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NIES Annual Report 2000

National Institute for Environmental Studies

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Foreword

It gives me great pleasure to present the year 2000 issue of our annual report in commemoration with the 25th Anniversary of the National Institute for Environmental Studies (NIES).

The progress made by NIES since its inception is punctuated by efforts to respond to societal concerns over ever-proliferating environmental problems. One such salient move was the re-organization and expansion of the Institute in 1990 to profess its further commitment in global environmental issues:global climate changes, universal pollution with organochlonine chemicals, maintaining the integrity of the eco-system and biodiversity, etc.

In April 2001, NIES will restart as an independent administrative institute in accordance with the on-going governmental reform. There are several tasks NIES must grapple with: First, NIES will continue to maintain a close partnership with the Environment Agency (EA) which will be promoted to the Ministry of Environment (ME), so that it will function not only as a research institute generating high quality outcomes but also as a foundation capable of providing EA with sound scientific basis in formulating effective environmental policies.

Second, maintaining a safe environment is one of the basic social services the country must ensure for its people. As a scientific partner of ME shouldering this burden, NIES is not at liberty to engage in economic enterprise in competition with private industries in the market; scientific findings and data obtained at NIES are expected to be impartial, and open to the public. This aspect is particularly important in the research of controversial issues like air pollution and endocrine disruptors.

Third, in view of the fact that the size of this earth keeps shrinking at an alarming rate relative to human activities, and shortage of natural resources is bound to become more acute in the 21st century, transnational cooperation in environmental research is imperative and should be effectively conducted. NIES is in a unique position to represent Japan assuming this intergovernmental responsibility.

With growing certainty, environmental research is disclosing the fact that one phenomenon takes place interrelatedly with all other phenomena. For instance, in global warming caused by anthropogenic greenhouse gases, cause-result relationship exists not in a linear fashion but pan-directionally: perpetrators are at once victims, and vice versa.This principle of interrelatedness-pratitya-samutpada in Sanskrit - was already recognized in India 2500 years ago, and stresses the fact that human beings are inextricably embedded in the web of the global ecosystem.

Our future seems to depend on how skillfully and effectively we can sustain balancing the interdependent web of the global ecosystem.

大井玄

Gen OHI, MD., D.Sci., M.P.H.
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, and Cape Ochi-ishi.

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 1999, the total number of NIES regular personnel was 267 (Table 1). In FY 1999, NIES invited 385 scientists (2 foreigners included) to carry out the research programs as occasion demanded and also 190 researchers (83 foreigners included) joined NIES's research activities. The total budget of FY 1999 was 16,584 million yen (Table 2).

Table 1
Full Number of Personnel

Research	175	65.5%
Management	45	16.9%
Env. Information Center	19	7.1%
Center for Global Env. Research	10	3.8%
Env. Training Institute	18	6.7%
Total	267	100%

(as of the end of FY1999)

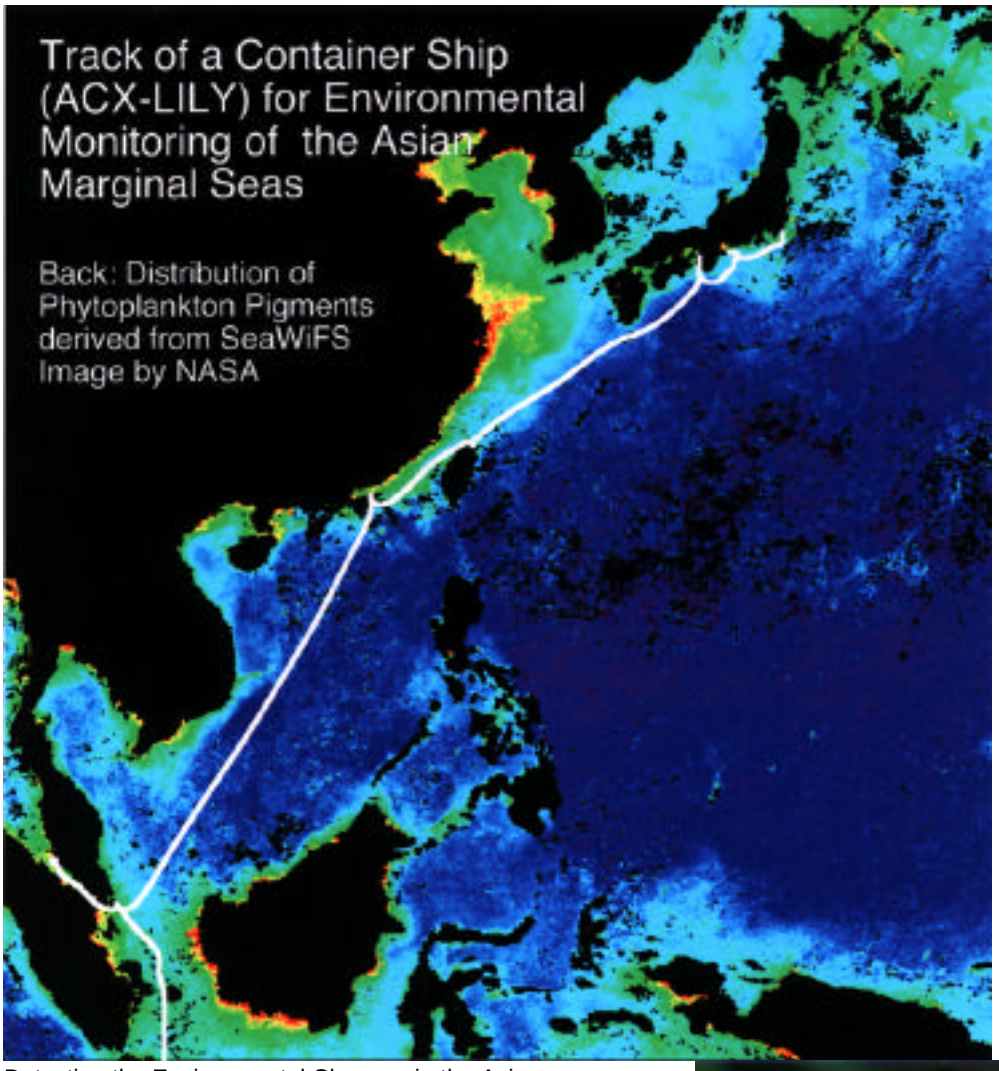
Table 2
Budget in Millions of Yen

Item	FY1997	FY1998	FY1999	
1. Primary budget				(% of total)
Personnel	2,348	2,358	2,295	(15.9%)
Research	786	913	1,034	(7.2%)
Facilities operations & maintenance	1,457	1,457	1,616	(11.2%)
Info. & related research	550	549	558	(3.9%)
Center for Global Env. Research	2,301	2,652	2,679	(18.6%)
Env. Training Institute	187	198	213	(1.5%)
Administration	358	364	388	(2.7%)
Facilities maintenance and repairs	285	8,967	5,644	(39.0%)
Total	8,272	17,458	14,427	(100%)
2. Additional resources from external research funds				
EA Research Funds	1,482	1,528	1,403	
STA Research Funds and etc.	537	773	754	
Total	2,019	2,301	2,157	

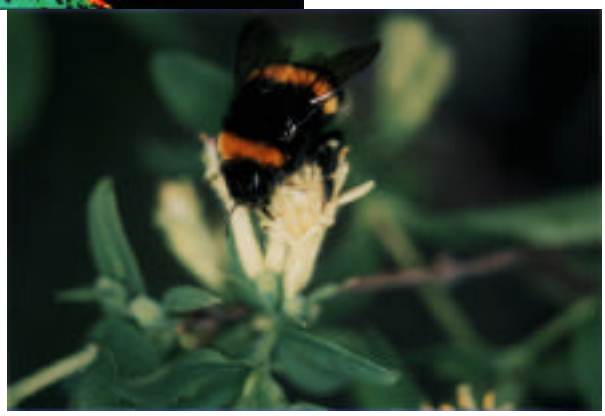
(EA=Environment Agency, STA=Science and Technology Agency)

Fig. 1
Organization of the National Institute for Environmental Studies.

Global Environment Division



Detecting the Environmental Changes in the Asian Marginal Seas by the Ship of Opportunity.



Introduced for the purpose of pollination of tomato plants in the greenhouses, the European bumblebee (Bombus terrestris) has become naturalized in Japan.

The Global Environment Research Division consists of 9 teams carrying out research projects to provide a better understanding of issues in current global environmental problems using interdisciplinary and integrated approaches. Hopefully, our research findings from technological, ecological and sociological aspects contribute to the decision-making processes of the Japanese government regarding the growing global environmental problems. The following report includes a brief introduction to the research activities of each team and detailed recent findings from three of the teams.

Global Warming Mechanism Research Team

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 concentration of atmospheric CO_2 at the two background-air monitoring stations, located at Hateruma Island in Okinawa Prefecture and at Cape Ochi-ishi in Hokkaido Prefecture, have been observed since 1993 and 1995, respectively. The rate of increase was highly variable from 1997 to 1999, which might be related with recent El Niño phenomena. 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 was started from another ship-of-opportunity sailing regularly between Canada and Japan in 1995, collecting atmosphere samples from lat 54°N to 36°N to extend the latitudinal coverage. Carbon isotopes of the collected air are analyzed at NIES. The results suggest changes in the proportions of the oceanic and terrestrial sinks of CO_2 during the period from 1997 to 1999. The results of pCO_2 measurement in surface seawater by the Japan-Canada ship-of-opportunity were analyzed to estimate the flux of CO_2 invasion and evasion in the North Pacific, combined with sea-surface wind velocity data. The mid-latitudes of the North Pacific form an important net sink area of atmospheric CO_2. A total CO_2 influx of approximately 0.24 Gt per year in the North Pacific north of 34°N was calculated based on the seasonally covered pCO_2 measurements.

Global Warming Response Research Team

This team has been developing the Asian-Pacific Integrated Model (AIM) with Kyoto University and collaborating institutes in China, India, Korea and Indonesia. The model is used for assessing policy options toward stabilizing the global climate, particularly in the Asia-Pacific region, with the objectives of reducing greenhouse gas emissions and preventing impact from climate change.

AIM has been used to estimate the economic impact of the Kyoto protocol and the emission reduction potential in Japan and collaborating countries. Technology and financial instruments are urgently required in Asian countries to improve energy efficiency and reduce greenhouse gas emissions. The model has also been applied to development of long-range emission scenarios. Together with potential for greenhouse gas emission reduction, adaptation strategies to climate change have been considered, based on both near-term and long-term benefits.

The research program has made major contributions to policy deliberations at the

national, regional and global levels. AIM has been used to provide global and regional emission scenarios and regional impact assessments for the Intergovernmental Panel on Climate Change. It has also been evaluated at the Stanford Energy Modeling Forum for 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 of UNEP, the UN Global Modeling Forum, and the Asian-Pacific Network Program.

Ozone Layer Research Team

The polar vortex is believed to play a key role in ozone depletion in the polar stratosphere. Low ozone values have frequently been observed in the Arctic stratosphere during the 1990s, which would be related to enhanced Arctic polar vortex activity. To determine trends and year-to-year variation in Arctic polar vortex attributes, Ertel's potential vorticity (PV) from 1958 to 1997 was calculated using National Centers for Environmental Prediction(NCEP) reanalysis data. The strength, size, stability and duration of the vortex could be defined using the equivalent latitude and averaged normalized PV gradient. From these analyses, we found that the Arctic polar vortex strengthened, expanded, and became more stable and long-lived during the study period.

In winter/spring in 1996 and 1997, a series of measurements using ozone sondes was made at the Moshiri Observatory in Hokkaido. During these measurements, low ozone values were observed in April, e.g. on 23 April 1996. To estimate the chemical loss of ozone in the air parcel arriving at Moshiri, an observation made over the Sapporo station on 13 April 1972 was used as a reference because the meteorological conditions, such as the vertical temperature and ozone profiles and the potential vorticity maps on the two days were similar. The backward trajectories both from Moshiri (23 April 1996) and from Sapporo (13 April 1972) returned to the inside of the Arctic polar vortex. Simulation with a photochemical multi-trajectory-box model showed that an increase in chlorine loading was the main factor in the ozone reduction at Mashiri. This result also suggested that the lower temperature inside the polar vortex was also important to explain the observed low ozone levels.

Heterogeneous reactions of acetone and formic acid in sulfuric acid solutions were investigated to assess their budgets and roles as HO_x and NO_x sources in the lower stratosphere and upper troposphere. The uptake of these carbonyls into sulfuric acid solutions was found to be reversible and their Henry's-law solubility constants were obtained as a function of temperature and acid content. The observed Henry's-law constant would unlikely be high enough to remove acetone efficiently from the gas phase; in addition, the reaction probability due to a sulfate-mediated condensation was found to be too low. The probability of acetone uptake into the acid solution was such that the reaction would not be fast enough to compete with photochemical loss in the gas phase.

We have developed 3-D chemical models in order to study 3-D fields and variations in chemical species. One of them is the CCSR/NIES nudging Chemical Transport Model that assimilates temperature and wind velocity data into the calculated fields

in the model by using the nudging method. A general circulation model including chemical reactions of sulfur has also been developed to study the effects of volcanic sulfuric acid aerosols on the ozone layer.

Acid Deposition Research Team

Acid deposition study topics range widely from the emission of acid pollutants, their flow and diffusion reactions, to impact on forest and inland aquatic ecosystems. In each field following results were obtained: 1) The dry deposition velocity of ozone onto a red pine forest in Oshiba-Kogen from 8 to 12 August was found to be abnormally high. The correlation between deposition velocity and sulfate aerosol concentration suggested that the anomaly was due to the reaction of ozone with terpenes. 2) A pilot machine for electrostatic dry coal cleaning was set up in a coal-mining factory in Nantong, China. Reduction of indoor SO_2 by use of bio-briquettes was investigated in Chongqing. The indoor concentration of SO_2 decreased to a level of one half to one third that when using regular raw coal. 3) Low-molecular-weight organic acids and inorganic anions in soil sample extracts were measured by Ion Chromatography (IC) with conductometric detection, by IC with indirect spectophotometric detection, and by the fluoride ion-selective electrode method. Oxalic acid, and fluoride and sulfate ions, which form stable complexes with aluminum, were found in the soil sample extracts. These ions can become ligands comprising 10 to 40% of the total complexed aluminum in the samples.

Satellite Remote Sensing Research Team

The Satellite Remote Sensing Research Team has been taking a leading role in promoting the Improved Limb Atmospheric Spectrometer (ILAS) and ILAS-II projects for monitoring the stratospheric ozone layer from space. The ILAS instrument on board the Advanced Earth Observing Satellite (ADEOS) spacecraft was in operation from November 1996 to June 1997, when ADEOS lost its functions due to solar battery failure. ILAS worked normally during its operation, and gathered good-quality data for 8 months in both the Northern and the Southern Hemispheres. The successor of ILAS, ILAS-II will be launched in 2002, and will have improved capabilities for characterizing the chemistry of the stratospheric ozone layer and polar stratospheric clouds (PSCs).

The Team developed and has been modifying the ILAS data-processing software. The revised software reflects the results of algorithm studies and instrument function evaluation conducted from 1996 through 2000. The ILAS data were processed to provide profiles of ozone and other minor gas species in the high-latitude stratosphere. Significant ozone depletion was found in 1997 in the Arctic high-latitude region based on ILAS measurements using a trajectory analysis technique. Also, PSCs were identified from ILAS data. This suggests that the ozone destruction mechanism that causes the Antarctic ozone hole is taking place in the Arctic as well.

The Team is also taking the leadership in preparing an algorithm for ILAS-II data retrieval at the ILAS-II Data Handling Facility (ILAS-II DHF). Many lessons learned during ILAS data processing are useful in this procedure. Also, we started studies on data retrieval from the Solar-Occultation Fourier transform spectrometer (FTS) for Inclined-orbit Satellite (SOFIS), which is a next-generation satellite sensor developed

by the Environment Agency of Japan. Since SOFIS will introduce a FTS instead of grating spectrometers that were used for ILAS and ILAS-II, we need to develop a new algorithm for SOFIS data retrieval. SOFIS is scheduled to be launched in 2006.

Marine Environment Research Team

Marine environments have been affected globally by human impact, which causes multiple and diverse problems. Among them we are dealing with such issues as 1) the deficit of silicon relative to nitrogen or phosphorus in coastal seas and consequent change in marine ecosystems caused by the alteration to land-based discharge of these elements, 2) pollution of seawater by hazardous chemicals, and 3) deterioration of coral reefs. These problems are becoming significant in Asian marginal seas. In order to assess 1) and 2), we are developing an integrated monitoring method using ships-of-opportunity, i.e., a container ship sailing between Japan and Southeast Asian countries to cover the Asian marginal seas, and a ferry in the Seto Inland Sea to obtain high temporal/spatial resolution of the change in biogeochemical parameters. To detect 3), we are making a long-term archive of underwater stereo images of coral reefs to record and analyze growth, deterioration (by processes such as by bleaching), and conservation of the biodiversity of the coral reef ecosystem.

Natural Vegetation Conservation Research Team

In order to clarify the ecological services of tropical rainforests, this team has studied 1) carbon sequestration potential of old-growth forests, 2) the mechanisms that maintain biodiversity in lowland rainforests, and 3) the socioeconomic value of tropical rainforests in Peninsular Malaysia. For the estimation of carbon sequestration and release from the forest, we employed a compartment model, which quantifies carbon fluxes. We reviewed the previous research conducted on lowland rainforests, which showed that for completion of the carbon flow model, further studies are needed on soil respiration, root growth and biomass, and decomposition processes. As a first step, we began a field experiment to estimate the rates of input of coarse and fine litter materials to the forest floor and of their decomposition. Soil respiration rate, measured under the canopy gaps and closed understory with a portable soil respiration system, showed great variability in both areas. The daily changes in soil respiration were greater in the gaps than in the closed understory. Similar studies will be conducted next year in logged-over and regenerating forest, as well as in an agricultural landscape.

In order to deepen our knowledge on the role of old-growth rainforest in maintaining high species diversity, the canopy structure and its dynamics in a primary forest and a regenerating forest that was logged in late 1950s, were compared. Canopy surface structure was much more complicated in the primary forest than in the regenerating forest, while the gap formation process was predicted to be delayed in the regenerating forest. Spatial and chronological heterogeneity of microenvironments on the forest floor were studied in the canopy gap and closed understory. The results will be used to explore whether niche separation among tree species is prevalent in tropical rainforests. In addition, in order to evaluate the effect of density of productive trees on the genetic diversity of conspecific juveniles, we studied the gene flow of a canopy-forming tree species (*Neobalanocarpus heimii*) in a lowland dipterocarp forest. For the evaluation of socioeconomic value of tropical forests, a pilot survey was conducted employing questionnaires regarding the best profile of land use.

Wildlife Conservation Research Team

To develop an integrated scientific background on biodiversity conservation, we have intensively collected information on the basic biology of wild animals, such as mating behavior, parasite load, habitat preference, and developmental stability. Next, we are investigating the dynamics of wild animals on a spatiotemporal scale. The habitat areas of wild animals have been reduced and fragmented by humans, a situation that threatens survival of those animals. We have devoted our efforts to revealing how wild animals inhabit fragmented habitats and investigating what steps to take to maintain and restore such threatened biodiversity. One way is to analyze the scale dependency of biodiversity. Two theoretical relationship types between local and regional species richness have been suggested. In the type-1 model (proportional-sampling model), local richness may be proportional to, but less than regional richness. In the type-2 model (ecological interaction model), local richness has an asymptote with increase in regional richness. Analysis of butterfly species richness in Japan based on grid cells of 80 km^2 showed that the type-2 relationship, which may suggest ecological interactions between species, is not sufficient to produce a marked effect on species richness. To analyze this relationship on a finer scale, we are now constructing high-quality data sets of various taxonomic groups including butterflies, dragonflies, fish, birds and mammals.

Human Dimensions Research Team

In light of the increasing importance of the human dimensions of global environmental issues, this Team started in FY1995 to reorganize the Global Environment Research Program research group whose interests were related to the International Human Dimensions of Global Environment Change Program (HDP). These interests cover 1) effects of land-use/cover change on global environmental change (Land Use for Global Environmental Conservation: LU/GEC); 2) international comparison of public perception, knowledge, behavior and communication regarding the environment; 3) human activity and its impact on the environment and socioeconomic system; and 4) quality of life and risk assessment. In June 1999, the third Open Meeting on Human Dimension Research was held at Institute for Global Environmental Strategies (IGES) in Shonan Village, Japan. Institute researchers on HDP participated in this meeting and presented their recent results. The meeting provided good opportunities for communication between researchers in this field towards future collaboration. All the research conducted in the Institute is directly or indirectly linked to the research projects initiated by the International Human Dimension Program (IHDP). In addition to the current research themes, one researcher has participated in the international science planning committee on industrial transformation (IT), which is also one of the scientific research projects of IHDP. The committee held 8 regional meetings and the research themes proposed at those meetings were finalized at the Open Scientific Meeting in the Netherlands in February 1999, and published as a science research plan.

In the 1999 fiscal year, the following 6 research projects were conducted by researchers in various fields and the results presented at the Shonan meeting.

1) International comparison of public perception, knowledge, behavior and communication regarding the environment (FY1997-99)

2) A study on risk perception and behavior in relation to developmental level and quality of life in Asia-Pacific countries (FY1997-99)

3) A study of the process and impact of land-use change in China (FY1998-2000)
4) Development and application of methodology to assess environmental security in the Asian region (FY1999-2001)
5) A preliminary study of the process of transformation towards an industrial society with least environmental burden (FY1999, feasibility study)
6) Studies on risk recognition and agreement processes on a countermeasure-making procedure concerning risk management for the global environment (FY1999-2001)

The first of the above studies has been conducted in close cooperation with international Global Omnibus Environmental Study (GOES). The second, fourth and sixth studies are closely related to the Global Environment Change and Human Security (GECHS) project, which is one of four IHDP science research projects. The third study is part of the Land Use and Cover Change (LUCC) project of the IHDP-IGBP cooperative research project, which focuses on land-use change and food issues in China. The fifth study is a part of the IT research.

Variations in atmospheric CO_2 concentration over Siberia

For a better understanding of the role of the terrestrial biosphere in the global carbon cycle, atmospheric CO_2 concentrations have been observed since July 1993 by air sampling using airplanes over 3 sites with different vegetation in Siberia. Air samples are collected at 8 different altitudes between 0.5 and 7 km over a wetland area near Surgut (lat 61°N, long 73°E) and a forest area near Novosibirsk (lat 55°N, long 83°E) and between 0.5 and 5 km over a forest area near Yakutsk (lat 62°N, long 130°E). Figure 1 shows the AN-30 airplane used for air sampling over Novosibirsk. The CO_2 concentrations of air samples collected over Siberia were analyzed in Japan using a nondispersive infrared analyzer.

The time series of CO_2 concentrations observed at 1, 2 and 5 or 5.5 km are shown in Fig. 2, together with the best-fit curves and the long-term trends. The seasonal cycles of CO_2 concentration at the respective altitudes and sites showed a maximum in late March or early April and a minimum in early or late August. The peak-to-peak amplitude of the seasonal cycle over Surgut is similar to that over Novosibirsk at 1 km and larger than that over Novosibirsk at 2 and 5.5 km. These results suggest that the wetland vegetation around Surgut is more active than the forest vegetation around Novosibirsk. Also, the weak respiration and soil oxidation in wetland vegetation could create a large seasonal amplitude in atmospheric CO_2 even if CO_2 uptake by

Fig. 1
AN-30 aircraft used for air sampling over Novosibirsk.

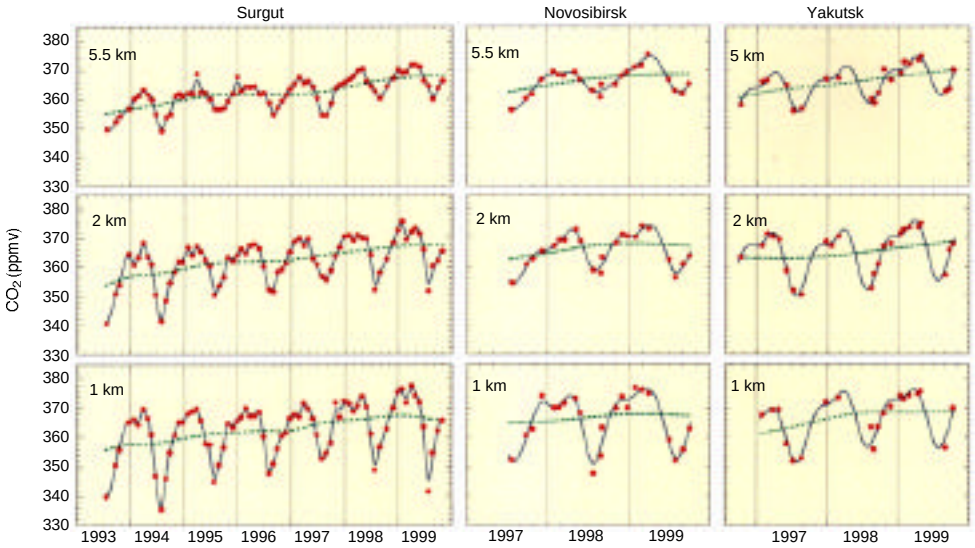


Fig. 2
Temporal CO_2 variations over Surgut, Novosibirsk and Yakutsk at 1, 2 and 5 or 5.5 km. Red circles represent observed CO_2 concentrations, solid blue lines represent the best-fit curves to the data and green dotted lines represent the long-term trends.

photosynthesis is comparable in the two land types. The seasonal amplitude over Yakutsk at 1 km is smaller than that over Surgut and Novosibirsk, because the air samples collected over Yakutsk at lower altitudes were occasionally contaminated by polluted air and did not show typical characteristics of the observed area. The larger seasonal amplitude of CO_2 concentration at 2 and 5 km over Yakutsk suggests higher biological activity of the forest around Yakutsk than around Surgut and Novosibirsk. The seasonal amplitude at 1 km over Surgut and Novosibirsk was 23.3 and 22.6 ppmv, respectively, significantly higher than values observed in coastal areas at similar latitudes. This is due to the fact that Siberia is located in inland area of the Eurasian Continent with a highly active terrestrial biomass.

Figure 3 shows the long-term trends in CO_2 concentration over Surgut, Novosibirsk and Yakutsk. Vertical differences in the long-term trends at the different altitudes are negligible or concentrations in lower altitudes were slightly lower than those in the higher altitudes. These results suggest that anthropogenic CO_2 release from the land surface is small and/or a substantial amount of CO_2 is absorbed by the terrestrial biosphere around Siberia. The long-term trend over Surgut shows increased growth rate in atmospheric CO_2 from late 1994 to early 1995 and from 1997 to 1998. Several studies have found a possible relationship between CO_2 growth rate and El-Niño and Southern Oscillation (ENSO) event. The rapid CO_2 increases over Surgut from late 1994 to early 1995 and from 1997 to 1998 were probably related to ENSO events that occurred in 1994 and 1997, respectively. From late 1994 to early 1995, a rapid CO_2 increase was observed almost simultaneously at all sampled altitudes over Surgut. This suggests that the rapid CO_2 increase occurred far from Surgut and was well

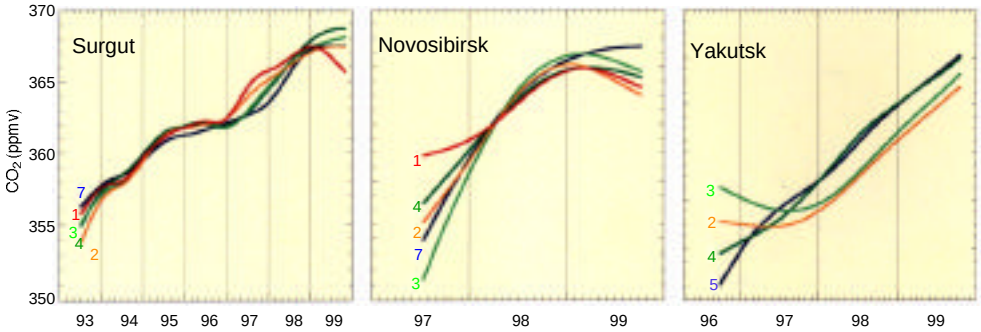


Fig. 3
Long-term trends in CO_2 concentration at different altitudes over Surgut, Novosibirsk and Yakutsk.

mixed into the air over Surgut. However, CO_2 concentrations at 1 km increased rapidly early 1997, and a similar increase was found about 2 months later at 2 km. The delay in rapid increase was longer at higher altitudes: about 5 months at 3 and 4 km and about 9 months at 7 km. This clear altitude dependence in CO_2 increase implies that the terrestrial biosphere around Surgut responded relatively rapidly to the climatic change accompanying the 1997 ENSO event compared with the response rate of other CO_2 sources and sinks around the world.

Greenhouse gas emissions and mitigation

Global climate change has become one of the key issues of the global environment and has attracted much attention both domestically and internationally in many countries, especially in the Asia-Pacific region. Obviously, the implementation of response measures to global climate change will significantly impact social and economic development. To promote such countermeasures, it is necessary to predict the amount of greenhouse gases likely to be emitted or absorbed by each country and the effects of introducing measures to mitigate emissions. In order to predict and make judgments on these issues, the Asian-Pacific Integrated Model (AIM) has been developed by an Asian collaborative project team composed of NIES and Kyoto University of Japan, and seven research Institutes of China, India, Korea and Indonesia.

AIM is a large-scale computer simulation model for scenario analyses of greenhouse gas emissions and the impact of global warming in the Asia-Pacific region. AIM consists of a greenhouse gas emission model, a climate change model and an impact model, and is used both to forecast CO_2 emissions in the Asian region and to analyze the effects of policy measures to mitigate them.

Japanese CO_2 emission forecasts and reduction potentials

Figure 4 shows Japanese CO_2 emission projections based on four different mechanisms for introducing technologies: frozen, market, carbon tax, and carbon tax plus subsidy cases. The frozen case means that the share of technologies is fixed at the 1998 level and new technologies will not be introduced into the market. In this case, CO_2 emissions would increase by 18% compared to the 1990 level by the year 2010. However, the introduction of new technologies is anticipated. The market case means that the cheapest technology will spread, based on market mechanisms. In this case, CO_2 emissions would increase by 10% by the year 2010. Even if energy-saving technologies

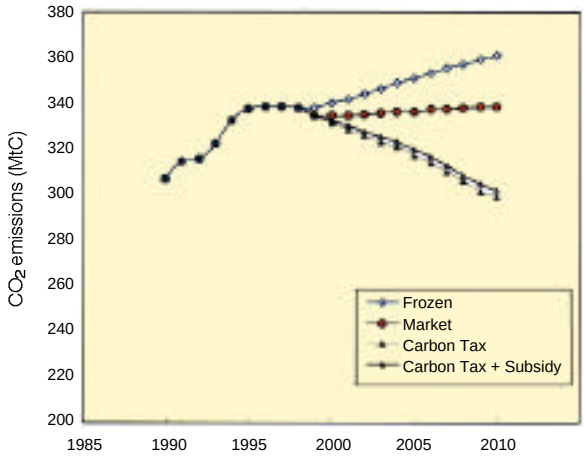


Fig. 4
CO_2 emission projections in Japan.

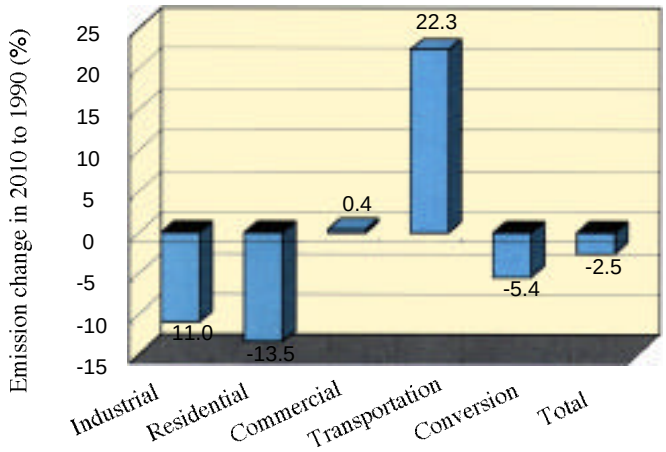


Fig. 5
Projected change in Japanese CO_2 emissions in 2010 relative to the 1990 level (carbon tax case).

are somewhat expensive, the spread of these technologies will proceed because it is possible to recover the costs through fuel savings in a short period of time. In either case, if no special countermeasures occur such as government intervention, the amount of CO_2 emissions will continue to increase. Quick action is necessary to stabilize and reduce CO_2 emissions.

The carbon tax case assumes 30,000 yen tax per ton of carbon to promote the introduction of energy-saving technologies, while the carbon tax plus subsidy case assumes 3, 000 yen tax per ton of carbon, and the tax is to be returned to companies and households in the form of subsidies for introducing energy-saving and recycling technologies. In these cases the emission would be reduced by 2.5% by 2010.

Figure 5 shows the changes in CO_2 emissions in 2010 compared to the 1990 levels. A large reduction can be expected in the industrial and residential sectors, but it is very difficult to reduce emissions in the transportation sector. To achieve the Kyoto Protocol targets, further policies are necessary, such as promoting new transportation systems, modal shift to mass transportation (car to rail, for example), and energy-saving lifestyle, and utilization of the Kyoto mechanisms.

Ways to achieve the Kyoto target

During the Kyoto conference, three mechanisms for international cooperation on global climate change issues were presented: emission trading, joint implementation, and a clean development mechanism (CDM). Effective international cooperation may help us find a way overcome global climate change problems more efficiently, economically and fairly.

Figure 6 shows marginal costs to achieve the Kyoto Protocol through 2030, domestically and by emission trading. The Japanese marginal cost in the no-trading case is $234, while the marginal costs in the Annex I trading case and the global trading case are $65 and $38 per ton of carbon, respectively in 2010. The marginal costs in the trading cases are significantly lower than in the no-trading case. Although the costs to reduce CO_2 emissions will be decreased in the trading cases, there are several problems. One problem concerns the so-called “hot-air” issue. This refers to the possibility that some Annex I countries might meet the Kyoto targets without any domestic action at all. In this case, they would be able to sell their surplus emission

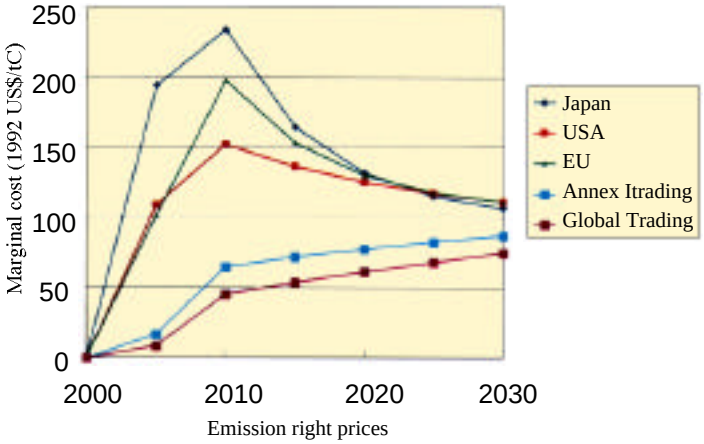


Fig. 6
Estimation of Emission-right prices.

allowance (hot air) without incurring any abatement cost. Another problem is the issue of carbon leakage in non-Annex I countries. About 8.5% leakage is observed in the no-trading case in total.

CDM is also an effective way to reduce global emissions. Figure 7 shows projections to 2025 for China of CO_2 emissions, which are expected to increase by a factor of 1.8 through 2010 from the 1996 level of 863 million tons of carbon. Figure 8 shows CO_2 emission reduction potential by introducing energy-saving technologies in China in 2010. Large reductions can be achieved if energy-saving technologies are introduced effectively.

If efforts are made to reduce CO_2 emissions even further than those mandated by the Kyoto Protocol, the necessary costs will certainly become larger. These are costs that corporations and households will have to bear. However, there will be an increase in effective demand for producers of energy-saving technologies. There is a high possibility that the indirect cost will be extremely small through energized environmental industries. Business opportunities for environmental industries will also increase as projects to reduce CO_2 emissions jointly with developing countries are implemented. Early investment in environmental industries will reduce the total cost in the long term.

Ozone layer monitoring from satellite-borne sensors ILAS and ILAS-II

The ozone hole over Antarctica has been growing, and decreases in stratospheric

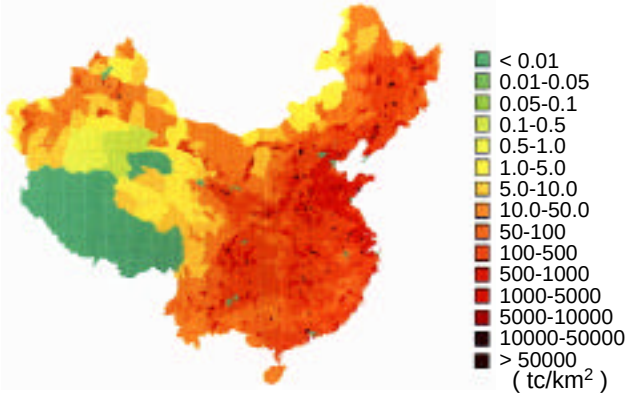


Fig. 7
Projected emission intensity of CO_2 in 2025, high growth scenario in China.

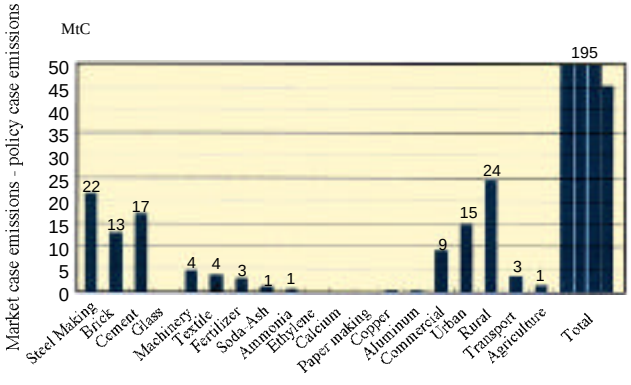


Fig. 8
CO_2 emission reduction potential in China in 2010.

ozone in the Arctic and mid-latitude regions have also been reported recently. Model calculations have predicted further ozone decreases, which will result in minimum levels in the decade beginning in 2010, roughly a decade after the maximum in stratospheric chlorine abundance. A further decrease in ozone is being caused by stratospheric cooling due to increasing concentrations of greenhouse gases. We need to continue monitoring the trend of ozone depletion in the long term and to study its chemistry and dynamics on a global scale. This can be done only by remote sensing from space.

The Environment Agency of Japan developed a satellite-borne sensor, the Improved Limb Atmospheric Spectrometer (ILAS). ILAS, onboard a Japanese satellite called the Advanced Earth Observing Satellite (ADEOS, renamed “Midori” after launch), was launched by an H-II rocket on 17 August 1996, and was successfully put on a sun-synchronous polar orbit. After the initial checkout period, ILAS functioned normally until 30 June 1997, when ADEOS lost its operation due to a solar battery failure. During its routine operation from November 1996 to June 1997, ILAS gathered more than 6700 profiles of ozone (O_3), nitric acid (HNO_3), nitrogen dioxide (NO_2), nitrous oxide (N_2O), methane (CH_4), water vapor (H_2O), aerosol extinction coefficient at 780 nm, temperature, and pressure in both northern and southern high-latitude regions.

NIES is in charge of development of the ILAS data processing computer system, and development and modification of ILAS data processing software. The revised software reflects the results of algorithm studies and instrument function evaluation conducted from the satellite launch up to the present time. Figure 9 shows vertical profiles of several gas species measured by ILAS on 1 November 1996 in the Antarctic, processed by the latest data retrieval algorithm (Version 5.00). Even compared with recent foreign satellite sensors, ILAS is unique in that it can simultaneously measure several gas components that are related to ozone chemistry, with high vertical resolution (1 km) continuously throughout winter in high latitudes.

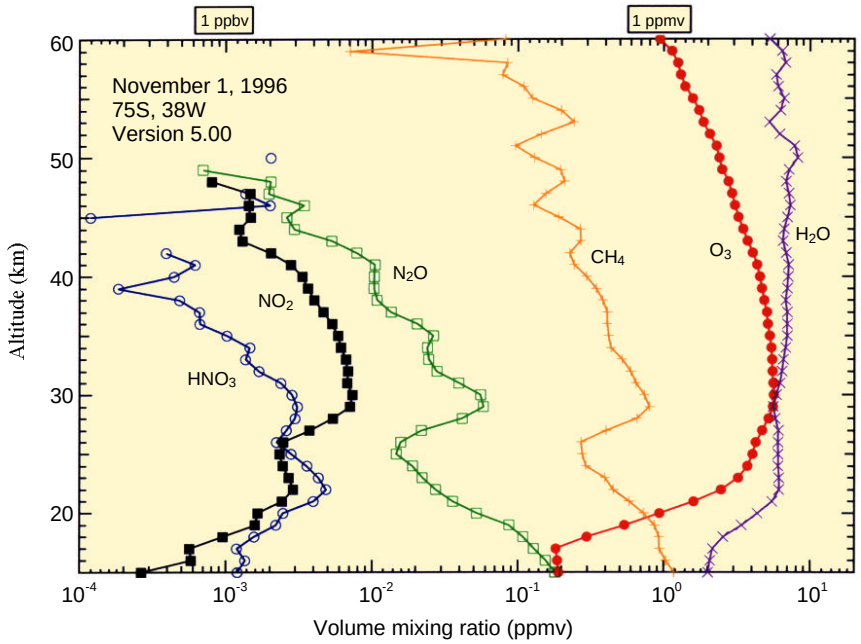


Fig. 9
An example of vertical profiles of O_3, H_2O, CH_4, N_2O, HNO_3, and NO_2 measured by ILAS on 1 November 1996 at 75°S, 38°W. These data were processed by the latest data retrieval algorithm (Ver. 5.00).

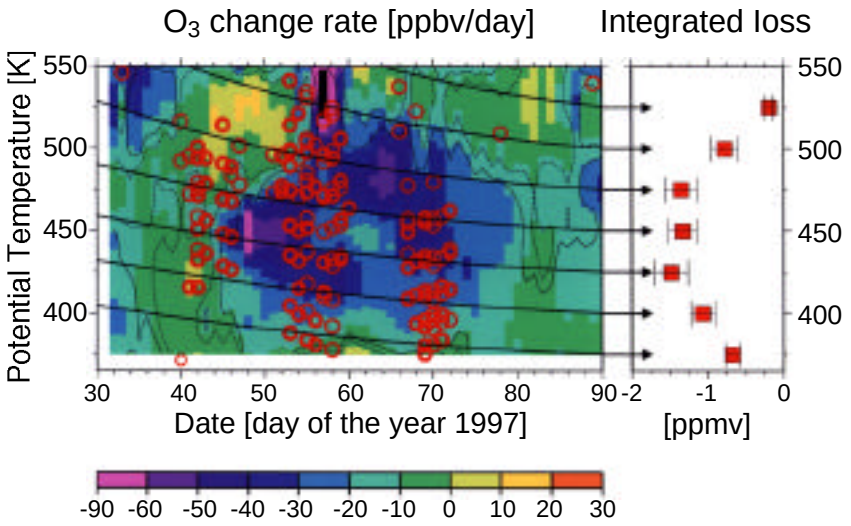


Fig. 10
(Left) Ozone change rates (in ppbv per day) as a function of potential temperature (a measure of altitude) and date. Values of 400 K and 550 K correspond to altitudes of about 15 and 21 km, respectively. Solid and dashed curves indicate statistical significance of 99% and 95%, respectively. Red circles indicate the appearance of PSCs. Smooth curves show altitude changes of air parcels due to diabatic descent. (Right) Integrated ozone loss from day-of-year 32 to day-of-year 90 along the smooth curves. For this analysis, ILAS Ver. 3.10 data were used.

The winter of 1996/97 in the northern high-latitude stratosphere was characterized by its long-lasting polar vortex and its very low temperatures in February-March. Many PSCs, which are thought to play an important role in ozone depletion in the winter/spring polar stratosphere, were detected by ILAS observations. Figure 10 (left panel) shows the ozone level change rates in February-March 1997 in the northern hemisphere in terms of volume mixing ratio per day; this was derived by comparing two or more ILAS measurements using a trajectory analysis technique and taking the effect of subsiding air by diabatic cooling into account. The appearance of PSCs, as evaluated by ILAS measurements, is indicated with red circles. Significant ozone loss rate was found on the 450-K potential temperature surface (about 18 km in altitude) in the latter half of February. This region corresponds well with that where the PSCs appeared. This fact suggests that the well-known ozone destruction mechanism that causes the Antarctic ozone hole (i.e. activation of chlorine radicals due to heterogeneous reactions on PSC surfaces leading to a chain reaction that destroys ozone in sunlit conditions) was actually taking place in the Arctic stratosphere in winter to spring in 1997. The right panel of Fig. 10 shows the integrated ozone change from day-of-year 32 (1 February) to day-of-year 90 (31 March). The maximum loss reached as much as 1.5 ppmv at around 425 K, which is about 50% of the initial (1 February) ozone concentration.

In addition to the study of winter/spring ozone depletion, ILAS data are also used for study of spring/summer dynamic features in the stratosphere. Figure 11 shows a time series of longitudinal variation in O_3, N_2O, and NO_2 at the 600-K potential temperature surface (about 23 km) from 1 April (day-of-year 91) to 29 June (day-of-year 180) 1997 in the Northern Hemisphere. Between 1 April (day-of-year 91) and 5 May (day-of-year 125), all these species showed wave-number-one structure, having their peaks either at 90° W or 90° E. This corresponds to the existence of the polar vortex, which had a center at 90 E over Siberia during this period. After the collapse of the polar vortex around 5 May (day-of-year 125), the wave-like structure, with a period of about 35 days, moved westward. Note that high NO_2 locations correspond to low O_3 and N_2O locations. It is suggested that the photochemical chain reaction including NO and NO_2 that is embedded in the planetary wave movement plays an important role in ozone destruction during summer in the lower stratosphere at high latitudes.

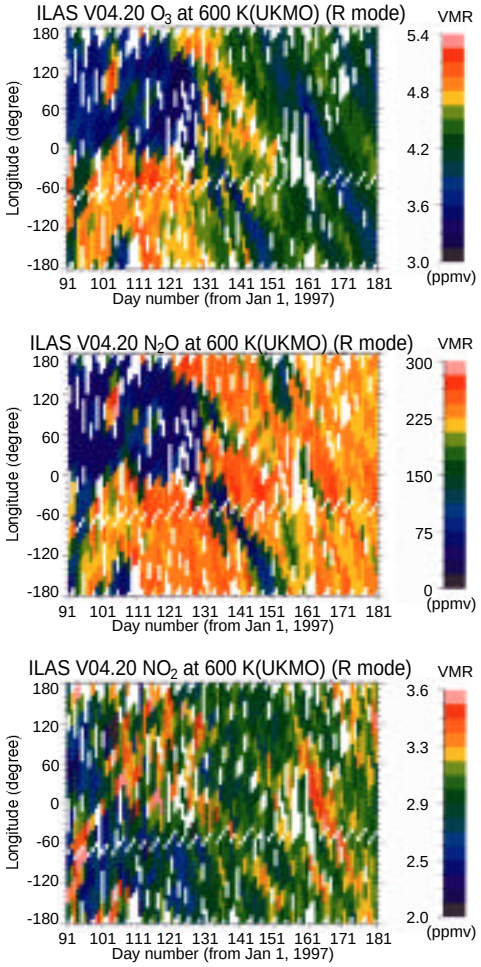


Fig. 11
Time series of longitudinal variation of O_3, N_2O, and NO_2 at 600 K potential temperature surface (about 23 km) from April 1 to June 30, 1997 in the Northern Hemisphere high latitude region. For this analysis, ILAS Ver. 4.20 data were used.

In order to continue these observations, ILAS-II is scheduled to be launched in 2002 on board the ADEOS-II spacecraft. ILAS-II is almost identical to ILAS, except that it carries two more spectrometers; one for more accurate retrieval of N_2O, CH_4, and H_2O by measuring the mid-infrared region, and the other for measurement of $ClONO_2$—which is one of the key species in ozone depletion—by a dedicated Echelle-type grating spectrometer. Also, vertical resolution and signal-to-noise ratio of the ILAS-II measurements will be improved compared with those of ILAS. We are now preparing the data processing system for ILAS-II observations with the help of many lessons that we learned from the ILAS experiences. Figure 12 shows an imaginary view of ILAS-II making a sunset observation on board the ADEOS-II spacecraft.

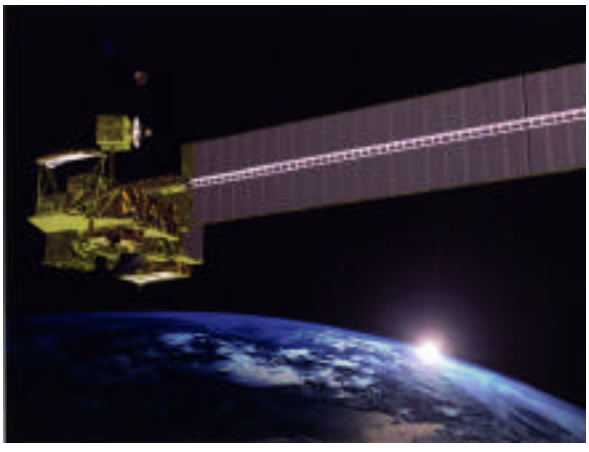


Fig. 12
An imaginary picture of ILAS-II making a sunset observation on board the ADEOS-II spacecraft.

Regional Environment Division

The Regional Environment Division is a research unit dealing with both national environmental issues and overseas environmental pollution problems. The unit is composed of 16 research teams and 3 principal research staff. Team 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, international research teams of the Division have been actively promoting the transfer of environmental technology to developing countries. Following is a summary of the current studies of the respective teams. Not all the Division's research projects are included in the present report. Research reports from the respective teams have also been published separately and are available upon request.

Traffic Pollution Control Research Team

This team mainly studies 1) methodology for environmental impact assessment of traffic systems, in particular motor vehicles; and 2) technology assessment of environmentally advanced transport systems, in particular electric vehicles.

In recent years, monitoring and regulation of some volatile organic compounds (VOCs) in air, e.g., benzene, 1,3-butadiene and formaldehyde, have been initiated as a result of their detrimental effects on health. Studies have been carried out to evaluate VOC emissions from motor vehicles and fuel distribution systems. Chassis-dynamometer studies have been reviewed in order to prepare VOC emission factors for these evaluations. A software system has been developed for the detailed assessment of traffic composition, which refers to the classification of vehicles in terms of emission regulations/factors, using existing statistics A calculafion system for VOC emissions from traffic in a 1 × 1-km grid has been desiged, which is based on a GIS, the emission factors, traffic composition and road traffic census data matched to a digital road map. Another software system has been developed for calculating fuel evaporation, i.e., vapor losses at gas stations and diurnal loss from parked vehicles, in a 1 × 1-km grid. For the calculation: 1) 20 gasoline samples were collected both in winter and summer; 2) 175 major and minor components of the gasoline samples were analyzed; 3) temperatures (monthly averages of daily lowest, highest and average) were calculated in a 1 × 1-km grid from AMeDAS data; and 4) geographical position data for more than 50,000 gas stations were prepared.

An automatic multi-VOC monitoring system using gas chromatography/mass spectrometry, developed last year, is providing large amounts of data that require careful processing, including analytical quality assurance. A software system to facilitate this quality assurance and other primary data handling has been developed to reduce the load in monitoring. Data handling time for 1-week's monitoring, which previously required more than a week, has been reduced to about 2 days by the system.

Studies on electric vehicles and future transportation systems have been carried out as part of a project entitled “Studies on Alternatives of Urban Transportation Systems”. Performance and energy consumption of the compact electric vehicle “Luciole”, developed in 1996, have been evaluated on the test course using an on-board monitoring system developed last year. Accurate information on car use, such as detailed patterns

of driving and trips, is indispensable to design/discuss an efficient and acceptable alternative to the present transportation system. The information is also important for improving the accuracy of emission estimations by providing realistic test patterns for emission-factor measurement. A different on-board car-use monitoring system based on GPS technology has been investigated to collect such information.

For the selection of future transportation systems in urban areas, various possible technologies have been evaluated from the viewpoint of life-cycle assessment. Desirable urban structure/planning to reduce vehicle emissions has been studied through comparison of energy consumption in different urban areas, which has been estimated from person-trip statistics.

Urban Air Quality Research Team

The major objectives of this research team are to investigate the mechanisms of urban air pollution formation in order 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. The team's program for FY 1998 to 2000 comprises 5 research activities, mainly focusing on characterization of sources of VOCs.

(1) An air pollution emission survey based on field measurements and inventory analysis. In FY 1999, a survey continued of VOC emissions from mobile and fixed sources based on inventory analysis, in cooperation with the Traffic Pollution Control Research Team. Using tunnel data, VOC emission factors for mobile sources were determined in the real world situation. The estimated emission factors were higher than those obtained from laboratory tests using a chassis dynamometer. The emission database for solvent VOCs was renewed. Fixed-source emissions were found to constitute approximately 72% of the total anthropogenic VOC emissions.

(2) Air pollution trend analysis related to changes in pollution loading from various sources. This analysis suggested a change over time in the mechanism of photochemical ozone formation in summer in both the Kanto and Kansai areas. Recently, regional photochemical ozone maxima have been observed outside the central Kanto and Kansai areas. This trend of spreading concentration maxima of urban oxidants might be a reflection of increasing NOx emissions and a decreasing ratio of the concentrations of VOCs and NOx, indicating an increase in ozone formation potential and a decrease in photochemical reactivity, respectively. In FY 1999, a series of 3-dimensional field observations was conducted covering the Kanto area to determine the mechanisms of air pollution formation.

(3) Wind-tunnel studies of the dynamic behavior of urban air pollution. Thermally stratified wind-tunnel studies, mainly focusing on air pollutant distribution in the street canyon, were conducted to understand the dynamic behavior of urban air pollution. A practical model for predicting air pollution concentration in different degrees of atmospheric stability and different street dimensions was established from the wind-tunnel data. The results are useful for determining the optimum sites for air pollution monitoring stations, particularly for investigating the concentrations of hazardous VOCs from automobiles. In FY 1999, we began a study to compare wind-

tunnel and computer-simulation data, in cooperation with the Japan Clean Air Program.

(4) Studies on an air pollution simulation model and its application to urban areas. Air pollution trend analysis has shown that annual average concentrations of ozone are increasing over a wide area of Japan. To learn the reason for this increase, an application study of Models-3/CMAQ (Community Multi-scale Air Quality) was continued in association with the US EPA/National Exposure Research Laboratory. In FY 1999, sensitivity analysis of VOC emissions was conducted.

Coastal Environment Research Team

The coastal zone of Japan, especially in the enclosed sea areas, is under continuous pressure from the consequences of human activities, such as eutrophication, pollution and overcrowding, as well as under potential pressure from proposed developments. Shallow areas have been reclaimed without appropriate consideration of marine ecosystems. The Coastal Environment Research Team aims to develop a precise scientific method to evaluate the vulnerability of ecosystems in 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, field surveys have been conducted in a shallow area, Sanban-se, at the head of Tokyo Bay; we have monitored water quality, phytoplankton and macro- and meiobenthos. Macrobenthic organisms were abundant in the shallow area in all seasons. Bivalves were the dominant benthos, accounting for more than 98% of the total biomass; dominant species were *Ruditapes philippinarum, Mactra quadrangularis* and *M. chinensis*. Bivalve filter feeders can remove organic matters by filtration and clear the water column in shallow areas. Growth rates of *R. philippinarum* were examined in offshore-inshore stations of Sanban-se during warm periods. Although growth rates based on shell length differed significantly among stations, differences in growth rates based on body dry weights were not apparent. This suggests that food supply does not limit the growth of the clams in the study area.
Seaweeds also make a significant contribution to water purification in shallow coastal areas by taking up nutrients from the water column. In this regard, we examined the quantitative contribution of seaweeds based on field surveys and *in situ* experiments carried out in the summer and winter seasons of FY 1999 in Matsukawa-ura, a lagoon located in northeastern Fukushima Prefecture, Japan. *Ulva pertusa* and *Zostera marina* were the dominant species during summer; *Monostroma latissimum* is cultured during winter. A tentative one-box-model calculation showed that dissolved inorganic nitrogen removal by the seaweeds in Matsukawa-ura amounted to 915 kg during the same period, or about 3% of total dissolved inorganic nitrogen removal.

In order to assess the material flux through sediments in the Seto Inland Sea, the abundance, biomass and growth of the mud-dwelling urchin *Echinocardium cordatum* were monitored around the Ie-shima Islands for 2.5 years. Ingestion rates of sediments by the urchin were also measured. Throughout the monitoring period, *E. cordatum* dominated the macrobenthic biomass, with an annual carbon production of 2 g m^{-2} yr^{-1}. This organism ingests sediments at a rate of ~1 g wet weight d^{-1}per individual. The results indicate that *E. cordatum* plays a major role in material cycling through

macrobenthic populations in the study area.

Lake Conservation Research Team

A steady increase in recalcitrant dissolved organic matter (DOM)-defined as the DOM remaining after a 100-day aerobic incubation at 20°C-has been observed in several lakes in Japan, such as Lake Biwa, and which may be a new type of water pollution in such lakes. This phenomenon is new and has not been given any previous consideration. However, the degree of accumulation of recalcitrant DOM in lake water clearly influences the way that lake environmental protection should be managed. DOM also presents a serious challenge for drinking-water management. Recalcitrant DOM could be a major precursor of trihalomethanes produced during chlorination in water treatment. Therefore, evaluation of the characteristics of DOM in lake waters is urgently needed.

A project is being carried out to develop a method by which DOM is separated into well-characterized macro-fractions, in order to examine the physico-chemical characteristics and dynamics of DOM in Lake Kasumigaura, the second largest lake in Japan; and to evaluate the effects of DOM on the growth of phytoplankton in the lake, and on lake-water quality as a drinking-water source.

The major findings in Lake Kasumigaura in FY 1999 were as follows: (1) the weight-averaged molecular weights of DOM, aquatic humic substances (AHS) and hydrophilic fractions (= hydrophilic acids + bases + neutrals) were found to be about 760, 990 and 600 g mole^{-1}, respectively (Fig. 1), which indicates that lake-water DOM is mainly composed of very small organic compounds; and (2) recalcitrant DOM excreted by bloom-forming Microcystis aerugionsa and Anabaena flos-aquae was found to contain only a negligible amount of AHS, suggesting that phytoplankton may not be significant AHS contributors in eutrophic lakes like Lake Kasumigaura.

Hazardous Waste Research Team

This team has undertaken experiments on the elution mechanism of hazardous chemical compounds from small-scale landfills using model wastes, and on development of a monitoring methodology for chemical substances and their toxicity in wastes and leachates.

Elution patterns of inorganic elements, organic phosphates and phenols from model wastes packed in glass columns were investigated. Two kinds of model wastes were prepared: one, sample waste, was the mixture of several plastics pieces (7.74 kg) and bottom ash (71.6 kg) from municipal waste incinerators and the other, control waste, was a mixture of Teflon pieces (8.06 kg) and the same bottom ash (74.3 kg). Distilled

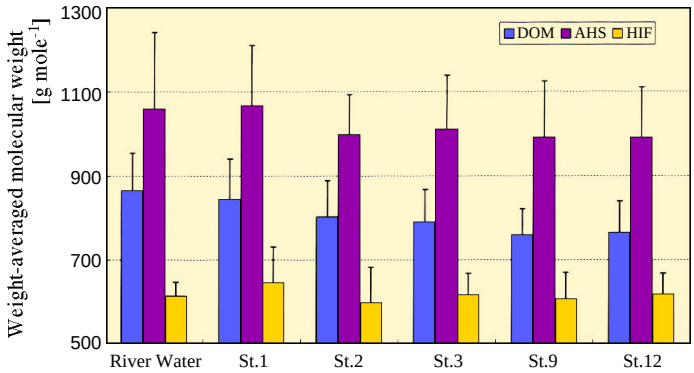


Fig. 1
Weight-averaged molecular weight of dissolved organic matter (DOM), aquatic humic substances (AHS), and hydrophilic fractions (HiF) of water samples from Lake Kasumigaura and its inflowing rivers. Water flows from rivers to St.1→St.2→St.3→St.9→St.12 and St.7→St.9→St.12. Error bars represent ±1 standard deviation of the mean of the measure-ments.

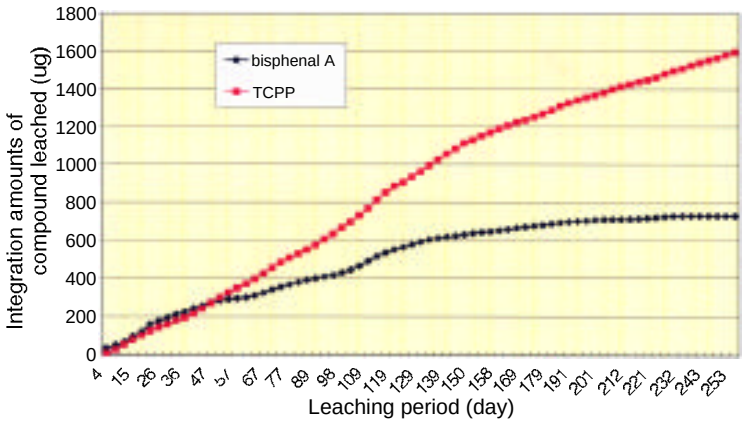


Fig. 2
Leaching pattern of bisphenol A and tris(chloropropyl) phosphate (TCPP) from model wastes in a small-scale landfill experiment.

water (1500 m*l* each time) was poured on the top of each column twice every week for a year and the leachates were analyzed by inductively coupled plasma-emission spectroscopy, ion chromatography, gas chromatography/mass spectrometry, etc. A clear difference was observed in pH value between leachates from sample waste and from control waste, 10 to 9 and ca. 11.5, respectively. The difference was due to the presence of additives in the plastics, which decreased the high pH value of the alkaline bottom ash by hydrolysis. Organic phosphates leached out over a long period at a constant elution rate, while phenols were eluted for around 250 days during which the elution rate decreased gradually as shown in Figure 2. Only 1.4% of tris (2-chloroethyl) phosphate, 4.6% of tris (chloropropyl) phosphate, 0.8% of tris (2-butoxyethyl) phosphate, and 1.5% of bisphenol A, which were contained in plastics, were eluted into leachates for a period of a year.

Boron concentrations in leachates from 48 landfills for industrial wastes were determined by inductively coupled plasma-mass spectrometry and the origin of the boron was determined by comparing the results with statistical analyses of the contents of the landfill wastes. Also, boron concentrations in leaching tests were compared with the boron content of various kinds of wastes. The conclusions were (1) boron concentrations (median value, 0.21 mg l^{-1}) of leachates from open landfills were lower than those (median value, 1.35 mg l^{-1}) from controlled landfills; (2) boron concentration was high in leachates from landfills containing incinerator ash and mineral slag; (3) ash, mineral slag, glass, and pottery contained boron; (4) the median value of boron concentration in the leaching test, 0.09 mg l^{-1}, was significantly lower than that in actual landfill leachates; and (5) a clear correlation between boron content in wastes and amounts leaching from the wastes was not observed.

Water Quality Renovation Technology Research Team

This team previously studied the contamination of soil and groundwater with hazardous chemicals. Since FY 1996, 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”. The study worked toward the development of comprehensive environmental impact assessment methodology from the life-cycle point of view in two areas of concern: fundamental methodologies for life-cycle impact assessment (LCIA) and the application of such methodologies to case studies of transportation and waste management systems. This project terminated in FY 1998 and the results were collated and arranged during FY 1999 to compile a concluding report.

In FY 1999, the Team continued its role as an ad-hoc interdisciplinary project team to manage a new research project entitled "Development of an Integrated Information System for Assessment and Management of Various Risks Including Environmental Endocrine Disrupters". The project was launched as a part of an overall research program on environmental endocrine disrupters.

In the first year of this new 3-year project, the following studies were carried out. An integrated information system named the "virtual world" was developed, based on a geographic information system (GIS), in order to support risk assessment and risk management of various chemical substances at local and regional levels. The system consists of models for emission, fate prediction and exposure assessment, and databases for emission inventories, environmental monitoring, and observed effects on humans and ecosystems. Data collection for the system focused on emission sources of dioxins and their concentration in several media, as well as the environmental concentration of endocrine disrupting substances. Software tools were developed to support the analysis of these data in various geographical units, e.g. water basins and sewage systems. In addition, substance flow analysis was applied to plastic additives, to seek possible sources of their release to the environment by tracing the flow of the substances "from cradle to grave". Geographic analysis of demographic and epidemiological data was also conducted.

Air Pollutants Health Effects Research Team

This team has investigated the mechanism of pathogenesis of and evaluated the risk of pulmonary and cardiovascular diseases due to suspended particulate matter such as diesel exhaust particles (DEP) and diesel exhaust, especially PM 2.5 (particulate matter smaller than 2.5μm).

In FY 1999, we started a new special program on the effects of PM 2.5 especially DEP on the pulmonary and cardiovascular systems. The program has the following sub-themes: 1) electrophysiology of pulmonary and cardiovascular functioning; 2) pathology of the cardiovascular system; 3) pharmacology of toxicity and toxic dosage in the cardiovascular system; 4) biochemistry of cardiac cells and blood endothelial cells exposed to PM 2.5 in vitro; 5) immunology of tissue and cell damage; and 6) evaluation of the overall risk to human health from exposure to PM 2.5.

DEP, intravenously injected into rats, induced cardiac arrhythmia such as alveolar premature, ventricular premature and atrioventricular (AV) block electrocardiograms and a spontaneous decrease in blood pressure. There was a significant dose-dependent relationship between the control and administration groups at DEP levels higher than 50 mg kg^{-1} ml^{-1}. Pharmacological investigation showed that the dose that induced the first arrhythmia and the lethal dose in guinea pigs were 75.5 and 132.0 mg kg^{-1}, respectively. Pathological analysis showed that DEP were present in the small arteries and veins of lungs of intravenously injected guinea pigs. DEP, however, did not affect arterial endothelial cells in acute exposure in guinea pigs. The subcutaneous injection of a low dose of DEP induced abortions in C57Black mice, suggesting that DEP might contain substances that affect the reproductive system.

These results clearly suggest that DEP exposure may cause toxic effects on the pulmonary, cardiovascular and reproductive systems. More detailed research is necessary.

Chemical Exposure and Health Effects Research Team

This team is in charge of a special research project entitled "Reproductive and Developmental Effects of Hormone-like Chemicals in the Environment" that began in FY 1997. The purpose is to obtain basal data for the assessment of risk of reproductive and developmental effects from endocrine disrupting chemicals. Dioxin was selected as a model chemical for the project because its toxicity is very strong and the exposure level of the general population in Japan to dioxin is relatively high. In FY 1999, developmental effects of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) on rat offspring were investigated sequentially. Here, we describe studies on the transfer of TCDD from dam to offspring and the effects on thyroid function of rat offspring exposed to TCDD *in utero* and lactationally. Pregnant Holtzman rats were administered a single oral dose of TCDD of 200 or 800 ng kg^{-1} body weight on gestational day 15 (GD 15).

On GD 16, following a TCDD dose of 800 ng kg^{-1}, maternal serum, placenta and fetus were found to have TCDD concentrations of 221, 135 and 111 pg g^{-1} wet-weight, respectively. On GD 20, these tissues contained 145, 114 and 47.6 pg g^{-1} wet-weight of TCDD, respectively. Thus, although the fetal TCDD concentration declined from GD 16 to 20, the amount of TCDD transferred from the dam to the fetuses increased from 0.8 ng per litter to 2.0 ng per litter in the same period. At weaning, individual pups had 14.2 ng of TCDD. The present results support the earlier findings that the TCDD exposure level via the placenta was lower than that via lactation. The dose of 800 ng kg^{-1} produced a TCDD body burden of 47.6 to 111 ng kg^{-1} in the fetus on GD 16 to 20. The half-life of TCDD in the maternal liver was estimated as approximately 6 days.

Serum thyroxine (T4) levels were significantly decreased at TCDD doses of 200 and 800 ng kg^{-1} in males and at 800 ng kg^{-1} in females at post-natal day 21 (PND 21). However, T4 levels recovered to the control level at PND 49 (Fig. 3). UDP-glucuronosyltransferase-1 (UGT-1), which catalyzes T4-glucuronidation, were significantly induced by TCDD doses of 200 and 800 ng kg^{-1} at PND 21. However, such induction was not observed at PND 49. TCDD concentrations in the serum, liver and adipose tissues were highest at PND 21 and decreased markedly by PND49. It is suggested that TCDD-dependent induction of UGT-1 and subsequent enhanced biliary excretion of T4 via glucuronidation were involved in the reduction of circulating T4 at PND 21.

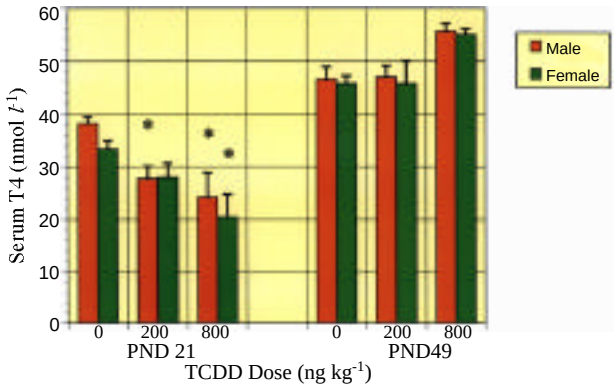


Fig. 3
Serum T4 levels of rat offspring exposed to TCDD *in utero* and lactationally.

Ecological Hazard Assessment Research Team

This team is studying effects of chemical substances on aquatic organisms and/or ecosystems. A number of long- and short-term test methods based on ecological functions were investigated for assessment of endocrine-disrupter effects on reproduction of the fish medaka (Orizias latipes). Pre-matured medaka were exposed to 0.01 and 0.1µg l^{-1} of 17-ß estradiol (E2) in semi-static conditions and after rearing to maturity for a month. Observations were made on body size, gonad weight, and the development of secondary sex characters of males, such as presence of papillae on the anal fin and increasing number of segments of the fin rays. The results showed that E2 inhibited both somatic and gonad growth in males exposed at 0.01µg l^{-1}, but the matured males were well differentiated morphologically and females had raped eggs in the ovary. At 0.1µg l^{-1} of E2, the growth of all individuals of both sexes was affected, and only one individual developed male secondary sex characters. However, half the fish examined were longer than 18 mm, a size at which secondary morphological sex characters were evident in the controls.

The mating success of adult medaka exposed to 0.1µg l^{-1} E2 was also investigated. The number of spawned eggs (per female per day) and fertilization rate were observed for 3 weeks after exposure for one week. No significant effects were observed on reproduction or mating behavior. The sensitivity to E2 of these activities seems to be not as high as that of growth and other characters in this life stage.

The effect of pollutant chemicals in river water on the hatchability of medaka eggs was investigated in the Sakura River in June 1999. A total of 300 fertilized eggs, collected a few hours after spawning, were exposed to untreated river water, river water filtered through activated carbon, and de-chlorinated tap water as a control. Eggs were placed individually in 3 ml of the water in 10-ml glass bottles, and the bottles were incubated at 25°C. The water was changed every 2 days during the observation period. The cumulative hatching rates in the control, filtered river water and untreated river water were 98, 91, and 81%, respectively, as shown in Figure 4. In this season, the Sakura River is polluted by several agricultural pesticides, mainly herbicides, that apparently caused a decrease in hatchability of medaka eggs. Activated carbon filtration reduced the concentration of the toxic substances in the river water. At the end of FY 1999, two mutant strains of medaka, d-rR and FLF, distinguishable as males and females at an early stage, were introduced to our laboratory from Nagoya University.

Biotechnology Products Assessment Research Team

This team studies the application of biotechnology to the preservation and restoration of the environment and the risks entailed. The approach is to produce genetically modified organisms useful for preservation or restoration of the environment and then to evaluate their impact.

Two strains of 1,1,1-trichloroethane-degrading bacteria, TA5 and TA27, were isolated from soil and identified as *Mycobacterium* spp. by their physiological characteristics and by 16S rRNA gene analysis. Strains TA5 and TA27 were found to utilize ethane and ethanol as their energy sources. Although neither strain could grow with TCA as the sole carbon source, both strains could degrade TCA co-metabolically in the presence of ethane. Strains TA5 and TA27 degraded more than 55% and 95%, respectively, of TCA at an initial concentration of 0.5 mg l^{-1} within 7 days, and strain

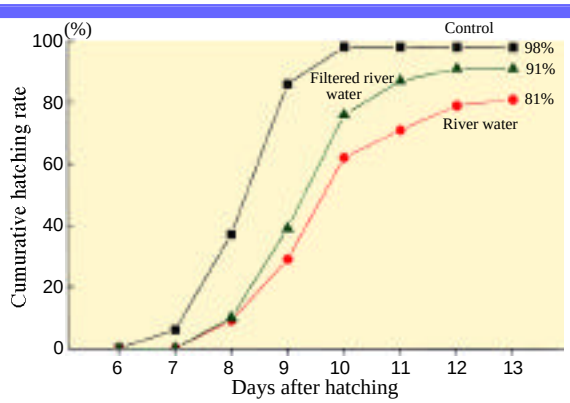


Fig. 4
Hatching rate of Medaka egg exposed to filtered river water (triangle) by activated carbon, river water (solid circle) and dechlorinated tap water as a control (square) in June, 1999.

TA27 degraded 30% of TCA at an initial concentration of 50 mg l^{-1} within 14 days. We found that pH was a very important factor in the degradation of TCA by strain TA27. The compound 2,2,2-trichloroethanol was produced as a metabolite of the degradation process. Both strains may be useful for bioremediation of TCA-contaminated sites.

A biological mercury removal system was developed for collection of volatilized elemental mercury by biological mercuric ion reduction. Using this system, removal of mercuric chloride from a mercury-containing buffer by resting cells of mercury-resistant bacteria *Pseudomonas putida* PpY101/pSR134 was tested in the absence of nutrients. Under optimal conditions of temperature, pH, thiol, and cell concentration, 92 to 98% of the initial mercuric chloride was removed. The efficiency of mercuric chloride removal from river water and seawater was as high as that observed for the buffer solution.

Ozone and sulfur dioxide are typical air pollutants. As components of acid rain and photochemical oxidants, they cause visible damage to the leaves of many plant species. It was found that the rate of ethylene production 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, activity of 1-aminocyclopropane-1-carboxylate synthase (ACS), which is the rate-limiting enzyme in the ethylene biosynthesis pathway, was induced after one hour, while visible injury was not observed until 12 hours later. After ozone exposure, the plants could be protected against damage by application of aminoethoxyvinylglycine and 2,5-norbornadiene, inhibitors of ethylene biosynthesis and ethylene action, respectively. These results suggest that ethylene acts as a hormone, triggering a cascade of reactions leading to irreversible leaf damage.

The cDNAs encoding ACS and 1-aminocyclopropane-1-carboxylate oxidase (ACO) were isolated 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.

Ascorbic acid (ASA) has an important function in decreasing active oxygen that is produced as a result of some environmental stresses. Therefore, increasing the ASA

content in plants may provide tolerance to environmental stress. Two complete cDNA clones for the ASA biosynthesis pathway have been isolated from Arabidopsis seedlings: these correspond to genes for galactono-1,4-lactone dehydrogenase (GLDH) and GDP-mannose pyrophosphorylase (GMP). Transgenic plants that over-produce GLDH or GMP cDNAs have already been generated independently. The ascorbic acid content of these transgenic plants and their tolerance to environmental stresses will be checked in the near future.

Urban Environment and Health Research Team

This team has studied the effects on human health of various urban environmental factors, such as air pollution and electromagnetic fields.

Public concern regarding possible health risks from residential exposure to low-level, extremely low-frequency electromagnetic fields (ELF-EMF) produced by power lines has been increasing in recent years. A project entitled "Health Risk Assessments of Exposure to Extremely Low-frequency Electromagnetic Fields" was carried out from FY 1997 to FY 1999.

An EMF exposure facility was built in the Homotron (Community Health and Noise Effects Laboratory). The exposure room (approximately 3 × 3 × 3 m) was designed for optimizing field uniformity of EMF, as well as for controlling room temperature and humidity. The facility has a 4-coil system that was used for each of the 3 orthogonal axes, north-south, east-west, and vertical. It provides flexibility of operation at different magnitudes of magnetic flux density, frequencies and polarization, and the capabilities for true active-sham exposure conditions using twisted-pair wires. Volunteers were exposed to EMF, and the R-R intervals (RRI) of their electrocardiograms were recorded. Within the range of 20 to 100 μT, we did not find consistent and dose-dependent trends in average RRI, coefficient of variance of RRI, or spectral powers of heart rate variance. Volunteers were also exposed to 50-Hz, 20-μT sinusoidal EMF + 3rd harmonics + 5th harmonics + transient 1-kHz, 100-μT EMF (at peak) evernight. There was no significant difference in serum melatonin or growth hormone levels between volunteers exposed to and not exposed to EMF at night.

A field survey of exposure to ELF-EMF in residences close to power lines was also conducted. The results showed that ELF-EMF levels in the bedrooms of the houses depended on the distance from power lines.,not on the usage of household appliances.

Comprehensive Risk Assessment and Bioassay Team

The main project of this team is to establish a comprehensive risk assessment system for environmental chemicals using various bioassays in combination. In particular, we have explored a novel biological index that represents the total hazards existing in the environment.

In FY1999, further comparisons were made of several simple bioassays, including cytotoxicity tests using 10 different cell lines from humans and rodents with 32 reference chemicals. In addition, simplified cytotoxicity testing methods were established and applied to the hazard assessment of environmental water and wastewater samples together with ecotoxicological testing. The results were compared with those of conventional chemical analysis. Also investigated were the molecular mechanisms by which these chemicals cause cell death, in order to establish a new biomarker for cellular damage.

Fig. 5
Interviewing residents to determine their health status, using a questionnaire.

Fig. 6
Diagnosis of respiratory functions of children, using a portable respirometer.

International Health Effects Research Team

This team has assessed the health risks associated with air pollution in Asia-Pacific countries, such as China, and will evaluate possible risk-reduction strategies. International cooperative research on assessment of exposure to both indoor and outdoor air pollution has been carried out in China. The results show elevated levels of atmospheric pollutants from combustion of fossil fuels both indoors and outdoors. Since atmospheric pollutants have potential toxicological significance, it is necessary to quantify the human health risks associated with exposure to them. In this regard, we surveyed the health status of residents, children and their mothers, using a questionnaire (Fig. 5); their respiratory functions were analyzed by respirometer (Fig. 6).

International Water Environment Renovation Research Team

The focus of this team is to protect the aquatic environment and to restore eutrophic lakes, reservoirs and rivers using systems based on bioengineering and eco-engineering. The main research activities are described here.

Wastewater treatment facilities, soils and wetland systems are now considered to be important sources of greenhouse gases, especially CH_4 and N_2O, that lead to global warming. For the development of adequate biological and ecological treatment technology for wastewater, N_2O emission control is of great and worldwide importance. We have conducted a theoretical study and undertaken technology development through field experiments. The main results are that nitrogen and

Fig. 7
The signing ceremony for undertaking joint reseach with China.

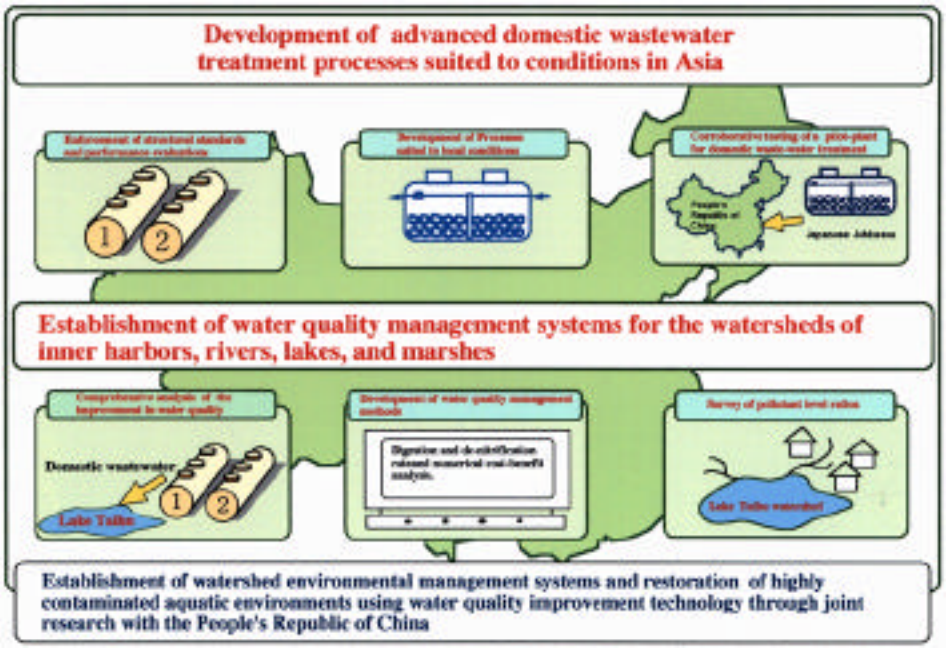


Fig. 8
Environmental restoration research of Taihu lake in China.

phosphorous removal and emission control of N_2O are possible through control of operating conditions of treatment facilities. Also, we determined the relationship between CH_4 and N_2O emission from the constructed wetland system, which is popular in developing countries.

Model aquatic ecosystems such as microcosms are being studied extensively by this team for use in evaluating the behavior and effects of chemicals, microbial pesticides and genetically-engineered microorganisms in bioengineered and eco-engineered systems. For microcosms consisting of microorganisms-bacteria as decomposers, micro-animals as predators, and algae as producers-we achieved very good reproducibility and similarity to natural ecosystems in research on material cycles, energy-flow and interactions. Based on our results, these approaches are being applied to predict the effects of chemical pollutants in natural ecosystems.

One very important joint research activity concerns restoration of the aquatic environment in developing countries such as China and Thailand (Fig. 7), where populations are increasing and industrial activities are growing. Their aquatic environments have been rapidly polluted as a result of this growth. Figure 8 shows an outline of Japan-China joint research on environmental restoration of Lake Taihu. The research includes transfer and improvement of wastewater treatment technologies, and a survey of Chinese wastewater characteristics and ratios of pollutant levels. Through this work, development through bioengineering and eco-engineering of systems such as aquatic-plant purification processes, soil treatment processes and on-site domestic wastewater treatment processes, is being promoted for aquatic environmental restoration in China.

International Ecosystem Management Research Team

The team has been investigating trophic interactions in ecosystems of some large lakes in Japan and China. In Lake Dongting, the second largest lake in China, a series of limnological surveys was conducted including hydroacoustic estimation of fish density, an inventory of fish species based on catch data, and monitoring of plankton

and water quality at several sampling stations. There have been no previous reports on the biology of this large shallow lake except for some fisheries statistics. The team has discovered new plankton species (e.g. 5 rotifers) and described many new records for other plankton species (e.g. 6 phytoplankton taxa, 13 protozoans and 34 rotifers) in Lake Dongting.

In Lake Donghu near Wuhan, long-term monitoring data on water quality, plankton, and fish were compiled in collaboration with the Institute of Hydrobiology, Chinese Academy of Science. The results of the team's subsequent research on the lake's ecosystem include: 1) fish yields, which consist exclusively of silver and bighead carp, have been increasing continuously, almost ten-fold since the early 1970s; 2) with the increase in fish biomass, the body size and shape of these fish has changed during this period; 3) the dominant groups in the phytoplankton community shifted from large colonial cyanobacteria to Cryptophyceae and Bacillariophyceae in the late 1980s; 4) the overall biomass of crustaceans has diminished substantially, and the major genera have changed from *Daphnia* to *Moina* and *Diaphanosoma*; and 5) nutrient levels in the lake are extremely high, but the concentration of chlorophyll *a* is lower than that in typical eutrophic lakes with similar nutrient levels in Japan.

Together with the findings previously made using mesocosm experiments in Lake Kasumigaura, the present findings show that considerable progress has been made in understanding the biology of shallow lakes, especially trophic interactions in such lakes.

International Atmospheric Environment Research Team

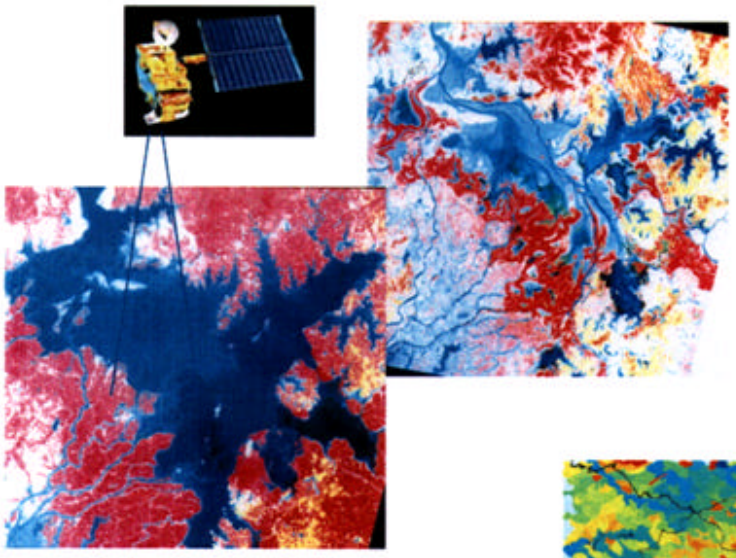
This team is investigating the origin and chemodynamics of atmospheric aerosols in China, using a chemical mass-balance method and stable-isotope ratios. Cities such as Beijing are exposed to high atmospheric concentrations of both anthropogenic aerosols and soil aerosols originating in desert/arid areas. One of the research topics is designed to increase our basic understanding of the environmental behavior of an aerosol from soil called kosa. We estimated the proportion of kosa aerosol in urban aerosols by the stable carbon isotope ratio ($\delta^{13}C$) and carbonate carbon concentration. In Beijing, the proportion of mineral aerosols (including kosa) in total aerosols was estimated at about 10 to 30% in spring and less than 10% in summer and winter. In Lanzhou and Yinchuan, the proportion of mineral aerosols was at least 10% of the total aerosol concentration in all seasons.

At Hotan on the southern edge of the Taklamakan Desert, the largest desert in China, we measured dust accumulation and its size distribution during a sandstorm. The rate of dust accumulation was estimated to be 200-300 tonnes km^{-2} at the edge of a sandstorm event observed during 23-24 April 2000; the average size of dust particles was about 60 μm and varied in the following manner: surface soil> saltation particles >fall-out dust>atmospheric aerosols.

Principal Senior Researchers

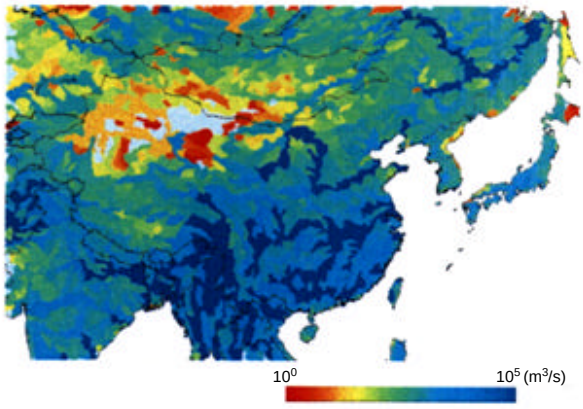
In addition to the above-mentioned 16 research teams, 3 principal senior researchers are working in specialized areas of environmental statistics, ecosystem preservation and health risk evaluation.

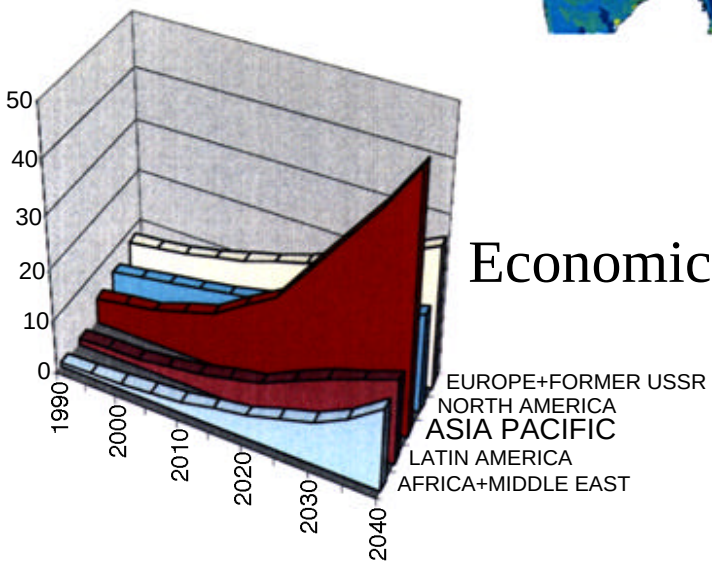
Social and Environmental Systems Division



Remote sensing

Physical modeling





Economic modeling

Environmental problems may be defined as those resulting from environmental changes that are consequences of various human activities. Whether these changes are pollution, physical degradation or ecosystem destruction, they adversely affect or threaten our daily lives, well-being and socio-economic activities. 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 is concerned primarily with present and future ways of interaction between social and environmental systems.

The Division consists of a Principal Researcher (PR) and four research units - on Environmental Economics (EE), Resources Management (RM), Environmental Planning (EP), and Information Processing and Analysis (IP), respectively. In FY1999, these sections conducted basic research on the following 9 topics.

Basic Research Topics of the Social and Environmental Systems Division

	Research Theme	Responsible Section
(1)	Fundamental Research on Perception of the Environment	(PR)
(2)	Analysis of the Impact of Environmental Policy on the Economy	(EE)
(3)	Institutions and Measures for the Development of International Coordination for Global Environmental Protection	(EE)
(4)	Analysis on the Environmental Changes Associated with Development of Water Resources	(RM)
(5)	Assessment of Environmental Loads Associated with Material Cycling and Measures for Their Reduction Towards A Sustainable Society	(RM)
(6)	Environmental Planning Modeling Considering Local Conditions	(EP)
(7)	Information Processing Systems for Geographic and Image Data	(IP)
(8)	Modeling and Simulation Methodologies for Environmental Evaluation	(IP)
(9)	Consideration of the Human Dimension in the Value of Landscape	(EP)

The first topic, which was conducted primarily by the Principal Researcher and his associate, deals with the effects of selected basic issues on people's awareness and perceptions of the environment. Based on theoretical discussion and analysis of various descriptions in free-association surveys conducted with local respondents near the Greater Seto Bridge, regional environmental recognition as well as regional policy needs were clarified.

Environmental Economics Section

The effects of a carbon tax on the macro-economy are being studied continuously under topic (2). In FY1999, using our economic model, which has been improved and expanded from 10 to 17 sectors, including different transport and service sectors, the macro-economic impact of a carbon tax was estimated with regard to use of the tax revenue. In research topic (3), focusing on the Buenos Aires Action Plan established in 1998 and the “Clean Development Mechanism” proposed in the Kyoto Protocol, the effects of climate policy options were analyzed in relation to the international negotiation process after 2000.

Resources Management Section

The impact of water resource development projects on water quality was studied under topic (4), using as an example a project on a system to distribute water from a eutrophicated resource. Changes of water quality within the system and its surroundings as well as, impact on agricultural land, and changes in the regional aqua-sphere were investigated. In addition, the use of communication tools for environmental monitoring with the participation of citizens was investigated.

Our society needs to undertake more environmentally oriented material cycling. Topic (5) deals with the development of Life-cycle Assessment (LCA) methodology for assessing options to reduce environmental burdens, focusing on improvements in energy and material flows. Case studies on beverage containers and on district heating/ cooling systems were conducted by analyzing environmental burdens resulting from their production, use, and disposal. Simplification of LCA methodology was also discussed.

Environmental Planning Section

Improvement of local environmental plans is a central theme of topic (6). Many regional and local authorities, prefectural as well as municipal, are now engaged in formulation of their own basic environmental plans in conformity with the National Basic Environment Plan. In addition, the latest national legislation on measures to prevent global warming requires intensive involvement of local authorities. In this regard, we have carefully identified and analyzed important common issues arising from the local planning process. In FY1999, an environmental management system (EMS) for local authorities was discussed in a symposium of the Academic Society of Environmental Science. An EMS that includes ISO 14001 standards, characterized by external review and performance evaluation, was identified as having the potential to improve the EMS system currently used by local authorities.

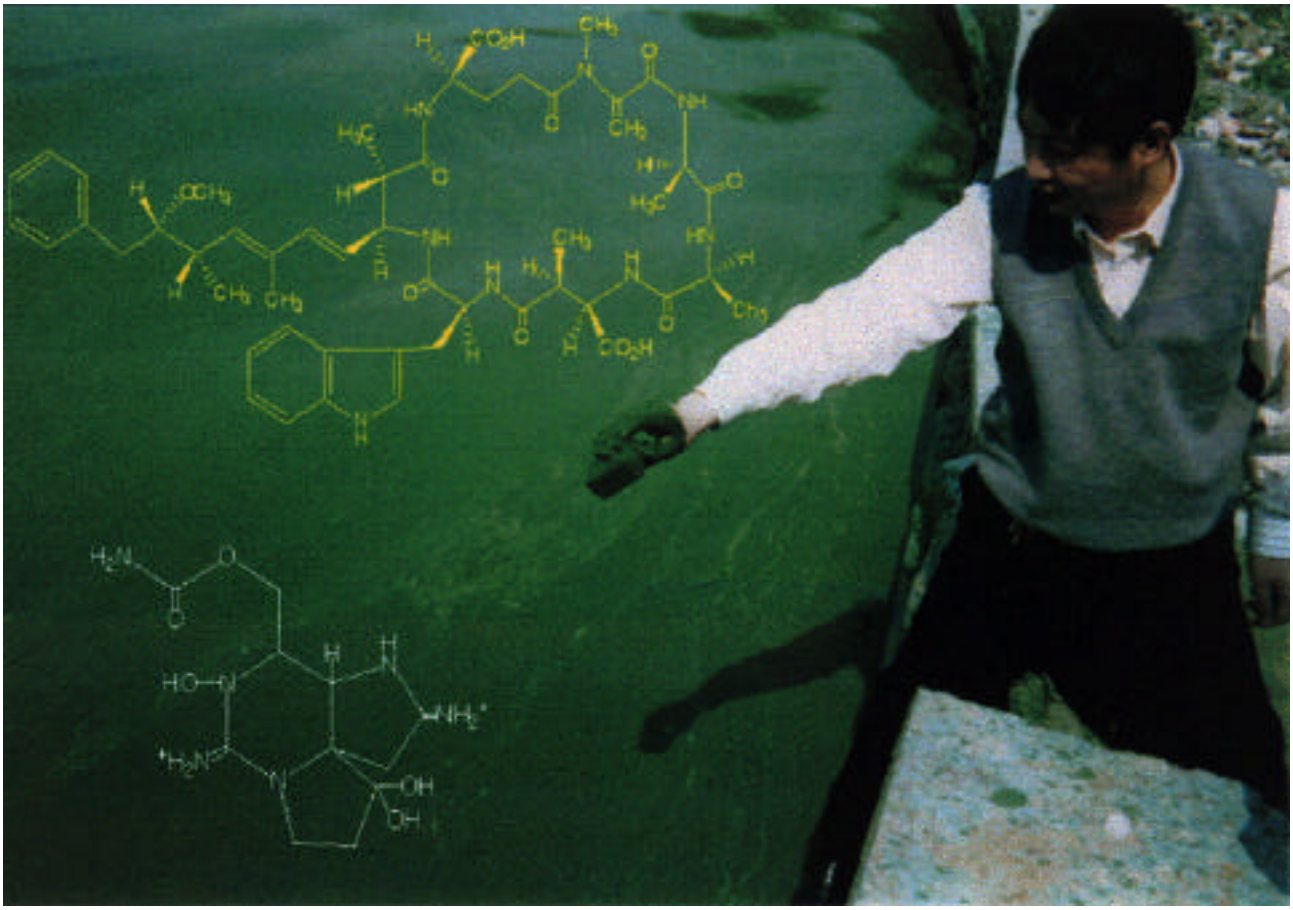
Under topic (9), landscape evaluation is the main theme. An extensive review of descriptions of the Japanese landscape by westerners was made and published. Analysis was made also of landscape descriptions by foreign visitors in the Meiji era to identify differences from those by Japanese persons.

Information Processing and Analysis Section

In topic (7), advanced data processing techniques have been developed for analyzing remotely sensed satellite imagery and geographic information data. The first monthly Normalized Difference Vegetation Index (NDVI) composite images covering East Asia were produced from NOAA/AVHRR satellite data received in 1997 by two NOAA receiving stations, at Tsukuba and Kuroshima, respectively. These data have been published by the Center for Global Environmental Research in CD-ROMs entitled “East Asia Monthly NDVI in 1997”. Also, a method using an airborne laser scanner has been developed for estimating forest canopy heights and biomass distribution; it has been applied to measuring forest biomass in Tomakomai Experimental Forest of Hokkaido University. In addition, the distribution of and environmental conditions in forests and wetlands of East Asia have been investigated using satellite data. The relationship between environmental conditions and biodiversity was analyzed.

Topic (8) focuses on development of models to analyze and evaluate quantitatively environmental changes, and on simulations based on these models, incorporating a new technique of transformation to predict changes. An elaborate traffic-noise propagation model was developed and improved using the boundary-element method. The model was found to simulate noise propagation under complicated environmental conditions more precisely than by conventional models. Also, methods for statistical analysis in the processing of environmental data were investigated.

Environmental Chemistry Division



Environmental contamination by new types of toxic chemicals like dioxins and endocrine-disrupting chemicals that threaten human health and ecosystems, continues to occur, emphasizing the importance of risk management of chemical contamination. To provide a scientific basis for the risk management of chemical contamination, the Environmental Chemistry Division conducts fundamental research on measurement of environmental parameters and on the fates and toxicology of chemicals. The Division consists of 4 sections: the Analytical Instrumentation and Methodology Section, which conducts research on analytical methods and instrumentation for environmental analysis, in particular using mass spectrometric systems; the Analytical Quality Assurance Section, which conducts research on standardization and quality assurance in environmental analysis; the Environmental Chemodynamics Section, which conducts research on analysis of chemical states and speciation, and isotope analyses, as well as their application to understanding the environmental fates of chemicals; and the Chemical Toxicology Section, which conducts studies on the chemical structure and toxicity of both natural and anthropogenic toxic compounds.

In FY 1999, 12 basic research projects covering a wide range of environmental pollution by various chemicals were implemented. Also, most members of the Division participated in many research projects promoted in other divisions of the Institute. Of particular interest were research projects concerning dioxins and endocrine-disrupting chemicals, in which Division researchers were core members of the research teams. In our Division, there are two ongoing programs supporting the environmental monitoring of chemicals: the Environmental Specimen Banking Program, and the Environmental Certified Reference Material (CRM) Program.

Brief accounts of some of the important results from the Division's research in 1999, focusing on dioxins and endocrine-disrupting chemicals, follow.

Determination of estradiol and its metabolites in water using gas chromatography/negative chemical ionization mass spectrometry

17*ß*- estradiol (E2) was detected at relatively high concentrations (> 10 ng l^{-1}) in waters of the Tama River, an urban river running through Tokyo, and Lake Kasumigaura during governmental surveillance of endocrine-disrupting chemicals. The E2 concentrations at the sampling stations were near the threshold value that induces vitellogenin, an egg-precursor protein, in male fish. The analytical methodology in the national surveillance studies was enzyme-linked immunosorbent assay (ELISA). ELISA is highly sensitive, and has been successfully applied to E2 determination in clinical studies, but not to environmental samples; it is not possible to confirm the presence of E2 by ELISA alone. For this purpose, we developed another sensitive, instrumental analytical method for E2, its metabolite (estron, estriol) and ethynyl estradiol. Sample waters are spiked with stable isotope-labeled E2-d4, and are extracted by the solid-phase extraction method. The extracts are sequentially converted to pentafluorobenzyl (PFB) derivatives by PFB bromide, and to trimethylsilyl (TMS) derivatives by TMS imidazole, and finally determined by gas chromatography/negative chemical ionization mass spectrometry. The detection limit of this method is about 0.1 ng l^{-1}. The E2 level in Lake Kasumigaura waters has been

monitored by this method for one year, and has remained less than 1 ng l^{-1}.

Development of a simple, operational estrogenicity assay system

We have developed a rapid estrogenicity assay procedure using the yeast two-hybrid system. The original assay system was implemented through two methods, the 96-well plate-culture method as a simple procedure and the chemiluminescent reporter-gene assay method for more sensitive determinations. The assay system is designed for use both as an agonist test with/without metabolic activation using rat liver S9 and as an antagonist test. The agonist activity of a sample is evaluated by ECx10, which is defined as the concentration at which the ratio of the chemiluminescent signal of the sample to that of the control is 10. In the agonist (-S9) test of five steroidal hormones and diethylstilbestrol, the lowest ECx10 value was found to be 0.085 nM, for ethynylestradiol. The agonist (+S9) test of methoxychlor showed clear dose-response with an ECx10 of 3000 nM. The IC_{50}, which is defined as 50% inhibition of 17 ß-estradiol (E2) activity, is calculated using the antagonist test; 4-hydroxy-tamoxifen exhibited an IC_{50} of 2400 nM. The agonist (-S9) test for *p*-t-octyl-phenol gave an ECx10 value of 67 nM; for *p*-nonylphenol, 550 nM; and for bisphenol A, 3500 nM. Using +S9 tests on various metabolites, the suggested agonist activities were: benzo[a]pyrene, 1800 nM; pyrene, 5100 nM; and 1-nitropyrene, 12000 nM. Antagonist activity levels (IC_{50}) of 820 nM for tetrabromobisphenol and 41000 nM for pretilachlor were also suggested. This system was applied to samples of environmental water and leachate from waste landfills. Estrogenic activity of Lake Kasumigaura water was detected by the agonist (-S9) test and found to be <1 ng l^{-1} (as E2).

Decomposition of bisphenol A, an endocrine-disrupting chemical, by cyanobacteria

Bisphenol A is a component of polycarbonate and other synthetic polymers, and has estrogenic activity. In the environment, bisphenol A is mainly found in water bodies. We found that bisphenol A was hydrolyzed to p-hydroxyphenylisopropanol and phenol by the cyanobacterium Oscillatoria agrdhii, which is the dominant species in Lake Kasumigaura throughout the year. The *p*-hydroxyphenylisopropanol was not coupled with rat estogen receptors, which were expressed in yeast cells by gene recombination. These findings show that bisphenol A is converted to non-active compounds by cyanobacteria.

Countrywide survey of imposex and organotin contamination in the rock shell, *Thais clavigera*

A countrywide survey on imposex and organotin (tributyltin (TBT), triphenyltin (TPT) and their metabolites) contamination in the rock shell *Thais clavigera* was conducted at 93 sites in Japan during September 1996 to January 1999. The occurrence of imposex was almost 100% at 73 sites while no imposex was observed at 6 sites. The degree of imposex, evaluated by the relative penis length (RPL) index, vas deferens sequence (VDS) index and percentage occurrence of sterile females (due to oviduct blockage caused by vas deferens formation), varied among sites. The observed values of the VDS index were positively correlated with those of the RPL index, and we estimated that more than half of the females were sterile where the RPL index value exceeded 40. Organotin concentrations in tissues of the rock shell also varied among the sites,

with a maximum of 152.7 and 223.3 ng g^{-1} wet wt for TBT and TPT, respectively. At several sites, where both the RPL index and TBT levels in tissues had not significantly decreased from 1990 to 1997, low larval recruitment rates and small numbers of spawned egg capsules were observed. The relationship between total triorganotin (TBT + TPT) concentration in rock shell tissues and the RPL index seems to continue be positively correlated, implying that organotin contamination is responsible for the current imposex symptoms in the rock shell samples. This contamination has persisted in Japanese inshore waters, although the maximum organotin concentration is lower than that in 1990 when the regulation for organotin use in antifouling paints took effect in Japan.

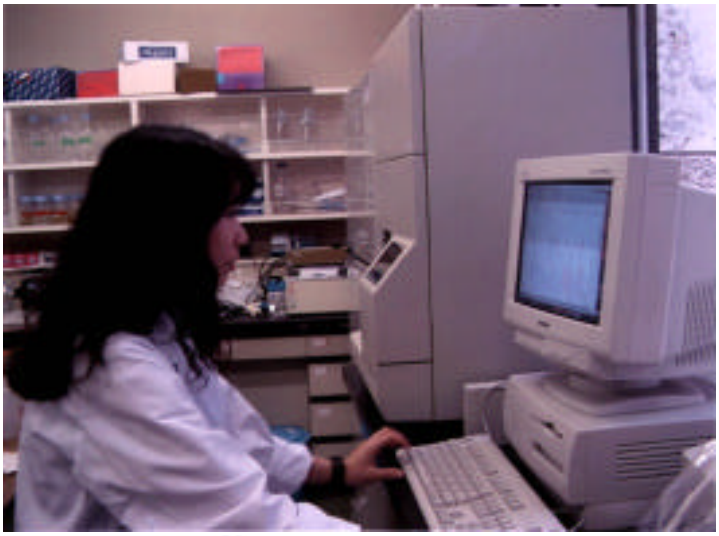
Chemical substance database system

A database system for chemical substances has been developed to support exchange of information between our partners on chemical substances in the environment. A World Wide Web service, Webkis-Plus, was established; it can be accessed by the general public. The database consists of three main parts. The first is a general chemical substances database with 5645 entries of chemicals, showing chemical/physical properties, toxicity, usage, regulation by law, examples of accidents, etc. This part of the database consists of several combined files, including KIS-NET (Kanagawa Prefecture Chemical Safety Information System), which is the major contributor. Second is a pesticide database that contains the structure of 3322 pesticides, formulations of 2608 registered pesticides, and 6176 commercial names. The amount of pesticide use in Japanese prefectures from 1992 to 1999 can be calculated and displayed on a map. The structure of pesticides was prepared by our partner, the Hyogo Prefectural Institute of Environmental Science. The third part of the database contains about 200 documents on analytical methods, including methods for assay of suspected endocrine-disrupting chemicals and of pesticides in water, foods, and agricultural products. Special lists of chemicals that are regulated by laws, and suspected endocrine-disrupting chemicals, have been prepared for the convenience of the general public.

Uranium isotope ratio study, related to an accident in a uranium conversion facility

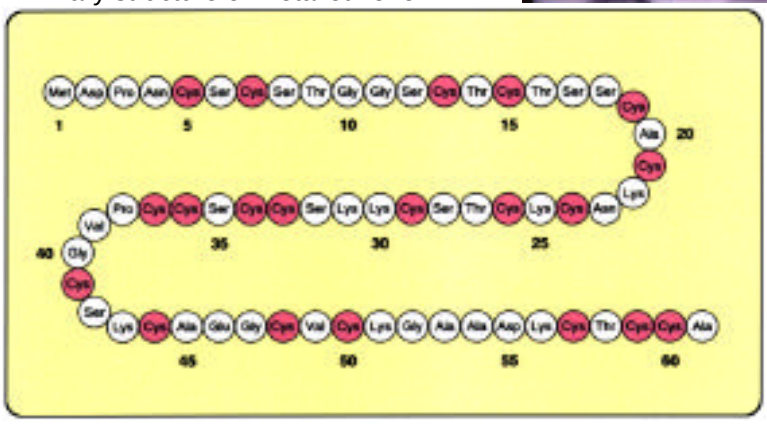
A criticality accident occurred at a uranium conversion facility in Tokai Village Ibraki Prefecture on account of the treatment of uranium solution of 18.8% enrichment in illegal manner. It was worried whether the uranium was discharged to the environment. The $^{235}U/^{238}U$ isotope ratios of soil and botanical samples collected inside and in the vicinity of the facility were analyzed by inductively coupled plasma mass spectrometry. High ratios were found in easily extractable fractions; uranium in the silicate portions of soil exhibited the natural isotope ratio, 0.00725. Mixing of enriched and natural uranium resulted in the observed isotope ratio. Therefore the maximum observed ratio is the minimum of the enriched contaminant. One leaf sample gave the highest $^{235}U/^{238}U$ ratio, 0.022. It limits the minimum isotope ratio of the source uranium. The impact of the enriched uranium, which was estimated by the mixing of natural and enriched uranium, was inversely proportional to the distance of the sampling site from the facility where the accident took place.

Environmental Health Sciences Division



Genetic analyzer

Primary structure of metallothionein



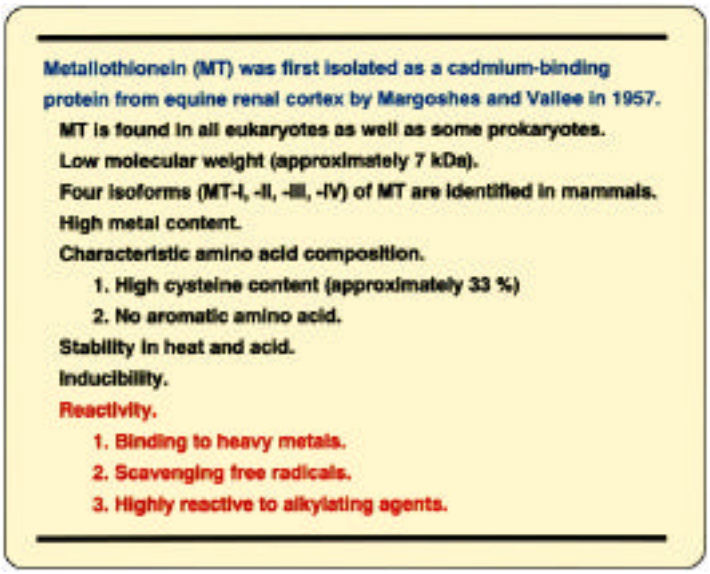
Skin tumors in metallothionein-null mouse treated with 7,12-dimethylbenz[a]anthracene/12-*O*-teradecanoylphorbol-13-acetate

The research interests of the Environmental Health Sciences Division are directed to studies on interactions of humans with harmful chemical and physical agents in the environment in the hope that the knowledge and information can be utilized to provide a scientific basis for risk assessment of these agents, alone or in combination. Due to the wide scope of research, the Division's activities are performed in experimental and epidemiological settings. Because the possible health effects of environmental contamination by dioxins and so-called environmental endocrine-disrupting chemicals have been arousing social and even political concerns, we have formulated special research projects to provide basic knowledge that could be used for risk assessment of these compounds. Environmental exposure to PM2.5, particulate matter smaller than 2.5 μm in diameter, as well as diesel exhaust particles (DEP) are becoming another very important research topics in terms of pulmonary and cardiovascular diseases. We also study health effects and pathogenesis of heavy metals, various chemical carcinogens and ultraviolet radiation. Depending upon the distribution of a given agent in the environment and its possible health effects, research topics are classified as either domestic or global environmental issues. During FY1999, we performed nine regular research programs. Experimental studies were performed in three sections: Biochemistry and Physiology, Experimental Pathology and Toxicology, and Biological and Health Indicators. Studies that deal with human populations were carried out by the Environmental Epidemiology Section. Research objectives that were considered 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 of the Global Environment and Regional Environment divisions. In addition, research projects supported by the Science and Technology Agency and other funding bodies were also performed.

Among the toxic effects of physical agents such as radiation and various harmful chemical substances in the general environment, carcinogenesis is an extremely important issue. It has been well recognized that individual differences in sensitivity to toxic substances exist for carcinogenesis in addition to other types of manifestations. Toxicity is manifested not only by direct action of a given chemical but also by indirect action such as generation of oxidative stress. The free radical hypothesis is supported by the fact that carcinogenesis can be suppressed by several free radical scavengers and antioxidant supplementation.

In this year's report, we describe the toxicological and physiological role of metallothionein (MT) in carcinogenesis by 7,12-dimethylbenz[a]anthracene (DMBA). Metallothionein, a cysteine-rich stress-inducible protein, is thought to play a role in protecting bioorganisms including man from toxicity of heavy metals, and oxidative-stress-inducing chemical and physical agents (Table 1). Since MT is a protein induced in response to various stimuli such as heavy metals and some inflammatory cytokines, we thought that the utilization of MT gene knockout mice (MT-null mice) would provide extremely useful information on possible involvement of MT. Utilizing MT-null mice, whose expression of MT-I and MT-II, major isoforms of MT, is suppressed, we have been studying the physiological and toxicological role of MT. We have already found that MT-null mice have increased sensitivity to heavy metals such as cadmium, inorganic mercury and mercury vapor, and oxidative stress-inducing

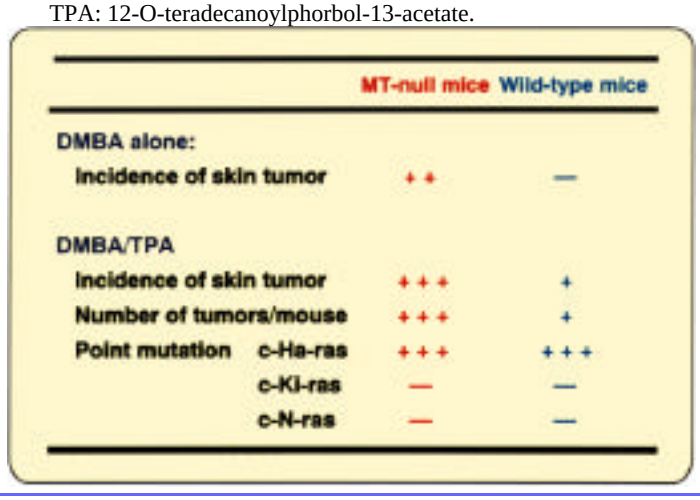
Table 1 Characteristics of metallothionein.



substances such as ethanol, paraquat, streptozotocin, acetaminophen and cisplatin. Thus, it is suspected that MT may act as a defensive factor against chemical carcinogenesis, and MT-null mice are thought to be a good model in those studies as well.

To elucidate the physiological role of MT in chemical carcinogenesis, we studied the susceptibility of MT-null mice in an experimental DMBA-caused skin carcinogenesis model as well as a two-stage skin carcinogenesis model by the use of DMBA/12-O-teradecanoylphorbol-13-acetate(TPA). Homozygous MT-null transgenic mice, a kind gift from Dr. A. Choo (Murdoch Institute for Research into Birth Defects, Royal Children's Hospital, parkville Australia), have been mated by backcrossing to the C57BL/6 strain and maintained without any phenotypic abnormalities. The basal MT level, determined by MT radioimmunoassay, in the skin of MT-null mice was negligible and approximately 2.0 μg/g tissue in wild-type mice. Female MT-null mice and wild-type mice were topically treated with a single dose of 100, 250, 500 or 1000 μg DMBA on the dorsal skin. Fourteen weeks after the DMBA treatment, skin tumors (papillomas) occurred in a dose-dependent manner in MT-null mice while no change was observed in wild-type mice (Table 2). The tumor cells showed proliferative activity

Table 2 Carcinogenicity of 7,12-dimethylbenz[a]anthracene in metallothionein-null mice and wild-type mice.
MT: metallothionein; DMBA: 7,12-dimethylbenz[a]anthracene;
TPA: 12-O-teradecanoylphorbol-13-acetate.



as shown by proliferating-cell nuclear antigen (PCNA) staining. The present results demonstrate that deficiency in MT enhances the promotion of DMBA-induced skin carcinogenesis (Zhang et al., Cancer Res., 58, 4044-4046, 1998).

In another study, female MT-null mice and wild-type mice were subjected to a single topical application of carcinogen (50 or 100 µg DMBA) and, after one week, received 10 µg TPA twice per week for 20 weeks. At 20 weeks, 90-100% of the MT-null mice, but only 10-40% of the wild-type mice, developed papillomas in the skin. No tumor was observed in wild-type or MT-null mice receiving TPA alone. These results indicate that MT-null mice are extremely susceptible to the two-stage carcinogenesis caused by DMBA/TPA (Table 2).

An investigation of mutations, by polymerase chain reaction(PCR)-restriction fragment length polymorphism (PCR-RFLP) and PCR-single-strand conformation polymorphism (PCR-SSCP) methods, in c-Ha-ras, c-Ki-ras and c-N-ras genes in the papilloma tissue of the wild-type and MT-null mice, showed the transversion of A^{182} to T of codon 61 of c-Ha-ras, indicating that MT is preventing the occurrence of the c-Ha-ras mutation that is activated by DMBA/TPA (Table 2). Our present studies clearly indicate that MT plays an important role as an anticarcinogenic factor in chemical carcinogenesis (Satoh, M. et al., unpublished data)

In conclusion, MT-null mice were found to be much more sensitive than wild-type mice to skin carcinogenesis produced by DMBA alone and DMBA/TPA in combination. Moreover, it was found that MT prevents the occurrence of the c-Ha-ras mutation that is activated by the DMBA/TPA combination. Thus, MT is an important protective factor against chemical carcinogenesis (Fig. 1). It is not known whether there is genetic polymorphism for the MT genes in humans; such a polymorphism might be associated with sensitivity to chemical carcinogenesis. A study on sensitivities to carcinogens in the general environment should be directed towards the genetic analysis of predisposition to cancer in human populations.

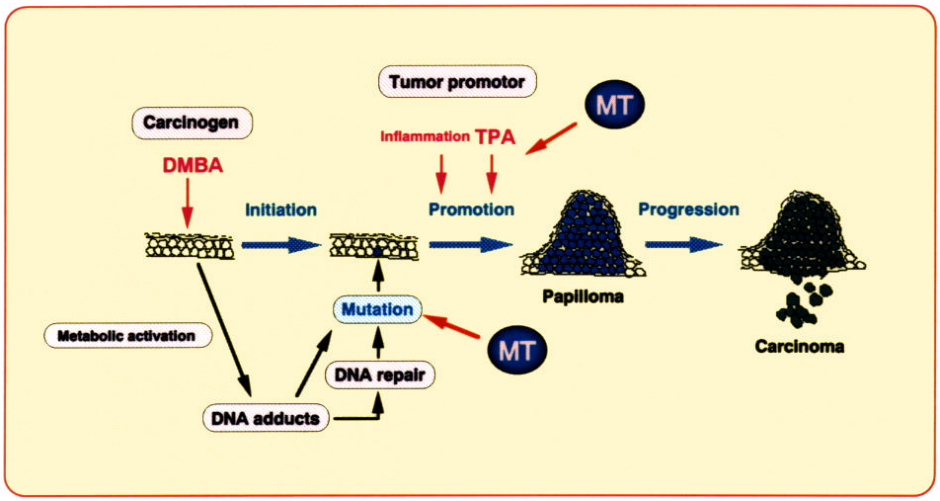


Fig. 1
Possible role of metallothionein in chemical skin carcinogenesis.
MT: metallothionein; DMBA: 7,12-dimethylbenz[a]anthracene; TPA: 12-O-teradecanoylphorbol-13-acetate.

Atmospheric Environment Division

The Atmospheric Environment Division conducts basic research on the distribution, properties and reactions of atmospheric constituents including pollutants, as well as joint project studies with other divisions on, for example, the ozone layer, global warming, acid rain, satellite observations, and urban air quality. The Division consists of four sections, whose research themes are briefly described below. Several experimental and measurement facilities, including a photochemical reaction chamber, a large-scale lidar (laser radar), an ozone lidar, an aerosol chamber and a wind tunnel, are operated for basic and project studies in cooperation with the Global Environment Division.

Atmospheric Physics Section

Research in the Atmospheric Physics Section is focused on numerical modeling and data analysis of atmospheric dynamics and climate systems. A major research topic is analysis of the global and regional climate system using observational data and the CCSR/NIES climate model developed through joint research with the University of Tokyo. The results facilitate studies of both global- and regional-scale environmental issues such as the evaluation of climate change. Related research topics include evaluation of the direct as well as indirect effect of aerosols on global-scale climate change under conditions of increasing atmospheric greenhouse gases, and the development of a regional climate model that includes land-surface processes in East Asia. Other specific research themes include derivation of tropospheric aerosol optical parameters from satellite image data, water exchange between atmosphere and land, improvement of parameterization of cumulus convection in climate models, effects of the tropical cumulus convection system on global-scale circulation especially in relation to the abrupt termination of the 1997-98 El Niño (Fig. 1), and global tracer transport in the tropospheric mid-latitudes associated with cyclonic vortices and in the stratospheric high latitudes associated with polar vortices.

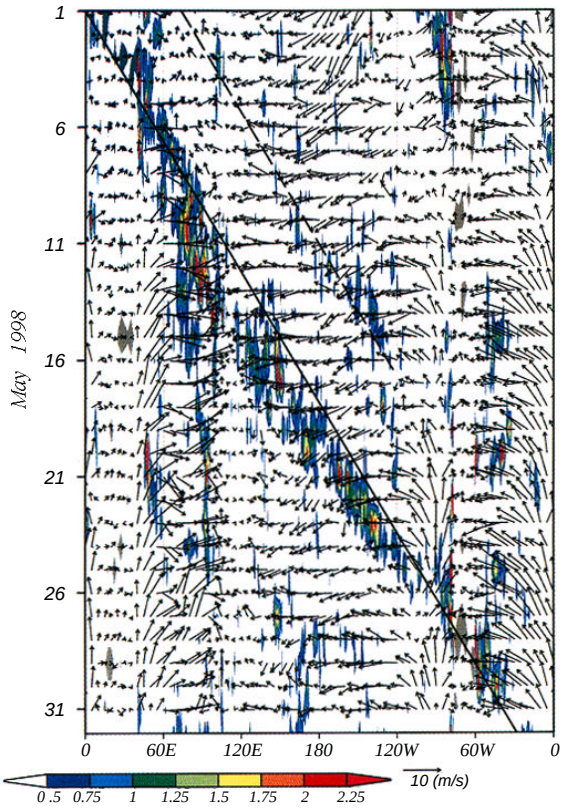


Fig. 1
The large-scale precipitation system traveling around the equator in May 1998 provided the triggering mechanism for the observed termination of the 1997-98 El Niño event. Colors show the rainfall rate (mm/h) obtained from satellite sensors; the vectors are surface winds on the equator.

Chemical Reaction Section

The Chemical Reaction Section deals with photochemical and thermal reactions of reactive atmospheric constituents. Studies of the photochemistry of free radicals, kinetics and mechanisms of atmospheric reactions, and field observations of reactive species related to photochemical ozone formation and acid deposition have been carried out.

Gas-phase reactions and spectrometry of radicals

Reactions of cyclohexenyl (cyclo-C_6H_9) and pentadienyl (C_5H_7) radicals with O_2 have been studied with a photo-ionization mass spectrometer coupled with pulsed laser photolysis. Equilibria between hydrocarbon radicals (R), O_2, and peroxyl radicals ($R\text{-}O_2$) were observed at 361 K for $R=C_6H_9$ and 268-308 K for $R=C_5H_7$. This result suggests that the C-O bond energy of $R\text{-}O_2$ is dependent on the resonance stabilization energy of the hydrocarbon radicals. A new laser-induced fluorescence spectrum of the C_6H_7 (cyclohexadienyl) radical was also measured.

Observations of atmospheric pollutants in China and remote islands in Japan

It is of great importance to monitor variations in atmospheric pollutant concentrations in both source and receptor regions to clarify their transport mechanisms and their acid precursors. China is one of the largest sources of atmospheric acid precursors in the world and large quantities of atmospheric pollutants are transported to Japan over the sea between them. During FY1999, we started to observe SO_2, NOx, ozone, and aerosol levels in China at Fenghuang Mountain (Liaoning Province), Tianheng Island (Shandong Province), and Shengsi Island (Zhejiang Province). Peroxyacetyl nitrate (PAN) measurements in Oki Island and hydrocarbon measurements in Okinawa were also started.

Upper-Atmospheric Environment Section

Researchers in the Upper-Atmospheric Environment Section study laser remote-sensing methods such as lidar (laser radar) and conduct observational studies of the atmosphere using these methods.

Aerosols and clouds have been observed in the western Pacific using a two-wavelength dual-polarization lidar on board the research vessel "Mirai". Vertical distributions and optical characteristics of aerosols and clouds were observed (Fig. 2). In the international observation experiment “Nauru99,” the structure of the marine boundary layer and distribution of sea-salt aerosols were studied in the tropical Pacific. A strong correlation was observed between surface wind speed and the density of sea-salt aerosols in the boundary layer.

Long-term observations with ground-based lidars have been conducted in Tsukuba and Jakarta to study climatological features of the distribution of aerosols and clouds. Measurements of depolarization ratios in Tsukuba revealed clearly the transportation of Asian dust. Histograms of the cloud base height in Jakarta suggest the formation of a stable layer at an altitude about 5 km in the tropical region.

Data analysis methods and data reduction algorithms were studied for space-borne Mie-scattering lidars to retrieve optical parameters and distribution of aerosols. The

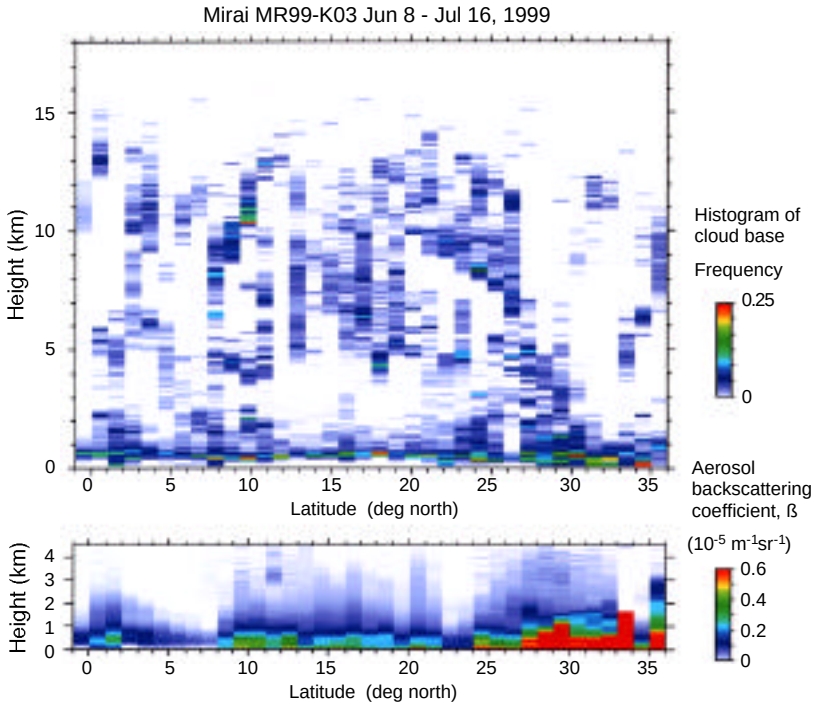


Fig. 2
Distribution of clouds and aerosols observed with a lidar on board the research vessel "Mirai" during the MR99-K03 cruise.

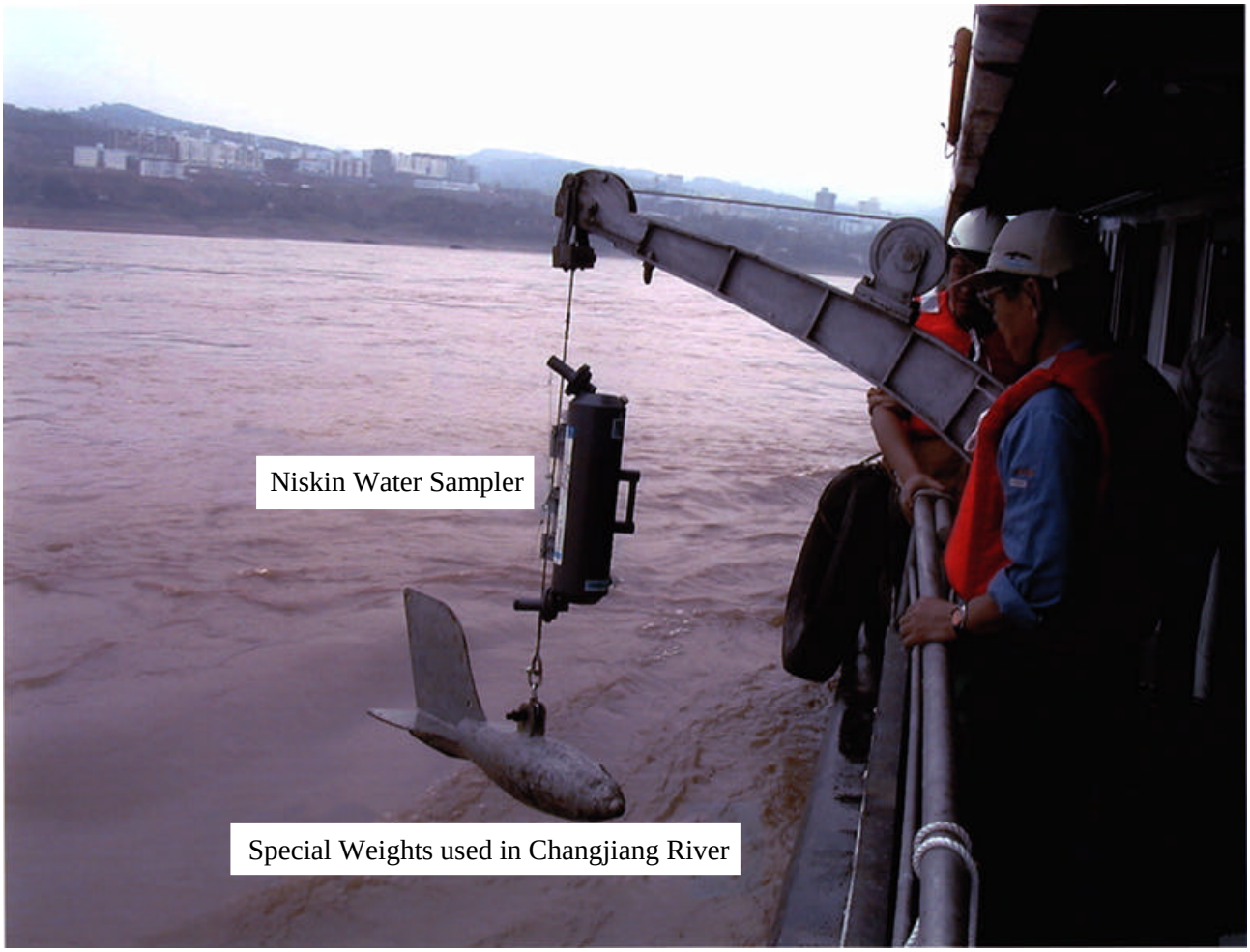
methods we developed were tested by application to data from the Lidar In-Space Technology Experiment (LITE), which was carried out by NASA in 1994 from a space shuttle.

Atmospheric Measurement Section

The special emphasis of the Atmospheric Measurement Section is on field studies of trace atmospheric constituents including greenhouse gases, reactive chemical species and aerosols. To understand their origins, distribution and fate in the troposphere, measurements of their concentration and isotopic composition have been carried out on a global and/or regional scale. In FY1999, measurements of N_2O and CO concentrations began at Ochiishi and Hateruma Monitoring Stations, respectively. The observations at Ochiishi suggested a seasonal variation in N_2O concentration, which seemed to increase toward winter; at Hateruma, CO concentration was found to be high in spring and low in summer. The continuing observations of CH_4 showed average annual increases of 5 and 6 ppbv at Ochiishi and Hateruma, respectively, during 1996 to 1999, while N_2O concentration at Hateruma increased at the rate of 0.68 ppb per year for the same period. The abundance ratio of stable isotope ^{13}C of CO_2 was measured for air samples taken over Siberia. The correlation between ^{13}C abundance ratio and CO_2 concentration indicated that the seasonal variation of CO_2 in this region was caused predominantly by the land biosphere; however, the correlation was found to be slightly dependent on the sampling locations.

It is necessary to evaluate the amount of dry deposition of atmospheric pollutants in order to understand their overall transport behavior. It is especially important to measure the dry deposition of O_3, since it is a possible cause of forest decline. An extensive observation of O_3 flux over a red-pine forest was carried out, which revealed unusually large deposition rates in summer. On the basis of simultaneous measurements of O_3 and particulate-sulfate concentration profiles in the canopy, it was suspected that such an anomaly in the O_3 deposition was due to the reaction of O_3 with terpenes emitted from pine trees.

Water and Soil Environment Division



Water sampling in Changjiang River

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 and biologically available nutrients in aquatic and soil systems. The results of these studies are integrated into biogeochemical models in order to contribute to the conservation and protection of the environmental quality of such systems.

The Division consists of 4 sections, Water Environment Engineering, Water Quality Science, Soil Science and Geotechnical Engineering. 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

Field Survey of the Changjiang River for aquatic environment and ecosystem modeling

Human activity in the Changjiang River catchment, including population growth; industrialization of agriculture; and water-resource development, such as construction of the Three Gorges Dam, results in large amounts of sediment, nutrients and chemical fertilizers flowing into the East China Sea. In order to predict the effect of future anthropogenic loads on the aquatic environment and ecosystem of the Changjiang River, it is essential to understand the present behavior of the river catchment and to construct a refined mathematical model. For this reason, a field survey was conducted from 18 to 30 October 1999 along the Changjiang River from Wuhan to Shanghai (about 2300 km) using a Chinese research vessel, with stations at intervals of 50 to 100 km. Water samples were collected for water quality analysis at 41 sites. At 5 sites, in situ incubation experiments with ^{13}C bicarbonate tracers were also carried out to determine the rate of transfer of carbon from bacterial and photosynthetic production to higher trophic organisms.

The results of the field survey suggested that the major factors characterizing the changes in aquatic environment along the River are (1) the extent of anthropogenic loads from 4 large cities-Chongqing, Wuhan, Nanjing and Shanghai; and (2) the relative contribution of fisheries and agricultural use of huge two lakes, Dongting and Poyang, to the buffer effect that regulates the quantity and quality of water and pollutant loads. The ^{13}C tracer experiment results suggest that microbial food webs are the dominant type of carbon cycling along the entire Changjiang River, with photosynthetic food webs becoming more active in the downstream than upstream areas of the river. This provides significant information for our ecological modeling.

Water Quality Science Section

Seasonal and Geographic Dynamics of Bacterioplankton in Eutrophic Lake Kasumigaura

The effect of chemical substances on algal blooms in eutrophic lakes has often been investigated, but algal blooms cannot be fully explained by chemical substances. To understand these phenomena, their ecological aspects also have to be investigated. The bacterial community of a lake functions as the foundation of its ecosystem. Thus, we studied the seasonal and geographic dynamics of the bacterial community structure in Lake Kasumigaura for one year, using 16S rDNA analysis.

Water samples were collected monthly from February 1999 to January 2000 at 5 sites using a 2-m water-column sampler. Bacterioplankton from each water sample were filtered onto a 0.2-µm polycarbonate filter after prefiltering through a 3-µm filter to remove larger organisms. Total DNA was extracted from each filter by bead-beating and subjected to denaturing-gradient gel electrophoresis. The diversity index (Shannon index, *H*') was calculated from band number and density. The bacterial community structure was described by principal component analysis (PCA) and 16S rDNA sequence of the major bands. The results were as follows:

1) The diversity of the bacterial community, according to values of *H*', was highest in February, then decreased and became lowest in August. The period of lowest diversity coincided with the period of highest total bacterial numbers.

2) Comparisons between band profiles by PCA indicated clear differences in the bacterial community between different sampling times, but not between sampling sites. PCA of band patterns showed that there were three types of bacterial community structures (spring, summer to autumn, and winter).

3) *Actinobacteria* dominated the bacterial community from February to April, while the Cytophaga/Flexibacter/Bacteroides(CFB) group formed a large proportion from July to January, as estimated from band sequences and density.

Soil Science Section

Examination of the validity of using precipitation data based on GCMs as input data for the hydrological model of a large catchment

Precipitation data based on general circulation models (GCMs) are usually used to simulate hydrological processes in large catchments. We examined the validity of using such data (P_G) as input data for a hydrological model of a large catchment by comparing them with rain-gauge-based precipitation data (P_R).

The study area was the whole catchment (160,000 km^2) of the Jialingjian River, a tributary of the Changjiang River. On the Jialingjian River there are 431 sites of daily precipitation observatories regulated by the Changjiang River Committee. Daily observed precipitation data in 1987 were used for this study. These observed point data were transferred to the daily distributed precipitation data at a spatial resolution of 1x1 degree by using 'kriging', which is one of the typical geostatistical interpolation methods. For the PG, 1-degree 6-hourly data included in the global meteorological and hydrological dataset of 1987 and 1988 developed by the International Satellite Land Surface Climatology Project were used. Hydrological Simulation Program Fortran(HSPF) ver. 11.0 was used as the hydrological model.

There were few differences between P_G and P_R in monthly total precipitation, but clear differences were found in temporal distribution and intensity of precipitation in summer (June to August). For P_G, there were 27 days more with precipitation of more than 1 mm per day than for P_R. Moreover, the maximum daily precipitation of P_R was 4.9 times larger than that of P_G. As a result of these differences, the output of the hydrological model using P_G showed less reproducibility than that using P_R to the observed rapid changes in discharges and suspended solids during summer. The results from this study mean that the present precipitation data based on GCMs are not adequate to make quantitative estimations of the effect on the runoff process of the excessive deforestation in large catchments, including sediment production. It is necessary not only to improve the algorithms of the GCMs, but also to utilize satellite-

image data and to collect rain-gauge data with higher spatial density in order to develop precipitation data that are both temporally and spatially more precise.

Geotechnical Engineering Section

Land subsidence in Takada, Joetsu, Japan

Urban Takada, situated south of the city of Joetsu in western Niigata Prefecture, is a typical heavy snowfall area in Japan. The groundwater level decreases greatly in winter due to excessive pumping of this water to melt snow, resulting in subsidence caused by consolidation of Quaternary deposits.

We observed groundwater level and subsidence at the site of Joetsu Junior High School in urban Takada. The results are shown in Fig. 1. In the winter of 1998-1999, the groundwater level was rapidly lowered by a maximum of 7.5 m following a snowfall and the ground surface subsided by up to 29 mm.

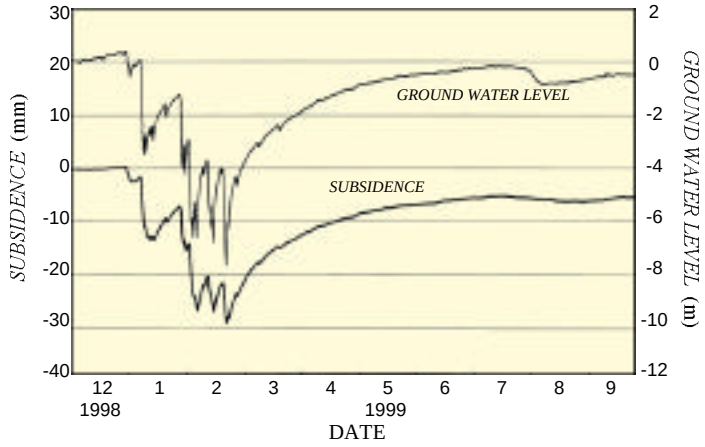
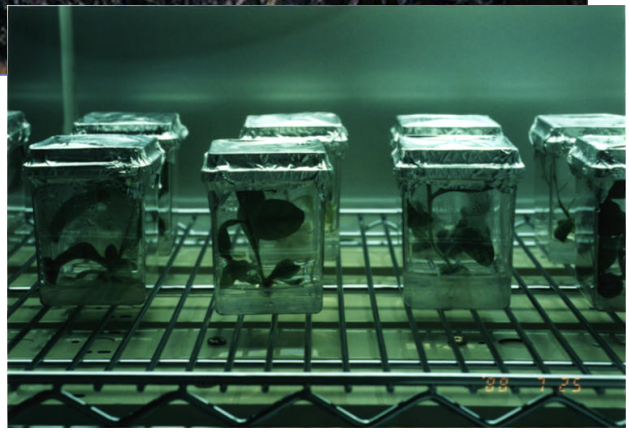


Fig. 1
Change in ground water level and subsidence at the site of Joetsu Junior High School, in Joetsu, Niigata Prefecture.

Environmental Biology Division



The Environmental Biology Division consists of four sections: Molecular Biology, Environmental Microbiology, Environmental Plant Science, and Ecosystem Study. 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 genetic biodiversity, species, and ecosystems. In 1999, the Division performed 17 studies funded by NIES, one study funded by the Environmental Research and Technology Division (Environment Agency) and 5 studies funded by the Science and Technology Agency.

Molecular Biology Section

Research in this Section has included physiological and molecular biological studies on the mechanisms of plant tolerance to stress caused by various environmental conditions.

Terrestrial plants, being sessile, have developed mechanisms for both immediate and acclimatory responses to changing environments. Many kinds of environmental stress result in the production of active oxygen species in plant cells, and the ability to scavenge these toxic substances seems to be indispensable to the survival of plants. Several enzymes and other substances are involved in the scavenging of active oxygen in plants, and the activities of some enzymes (antioxidant enzymes) are known to increase upon exposure of plants to some stressors. We carried out a systematic study to characterize the specific effects of various environmental stressors on the activities of several antioxidant enzymes in a model plant species, *Arabidopsis thaliana*, under comparable experimental conditions. The results show differences in responses among the enzymes and among environmental stressors, and suggest that in *A. thaliana*, environmental stressors may be classified into those that induce dehydroascorbate reductase and those that induce ascorbate peroxidase (Table 1).

Table 1 Changes in activity of antioxidant enzymes in leaves of *Arabidopsis thaliana* during exposure to environmental stresses.

Stress	APX	MDHAR	DHAR	GR	PER	SOD	CAT
High temperature (30 C)	0	0	+	0	0	0	0
Enhanced light intensity (200 µE/m^2/sec)	0	0	+	0	0	0	0
Water deficiency (23-62% water loss)	0	0	+	0	+	0	0
Ozone (0.1-0.15 µl/l)	+	0	0	0	+	0	0
Sulfur dioxide (0.1-0.15 µl/l)	+	0	0	0	+	0	0
Chilling temperature (5 C)	+	0	0	+	0	0	–
UV-B (0.25 W/m^2)	+	+	0	+	+	+	0
UV-B (0.094 W/m^2)	0	0	0	0	+	0	0

+ ; increased. – ; decreased. 0 ; not significantly different from control.
Abbreviations: APX, ascorbate peroxidase; CAT, catalase; DHAR, dehydroascorbate reductase; GR, glutathione reductase; MDHAR, monodehydroascorbate reductase; PER, guaiacol peroxidase; SOD, superoxide dismutase; UV-B, ultraviolet-B.

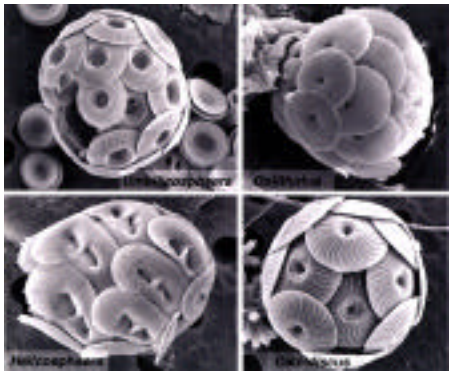


Fig. 1
Scanning electron micrographs of the representative coccolithophorid species recognized from the pelagic environment.

Environmental Microbiology Section

The main environmental microbiology research areas are 1) studies on microbial diversity including genetic and morphological variations, potential biodiversity in nature, and structure and function of microbial communities; 2) management of the NIES microorganism culture collection and development of related techniques; 3) analysis of microbial activity in carbon and nutrient cycles; 4) development of genetic markers in microalgae; and 5) biodiversity and ecophysiological studies on coccolithophorids.

Coccolithophorids are a phytoplankton group that is becoming well known for large-scale blooms that can be recognized from satellite images. Because of their distinctive production of both coccoliths (the extracellular structure, composed of $CaCO_3$) and dimethyl sulphide(DMS) (a sulfur compound causing acid rain), their biological participation in the carbon and sulfur cycles and in global climate change has been recognized. However, only a few species like *Emiliania huxleyi* have been studied so far. We have worked on their biodiversity and ecophysiological properties and succeeded in establishing 14 culture strains (5 species) including 3 pelagic species, *Oolithotus fragilis*, *Calcidiscus leptoporus* and *Umbilicosphaera sibogae* (Fig.1). These three pelagic species were used for ecophysiological experiments: *Oolithotus* grew with a maximum rate of about 0.5 divisions per day at 20-25˚C, 8-16 µE m^{-2} s^{-1}, and 4-6 nitrogen and phosphate ratio (N/P) using modified K medium; while *Emiliania* grew with a maximum of about 2 divisions per day at 15-27˚C, 1.6-80 µE m^{-2} s^{-1}, and 4-20 N/P. *Oolithotus* have much stricter growth requirements than *Emiliania*. Thus, it is necessary to maintain strictly controlled conditions in the culture of pelagic species.

Environmental Plant Science Section

Research in this Section has included 1) the effects of desertification and global warming on plants; 2) strategies to prevent desertification; 3) conservation of alpine and subalpine plant species; 4) the mechanism of plant-to-plant interaction in natural plant communities; and 5) the patterns and processes of conifer forests in northern Siberia.

Simulation studies of the expected global warming suggest pronounced temperature rise at higher latitudes. The vast forested area in Siberia is a large reserve of organic carbon. The potential effects of the temperature rise on the dynamics of the Siberian forest may include feedback effects on the global carbon cycle, which may affect the global climate. We examined the factors controlling the growth and survival of the trees of deciduous conifer forests in the permafrost region dominated by *Larix gmelinii*. Depth of the soil's active layer (layer of soil that thaws in summer) is considered to be

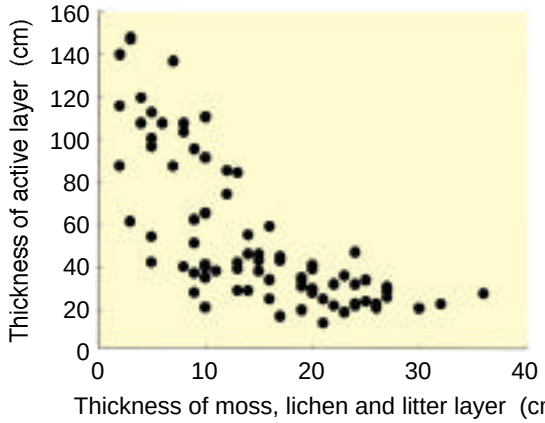


Fig. 2
Relationship between the active layer (the layer that thaws in summer) of the soil and the thickness of the soft mat layer composed of moss, lichen and litter in a Siberian forest.

one of those factors. The depth of the active layer was measured along a transect set on a slope down to a river, near the settlement of Tura, Evenkia region. The ground is covered with a soft mat of moss, lichen and litter. The occasional forest fire burns the soft mat. The recovery of the mat takes several decades. A negative correlation was found between the thickness of the soft mat layer and the depth of the active layer (Fig.2). High mortality of trees was observed where the mat is dense and the active layer is shallow.

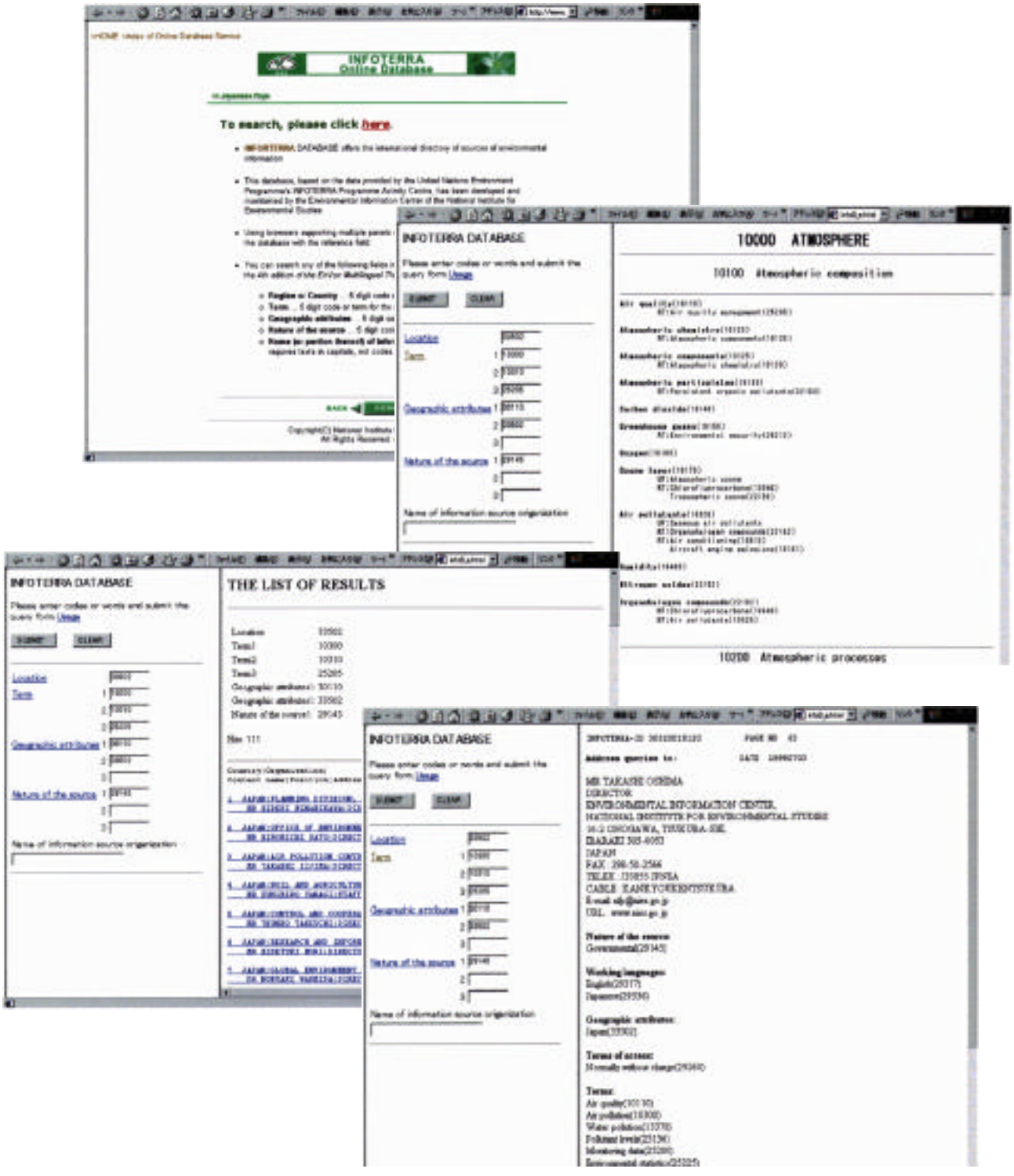
Ecosystem Study Section

Ecosystem research has included 1) studies on the process of restoration of disturbed ecotone ecosystems of lakes; 2) the significance of natural populations of fireflies as an indicator of the environment status; 3) studies on benthic habitats in the littoral zone of lakes; 4) fundamental studies on the classification and ecology of lotic macroinvertebrates; and 5) comparative studies on population dynamics of wetland macrophytes.

Macroinvertebrate fauna of subtropical streams on the oceanic Bonin Islands were studied. Freshwater caridean shrimps of the families Atyidae and Palaemoniidae were found to be dominant. Seven species of caridean shrimps were collected from the streams.
Caridina typus and *Caridina japonica* (Fig. 3) were widely distributed in the streams but not in estuaries, while the distribution of *Palaemon ogasawaraensis* was restricted to river mouths and estuaries. *Atyoida pilipes* occurred only in high-gradient streams. Aquatic insects of the orders Ephemeroptera and Plecoptera were not found at any sampling station. The absence of these insects, commonly found elsewhere in Japan, could be ascribed to the geological history of the islands. Insects of the order Odonata, which contains several endemic species and subspecies, were only found in Haha-jima Island. In spite of efforts to find them, their nymphs were not found in the streams of Chichi-jima Island.

Fig. 3
A caridian shrimp, *Caridina japonica*, from the Bonin Islands.

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 Environmental Information Databases

1) Monitoring data files.

Many types of numerical environmental data are needed for both environmental research and environmental policy development, implementation and enforcement. The Center has compiled, processed, stored and provided access to (in computer-accessible form) data files of air quality 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. In addition, data files are exchanged with other governmental organizations.

2) Natural environment.

Development of a General Reference System for the Natural Environment began in FY1991, with the aim of providing 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 FY1995, a system to provide database access by personal computers (PGREEN) has been developed, based on previously recorded results and data. PGREEN is available on Windows-based PCs, enabling graphical display and user-friendly operation.

3) Environmental information sources.

Surveys of environmental information have been in progress since FY1992, 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 are being provided to the general public. We call this database “EI-Guide”.

NIESWWW

In March 1996, NIES began to provide environmental information on NIES research activities and results (in English and in Japanese) to the world via Internet (URL http://www.nies.go.jp/). In March 2000, NIESWWW was modified to enable the general public to access NIES information more easily. By May 2000, the number of visits to the website each month reached about 1,485,000.

EICnet

In March 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, in order to promote national activities for conservation of the environment. This system is available only in Japanese

via Internet (URL http://www.eic.or.jp/) and facsimile. By may 2000, the number of visits to the website each month reached about 3,352,000.

Library and Research Information Section

Compilation of documentary information on 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.

Commercial databases available off-line on CD-ROM or diskette in the Institute include NTIS, Ei Energy and Environment, Environment Library, and Current Contents on Diskette. MEDLINE is available on-line from the ERL Internet Service. Access is also provided to several other on-line databases: JOIS, DIALOG, STN-International and G-Search.

Library management and operations

As of March 2000, 40,824 books, 743 technical and scientific serials, 8,501 maps, 112,588 microfiches, and various other reports and reference materials were held 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 (NIES News, in Japanese), and other reference materials are edited by the Center and distributed to many organizations.

Information Management Section

INFOTERRA

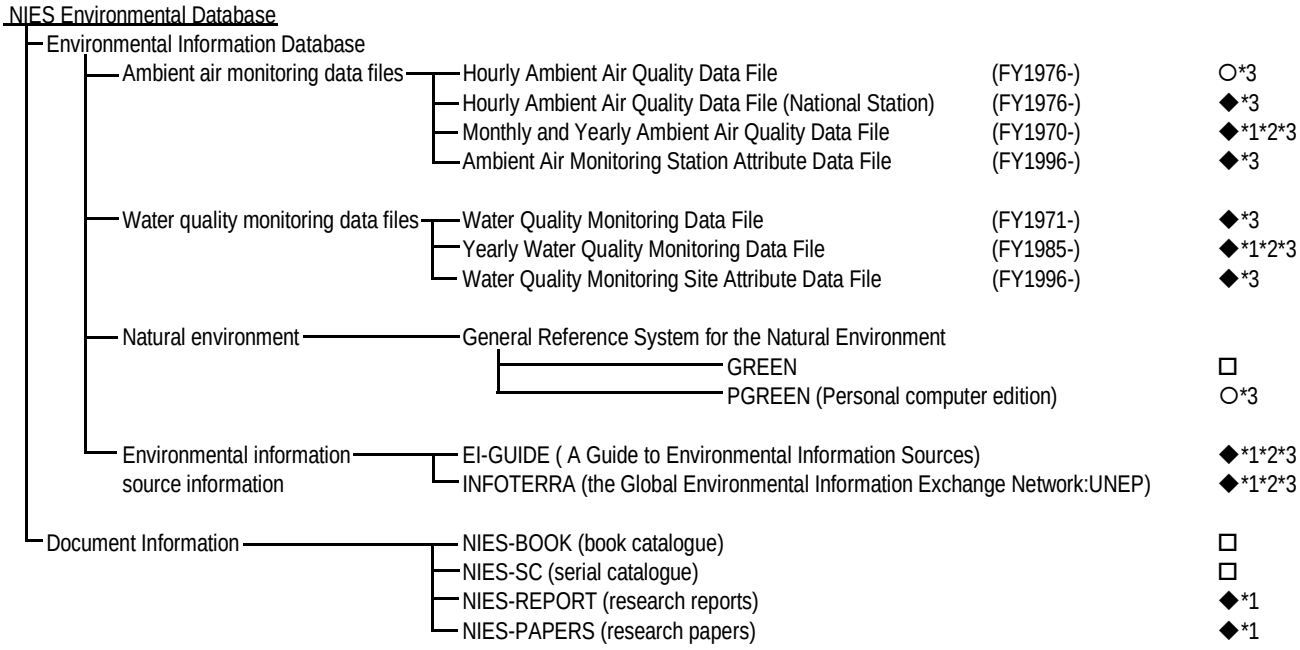
INFOTERRA, the Global Environmental Information Exchange Network designed by UNEP to stimulate and support the exchange of environmental information between partners, is operated at the national level by national focal points. This Center is designated as the INFOTERRA National Focal Point for Japan. As of March 2000, 178 countries were participating in INFOTERRA, and information sources registered in INFOTERRA numbered about 8,000 (576 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 the increasing demand for computing resources and a multiplicity of processing uses. This UNIX-based computing environment consists of a comparatively large-scale supercomputer system (NEC SX-4/32 (32 CPU)) and various subsystems such as a scalar-computing server (IBM RS6000/SP2 (16 CPU)), database servers (3 sets of SUN Enterprise 2/1200 (Oracle7, SAS), and 2 sets of NEC Express 5800/160 Pro (Oracle7 Workgroup)), and file servers (a DEC Alpha Server 8400 5/440 (4 CPU), 2 sets of Alpha Server 4100 5/400, 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) and executes large-scale programs to handle global environmental problems. It is also equipped with an image processor and a three-dimensional graphics processor (SGI Onyx MIPS R10000/R4400 (2 CPU)).

A LAN, called the NIES Network (NIESNET), was established at the Institute in 1992. File transport in various computer systems, as well as the IP Switch and IP Switch Gateway, were upgraded in March 1997; the network configuration was restructured and large-scale file transport performance was improved at that time. All Institute researchers can access the computer system from their own desk through the LAN. Foreign as well as Japanese registered users outside the Institute have remote access to the supercomputer system through NIESNET's connection to the Internet via the Inter-Ministry Network (IMnet).

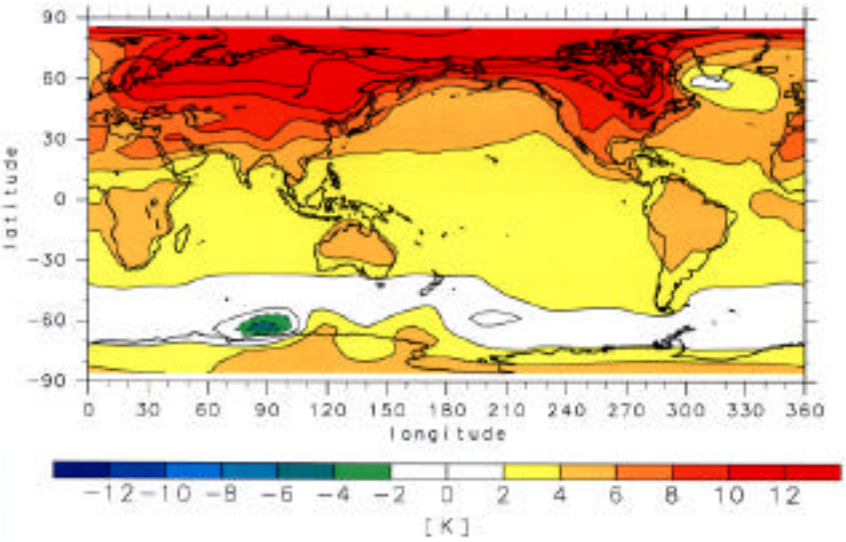


Availability Codes

◆ Provided to general public
○ Provided to administrative organizations, researchers, etc.
□ Restricted to use in NIES
*1 NIES World Wide Web Server (WWW)
*2 EICnet
*3 Provided by electronic media

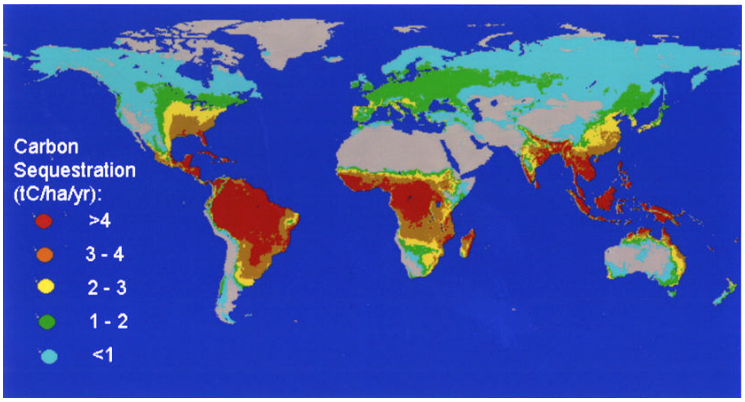
Fig. 1
Composition of the NIES environmental databases.

Center for Global Environmental Research



Radiative impact of tropospheric aerosols of sulfate, carbon, sea salt, and soil dust.

Tomakomai Flux Research Site



Potential rate of carbon sequestration during the 1st commitment period(2008-2012) that might be induced by an afforestation project carried out in 2000; simulated with a model of forest carbon cycle for average climate

The Center for Global Environmental Research (CGER) was established in October 1990 to contribute broadly to the scientific understanding of global change and the elucidation and solution of our pressing environmental problems. CGER has 3 major activities: integration of global environmental research, management of a global environmental database, and global environmental monitoring.

Integration of global environmental research

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 of Japan 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 using 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 1999. Within this fiscal year, the annual Global Environment Tsukuba conference, which brings together researchers and decision-makers with the general aim of enhancing communication, was held twice (Table 1). In July 1999, the 14th Global Environment Tsukuba was held in Tsukuba with the theme of “Biodiversity and its Information”, and in March 2000, the 15th Global Environment Tsukuba was held in Tokyo with the theme of “Indonesian Forest Fire”. CGER also supported groups seeking to organize workshops or symposia on specific research programs. In FY 1999, CGER supported and participated in the following workshops/symposia: “2nd IGBP Congress”, “The 1999 Open Meeting of the Human Dimensions of Global Environmental Change Research Community”, “The 8th Symposium on the Joint Siberian Permafrost Studies between Japan and Russia in 1999”, “Workshop on Greenhouse Gas Inventories for the Asia-Pacific Region”, and “Workshop on Biodiversity Research and Information in Asia Oceania.”

Cooperation to promote and coordinate global environmental research

With the cooperation of the Research & Information Office, Environment Agency of Japan, CGER actively serves as the secretariat for the “Scientist Network on Indonesian Forest Fires” (SNIFF). In FY1999, CGER started a new activity as the regional center

Table 1 Recent Global Environment Tsukuba

Topic	Date	Place	Participants
Carbon dioxide in the oceans	Jan. 1999	Tsukuba	217(63)
Carbon dioxide and vegetation	Mar. 1999	Tsukuba	92(27)
Biodiversity and its information	July 1999	Tsukuba	133(69)
Indonesian forest fire	Mar. 2000	Tokyo	68(15)

* Figure in Parentheses shows participants from overseas

of Species 2000 Asia Oceania, an international project on information regarding biodiversity.

CGER has been actively participating in the work of the Intergovernmental Panel on Climate Change (IPCC), which is preparing its Third Assessment Report for completion in February 2001. CGER also contributed to several international activities, such as the Interim Steering Committee for the Global Biodiversity Information Facility (GBIF); the Thematic Programme Network 1 (TPN1), which is a regional program of the Convention to Combat Desertification (CCD); and the Acid Deposition Monitoring Network in East Asia (EANET).

Coordinating supercomputer-aided research programs

CGER upgraded its supercomputer system to an NEC SX-4/32 in March 1997 and in March 1999 added ultra-high-speed functions and large magnetic disks, which have greatly improved the system's performance and facilitated research on global change. The annual supercomputer activity report was published and the 7th Supercomputer Research Workshop was convened by CGER to disseminate the latest knowledge obtained by users of the supercomputer.

Integrated research on policy options

Integrated Research, a special research category in the Environment Agency's Global Environment Research Program, is directed towards actual decision-making processes, through the development of conceptual models and the generation of data used widely in interdisciplinary research. Three research projects in this category were implemented in 1999: Studies on Integrated Environmental-Economic Analysis Toward a Sustainable Global Society; Studies on Methodology for Establishing Greenhouse Gas Inventory System, and Studies on Integration and Systematization for Promoting Global Environment Research.

Management of the global environmental database

CGER is establishing a global environmental database system as well as producing and distributing UNEP/GRID environmental data sets to support environmental research and administrative decision-making. During FY 1999, we focused on constructing a database on sinks of greenhouse gases. We have collected satellite data and modeled sink activities.

Another important role of CGER is to provide metadata information. We have published information on international research institutions/programs and on access to global environmental data.

During the year, we began work on a database on mitigation measures for climate change, and updated the IPCC-scenario database on greenhouse gas emissions for predicting the future environment of the Asian region. Regarding global warming response, the “Data Book of Sea-Level Rise 2000” was published. This is a revision of a 1995 publication, incorporating new information during recent years. An inventory of the sources of SO_2 and NOx discharge in Korea, China and India was also updated; it was developed as a basic database for elucidating long-range transboundary air pollution in East Asia. Land-use maps for the areas around the North China Plain (Ca,1990) and around the capital of North Korea (Ca,1980) were produced to show

land-use change in East Asia. We also continued to collect terrestrial ecosystem data from sites in Thailand and Malaysia in order to determine the present conditions and changes over time in tropical forests. Global environmental monitoring data were published as two CD-ROMs: “East Asia Monthly NDVI in 1997”, which includes a vegetation index calculated from NOAA satellite data obtained at the Tsukuba and Kuroshima receiving stations; and “Data of IGAC/APARE/PEACAMPOT Aircraft and Ground-based Observations '96-'98 Collective Volume”, which contains long-range transboundary air pollution data in East Asia obtained by NIES and other institutions.

Global Resource Information Database (GRID)

GRID was established in 1985 within UNEP 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 1999, 147 data sets including distribution via GRID-Tsukuba web site, were distributed to users in and outside Japan in response to 25 requests.

Data on world solar radiation were arranged in a 0.5 × 0.5-degree grid to provide a database for studies on sinks of greenhouse gases. We updated information in the GRID-Metadata Directory, which is used to collate data sets and data sources of the GRID centers.

Global Environmental Monitoring

CGER has observed and recorded data on various global phenomena via long-term monitoring programs. These data are available through published data reports or data set files provided by international data networks in which CGER participates. The following 12 projects are presently coordinated by CGER.

Ozone monitoring with ozone lidar (laser radar) and a millimeter-wave ozone radiometer system

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 to extend the ozone measurement range from 10 to 45 km. Millimeter-wave measurements started in October 1995. Since then, vertical ozone profiles through the whole stratosphere have been determined. The millimeter-wave measurement results are analyzed to clarify the temporal variations in ozone levels.

Monitoring network for UV-B

To identify trends in the urban ultraviolet-B (UV-B) intensity of solar radiation resulting from stratospheric ozone depletion, CGER installed a Brewer Spectrophotometer on top of a building in Tokyo. Monitoring had been conducted from November 1993 to may 1999. In 1998, CGER started a nationwide UV-monitoring network in collaboration with several universities and other institutions.

Stratospheric monitoring in northern Japan

To monitor the ozone layer over the northern part of Japan, the Rikubetsu Station for the Detection of Stratospheric Change was founded in Hokkaido in October 1997.

NIES has cooperated with the Solar-Terrestrial Environment Laboratory of Nagoya University in monitoring ozone and related species. A millimeter-wave radiometer which measures ozone levels hourly at heights of 20 to 60 km and a Brewer Spectrophotometer were installed in March 1999 and May 1999, respectively.

Ground-based monitoring of GHGs (Hateruma Island and Cape Ochi-ishi)

The concentrations of greenhouse gases (GHGs) at these two stations are continuously monitored to understand trends in the background air quality in Japan. Atmospheric data from the monitoring station on Hateruma, the southernmost inhabited island in Japan, should be representative of the air quality in southern Japan. Monitoring there started in October 1993. Similar data for northern Japan have been collected at the station at Cape Ochi-ishi, Hokkaido, since September 1995; in 1999, this station joined the Acid Rain Monitoring Network in East Asia as a rural site.

Monitoring of GHGs over Siberia by aircraft

The boreal forest CO_2 sink and CH_4 emission are among the factors that govern variations in the carbon cycle in the northern hemisphere. Vertical concentration profiles of GHGs from 500 to 7,000 m in several areas of Siberia are obtained monthly by sampling from aircraft, followed by laboratory analysis in Japan. Monitoring has been carried out over Surgut in central western Siberia since 1993, over Yakutsk in eastern Siberia since 1996 at the same latitude (60˚N), and over Novosibirsk (55˚N) in southwestern Siberia since 1997. The seasonal amplitude of CO_2 variation over Siberia appears to be larger than that measured over the sea at the same latitude.

Monitoring of GHGs along a north-south transect by ship-of-opportunity in the western Pacific

Routine sampling of background air along a north-south transect became possible by using a cargo ship sailing between Japan and Australia 8 times a year on a regular basis. Additional sampling at higher latitudes started in 1995 by utilizing a cargo ship sailing regularly between Canada and Japan. Samples are collected and sent to the CGER after every voyage for high-precision determination of GHGs such as CO_2, CH_4, and N_2O. The data are useful for studies on global cycles of GHGs.

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

Invasion of CO_2 from the atmosphere to the ocean constitutes one of the most important sinks in global carbon cycling. For estimating the net rate of atmosphere-ocean CO_2 exchange, instruments were installed on a cargo ship sailing between Canada and Japan to measure the partial pressure of CO_2 in the air and surface of the ocean automatically. There is clear invasion of CO_2 into the ocean in summer and evasion from the ocean in winter in the northern subarctic Pacific. In the mid-latitude Pacific, the ocean behaves as a sink of CO_2 throughout the year.

Monitoring the flux of greenhouse gases in a northern forest

Since 1999, CGER has been preparing a site for the measurement of CO_2 flux in woodland ecosystems in cooperation with the Hokkaido Regional Forestry Office as

a global environmental monitoring activity. The site is in a deciduous larch (Larix) forest located in the Tomakomai National Forest. The project aims to measure fluxes of CO_2 and energy according to internationally standardized techniques, provide continuous measurements of various functions of the ecosystem, and provide a core site for development and examination of observation systems in Japan and Asia in cooperation with universities, national research institutes and local institutions.

High temporal-spatial resolution biogeochemical monitoring of the western Pacific by ship-of-opportunity

The cycles of chemical elements such as C, N, P and Si have changed from those in pre-industrial and pre-agricultural times. These changes are thought to have an impact on the ocean through marginal seas. CGER has been measuring temperature, salinity, pH, fluorescence, dissolved nutrients, chlorophyll a and pheopigments in the continuous water intake of vessels (Osaka-Beppu). The Center is continuing this mission from a container ship sailing between Japan and other Asian countries.

Mapping the vegetation index with NOAA satellite data

In order to monitor changes in vegetation and land cover in East Asia, Normalized Difference Vegetation Index (NDVI) mosaic images are composed from Advanced Very High Resolution Radiometer (AVHRR) data of NOAA satellites. In FY 1999, monthly NDVI mosaic images from January to December 1998 were produced from AVHRR data received by the two receiving stations, at Tsukuba in Ibaraki Prefecture and Kuroshima in Okinawa Prefecture, respectively. Net primary production (NPP) values of vegetation were estimated by integrating monthly NDVI values over a year.

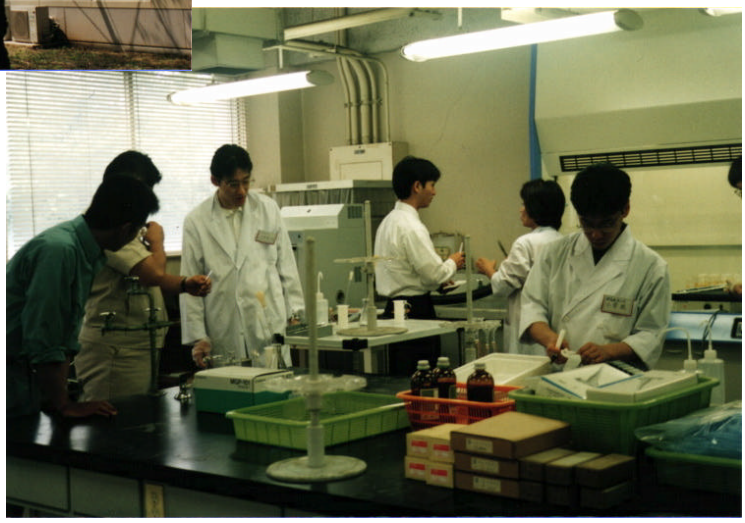
ILAS & RIS and ILAS-II data-handling facilities

The ILAS & RIS data-handling facility (DHF) was used for re-processing ILAS data in order to retrieve atmospheric gas profiles in the polar ozone layer. ILAS was a satellite-based sensor, which operated for about 8 months from November 1996 to June 1997. Operation of the ILAS & RIS DHF was completed in January 2000. The resulting data products have been used for atmospheric scientific research and provided to general users via the Internet. The ILAS-II DHF is the computer system for handling data from ILAS-II, which will be launched in 2001. System performance tests of the ILAS-II DHF were accomplished in FY 1999. Management of the ILAS & RIS DHF and the ILAS-II DHF is the responsibility of CGER in cooperation with the Satellite Remote Sensing Research Team.

GEMS/Water program

GEMS/Water is the Global Environmental Monitoring System for rivers and lakes, organized under UNEP and WHO. A network of 21 stations in Japan has been established for GEMS/Water Phase II activities. 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) Program by providing certified reference materials (CRMs/river sediment) to laboratories analyzing samples from GEMS/Water flux monitoring stations.

Environmental Training Institute



The National Environmental Training Institute (NETI) has provided training courses on administrative skills and analytical techniques in the environmental field to governmental staff since its foundation in 1973. The courses have been changed as the environmental policy priorities shifted.

In FY1999, 21 courses on administration, 10 on laboratory analysis and 5 on international cooperation were provided (Table 1). There were two new courses: an Environmental Monitoring Training Course on Dioxins, which aims to develop trainees' knowledge and analytical skills for measuring dioxins; and a course on Development of Experts in International Cooperation on the Environment (step 3), which is the most comprehensive of the three courses we provide that enable trainees to work on solving various environmental problems in developing countries in cooperation with the local people.

A total of 29,609 persons from various organizations had completed their training at NETI by the end of March 2000. Seventy percent were from local governments, twenty percent from the central government, and the remainder from public corporations (Fig. 1). NETI also accepts trainees from overseas.

Currently, the pressing need to improve the system for detecting and monitoring contamination by dioxins is widely recognized throughout the country. For this reason, we introduced the new course on dioxin analysis, focusing on providing specialized knowledge and advanced skills for technical personnel to conduct analyses of dioxins found in various forms in the environment. Also, the law concerning the Promotion of the Measures to Cope with Global Warming, which is a follow up of the Kyoto Protocol, calls for local governments as well as the national government to make efforts to reduce emissions of greenhouse gases, including formulation of plans for these actions. Thus, NETI is committed to providing a useful training course for local authorities to draw up action plans for limiting greenhouse gas emission.

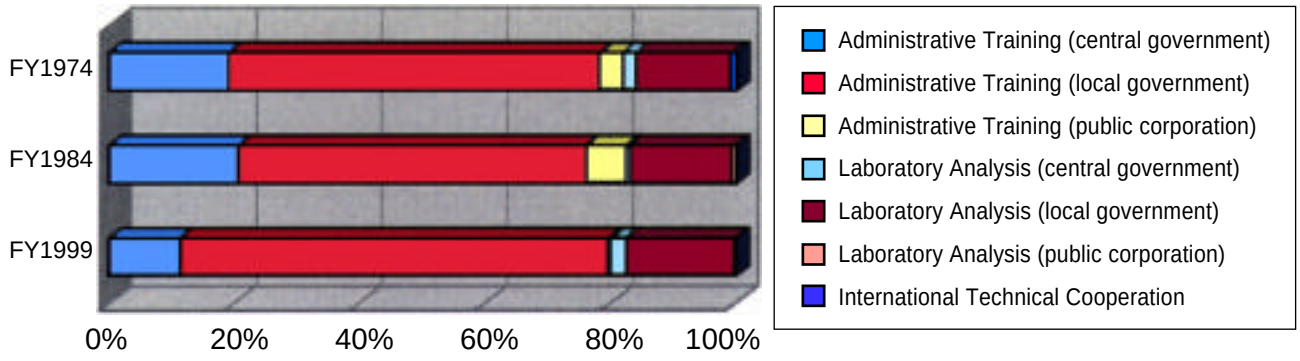


Fig. 1
Percentages of participants in the different courses over time. In the figure, participants in international cooperation training courses are combined with those in administrative training courses.

Table 1 (FY1999)

Administration Training Courses

Course Name	Length (days)	Number of Participants
Seminar for Environmental Policy Managers/Supervisors	5	33
Regional Environment(Environmental Management)	5	56
Environmental Impact Assessment(Administrative)	5	58
Environmental Impact Assessment (Technical)	8	40
Environmental Education(Administrative)	5	60
Environmental Education(Practical)	3	23
The Basic Environment Plan	5	79
Nature Conservation	5	64
Wildlife Conservation	5	44
Air Pollution Control	6	87
Noise and Vibration Control	5	68
Water Pollution Control	6	109
Environmental Conservation of Groundwater and Ground Subsidence	5	45
Environmental Information Management	8	19
Staff of the Environment Agency(Sub-Section Chiefs)	5	15
New Recruits of the Environment Agency(Class I)	7	13
New Recruits of the Environment Agency(Class II&III)	5	13
National Park Management	5	41
Newly Assigned Regional Environmental Intelligence Officers	4	8
Comprehensive Policy Formulation	56	4
Sub Total	—	875

Laboratory Analysis Training Courses

Course Name	Length (days)	Number of Participants
Instrumental Analysis	13	41
Environmental Monitoring Training Course on Dioxins	28	20
Air Quality Analysis	13	24
Water Quality Analysis	13	44
General Water Quality Analysis	5	22
Offensive Odor Analysis	5	8
Special Instrumental Analysis(twice)	5	8
Special Instrumental Analysis	5	11
Special Topics		
Plankton	5	13
Macrobenthic Invertebrates	5	11
Water Blooms	7	8
Sub Total	—	210

International Cooperation Training Courses

Course Name	Length (days)	Number of Participants
Global Environmental Conservation	8	38
Trainers for Overseas Trainees	5	8
Development of Experts in International Environmental Cooperation(step 1)	5	56
Development of Experts in International Environmental Cooperation(step 2)	10	17
Development of Experts in International Environmental Cooperation(step 3)	20	10
Sub Total	—	129

International Technical Cooperation Training Course

Course Name	Length (days)	Number of Participants
Environmental Monitoring (Water Quality)(JICA)	31	12
Grand Total	—	1,218

<Global Environment Research Projects>

Ocean biological processes related to uptake of CO_2 in the North Pacific, Mukai, H., 1999-2000

Factors influencing the future ozone layer, Imamura, T., 1999-2001

Development of matrix for air pollutants emission and deposition and international cooperative field survey in East Asia, Hatakeyama, S., 1999-2001

Environmental load through Chang Jiang River catchment and its effect on marine ecosystem in East China Sea, Watanabe, M., 1999-2001

Optimizating the sustainable management of tropical forests, Okuda, T., 1999-2002

International collaborative studies for applying the Asian-Pacific Integrated Model (AIM) to assess global warming abatement policies with developing countries, Morita, T., 1997-1999

Risk perception and behaviors in relation to developmental level and quality of life (QOL) in the Asia/Pacific countries, Kabuto, M., 1997-1999

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

<Special Research Projects>

Health risk assessment of exposure to extremely low frequency electromagnetic field, Nitta, H., 1997-1999

Origin and dynamics of recalcitrant organic matter in lake and its effects on lacustrine ecosystems and water quality, Imai, A., 1997-1999

Reproductive and developmental effects of hormone-like chemicals in the environment, Yonemoto, J., 1997-1999

Chemical behavior of hazardous substances from waste landfill, Yasuhara, A., 1998-2000

Development of comprehensive toxicity testings for the assessment of total risk from environmental chemicals, Kunimoto, M., 1998-2000

VOCs distribution and it's effects on urban air quality, Wakamatsu, S., 1998-2000

Experimental study on damaging-mechanism on cardiovascular system of suspended five particulate matters(PM2.5), Takano, H., 1999-2001

<International Joint Research Projects>

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

Development of technology and methodology for automatic sampling and analysis of air toxic compounds, Tanabe, K., 1997-1999

Comprehensive studies on the endocrine disrupting compounds (EDC) in the environment, Morita, M., 1999-2003

IPCC Asian Regional Expert Meeting

June 21-23, 1999
NIES,
Tsukuba,Japan

The Intergovernmental Panel on Climate Change (IPCC) initiated to produce the Third Assessment Report (TAR) in 1997. The detail contents of the Working Group 2, which is responsible for the impacts and adaptation of global warming, were determined based on the discussion among authors. There are 19 chapters in the report, and 8 chapters are dedicated to regional impacts assessment. The IPCC Asian Regional Expert Meeting was held as a part of such regional impacts assessment to make a concrete contents and a detailed schedule. IPCC authors and experts in various fields in Asian region attended this meeting.

14th Global Environment Tsukuba '99

-The International Joint Workshop for Studies on Biodiversity-

July 14-16, 1999
Tsukuba International
Congress Center
Tsukuba,Japan

Regarding the increasing loss of biodiversity due to the global climate change and other environmental problems, the importance of fundamental information of known species is essential. CGER invited researchers participating in networking on biodiversity information, classification, and ecology from Asia, Europe and America. to discuss and exchange the latest information. More than 130 partiticipants attended this workshop and 40 oral presentations and 35 poster presentation were made on the topics such as "Global Biodiversity and Its Information","Distributed Nature of Biodiversity", "Accessbility of Catalogue of Nature","Global Species Databases", "Regional Biodiversity Information and Related Studies"and "Asia-Oceanian Scene".

15th Global Environment Tsukuba '99

-The Joint Workshop for the Indonesian Forest Fire and its Environmental Impacts-

March 7,2000
Nihon Kyouiku Kaikan
Tokyo,Japan

This workshop aimed to exchange existing data and information about forest fires in tropical rain forests, such as in Indonesia. Especially focused on the latest works after "The International Study Conference on 1997 Indonesian Forest Fire Event" held in March 1998, about 70 researchers and officers gathered in this workshop. About 20 leading researchers working in Asia-Oceania region made their presentation with the theme of "Aspects of Climate and Atmosphere" "Effects on Biodiversity and Ecosystems" and "Aspects of Human Dimension and Environmental Security" .

JST, CREST Tohyama-Team Seminar on Health Effects of Dioxin and Related Compounds and Mechanism of Toxicity

February 8,2000
Tsukuba International
Congress Center,
Tsukuba, Japan

This seminar was held under the framework of a CREST project, entitled as "elucidation of endocrine disrupting mechanism of dioxin and related compounds for health risk assessment". The main objective was to discuss the above-mentioned theme in the specific topics about Yucheng study, immunomodulation of dioxins and possible estoradiol involvement, and AhR signaling pathway and downstream responsive genes, by Drs. L. Guo, A. Silverstone and M. Goettlicher, respectively.

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.
4. A comprehensive database of microbial diversity: cyanobacteria
University of NSW
Environmental Biology Div.
5. Trace characterization of organic/inorganic carbon in marine environment
WA. Marine. Res. Labs
Regional Environment Div.

CANADA
1. Arctic atmosphere under polar sunrise
Atmospheric Environment Service
Environmental Chemistry Div.
2. Elucidation of the cycling and transformation of chemical substances in the North Pacific Ocean
Dept. Chemistry, Univ. British Columbia
Environmental Chemistry Div.
3. Monitoring of the atmosphere-ocean carbon dioxide exchange rate
Center for Ocean Climate Chemistry, Institute of Ocean Sciences
Global Environment Div.
4. Development of new methodologies to assess physiological effects by environmental pollutants
University of Western Ontario
Environmental Health Sciences Div.
5. Development of assessment and testing method for endocrine disrupting chemicals
Division of Environmental Risk Assessment, National Institute of Environmental Research
Regional Environment Div.

CHINA
1. Advanced wastewater treatment processes for China
Research Institute for Environmental Engineering/Dept. Environmental Engineering, Tsinghua Univ.
Regional Environment Div.
2. Advanced sewage treatment processes by soil system applicable to China
Institute of Applied Ecology, Chinese Academy of Sciences
Regional Environment Div.
3. Development of wastewater and water resources treatment processes applicable to China
Chinese Research Academy of Environmental Sciences
Regional Environment Div.
4. Preparation and evaluation of environmental certified reference materials
China-Japan Friendship Environmental Protection Center
Environmental Chemistry Div.
5. Development of monitoring method and surveillance of dry deposition
China-Japan Friendship Environmental Protection Center
Atmospheric Environment Div.
6. Effects of environmental load on marine ecosystem in the East China Sea and the impacts of runoff on marine ecosystem
Department of International Cooperation State Oceanic Administration
Water and Soil Environment Div.
7. A study on the health effects of heavy metals in China
Environmental Medical Research Institute, Beijing Medical University
Environmental Health Sciences Div.
8. Research on the development of water pollution control techniques for the Taihu Lake in China by bio/ecoengineering
Chinese Research Academy of Environment Sciences
Water and Soil Environment Div.
9. Dioxins analysis and survey of dioxins sources in China
China-Japan Friendship Center for Environmental Protection
Regional Environment Div.
10. Development of suitable technologies to control the greenhouse gas emission during the treatment of domestic waste water
Tongji University
Regional Environment Div.
11. Development of eco-engineering technologies for the control of eutrophication in the drainage area Honfeg Lake and Baihua Lake in China Guizhou
Guizhou Provincial Environmental Protection Bureau
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. Chemotaxonomy and molecular phylogeny of cyanobacteria
Institute Pastuer
Environmental Biology Div.

4. A molecular biological study for mechanisms of environmental adaptation plants
   University of Picardie
   Environmental Biology Div.
5. Studies on intermediary species in atmosphere and flames
   Lab. of University Pierre et Marie Curie
   Environmental Chemistry Div.
6. Biodiversity of microalgae obtained from the Atlantic and the Pacific Ocean
   University of Caen
   Environmental Biology Div.
7. Hormonal regulation of the toxicity of environmental pollutants
   INSELM U469
   Regional Environment Div.
8. Study on measurement of atmospheric trace species using FTIR and other methods in Siberia
   Institute of Solar-Terrestrial Physics, RAS
   Atmospheric Environment Div.

GERMANY
1. Monitoring of stratospheric ozone by laser radar
   Hohenpeissenberg Meteological Observatory
   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 Japan and Germany
   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.
7. Satellite measurement of atmospheric gases (ADEOS project)
   Alfred Wegener Institute
   Global 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. A joint-study on health effects of high-tech-related materials
   Gyeong-Sang Natl. University
   Regional Environment Div.
4. Cross-cultural comparison of landscape evaluation between Japanese and Korean
   KyungPook University
   Social and Environmental Systems Div.
5. Organotin pollution and “imposex” in sea snails in Korea
   Yosu National University
   Regional Environment Div.
6. Study on the monitoring of harmful algal bloom and effects of nitrogen and phosphorus
   National Institute of Environmental Research
   Regional Environment Div.
7. Study on the monitoring of long range transported air pollutants and acid deposition in the northeast Asia region
   Department of Air Pollution, 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. Global environmental database
   GRID-Arendal
   Center for Global Environmental Research

POLAND
1. Molecular mechanisms of plant adaptation to atmospheric stresses
   Plant Breeding and Acclimatization Institute
   Regional Environment Div.
2. Establishment of methodology of health risk assessment on air pollutants
   Institute of Occupational and Environmental Health
   Environmental Health Science Div.

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
   Center for Global Environmental Research
3. Modeling of methane emission rates from natural wetlands
   Institute of Microbiology
   Center for Global Environmental Research
4. Measurement of methane emission rates from permafrost areas
   Permafrost Institute
   Center for Global Environmental Research
5. Environmental change and its effects on the global warming in Siberian permafrost region
   Yakut Institute of Biology, Permafrost Institute, Pacific Oceanological Institute
   Center for Global Environmental Research

6. Research programs under the Baikal international Center for Ecological Research (BICER)
   Limnological Institute, RAS
   Environmental Chemistry Div.
7. Vertical profile measurement of greenhouse gases over Siberia
   Institute of Atmospheric Optics
   Center for Global Environmental Research
8. Collaborative research on management of wetland ecosystems
   Institute of Biology & Soil Sciences
   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. Solubilization of toxic heavy metals from man-made objectives by acid rain
   Dept. Earth Science, Univ. Sheffield
   Regional Environment Div.
2. In vivo NMR spectroscopy method and its application to the field of environmental health
   Dept. Biochemistry, Univ. Cambridge
   Environmental Health Sciences Div.
3. Effects of environmental pollution on the metabolism of trace elements in man
   Rowett Research Institute
   Environmental Health Sciences Div.
4. Algae and Protozoa
   CCAP, Institute of Freshwater Ecology
   Environmental Biology Div.
5. Impacts of atmospheric change on crops and native species
   University of Newcastle
   Center for Global Environmental Research
6. Cooperation on the development and application of Coupled Chromatography-Accelerator Mass Spectrometry Techniques
   University of Oxford
   Environmental Chemistry Div.
7. Studies on intermediary species in atmosphere and frames
   Department of Chemistry, University of Wales Swansea
   Environmental Chemistry Div.
8. Structural and biological characterization of novel toxic products in filamentous cyanobacteria (*Oscillatoria* and *Nostoc*) from Japanese and British waterbodies
   Department of Biological Sciences, University of Dundee
   Environmental Chemistry Div.
9. Studies on molecular biology and ecology of methanotrophs
   University of Warwick, Department of Biological Sciences
   Water and Soil Environment Division
10. Analysis of observation of stratospheric ozone layer using three dimensional models
    Department of Chemistry, University of Chembridge
    Atmospheric Environment Div.
11. Studies on the bark pockets as pollution time capsules for monitoring of the environment
    University of Sheffield
    Global Environment Div.
12. Biodivetsity and phylogeny of coccolithophorids
    Paleontology Department, The Natural History Museum
    Environmental Biology Div.
13. Mechanisms of phagocytic activities in alveolar macrophages
    Sir William Dunn School of Pathology University of Oxford
    Regional Environment Div.

U. S. A.
1. Ecological and physiological aspects of methanotrophs
   Dept. Microbiology, Biochemistry and Molecular Biology, Univ. Maine
   Water and Soil Environment Div.
2. Development of bioremediation technologies for cleanup of contaminated soil
   Center for Environmental Biotechnology, Univ. Tennessee
   Water and Soil Environment Div.
3. Precise measurement of the greenhouse gases in the global baseline atmosphere
   Climate Monitoring and Diagnostics Lab, NOAA
   Center for Global Environmental Research
4. Health impacts of climate change and environmental degradation on human morbidity in regional societies
   National Institute of Environmental Health Sciences
   Regional Environment Div.
5. Effects of logging on lakes ecosystems
   University of Alaska Fairbanks
   Regional Environment Div.
6. Human impacts on biodiversity and nutrient cycling in mire wetland
   Smithsonian Institute
   Environmental Biology Div.
7. Establishment of phytotron research network
   Duke University
   Environment Biology Div.
8. Studies on standardization of measurement and health effect of particulates
   USEPA, National Center of Environmental Assessment
   Environmental Health Sciences Div.
9. Studies on the feasibility of the FTIR network for vertical profiling atmospheric trace species
   University of Denver
   Atmospheric Environment Div.
10. Conservation and reproductive biology of wildlife
    Department of Animal and Plant Science, Sheffield University
    Global Environment Div.

CANADA Agreement between National Institute for Environmental Studies and Institute of Ocean Sciencies (1995).

CHINA Agreement for Collaborative Research to develop a Chinese Greenhouse Gas Emission Model. Energy Research Institute of China (1994).

Agreement on cooperative research projects between the National Institute for Environmental Studies, Environment Agency of Japan and the Institute of Hydrobiology, Chinese Academy of Sciences (1995).

Memorandum of understanding between Institute of Hydrobiology, Chinese Academy of Sciences, Peoples's Republic of China (IHBCAS) and National Institute for Environmental Studies, Japan (NIES) for collaborative research on microalgal toxicology, systematics and culture collection operations (1995).

Memorandum of Understanding between Institute of Remote Sensing Applications, Chinese Academy of Science, People's Republic of China (IRSACAS) and National Institute for Environmental Studies, Japan (NIES) for Collaborative Research on Development of Remote Sensing and GIS Systems for Modeling Erosion in the Changjian River Catchment (1996).

Memorandum of Understanding between Changjiang Water Resources Commission, Ministry of Water Resources, People's Republic of China and National Institute for Environmental Studies, Japan for Collaborative Research on Developments of Monitoring Systems and Mathematical Management Model for Environments in River Catchment (1997).

Memorandum of Understanding between National Institute for Environmental Studies, Japan (NIES) and Chinese Research Academy of Environmental Sciences, People's Republic of China (CRAES) for Collaborative Research on Advanced Treatment of Domestic Wastewater (1997).

Memorandum of Understanding between National Institute for Environmental Studies and School of Environmental Science and Engineering Shanghai Jiao Tong University for Collaborating Research on Eutrophicated lake and marsh water improvement using Bio-ecoengineering Technology (2000).

INDIA Memorandum of Understanding between the Indian Council of Agricultural Research and the National Institute for Environmental Studies for Collaborative Research on Desertification (1993).

KOREA Agreement for Collaborative Research to develop a Korean Greenhouse Gas Emission Model. Korean Energy Economics Institute (1994).

Implementing Arrangement between the National Institute for Environmental Studies of Japan and the National Institute of Environmental Research of the Republic of Korea to establish a cooperative framework regarding environmental protection technologies (1988, and revised in 1994).

Implementing Agreement between National Institute for Environmental Studies of Japan and National Institute of Environmental Research of the Republic of Korea to establish a cooperative framework regarding endocrine disrupting chemicals research (1999).

MALAYSIA Memorandum of Understanding between the Forest Research Institute Malaysia (FRIM), the University Pertanian Malaysia (UPM) and the National Institute for Environmental Studies, Japan (NIES) for Collaborative Research on Tropical Forests and Biodiversity (1991, and revised in 1995).

RUSSIA Agreement on a Joint Geochemical Research Program; Impact of Climatic Change on Siberian Permafrost Ecosystems between the Permafrost Institute, Siberian Branch, Russian Academy of Sciences, Russia and the National Institute for Environmental Studies, Japan (1992).

Agreement on a Cooperative Research Project between the Central Aerological Observatory, Committee for Hydrometeorology and Monitoring of Environment, Ministry of Ecology and Natural Resources, Russian Federation and the National Institute for Environmental Studies, Japan (1992).

Agreement on Cooperative Research Projects between National Institute for Environmental Studies, Environment Agency of Japan and Institute of Atmospheric Optics, Russian Academy of Sciences (1997).

THAILAND Memorandum of understanding between Kasetsart University, Bangkok, Thailand and National Institute for Environmental Studies, Japan (NIES) for collaborative research on microalgal and protozoan biochemistry and toxicology, systematics and diversity, and application (1995).

UN Memorandum of Understanding referring to the establishment and operation of a GRID-compatible Centre in Japan (1991).

<Host Division>

Researcher, COUNTRY, Research Period
Research Subject (Host Researcher)

<Global Environment Division>

Glucksnis, Allison Marie, U.S.A., 1999. 9. 7~2000. 3.31
Effects of Sika-deer browsing on vegetation dynamics (Okuda, T.)

Hooper, Rowan Earle, ENGLAND, 1999.8.26~2000.3.31
Polymorphic reproductive strategies and immune system in Mnais costalis (Tsubaki, Y.)

Jana, Anna Kubiznakova, CZECH, 1999.11. 8~2000. 3.31
Studies on the pollution time capsules using bark pockets (Satake, K.)

Klotz, Björn, GERMANY, 1999.10.15~2000. 3.31
Photooxidation Reactions of Aromatic Hydrocarbons in the Atmosphere (Washida, N.)

Lefèvre, Franck, FRANCE, 1999. 8. 1~1999.10.31
A study on formation of Polar stratospheric clouds(PSCs) using ILAS date and 3D chemical transport model(Reprobus) (Nakajima, H.)

Murphy, Paulette, U.S.A., 1999. 6. 15~2000. 3.31
Time Series Observation of Ocean Biogeochemical Cycles in the Northwestern Pacific (Nojiri, Y.)

Oshchepkov, Sergey Leonidovitch, BELARUS, 1999. 7. 5~ 2000.3.31
A study on retrieving gases and aerosols simultaneously from ILAS and ILAS-II date (Nakajima, H.)

Plaistow, Stewart John, U.K., 1999.9.24~2000. 2.29
Local population variation in reproductive ecology in insects (Tsubaki, Y.)

Yang, Hong-Wei, CHINA, 2000. 1.10~2000. 3.31
Analysis of Carbon Dioxide Emission Reduction Potential in China (Kainuma, M.)

<Regional Environment Division>

Anuradha, D. Cunnigaipur, INDIA, 1999.11. 2~2000. 3.31
Gene expression in the lung following exposure to airborne toxic substanses (Hirano, S.)

Cui, Tailin, CHINA, 1999. 6.11~2000. 3.31
Development of respiratory damage indicators for environmental health risk assessment (Hirano, S.)

Dirk, Mathilde Hendrik Van Gogh, BELGIUM, 1999. 7. 1~ 1999. 9.10
Study on the design implementation of land transport systems to mitigate environmental burdens (Kondo, Y.)

Frank, Stagniti, AUSTRALIA, 1999.11. 1~1999.12.31
Risk of groundwater contamination from surface-applied agrochemicals : Assessment & Modeling (Morita, M.)

Graem, Allinson, AUSTRALIA, 1999.10.25~2000. 1.24
Study on chemical mobility of toxic substances in ground water (Nishikawa, M.)

Gui, Ping, CHINA, 1999. 9.18~2000. 3.31
Development of CH_4, N_2O control technology using ecoengineering system such as soil-trench, wetland, lagoon and aquatic plant purification method (Inamori, Y.)

Ha, Kyong, KOREA, 1999.11.16~2000. 3.31
Fundamental Studies on lakes andrivers for ecosystem managements : with the emphasis on interrelation ships among aquatic organisms (Takamura, N.)

He, Yao-wu, CHINA, 1999. 4. 1~2000. 3.31
Development of organic waste recycling technology for the control of CH_4, N_2O emission (Inamori, Y.)

Jai, Prakash Gaur, INDIA, 1999. 6. 7~1999. 7. 5
Carbon and Nitrogen cycling in ecosystems with different food chains (Takamura, N.)

Jia, Guang, CHINA, 2000. 2. 1~
Mechanistic study of heavy metal-induced carcinogenesis (Sone, H.)

Kim, Baik-Ho, KOREA, 1999. 4.16~2000. 3.31
Relations between Aquatic Organism and Water Quality in Shallow Lake Kasumigaura (Takamura, N.)

Kim, Han Soon, KOREA, 1998. 9.17~1999.8.31
Distribution of chrysophyceal in a experimental pond without fish (Takamura, N.)

Kim, Jeong-Sook, KOREA, 1999.11. 1~2000. 3.31
Emission control of global warming as in sewage treatment process using microorganisms immobilized method (Inamori, Y.)

Ki-Young, Lee, KOREA, 1999. 6. 1~1999. 7.31
Development of database on health effects of diesel exhaust published in Japan (Nitta, H.)

Lee, Sang Hyon, KOREA, 2000. 1.17~2000. 2.26
Advanced nitrogen and phosphorous removal process (Inamori, Y.)

Loan, Thi Nguyen, VIET NAM, 1999. 7. 1~1999. 9.30
Development of nitrogen and Phosphorous removal process from domestic wastewater using bio-ecoengineering system (Inamori, Y.)

Lu, Xi-wu, CHINA, 1999. 7.15~2000. 3.31
Development of Appropriate Wastewater and Sludge Treatment Technology for Controlling CH_4 and N_2O emission (Inamori, Y.)

Nam, Kwang-Hyun, KOREA, 1999.12.21~2000. 3.31
Study on development of advanced nutrient substance removal process in sewage treatment system (Inamori,Y.)

Park, No-Suk, KOREA, 2000. 1.17~2000. 2.26
Study on optimization of advanced treatment process for polluted drinking water reservoir (Inamori, Y.)

Sarkar, Shubhashish, INDIA, 1997. 6. 3~1999. 6. 2
The role of zinc involved in the antioxidative mechanisms against oxidataive stress induced by environmental pollutants (Yonemoto, J.)

Sun, Liwei, CHINA, 1999. 5.28~2000. 3.31
Changes in aquatic organisms and ecosystem management in a shallow lake (Takamura, N.)

Yeru, Huang, CHINA, 1999. 1. 6~1999. 4. 5
Study on simultaneous determination for voc's in atmospheric aerosols by a GC/MS (Nishikawa, M.)

Zbigniew, W. Rybka, POLAND, 1999.12. 8~2000. 3.20
Molecular and physiological baces of resistance of commercial wheat cultivars to UV-B (Nakajima, N.)

<Social and Environmental Systems Division>

Ahish, Rana, INDIA, 1999. 3.26~1999.6.25
Scenario analyses of Indian energy, economy and emissions based on a general equilibrium model (Morita, T.)

Ahish, Rana, INDIA, 1999. 12.21~2000.3.18
Development of CO_2 emission Model in India (Morita, T.)

Dikdik, Setia Permana, INDONESIA, 1999. 8. 9~2000. 3.31
Measurements of plant 3-D structures using optical sensors (Tamura, M.)

Eric, W. Welch, U.S.A., 1998. 7.31~1999. 7.31
Managerial and Policy Effects on Consumption Behavior of Organizations (Gotoh, S.)

Guan, Hong Liang, CHINA, 2000. 1.26~2000. 3.31
Study on the conservation of forests, wetlands and biodiversity in Asian Pacific region (Tamura, M.)

Lee, Dong-Yup, KOREA, 2000. 1.17~2000. 2.26
Life Cycle Assessment and Material Flow Analysis of Major Industrial Materials (Moriguchi, Y.)

Murari, Lal, INDIA, 1999. 6. 1~1999. 8.31
Integrated Assessment on Vulnerability of South-East Asia to climate change (Morita, T.)

Pranab, Jyoti Barush, INDIA, 2000. 1. 7~2000. 3.31
Water quality analysis of Lake Kasumi-ga-ura using satellite date (Tamura, M.)

You, Song Cai, CHINA,1999. 8. 9~2000. 3.31
Development of assessment model of climate change impact on agriculture (Morita, T.)

Werner, Nohl, GERMANY, 1999.10.18~1999.11.31
Recreational use of landscape (Aoki, Y.)

<Environmental Chemistry Division>

Alam, Md. Golam Mahbub, BANGLADESH, 1999. 8. 9~ 2000. 3.31
Bioaciumulation of heavy metals through food web system in Lake Kasumigaura (Tanaka, A.)

Chatterjee, Amit, INDIA, 1998. 6.10~2000. 3.31
Studies on the Speciation of Arsenic in the Environment and its Efficient Removal Method (Shibata, Y.)

Chowdhury, A.Z.M. Shaifullah, BANGLADESH, 1999.10. 1~ 2000. 3.31
Arsenic speciation in the environment : in context of Bangladesh (Shibata, Y.)

Forchert, Ayako Kikue, GERMANY, 1999. 5.10~1999. 8. 9
Structure elucidation of bioactive compounds isolated from toxic cyanobacteria (Kaya, K.)

Kareev, Mikhail Sergeyevich, UZUBEKISTAN, 1998.11.25~ 2000. 3.31
Studies on Intermediary Species in Atmosphere and Flames using Li+ion attachment mass spectrometry (Fujii, T.)

Kim, Woo Hyun, KOREA, 2000. 1.17~2000. 2.26
Analysis of anatoxin-a in waterblooms of Noktong River (Kaya, K.)

Lu, Ming, CHINA, 1999. 8. 9~2000. 3.31
Analytical chemical studies on effects of endocrine disruptors to reproduction in aquatic organisms (Horiguchi, T.)

Min, Jiho, KOREA, 2000. 1.17~2000. 2.26
Development of analytical technique for quantication of choriogenin mRNA in Medaka fish (Shiraishi, H.)

Moon-Soo, Park, KOREA, 1999. 6.14~1999. 9. 5
Adverse effects of endocrine disruptors to aquatic organisms (Horiguchi, T.)

Sundram, Arulmozhiraja, INDIA, 1998. 8. 1~2000. 3..31
Structure, energy and reaction of Dioxin (Fujii, T.)

<Environmental Health Sciences Division>

Jana, Nihar R, INDIA, 1997. 6.15~1999. 6.14
Mechanism of toxicity of environmental endocrine disruptors in the male reproductive organs (Tohyama, C.)

Lee, Jae-Seong, KOREA, 1999.10. 1~2000. 3.31
Development of transgenic zebrafish for detecting mutagen (Aoki, Y.)

<Atmospheric Environmental Division>

Lukyanov, Alexander, RUSSIA, 1999. 8. 2~2000. 3.31
Analysis of satellite and balloon data with a photochemical model (Nakane, H.)

Patroescu-Klots, Inlia Varelia, ROMANIA, 1999. 9. 1~
Studies on the photochemical oxidation of organic sulfur compounds (Hatakeyama, S.)

Sivanesan, Subramanian, INDIA, 1999. 2. 1~2000. 1.31
Studies on photooxidation processes of the atmospheric minor constituents by use of a $6m^3$ photochemical reaction chamber (Hatakeyama, S.)

Song, Yongchen, CHINA, 1999. 4.19~2000. 3.31
Study on polar-midlatitude interactions and ozone variability (Nakane, H.)

Subbaiyan, Masilamani, INDIA, 1999.10.20~2000. 1.19
Studies on the mechanisims of the formation of peroxides from ozone-olefin reactions (Hatakeyama, S.)

Voelger, Peter, GERMANY, 1998. 8.31~2000. 3.31
Relevance of multiple scattering in space lidar measurements of clouds and aerosols (Sugimoto, N.)

Zhang, Jiahua, CHINA, 1999. 7. 1~
Modeling of carbon exchange processes at the land surface (Kanzawa, H.)

<Water and Soil Environment Division>

Belova, Svetlana E., RUSSIA, 1998. 10. 6~1999. 7. 5
Biodiversity of microorganisms responsible for methane formation in the West Siberia wetland (Uchiyama, H.)

Jiao, Nianzhi, CHINA, 1997.11. 1~1999.10.31
Biodiversity of picoplankton in East China Sea (Watanabe, M.)

Wang, Qinxue, CHINA, 1998. 7. 1~2000. 3.31
Digital database for diagnostic analysis of environment in Northern and Northeastern parts of China (Otsubo, K.)

Yonghui, Yang, CHINA, 2000. 3. 1~2000. 3.31
The effect of global warming on productivity and water cycle in China (Watanabe, M.)

Zhao, Xin, CHINA, 1999. 5.28~2000. 3.31
Microorganisms responsible for degradation of plant body in wetland (Uchiyama, H.)

<Environmental Biology Division>

Gontcharov, Andrei A., RUSSIA, 1997. 11. 1~1999.10.31
Studies on species diversity of microalgae based on reproductive isolation mechanisms (Watanabe, M.M.)

Hehmann, Anett, GERMANY, 1999. 7. 1~2000. 3.31
Selective control of toxie cyanobacteria and detoxication of toxie compoands, microcystins using algicides (Watanabe, M.M.)

Ik, Kyo Chung, KOREA, 1999. 8.19~2000. 3.31
Toxonomy and culture of marine picoplankton (Watanabe, M.M.)

Qiu, Guo Yu, CHINA, 1999.10. 1~2000. 3.31
Evaluation of the Activities and Technologies to Combat Desertification in China (Tobe, K.)

Robertson, Bronwyn R, AUSTRALIA, 1998. 6. 1~2000. 3.31
Molecular taxonomy and phylogeny of cyanobacteria as a model for evaluating biodiversity (Watanabe, M.M.)

<Center For Global Environmental Research>

Alexandrov, Georgii Albertovich, RUSSIA, 1999. 7.25~ 2000. 3.31
Modeling of Carbon Cycle in Forests (Inoue, G.)

Kataev, Mikhail Yurievich, RUSSIA, 1999. 8.23~2000. 3. 5
Inversion Analysis of Solar FTIR spectra to Obtain CO_2 distribution (Inoue, G.)

Logofet, Dmitry Olegovich, RUSSIA, 1999. 9.28~1999. 12.28
Risk Assessment in Carbon sequestration (Yamagata, Y.)

Maksyutov, Shamill, RUSSIA, 1998. 5.18~2000. 3.31
Modeling of Green house Gases Flux (Inoue, G.)

Pumijumnong, Nathsuda, THAILAND, 2000. 1.10~2000. 3.31
Carbon sink accounting under Kyoto Protocol and its implication to Asia countries focus point in Thailand (Yamagata, Y.)

Si, Weiduo, CHINA, 2000. 1.19~2000. 3.18
Database of microbes in extreme environment (Shimizu, H.)

Thomas, Paul Kurosu, GERMANY, 1999.11. 1~2000. 3.31
Detection of Tropospheric and Polar Stratospheric Clouds for ILAS-type Satellite Sensors (Yokota, T.)

Zheng, Youbin, CHINA, 1998. 3.19~2000. 3.18
Combined effects of environmental changes due to global warming on forest trees (Shimizu, H.)

Akiyama, N. (*1), Murata, S. (*2), Alexander, D. B. (*1), Yaoita, H. (*2), Aoki, Y., Noda, M. (*1) (*1Kyoto Univ., *2Jichi Med.Sch.) (1999)
Cytotoxicity and Mutagenicity of UVB Assessed Using Cultured Rat Fibroblast, *J.Epidemiol*., **9**(**6**)**Suppl**., 72-77

Alexandrov, G. A., Yamagata, Y., Oikawa, T. (*1) (*1Tsukuba Univ.) (1999)
Towards a model for projecting Net Ecosystem Production of the world forests, *Ecol.Modelling*, (**123**), 189-191

Amagai, T. (*1), Olansandan,. (*1), Matsushita, H. (*1), Ono, M., Nakai, S. (*2), Tamura, K. (*3), Maeda, K. (*4) (*1Shizuoka Univ., *2Yokohama Natl.Univ., *3Natl.Inst. Minamata.Dis., *4Tokyo Kasei Univ.) (1999)
A Survey of Indoor Pollution by Volatile Organohalogen Compounds in Katsushika,Tokyo,Japan, *Indoor Built Environ*, **8**, 255-268

Amanuma, K., Takeda, H. (*1), Amanuma, H. (*2), Aoki, Y. (*1Natl.Inst.Genet., *2RIKEN.) (2000)
Transgenic zebrafish for detecting mutations caused by compounds in aquatic environments, *Nat.Biotechnol*., **18**(**1**), 62-65

Aoyagi-Usui, M. (1999)
Comparative Analysis of Citizens'Values and Pro-Environmental Behavior, *Asian Geogr*., **18**(**1-2**), 123-134

Arulmozhiraja, S., Fujii, T., Tokiwa, H. (*1) (*1Rikkyo Univ.) (1999)
InOH:A Quantum Chemical Study, *J.Phys.Chem.*, **103**,4085-4088

Asai, N. (*1), Nakajima, N., Kondo, N. (*2), Kamada, H. (*1) (*1Tsukuba Univ., *2Univ.Tokyo.) (1999)
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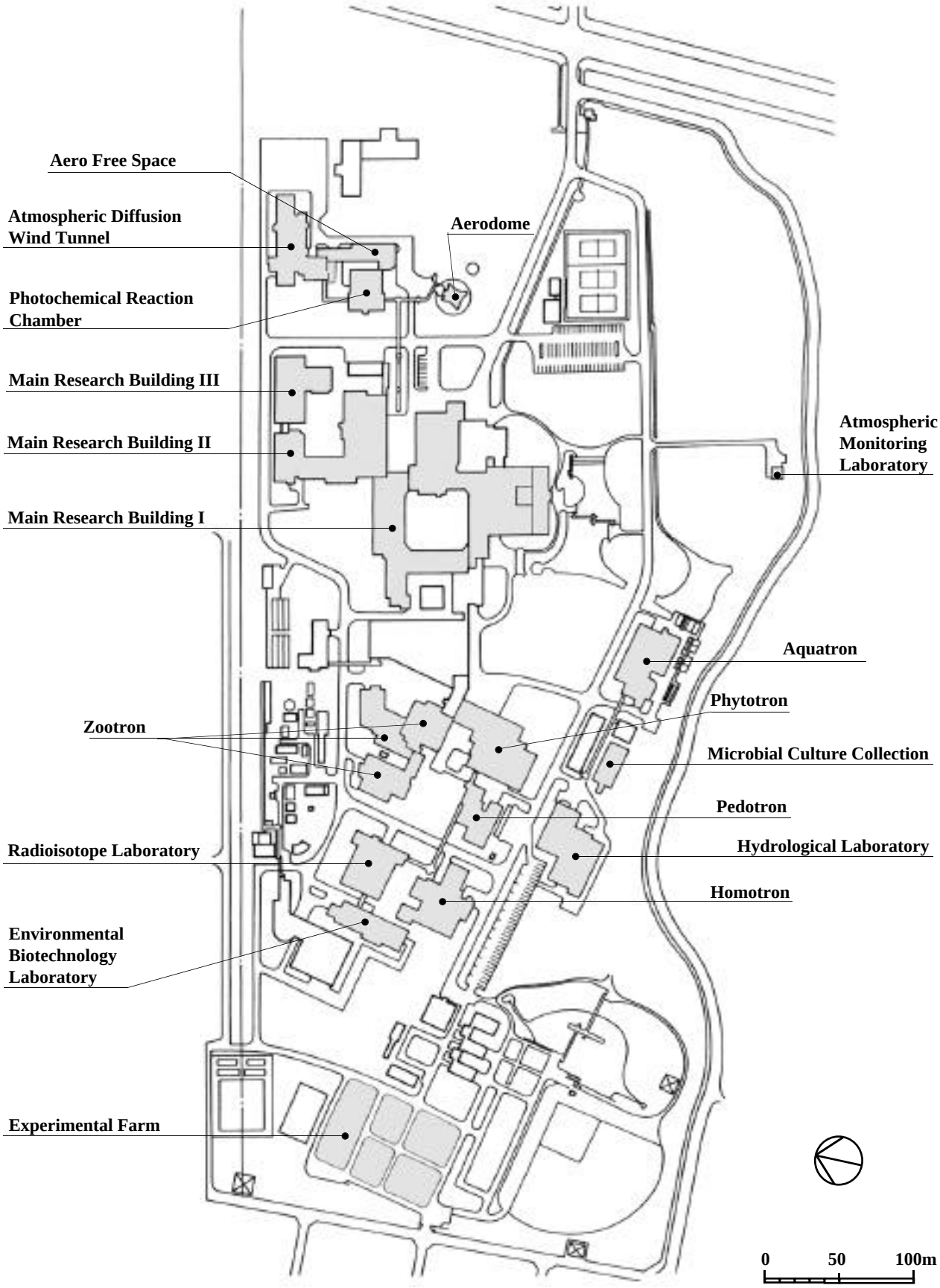
Aero Free Space
Atmospheric Diffusion Wind Tunnel
Aerodome
Photochemical Reaction Chamber
Main Research Building III
Main Research Building II
Main Research Building I
Atmospheric Monitoring Laboratory
Aquatron
Phytotron
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Microbial Culture Collection
Pedotron
Hydrological Laboratory
Radioisotope Laboratory
Homotron
Environmental Biotechnology Laboratory
Experimental Farm
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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 scan rapidly and sensitively, 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 calibration for both laboratory and field experiments. It is also available for atmospheric research that cannot be done in any of the other atmospheric research facilities.

The ozone laser radar is equipped with 3 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 freshwater 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 3-dimensional data. These features, together with the use of models of buildings or mountains in the tunnel, allow accurate simulation of air flow and pollutant transport under a variety of atmospheric conditions.

Atmospheric Monitoring Laboratory
Automatic instruments to monitor the concentrations of 7 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, visible 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 that interfere with them are studied.

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

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 and bioremediation, to researchers at the Institute.

Global Environmental Moniotoring Stations (Hateruma and Cape Ochi-ishi)
These Monitoring stations were set up mainly to monitor the long-term changes in baseline level of global-warming gases at sites where the effect of urban air pollution is virtually negligible. Hateruma Station is located in Okinawa Prefecture, on the eastern edge of Hateruma Island, the nation's southernmost inhabited island. This site is suited for monitoring the baseline atmosphere over the subtropical Pacific Ocean. Cape Ochi-ishi Station is located in Hokkaido Prefecture, at the tip of Cape Ochi-ishi, which is located at the root of Nemuro Peninsula. This site is suited for monitoring the baseline atmosphere over the Pacific Ocean in summer and over Siberia in winter.

These stations are automated systems for high-precision monitoring of global-warming gases and other atmospheric species; human attendance is not required.

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 for testing the psycho-physiological effects of noise on health. The Community Health Laboratory provides facilities for 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 used 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
This building houses analytical instrumentation and support facilities such as clean rooms. The 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 that are used for research and development of new analytical methods.

Table of Analytical Instrumentation in Main Research Building I

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 Systems (SAPIENS)

ELMES includes a medium-sized conference room that 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 room for archives. Environmental specimens are stored here for long periods. Research on specimen preservation is also conducted.

Main Research Building III

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

FT-MS has very high mass resolution, more than 10^6 at m/z = 131, with a superconducting magnet rated at 3 Tesla. Cluster ions with high mass numbers, isotopes/isobars, and reactions 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 6.5×10^4, 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 million V (max.) terminal voltage is interfaced with two ion sources and an analytical mass spectrometer system. Isobaric atomic ions 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-markers (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 the 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; discharge water is also treated with a charcoal filter system. These filters and other wastes are destroyed by appropriate incineration facilities installed within the area. The Hazardous Chemicals Area contains 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, and were developed by the Environment Agency of Japan as components of the Advanced Earth Observing Satellite (ADEOS), named Midori after launching. In August 1996, ADEOS was launched by an H-II rocket from the Tanegashima Space Center of Japan. Data obtained by ILAS/RIS are 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 astronomical measurements of gaseous molecules in space. Ozone molecules in the stratosphere and mesosphere radiate millimeter-range radio waves. The spectrometer system was completed in October 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

This is 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 hot water generated 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 (NOAA, USA) 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). The NIES AVHRR facilities consist of 2 receiving stations—one at NIES, Tsukuba, and the other on the island of Kuroshima, 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). The 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 work stations 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
The 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 is the soil laboratory, which contains 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 also studied.

Photochemical Reaction Chamber
This is a 6-m^3 stainless steel chamber that 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
The 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 has 2 simulators that permit the creation of micro-environments stratified from the soil up through the overlying atmosphere.

Radioisotope Laboratory
In this laboratory, radioisotopes are used to 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.

Rikubetsu Stratospheric Monitoring Station
NIES has carried out the monitoring of the stratospheric ozone layer over Hokkaido in collaboration with Solar-Terrestrial Environment Laboratory (STEL) in Nagoya University. Also, the monitoring has been made in a room of the Rikubetsu Astronomical Observatory administered by Rikubetsu town. The center has taken varions systems to monitor, including vertical distribution of stratospheric ozone measured by Millimeter-wave radiometer, observation of harmful ultraviolet rays monitored by Brewer spectrometer and vertical temperature distribution of stratospheric ozone monitored by laser radar.

The aim is to reveal the ozone depletion in the stratosphere and the effects of "Arctic ozone hole". Since parts of the polar vortex in the Arctic region sometimes arrive over Hokkaido in winter/spring, Rikubetsu is one of the sites to study the effects of the Arctic polar vortex.

Tomakomai Flux Research Site
The main research objectives are to develop and evaluate the observation systems for measurement of fluxes of CO_2 and energy in woodland ecosystem at Tomakomai National Forest in Hokkaido. The comprehensive research has carried out continuous monitoring in deciduous larch forest to elucidate carbon cycle function such as CO_2 fiux. Under the cooperation of universities, national research institutes, regional government and Hokkaido Regional Forest Office as a main site, the observation has been implemented.

Zootron
The animal laboratory has two facilities, in which environmental conditions are controlled. Facility I breeds conventional and specific pathogen-free laboratory animals and has complex gas exposure chambers. 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 (NMRI) 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	38
Global Environment Division	21
Regional Environment Division	42
Social and Environmental Systems Division	16
Environmental Chemistry Division	16
Environmental Health Sciences Division	19
Atmospheric Environment Division	20
Water and Soil Environment Division	16
Environmental Biology Division	16
Environmental Information Center	18
Center for Global Environmental Research	9
Environmental Training Institute	18
Total	256

Field of Expertise

Basic Sciences	85
Engineering	40
Agricultural Sciences	21
Medical Science	15
Pharmacology	7
Fisheries Science	3
Economics	2
Total	173

Division Section/Team	Position	Staff Member	Extension	E-mail (@nies.go.jp)
Director	Director General	OHI, Gen	2300	ohigen
	Deputy Director General	GOHSHI, Yohichi	2301	gohshi
Research Coordinators	Principal Research Coordinator	TAKAGI, Hiroaki	2302	htakagi
	Research Coordinator	TAKIMURA, Akira	2453	takimura
	Research Coordinator	USHIBA, Masaki	2303	ushiba
	Research Coordinator (∗)	SUGA, Shinsuke	2305	sugas
	Research Coordinator (∗)	HIRANO, Seishiro	2306	seishiro
	Research Coordinator (∗)	SUGIYAMA, Ken-ichiro	2307	kensugi
	International Research Coordinator	HIROKANE, Katsunori	2308	hirokane
	International Coordination Researcher	UEHIRO, Takashi	2309	uehiro
General Affairs Division				
	Director	SAITO, Teruo	2311	steruo
General Affairs Section				
	Chief	YAMAMOTO, Hiroshi	2312	hiroshi
Accounting Section				
	Chief	INABA, Hiroshi	2319	inaba
Facility Section				
	Chief	USUKI, Tamio	2325	usuki
Global Environment Division				
	Director (∗)	WASHIDA, Nobuaki	2337	wasida
	Deputy Director	TSUBAKI, Yoshitaka	2482	tsubaki
	Deputy Director (∗)	NAKANE, Hideaki	2491	nakane
	Independent Senior Researcher	MURANO, Kentaro	2537	murano
Global Warming Mechanism Research Team				
	Leader	NOJIRI, Yukihiro	2499	nojiri
		MUKAI, Hitoshi	2536	lnmukaih
		MACHIDA, Toshinobu	2525	tmachida
Global Warming Response Research Team				
	Leader	KAINUMA, Mikiko	2422	mikiko
		MASUI, Toshihiko	2524	masui
		FUJINO, Junichi	2504	fuji
Ozone Layer Research Team				
	Leader	IMAMURA, Takashi	2406	imamura
		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
Natural Vegetation Conservation Research Team				
	Leader	OKUDA, Toshinori	2426	okuda
		TANG, Yanhong	2481	tangyh
Wildlife Conservation Research Team				
	Leader	TAKAMURA, Kenz	2470	takaken
		NAGATA, Hisashi	2493	hnagata
		GOKA, Kouichi	2480	goka
Satellite Remote Sensing Research Team				
	Leader	NAKAJIMA, Hideaki	2800	hide
		SUGITA, Takafumi	2460	tsugita
Human Dimension Research Team				
	(∗)	HARASAWA, Hideo	2507	harasawa
	(∗)	HATAKEYAMA, Shiro	2502	hatashir

(∗) Multiple roles

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	HIRANO, Seishiro	2512	seishiro
Traffic Pollution Control Research Team			
Leader	TANABE, Kiyoshi	2478	tanabe
	KONDO, Yoshinori	2441	kondos
	MATSUHASHI, Keisuke	2511	matuhasi
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	IMAI, Akio	2405	aimai
	MATSUSHIGE, Kazuo	2527	matusige
Hazardous Waste Research Team			
Leader	YASUHARA, Akio	2544	yasuhara
	HASHIMOTO, Shunji	2531	shunji
	YAMAMOTO, Takashi	2547	tyama
Water Quality Renovation Technology Research Team			
Leader	SUZUKI, Noriyuki	2331	nsuzuki
	SAKURAI, Takeo	2801	tsakurai
Air Pollutants Health Effects Research Team			
Leader	TAKANO, Hirohisa	2334	htakano
	SUZUKI, Akira	2461	suzukiak
	FURUYAMA, Akiko	2521	kawagoe
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 (∗)	MORITA, Masatoshi	2332	mmorita
	SUGAYA, Yoshio	2458	sugaya
	TADA, Mitsuru	2475	mtada
Biotechnology Products Assessment Research Team			
Leader (∗)	YAGI, Osami	2542	yagiosa
	NAKAJIMA, Nobuyoshi	2490	naka-320
	IWASAKI, Kazuhiro	2407	kiwasaki
	TAMAOKI, Masanori	2466	mtamaoki
Urban Environment and Health Research Team			
Leader	NITTA, Hiroshi	2497	nitta
	TAKAHASHI, Shinji	2467	stakahas
	IMAI, Hideki	2404	imahide
Comprehensive RiskAssessment & Bioassay Team			
Leader	KUNIMOTO, Manabu	2433	kunimoto
	ISHIDO, Masami	2396	ishidou
	ADACHI, Tatsumi	2546	taadachi
International Health Effects Research Team			
Leader	ANDO, Mitsuru	2395	mando
	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

(∗) Multiple roles

International Atmospheric Environment Research Team			
Leader (*)	MORITA, Masatoshi	2332	mmorita
	NISHIKAWA, Masataka	2495	mnishi
Social and Environmental Systems Division			
Director	MORITA, Tsuneyuki	2541	t-morita
Deputy Director	OI, Ko	2416	koimoon
Independent Senior Researcher	AOKI, Yoji	2389	yojiaoki
Environmental Economics Section			
Leader	HARASAWA, Hideo	2507	harasawa
	AOYAGI, Midori	2392	aoyagi
	HIBIKI, Akira	2510	hibiki
	KAWASHIMA, Yasuko	2430	ykawas
Resources Management Section			
Leader	MORIGUCHI, Yuichi	2540	moriguti
	MORI, Yasuhumi	2539	mori-y
	TERAZONO, Atsushi	2506	terazono
Environmental Planning Section			
Leader	OTOMA, Suehiro	2420	otoma
	TAKAHASHI, Kiyoshi	2543	ktakaha
Information Processing and Analysis Section			
Leader	TAMURA, Masayuki	2479	m-tamura
	SUGA, Shinsuke	2456	sugas
	SHIMIZU, Akira	2452	ashimizu
	YAMANO, Hiroya	2477	hyamano
Environmental Chemistry Division			
Director	NAKASUGI, Osami	2335	nakasugi
Deputy Director	FUJII, Toshihiro	2516	t-fujii
Independent Senior Researcher	KAWAI, Takayoshi	2429	tkawai
Independent Senior Researcher	YOKOUCHI, Yoko	2549	yokouchi
Analytical Instrumentation and Methodology Section			
Leader	SOMA, Yuko	2463	yukosoma
	KUME, Hiroshi	2436	hkume
Analytical Quality Assurance Section			
Leader	SHIRAISHI, Hiroaki	2455	hirosira
	ITO, Hiroyasu	2398	h-ito
	HORIGUCHI, Toshihiro	2522	thorigu
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
	MOCHITATE, Katsumi	2538	mochitat
	NOHARA, Keiko	2500	keikon
	KUROKAWA, Yoshika	2437	kurokawa
Experimental Pathology and Toxicology Section			
Leader	AOKI, Yasunobu	2390	ybaoki
	MATSUMOTO, Michi	2528	michi
	SATOH, Masahiko	2448	masahiko
	OHSAKO, Seiichiro	2519	ohsako
	ISHIMURA, Ryuta	2397	ishimura

(*) Multiple roles

Biological and Health Indicators Section			
Leader	MITSUMORI, Fumiyuki	2532	mitumori
	UMEZU, Toyoshi	2415	umechan
	YAMANE, Kazusuke	2419	kyamane
	ISHIZUKA, Mayumi	2372	ishizum
Environmental Epidemiology Section			
Leader	ONO, Masaji	2421	onomasaj
	TAMURA, Kenji	2520	ktamura
	MIYABARA, Yuichi	2523	miyabara
Atmospheric Environment Division			
Director	SASANO, Yasuhiro	2444	sasano
Deputy Director	NAKANE, Hideaki	2491	nakane
Atmospheric Physics Section			
Leader	KANZAWA, Hiroshi	2431	kanzawa
	SUGATA, Seiji	2457	sugatas
	EMORI, Seita	2498	emori
	NOZAWA, Toru	2530	nozawa
	HIGURASHI, Akiko	2423	hakiko
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(*) Multiple roles

ACO	1-aminocyclopropane-1-carboxylate oxidase
ACS	1-aminocyclopropane-1-carboxylate synthase
ADEOS	Advanced Earth Observing Satellite
AIM	Asian-Pacific Integrated Model
APARE	East Asia/North Pacific Regional Experiment
APN	Asia-Pacific Network for Global Change Research
ARD	Aforestation, Reforestation and Deforestation
AVHRR	Advanced Very High Resolution Radiometer
BAHC	Biospheric Aspects of the Hydrologic Cycle
CCD	Convention to Combat Desertification
CCSR	Center for Climate System Research, the University of Tokyo
CDM	Clean Development Mechanism
CGER	Center for Global Environmental Research
CRA	comparative risk assessment
CRM	certified reference material
DE	diesel exhaust
DEM	Digital Elevation Model
DEP	diesel exhaust particles
DGGE	denaturing gradient gel electrophoresis
DHF	Data Handling Facility
DMBA	7,12-dimethylbenz[a]anthracene
DMS	dimethyl sulfide
E2	17 ß-estradiol
EANET	Acid Deposition Monitoring Network in East Asia
ECG	electrocardiogram
EC_{10}	10% effective concentration
ELISA	enzyme-linked immunosorbent assay
FA	Fluctuating Asymmetry
FAO	Food and Agriculture Organization of the United Nations
FTS	Fourier Transform Spectrometer
GBIF	Global Biodiversity Information Facility
GC/MS	gas chromatography/mass spectrometry
GCM	General Circulation Model
GECHS	Global Environmental Change and Human Security
GEMS/Water	Global Environmental Monitoring System/ Assessment of Freshwater Quality
GIS	geographical information system
GOES	Global Omnibus Environmental Study
GRID	Global Resource Information Database
HDP	Human Dimensions Programme on Global Change
IC	Ion Chromatography
IC_{50}	median inhibition concentration
ICP-MS	inductively coupled plasma-mass spectrometry
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere Biosphere Programme
IHDP	International Human Dimension Program on Global Environment Change
ILAS	Improved Limb Atmospheric Spectrometer
ILAS-II	Improved Limb Atmospheric Spectrometer-II
IPCC	Intergovernmental Panel on Climate Change
IT	Industrial Transformation
KIS-NET	Kanagawa Prefecture Chemical Safety Information System
LAN	Local Area Network
LCA	Life-Cycle Assessment
LCIA	life-cycle impacts assessment
LU/GEC	Land Use for Global Environmental Conservation
LUCC	Land Use/Cover Change
LUTEA	LUCC under Temperate East Asia
MT	metallothionein
MT-null mice	MT gene knock-out mice
NCEP	National Centers for Environmental Prediction
NDVI	Normalized Difference Vegetation Index
NETI	The National Environmental Training Institute
NOAA	National Oceanic and Atmospheric Administration
NP	nitrogen and phosphate
NPP	Net Primary Production
PCA	principal component analysis
PCNA	proliferating-cell nuclear antigen
PCR-RFLP	polymerase chain reaction-restriction fragment length polymorphism
PCR-SSCP	PCR-single-strand conformation polymorphism
PEACAMPOT	Perturbation by the East Asian Continental Air Mass to the Pacific Oceanic Troposphere
PFB	Pentafluorobenzyl
PM2.5	particulate matters less than 2.5µm
PSCs	Polar Stratospheric Clouds
RIS	Retroreflector In Space
RPN	relative penis length
SFA	Substance Flow Analysis
SNIFF	Scientist Network on Indonesian Forest Fires
SOFIS	Solar Occultation Fourier Transform Spectrometer for Inclined-orbit Satellite
SPM	suspended particulate matters
START	Global Change SysTem for Analysis, Research Training
T4	thyroxine
TBT	tributyltin
TCA	1,1,1-trichloroethane
TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEACOM	Temperate East Asia Planning Committee for START
TMS	trimethylsilyl
TPA	12-O-teradecanoylphorbol-13-acetate
TPN	Thematic Programme Network
TPT	triphenyltin
UNEP	United Nations Environment Programme
VDS	vas deferens sequence
VOC	volatile organic compound
WHO	World Health Organization
WWW	World Wide Web

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