal Environment Research Team			
Leader	KOHATA, Kunio	2438	kohata
	NAKAMURA, Yasuo	2492	yasuo
Lake Conservation Research Team			
Leader (*)	MORITA, Masatoshi	2332	mmorita
	MATSUSHIGE, Kazuo	2527	matusige
	IMAI, Akio	2405	aimai
Hazardous Waste Research Team			
Leader	SHIRAISHI, Hiroaki	2455	hirosira
	HORIGUCHI, Toshihiro	2522	thorigu
Water Quality Renovation Technology Research Team			
Leader	MORIGUCHI, Yuichi	2540	moriguti
	MATSUHASHI, Keisuke	2511	matuhasi
Air Pollutants Health Effects Research Team			
Leader	SAGAI, Masaru	2443	sagai
	ICHINOSE, Takamichi	2397	ichinose
	TAKANO, Hirohisa	2466	takano
Chemical Exposure and Health Effects Research Team			
Leader	YONEMOTO, Junzo	2553	yonemoto
	TAKAGI, Hiroo	2465	takakiho
	SONE, Hideko	2464	hsone
Ecological Hazard Assessment Research Team			
Leader	HATAKEYAMA, Shigehisa	2503	hata-tox
	KASAI, Fumie	2424	kasaif
	SUGAYA, Yoshio	2458	sugaya
	GOKA, Kouichi	2480	goka
Biotechnology Products Assessment Research Team			
Leader	YAGI, Osami	2542	yagiosa
	NAKAJIMA, Nobuyoshi	2490	naka-320
	IWASAKI, Kazuhiro	2407	kiwasaki
Urban Environment and Health Research Team			
Leader	NITTA, Hiroshi	2497	nitta
	TAKAHASHI, Shinji	2467	stakahashi
	KUROKAWA, Yoshika	2437	kurokawa
	IMAI, Hideki	2404	imahide
International Health Effects Research Team			
Leader	ANDO, Mitsuru	2395	mando
	HIRANO, Seishiro	2512	seishiro
	YAMAMOTO, Shoji	2548	snyamamo
International Water Environment Renovation Research Team			
Leader	INAMORI, Yuhei	2400	inamori
	MIZUOCHI, Motoyuki	2496	mizuochi
International Ecosystem Management Research Team			
Leader	TAKAMURA, Noriko	2471	noriko-t
	FUKUSHIMA, Michio	2427	michio
International Atmospheric Environment Research Team			
Leader	UEHIRO, Takashi	2309	uehiro
	NISHIKAWA, Masataka	2495	mnishi
Social and Environmental Systems Division			
Director	GOTOH, Sukehiro	2334	sgotoh
Deputy Director	OI, Ko	2416	koimoon
Independent Senior Researcher	AOKI, Yoji	2389	yojiaoki

(*) Multiple roles

Environmental Economics Section			
Leader (*)	GOTO, Noriyuki	2592	
	AOYAGI, Midori	2392	aoyagi
	HIBIKI, Akira	2510	hibiki
	KAWASHIMA, Yasuko	2430	ykawas
Resources Management Section			
Leader	OTOMA, Suehiro	2420	otoma
	MORI, Yasuhumi	2539	mori-y
	TERAZONO, Atsushi	2506	terazono
Environmental Planning Section			
Leader	HARASAWA, Hideo	2507	harasawa
	TAKAHASHI, Kiyoshi	2543	ktakaha
Information Processing and Analysis Section			
Leader	TAMURA, Masayuki	2479	m-tamura
	SHIMIZU, Akira	2452	ashimizu
	SUGA, Shinsuke	2456	sugas
	YAMAGATA, Yoshiki	2545	yamagata
Environmental Chemistry Division			
Director	NAKASUGI, Osami	2335	nakasugi
Deputy Director	FUJII, Toshihiro	2516	t-fujii
Independent Senior Researcher	KAWAI, Takayoshi	2429	tkawai
Analytical Instrumentation and Methodology Section			
Leader	SOMA, Yuko	2463	yukosoma
	YOKOUCHI, Yoko	2549	yokouchi
	KUME, Hiroshi	2436	hkume
Analytical Quality Assurance Section			
Leader	YASUHARA, Akio	2544	yasuhara
	ITO, Hiroyasu	2398	h-ito
	YOSHINAGA, Jun	2551	junyosh
	YAMAMOTO, Takashi	2547	tyama
Environmental Chemodynamics Section			
Leader	SHIBATA, Yasuyuki	2450	yshibata
	SEYAMA, Haruhiko	2462	seyamah
	TANAKA, Atsushi	2476	tanako
	YONEDA, Minoru	2552	myoneda
Chemical Toxicology Section			
Leader	KAYA, Kunimitsu	2428	kayakuni
	SHIRAISHI, Fujio	2454	fujios
	SANO, Tomoharu	2449	sanotomo
Environmental Health Sciences Division			
Director	TOHYAMA, Chiharu	2336	ctohyama
Deputy Director	KOBAYASHI, Takahiro	2439	takakoba
Physiology and Biochemistry Section			
Leader	FUJIMAKI, Hidekazu	2518	fujimaki
	SUZUKI, Akira K.	2461	suzukiak
	MOCHITATE, Katsumi	2538	mochitat
	NOHARA, Keiko	2500	keikon
	FURUYAMA, Akiko	2521	kawagoe
Experimental Pathology and Toxicology Section			
Leader	AOKI, Yasunobu	2390	ybaoki
	MATSUMOTO, Michi	2528	michi
	ISHIDO, Masami	2396	ishidou
	SATOH, Masahiko	2448	masahiko
Biological and Health Indicators Section			
Leader	MITSUMORI, Fumiyuki	2532	mitumori
	KUNIMOTO, Manabu	2433	kunimoto
	UMEZU, Toyoshi	2415	ume
	ADACHI, Tatsumi	2546	taadachi

(*) Multiple roles

Environmental Epidemiology Section			
Leader	ONO, Masaji	2421	onomasaj
	HONDA, Yasushi	2523	yxh001
	KAGEYAMA, Takayuki	2423	kage
Atmospheric Environment Division			
Director	WASHIDA, Nobuaki	2337	wasida
Deputy Director	INOUE, Gen	2402	inouegen
Atmospheric Physics Section			
Leader	UNO, Itsushi	2414	iuno
	MITSUMOTO, Shigeki	2531	mitumoto
	TAKAYABU, Yukari	2472	yukari
	SUGATA, Seiji	2457	sugatas
	EMORI, Seita	2498	emori
Chemical Reaction Section			
Leader	IMAMURA, Takashi	2406	imamura
	SAKAMAKI, Fumio	2442	fsakamak
	INOMATA, Satoshi	2403	ino
	FURUBAYASHI, Masashi	2419	masashif
Upper-Atmospheric Environment Section			
Leader	SUGIMOTO, Nobuo	2459	nsugimot
	MATSUI, Ichiro	2526	i-matsui
	KOGA, Nobuhiko	2477	koga
Atmospheric Measurement Section			
Leader	FUKUYAMA, Tsutomu	2515	fukuyamt
	UTIYAMA, Masahiro	2411	utiyama
	TOHJIMA, Yasunori	2485	tohjima
	TAKAHASHI, Yoshiyuki	2468	yoshiyu
Water and Soil Environment Division			
Director	WATANABE, Masataka	2338	masawata
Deputy Director	OTSUBO, Kuninori	2417	kuninori
Independent Senior Researcher	TAKESHITA, Shunji	2473	stake
Water Quality Science Section			
Leader	UCHIYAMA, Hiroo	2412	huchiyam
	TOMIOKA, Noriko	2487	tomioka
	KOSHIKAWA, Hiroshi	2505	koshikaw
Water Environment Engineering Section			
Leader	MURAKAMI, Shogo	2388	murakami
	UTSUNOMIYA, Yojiro	2413	utunomiy
	INOUE, Takanobu	2401	tinoue
	NISHIMURA, Osamu	2530	osamura
	AMANO, Kunihiko	2394	amanok
Soil Science Section			
Leader	TAKAMATSU, Takejiro	2469	takamatu
	MUKAI, Satoshi	2535	
	HATTORI, Hiroyuki	2504	hhattori
	HAYASHI, Seiji	2599	shayashi
	KANAO, Masami	2440	mkanao
Geotechnical Engineering Section			
Leader	TONO, Ikuo	2484	tohno
	DOI, Taeko	2488	tdoi
	INABA, Kazuho	2399	inabakz
Environmental Biology Division			
Director	WATANABE, Makoto M.	2555	mmw
Deputy Director	FURUKAWA, Akio	2519	afkawa
Environmental Plant Science Section			
Leader	OMASA, Kenji	2418	omasa
	NATORI, Toshiki	2494	tnatori
	SHIMIZU, Hideyuki	2451	hshimizu
	TOBE, Kazuo	2486	tobe

Environmental Microbiology Section				
	Leader (*)	WATANABE, Makoto M.	2555	mmw
		HIROKI, Mikiya	2513	hiroki-m
		SATAKE, Kiyoshi	2446	satanii
Ecosystem Study Section				
	Leader	NOHARA, Seiichi	2501	snohara
		MIYASHITA, Mamoru	2534	miyasita
		UENO, Ryuhei	2408	uenor
		TADA, Mitsuru	2475	mtada
Molecular Biology Section				
	Leader (*)	FURUKAWA, Akio	2519	afkawa
		SAJI, Hikaru	2445	hsaji
		KUBO, Akihiro	2435	kub
		AONO, Mitsuko	2391	maono
Environmental Information Center				
	Director	OSHIMA, Takashi	2340	toshima
Information Management Section				
	Chief	ABE, Shigenobu	2341	sabe
Database Section				
	Chief	KANDA, Shuji	2342	skanda
Library and Research Information Section				
	Chief	SEKIMURA, Takemitsu	2343	sekimura
Center for Global Environmental Research				
	Director	YASUOKA, Yoshifumi	2345	yyasuoka
	Research Program Manager	FUJINUMA, Yasumi	2517	fujinuma
	Research Program Manager	KANZAWA, Hiroshi	2431	kanzawa
	Research Program Manager	HATAKEYAMA, Shiro	2502	hatashir
	Research Program Manager	YOKOTA, Tatsuya	2550	yoko
		ICHINOSE, Toshiaki	2598	toshiaki
	(*)	NAKAJIMA, Koki	2489	knakajim
	(*)	NOJIRI, Yukihiro	2499	nojiri
	(*)	MORITA, Tsuneyuki	2541	t-morita
	(*)	NAKANE, Hideaki	2491	nakane
	(*)	HARASHIMA, Akira	2508	harashim
	(*)	SASANO, Yasuhiro	2444	sasano
	(*)	MORIGUCHI, Yuichi	2540	moriguti
	(*)	MATSUSHIGE, Kazuo	2527	matusige
	(*)	OTOMA, Suehiro	2420	otoma
	(*)	HARASAWA, Hideo	2507	harasawa
	(*)	TAMURA, Masayuki	2479	m-tamura
	(*)	SHIBATA, Yasuyuki	2450	yshibata
	(*)	KAWAI, Takayoshi	2429	tkawai
	(*)	INOUE, Gen	2402	inouegen
	(*)	OTSUBO, Kuninori	2417	kuninori
	(*)	ABE, Shigenobu	2341	sabe
Environmental Training Institute				
	Director	GOTO, Yahiko		
	Training Program Coordinator	FUJITA, Hachiteru		
General Affairs Section				
	Chief	UEKI, Ken		
Education Affairs Section				
	Chief	MARUYAMA, Ryoji		
	Senior Professor	MAKINO, Kazuo		
	Professor	KIRITA, Kuwako		
	Professor	NAKAMURA, Yuji		
	Professor	WATANABE, Seiji		

(*) Multiple roles

ADEOS	Advanced Earth Observing Satellite
APARE	East Asia/North Pacific Regional Experiment
APN	Asia-Pacific Network for Global Change Research
APX	ascorbateperoxidase
AQC	Analytical Quality Control
AVHRR	Advanced Very High Resolution Radiometer
BAHC	Biospheric Aspects of the Hydrologic Cycle
BFC	bromofluorocarbon
BOD	biological oxygen demand
CCC	Canadian Centre for Climate
CFC	chlorofluorocarbon
CGER	Center for Global Environmental Research
COD	chemical oxygen demand
CRA	comparativeriskassessment
CRM	certified reference material
DE	dieselexhaust
DEP	diesel exhaust particles
DHF	Data Handling Facility
DO	dissolved oxygen
ECG	electrocardiogram
ECP	eosinophil cationic protein
EEG	electroencephalogram
EPO	eosinophil peroxidase
EPR	Extended Producer Responsibility
ESI	electrospray ionization
FAB	fast atom bombardment
GC	gaschromatograph(y)
GCM	atmospheric general circulation model
GEMS/Water	Global Environment Monitoring System/ Assessment of Freshwater Quality
GFDL	Geophysical Fluid Dynamics Laboratory
GHGs	greenhousegases
GIS	geographical information systems
GISS	Glddard Institute for Space Studies
GRID	Global Resource Information Database
HCFC	hydrochlorofluorocarbon
HPLC	high performance liquid chromatograph(y)
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere Biosphere Programme
IL-2	interleukin-2
IL-5	interleukin-5
ILAS	Improved Limb Atmospheric Spectrometer
IPCC	Intergovernmental Panel on Climate Change
LAN	local area network
LC	liquid mass chromatograph(y)
LCA	life cycle assessment
LCIA	life cycle impacts assessment
LUCC	Land Use/Cover Change
LUTEA	LUCC under Temperate East Asia
MBP	major basic protein
MPZ	microprotozooplankters
MRI	Meteorological Research Institute (Japan)
MS	massspectro(meter)(metry)
NIES	The National Institute for Environmental Studies
NOAA	National Oceanic and Atmospheric Administration
OA	ovalbumin
OSU	Oregon State University/Institute of Atmospheric Physics
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEACAMPOT	Perturbation by the East Asian Continental Air Mass to the Pacific Oceanic Troposphere
PM	particulate matter
RIS	Retroreflector in Space
RTPSS	Regional Traffic Pollution Simulation System
SPM	suspended particulate matter
SS	suspendedsolids
START	System for Analysis, Research, and Training
TEACOM	Temperate East Asia Planning Committee for START
TOC	total organic carbon
UIUC	University of Illinois at Urbana-Champaign
UKmet	United Kingdom Meteorological Office
UNEP	United Nations Environment Programme
UVR	ultraviolet radiation
VOC	volatile organic compound
WHO	World Health Organization
WWW	World-Wide Web
XPS	X-ray photoelectron spectroscopy

Keyword List

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