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NIES Annual Report 2003

National Institute for Environmental Studies

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NIES Annual Report 2003

National Institute for Environmental Studies

Foreword

This booklet is the second annual report from the new-look NIES. NIES was transformed 2 years ago from a research institute of the Japanese Government to an independent research agency. During fiscal year 2002, various adjustments to the new management system, adopted in 2001, were proposed after 1 year's experience of practical operation. Substantial improvements were achieved, especially in the budgetary system. The performance of our large experimental facilities was reviewed and several decisions to renovate or shut down facilities were made. New facilities—the Environmental Specimen Time Capsule Building and Nanoparticle Health Effect Research Laboratory (NanoHERL)—are being constructed.

Although the first 5-year mid-term research programs of NIES are still in progress, it is not too early to discuss the next mid-term research programs. As our research resources are limited, it is important that we have a far-sighted view of environmental issues so that we can formulate relevant research programs and thus establish truly effective preventive and remedial strategies. This long-term focus has been described by our task force as the " vision of NIES research".

The structure of the institute—6 research divisions, 6 special priority research projects, 2 policy-response research centers, and 2 groups for the development of fundamental research techniques—has been maintained. However, we have added 3 research teams to deal with environmental issues that are currently of pressing concern: the Greenhouse Gas Inventory Office, the Kosa Research Team, and the Research Group on Nanoparticles in the Environment.

All of these activities of our institute are summarized in this annual report. I hope that this report will help you to become familiar with our achievements and activities during 2002.

Y. Gohshi

Yohichi Gohshi
President of NIES

Contents

During the 1950s and 1960s, Japan experienced serious environmental pollution problems accompanying the rapid economic growth. In 1971, the Environment Agency was established within Japanese Govenment to develop countermeasures to serious environmental pollution problems such as 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. 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 50km north of Tokyo as a branch of the Environment Agency. NIES is the sole national institute for comprehensive research in the environmental sciences.

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 Station, the Okunikkou Field Monitoring Station and GHGs' Monitoring Station in Hateruma and Cape Ochi-ishi.

For these two decades, 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 on July 1, 1990 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 Principal 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. On January 2001, in the context of re-organization of Japanese government, the Environment Agency was promoted to the same time, NIES established Waste Management Research Division to conduct waste management research.

On 1 April 2001 the National Institute for Environmental Studies was reborn as an Independent Administrative Institution. The change from being a governmental institute to the new independent status allows us more flexibility in our operations, in order to provide better services to society.
NIES has prepared the medium-term plan that sets down our five-year work plans corresponding to the Ministry of the Environment's medium-term objectives. NIES hopes to obtain the understanding and support of the public by articulating its research orientations and objectives, and will disseminate the results of its research widely.

As of the end of FY 2002, the total number of NIES regular permanent personnel was 277 (Table 1). In FY 2002, NIES invited 311 scientists (8 foreigners included) to carry out the research programs as occasion demanded and also 205 researchers (64 foreigners included) joined NIES's research activities. The total budget of FY 2002 was 14,956 million yen (Table 2).

Table 1
Number of Permanent Personnel

Research	206	74.4%
Support & Management	48	17.3%
Env. Information Center	15	5.4%
Center for Global Env. Research	8	2.9%
Total	277	100%

(as of FY2002)

Table 2
Budget for Medium-Term Plan of NIES

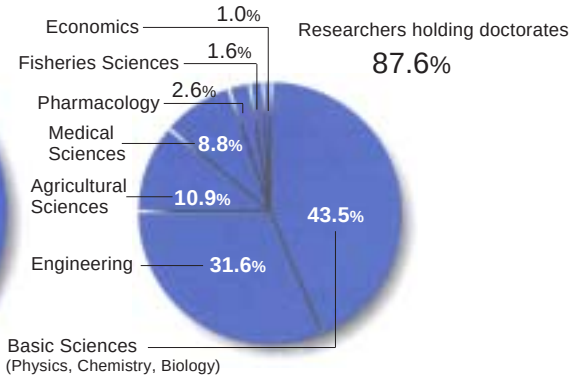
	Category	2001-05 Budget(5years)		Fiscal 2002 Budget	
		million $	million ¥	million $	million ¥
Revenues	Grant for Operating Costs	407	48,849	79	9,516
	Subsidies for Facilities	26	3,093	2	240
	Loan Without Interest	15	1,850	15	1,850
	Commissioned Work	146	17,576	28	3,350
	Total	594	71,368	124	14,956
Expenditures	Project Costs	266	31,873	51	6,142
	for Special Priority Research Projects	59	7,050	9	1,061
	for Policy-Response Research Areas	34	4,109	5	578
	for Environmental Information	18	2,132	3	349
	Facility improvements	31	3,709	17	2,090
	Expenses for Commissioned Work	146	17,576	28	3,350
	Personal Expenses	121	14,545	24	2,854
	General Administrative Expenses	20	2,431	4	520
	Total	594	71,368	124	14,956

Note:The budget for each annual work plan will be requested and decided each fiscal year, based on the Medium-Term Plan.
$1=¥120

Number of Permanent Staff

277

Fields of Expertise

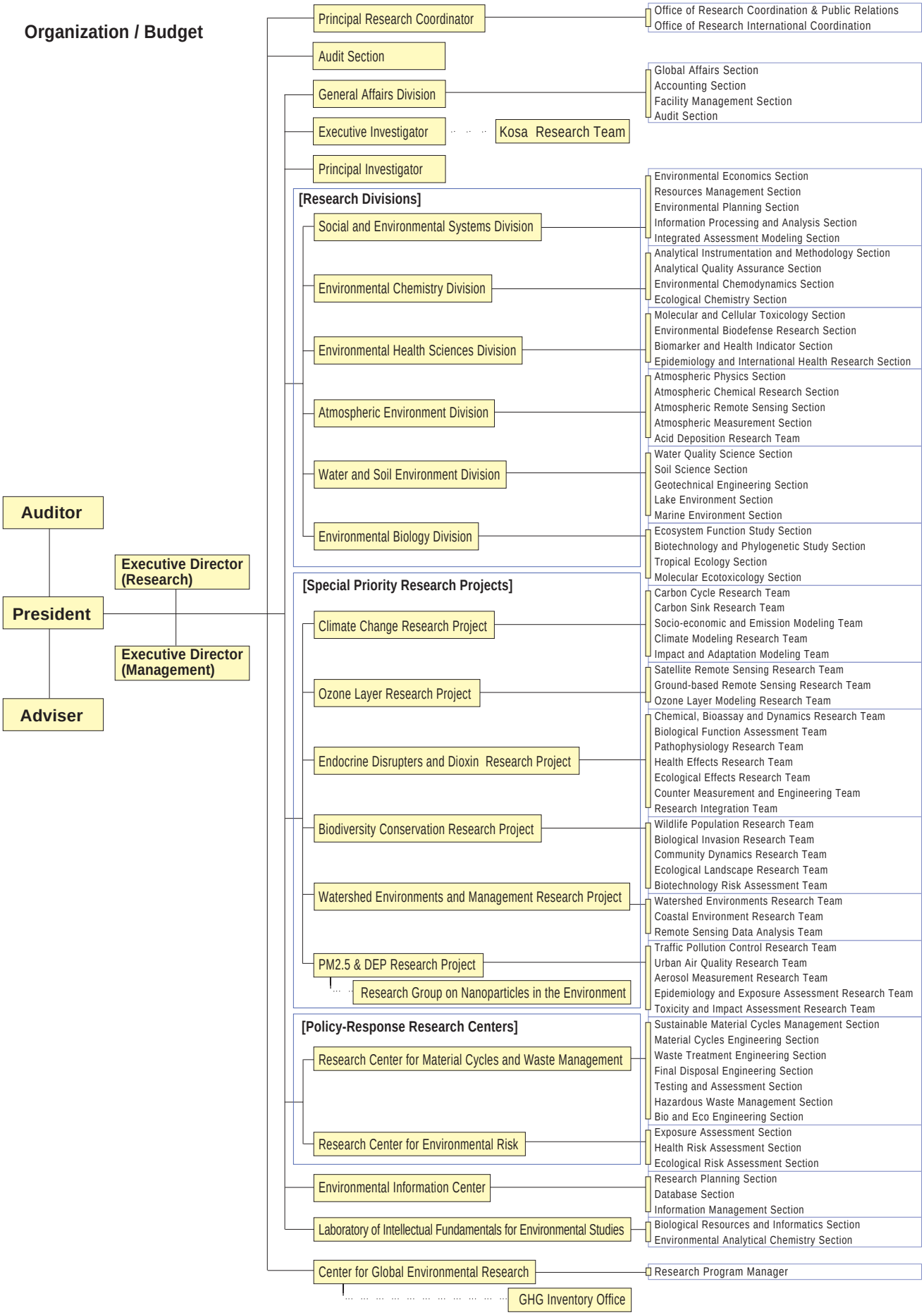


Number of Visiting Researchers

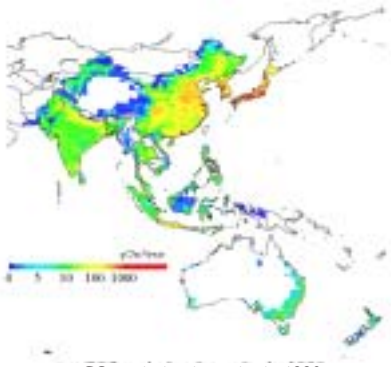
516(72)

( ) Foreign Researchers

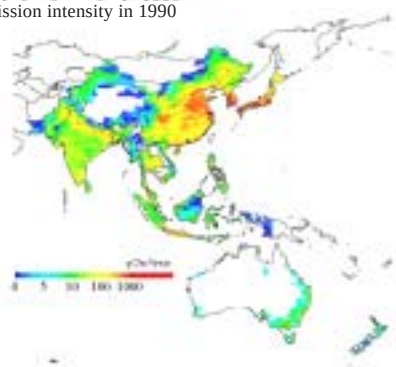
Organization / Budget



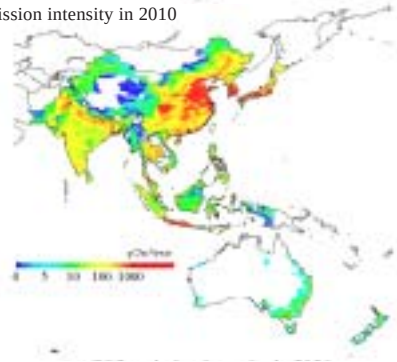
Climate Change Research Project



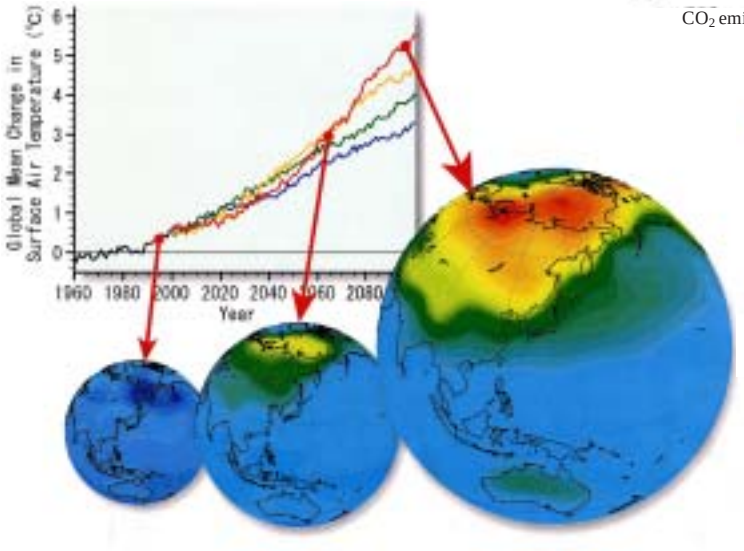
CO_2 emission intensity in 1990



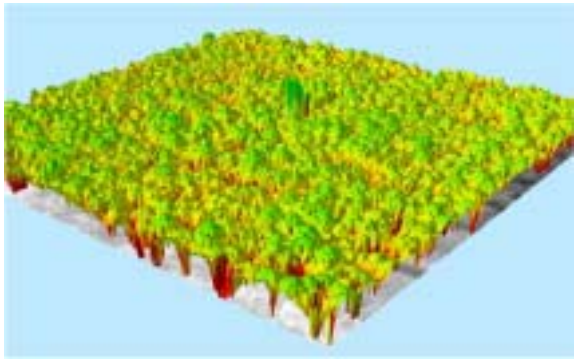
CO_2 emission intensity in 2010



CO_2 emission intensity in 2030



Global warming projections using the CCSR/NIES climate model



3D View of Canopy Digital Surface Model using airborne laser lider data.

Sub-project on carbon cycle research

This sub-project was initiated to determine the patterns and driving forces of the carbon cycle among anthropogenic sources and the pools of atmospheric, biospheric, and oceanic carbon. The two research teams involved in this sub-project are the **Carbon Cycle Research Team** and the **Carbon Sink Assessment Team**. This year we are reporting on the atmospheric research activities of the Carbon Cycle team; the activities of the Carbon Sink team will be discussed in later reports.

1. Analysis of carbon sink ratio between land and ocean from changes in the atmospheric oxygen concentration and stable carbon isotope ratio.

Increases in the carbon dioxide concentration in the atmosphere as a result of anthropogenic activities will lead to climate change on a global scale. About 60% of the total anthropogenic emission accumulates in the atmosphere, and the sinks in the terrestrial ecosystem and the ocean are remarkable. The partitioning between terrestrial and oceanic sinks changes from year to year, and the driving force behind this change is an urgent research target, because it will be the key to predicting future atmospheric CO_2 concentrations under climatic change.

The atmospheric oxygen concentration is decreased by fossil fuel burning and increased by photosynthesis. The oxygen concentration by solution of CO_2 into ocean does not change. In this project, we are monitoring the oxygen concentration in the atmosphere at Hateruma and Ochi-ishi ground-base monitoring stations (Y. Tohjima) (Fig. 1).

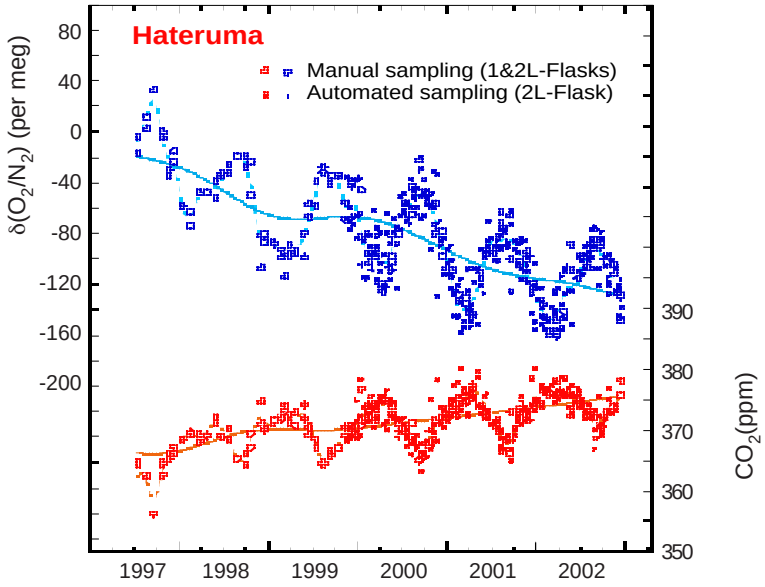


Fig. 1
Six-year record of O_2/N_2 ratio and CO_2 concentration observed at Hateruma Station.

This monitoring began in 1997 with monthly sampling followed by laboratory analysis by gas chromatography–thermal conductivity detection. The sampling frequency was increased to every fourth day in 1999. From the annual change of–19.1 ± 1.0 per meg/y and 1.61 ± 0.15 ppm/y for O_2 to N_2 ratio and CO_2 concentration, respectively, and the input to the atmosphere of CO_2 from fossil fuel as 0.2 Gt C/y, we calculated

the terrestrial sink to be 0.7 ± 0.4 Gt C/y and the oceanic sink to be 2.5 ± 0.7 Gt C/y. These values are tentative because they cover only a limited period of observation; further research is required to give more reliable values.

In a similar manner, the stable carbon isotope ratio in atmospheric carbon dioxide is influenced by fossil fuel combustion and the sink ratio between the land and ocean. There is a trend of decrease in the heavy isotope ratio because fossil fuel origin is light-carbon rich. Analysis of isotope ratios in air sampled from ships of opportunity sailing between Japan and Australia has been conducted since 1995 (H. Mukai). From the average isotope ratios in latitudes ranging from S25˚ to N50˚, we evaluated the carbon sinks in the terrestrial ecosystem and the ocean, and plotted them in Fig. 2, together with anthropogenic CO_2 input, southern oscillation index (SOI) and temperature anomalies of the southern hemisphere. There was a good correlation between high temperature and small land sink or land source (Fig. 2).

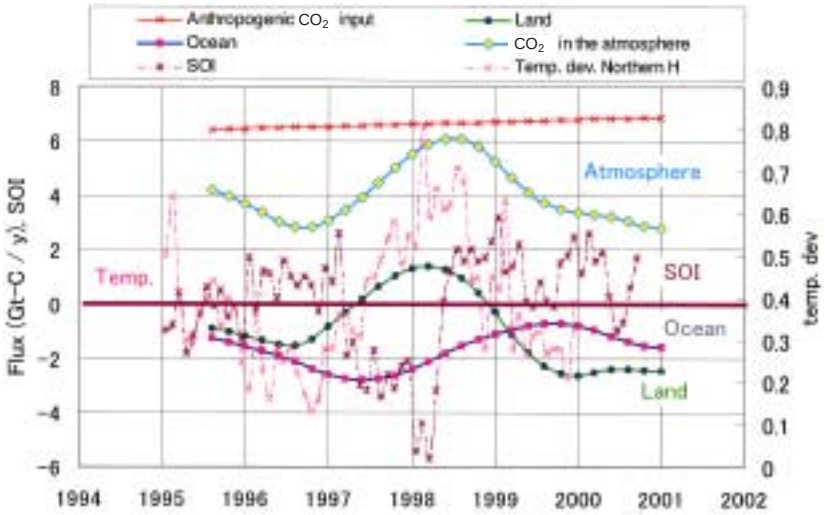


Fig. 2
Change of ocean and land sink strengths in the latitude range S25˚–N50˚, and controlling parameters.

Estimation of sink distribution in continents by atmospheric CO_2 distribution measurements: a top-down approach to carbon sinks

One promising approach to the identification of the sink–source distribution of carbon over continents is the estimation from atmospheric carbon dioxide distribution.

A sink–source interface exists on the surface, and air that has interacted with the surface is transported elsewhere, resulting in a three-dimensional carbon dioxide distribution. This process can be simulated by using a sink–source model and an atmospheric transport model, then, the agreement between simulated and observed distributions can be maximized by adjusting the sink–source pattern within various boundaries. This process is called as Inverse Model Analysis. This approach has been successful in identifying sink–source distribution on a sub-continental scale; by dividing the Earth's surface into 22 areas.

Our research aim was to apply this method on a smaller scale to obtain a much more precise sink–source distribution, and to compare the results with those of a carbon

budget model that combines ground-based flux measurement and a scaling-up process that uses satellite data. One key to the scaled-down inverse model analysis is a better understanding of CO_2 transport within the boundary layer and the interaction between the boundary layer and the free troposphere.

A pilot study of the network was started in 2001, and the first full year's data were obtained in 2002 (Machida and Watai). The monitoring site is at Berezorechika village, lat 56˚10'N, long 84˚20'E, northwest of Tomsk, in West Siberia. The air is sampled from a telecommunications tower and analyzed by a system developed in 2001. The CO_2 concentration 80m from the ground is constant in winter. It begins to decrease in mid-May, when forest photosynthesis becomes active, and is at a minimum at the end of July (Fig. 3). The concentration at 5 m shows similar behavior, but the night-time concentration in summer is more than 100 ppm higher than the daytime value.

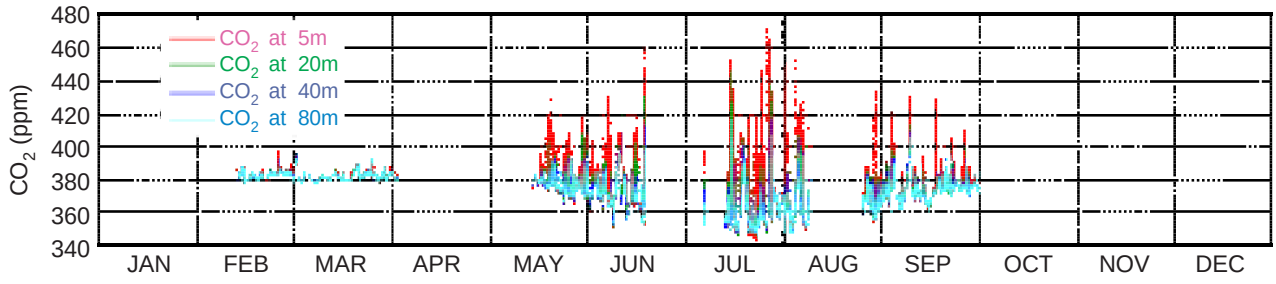


Fig. 3
Seasonal variation in atmospheric CO_2 observed at Beresorechika Village in West Siberia.

We also performed observations from aircraft over the tower and obtained seasonal values at different heights from 100 to 3000 m (Fig. 4). When the lowest-level data obtained by aircraft were compared with ground-based daytime data, the aircraft values fitted the minimum envelope curve of the ground data (Fig. 4), because the aircraft observations were performed under a clear sky at midday. This result suggests that the ground-based data represent the mixing layer concentration of CO_2 when convex mixing is strong.

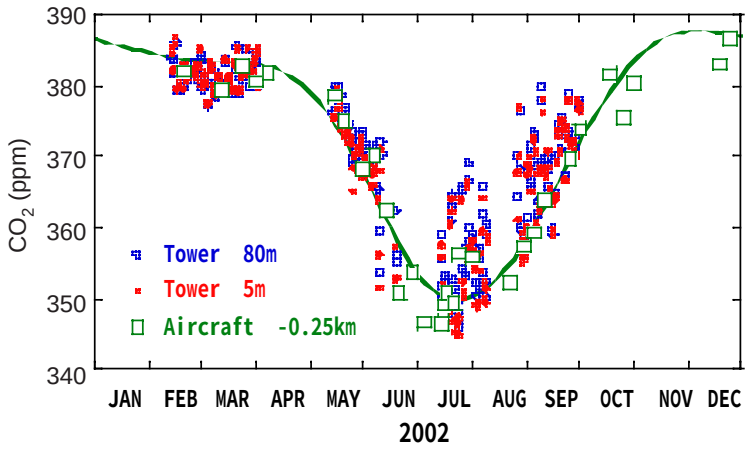


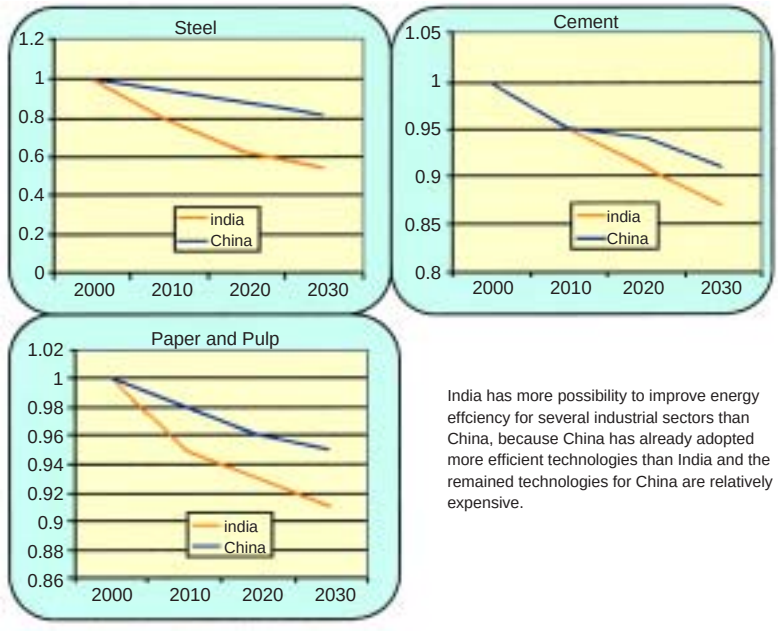
Fig. 4
Seasonal fluctuation in daytime atmospheric CO_2 concentration at 250 m height, obtained by aircraft observation (green squares), and at 80 m (blue circles) and 5 m (red dots).

Sub-project on climate change scenarios and comprehensive mitigation strategies based on integrated assessment models

This sub-project resulted from the outcomes of research over the past 10 years at NIES and aims to address new policy needs arising from the Kyoto Protocol, post-Kyoto negotiations, and long-term integration between climate and sustainable development policies. The target of this sub-project is to develop a set of models for integrated assessment of economic growth, climate change, and their impacts. These models will then be used to help estimate the effects of Kyoto and post-Kyoto interventions on global climate change and its regional impacts. The sub-project is also expected to identify the most effective future strategies for integrating sustainable development in Asia and climate change mitigation under alternative paths of future development.

The 3 research teams involved in this sub-project–the Socioeconomic and Emission Modeling Team, the Climate Model Research Team, and the Impact and Adaptation Modeling Team–achieved the following outcomes in FY 2002.

The **Socioeconomic and Emission Modeling Team** used an emission model for greenhouse gases (GHGs) and air pollutants for scenario analyses of major Asian countries (Japan, China, India, Korea, Thailand, Malaysia, Vietnam). The model simulates choices of technologies for producing goods and services that enable the user to assess the cost of GHG mitigation, the effect of economic interventions such as carbon taxes, and the achievable levels of energy and emission intensity (Fig. 5). The Emission Modeling Team also refined the economic model to consider energy and material flow in an integrated way. This model was used to investigate environmental degradation (including the effect of recycling policies) in India and China. The team is now developing a new multi-regional general equilibrium model. A detailed database for the energy sector, an important component of this model, was developed this year.



India has more possibility to improve energy effciency for several industrial sectors than China, because China has already adopted more efficient technologies than India and the remained technologies for China are relatively expensive.

Fig. 5
Projected energy intensities of the steel, cement and paper, and pulp industries in China and India from 2000 to 2030, simulated by AIM.

The **Climate Model Research Team** improved the performance of their global climate model by revising the simulated processes. This revised formulation, along with a new input for cumulus convection, improved the representation of summer precipitation in Asia (Fig. 6). Further, refinement of the land surface model and the introduction of direct and indirect aerosol effects improved the representation of vapor pressure in the air close to the land surface in continents of the northern hemisphere. The Climate Model Team is also developing an interface to facilitate linkage between the emission model study and the climate model study. In this regard, a tool for producing grid data on aerosol emissions with a spatial resolution of 0.5˚ × 0.5˚ from country-wide aerosol emission statistics was developed this year.

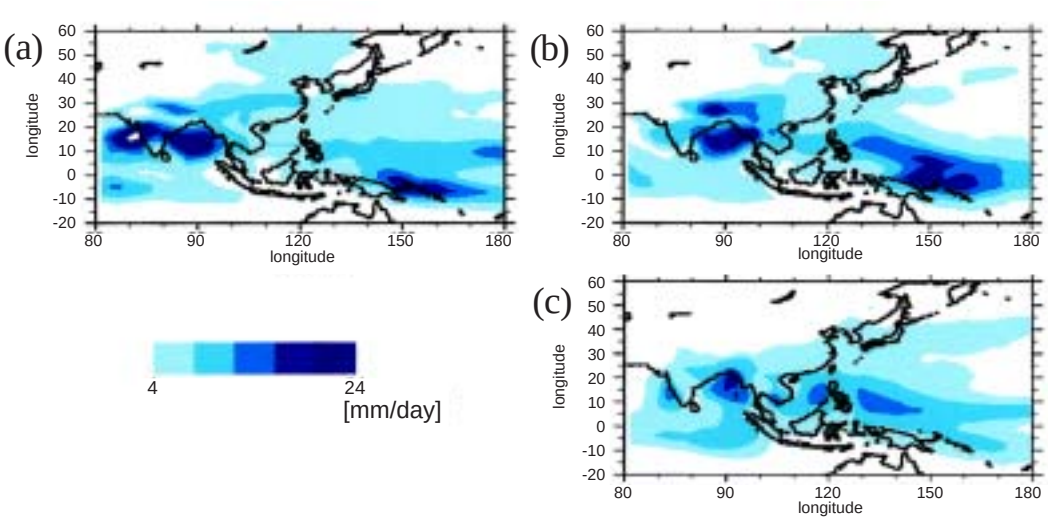


Fig. 6
Summer precipitation in Asia.
(a) Result of simulation performed with the old version of the models.
(b) Results of simulation performed with the new version of the model, with the revisions mentioned in the text.
(c) Spatially interpolated data derived from climatological observations.

The **Impact and Adaptation Modeling Team** developed a distribution package for impact models, tools, databases, and visualization modules, with an interface that enables these elements to be used in an integrated way. The package will be publicly distributed through the web site. We expect that the package enable researchers in developing countries to assess national-scale impacts independently. The Impact Team also refined its water resource model and assessed the future water stresses in each global river basin (Fig. 7). The risk of water shortage will increase, especially in developing countries, as a result of population growth and rapid industrialization. Climate change would add to this water stress in regions where precipitation is projected to decrease.

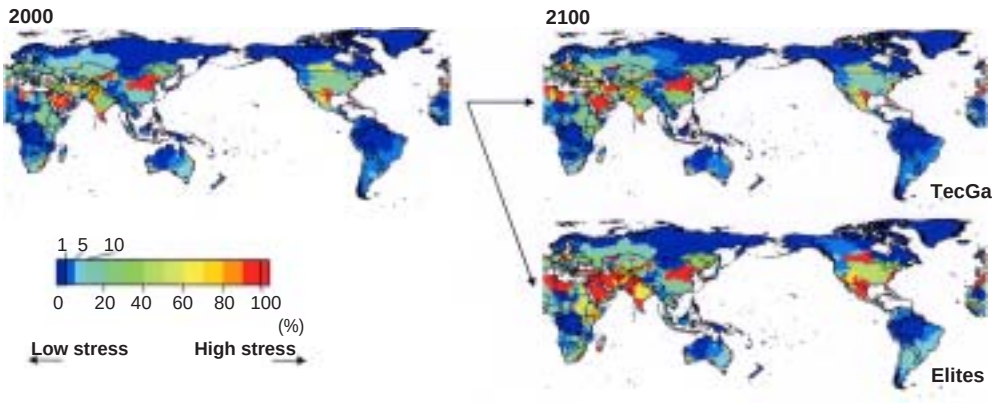
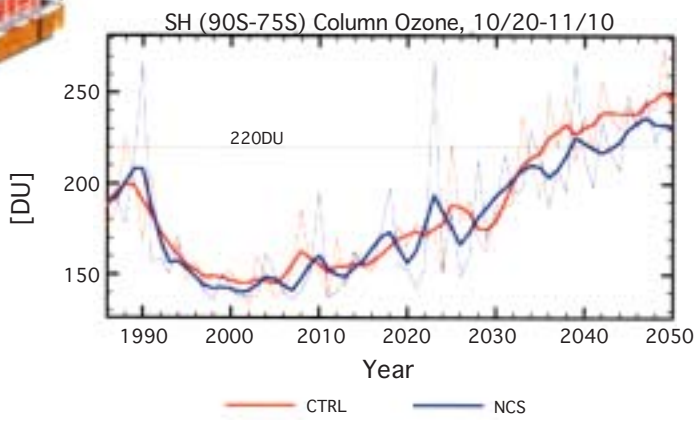


Fig. 7
Current and projected Water Stress Index under different future scenarios of world development. Water Stress Index = water withdrawal / renewable water resource
TecGa: Future world that assumes globalization, rapid technological improvement, low population increase and high environmental consciousness.
Elites: Future world that assumes regionalization, slow technological improvement, high population increase and low environmental consciousness.

Ozone Layer Research Project

Stratospheric ozone layer observation
by ILAS-II onboard ADEOS-II.



Temporal profiles of column ozone in the ozone hole simulated under the conditions of increasing (CTRL) and fixed (NCS) CO_2

Background and Purpose

To counter the problem of ozone depletion due to specific chlorofluorocarbons, bromofluorocarbons, and other substances, various measures have been taken by a number of governments in accordance with the Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol on Substances that Deplete the Ozone Layer, and other relevant international agreements. As a result, the total content of organic halogen compounds that are destroying ozone layer has started to decrease, even in the stratosphere. Nevertheless, the Antarctic ozone hole still appears to be growing larger every year, even considering its great annual variation, and springtime ozone depletion over the Arctic is increasing. Therefore, it may not be appropriate to predict the scale of ozone depletion by chlorine content alone. Continuous monitoring of the stratospheric ozone layer is required to explore how the ozone layer changes with the decreasing halogen concentration in the stratosphere. We also need to accumulate scientific knowledge on the meteorological conditions and climate of the stratosphere, as well as on the physical and chemical processes that affect the depletion of the ozone layer. Together with the Ministry of the Environment (MOE), we have been monitoring the ozone layer by using a satellite-borne ozone sensor and ground-based remote-sensing equipment, analyzing the data obtained, and conducting research using numerical models.

The stratospheric ozone layer over both poles (high latitude regions) is considered to be the most susceptible to changes in various ozone-depleting factors, including the concentrations of halogen species, temperature, and the strength of the polar vortex. The stratospheric ozone layer over the mid-latitudes seems to be susceptible to changes in transport processes and to in situ chemical ozone loss. Accordingly, we have been monitoring, and will continue to monitor, the ozone layer by using satellite-borne sensors for the high-latitude regions and ground-based remote-sensing equipments for the mid-latitudes. We have gathered data both within and outside Japan to help monitor and identify the mechanisms of change in the ozone layer. The project also conducts data analysis and numerical modeling to accumulate scientific knowledge on the mechanisms of change in the ozone layer, thus contributing to the prediction and validation of future ozone layer changes.

Objectives

The 5 main objectives for the mid-term stage of this project are: 1) provision of new versions (5.20 and 6.0) of validated Improved Limb Atmospheric Spectrometer (ILAS) data products to the scientific community; 2) acquisition and processing of ILAS-II data (ILAS-II is a satellite-borne ozone layer monitoring sensor developed by MOE to provide ILAS-II data products both within and outside Japan for scientific use, such as research and monitoring of the ozone layer. It launched on 14 December 2002); 3) continued ground-based ozone layer monitoring at Tsukuba (NIES) and Rikubetsu (Rikubetsu Integrated Stratospheric Observation Center) for registration of the obtained data in the Network for Detection of Stratospheric Change (NDSC) international database, and provision of the data to organizations both within and

outside Japan; 4) identification of the role played in polar ozone layer changes by processes involving physically and chemically important elements, and identification of the mechanisms of these processes; and 5) validation of predicted future ozone layer changes as a basis for formulating measures to protect the ozone layer, and validation of the latest predicted ozone layer changes to provide expert knowledge for evaluating the effectiveness of these protection measures.

Achievements in Fiscal Year 2002

Vertical profiles of atmospheric constituents, such as ozone, water vapor, methane, nitrous oxide, nitric dioxide, and nitric dioxide were observed by the ILAS sensor. The data were processed with the version 5.2 retrieval algorithm and released to the public this fiscal year. The vertical profiles derived from the version 5.2 data were compared with those obtained by various remote-sensing techniques. For example, the vertical profiles of ozone concentration obtained by the version 5.2 algorithm were compared with those obtained by 3 foreign satellite-borne sensors: the version 19 Halogen Occultation Experiment (HALOE), version 6 Stratospheric Aerosol and Gas Experiment II (SAGE II), and version 6 Polar Ozone and Aerosol Measurement II (POAM II) algorithms. The agreement between ILAS ozone data and other satellite data was better than ± 12% for most scenarios between 21 and 50 km altitude, with the exception of January in the southern hemisphere at 41 to 50 km. ILAS version 5.2 ozone data were also compared with the vertical ozone profiles measured by ozonesondes, balloon- or aircraft-based instruments, and ground-based instruments. The agreement between ILAS and ozonesonde comparisons between 13 and 30 km was good (within ± 10%) for both hemispheres. The ILAS ozone data also agreed within ± 10% with data from the balloon, aircraft-, and ground-based instruments between 9 and 50 km, with some exceptions. The validation study demonstrated that the version 5.2 ILAS ozone data were more accurate than the former, version 3.10, ILAS data. The validation of other chemical species was also studied.

ILAS-II onboard the Advanced Earth Observing Satellite-II (ADEOS-II) was successfully launched on 14 December 2002. ILAS-II Initial Checkout (ICO) was implemented between 20 and 23 January 2003. During ICO, some of the data measured by ILAS-II were processed and analyzed and the vertical profiles of the concentrations of ozone and other atmospheric trace species were retrieved. (Fig. 1) shows the vertical ozone profiles observed over Greenland at 16:52 UT on 22 January 2003 (Fig. 1(a)), and over Japan's Antarctic Syowa Station at 18:01 UT on the same day (Fig. 1(b)). The averages and ranges of fluctuation (3s) of data observed by ILAS for January 1997 are also shown, for comparison. The ozone profile observed by ozonesonde over Syowa station on 20 January 2003 is shown in Figure 1b. The ozone profiles derived from ILAS-II are in agreement with those observed by ILAS and by ozonesonde at altitudes higher than 15 km. (Fig. 1)

Ozone lidar data, which have been collected at Tsukuba since 1986, were re-analyzed with an improved algorithm. Systematic errors caused by background signals, signal-induced noises, and dead-time effects were successfully eliminated from the original return signals, then the quality of the detected signals was improved. Atmospheric

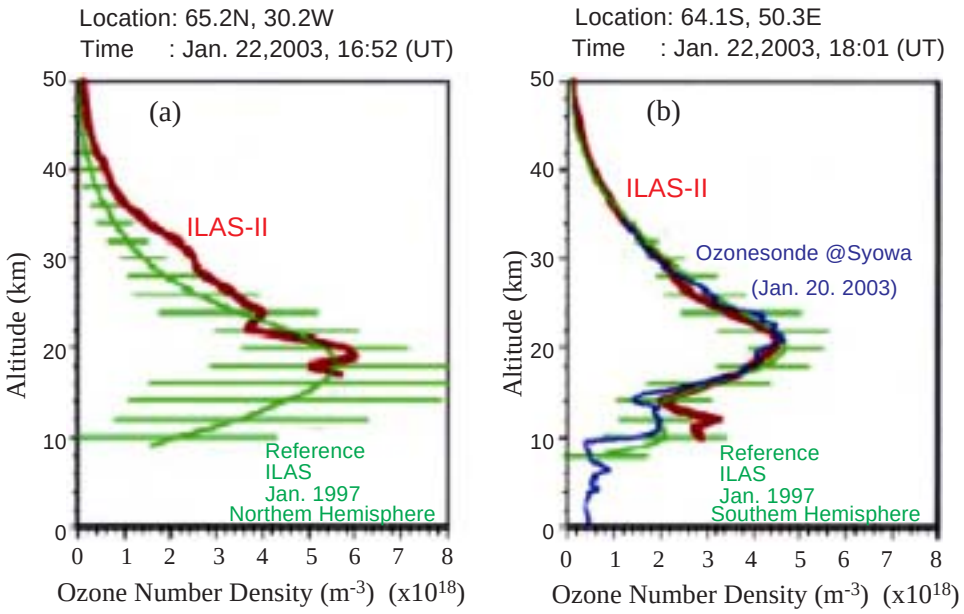


Fig.1
Vertical profiles of ozone concentration retrieved by analyzing ILAS-II data (red lines) collected on 22 January (a) at 16:52 UT over Greenland and (b) at 18:01 UT over Japan's Antarctic Syowa Station. The average values of data observed by ILAS in the same month in 1997 are also shown as reference values (green lines). The error bars indicated are 3 times the standard deviation. The ozonesonde observation was performed by the 43rd Japanese Antarctic Research Expedition at Syowa Station 2 days before the ILAS-II observation, and the result is shown in (b) by the blue line.

optical values and parameters, such as the ratio of aerosol extinction coefficient to backscattering coefficient, wavelength dependence, boundary altitudes, and atmospheric density were modified by changes in practical and temporal values after the comparison of lidar data with other supportive data from SAGE II, CIRA, NCEP, and radiosonde. We confirmed that the vertical profiles of the lidar ozone concentration agreed with those obtained by SAGE II within ±10% in the range of 20 to 40 km altitude.

Because ILAS measurements provide vertical profiles of several chemical species, including O_3, N_2O, HNO_3, and NO_2, in the Arctic region in 1997, changes in ozone concentration were quantified on the basis of an N_2O-O_3 correlation using ILAS N_2O and O_3 data. The quantified ozone changes were plotted against the amounts of HNO_3 + NO_2, which were calculated from ILAS data. We found that a rate of ozone loss of about 1 ppmv/month was maintained until the middle of April of 1997 for air masses with 5 to 7 ppbv NO_y (total oxides of nitrogen) content. Maximum ozone loss (1.4 ppmv/month) was observed at the 500-K of potential temperature level in mid-March, when the residual NO_y level was reduced to 8 ppbv, mainly because of denitrification. Detailed analyses of the data suggested that air masses with smaller NO_y content experienced greater ozone loss.

By using HNO_3-N_2O and HNO_3-O_3 correlations derived from the ILAS data, we also evaluated the irreversible redistribution of HNO_3 during the Arctic winter of 1996—1997. Denitrification and nitrification started just after the Arctic vortex had cooled to below the ice frost poin(T_{ice}). Trajectory analyses of the air masses observed by ILAS suggest that denitrification occurred only in the air masses that were once cooled to near T_{ice} and were kept at temperatures below the nitric acid trihydrate saturation threshold continuously for more than 4 days. A box model including polar stratospheric cloud formation, growth, and gravitational sedimentation processes was developed to clarify the mechanism of the denitrification process.

As a chemical climate model, we developed an atmospheric general circulation model with fully interactive stratospheric chemistry. We used the model to calculate the time—latitude cross-section of the zonal mean column ozone. We then compared the results of the calculation with the observed cross-section. Although the calculation overestimated the amount of ozone in the southern mid-latitudes and indicated a delayed appearance of the Antarctic ozone hole, it was capable of reasonable reproduction of our observations.

We used the chemical climate model to examine the numerical integration of ozone change against increasing CO_2 concentration. We performed 65-year model integrations for the evolution of 2 different scenarios from the same initial state, which was created by 22 years of integration for 1986 conditions. One of the integrations ('CTRL') was a control experiment that included the trends in concentration of halocarbons and those of all well-mixed greenhouse gases, such as CO_2, CH_4, and N_2O, from 1986 to 2050. The other experiment ('NCS') studied the chlorine trend but the CO_2 concentration was not increased: instead, 1986 conditions for CO_2 were used throughout the integration. The results of the numerical integration are shown in (Fig. 2). The calculated column ozone level in the Southern Hemisphere polar region decreased at the same time as the ozone hole became smaller, between 1986 and 2000; the smallest value for column ozone (ca. 140 DU) appeared at around 2000. After 2000, the Antarctic springtime ozone level remained very low at about 150 DU, increased slightly until 2015, and then continued to recover steadily until the end of the integration. The long-term trend of column ozone calculated in the NCS experiment was similar to that in the CTRL experiment. This result indicates that the temporal evolution of ozone seems to be affected by increases in the simulated chlorine loading, not by CO_2 increase. (Fig. 2)

It is well known that a local total ozone minimum appears over the subtropical western Pacific in the Northern Hemisphere in winter. To examine the vertical structure of this ozone minimum, we analyzed vertical profiles of HALOE ozone data. The total ozone minimum was found to result from a minimum in the stratospheric ozone. We also found that the vertical profile of the ozone mixing ratio deviation from the zonal mean showed a bimodal structure: 1 minimum at around 20 km altitude and the other at around 30 km. Analysis with a simple photochemical transport model suggested that the low level of mid-stratospheric ozone is caused by southward transport of high-latitude ozone-poor air from the Arctic region, and that the ozone minimum in the lower stratosphere is caused by northward advection of ozone-poor air from the equatorial region. A nudging Chemical Transport Model (nudging CTM) developed at NIES was applied to simulate the total ozone minimum over the subtropical western Pacific in the northern hemisphere. The horizontal distribution of the observed ozone minimum was well simulated by the model. The vertical structure of the ozone mixing ratio deviation from the zonal mean was also calculated with the nudging CTM. The distinctive features of the vertical distribution—that is, the two negative deviations from the zonal mean—could be reproduced by the model.

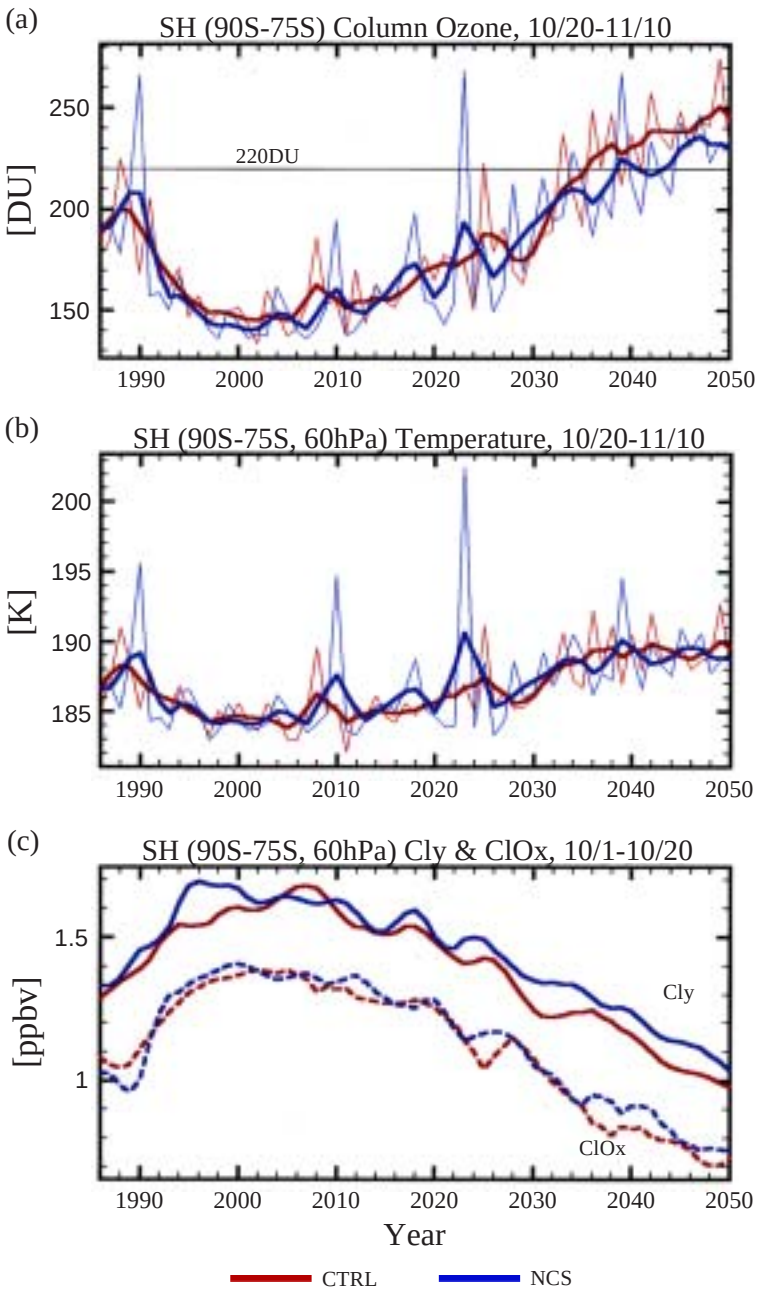
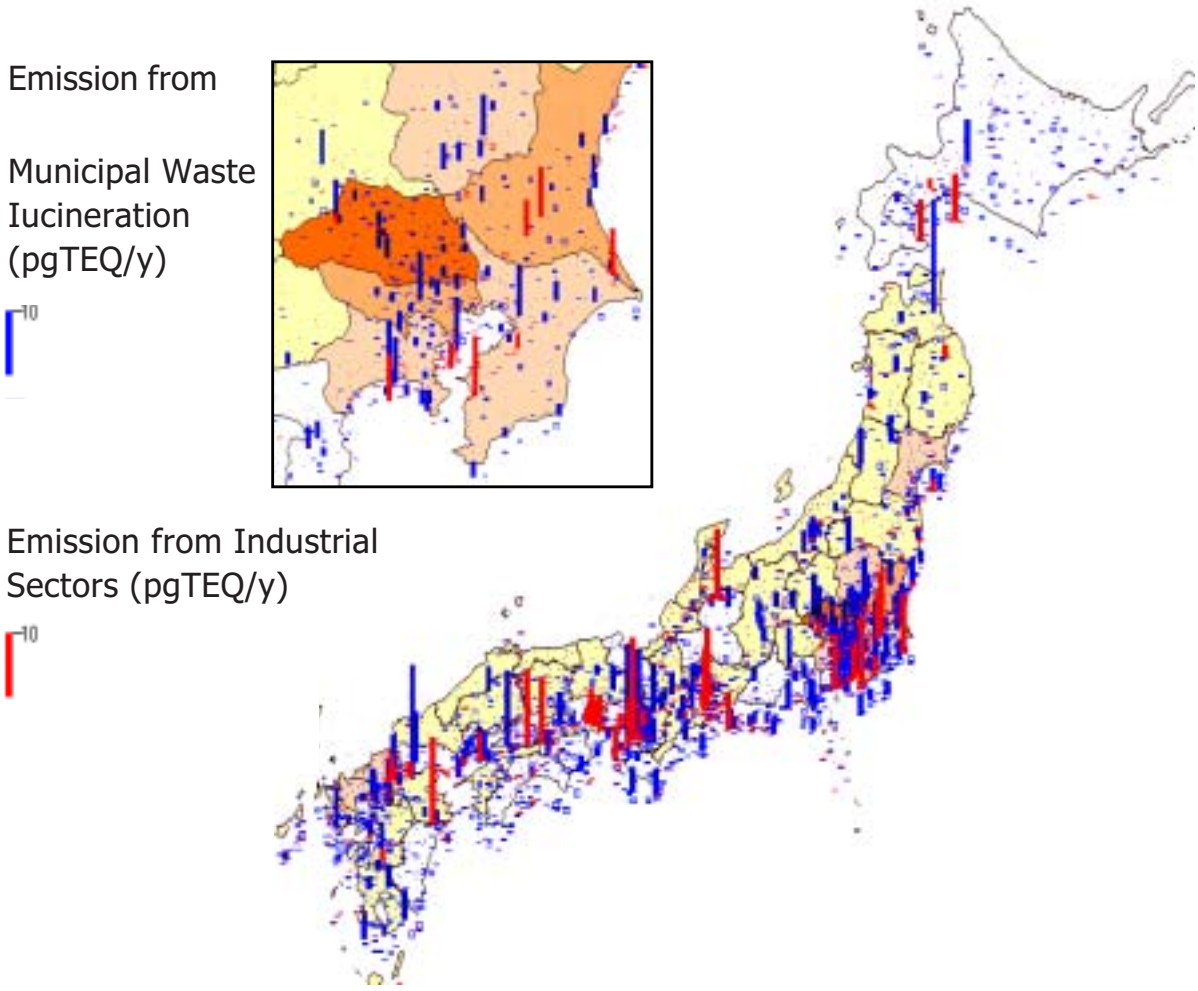


Fig.2
Simulated temporal evolution of various parameters averaged between 90˚and 75˚S. (a) Column ozone averaged between 20 October and 10 November; (b) Temperature at 60 hPa averaged over the same period; (c) Cl_y (continuous lines) and ClO_x (dotted lines) mixing ratio at 60 hPa, averaged for the period 1 to 20 October. Thick lines in (a) and (b) are 5-year moving averaged data, whereas the thin lines are data for individual years. All lines in (c) are 5-year moving averaged data. Red lines show the results of a control experiment that included the trends of halocarbons and those of all well-mixed greenhouse gases, such as CO_2, CH_4, and N_2O, from 1986 to 2050. Blue lines present the results of a numerical experiment that included the chlorine trend; 1986 conditions for CO_2 were used throughout this integration.

Endocrine Disrupters and Dioxin Research Project



Geographical Distribution of Dioxin emission in Japan

The work of the Endocrine Disrupters and Dioxins Research Project, which utilizes NIES's new Endocrine Disrupter Research Facility and Specific Research Facility for Dioxins, has covered the following 4 themes: 1) development of methods for measurement and bioassay of these substances; 2) evaluation of the current status of environmental pollution; 3) hazard and effects assessments; and 4) development of countermeasures and integrated information technologies.
In FY 2002, we made major advancements in the following areas.

1) **Measurement of chemicals in environmental samples** was improved through the use of GC–NCI–MS and LC–ECD for non-volatile and thermally unstable compounds, and by the use of a GC–HRMS method to measure very low amounts of volatile compounds such as dioxins. We developed a LC–MS–MS method for the analysis of estrogens and their conjugates in sediment and water samples. We applied this improved method to water samples and surface sediments taken from Tokyo Bay to investigate the distribution of estrogens and their conjugates in the environment (Fig. 1).

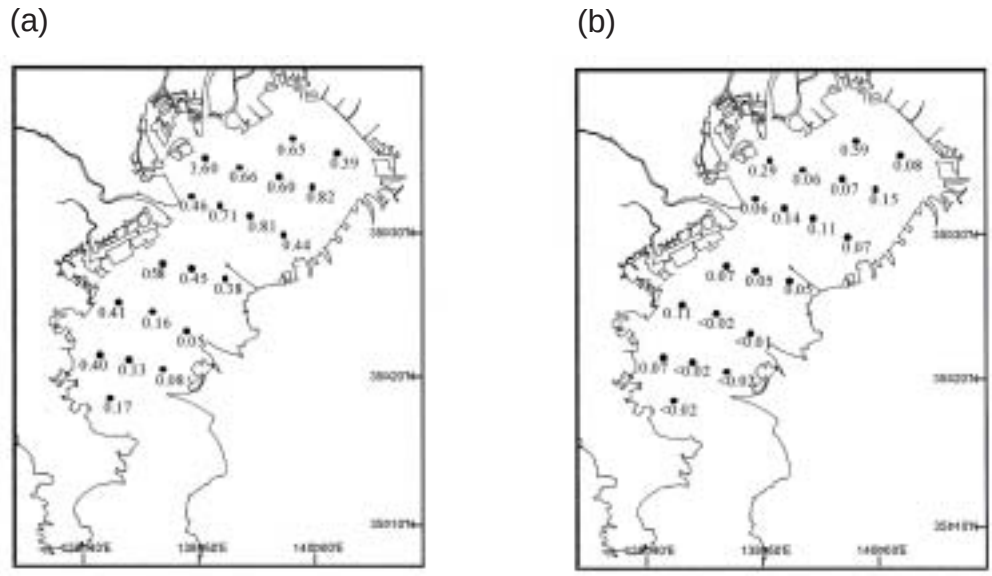


Fig. 1
(a)
Distribution of estrone in surface sediment in Tokyo Bay (ng/g-dry).
(b)
Distribution of 17 ß-estradiol in surface sediment in Tokyo Bay (ng/g-dry).

We also improved our ability to detect 2, 3, 7, 8-TCDD by fine-tuning of our high resolution mass spectrometer and high volume injection for gas chromatography; this enabled us to assess human blood samples as small as 10 mL.

2) *In vivo* and *in vitro* bioassays are important methods of screening chemicals for their endocrine disrupting properties. We developed 7 *in vitro* assays, including yeast two-hybrid reporter-gene assays to assess estrogen, androgen and thyroid hormone

activity, as well as an ELISA-based assay for human estrogen receptor binding and for cell proliferation using neuronal cell lines. We showed that the receptors of different species have different affinities to chemicals: for example, the estrogen receptor -α of the freshwater fish medaka had higher sensitivity to the alkylphenols tested than did human estrogen receptor -α or -β. We tested environmental samples and samples of industrial effluent by using a medaka estrogen receptor (ER) system, and found that many samples showed estrogenic activity by the medaka system but not the human ER system (Fig. 2).

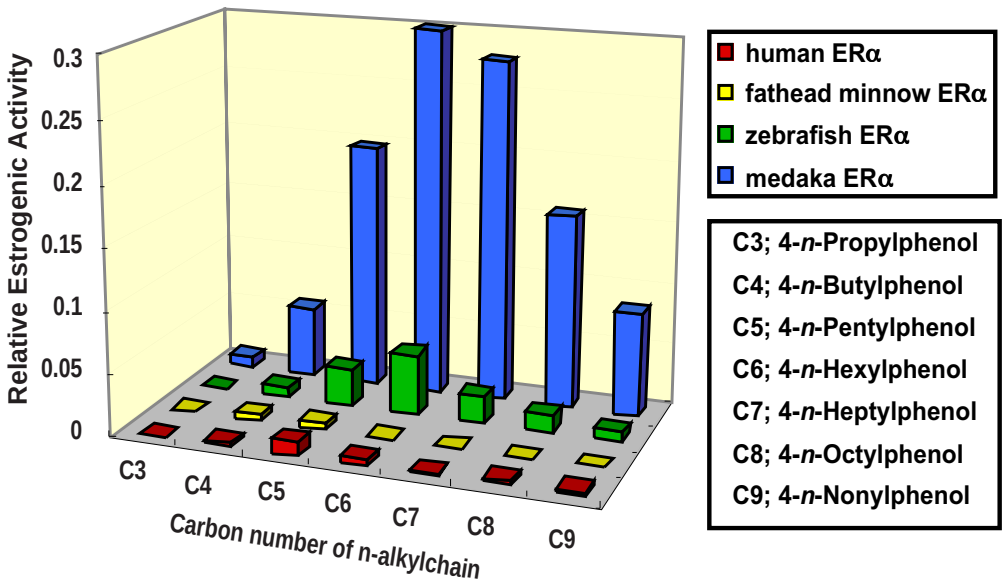


Fig. 2

We used *in vivo* assays in medaka to detect vitellogenin synthesis and to perform one-and-a-half generation tests. The small crustacean *Daphnia magna* is also used in our laboratory as a test animal to investigate the effects of endocrine disrupting chemicals on invertebrates. We found that the sex ratio of the offspring of *D. magna* was skewed dramatically toward males by exposure of mature adults to juvenile hormones and juvenile-hormone-mimicking pesticides. We also use *in vivo* testing of a frog (*Xenopus*) and reproduction and developmental toxicity tests in freshwater shrimp, chickens, freshwater mud snails, mice, and rats. The use of both *in vitro* and *in vivo* assays has enabled us to find several new compounds with estrogenic activity.

3) We have also been studying the **effects of EDCs on the neuro-brain system**. We have installed a high-field (4.7 T) magnetic resonance imaging (MRI) spectrometer for human study. We developed a method to obtain a 3-dimensional anatomical image of the human brain with 1 mm resolution at 4.7 T. Further, ^{1}H and ^{31}P spectra from an area of interest can be observed in 10 min, exhibiting glutamate (a representative

excitatory neurotransmitter) and ATP (an energy source for brain activity) in both human and rat brains.

To assess the effect of EDCs on the nervous system and behavior, we observed the effects of bisphenol-A (an endocrine disrupter), ethylenethiourea, and other positive controls on experimental animals. Treatment with the organotin neurotoxicant trimethyltin (TMT) induced reactive astrocytosis in the rat hippocampus, as evidenced by the results of vimentin immunohistochemistry; the effects were profoundly exacerbated by adrenalectomy. Prolonged administration of dexamethasone (a type II glucocorticoid receptor agonist) not only attenuated the exacerbating effects of adrenalectomy but also partly reversed the TMT-induced neuronal loss and reactive astrocytosis.
Intracisteral administration of bisphenol A in 5-day-old Wistar rats caused hyperactivity at 4–5 weeks of age. These rats were about 1.6 times more hyperactive than vehicle-treated rats in the nocturnal phase (Fig. 3).

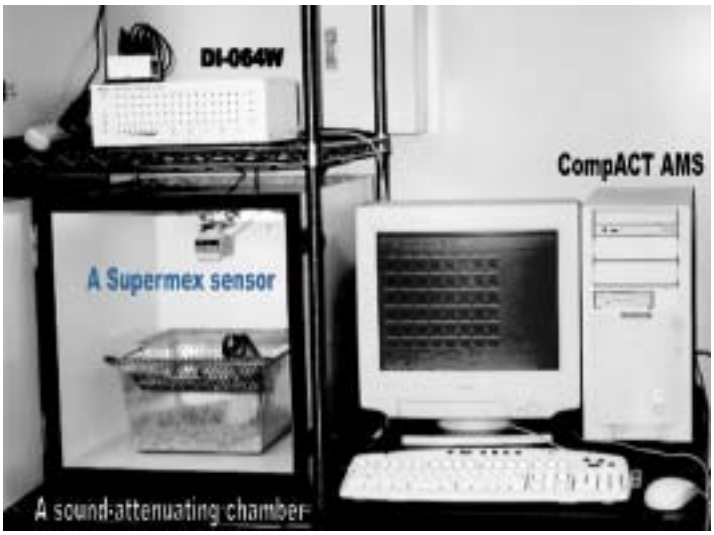


Fig. 3
The Supermex system. The general view of a system consisting of a sound-attenuating chamber, a Supermex sensor, a rat in the home cage, a 64-channel interface (DI-064W), and a personal computer with CompACT AMS software.

We compared the relative impacts of in utero versus lactational exposure to TCDD on serum thyroxine (T4) levels by using a cross-fostering protocol in Holtzman rats. The T4-suppressing effects of TCDD on postnatal day 21 were mainly due to lactational rather than in utero exposure, and we suggested that these effects were caused by enhanced biliary excretion of T4-glucuronide through induction of UDP-glucuronosyltransferase (UGT-1), a TCDD-inducible enzyme.
Novel TCDD-responsive genes were sought among those responsive to estrogen, using DNA microarrays spotted with estrogen-responsive genes. We verified 23 genes up- or down-regulated by TCDD exposure in MCF-7 cells and 14 genes in RL95–2 cells.

4) To determine the **effects of EDCs on wildlife**, we observed sea snails and bivalves along the Japanese coast. Some species of snail now face reproductive toxicity from organotin compounds. We collected abalone (*Haliotis gigantea*) specimens from 32 coastal sites to examine tissue concentrations of organotin compounds and search for histological abnormalities in the gonads. Laboratory flow-through exposure experiments with TBT were also conducted in abalone to evaluate ovarian spermatogenesis in a dose-dependent manner. We also carried out preliminary evaluation of the reproductive success of abalone exposed to organotins, from the results of *in situ* reproductive experiments on adult abalone; laboratory toxicity tests on fertilized eggs and larvae; and field observations of the distribution, settlement, and growth of larvae.

In October 2002 we began another field study to search for endocrine disruption in marine fish in Tokyo Bay. We selected the mud dab (*Pleuronectes yokohamae*) as a target species. We have analyzed its population dynamics, measured vitellogenin and steroid hormones in the plasma, histologically examined the gonads, and evaluated the presence of estrogenic compounds and other endocrine disrupters in the tissues (Fig. 4).

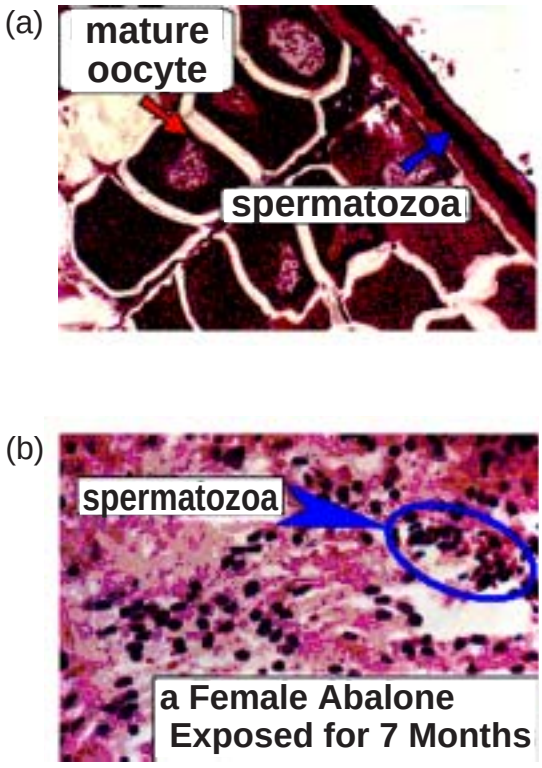


Fig. 4
(a) Ovarian spermatogenesis observed in giant abalone, Haliotis madaka, collected from an organotin-contaminated site in April 1996.
(b) Results of *in situ* exposure experiments near a shipyard for 7 months, using abalone (*Haliotis gigantea*) from a reference site. Ovarian spermatogenesis was observed in approximately 90% of females. We also observed marked accumulation of organotin (tributyltin and triphenyltin) in the muscle of abalone exposed to organotin-contaminated seawater at the site for 7 months (June 1998 to January 1999).

We also examined fish and freshwater snails in Lake Kasumigaura, and we sampled seabirds for thyroid dysfunction.

5) To **reduce the emission of dioxins and prevent secondary emission to the environment,** we studied a method of monitoring and decomposing dioxins. We compared simple and rapid analytical methods, including a bioassay, and designed real-time monitoring equipment. To construct a system for identifying the source(s) of dioxins, we first categorized sources and environmental samples by a principal component analysis (PCA) based on their own homologue profiles. Pretreatment of data was required before we were able to determine that PCA and statistical standardization were the best methods. The use of 2,3,7,8-position chlorine-substituted homologues of PCDD/Fs and 1,2,3,4,6,7,9-HpCDD explained the differences among samples well. As a method of decomposing dioxins we trialed the use of ultrasonic irradiation. We also studied biological decomposition or inactivation of EDCs by using plant and soil bacteria.

6) Development of **integrated risk assessment and management of endocrine disrupting chemicals and other contaminants** by comprehensive integration of information and methodologies into an assessment scheme is a major objective of our team. A basis of this project is the "virtual world" geographic information system (GIS) framework, which has been developed since FY 1996 by an ad-hoc project team to manage the new interdisciplinary area of risk assessment and management of various chemicals at local and regional levels.
The FY 2002 study continued the efforts from FY2001, including development of an environmental-fate-modeling methodology, system and databases; development of emission inventory modeling methodologies; and statistical/geographic analysis of monitoring data. A grid-catchment integrated modeling system (G-CIEMS), a multimedia fate model for geo-referenced and spatially resolved fate simulation on a GIS system, was developed for the entire Japanese land environment and the surrounding ocean. A case study of dioxins was conducted over thirty-eight thousand 5 × 5 km air grid cells, covering 38 000 catchments and river segments with 7 land-use categories, a river-networking database, and tentative sea compartments. The model can predict averaged environmental concentrations to within a factor of 2–3, a result that is a great improvement on existing multimedia fate modeling techniques.

We also prepared a database of EDCs; it is available through the web.

Biodiversity Conservation Research Project

left: Ponds having lots of Odonata species
right: Ponds only a few species of Odonata inhabit

The recent rapid expansion of human activity worldwide has resulted in continuing degradation of wildlife habitats and loss of biological diversity. In addition, ecological disruption by incursion of invasive species and production and release of genetically modified organisms has become a new problem. In the Biodiversity Conservation Research Project, which is composed of the 5 research teams described below, we are developing methodologies to assess changes in biodiversity on a variety of spatial scales, and are researching the ecological disruption caused by invasive species and genetically modified organisms.

Wildlife Population Research Team

As the need to prevent the extinction of wild species is increasing, the Wildlife Population Research Team has been researching the mechanisms of population colonization and extinction, which comprise the process of species persistence. Dispersal of individual organisms is occurring between populations and may be influencing the viability and genetic uniqueness of each population. One of our interests is to study how populations are connected. In this fiscal year, we found that numbers of a threatened bird species, the Japanese marsh warbler (*Megalurus pryeri*), are increasing in one of a few remnant populations that are dispersed but interconnected within eastern Japan. Another focus is to incorporate our knowledge of the mechanisms of population connection into regional-scale plans for the conservation of population networks. We found that Japanese populations of a threatened freshwater fish, the three spine stickleback (*Gasterosteus aculeatus*), have maintained their well defined genetic diversity, which was formed in the historical course of population colonization (including artificial introduction) and extinction (Fig. 1). This genetic diversity is worth preserving from the point of view of restoration and transplantation of populations.

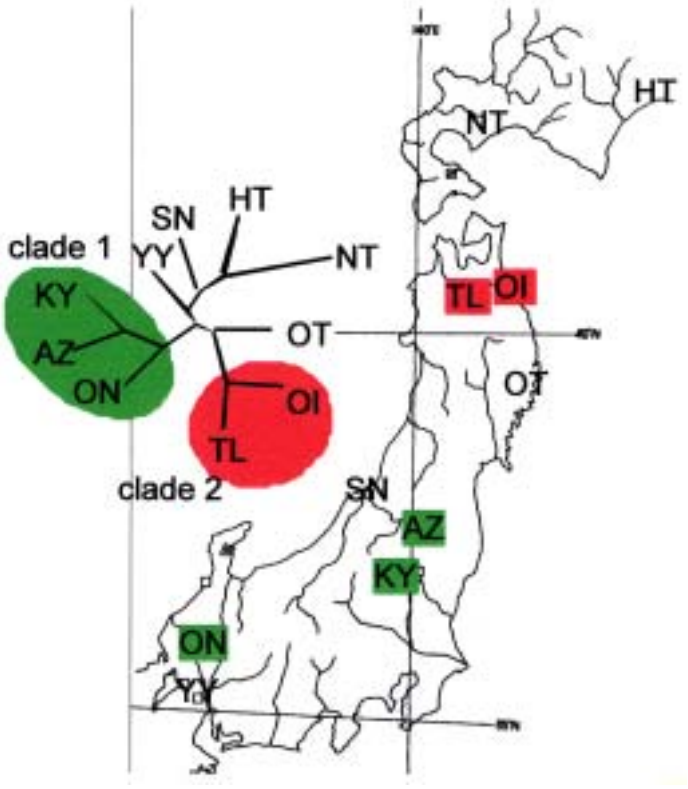


Fig. 1
Genetic relatedness among 10 Japanese populations of a freshwater fish, the three-spined stickleback *Gasterosteus aculeatus*. Two genetically defined groups (clades 1 and 2) were recognized.

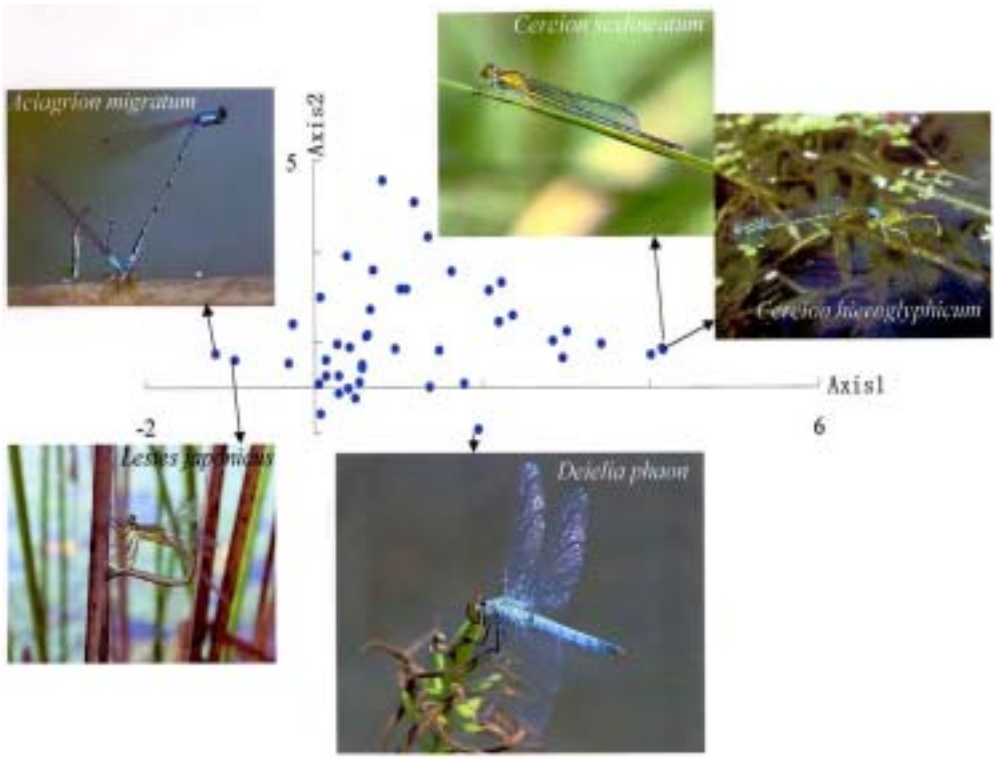


Fig. 2
Detrended correspondence analysis ordinations of 45 species of Odonata in ponds. (Photographs: Takashi Aoki) *Aciagrion migratum* and *Deielia phaon*, located at the left extremity of axis 1, prefer forests, whereas *Cercion hieroglyphicum* and *C. sexlineatum*, located at the right extremity of axis 1, prefer the flatter and warmer environment of paddy fields. *Lestes japonicus*, located at the lower extremity of axis 2, needs aquatic vegetation.

Ecological Landscape Research Team

The Ecological Landscape Research Team explores the patterns of landscapes and their relationship to species diversity in aquatic ecosystems. We investigated the factors that regulate dragonfly and damselfly (Odonata) communities in a number of small agricultural ponds in Hyogo Prefecture, Japan. Multiple regression analysis showed that over 81% of the variation in richness of Odonata species inhabiting these ponds could be explained by 4 variables: the species richness of aquatic plants in the ponds; the presence of a forested area within a 200 m radius of the pond; the length of pond perimeter not covered by concrete edging; and the concentration of nitrogen in the pond water. Ordination by detrended correspondence analysis of 45 species (Fig. 2) revealed that the 2 most explanatory axes were closely related to species-specific voltinism and breeding organs. The positive significantly correlated environmental variable selected by axis 1 was the presence of a forested area within a 200 m radius of the pond, and the negative ones were the presence of a paddy field within a 200 m radius of the pond and the index of solar radiation. Those selected by axis 2 were a number of variables related to aquatic vegetation. Our results revealed some key properties of habitat selection by Odonata, as well as important environmental elements for the conservation of Odonata in these ponds.

We also examined the effects of habitat fragmentation on fish species richness on Hokkaido, the northernmost island of Japan.

Biological Invasion Research Team

The Biological Invasion Research Team investigated the ecological impact of an "insect industry", the commercial production of stag beetles. The breeding of these beetles has boomed in recent years in Japan. Many native and exotic species of stag beetle are now sold throughout Japan as pets (Fig. 3).

Fig. 3
A stag beetle, *Dorcus titanus*, collected from Fuji City, Shizuoka Prefecture, Japan. It possessed the *mtDNA* haplotype of a Thai strain.

This commercialization is expected to have serious ecological impacts on the biodiversity of native stag beetles. Potential impacts are the destruction of natural populations in their native habitats, competition between native and exotic species, and alien parasite invasion. We focused on genetic disturbance as one of the ecological risks posed by this insect industry.

We investigated variations in the nucleotide sequence of *mtDNA* in Japanese and exotic *Dorcus titanus* stag beetles. Our aim was to determine the genetic differences between exotic and native beetles of this species and thus to assess the need to protect the genetic integrity of local beetle populations. Our results revealed that some of the Japanese individuals collected in the field had originated from exotic beetles. Commercialization of stag beetles has caused introgression of the genes of exotic beetles into Japanese beetle populations.

Community Dynamics Research Team

The biodiversity of a forest ecosystem relies largely on the diversity of tree species. The coexistence of tree species is apparently paradoxical, because all species are competing for the same resources—namely, light, water, and nutrients. The reason why the most competitive species do not exclude others has been sought for a long time. Numerous hypotheses on the mechanism of tree species' coexistence within a forest have been proposed. One of them is the temporal fluctuation of reproduction, that is, the concept that species coexistence of sessile organisms competing for space is promoted if each organism produces offspring more than once in its life, and this reproduction is synchronous within each species but asynchronous among species. A minority species may recover its population size when it produces offspring and the other species do not. Available open spaces are then occupied by the minority species.

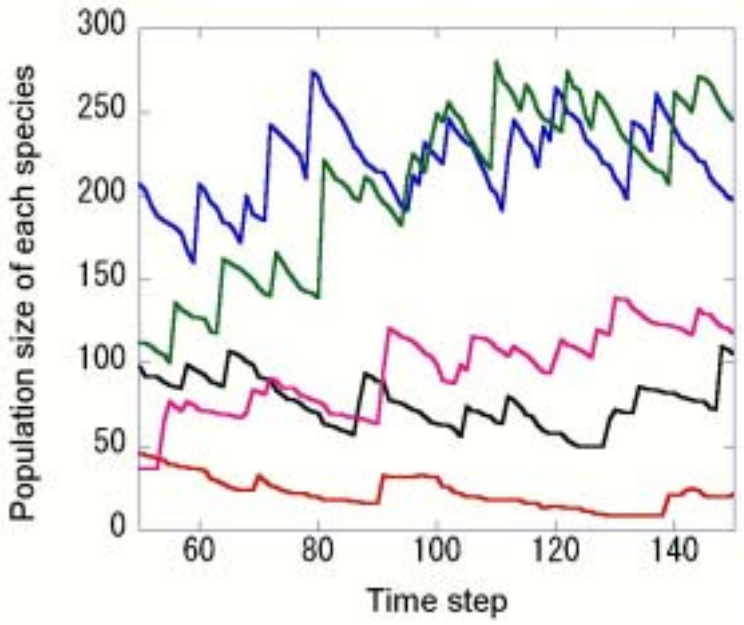


Fig. 4
Temporal change of population size of tree species within a simulation model of forest dynamics. Different lines represent different species. Abrupt rises in the population size occur in seed-production years. These rises are especially pronounced when the random reproduction events of a particular species do not overlap with those of other species, and the reproducing species can therefore monopolize vacant spaces.

In 2002, we tested the validity of this hypothesis as a mechanism for promoting species coexistence in a forest. We developed a spatially explicit simulation model of forest dynamics and used it to investigate the dynamics of species composition (Fig. 4). In the model, the density of dispersed seeds decreased with distance from the parent tree. We found that limited seed dispersal around parent trees enhanced species coexistence. The shorter the dispersal range, the greater the number of species that coexisted. Limited seed dispersal increases the probability that the offspring of minority species will be able to occupy open space in the absence of offspring of dominant species.

Biotechnology Risk Assessment Team

Genetically modified or “transgenic” plants have been generated and utilized for a variety of purposes, and there is public concern over their potential effects on the natural environment. A satisfactory method of evaluating and monitoring these effects needs to be established. *Glycine soja* is a Japanese domestic soybean and is widespread in Japanese soybean fields. Cultivation of transgenic soybean will bring about hybrids of *G. soja* and transgenic soybean (Fig. 5). We constructed F1 hybrids of soybean and *G. soja* and evaluated their phenotype and the stability of the transgene.

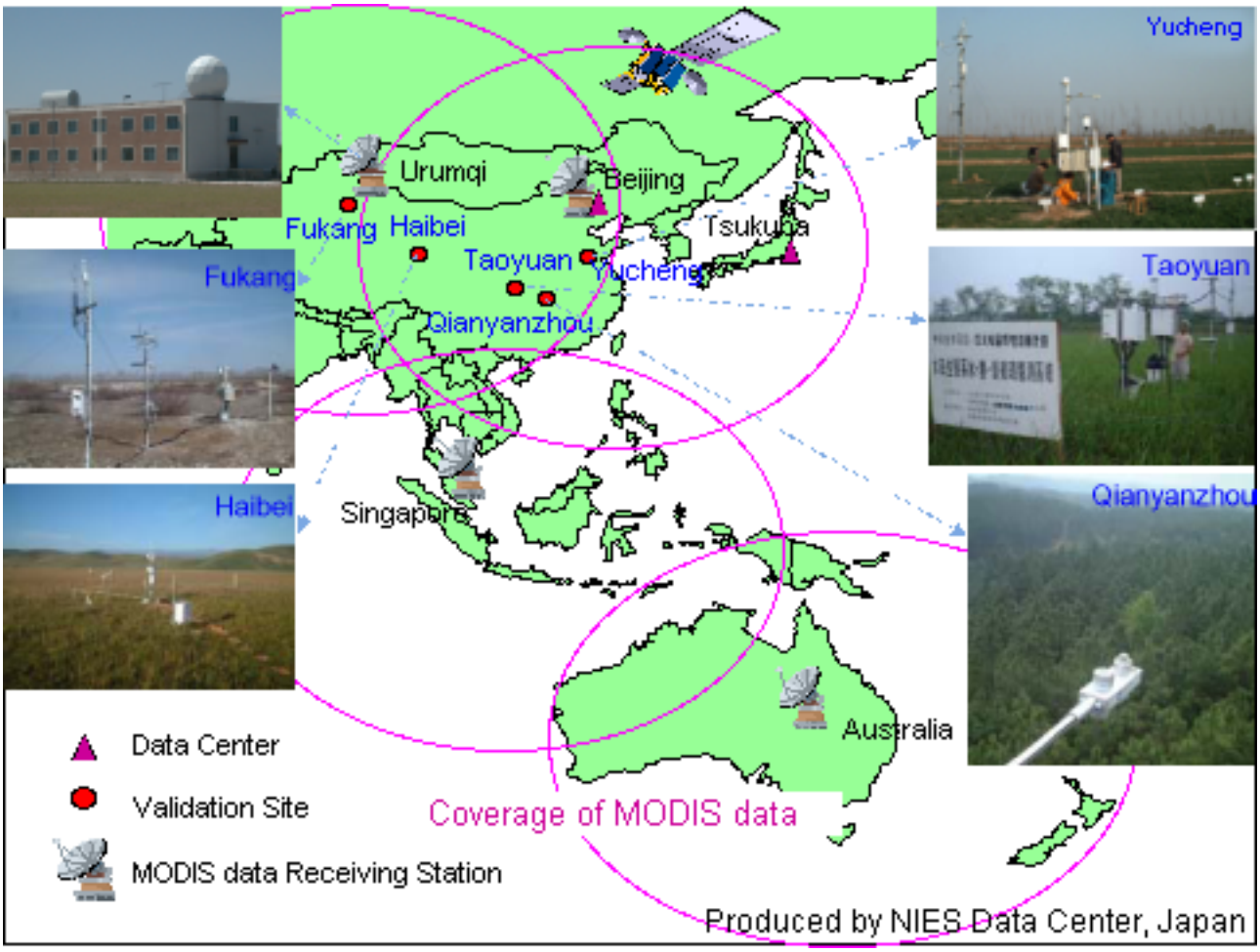
To monitor the fate of genetically engineered microorganisms introduced into the environment, we constructed a genetically engineered soil bacterium possessing a specific marker gene, the mercury resistance operon. This marker was maintained stably in host cells and proved to be a useful, easily detected tool. *Pseudomonas putida* PpY101/pSR134 containing the marker gene was introduced into an aquatic microcosm. We found that the numbers of this bacterium decreased more rapidly under light than in the dark.

In response to unsuitable environmental conditions, bacteria will change their metabolic and cellular components and enter a non-growth stage (VBNC; viable but non-culturable). To confirm this phenomenon, we isolated 5 strains from a municipal sewage disposal plant and stressed them by chlorination. Four strains became VBNC, suggesting that the VBNC stage is common, and that we need a new system for determining whether such bacteria are living or dead.

Glycine soja F1-hybrid transgenic soybean

Fig. 5
F1 hybrid constructed from *Glycine soja* and transgenic soybean . Left: *Glycine soja* plant and seeds. Middle: F1-hybrid plant and seeds. Right: transgenic soybean plant and seeds.

Watershed Environments and Management Research Project



Objectives

Environmental conditions are deteriorating in the Asia-Pacific region, home to about 60% of the world's population and currently experiencing rapid population and economic growth. The fact that many countries in the region are at different stages of economic development creates a complex set of problems that seriously constrain balanced and sustainable economic development. Examples are the health impacts of industrial pollution, degradation of natural resources through industrial development, increased pollution associated with greater use of motor vehicles and the concentration of populations in cities, and increased greenhouse gas emissions. In the context of the major economic growth in Asia in the twenty-first century, we must give thought to sustainable methods of managing the environment that take into account the ecosystem functions that govern the cycle of nature. Our research will focus on the circulation of water and materials in East Asia; we will be working to scientifically observe and understand the ecosystem functions of major river basins in China, the heart of the region. In addition to developing methods to forecast the degradation and recovery of ecosystem functions through models that manage the river basin environment on the basis of ecosystem function, we will propose sustainable environmental management plans that cover the application of environmental recovery technologies, the re-evaluation of development plans, and the reduction environmental loadings.

Monitoring of disasters and environmental degradation

If we are to take effective countermeasures against such environmental depletion and degradation we will need to examine the present environmental conditions and changes in natural resources. As one step toward solving these problems, the National Institute for Environmental Studies (NIES) in Japan and the Institute for Geographical Sciences and Natural Resources Research (IGSNRR) of the Chinese Academy of Science have carried out collaborative research to develop an integrated environmental monitoring network system which, since the formal participation of Singapore and Australia, has now expanded to cover the entire Asia-Pacific Region. The data-analysis centers at IGSNRR and NIES store a database that includes satellite data (e.g. MODIS, LANDSAT, ASTER, NOAA, TRMM), geographic information system (GIS) data, and measurements from ground-truth ecological stations.

Monitoring of disasters and environmental degradation

In eastern Asia, serious disasters occur frequently on large regional scales owing to environmental degradation. For example, dust storms now occur on a larger scale, and the damage they cause increases each year. Meanwhile, desertification and grassland degradation are becoming more severe, thanks to human-driven factors such as overcultivation, overgrazing, exploitation and misuse of water resources. Satellite observation is a tool that can help us to monitor these phenomena over time. Spatially wide and temporally long observations by satellite data enable us not only to monitor natural disasters, but also to detect the land use and land cover changes that occur as a result of human activities. The integrated monitoring network estimated the surface area and volume of Eastern Lake Dongting in eastern China with NOAA-AVHRR and MODIS data coupled with a digital elevation model (see Fig. 1).

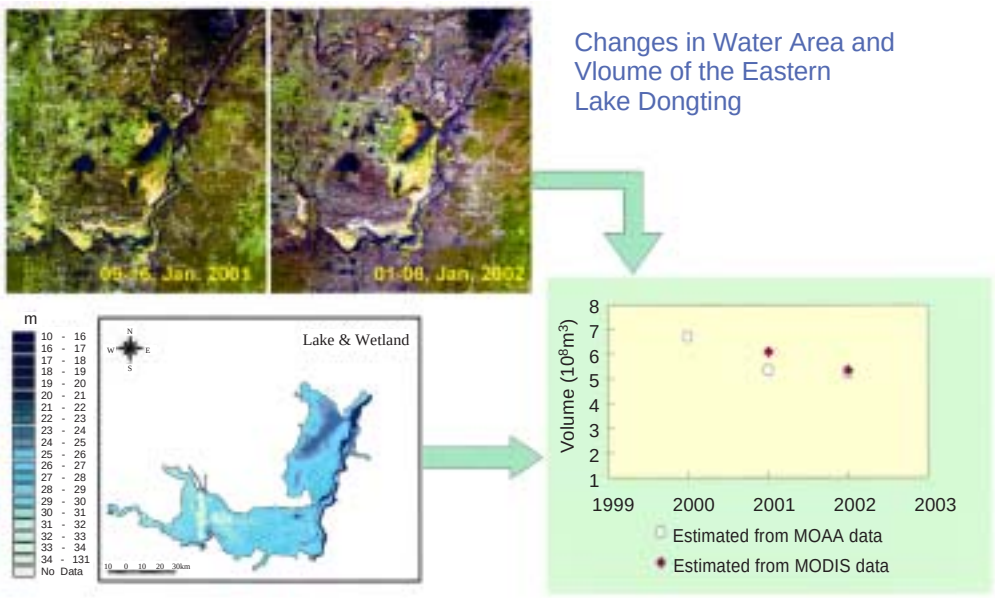
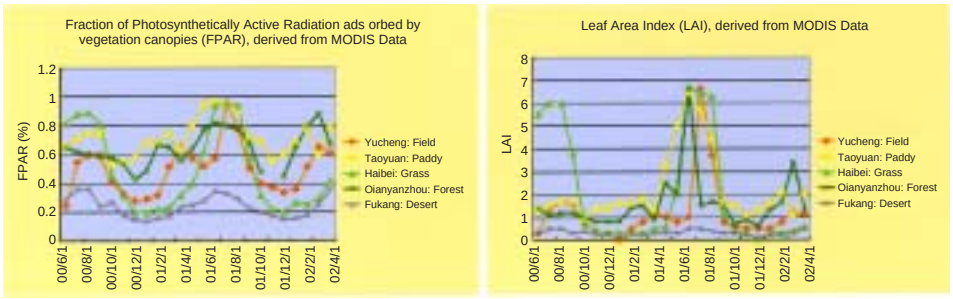


Fig. 1
Estimation of surface area and volume of Eastern Lake Dongting in China from satellite data (NOAA–AVHRR and MODIS) and a high-resolution digital elevation model.

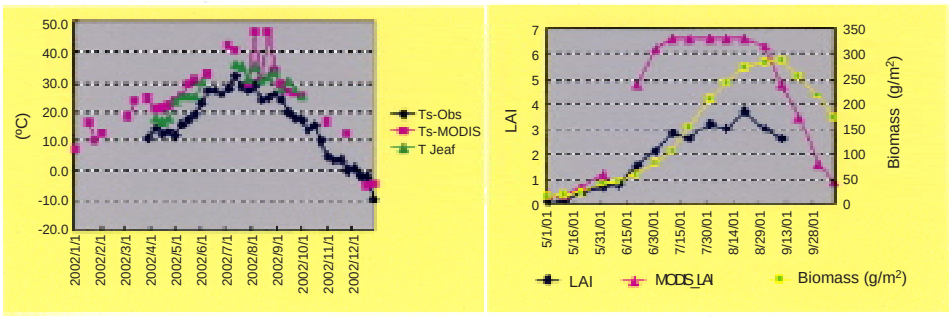
Development of a data-processing system for the derivation of environmental indices and its validation from ground-truth data

At the NIES data center we have already improved a data-analysis system based on an algorithm that NASA has developed, and we now produce the following high-order land products of MODIS: surface reflectance, land surface temperature (LST) and emissivity, land cover and land cover change, vegetation indices, thermal anomalies, fires and biomass burning, leaf area index (LAI) and fraction of photosynthetically active radiation absorbed by vegetation (FPAR), net photosynthesis (PSN), and net primary productivity (NPP). Although we can produce MODIS high-order products by a data processing system, most of them have not yet been calibrated or validated by ground-truth data in various ecological systems. (Fig. 2(a)) shows the annual changes in FPAR and LAI at each of the 5 validation stations listed below, and (Fig. 2(b)) shows the results of validation; such comparisons indicate that the MODIS products must be validated before they are put into use.

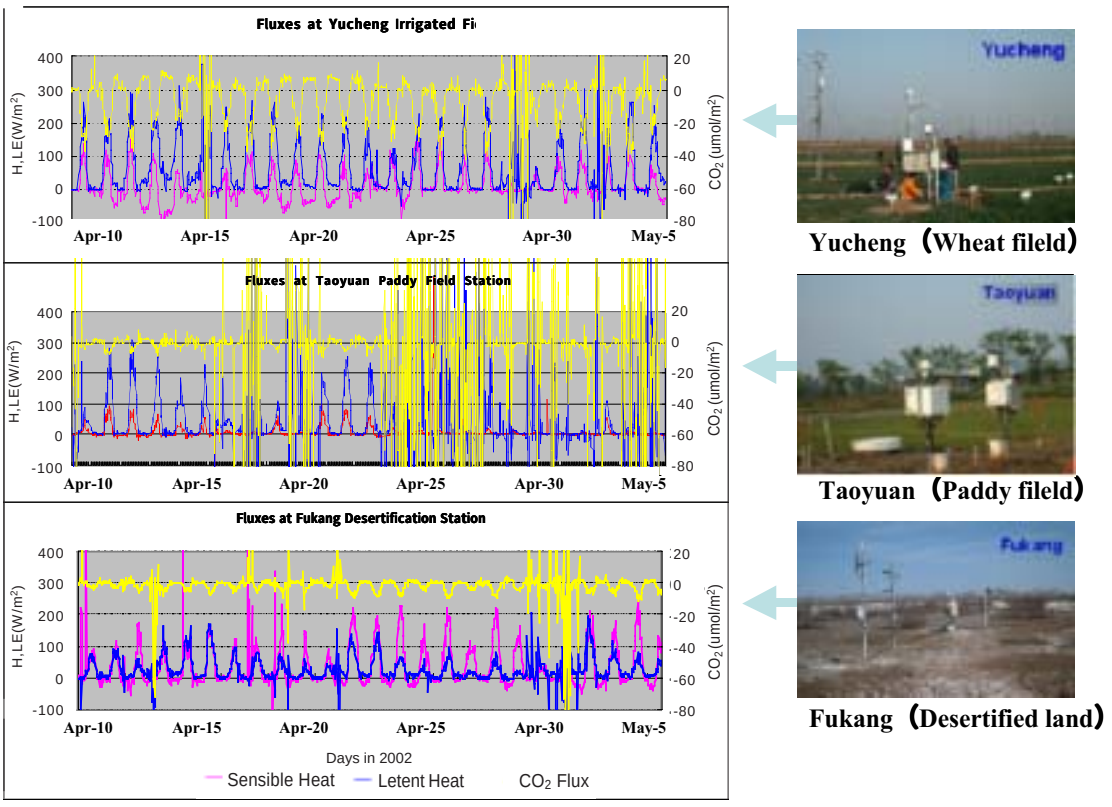
To validate satellite remote-sensing data, in 2002 we established a ground-truth observation network through which long-term measurements of water vapor, energy exchange, and carbon dioxide from a variety of ecosystems—at Haibei (grassland), Yucheng (irrigated fields), Taoyuan (paddy fields), Qianyanzhou (forest), and Fukang (desert) in China—are measured and integrated into a consistent, quality-assured, and documented dataset. The dataset includes micrometeorological factors, eddy covariance fluxes, vegetation characteristics, and soil physical and chemical properties. An example of the observed heat, water, and CO_2 fluxes at Yucheng Station in 2002 is shown in (Fig. 2(c)). Clearly, marked CO_2 absorption and H_2O evapotranspiration occurred during the crop growth season.



(a) Annual changes in fraction of photosynthetically active radiation absorbed by vegetation canopies (FPAR) and leaf area index (LAI) derived from MODIS data at five validation sites



(b) Comparison between observed land surface temperature (left: Yucheng site), and leaf area index (LAI) (right: Haibei Site) with MODIS products in 2001



(c) Examples of observed data at each ecological station in China

Fig. 2
Results and their validation by the integrated monitoring network.

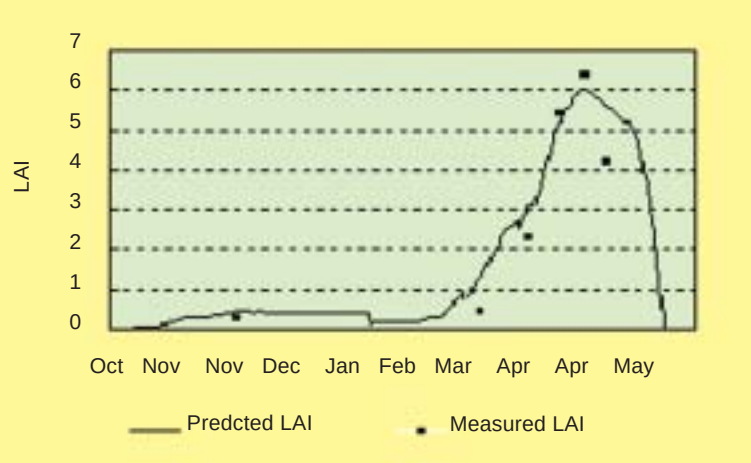
Optimum irrigation management on the North China Plain

To achieve sustainable agriculture, we must manage optimum water use for cropping, and we must understand the relationship between vegetation growth and water consumption. A sophisticated Decision Support System for Agro-technology Transfer (DSSAT) model has been used to simulate agricultural production.

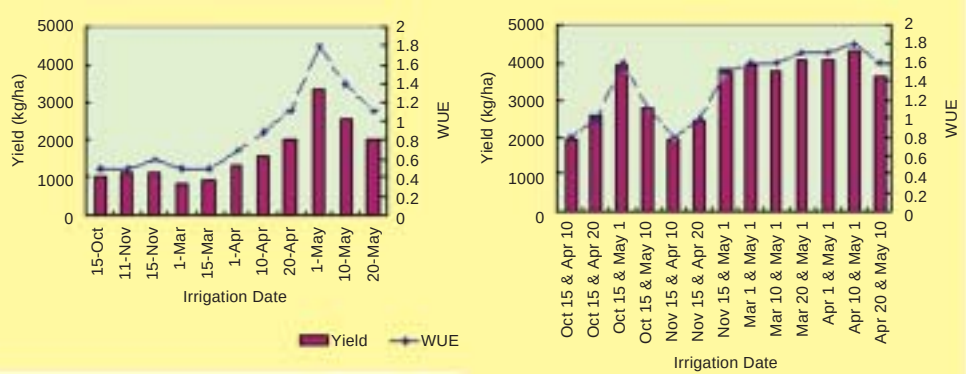
A simulation was applied to wheat production on the North China Plain, one of the largest bases of crop production in China. The widely distributed irrigation networks rely on the use of groundwater, and this has caused a rapid decline in the water table in the region. It is reported that the groundwater level dropped 19.7 m over a 28-year period from 1974–2001 in Gaocheng County. Groundwater drawdown takes place mainly in March–June, which coincides with the wheat-growing season. Sustainable development of agriculture in this area is facing huge challenges. In such areas, it is very important for us to determine the best irrigation scheme for decreasing the amount of water used for irrigation. Our strategy is to produce the highest or near-highest yield with the smallest amount of irrigation water through the improvement of water use efficiency (WUE).

The model can simulate, in daily steps, wheat phonological development from planting through to germination, maturity and harvest; photosynthesis and plant growth; carbon allocation to the root, stem, leaf, and grains; and soil water and nutrient movement. To test the validity of the model in the study region, experimental data from the 2000–2001 wheat-growing seasons were used. Comparisons of the simulation results and the measured results for LAI of wheat in Gaocheng County are shown in (Fig. 3(a)); they indicate that the model simulation is acceptable in the study region for winter wheat management.

The simulation results indicate that this model is a strong tool for determining the wise use of ecological goods and services, such as freshwater resources (irrigation) for crop production. It can provide information on the amount and timing of irrigation to produce the highest crop yield. For example, we determined the optimum timing of irrigation with the same amount of water applied as either 1 or 2 irrigations (Fig. 3(b)). According to the simulation, the highest yield from a single irrigation was achieved by irrigating on 1 May, but an even higher yield, and thus greater WUE, was achieved by dividing the water resource into 2 irrigations, on 10 April and 1 May. Through scientific irrigation scheduling, WUE can be improved and irrigation water can be saved while maintaining a high wheat yield.



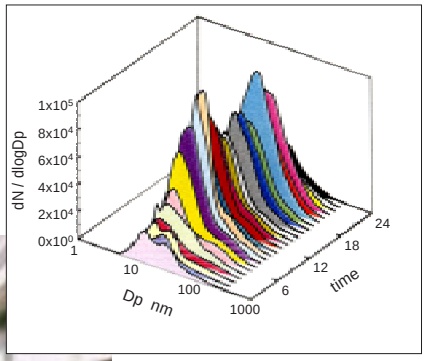
(a) Measured and simulated leaf area index (LAI) of wheat in Gaocheng County, China



(b) Results of DSSAT model simulation of wheat yield and water use efficiency with one or two irrigations in Gaocheng County, China

Fig. 3
Application of optimum management of agricultural water-use.

PM2.5 & DEP Research Project



Size distrbution observed

Roadside site

Measurement equipments

Observation of ultra fine particles at a roadside atmosphere

Environmental fate and risk assessment of fine particulates and diesel exhaust particles

Air pollution from vehicle emissions remains a serious problem in urban areas. The PM2.5 and DEP Research Project Group is carrying out investigations to better understand the characteristics of pollution sources as well as the environmental fate of fine particulate matter ($PM_{2.5}$) and diesel exhaust particles (DEP) and their effects on human health.

Independent Senior Researcher

An independent senior researcher began a 3-year interdepartmental project on approaches to reducing the air pollution caused by diesel vehicles along heavily trafficked urban roads. Reduction strategies studied were: (1) enhancement of the diffusion of exhaust around roads by changing the roadside environment; and (2) improvement of fuel and thus reduction of the toxicity of diesel exhaust. Several PM2.5 & DEP Research Project members conducted wind tunnel experiments and field surveys in relation to strategy (1). They made progress in the first year of the project, FY 2002, as follows.

The wind tunnel experiments were performed on a 2-dimensional 1:300 scale model of a real built-up area in Ikegami-Shinmachi, Kawasaki, where a heavily trafficked roadway runs at ground level below an elevated parallel road. We studied the flow and distribution of air pollutants around the roadway and the lid effect of the elevated road on pollution. We then studied the effects of structural changes to the roads and the surrounding environment on pollution levels. We also studied the effect of thermal stratification on pollution in the area and found that it greatly increased the pollution at the roadside and in its surrounding area. We obtained several suggestions for reduction of pollution. Further, in the wind tunnel experiment, we succeeded by the PIV (particulate image velocimetry) method (see Fig. 1) in observing an instantaneous 2-dimensional velocity distribution of air in a cross-section perpendicular to the road and the elevated road. We now have a tool to study transient states in addition to mean states.

We also conducted 2 field surveys in Kawasaki to measure the real spatial distribution of particulate matter (PM) and NO_2 around the crossing. These results will be compared with those of the wind tunnel experiments and numerical simulations. For particulates 1.0–10 μm in size, we developed sensing units from LED (light emitting diode) dust sensors. We distributed the sensing units at about 30 points around the crossing and measured the particulate density at these points simultaneously every 1–10 min. In addition, we measured the numbers of particulates over 0.03–1 μm that had accumulated. The densities of particulates of both size ranges diminished quickly with increasing distance from the road. This fact suggests that upward diffusion plays a key role, and we are now seeking ways to promote upward diffusion.

Traffic Pollution Control Research Team

The Traffic Pollution Control Research Team formulated emission inventories and reduction strategies for PM, DEP, and other environmental burdens imposed by automobiles. We measured automotive exhausts on a chassis dynamometer, performed

field surveys near trunk roads, compiled emission inventories, reviewed technical and regulatory measures, and developed GIS-based tools for assessing traffic pollution. In fiscal year 2002, particulate and gaseous pollutants from diesel-engine vehicles were measured on the chassis dynamometer as well as by on-board equipment to examine emission factors under various realistic driving conditions. Changes in the size distribution and concentration of particles after emission were observed in a dispersion chamber. Field measurements focusing on the size distribution of ultra-fine particles were undertaken at roadside sites under various traffic conditions. We found that heavy-duty vehicles were the greatest contributors of particles under 50 nm in diameter. We also designed the framework of a GIS-based integrated system for assessing the effectiveness of various policy measures: it consists of numerical models of traffic flow, particulate emission and dispersion, and exposure assessment. In particular, the integration of a dynamic traffic flow simulation model into the system was examined to assess the effectiveness of traffic demand management policies.

Urban Air Quality Research Team

The Urban Air Quality Research Team has been investigating the relationships between changes in the relative importance of various air pollution sources and the spatial and temporal distribution of urban air pollution. To clarify the behavior of airborne particulates – such as $PM_{2.5}$ and DEP – and combinations of gaseous air pollutants, we have been conducting wind tunnel experiments, field observations, data analyses, and computer model simulations. In fiscal year 2002, we performed a series of thermally stratified wind tunnel studies, focusing mainly on air pollution distribution around the road overpass in Kawasaki, to determine the dynamic behavior of air pollution near roadsides. From 3-dimensional field observations, monitoring of data, and using the computer simulation model, we continued our research into the reasons behind the observed trend of ground-level ozone increase in urban and rural areas of Japan. Taking this wider-scale air pollution into consideration, we continued our studies of urban air pollution in Tokyo and Osaka.

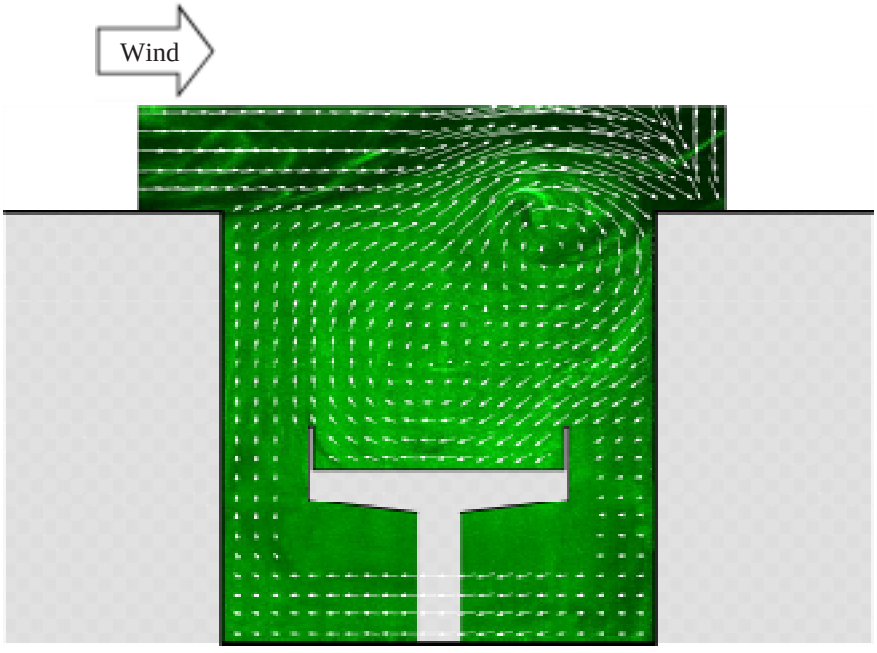


Fig. 1
Wind tunnel experiment: An instantaneous vector field within the street canyon lidded by the elevated roadway, Measured by Particle Image Velocimetry (PIV).

Aerosol Measurement Research Team

The Aerosol Measurement Research Team has been investigating new technologies for measuring particulates and gaseous pollutants. To do this, we have developed a high spatial and temporal resolution monitoring system. We also use a thermal decomposition method to investigate systems for analyzing carbon species.
In fiscal year 2002, we conducted a multi-location measurement of NO_2 and particulate matter in a city with heavy traffic. In addition, to examine the applicability of the β-ray absorption method to the measurement of $PM_{2.5}$, we continued our comparison studies with other commonly used methods, such as TEOM and the gravimetric filtration method.

Epidemiology and Exposure Assessment Research Team

The Epidemiology and Exposure Assessment Research Team is investigating the extent of human exposure to $PM_{2.5}$ and DEP. Assessment of exposure is an integral, essential component of environmental epidemiology, risk assessment, and risk management. The methodologies used to assess exposure employ various direct and indirect techniques, such as personal monitoring and modeling. We are currently investigating an exposure modeling approach for airborne PM, based on microenvironmental concentrations and time-activity data. So far, in cooperation with the Traffic Pollution Control Research Team and the Urban Air Quality Research Team, we have conducted a basic study using a GIS to establish an exposure assessment system. We have completed the first-phase model, which can calculate the level of exposure in the population according to the level of pollution concentration, calculated from a diffusion model using concentrations of air pollution emitted from roads and other sources, superimposed on the population distribution. In fiscal year 2002, we proceeded to the second-phase model. The components of the model can include concentrations of PM in typical microenvironments (e.g. homes, roadsides, vehicles) where people spend time; the amount of time spent there; and equations for the relationships between indoor and outdoor concentrations. In metropolitan areas, many people commute a long way to offices or schools, and we therefore need to consider their exposure in these places as well as at home. From the second-phase model, we estimated the DEP exposure of the population of the Kanto region. We also analyzed data on vital statistics in various regions, looking for statistical correlations between exposure levels and mortality rates. We conducted a data analysis on mortality in 13 big cities in Japan to investigate the short-term effects of particulate matter on mortality. These results suggest a positive relationship between PM concentrations and daily mortality in Japan.

Toxicity and Impact Assessment Research Team

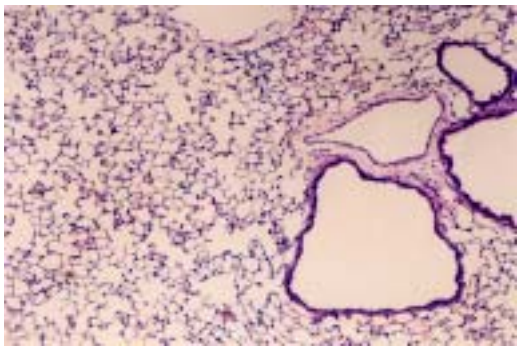
The Toxicity and Impact Assessment Research Team designed toxicological studies to clarify the effects of DEPs – major components of particulate pollutants – and $PM_{2.5}$ on respiratory, cardiac and immunological function in rats.
Although many articles about the influence of air pollution on human health have been published, few have addressed the effects of diesel exhaust (DE) or DEP on the cardiovascular system. To elucidate the effects of inhalation of DE on cardiac function, we obtained electrocardiograms of young (2 months old) and old (14 months old) rats

exposed to DE at concentrations of 0, 0.3, 1.0, or 3.0 mg DEP/m^3 for 12 h a day, 7 days a week for 6 months. The old rats had a markedly higher frequency of arrhythmias than the young rats at any exposure concentration. The arrhythmias of the young rats were mainly ventricular premature contractions (> 98%), but those of the old rats consisted of atrioventricular block (> 7%) and ventricular premature contraction(< 93%). Our results suggest that inhalation of DE is much more likely to provoke arrhythmias and changes in cardiac function in older rats than in young ones.

We then aimed to determine which chemicals in DEP were affecting cardiovascular function. We attempted to isolate and characterize the compounds in DEP that are responsible for vasodilatation of the rat thoracic artery. We isolated 3 vasodilatating nitrophenols , 2-methyl-4-nitrophenol, 3-methyl-4-nitrophenol, and 4-nitrophenol , from a benzene extract of DEP. The concentrations of these nitrophenols were estimated by GC-MS to be 34, 28, and 15 mg/kg DEP, respectively.

We previously showed that DEP enhanced acute lung injury caused by bacterial toxins in mice (Fig. 2(a)-(d)). These effects of DEP were concomitant with the enhanced lung expression of inflammatory molecules such as intercellular adhesion molecule-1, interleukin-1β, macrophage chemoattractant protein-1, keratinocyte chemoattractant, and, in particular, macrophage inflammatory protein-1α. However, the components of DEP responsible for these effects have not been identified. Currently, we are examining the effects of organic chemicals (DEP-OC) and residual carbonaceous nuclei (‘washed DEP’) derived from DEP on acute lung injury related to bacterial infection. Both DEP-OC and washed DEP enhanced the infiltration of neutrophils into bronchoalveolar lavage fluid in the presence of bacterial toxin. Washed DEP combined with bacterial toxin synergistically exacerbated pulmonary edema and induced alveolar hemorrhage, which coincided with the enhanced lung expression of interleukin-1β, macrophage inflammatory protein-1α, macrophage chemoattractant protein-1, and keratinocyte chemoattractant, whereas DEP-OC combined with bacterial toxin did not. The enhancement effects of washed DEP on lipopolysaccharide-related changes were comparable to those of whole DEP. These results suggest that the residual carbonaceous nuclei of DEP, rather than the extracted organic chemicals, are the predominant contributors to the aggravation of lung injury related to bacterial infection. This may be mediated through the expression of proinflammatory molecules, including cytokines and chemokines.

(a)



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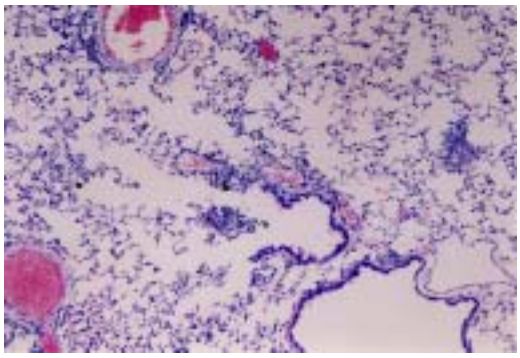

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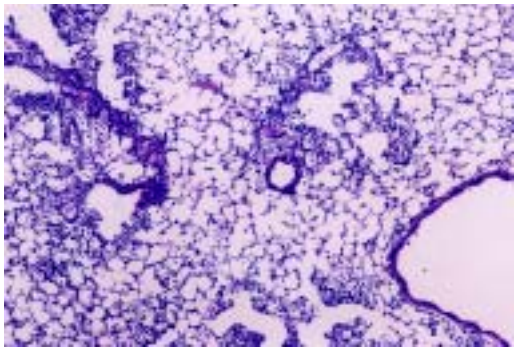


(d)

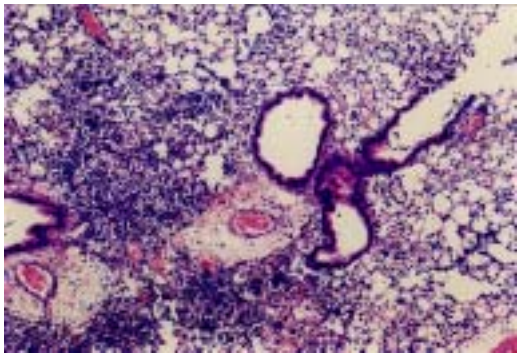
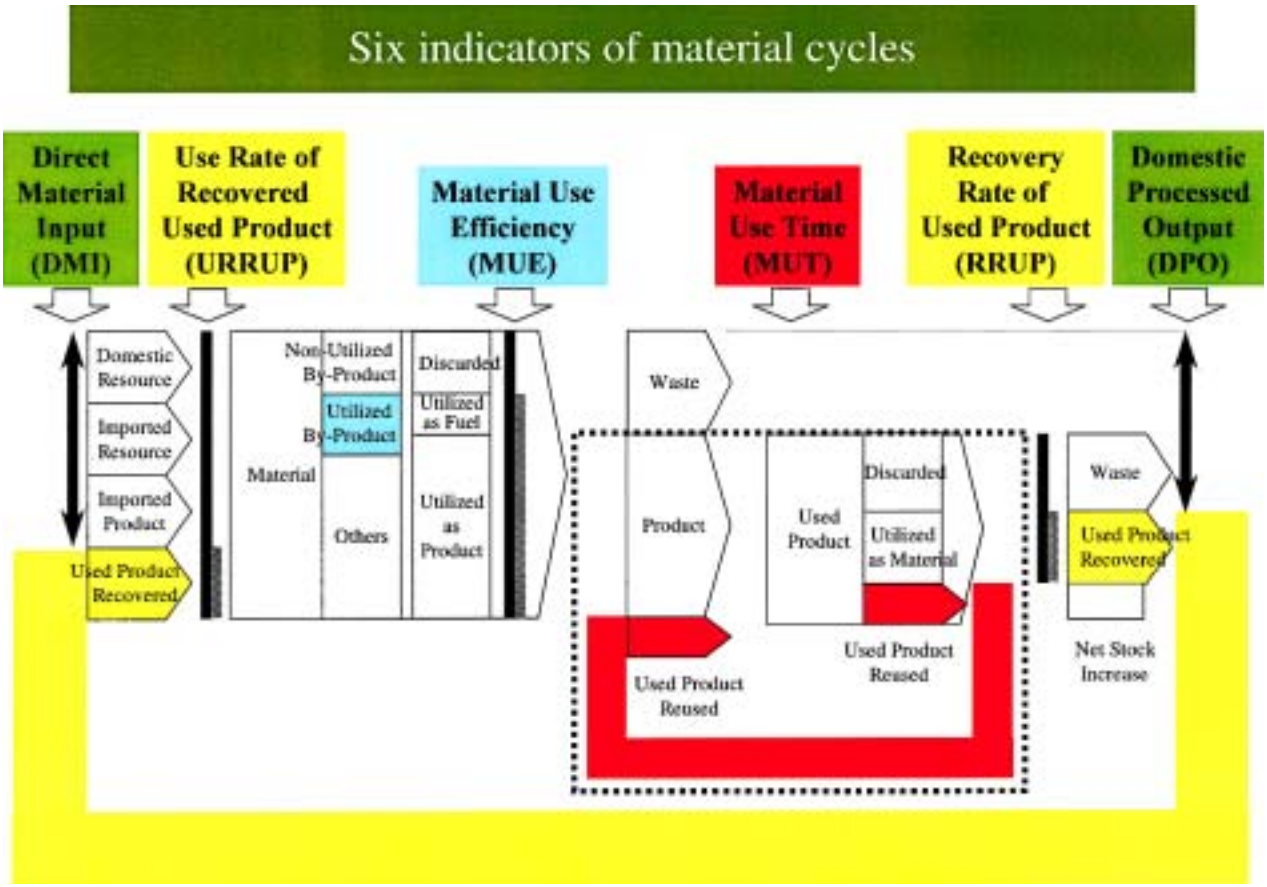


Fig. 2
(a) Lung histology of mice challenged with vehicle exhaust
(b) Lung histology of mice challenged with DEP
(c) Lung histology of mice challenged with bacterial toxin
(d) Lung histology of mice challenged with DEP and bacterial toxin

Research Center for Material Cycles and Waste Management



Introduction

Under the current economic and social system—one of mass production, mass consumption, and mass disposal—we are developing into an economy and society oriented toward material cycling. However, a precise map and compass for where the world is going in terms of material cycling and how it should arrive there is not yet available. Under these uncertain circumstances, in April 2001, the Research Center for Material Cycles and Waste Management was established at NIES, and energetically set out to promote appropriate research. This research center intends to keep an eye on progress toward the realization of a material cycling society by developing methods for processing and analyzing a wide range of information, innovative technologies, and monitoring techniques. The tools we intend to use in our research and policy development include system analysis, technological development, and comprehensive risk control.

Many waste-related issues—from waste prevention to the recycling, treatment, and disposal of wastes—are the targets of our research, which will range from studies of waste characterization, hazard characterization and risk management, to practical studies of technological control methods and system development and assessment. We will tackle 4 main topics: 1) methods for assessing sustainability and the basic organization of a material cycling society; 2) technologies for material recycling, treatment, and disposal; 3) comprehensive risk control methods related to material cycles; and 4) remediation technologies for polluted environments. We are currently focusing on developing methods for assessing sustainability and the preparation of basic systems for supporting the transformation to a material cycling society.

Material Systems Research

As an initial step, it is essential to develop assessment tools and an information base for supporting this transformation. In this respect, we have carried out methodological and empirical studies, applying 3 particular tools: material flow accounting/analysis (MFA), economic input-output analysis (IOA) and life cycle assessment (LCA).

MFA is a useful tool for systematically capturing the flow of resources, products, and wastes, as well as the problems associated with these flows. Development of indicators representing sound material cycles on the basis of the MFA framework was one of our priority studies and was intended to support the government in the preparation of its Basic Plan for a Recycling-based Society. Establishment of these indicators is important in enabling objective measurement of the effectiveness of policies and actions. A trial set of 6 indicators representing the key points of the whole life-cycle of materials was proposed. The set consists of direct material input (DMI), use rate of recovered used products (URRUP), material use efficiency (MUE), material use time (MUT), recovery rate of used product (RRUP), and domestic processed output (DPO). After the consideration of data availability and readability, indicators for 3 key points of material cycles were eventually adopted by the Plan, with a quantitative target.

Progress was made also on industrial waste accounts by sector and by type of waste, which were compiled in a consistent way with economic input-output tables. This

enabled us to analyze how much and what kinds of industrial wastes are created by different final demands of economic activity. According to an empirical analysis, for example, household consumption expenditure induces the production of about 100 million tons of industrial waste (Fig. 1). This amounts to 3 times as much as the municipal solid waste (MSW) directly generated by households. The results suggest that changes in the consumption patterns of households may help reduce the production of both MSW and industrial wastes.

We also made progress in developing tools for assessing whether recycling is really good for the environment, from a broader perspective. A case study was designed to apply LCA to a comparison of the effectiveness of recycling technologies of the plastics for containers and wrappings. Another study to assess the risks from harmful substances contained in recycled materials and in the products themselves was also undertaken. We are developing and standardizing testing techniques to verify the safety of materials that have been recycled, so that when they are used the substances they contain do not have any negative impacts on the environment or human beings.

In addition, to support effective material cycles tailored to local conditions, we work with local governments to build systems to assess whether or not the generation, distribution, and use of recovered resources are suitable at a local level. This is done by integrating information on local industries, waste management, and recycling.

Other studies we have conducted include questionnaire surveys of consumer behavior with regard to the possession, maintenance and discarding of consumer durables, and analyses of the material flow of typical recyclable materials between Japan and other Asian countries.

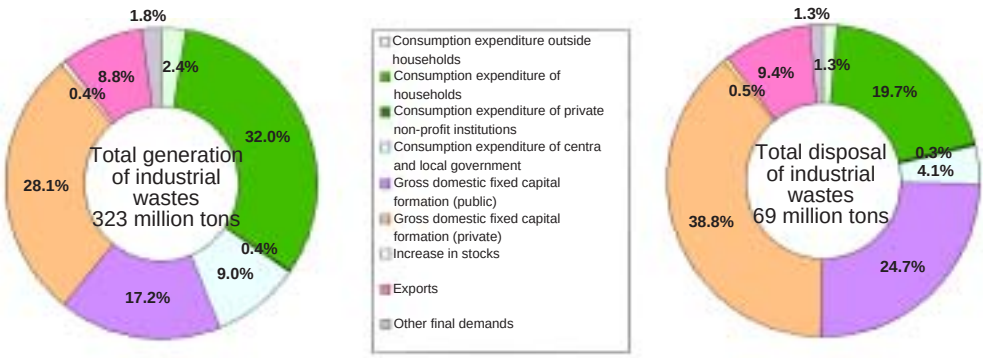


Fig. 1
Generation and final disposal of industrial wastes induced by various types of final demand.

Material Cycle Technologies

Advanced techniques for flue gas treatment using activated carbon and coke as adsorbents were investigated for the reduction of environmental pollutant loads from thermal treatment plants. We used a synthetic flue gas containing 1,2,3,4-tetrachlorobenzene in low ppb concentrations as an alternative compound to dioxins. Breakthrough curves were measured to determine equilibrium adsorption amount of each adsorbent. We found that specific surface area and a micropore volume of less than 2 nm diameter were important properties for estimating adsorptive capacity of

the materials. The potential for dioxins to form from heated ash samples was evaluated in an experiment using ashes generated from gasification-melting processes. The content of carbon in the solids was found to be an influential factor in the potential to form dioxins.

We carried out a field study of organic waste generation in a prefecture to measure unit discharge rates, and to characterize the generation structure in each municipality. A characterization database for recycling resources was also developed, and the data necessary for it were collected. Optimum range of initial pH and operational pH values for the lactic fermentation of organic wastes were determined. We also demonstrated that manganese addition has positive effect on this fermentation process. Material balance of lactic acid fermentation and quality of the recovered lactate were determined in a pilot-scale fully automated fermenter. On the other hand, the ammonium absorption properties of heat-treated MAP (magnesium ammonium phosphate; H-MAP) were compared with those of heat-treated MHP (magnesium hydrogen phosphate; H-MHP). We determined the amount of ammonium absorbed by each type of granule and found that the absorption rate of H-MAP granules was much greater than that of H-MHP granules.

A high concentration of hydrogen sulfide gas is an important issue at inert waste landfills. Causes of high hydrogen sulfide generation are now under investigation. They include high concentrations of sulfate and organic substances, presence of anaerobic conditions, and accumulation of stagnant water in the landfill. Prevention of landfilling of wastes containing large amounts of organic matter and sulfate—which can easily be monitored by a simplified rapid bioassay—is important if we are to avoid the buildup of high concentrations of hydrogen sulfide in inert waste landfills. By using this evaluation method, we determined the critical concentration of dissolved organic carbon extracted by hot water from wastes. We have also used bench-scale lysimeters to study the mechanism of hydrogen sulfide formation from gypsum panel wastes. Methane emission from landfills is an index of landfill site stabilization. We investigated 3 landfills to diagnose their stabilization status through evaluation of methane emission from their surfaces. A thermal camera and a laser methane detector were used in combination to spot the locations where significant emissions occurred, and a closed chamber method was used to quantify the emissions (flux). We are also working on developing technologies for the acceleration of landfill stabilization. Field-scale tests are conducted, using aerobic and anaerobic landfill bioreactor processes with young and comparatively old wastes. Preliminary results have indicated that aerobic landfill bioreactor operation is an effective and promising technology for accelerating the stabilization of landfilled wastes.

We are also using a bio-eco engineering research laboratory to develop technologies for the treatment of liquid wastes such as domestic wastewater. Our results showed that one phosphorus-adsorbing carrier had the potential to cope with effluent phosphorus levels of 1 mg/L for up to 12 months when used with advanced Johkasou systems installed in a real household, and that phosphorus with a purity of more than 95% could be recovered from the carrier saturated with phosphorus as a resource by

desorption and regeneration. In addition, in an effort to stabilize the nitrogen-removal capacity of advanced Johkasou systems, we established a simple, rapid method for determining the presence of specific nitrifying bacteria by the ELISA method using a monoclonal antibody, and developed a method for recognizing nitrifying bacteria by in situ PCR in Johkasou systems. Furthermore, we used a mathematical model to analyze the purification capacity of aquatic plant purification systems. Results showed that the plant was effective in removing nitrogen and phosphorus; this was also demonstrated by an estimation of algal growth potential. Thus, we have been developing bio-eco engineering systems for processing wastewater as liquid waste.

Material Cycles and Risk Management

We promote research to develop overall control methods for the chemical risks presented by using recycled material and managing wastes. As this point, there are 2 challenges: the development of a systematic detection method for non-volatile substances, and the development of an integrated index, using bioassay methods, for the comprehensive management of chemical risks. By utilizing these methods, we are now promoting research on the behavior and control of organic brominated flame retardants related to brominated dioxins, and on a method of destroying wastes containing organic chlorinated compounds.

To analyze the chemical substances included in recycling resources and final wastes, we advanced the upgrading of our chemical analysis and application of bioassay methods. By using the ionization method of liquid chromatography-mass spectrometry (LC/MS), we successfully improved the detection sensitivity for substances such as nitro naphthalene. Application of the Chemical-Activated LUciferase eXpression (CALUX) method, one of aryl hydrocarbon (Ah) receptor binding assays, to incineration fly ash from MSW found that highly sensitive detection of pg-TEQ/g was possible (TEQ: dioxin toxicity equivalent). We verified that, in dechlorinated fly ashes, when the chemical analysis TEQ was low, the bio TEQ was also low, and substances similar to chlorinated dioxins could be hardly formed in the dechlorination process.

Organic brominated compounds such as polybrominated biphenyl ethers (PBDEs) were detected in the leachate from landfill sites. We found that these substances were leached from crushed TV casings, and confirmed that it was possible to remove them by leachate treatments such as coagulation sedimentation and other biological processes. Fate assessment of hazardous chemicals in processes related to waste treatment is essential for reducing the environmental impact of such chemicals. To understand the environmental behavior of brominated organic compounds, including brominated flame retardants, we measured the aqueous solubility and 1-octanol/water partition coefficients of these compounds. From these property data, we hypothesized that the environmental behavior of brominated phenols differed greatly from that of other hydrophobic compounds.

Photochemical dechlorination (PCD) and catalytic hydro-dechlorination (CHD) over a palladium-carbon catalyst were studied as destruction technologies for waste

polychlorinated biphenyls (PCBs). To confirm that PCB destruction systems are being managed well, it is important not only to find low levels of PCBs but also to know the mechanisms of their degradation and to check that there are no byproducts of other toxic substances in the degradation processes. Nine individual PCB congeners (2-CB (IUPAC #1); 3-CB (#2); 4-CB (#3); 2,3,4-T_3CB (#21); 2,2',5,5'-T_4CB (#52); 2,3',4 ,4',5-P_5CB (#118); 3,3',4,4',5-P_5CB (#126); 2,2',4,4',5,5'-H_6CB (#153); and D_{10}CB (#209)) were decomposed by PCD and by CHD, as starting compounds. The reacted solution was periodically sampled during the decomposition of individual congeners and analyzed by gas chromatography-mass spectrometry (GC/MS). By comparing differences in the dechlorination rates for different positions of substitution of the chlorine atom, we were able to compare the pathways of PCD and CHD with regard to chlorine reactivity.

Congener #21 has 3 consecutive substituted chlorine atoms, with steric congestion. The major mono-dechlorination product was #12, from ortho-elimination by PCD, whereas #5 was a para-dechlorination product of CHD (Fig. 2). Subsequently, dechlorination occurred in the meta-position by both methods. Although 2',3,4-T_3CB was observed as a result of a photorearrangement reaction, this pathway was not a major one in PCD. In the case of D_{10}CB, congener #209 was dechlorinated to produce almost equal amounts of #207 and #208, whereas #206 was not observed in either PCD or CHD. Meta- or para-dechlorination was the major reaction, because dechlorination did not easily occur at the ortho-position in D_{10}CB. The subsequent dechlorination reaction proceeded mainly in the remaining chlorine atoms at the ortho-position and produced #54 with 4 ortho-chlorine atoms. In the next reaction, the pathways of photorearrangement of #54 were major in PCD, whereas the reaction proceeded almost exclusively by stepwise ortho-dechlorination in CHD. With PCD, the chlorine atom appeared to be easily rearranged to a stable position from its unstable ortho-position. In this way, we could explain the differences in reaction mechanisms between the 2 methods: ortho-dechlorination occurred easily in PCD, unlike in CHD. These results will prove very useful in the promotion of waste PCB treatment.

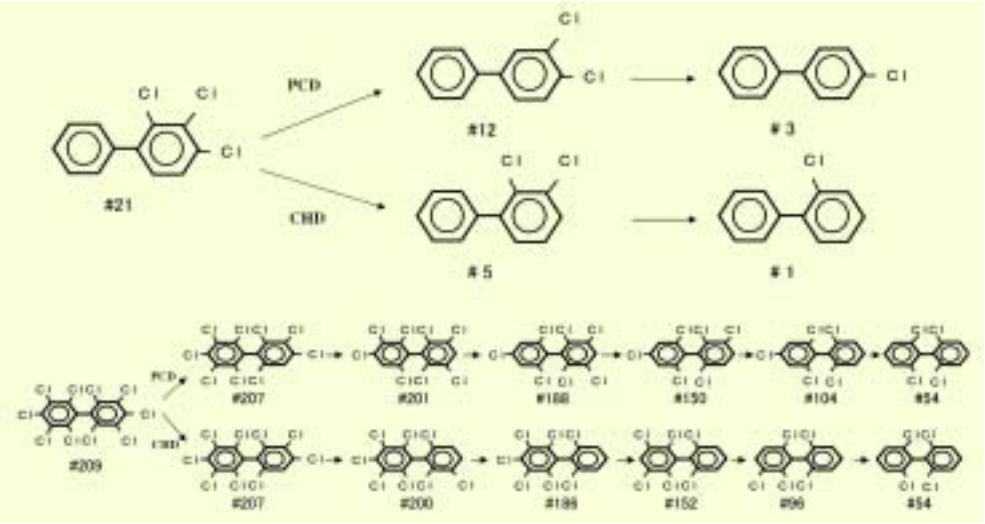


Fig. 2
Differences in the dechlorination pathways of photochemical dechlorination (PCD) and catalytic hydro-dechlorination (CHD) over a Pallaium-carbon catalyst.

Research Center for Environment Risk

Sediment toxicity test using chironomid. In each glass container, artificial sediment polluted with or without test chemicals and upper layer water was set. After 48 hours 20 individuals of chrinomid 1st instar larvae are introduced. The effects of the chemical are evaluated by emergence rate of chironomid compared to the control.

This Center promotes research projects on environmental risk assessment. Currently, there are 7 project themes, covering the development of methodologies for: 1) assessment of exposure to environmental risk in light of variability; 2) exposure assessment on the basis of limited information; 3) assessment of health risk in light of individual variations in susceptibility to chemical substances; 4) bioassay systems for environmental monitoring; 5) assessment of health risk from concurrent exposure to a number of chemical substances; 6) assessment of ecological risk of chemicals on the basis of their toxicity to individual organisms; and 7) communication of environmental risks.

Below are brief descriptions of some of the important results of these projects for 2002.

Development of a methodology to assess exposure on the basis of limited information

In this sub-theme, we built 3 models that could predict the concentration of a chemical in the environment from limited information. The first was a simple statistics-forecasting model. We performed a multiple regression analysis using the air concentration of the chemical substance as a dependent variable, and population density, industrial shipment density, demand, Henry's law constant, atmospheric OH rate constant, and a dummy variable of usage as independent variables. The model was built from data on 5 of 12 substances, and its accuracy was verified from the monitoring data of the 7 remaining substances. We obtained a regression equation with $R^{2*} = 0.67$ (Fig. 1). In the validation experiment the predicted value was within the limits of ± 1 order of measurement for 80% or more of the samples (Fig. 2).

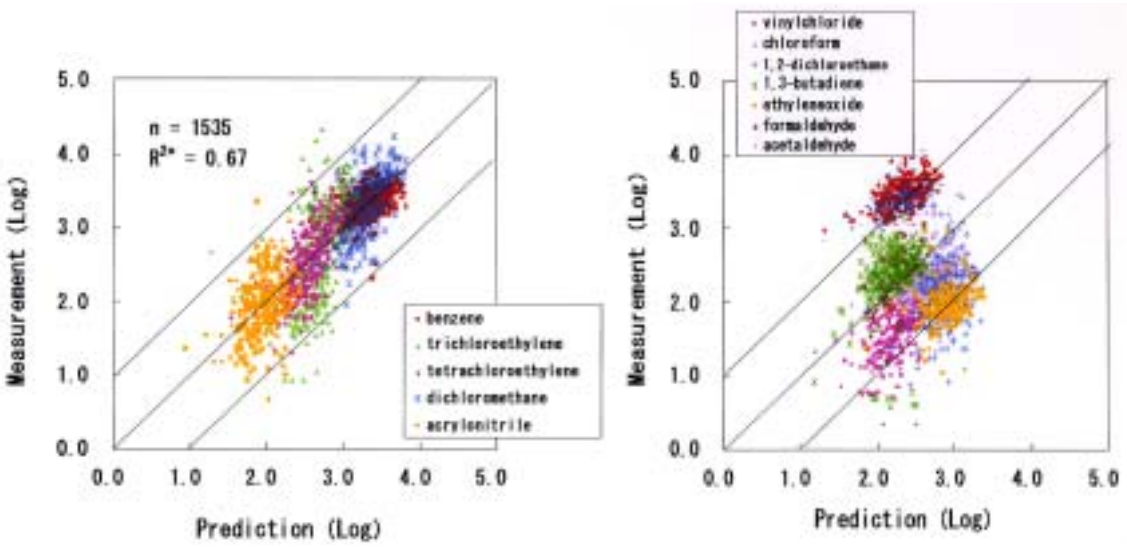


Fig. 1
Comparison of air concentrations measured and predicted by a statistics-forecasting model.

Fig. 2
Verification of the statistics-forecasting model.

The second model was a 1-dimensional unsteady flow river model. The computer code consisted of an unsteady flow/advection diffusion calculation solved by the cubic interpolated pseudoparticle method, and a transfer/degradation calculation solved by the Runge-Kutta method. From a sensitivity analysis, we identified water depth, sediment porosity, and concentration and organic content of suspended solids as parameters that had a marked influence on the predicted concentration of chemicals.

The third model was a coupled 3-dimensional hydrodynamic and ecotoxicological model. The variables and processes in the model could be added or deleted to suit regional characteristics, the availability of data, and the characteristics of aquatic products. We used this model to simulate the behavior of bisphenol A in Tokyo Bay (Fig. 3). The model was calibrated with monitoring data from the study area. The

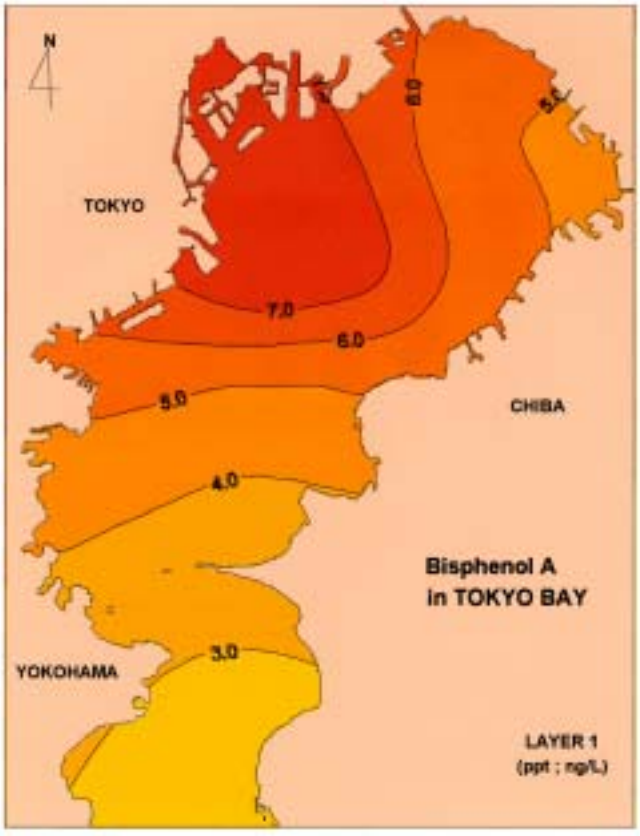


Fig. 3
Simulated distribution of bisphenol A in a Tokyo Bay model.

simulated results for dissolved bisphenol A were well correlated with the observed values ($r = 0.8931$). Results of sensitivity analysis showed that biodegradation rate and bioconcentration factor were the most important parameters determining the concentrations of dissolved bisphenol A and bisphenol A in the phytoplankton cells, respectively. Biodegradation rate and partition coefficient were both important determinants of the bisphenol A concentration in particulate organic carbon.

Development of a methodology to assess health risks in light of individual variations in susceptibility to chemicals

Genetic factors, such as polymorphisms, are important determinants of differences in susceptibility to chemical substances among humans. In more than 1000 DNA samples collected from residents in the town of Kiyotake in Miyazaki Prefecture, we analyzed single nucleotide polymorphisms (SNPs), which are abundant in the human genome, by 2 different methods: the Pyrosequencer and restriction fragment length polymorphism (RFLP) (Fig. 4). SNPs at 2 different sites (SNP1 and SNP2) of the aldh2 gene, including the active center of acetaldehyde dehydrogenase 2 (aldh2), were analyzed (Fig. 5). There was no polymorphism at the SNP1 site, but, in contrast, there were polymorphisms at SNP2. The percentages of C/C, C/T, and T/T types agreed well with previously reported data.

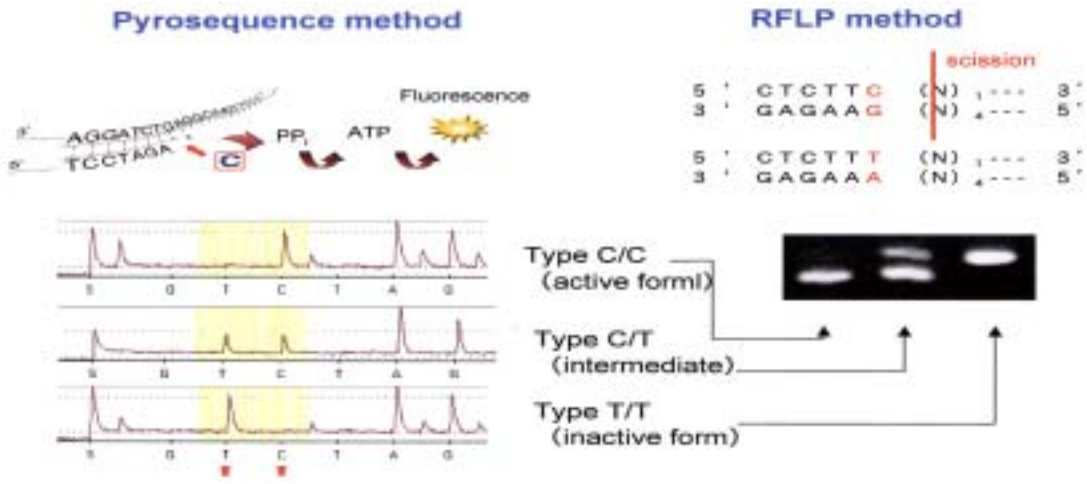


Fig. 4
Schematic representation of 2 different methods of single nucleotide polymorphism (SNP) analysis.

	C/C (G/G)	C/T (G/A)	T/T (A/A)
SNP 1	601/601	-	-
SNP 2 (active site)	525/806	242/806	39/806

Fig. 5
Results of SNP analyses for acetaldehyde dehydrogenase 2 in the Japanese population.

We also investigated susceptibility to environmental contaminants in an area in China where arsenicosis is endemic. Urine samples were collected from 38 inhabitants of the village of Changqing (Xing Ren County, Guizhou Province, PR China). These people have been chronically exposed to inorganic arsenic through coal combustion. Inorganic arsenics are known to be methylated to monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA) in the body. The concentrations of MMA and DMA in the urine were significantly correlated (R^{2*} = 0.626). However, the correlation between the urinary concentration of inorganic arsenic (iAs^{+5}) and DMA was low (R^{2*} = 0.080). Two subjects excreted higher concentrations of DMA than inorganic arsenic in the urine, suggesting that there may be polymorphism in arsenic methyl transferases.

Development of bioassay systems for environmental monitoring

Bioassay methods are believed to be useful for identifying the hazardous effects of complex mixtures of chemical substances in the environment. To build bioassay systems that could estimate the total impact of exposure to a number of chemicals in the environment, we investigated the quantitative relationship between bioassay data and the adverse effects of air pollutants.

We compared the Ames test, a standard *in vitro* test for detecting mutagens, with an *in vivo* mutagenicity test in a transgenic mouse called the gpt delta mouse, established by Dr. Nohmi. We instilled the mutagen benzo[a]pyrene (BaP) into the lungs of these mice; as the incidence of lung cancer from the instillation of BaP in the lung had already been described in the literature, we were able to compare the *in vitro* and *in vivo* mutagenicity of BaP.

The frequency of mutations in the lungs of BaP-treated mice increased linearly with the dose of BaP. From the linear relationship between mutation frequency in the lung and the incidence of cancer, we estimated that the mutation frequency required to increase the incidence of lung cancer by 10% was 2.9×10^{-5}. This value appears to be an informative parameter for describing the relationship between bioassay data (mutation frequency) and the incidence of adverse effects (cancer).

Development of a methodology to assess ecological risk on the basis of chemical toxicity to individual organisms

We gathered data on the ecological hazards of chemicals from several existing database and references. The data were compiled and analyzed to examine intra- and interspecies variations in sensitivity to chemicals and to clarify the relationship between acute and chronic values. We found that Crustacea were more sensitive to amines than to other chemical species.

We also assessed a method for testing sediment toxicity in a non-biting midge (*Chironomus yoshimatsui*), a species endemic to Japan, to develop 2 new OECD test guidelines (drafts 218 and 219). Toxicity tests were performed on this species in accordance with draft TG 218. We also performed supplementary experiments to

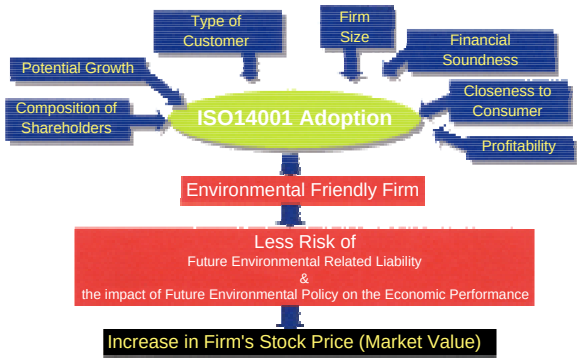
determine the optimum test conditions for factors such as amount and quality of food given in the test period, volume of air bubbled through the test tanks, and the procedure used to prepare the artificial sediment. To check the validity of draft guideline TG218 for substances with relatively low log P_{ow} (less than 5), we performed a ring test together with 3 laboratories in Japan. Pyrene was selected as the test substance, and the test was performed with the materials and protocol proposed by our team.

EnvMethod (Environmental Analytical Method) Database

Environmental monitoring data is essential for our evaluation of exposure to chemicals, and also for calibration of environmental numerical models. Various methods of analyzing environmental chemicals have not been reported in the scientific literature and may have appeared only in the regulating official method, or in reports from the Ministry of Environment. We developed the EnvMethod database to collect these widely scattered reports of analytical methods and to offer this information to researchers engaged in the development of analytical methods and to chemical laboratory technicians. EnvMethod is a web-based database that is searchable by features such as name of chemical substance, legal implications, references, title of the analytical method, and environmental medium, and is linked with the WebKis-Plus chemical database by CAS (Chemical Abstract Service) number. We have collected data on 1694 analytical methods and 1712 chemical substances; the analytical methods are downloadable.

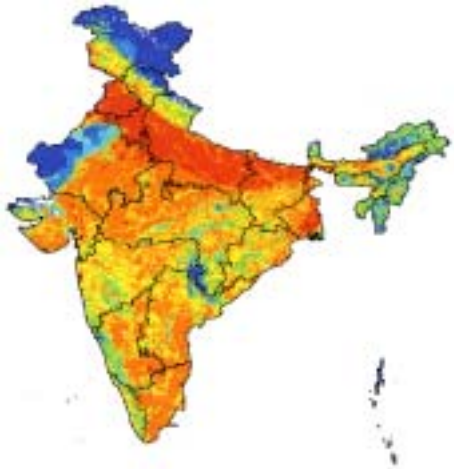
Social and Environmental Systems Division

Incentive of ISO14001 Adoption & Mechanism of Market Valuation



Econometric analysis

Physical modeling



Projection of water withdrawal per unit area in 2030

Remote sensing

Satellite tracking data of Oriental White Storks

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 can threaten our daily lives, well-being, and socio-economic activities. Therefore, the human and societal dimensions of environmental change 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 interactions between social and environmental systems.

The Division consists of 5 research sections: Environmental Economics, Resources Management, Environmental Planning, Information Processing and Analysis, and Integrated Assessment Modeling. In addition, there are 2 Independent Senior Researchers. In FY 2002, the division conducted the following research.

Environmental Economics Section

(1) Comparative international study of sustainable consumption

We analyzed the results of both an international comparative survey and domestic surveys of the producer–retailer–consumer chain. We found, 1) Consumer trust in producers has an important influence on purchasing decisions; 2) The level of consumer trust in Japan is lower than in Germany; 3) "Health effects" product attributes are more important to consumers than "environmentally friendly" attributes.

(2) Study of firm's incentives to adopt ISO 14001 and its market valuation

We explored incentives for Japanese manufacturing firms to adopt ISO14001 and the impact of its adoption on the market value of firms. Our main findings are: (a) Larger firms with higher profitability and larger exports had a higher incentive, (b) Adoption of ISO14001 increases in firm's market value. (Fig. 1).

(3) Study of international institutions for sustainable development

This study evaluated effectiveness of international institutions for global sustainable development. Little progress was observed at comprehensive levels, but large conferences affected multilateral environmental negotiations at issue-levels.

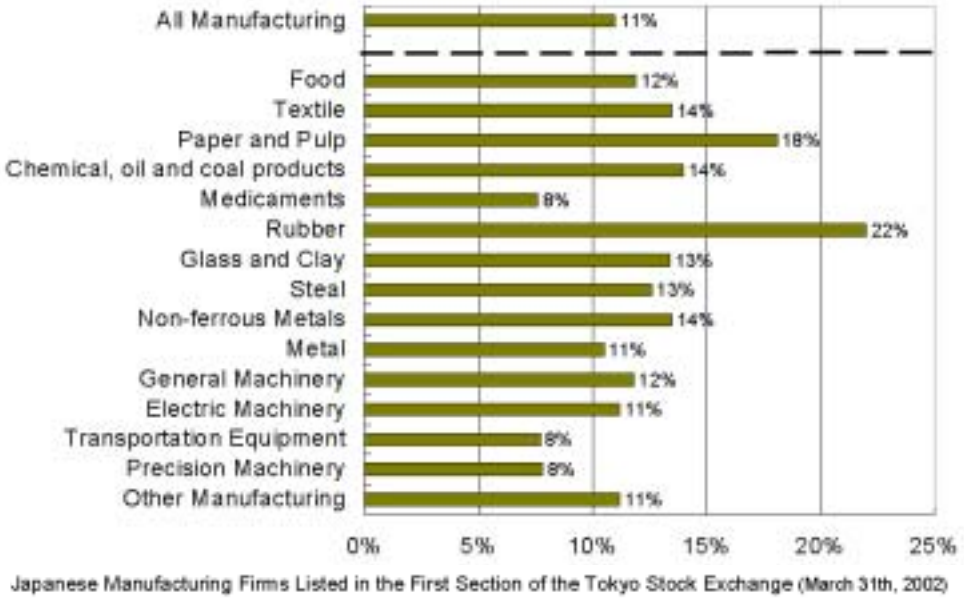


Fig. 1
Estimates of the increase in market value of industries as a result of adoption of ISO14001.

Resources Management Section

The Resources Management Section studies methodologies for quantifying the environmental burdens and impacts associated with various socio-economic activities. (1) Material Flow Accounting/Analysis (MFA) is one of the key tools used for this purpose. Physical Input – Output Tables (PIOT) are designed to describe the flows of natural resources, produced materials, as well as solid waste and recycled materials. (2) We analyzed the incentives for, and effects of, adoption of ISO 14001 standard by firms in Japan and the USA. We applied models based on economic and political economic theory to help us understand what factors encourage facilities to adopt ISO 14001 and how their environmental management systems work. (3) Another issue was the application of Life cycle assessment to the use of underutilized energy sources to reduce carbon dioxide emissions. (4) We also applied some other comprehensive environmental assessment methods like conjoint analysis and cost–benefit analysis to transportation and waste management scenarios.

Environmental Planning Section

Our section studies techniques for planning and evaluating environmental conservation policies. Our research includes the setting of local environmental policy goals, as well as the prediction of global warming and assessment of its impacts. In 2002, we conducted the following researches.

(1) At the annual meeting of the Environmental Science Society, we organized a symposium on environmental indices essential to regional environmental management. The more efficient methods of improving mutual understanding among administrators, researchers, and local residents were summarized.

(2) Urban rehabilitation and reconstruction are inevitable if we are to make cities sustainable. We examined the concept of the compact city as an environmentally friendly city. To develop ways of improving the sustainability of the world's large cities, we collected data and developed an urban database that can be used to compare a city against the compact city model. Then we developed an indicator of city size and population density and applied it to time-scale comparisons of cities. (Fig. 2).

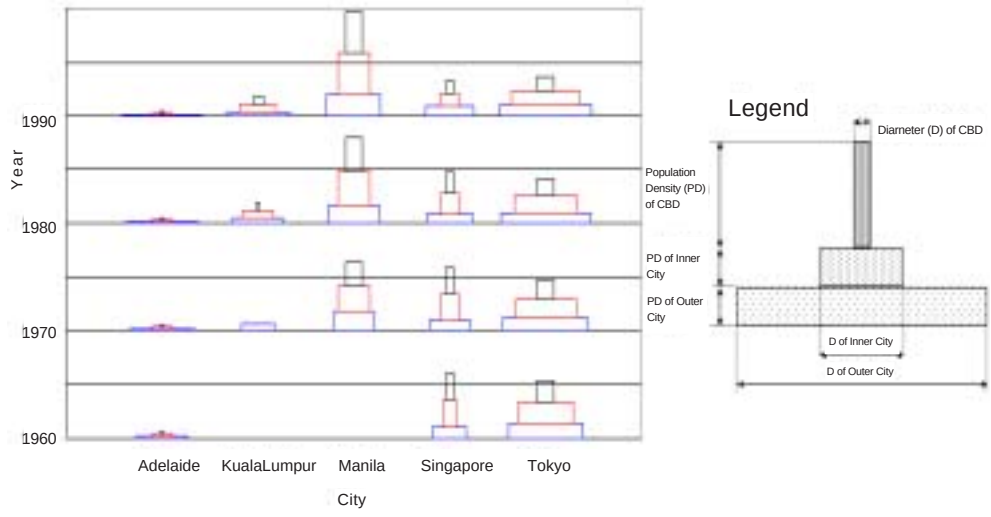


Fig. 2
Size and population densities of cities.

Information Processing and Analysis Section

Our section promotes comprehensive research on methods of environmental monitoring; numerical simulation analysis; and the processing of information from many kinds of observational data. Examples are the processing and analysis of remote-sensing satellite data on the atmosphere, land, and oceans; the non-destructive and sensitive discrimination of types of bird egg; and numerical simulation of diffusion of urban air pollution. We also process and analyze research data generated by the other Sections in our Institute. In 2002, we processed information on several special priority research projects, including the evaluation of grassland and coral reef environments by using hyper-spectral sensor data; and the development of a new method of hazard prediction and detection of forest fires and burned areas of land from satellite images of the Russian Far East.

Integrated Assessment Modeling Section

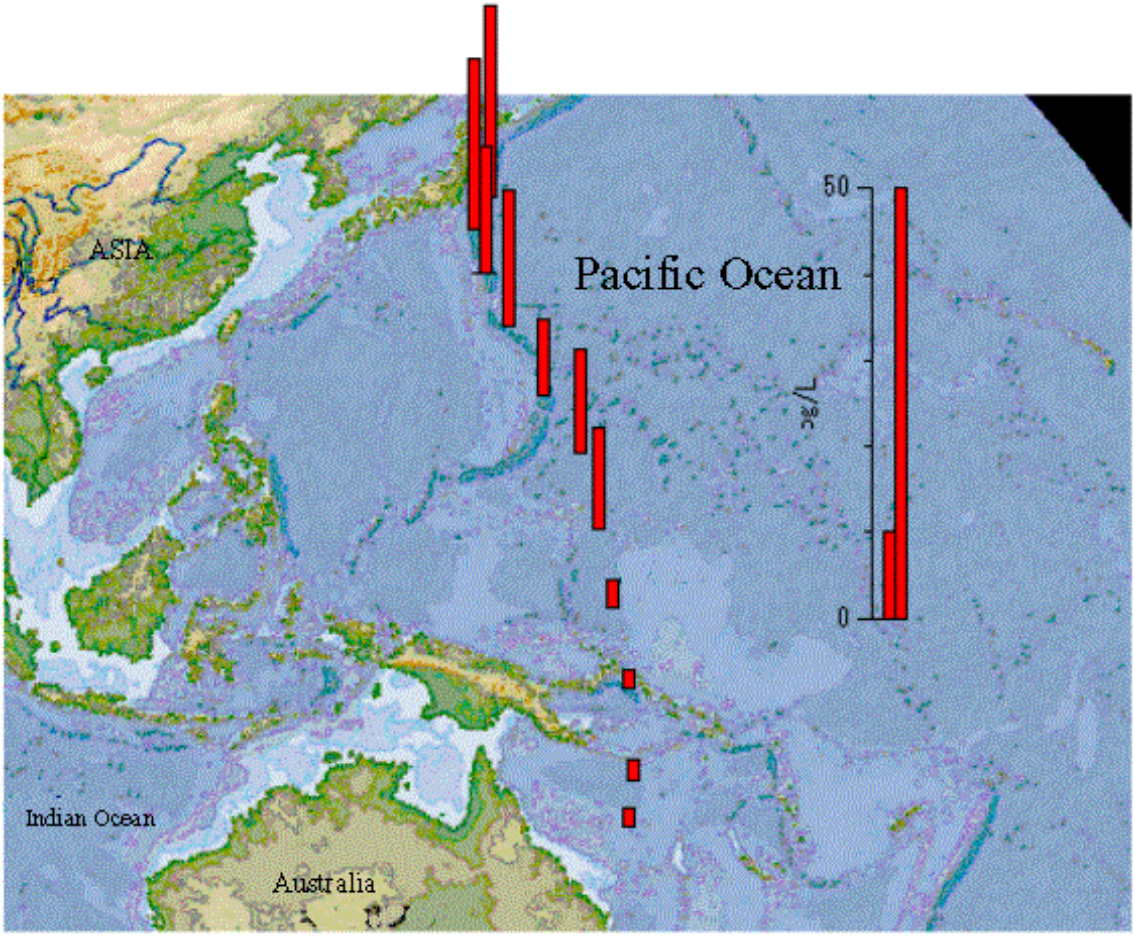
The "Integrated Assessment Model" has been developed to evaluate environmental conservation. This model covers a wide range of environmental problems; economic activities, land use change, lifestyle change, and recycling. It evaluates the impact of environmental conservation measures on the economy. For conserving global environment in the future, it is essential to cooperate with developing countries in the Asia Pacific region such as China, India, Thailand. Presenly the priority for environmental conservation in developing countries is much lower than that in developed countries. However it is essential that developing countries give importance to environment conservation and include it in their list of development priorities.The techniques to evaluate strategies that combine local and global environment measures have been examined. Bioenergy is a good example to consider such strategies. Its supply potential in Japan was investigated to assess the role of renewable energy for other Asia-Pacific countries. Renewable energy scenarios for the year 2032 were also prepared for each of the Asia-Pacific countries.

Independent Senior Researcher

A type of landscape appreciation called the "Eight Scenery" was established in ancient China. It spread to surrounding areas and eventually influenced the appreciation of landscape throughout East Asia (Fig. 3). We investigated the relevance of the Eight Scenery to modern-day landscape preservation in China, Korea, and Japan.

Fig. 3
Distribution of Eight Scenery sites in Asia.

Environmental Chemistry Division



ß -HCH concentration in the surface sea water

Marine monitoring for POPs and heavy metals using marchant vessel (sampling on the Japan - Australia Line).

The Division of Environmental Chemistry, with its 4 research sections, develops analytical and geochemical methods of examining the chemical aspects of the environment.

The Analytical Instrumentation and Methodology Section has developed new analytical methods and instrumentation. We developed lithium-drifted silicon (Si(Li)) detectors with high-quality large areas for charged particles and X- or gamma rays. We achieved long-term stability of these detectors at room temperature by 1) fabricating a thin p-n junction by using a photo-engraving process; 2) heat treatment at 120 ˚C for 20 h with no bias after complete compensation. The properties of the Li-compensated region were investigated by a combination of copper plating and subsequent micro-X-ray fluorescence (XRF) analysis. The Si(Li) detectors were found to exhibit better energy resolution for both α-particles from ^{241}Am and conversion electrons from ^{207}Bi.

One of the application programs of the section is the monitoring of yellow sand (Kosa) aerosols by chemical analysis and remote sensing to determine how they are generated and transported. We aim to establish Kosa model for the creation of an early warning system and the assessment of environmental policy to prevent desertification. Continuous lidar observations in Beijing, Nagasaki, and Tsukuba revealed that the number of dust events in 2002 was similar to that in 2001 in Beijing, but it was larger in Japan, especially at Tsukuba. This suggests that some changes in long-range transport are the major cause of this increase in Japan.

The Analytical Quality Assurance Section has developed methods for analytical quality control by evaluating the most appropriate environmental analytical methods and preparing certified reference materials. We investigated sample preparation methods and gas chromatography – high resolution mass spectrometry (GC-HRMS) for polychlorinated-*p*-dibenzodioxins (PCDDs) and polychlorinated-*p*-dibenzofurans (PCDFs) in various environmental samples. We successfully performed analytical quality assurance of environmental PCDD/PCDF monitoring by using certified environmental reference material NIES CRM-No. 20, “Sediment”.

We also studied methods for measuring fine particulates and volatile organic compounds (VOCs) in the atmosphere. Continuous monitoring of VOCs was initiated at Tsukuba and Tokyo to establish quality assurance for the sophisticated automatic sampling GC–MS instruments and to characterize VOC pollution in the metropolitan area. About 20 of the 40 compounds measured were detected frequently, and their concentrations varied greatly from day to day.

We investigated a method of analyzing individual fine airborne particulates by using synchrotron radiation and an X-ray microscopic analytical system. The chemical composition of the particulates was determined by XRF spectrometry, and the chemical species of some transition metals were analyzed by X-ray absorption fine structure (XAFS). Roadside fine airborne particulates about 100 nm in diameter were successfully analyzed: S, Cl, and Fe(III) were major detectable components, but the

composition was variable. The dominance of Fe(III) suggested that the particulates were anthropogenic.

The Environmental Chemodynamics Section has developed methods for chemical speciation by liquid chromatography – inductively coupled plasma mass spectrometry (LC–ICPMS), determining stable isotopes by isotope ratio mass spectrometry (IRMS), and radiocarbon by accelerator mass spectrometry (AMS). Research has been conducted to improve both the precision and sample throughput of radiocarbon analysis. Routine sample analysis at a precision better than 0.4% has been realized, and a new sample pretreatment device based on an elemental analyzer has been constructed. We conducted a GC–AMS program for compound-specific radiocarbon analysis to identify major sources (Fig. 1) and/or the environmental behavior of chemical pollutants. More than 10 AMS studies were conducted at our AMS facility, including those related to global carbon circulation, pollutant source apportionment, and reconstruction of historical environmental changes; these studies were reported at the 9th International AMS conference, held at Nagoya in September 2002.

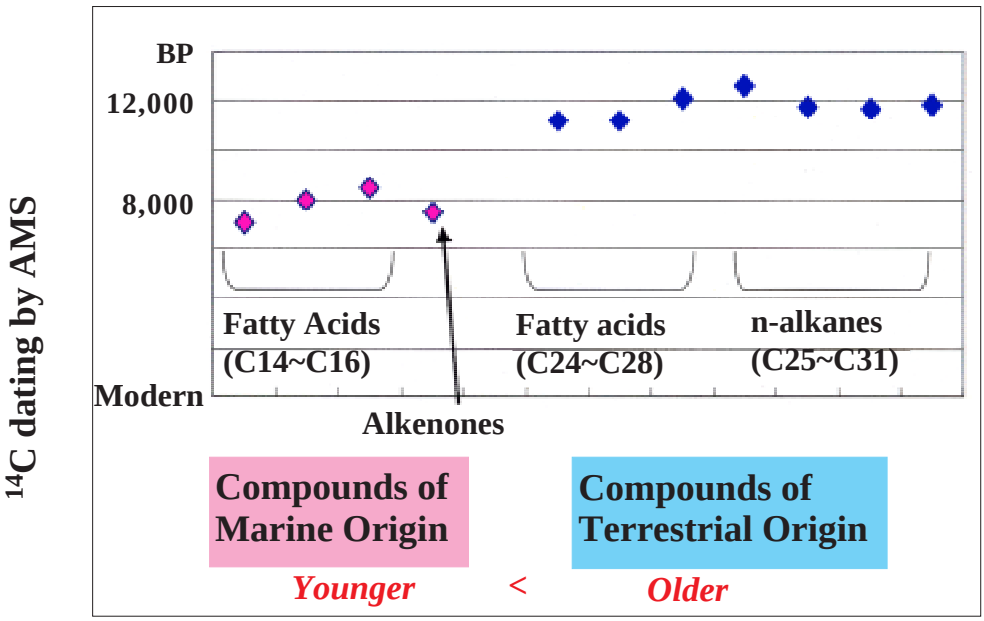


Fig. 1
^{14}C ages of various compounds in the sediment reflect the differences in environmental cycling.

As part of our activities to support the implementation of the Stockholm Convention on global elimination of persistent organic pollutants (POPs), we developed POPs sampling and pretreatment methods, as well as a sensitive and selective GC–MS analytical method based on electron-capture negative ionization detection. We also devised a marine pollution observation system by a merchant vessel navigated between Japan and the Persian Gulf and also between Japan and Australia. The concentrations of POPs and heavy metals in surface seawater were measured. α-HCH, β-HCH, γ-HCH, TBT, nonylphenol, and BaP were detected in almost all samples.

We used surface analysis techniques to study a weathering process that produces clay minerals from rocks. Surface alteration of plagioclase ($Na_{0.5}Ca_{0.5}Al_{1.5}Si_{2.5}O_8$) reacted with H_2SO_4 was studied by X-ray photoelectron spectrometry (XPS). The X-ray

photoelectron spectra of the acid-leached plagioclase samples showed a decrease in surface concentrations of Na, Ca, and Al with increasing reaction time, suggesting the formation of hydrous silicon dioxide on the mineral surface. Because the mechanism of chemical weathering depends on the condition of the ambient solution reacting with the minerals, surface characterization of weathered minerals gives us useful information about weathering conditions.

The Ecological Chemistry Section has been studying biochemical measurement and the biological effects of chemicals. Bioaccumulation and chemical transformation of arsenic in marine organisms is one study area, and endocrine disrupting chemicals are another important subject. We widely observed imposex symptoms in the rock shell and evaluated the presence of this condition in relation to organotin contamination of Japanese coastlines.

We also performed initial risk assessment of pharmaceuticals in the aquatic environment. We calculated the predicted environmental concentration/predicted no-effect concentration (PEC/PNEC) ratio, the half-life in river water, and the bioconcentration factor (BCF) of 85 pharmaceuticals, the annual consumption of which in Japan is estimated at more than 10 tonnes. The PEC/PNEC ratio was higher than 0.1 for 5 substances, and the half-life was longer than 2 months for another 3 substances. A method for measuring these 8 substances by LC–MS was studied.

Further, our senior research scientist conducted a research program on the fate of methyl halides and other VOCs on a global scale. The atmospheric concentration of methyl bromide (CH_3Br), measured at a remote ground station in the Arctic (mid-1996 to early 2002), showed a steady annual average decrease of 4%–5%. This trend (Fig. 2) was consistent with an effect simulation of the phase-out of anthropogenic emissions under the Montreal Protocol and its amendments, suggesting that a decrease of about 40% in CH_3Br concentration in the northern hemisphere, beginning in the early 1990s, will be possible by the completion of the program.

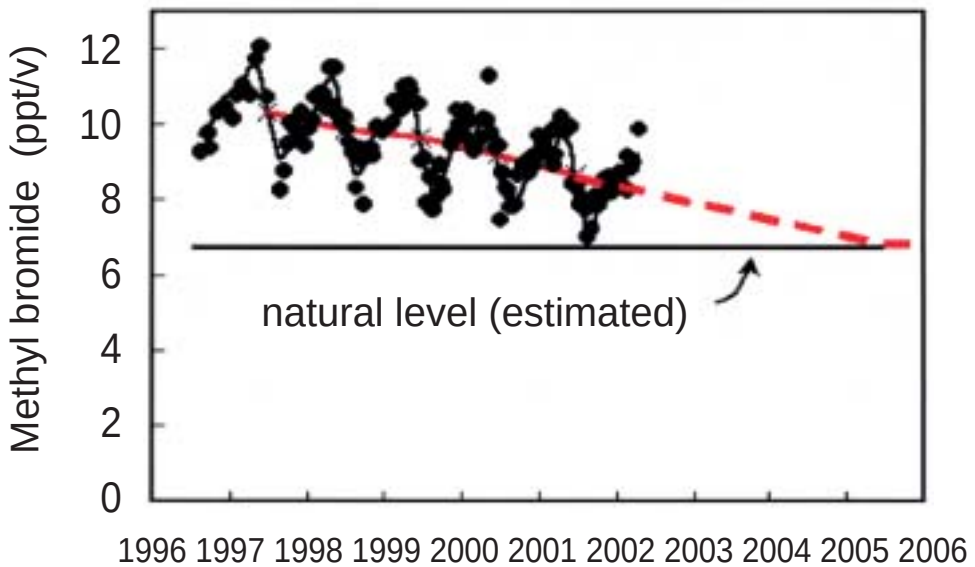
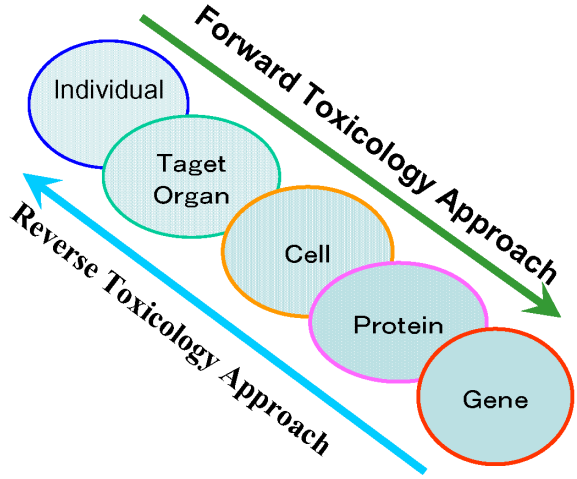
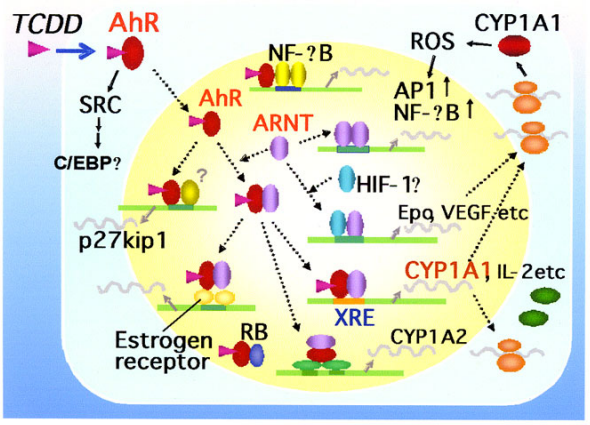


Fig. 2
Pattern of decrease in the methyl bromide concentration at a ground monitoring station in the Arctic (study performed in cooperation with the Meteorological Service of Canada).

Environmental Health Sciences Division





The mission of the Environmental Health Sciences Division is to study the possible effects of harmful environmental chemicals (e.g. dioxins, environmental endocrine disrupters, heavy metals, air pollutants) and physical agents (e.g. ultraviolet radiation and electromagnetic fields) on human health. With this perspective, we aim to utilize the information obtained from these studies as a scientific basis for the risk assessment of these agents, alone or in combination. In this Division we perform both epidemiological and experimental studies. In the latter, we use laboratory animals as experimental models for humans. Although the use of these animals is essential in studying how environmental chemicals affect humans, the importance of alternative experimental models that replace laboratory animals has been recognized. Below, we highlight our progress in several study areas.

In the Molecular and Cellular Toxicology Section, we investigated the target cells, proteins, and genes involved in dioxin toxicity. We focused on the immune system, the reproductive system, and placental function, with the ultimate goal of clarifying how dioxin elicits adverse health effects. Exposure to dioxin during pregnancy causes fetal death in many animal species. To identify the molecules responsible for the alteration of placental function by dioxin, we used 2-dimensional gel electrophoresis (2D-E) to analyze proteins from the placentas of control or dioxin-exposed rats. Pregnant Holtzman rats were given a single oral dose of 1600 ng dioxin/kg bodyweight on gestation day (GD) 15. The proteins were analyzed on GD 16 and GD 20. The amounts of several proteins were altered by dioxin exposure (Fig. 1), and these proteins were further characterized by amino acid sequence analysis. The concentration of glyceraldehyde-3-phosphate dehydrogenase (GAPDH), for example, was approximately double on GD 20. When a uterine-artery ligation model was prepared on GD15, an increase of GAPDH concentration was also observed on GD20, showing that GAPDH is increased during hypoxia. These results strongly suggest that dioxin causes hypoxia in the placenta and thus increases the incidence of fetal death.

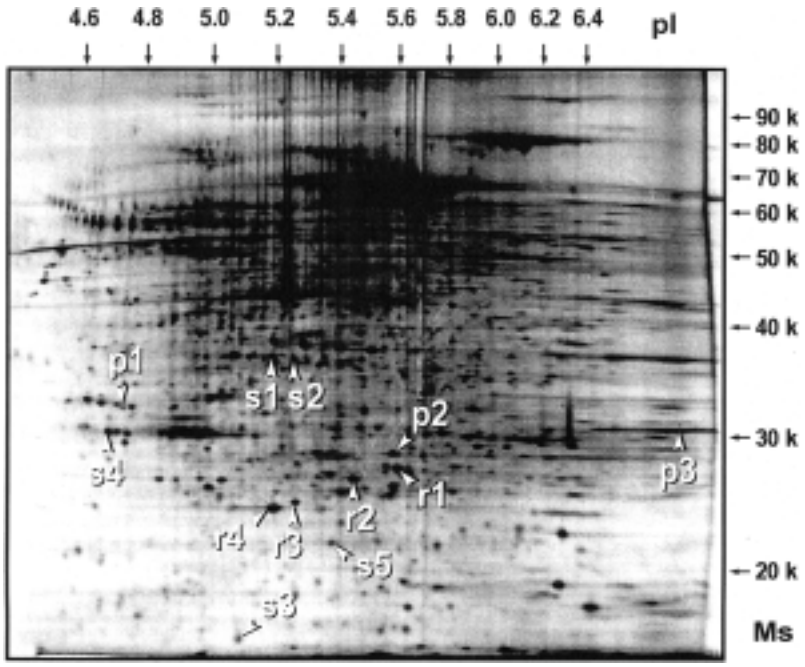


Fig. 1
Two-dimensional gel electrophoresis of proteins from rat placentas at GD 20, after exposure to dioxin. 'p3' is GAPDH.

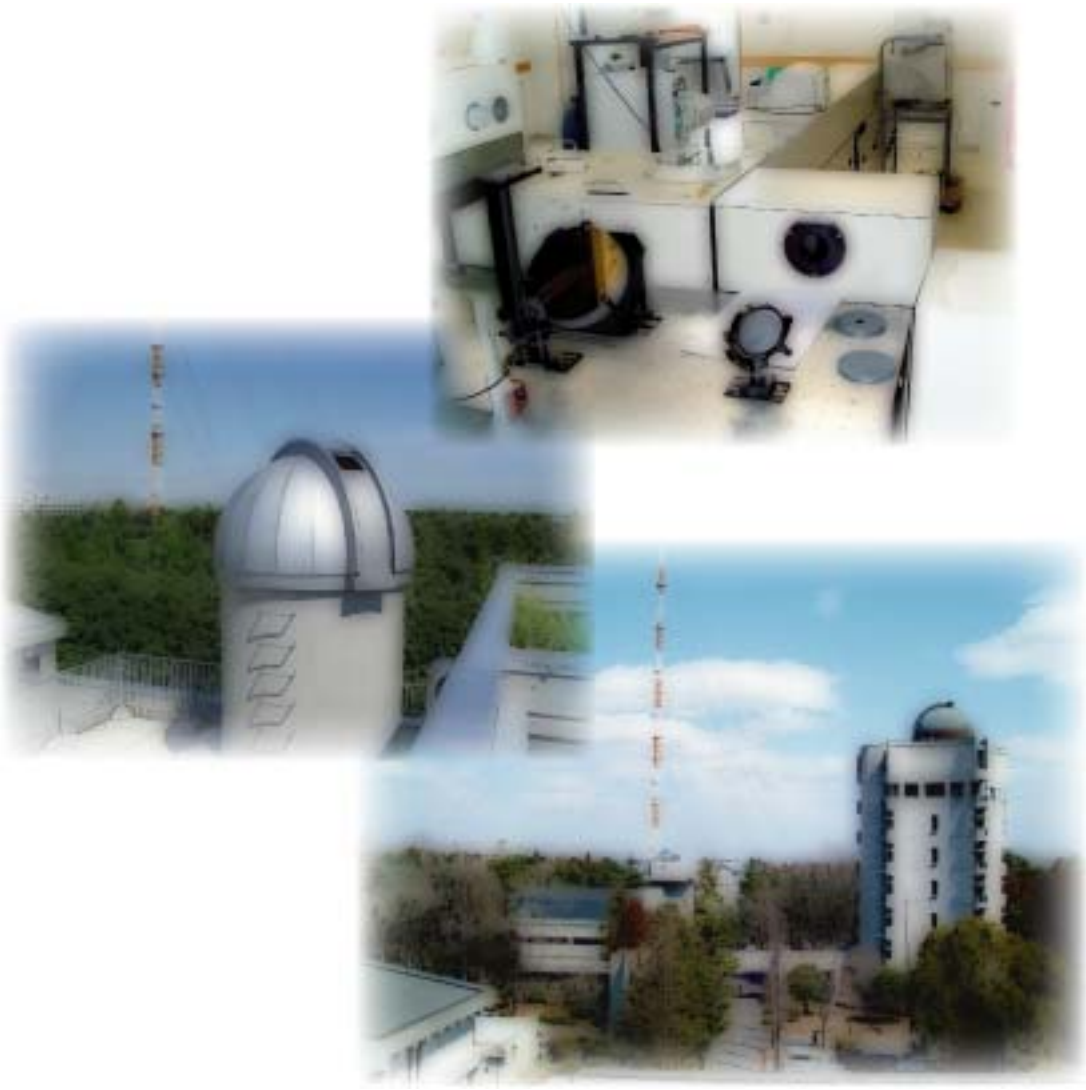
One of the major research themes of the Environmental Biodefense Research Section is to study how exposure to low levels of volatile chemical compounds, such as formaldehyde and toluene, is involved in the development of multiple chemical sensitivities and sick building syndrome. We investigated the effects of chronic formaldehyde inhalation on the expression of neuroreceptor mRNAs in the hippocampus and amygdala. Exposure of mice to 0.4 ppm formaldehyde for 12 weeks increased the expression of glutamate receptor ε1 mRNA in the hippocampus and ε1 and ε2 mRNAs in the amygdala, but decreased the expression of hippocampal ε2 mRNA. When we examined the effect of formaldehyde on neural transmission in mice, long-term potentiation in the hippocampus was significantly suppressed. These results suggest that low levels of formaldehyde inhalation may modulate the function of the central nervous system. We found no significant enhancement in the production of proinflammatory cytokines such as interleukin-1β, -6 and tumor necrosis factor-α in the brains of these mice. These results may provide insights on the consequences and mechanisms of chemical sensitivity.

In the Biomarker and Health Indicator Section, we search for new biomarkers of exposure to environmental pollutants (e.g. cadmium, arsenic, and airborne particulate matters) in the hope that these biomarkers can be used for diagnosis or detection in the early stage of exposure and/or manifestation of toxicity. The most prominent progress this fiscal year was in the cloning of new genes that might be good molecular biomarkers of cadmium exposure. It is known that people who smoke 1 pack of cigarettes a day accumulate an additional 1.5 μg of cadmium a day, suggesting that the airway is an important route of cadmium intake. Lung epithelial cells are exposed to cadmium, so we investigated the differential expression of genes in these cells. We adopted a polymerase chain reaction (PCR)-based subtraction technique, a technique for comprehensive gene expression profiling, to extract Cd-inducible genes in rat lung type 2 epithelial cells. Upregulation of those genes was further confirmed by Northern blot analysis and categorized into 3 groups (highly, moderately, and weakly inducible genes). Heme oxygenase-1 (HO-1), heat shock protein (HSP) 72, hepatic steroid hydroxylase/CYPIIA2, and Cd-inducible gene 1 (cdig1, a new gene, accession number: AB086233 and AB086234) were highly inducible genes. Testosterone-repressed prostate message 2 mRNA was moderately inducible, and the mRNAs of collagen-binding protein and cdig2 (another new gene, accession number: AB086193) were weakly inducible. In response to 10 μM Cd, expression of cdig1 increased linearly with time up to 9 h, whereas that of HO-1 reached its maximum value at 4 h. We thus newly discovered the Cd-induced upregulated transcription of several genes in lung epithelial cells of rat origin.

In the Epidemiology and International Health Research Section, we performed field studies and biostatistical analyses of various environment-related health phenomena. We assessed residential exposure to $PM_{2.5}$ by using personal $PM_{2.5}$ samplers, to study the relationship between fine particulate mater ($PM_{2.5}$) concentration and its health effects on people living in 7 cities in Japan. In 20 households, we measured $PM_{2.5}$ concentrations inside and outside the house for 1 week in spring. In the city of Fushun, in Liaoning Province, China, we also performed an epidemiological study of the

possible relationship between air pollution (SO_2 and $PM_{2.5}$) and pulmonary function in school children. Results already in hand from Shenyang City (where the survey was conducted the previous year) showed elevated levels of atmospheric pollutants, both indoors and outdoors, from combustion of fossil fuels. Pulmonary function values among children were significantly depressed in April, the month when atmospheric pollutant values peaked, suggesting that subacute disorders of pulmonary function were induced by the air pollution. Further, we analyzed the short-term effects of air pollutants on daily mortality in 13 major cities in Japan, particularly focusing on the effects of suspended particulate matter (SPM) on respiratory diseases and cardiovascular diseases. We found that an increase of 10 $\mu g/m^3$ in SPM concentration increased the daily mortality rate by 0.7% from all causes other than accidents, 1.1% from respiratory diseases, and 0.9% from cardiovascular diseases.

Atmospheric Environment Division



This Division is conducting research with the aim of understanding and solving atmospheric environmental problems ranging from urban air pollution to global and trans-boundary atmosphere-related issues. The division consists of 4 sections and 1 team: the Atmospheric Physics Section, which conducts research on numerical modeling and data analysis of atmospheric dynamics and climate system; the Atmospheric Chemical Reaction Section, which conducts research on chemical processes taking place in the atmosphere; the Atmospheric Remote Sensing Section, which conducts research on observations of the atmospheric environment using remote sensing techniques such as lidars (laser radars); the Atmospheric Measurement Section, which conducts field research on natural and anthropogenic trace species; and the Acid Deposition Research Team, which conducts research on trans-boundary air pollutants. Many of the members of this division also work for Special Priority Research Projects such as Climate Change Research, Ozone Layer Research, PM2.5 & DEP Research, and the Center for Global Environmental Research.

Following are brief accounts of some important results of our research in FY 2002.

Aerosol classification from satellite remote sensing

Knowledge of aerosol types is important if we are to improve our estimates of aerosol radiative forcing, because the effects of aerosols on climate vary considerably from one type of aerosol to another. We developed an algorithm to derive the aerosol optical thickness, Ångström exponent, and absorptivity of radiation in the blue spectral region. The algorithm made it possible to classify aerosols into 4 major types – soil dust, carbonaceous, sulfate, and sea salt – using the Ångström exponent and absorptivity. The algorithm was applied to SeaWiFS four-channel data on East Asia. Fig. 1(a) and 1(b) are, respectively, a near-true color SeaWiFS image of the Izu Islands and a map of the aerosol data retrieved from the same area on 4 May 2001. In Fig. 1(a), volcanic plumes are clearly seen as white plumes from Mt. Oyama on Miyakejima Island (lat 34˚ 5´N, long 139˚ 32´E); these plumes are suitably classified as sulfate aerosols (green) in Fig. 1(b). Soil dust, carbonaceous, and sea salt aerosols are also clearly shown.

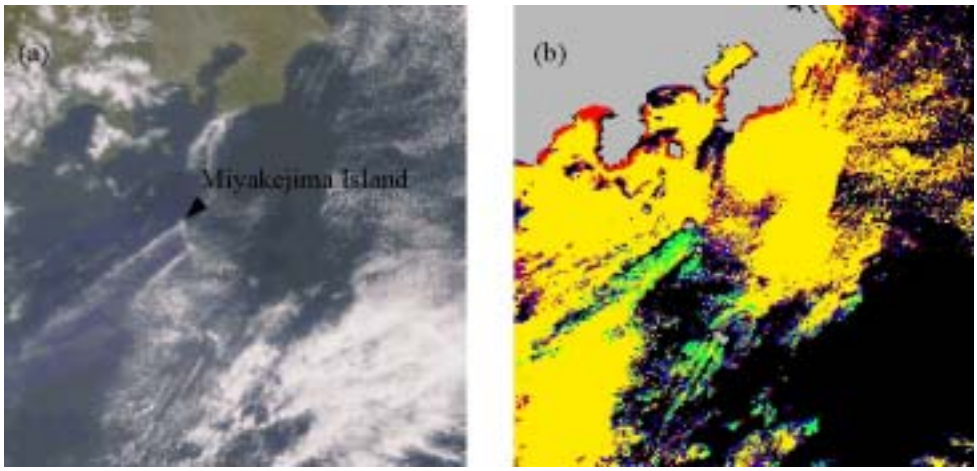


Fig. 1
A near-true color SeaWiFS image (a) and retrieved aerosol type data (b) for 4 May 2001 at lat 32˚N to 36˚N and long 138˚E to 142˚E. The aerosol types shown in panel (b) are soil dust (red), carbonaceous (yellow), sulfate (green), and sea salt (blue).

Aerial observation of atmospheric pollutants in China

Aerial observations of aerosols and gaseous pollutants were carried out around Shanghai, China, in collaboration with Chinese researchers. Experiments took place from 25 December 2002 to 6 January 2003. The airplane used was a Chinese twin-engine airplane, the Yun-12. Changzhou (a small city near Shanghai) was chosen as the base of the experiment. A total of 11 flights were made around Shanghai, Ningbo, and Qingdao. For measurement of gaseous pollutants, an ozone analyzer, an SO_2 analyzer, and an NOx analyzer were placed on board. For aerosol measurements, a particle sizer, a CNC, PM_{10} and $PM_{2.5}$ samplers, and an aerosol mass monitor were on board. High concentrations of SO_2 and NOx were observed at low altitudes. Backward trajectory analysis revealed that the air mass caught at lower altitude originated in the northern part of China. In the presence of the high-pressure system centered in north central China, the polluted air was confined to low altitudes.

Ground-based, shipborne and airborne lidar observations of cloud and aerosols

We have been observing Asian dusts and anthropogenic aerosols with a ground-based lidar network. Currently, dual-wavelength polarization lidars are operated continuously at 10 locations, including Beijing, Hefei (China), Suwon (Korea), Sri Samrong (Thailand), Nagasaki, and Tsukuba in cooperation with the China–Japan Friendship Center for Environmental Protection, Anhui Institute of Optics and Fine Mechanics, Kyung-Hee University, and other organizations. Movement and climatological characteristics of Asian dusts and air-pollution aerosols are being studied with the lidar data and a chemical transport model. Lidar observations have also been conducted in the ocean from the research vessel ‘Mirai’. An airborne lidar was developed for simultaneous measurement with a 95-GHz cloud profiling radar. Observations were performed for various types of clouds and aerosols from a Gulfstream-II aircraft with the CPR of the Communications Research Laboratory. Analysis is underway to derive the optical characteristics and microphysical parameters of clouds. This study is a part of the algorithm validation experiment for the EarthCARE satellite, which is being studied in “Phase A” by the European Space Agency (ESA) and the National Space Development Agency of Japan (NASDA).

Precise measurements of the atmospheric oxygen to nitrogen ratio

Since July 1997 we have determined the O_2/N_2 ratios of air samples collected at Hateruma Island (lat 24°3´N, long 123°49´E), and since December 1998 at Cape Ochi-ishi (lat 43°10´N, long 145°30´E) (Fig. 2). Changes in the O_2/N_2 ratio are essentially equivalent to changes in the O_2 mixing ratio, because atmospheric N_2 is much more stable than atmospheric O_2. The observed O_2/N_2 ratios clearly showed decreasing trends and seasonal variations, increasing in spring and summer, and decreasing in autumn and winter. Precise determination of atmospheric O_2 variations can give us valuable information on the global carbon cycle. This is based on the fact that O_2 fluxes to the atmosphere are inversely related to the CO_2 flux through the processes of combustion, respiration, and photosynthesis. For example, the observed loss rate of the O_2/N_2 ratio, about 4 ppm y^{-1}, was slightly smaller than the O_2 removal rate estimated from the fossil fuel consumption rate. This discrepancy suggests that

there was an additional O_2 source, which may have been O_2 release from the terrestrial biosphere in association with fossil CO_2 uptake.

Measurement of pH of precipitation in the South Siberia region

We collected and measured precipitation at remote (Mondy), rural (Listvyanka), and urban (Irkutsk) sites in East Siberia to evaluate trans-boundary air pollution from Europe to Asia. Annual mean pH ranged from 4.85 to 6.19. Annual mean concentrations of nss-SO_4^{2-} and NO_3^- in the precipitation in East Siberia were higher than those in Japan. The annual deposition rates of these ions were much smaller than in Japan because of the smaller annual precipitation rate.

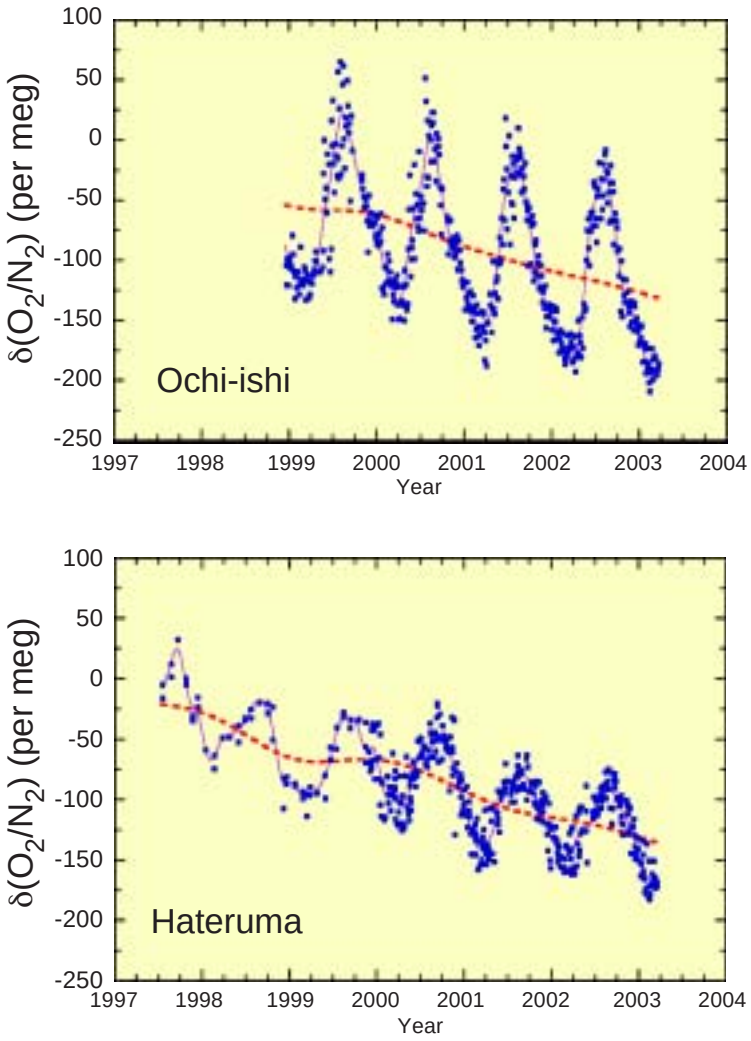
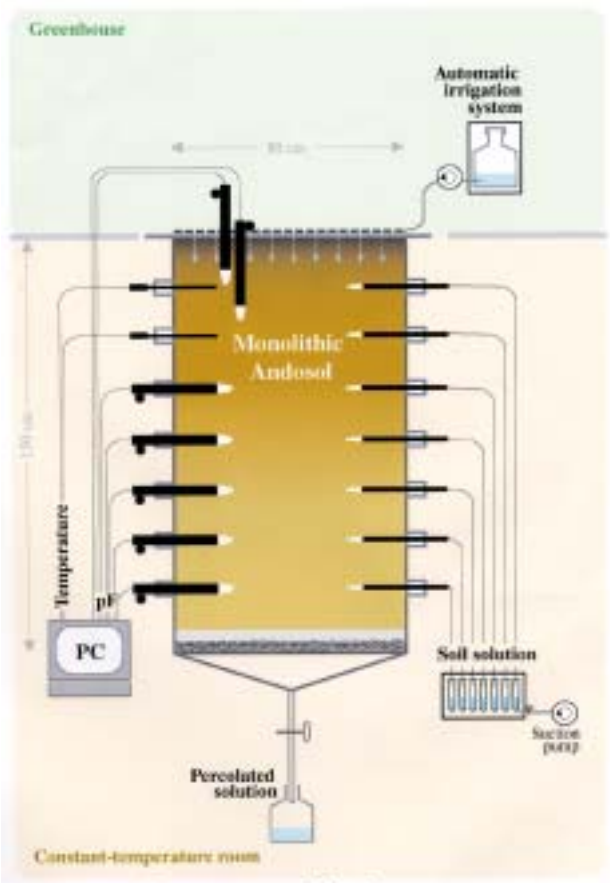
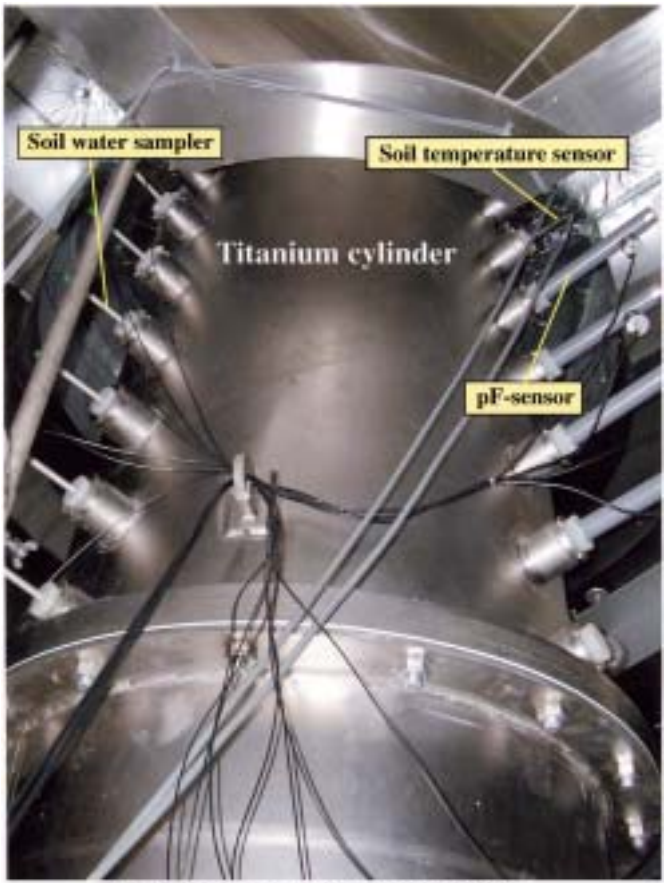


Fig. 2
O_2/N_2 ratios of air samples collected at Hateruma and Ochi-ishi monitoring stations. The thin and dashed lines represent the smooth curve fit and the deseasonalized trends, respectively. Changes in the O_2/N_2 ratios are expressed in 'per meg' units; 4.8 per meg is equivalent to 1 ppm change in the O_2 mixing ratio.

Water and Soil Environment Division



Structure of lysimeter



Underground view of lysimeter

Water—in precipitation, rivers, lakes, seas, and soil—is vital for our lives. Once the environment has been polluted, the time and cost needed for its restoration are enormous. Our Division undertakes research from a variety of approaches on the environmental pollution and ecological changes that occur via the media of water and soil.

Application of microbial ecology to environmental management

We have studied the application of microbial ecology to the management of natural ecosystems and the impact of this application on ecosystems.

For example, we have examined the use of bioremediation technology to remediate coastal areas damaged by oil contamination. Techniques for evaluating bacterial community structure were applied to field validation testing carried out on the Sakondani i Coast, Hyogo Prefecture. A change in the bacterial community structure due to nutrient addition was detected by PCR - denaturing gradient gel electrophoresis (PCR-DGGE) analysis of the 16S rRNA gene (16S rDNA). Then, to clarify the microbial decomposition of petroleum, PCR primers derived from the genes *AlkB* (Group I) and C12O of hydrocarbon- and aromatic-hydrocarbon-degrading bacteria, respectively, were adapted to sea water from the field validation test area. Numbers of hydrocarbon- and aromatic-hydrocarbon-degrading bacteria were increased by nutrient addition.

The seasonal dynamics of bacterioplankton in Lake Kasumigaura, one of the most eutrophic lakes in Japan, was studied by 16S rDNA analysis, with 2 approaches, DGGE and the cloning of nearly complete 16S rDNA sequences. DGGE banding patterns, which represent bacterioplankton dynamics, were analyzed by multivariate analysis, and the major 16S rDNA bands were sequenced. The community compositions calculated from the percentages and sequences of DGGE bands corresponded well to those calculated from clone sequencing. The results of principal component analysis showed that the community structures changed seasonally, largely in the bands associated with High G+C gram-positive bacteria.

Behavior of constituent metals of Pb-free solders in the soil sphere

Recently, soil pollution from Pb leaching out of solder in discarded electrical appliances has become an important environmental problem. Therefore, in the near future, Pb-solders will be replaced by Pb-free solders containing other materials, such as Ag, Bi, In, Sb, or Sn. However, information about the behavior of metals in soil and their effect on soil ecosystems is extremely limited. We therefore investigated: 1) the dissolution mechanisms of Pb-free solders exposed to precipitation; 2) the behavior of dissolved metals in soil, by using meso-scale lysimeters and small soil columns; and 3) the effect of the dissolved metals on soil microorganisms. We found that Pb-free solders dissolved more rapidly in forest (under tree canopies) than on bare land. The dissolution rates in forest (under tree canopies) changed seasonally (the maximum rate was observed in spring), and differed among tree species. Dissolved metals added to the surface of Andosols were mostly retained within the upper several-centimeters of soil for 6 months, but those in Regosols moved downward slightly. Of the metals added, In and Bi moved more easily than the other metals. The adsorptive ability of

soils for metals was in the order of Andosol > Cambisol ≥ Fluvisol > Regosol. Silver was very toxic to soil bacteria in culture and depressed the respiratory (dehydrogenase) activity of soil. Bismuth, solubilized as complexes with thiol compounds, was also toxic, and its toxicity increased with increasing hydrophobicity of the compounds (Fig. 1).

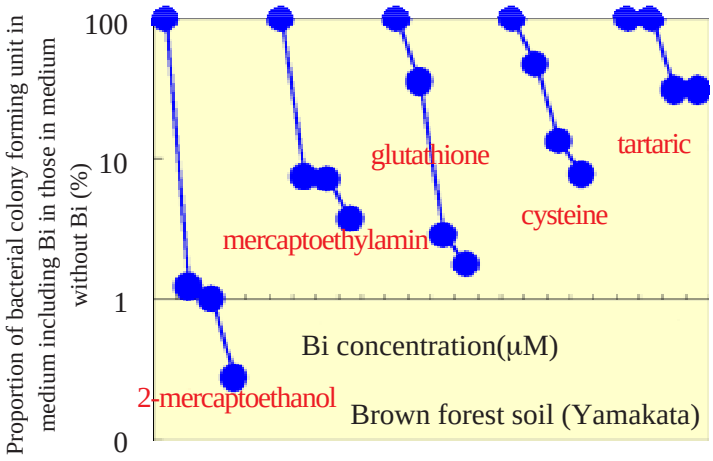


Fig. 1
Effect of Bi on soil bacteria in solution media containing Bi-thiol compounds.

Development of an "environmentally benign" extraction/concentration system for hazardous organic chemicals

We have developed a new method for the extraction and concentration of several hazardous organic chemicals. This new method does not use hazardous organic solvents. As the key test of the feasibility of such a new method is its ability to extract chemicals, we conducted an extractability test of a thermoresponsive poly(vinylmethyl) ether precipitate system. Four toxicants—nonylphenol, triclosan, b-estradiol, and bisphenol A—were extracted from aqueous solutions into a gum-like precipitate, which formed by aggregation when the solution was heated to greater than 305 K. The extractability of the chemicals was acceptably high and the procedures were easy; this polymer extraction system seems to be an environmentally benign alternative to existing liquid-liquid extraction methods that use hazardous organic solvents.

Characterization of recalcitrant dissolved organic matter in lake water

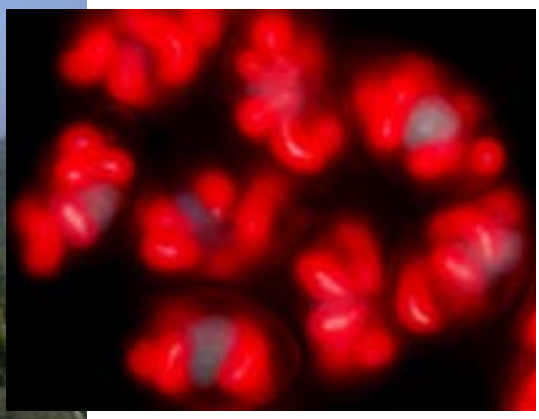
A steady increase in recalcitrant dissolved organic matter (DOM) has been observed in several lakes in Japan and may represent a new type of lake-water pollution. The accumulation of recalcitrant DOM in lake water will clearly influence the way we manage the environmental protection of lakes, but this phenomenon is new and has not yet been studied. It also presents a serious challenge for drinking-water management. Recalcitrant DOM could be a major precursor of trihalomethane, which is produced during the chlorination of water. Therefore, evaluation of the characteristics of DOM in lake waters is urgently needed.

We have developed a method by which DOM is separated into well characterized macro-fractions so that we can examine its characteristics and dynamics in lake water. The DOM fractionation scheme consists of 2 experimental procedures: a long-term (100-day) degradation test, and a DOM resin-fractionation method. The DOM resin-adsorption fractionation method divides DOM into 5 fractions: aquatic humic substances (AHS), hydrophobic neutrals (HoN), hydrophilic acids (HiA), bases (BaS), and hydrophilic neutrals (HiN). Consequently, the DOM is fractionated into 10 further fractions: these 5 and their recalcitrant fractions.
We applied the DOM fractionation method to the water in Lake Kasumigaura, the second largest lake in Japan, and found that the majority of recalcitrant DOM in the lake water was composed of AHS and HiA. HiA predominated heavily over AHS. The trihalomethane formation potential (THMFP) of DOM, AHS, and HiF (= HiA+BaS+HiN) was also evaluated in water samples from Lake Kasumigaura, which is the source of raw drinking water for about 660 000 people. We found that, contrary to conventional belief, the THMFP of HiF was much greater than that of AHS (0.374 vs. 0.229 mmol L^{-1}, respectively).

How does human activity affect aquatic and marine continua?

The Laboratory of Marine Environment is working with marine environmental changes of anthropogenic origin that are putting pressure on the relationship between nutrient levels and the health of marine ecosystems. Our main project is to find evidence to support the “silica deficiency hypothesis”, which explains the deterioration of the marine environment in terms of increased loadings of (N) and phosphorus (P) and a decrease in the supply of silica from rivers. According to this hypothesis, freshwater diatoms take up DSi (dissolved silicate) and sink to bottoms of reservoirs and dams, leading to a reduction in the amount of DSi flowing down to the sea. Increased anthropogenic loading of N and P and the construction of reservoirs and dams further enhance this tendency. Consequently, the numbers of non-diatomaceous algal species (which are non-siliceous and potentially harmful) increase in place of diatoms (which are siliceous and mostly benign) in coastal areas, because diatoms cannot grow without Si. This process of marine deterioration has become recognized worldwide and in the near future will be one of the most worrying global environmental issues. To verify this hypothesis, we examined an aquatic continuum composed of Lake Biwa, the Yodo River and the Seto Inland Sea. We surveyed historical datasets of river water quality in the 1950s and 1970s and records of red tide outbreaks. We also monitored concentrations of nutrients in the Seto Inland Sea over the period 1994-2000. By analyzing these data sets, we found that the concentration of DSi in Lake Biwa is one order of magnitude smaller than that in the rivers flowing into the lake, which confirms that Si is trapped in the stagnant water body. We found that the concentration of DSi in the outflow from Lake Biwa decreased in the 1970s and increased in 1990, possibly corresponding to an increase and decrease, respectively, in the loading of P. Furthermore, the increase in the DSi concentration in the Yodo River in the 1990s, can be correlated with an increase in the ratio of diatom-induced red tides to flagellate-induced red tides in Osaka Bay (on the eastern part of the Seto Inland Sea). These results support the silica deficiency hypothesis.

Evironmental Biology Division



The Environmental Biology Division consists of 4 sections: Ecosystem Function Study, Biodiversity and Phylogenetic Study, Tropical Ecology, and Molecular Ecotoxicology.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 toward the conservation of genetic biodiversity, species, and ecosystems. In 2002, the Division performed 25 studies funded by NIES, 5 studies supported by the Global Environmental Research Fund (Ministry of the Environment) and 2 studies funded by the Ministry of Education, Culture, Sports, Science and Technology.

Ecosystem Function Study Section

Classification of tidal flat ecosystems for development of a functional assessment model in Japan

A tidal flat ecosystem can be classified into tidal flats at the shore fringe, in the lagoon, and in the estuary (Fig. 1). The ecosystem can also be classified into, for example, sandy tidal flat or tidal flat where gravel intermingles with sand, depending on the category of bottom material used as a reference site in the geographical classification. The functions of a wetland tend to roughly correspond to the characteristics of both the water and sediments within the wetland. We selected 13 intertidal sand or mud flat wetlands from Hokkaido to Okinawa, from the sub-arctic zone (3 sites in Hokkaido), to the temperate zone (3 in Tokyo Bay, 2 in Ise Bay, 2 in the Ariake Sea), to the subtropical zone (3 sites on Okinawa Island) as reference sites for an environmental impact assessment. Indicators for water and sediment were investigated as a first step. The traditional classification of landform subclasses was unclearly changeable, and it often did not agree with the functional classification. In the intertidal sand and mud flat wetlands of Japan, subclasses for a unique Japanese hydrogeomorphic (JHGM) ecosystem model should be set according to the characteristics of the influent water and sediments. The hydrogeomorphic units used for ecosystem evaluation in Japan need to be on a smaller scale than those used in the original HGM approach in the USA.

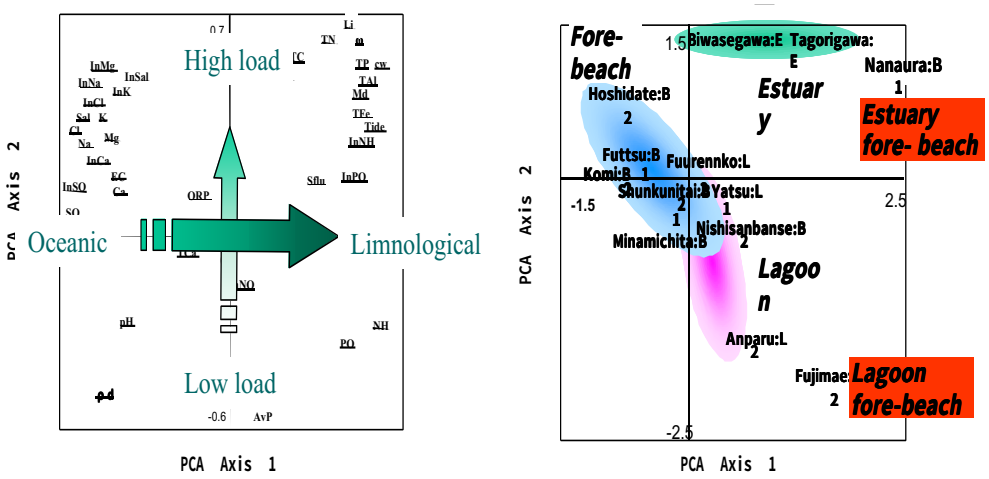


Fig. 1
Principal component analysis of measurement parameter (left) and study site (right). B:fore-beach, L:Logoon, E:Estuary.

Biodiversity and Phylogenetic Study Section

The Biodiversity and Phylogenetic Study Section conducts fundamental research on the diversity of microorganisms and benthic animals. A taxonomic survey of microalgae in Thailand was conducted in cooperation with local researchers; several microalgal groups, such as extremely small and fragile microalgae (e.g. Chrysophyceae and Haptophyceae) were especially targeted. From this taxonomic study we are preparing an inventory of microalgae that will gather together the basic information we need to conserve microbial diversity in tropical countries. We also initiated 2 studies to clarify the potential diversity of microalgae in nature: one on toxin gene diversification in the cyanobacterium *Microcystis*, and the other on the genetic diversity of symbiotic microalgae on lichen. We also tried to isolate algae-lytic bacteria, which are relevant to microbial diversity because they are involved in regulation of the occurrence of water blooms. A taxonomic study of chironomids, some of the best environmental indicators, is being conducted; we have a special interest in the morphology of the heads of chironomid larvae, which is critical in the identification of these organisms.

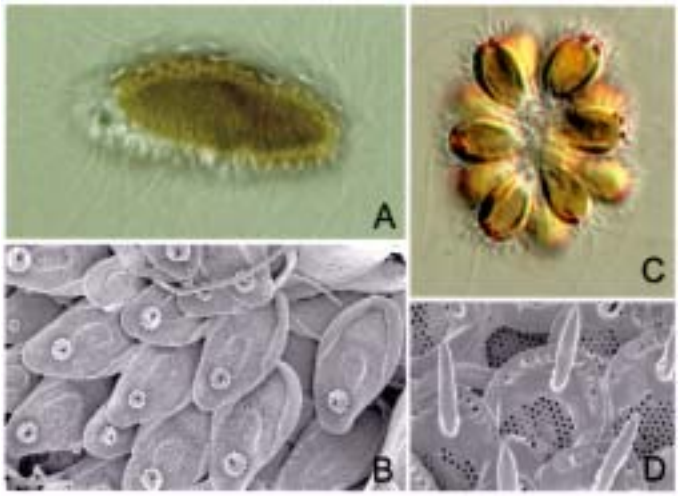


Fig. 2
A—D. Two chrysophyte species, *Mallomonas* sp. (A) and *Synura spinosa*. (C) found in a freshwater pond. Species identification usually hinges on the fine structure of the elaborate cell coverings. B and D correspond to scales on the cells of A and C, respectively. SEM specimens are easily prepared by placing several drops of cell suspensions on a filter and drying them.

Tropical Ecology Section

With the aim of providing a new ecological assessment tool for viewing the current degradation status of forests and forecasting future environmental threats to forests from landscape changes, we conducted the following studies in a pilot study area of Peninsular Malaysia and China. 1) We collected all available information related to the ecological services of the landscape of the pilot study area and established a database. We also performed an economic assessment of the local and global economies. From this database we developed a PC-based risk assessment system coupled with a GIS. 2) To facilitate rapid assessment of the target ecosystem, we studied the habitat range and ecology (e.g., behavior and food habits) of forest wildlife and the 3-D structure of the forest to enable us to evaluate the forest's overall condition and management status. 3) To deepen our understanding of the problems faced by local communities in relation to deforestation, we studied the sociological and ethnic use of forest products and the historical background of forest use by local communities. By combining all three steps above, we are now establishing an integrated environmental management system (IEMS), which will act as a pilot program for the introduction of an ecosystem management approach to tropical

landscapes (Fig. 3). IEMS can clarify all the decision-making processes needed for landscape change and management. 4) We are studying carbon dynamics in relation to global warming in China.

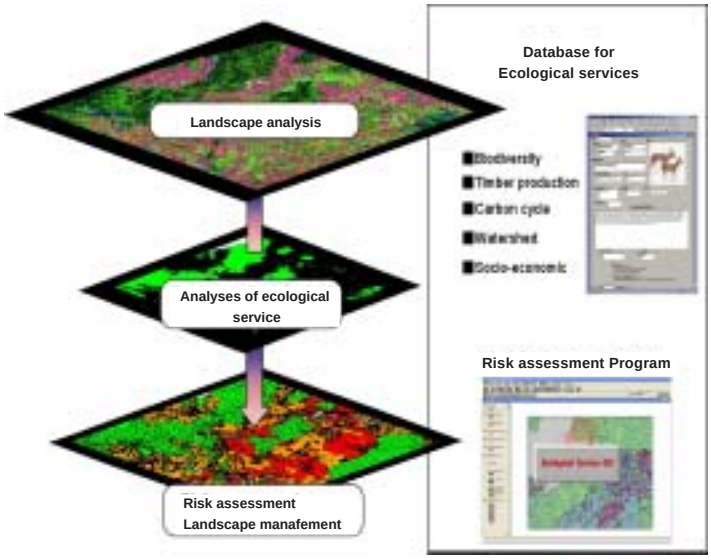


Fig. 3
Schematic illustration of the IEMS (integrated environmental management system) concept. The study includes: (1) landscape analysis; (2) database of ecological services; and (3) risk assessment and zoning plan with GIS

Molecular Ecotoxicology Section

The Molecular Ecotoxicology Section aims to elucidate the effects of environmental stressors such as air pollutants and ultraviolet light on plants and the mechanisms of plant tolerance to conditions of stress. We are focusing on the genes that are involved in these protection mechanisms and are conducting molecular biological studies with various stress-related mutants of *Arabidopsis thaliana*.

Insertion of T-DNA from the *Agrobacterium* Ti plasmid in the plant genome can be used for insertional mutagenesis and as a tag to identify mutated genes. By screening the T-DNA tagging lines of *A. thaliana*, we obtained 22 ozone-sensitive mutant lines with kanamycin resistance, which is a marker for T-DNA insertion. Among them we found 11 lines in which T-DNA was inserted at only one site in the genome according to the segregation of kanamycin resistance after backcrossing. Analysis by polymerase chain reaction with DNA extracted from plants of the segregating generation revealed a linkage between ozone sensitivity and T-DNA insertion in 4 mutant lines, all of which were recessive for the ozone-sensitive phenotypes (Table 1). These mutants can be used to identify the genes that are required for plant tolerance to ozone.

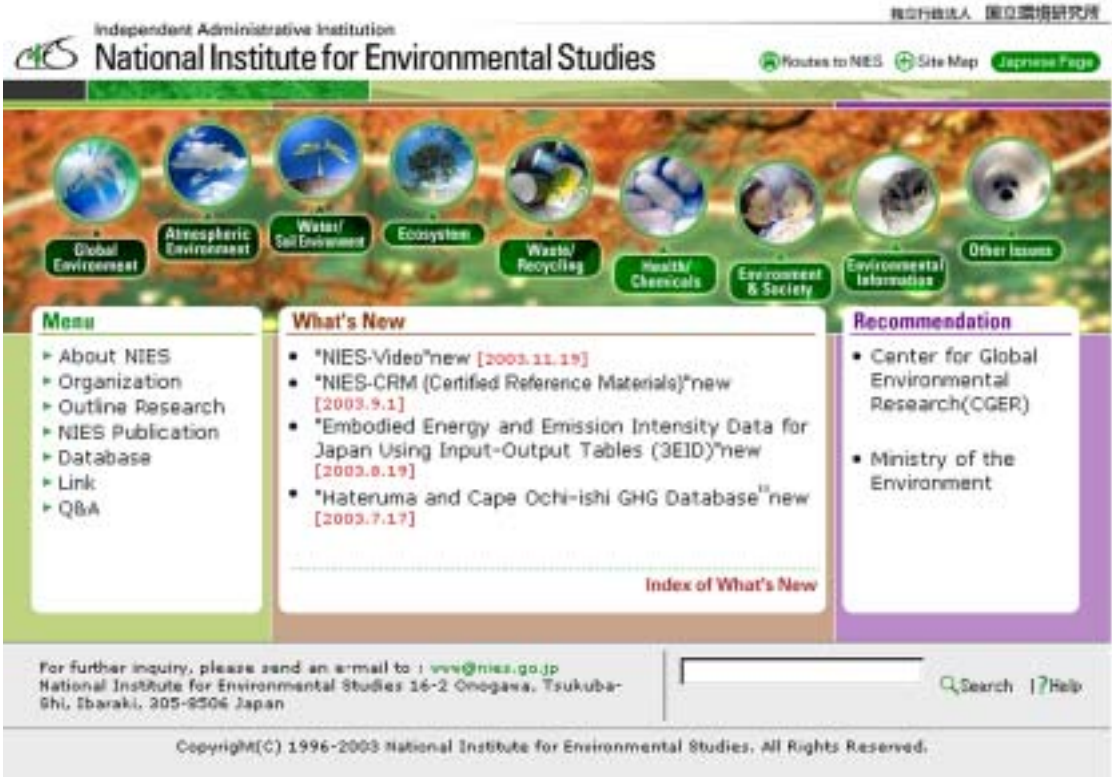
Table 1
Characteristics of ozone-sensitive mutant lines of *Arabidopsis thaliana*, showing linkage between ozone sensitivity and T-DNA insertion at 1 site in the genome.

Mutant line	Dominance of ozone-sensitive phenotype	Growth under normal conditions	Sensitivity to			
			ozone	sulfur dioxide	low temperature	high-intensity light
HL19963	recessive	—	+ (under high-intensity light)	—	—	—
OZ31012-3	recessive	—	+ (exaggerated under high-intensity light)	?	—	+
OZ31028-1	recessive	—	+	—	—	?
OZ31032-2	recessive	—	+	—	—	?

—, similar to wild type; +, more sensitive than wild type; ?, not yet determined

Environmental Information Center

NIES WWW (http://www.nies.go.jp/index.html)



The Environmental Information Center (i) provides information technology support for research and related activities at NIES, and (ii) carries out public relations activities for NIES and publishes items such as NIES research reports. In addition to these activities, the Center promotes the collection, processing and dissemination of environmental information.

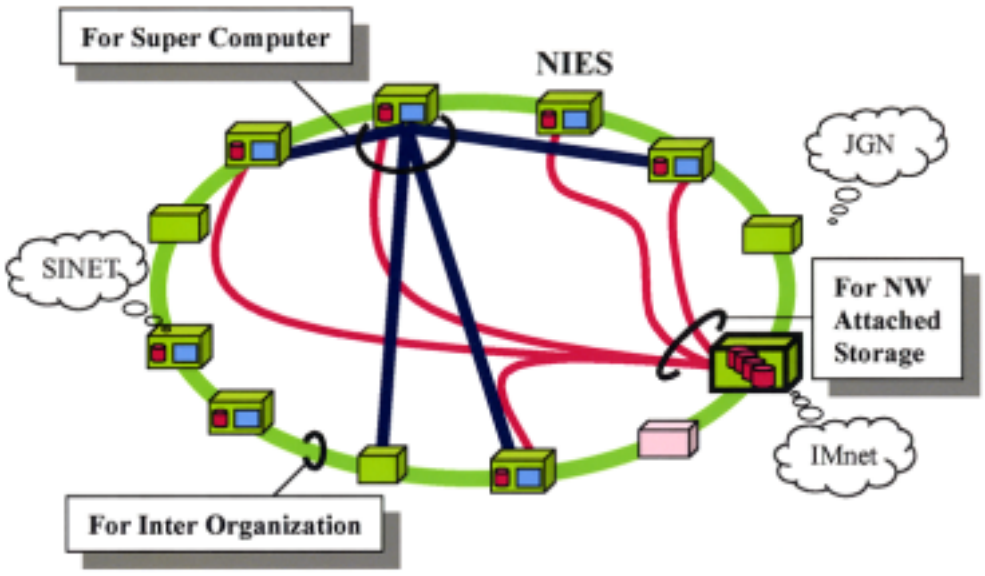
(i) Information technology support for research and related activities at NIES

The activities of the Center in this field comprise: (a) management and operation of computers and related systems; (b) compilation of documentary information on environmental research; and (c) library management and operations.

(a) Management and operation of computers and related systems

A new computer system started operation in March 2002. The system is 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 tasks. This UNIX-based computing environment consists of a supercomputer system and various subsystems, such as a scalar-computing server, a front-end server, storage devices, and application servers. Our vector-computing server (NEC SX-6/64M8), which employs an operating system equipped with a FORTRAN compiler with high-level debugging capability and high-efficiency optimization, executes large-scale programs necessary to handle global environmental problems.

A LAN called NIESNET was established at NIES in 1992. File transport in various computer systems, including the Gigabit Ethernet, was upgraded in March 2002. The network configuration was restructured, and large-scale file transport performance was improved at that time. Registered users outside the Institute have remote access to the supercomputer system through the Tsukuba-WAN via the Inter-Ministry Network (IMnet) connection to the Internet.



Configuration of Tsukuba-WAN

(b) Compilation of documentary information on environmental research

Documentary information on environmental research and related subjects is essential to competent research at NIES. To offer the information to NIES researchers, the Center has introduced commercial databases such as Web of Science, MEDLINE, JOIS, DIALOG, STN-International, G-Search, and the British Library inside web.

(c) Library management and operations

As of March 2003, the NIES library held 45,739 books, 583 technical and scientific serials, 8,501 maps, 115,862 microfiches, and various other reports and reference materials. Library facilities include separate reading rooms for books, journals, indexes and abstracts, reports, and maps and microfiche, as well as a database access room.

(ii) NIES public relations activities and publication of items such as NIES research reports

The activities of the Center in this field comprise (a) management of the NIES World Wide Web (WWW) internet site and (b) editing and publication of items such as the NIES Annual Report and research reports.

(a) Management of NIES WWW

NIES began to provide public information on its research activities and results via the internet (www.nies.go.jp) in March 1996. Because NIES was restructured in April 2001 with a new status as an independent administrative institution, the homepage was completely renewed and improved.

(b) Editing and publication of items such as the NIES Annual Report and research reports

Reports of NIES research activities and results, such as the NIES Annual Report and research reports, official newsletters (NIES News, in Japanese), and NIES research booklets (Kankyo-gi, in Japanese) are edited, published and distributed by the Center.

(iii) Other activities

In addition to the activities mentioned above, the Center (a) collects, processes, and disseminates environmental information, (b) acts as the national focal point of UNEP-Infoterra, and (c) conducts tasks commissioned by the Ministry of the Environment.

(a) Collection, processing, and dissemination of environmental information

The collection, processing, and dissemination of environmental information are carried out as stipulated in the Law for the Establishment of NIES. The Center (a-1) processes and manages environmental information databases, and (a-2) provides environmental information using GIS (geographic information systems).

(a-1) Processing and management of environmental information databases

Various environmental data are needed for research, policy decisions, and policy enforcement. The Center compiles and processes air quality and water quality data as measured by local governments and reported to the Ministry of the Environment. These processed data can be accessed through the database on the NIES WWW, and duplication services and lending services are also available.

(a-2) Provision of environmental information using GIS

The Center, with the cooperation of the Ministry of the Environment, has been developing an environmental data provision system using GIS. This system can help users to easily understand the status of the environment, because it shows data on

environmental quality together with other information on maps. The system has been publicly available through the internet since September 2002.

(b) National focal point of UNEP-Infoterra

UNEP-Infoterra is the global environmental information exchange network of the United Nations Environment Programme. The network operates through a system of government-designated national focal points. The Center has been the designated national focal point for Japan since 1975. These focal points provide a wide range of environmental information, including directories of information sources.

(c) Tasks commissioned by the Ministry of the Environment

The Center has performed 3 tasks commissioned by the Ministry of the Environment this fiscal year.

(c-1) Development of an information system on the total management of aquatic environments

The purposes of the system are to help a wide range of people understand the aquatic environment and to support conservation activities and scientific investigations. The Center has developed a number of data management programs and a GIS to show the programs on a map.

(c-2) Management of display systems for wide-area air pollutant surveillance

In January 2002, the Center made publicly available through the internet a system developed for the enforcement of air pollution controls against substances such as photochemical oxidants. This fiscal year, while managing the system, we newly developed a sub-system that can be accessed from any mobile phone. We also began testing a system that collects information on newly scattered pollen.

(c-3) Development of an information management system on noise, vibration and offensive odor

This fiscal year, we conducted a preliminary study into the configuration and conceptual design of a system to compile data on noise, vibration, and offensive odor via the internet. We also developed an information management system for these data.

Laboratory of Intellectual Fundamentals for Environmental Studies

This laboratory consists of 2 research sections, the Environmental Analytical Chemistry Section and the Biological Resources and Informatics Section. They are responsible for organizing all of the intellectual research fundamentals accumulated since NIES began, and for developing basic research techniques that will be needed in the future. These techniques are used within NIES for effective implementation of research and to form research networks. They are also made available to organizations outside NIES.
LIFES functions as a reference laboratory for environmental research in Japan through: 1) improving methods of ensuring analytical quality control and cross-checking of analytical techniques; and 2) improving methods of classifying and identifying microalgae and laboratory organisms, and preserving and supplying those organisms to provide standards for classification, standard strains for algal growth potential (AGP) tests, and strains with special functions (Fig. 1).

Fig. 1
Home page of MCC-NIES (the Microbial Culture Collection at the National Institute for Environmental Studies)

Preparation of Environmental Certified Reference Materials (CRMs)

A number of chemical analyses of environmental samples have been carried out in laboratories. Unfortunately the reliability of the data used may be low, because there is a lack of appropriate standard reference materials. In response, NIES has developed Certified Reference Materials (CRMs). NIES has been preparing and distributing environmental and biological Certified Reference Materials for the past 20 years. Eleven kinds of CRMs are now available (including 1 that cannot be sent overseas). Over 120 CRMs were distributed to researchers this fiscal year (Fig. 2).

Long-term storage of environmental samples (environmental specimen bank)

For retrospective analysis of pollutants, we expanded our program and continued to collect and prepare environmental samples for long-term, low-temperature storage. We have collected and stored such samples for more than 20 years. We also started detailed monitoring and sampling in Tokyo Bay and developed a new cryo-homogenization technique for biological samples.

Fig. 2
Certified Reference Materials developed so far.

Investigation, collection, and storage of microbes useful for environmental conservation; development of laboratory organisms; and preservation of cells and genes of endangered wildlife species

As activities of the Microbial Culture Collection (MCC), we: 1) accepted 63 microalgal strains deposited by scientists inside or outside NIES after their evaluation by the Committee for Evaluating Microbial Culture Strains; 2) froze 48 strains of cyanobacteria, which are now entirely preserved in liquid nitrogen (we now have a total of 215 strains); 3) distributed 424 algal strains; and 4) revised the MCC database format, which now consists of 96 items including information on taxonomy, habitats, preservation conditions, and strain histories. These activities are also conducted in collaboration with 5 institutions as part of the National Bio-Resources Project.

To help conserve endangered wildlife, we began research aimed at preserving the germ and somatic cells of endangered animals. To preserve the sperm of the endangered fish *Plecoglossus altivelis ryukyuensis* in liquid nitrogen, we first determined the optimum storage conditions by using cultivated *P. altivelis altivelis* sperm as surrogates. We also began to preserve several strains of endangered charophytes and freshwater red algae in culture (Fig. 3).

Fig. 3
Liquid nitrogen tanks used to preserve microalgae and germ and somatic cells of endangered animals. To avoid contamination, microalgae are now preserved in the vapor phase of liquid nitrogen instead of being immersed in liquid nitrogen.

Development of information networks for biological resources

The laboratory has been promoting government and international collaboration for classification and preservation of biological resources, and has also been promoting the creation of national and international networks for exchange of biological resource information. Information sharing for the Global Taxonomy Initiative (GTI), a core program of the Convention on Biological Diversity, is made available through the GTI website at www-gti.nies.go.jp (Fig. 4).

Fig. 4
The Global Taxonomy Initiative web site.

Management and operation of analytical equipment

The laboratory has been working to improve the sensitivity and accuracy of analysis of environmental specimens at NIES, and has been managing and operating commonly used equipment, such as GC/MS, ICP/MS, electron microscopes, and NMR, in support of the development of new analytical methods (Fig. 5).

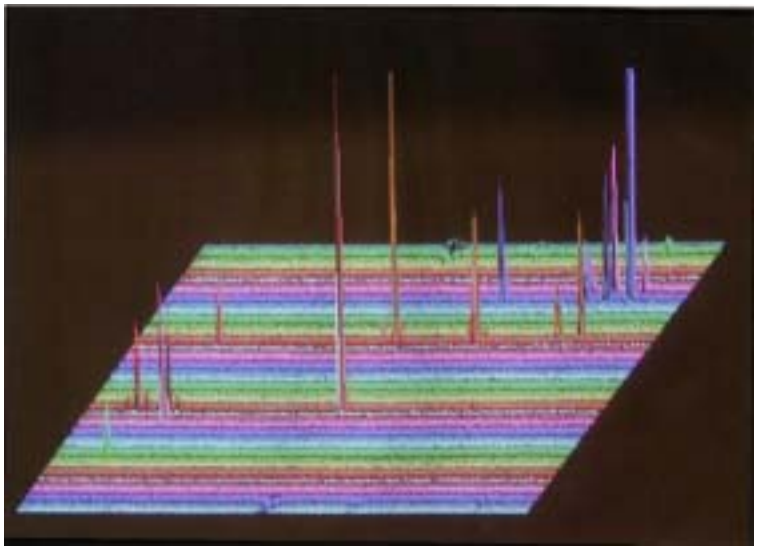
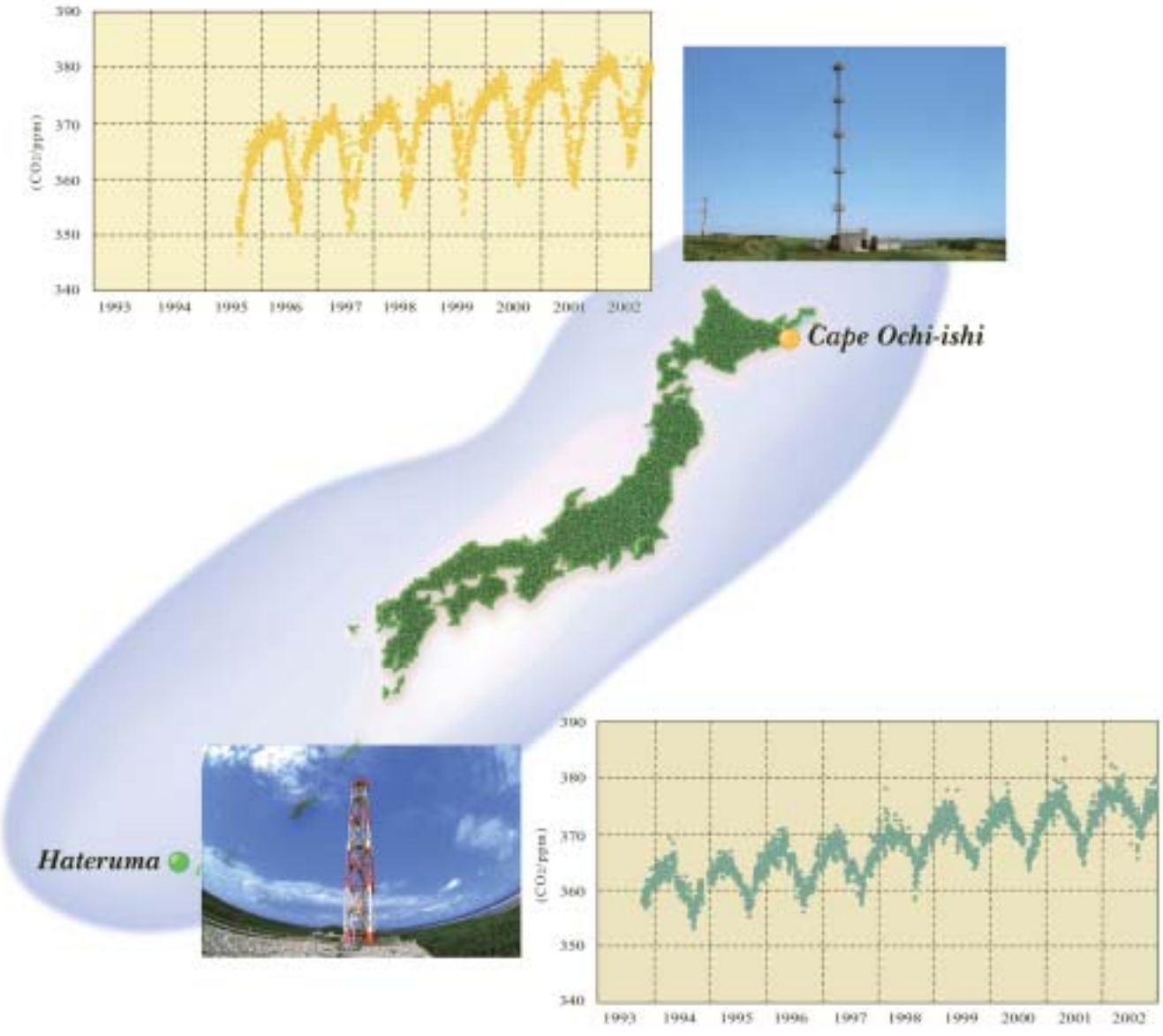


Fig. 5
Two-dimensional NMR spectrum of an aromatic compound, obtained with a JEOL JNM A-500 spectrometer (^{1}H, 500 MHz; ^{13}C, 125 MHz).

Center for Global Environmental Research



CGER was established in 1990 to promote and support global environmental research from both a national and an international viewpoint to reduce the uncertainties of future prediction. CGER has 3 missions: monitoring of the global environment; support for global environmental research; and synthesis of global environmental studies.

1. Monitoring of the Global Environment

In situ monitoring of greenhouse gases (GHGs). GHGs are monitored at 2 remote stations –Hateruma Island, over 1000 km southwest of the Japanese mainland, and Cape Ochi-ishi, in northeastern Hokkaido – together with related species (e.g. NOx, SOx, carbon isotope ratio, and oxygen concentration), with the aim of furthering our understanding of carbon cycle processes. Most species are measured automatically. An open day and evening seminar were held at Hateruma in June 2002 to commemorate the 10th anniversary of the station. Over that 10 years, the CO_2 concentration measured at the station has increased from about 360 ppm to 375 ppm (Fig. 1). This rate of increase is close to that observed in Hawaii, which is at a similar latitude to Hateruma. However, the seasonal fluctuations in the Hateruma data are larger than those in Hawaii. The concentrations at Hateruma fluctuated in winter because of the influence of emissions from the Asian continent. At Ochi-ishi station, CO_2 data have shown a larger seasonal variation than at Hateruma, but the general increasing trend is similar, with a small difference in 2000. The N_2O concentration at both stations increased continuously from 1996 to 2003, but CH_4 has increased only very slightly over the last 7 years.

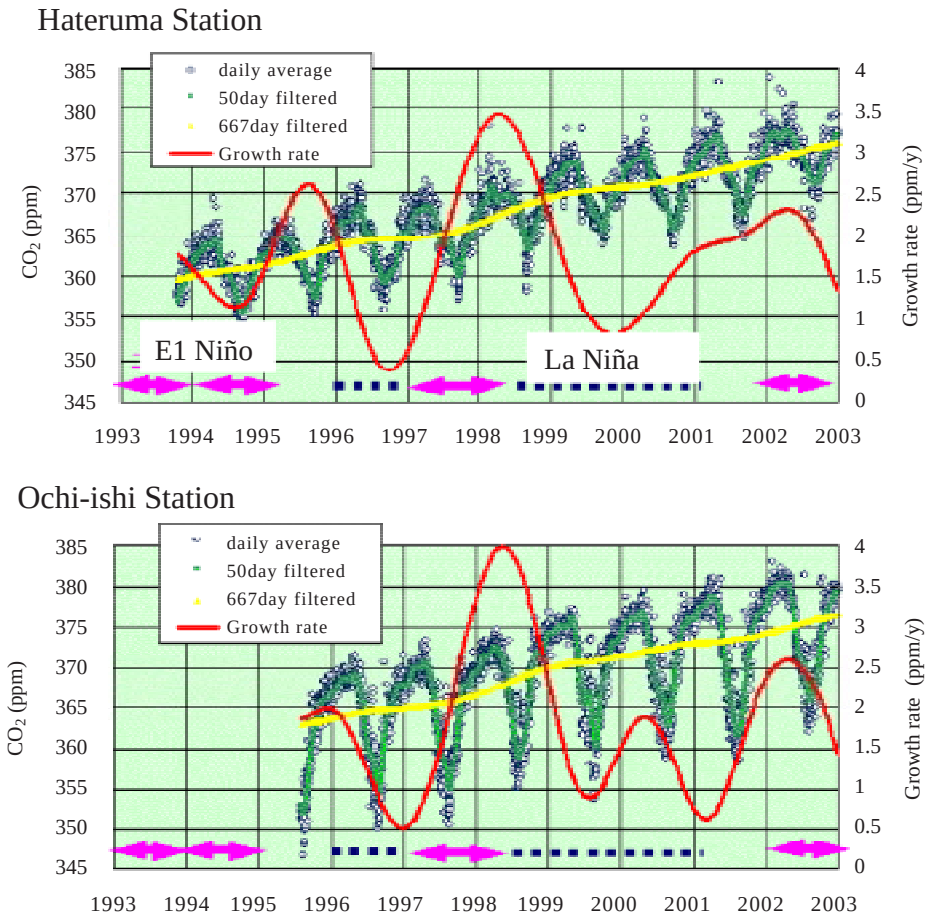


Fig. 1
CO_2 concentrations and trends at the Hateruma and Ochi-ishi monitoring stations.

In addition, in the Pacific, 2 ships of opportunity were used to collect air samples along shipping routes between Japan and Australia and between Japan and the USA. The latitudinal distribution of GHGs was observed and isotope measurements performed, and seasonal trends were discussed. Carbon isotope ratio measurements showed that large variations in the CO_2 growth rate were associated with large variations in the land biota sink–source relationship. In Siberia, the vertical distribution of CO_2 was measured over 3 sites every month. A larger seasonal variation in CO_2 concentration was observed at lower altitudes. Forests in Siberia seem to play important roles as sinks of CO_2 from the atmosphere, but Siberian wetlands appear to constitute a large source of CH_4.

Integrated carbon dioxide flux monitoring. In 1999, at Tomakomai in Hokkaido, we began direct measurements of the carbon balance between the atmosphere and a forest. We use the eddy correlation method, which measures covariance between the instantaneous vertical wind velocity and CO_2 concentration. To gain a better understanding of the mechanism behind this CO_2 balance, we are making other observations at the station, including soil respiration, stem respiration, and photosynthesis by tree leaves. A new optical remote-sensing system for the detection of photosynthesis activity is being developed. We have also successfully detected biomass change at an accuracy of 90% with an altimeter from an aircraft.

Monitoring of stratospheric ozone. Vertical profiles of ozone are monitored at Tsukuba (lat 36°02´N, long 140°07´E) and at Rikubetsu in Hokkaido (lat 43°30´N, long 142°42´E) with millimeter-wave radiometers by measuring the emission spectra of ozone at 110.836 GHz. These radiometers are equipped with supercooled superconductor-insulator-superconductor (SIS) mixers, local oscillators, intermediate frequency processors and acoustic optical spectrometers (AOS). At Tsukuba, the bandwidth of the instrument was originally 60 MHz with 40 kHz frequency resolution, allowing measurements of vertical profiles of ozone from 38 km to 76 km in altitude. In FY 2002, we developed and added a wide-band channel whose bandwidth is 1GHz, enabling measurements from 15 km. A cold blackbody and an elevation switch system were also added. The ozone profiles obtained at Rikubetsu station were compared with those from satellite sensors and showed good agreement.
In 2002 we also established a harmful UV monitoring network and performed inter-comparison to improve its accuracy.

Monitoring the ozone layer over the polar regions from space. An Improved Limb Atmospheric Spectrometer II (ILAS-II) was successfully launched aboard the ADEOS-II satellite on 14 December 2002. The ILAS-II data handling facility (DHF), which is under the management of CGER, has been used to process, store, and distribute the ILAS-II data. The initial checkout, exclusively for ILAS-II, was done in January 2003 by using the DHF. Routine ILAS-II data processing began in April 2003 after several test measurements and test data processing were performed in February and March 2003. The ILAS-II data products from the DHF will be distributed to registered researchers from July 2003.

Water quality monitoring: GEMS/Water. CGER is participating in the Global Environmental Monitoring System/Freshwater Quality Program(GEMS/Water), organized by UNEP and WHO for the collection and integration of monitoring data on terrestrial water bodies. Since 1994, monitoring data on river and lake water at 23 stations have been compiled.

- **Lake Mashu baseline monitoring:** Lake Mashu, in northeast Hokkaido, is one of the clearest lakes in the world. Since 1980, the water of Lake Mashu, as representative of lakes least affected by pollution sources, has been sampled in late summer, when thermal stratification develops. Extremely precise analyses are performed on the samples, which are taken from the surface to the deepest point (212 m depth).
- **Lake Kasumigaura trend monitoring:** Since 1976 we have been conducting continuous field studies at Lake Kasumigaura, northeast of Tokyo, a representative Japanese eutrophic lake.

2. Support for Global Environmental Research

Standard gas system. We have developed a standard gas system for baseline monitoring of greenhouse and other gases. International comparison works with NOAA/WMO, the EU and Australia have been started recently.

Global environment databases. CGER is creating original research databases for researchers and policymakers. They include: 1) a greenhouse gas emission scenario database; 2) estimates of CO_2 sequestration by forests, obtained by remote sensing; 3) an emission inventory of air pollutants in Asia; 4) a terrestrial ecosystem database for the tropics. This year we began a comparison of terrestrial ecosystem models. (Fig. 2)

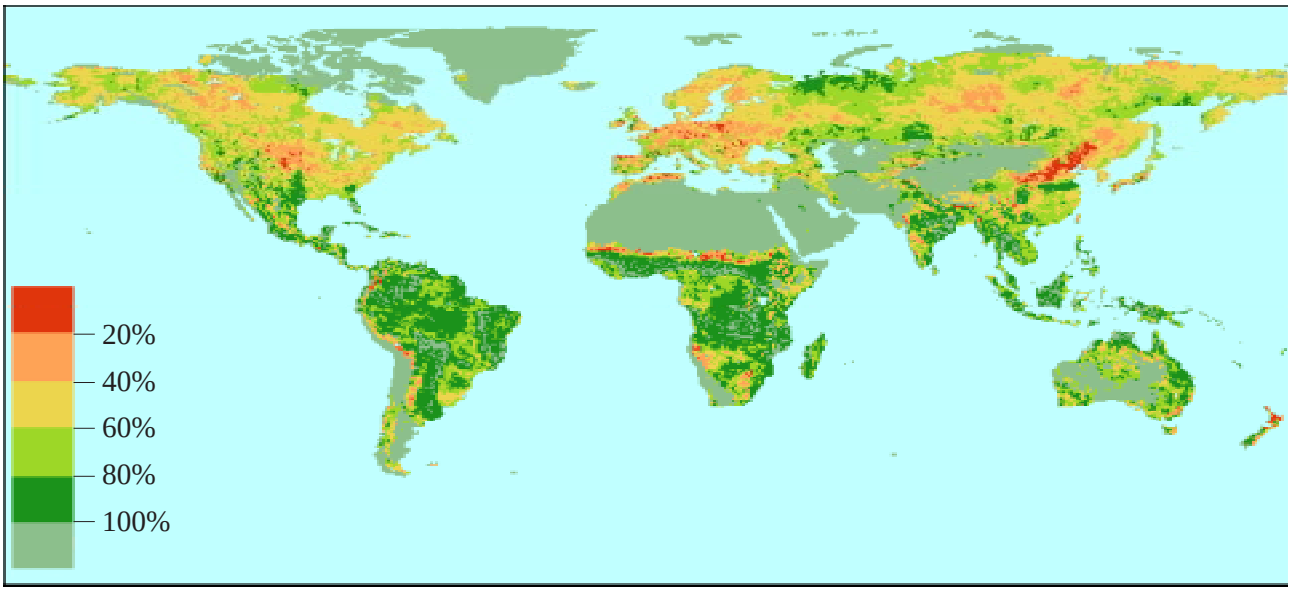


Fig. 2
Agreement between two terrestrial carbon cycle models, the Osnabruck Biosphere Model and TsuBiMo, a biosphere model of CO_2 fertilization effects. The colors chart the percentages of cases in which projections of net ecosystem production for 1966-1995 had the same sign in both models.

Greenhouse Gas Inventory Office of Japan. The Greenhouse Gas Inventory Office of Japan (GIO) was established in 2002. Its primary mission is to prepare and develop national inventories on emissions and removals of GHGs, to be submitted to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). GIO has been integrating diverse information relevant to GHG inventories and providing it to the public to promote GHG mitigation strategies and measures against global warming. Its main activities are:

- **Preparation of national inventories:** GIO estimated emissions and removals of GHGs for the period 1990–2000, then compiled and submitted them as national inventories, including CRFs, to the Secretariat of the UNFCCC in August 2002. These inventories show that the total emissions in 2000 were 8.0% higher than those in 1990.
- **Conducting trend analyses of GHG inventories:** GIO conducted trend analyses of GHGs from 1990 to 2000; for example, it identified comprehensive emission trends of GHGs, analyzing the causes of decreases and increases.
- **Performing various tasks relevant to GHG inventories:** GIO has developed a web site and provides Japan's GHG emissions data to the public, thus facilitating the review of Japan's Third National Communications by the UNFCCC. It has also participated in the development of the IPCC Emission Factors Data Base (EFDB), centralized review of the GHG inventories under the UNFCCC, and GHG inventories review-training under the UNFCCC. GIO has assisted in international negotiations such as the Conference of Parties to the UNFCCC. (Fig. 3, Table 1)

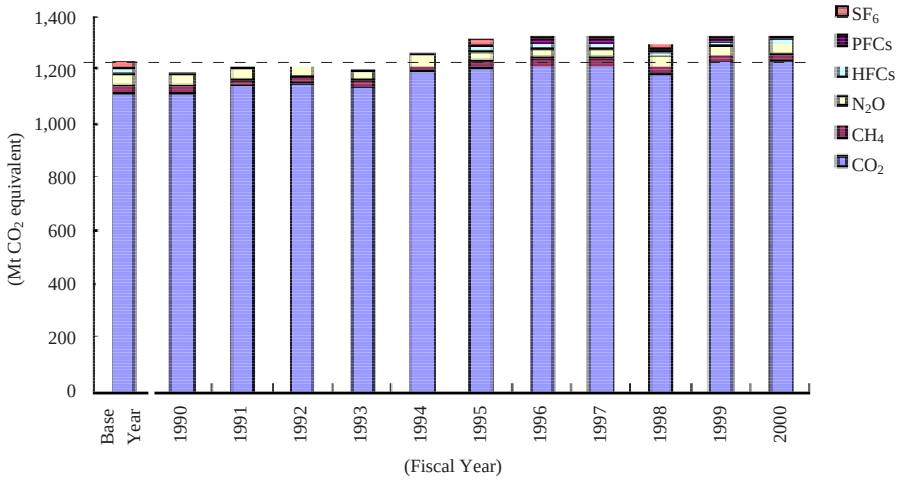


Fig. 3
Trends in emissions of greenhouse gases in Japan.

Table 1 Trends in emissions of greenhouse gases in Japan

[Mt CO_2 equivalent]

	GWP	Base Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Carbon Dioxide (CO_2)	1	1,119.3	1,119.3	1,138.5	1,148.9	1,136.4	1,194.8	1,208.0	1,219.4	1,219.4	1,191.7	1,232.8	1,237.1
Methane (CH_4)	21	26.7	26.7	26.9	26.5	26.4	26.0	25.3	24.6	23.7	23.0	22.6	22.0
Nitrous Oxide (N_2O)	310	38.8	38.8	38.4	38.7	38.5	39.4	39.6	40.5	41.0	39.7	34.0	36.9
Hydrofluorocarbons (HFCs)	HFC-134a : 1,300 ,etc	20.0						20.0	19.6	19.6	19.0	19.5	18.3
Perfluorocarbons (PFCs)	PFC-14 : 6,500 ,etc	11.5						11.5	11.3	14.0	12.4	11.1	11.5
Sulfur Hexafluoride (SF_6)	23,900	16.7						16.7	17.2	14.4	12.8	8.4	5.7
Total		1,233.1	1,184.9	1,203.9	1,214.1	1,201.3	1,260.1	1,321.2	1,332.7	1,332.2	1,298.5	1,328.3	1,331.6

*Base Year CO_2, CH_4 & N_2O:1990, HFCs, PFCs & SF6: 1995

Coordinating supercomputer-aided research programs. To predict climate change on a 100-year timescale, several groups of scientists around the world have conducted model calculation experiments based on emission scenarios proposed by the socioeconomic research group. A new supercomputer system, an NEC SX-6/64 Mb (64 CPU = 8 CPU/node ¥ 8 nodes, 512 GFlops, 512 GB memory) was introduced in 2002. CGER published 2 annual reports in 2002: "CGER's Supercomputer Activity Report", vol. 10, and "CGER's Monograph Report", vol. 8.

3. Synthesis of Global Environmental Studies

International Research Cooperation: AsiaFlux. To promote cooperation and exchange of information on carbon flux observations in Asia, the AsiaFlux network was established in 1999. The executive office is now in CGER and issues a quarterly newsletter in both English and Japanese.

Enhancement of communication among scientists and citizens. CGER NEWS is published monthly to inform the Japanese public of recent progress in global environment research activities and to enhance communication among scientists in this field of research. More than 3500 copies are sent by mail, and it can also be accessed on our homepage. Total readership is estimated to be 5000.

NIES-UNU/IAS Tokyo Roundtable on Climate Change Implementation and Future Negotiation of the Kyoto Protocol

May 9, 2002
United Nations University
Shibuya, Tokyo

The aim of this roundtable seminar was to bring together a variety of pertinent views on the implementation strategies of the Kyoto Protocol within the discussion and consideration of a way ahead after its ratification. Various Japanese stakeholders and speakers from abroad fully participated in this full-day open discussion.

Symposium for Biological Resource Collection—Culture Collection and Environmental Researches

July 23, 2002
NIES
Tsukuba, Ibaraki

This symposium was held to celebrate the start of Biological Resource Collection, as a satellite symposium of Algae 2002, the joint conference of Japanese Society of Phycology and Asian Pacific Phycological Forum. This symposium focused on diversity of algae as biological resources, environmental issues peculiar to Asia and Oceania, bioactive compounds produced by algae, and culture collections. More than 100 professionals and students participated in the symposium from various countries in Asia.

1st Global Taxonomy Initiative Regional Workshop in Asia

September 10-17, 2002
Marriot Putrajaya Hotel
Putrajaya, Malaysia

NIES has organised the workshop with the representation of 128 participants from 22 countries and economies, included taxonomists across all taxonomic disciplines, government officials and specialists from a wide range of disciplines. The workshop recommended the formation of an international (regional) committee, including representatives of the extant networks, and national GTI or CBD focal points, to organize training, establish standards for data collection, and coordinate training workshops for sectoral issues, starting with quarantine and agriculture.

APEIS Capacity Building Workshop on Integrated Environmental Monitoring in Asia-Pacific Region

September 10-17, 2002
Friendship Hotel
Beijing, China

The purpose of this workshop is to address the following issues; 1) Current situation and problems at the MODIS data receiving stations, 2) Data use policy for both NODIS data and ground-truth observation data, 3) Methodology for integrated monitoring of environmental degradation and disasters, 4) Integrated modeling of land-surface processes and ecological functions at watershed scale.

Interaction of the Pacific Atmosphere-Ocean System on Circum-Pacific Carbon Balance

October 15-17, 2002
East West Center
Hawaii, USA

The carbon balance between atmosphere-ocean and atmosphere-terrestrial ecosystem in the Pacific Limb was discussed. One of the topics was the relation with SIO (Southern Oscillation Index), and it was emphasized that the tele-connection effect is an important mechanism to disturb the sink strength. The cooperation among the observation groups was agreed. Participants were from Japan, U. S. A., Korea, and Taiwan.

APEIS Capacity Building Workshop on Integrated Environmental Assessment in Asia-Pacific Region

October 24-26, 2002
Hotel Grand Inter-Continental
New Delhi, India

The workshop aims to provide exposure to the state-of-the-art knowledge about model structures, applications and hands-on experience with the Asia-Pacific Integrated Model (AIM). The modeling team from NIES, together with researchers from IIMA, India, demonstrated the operation of the models and their applications. The policy implications of these models were also presented, focusing on the Asia-Pacific region.

Asia-Pacific Forum for Collaborative Modeling of Climate Policy Assessment

October 25, 2002
Hotel Grand Inter-Continental
New Delhi, India

The forum was held as a COP8 side event to provide a platform for collaboration among climate policy modelers and integrated assessment researchers. While its focus area is Asia-Pacific, the modeling and assessment perspective of the forum is global. This Side-Event includes presentations on models, applications and policy insights by integrated assessment researchers from Asia-Pacific Region.

International Workshop on Japan-Korea-China Cooperative Research for Freshwater (Lakes) Pollution Prevention Project, TEMM

October 24-26, 2002
Tsukuba International
Congress Center
Tsukuba, Ibaraki

For making the eco-sound water bodies, freshwater (Lakes) pollution prevention project have been promoting. In this work shop, Japan (NIES)-Korea (NIER)-China (CRAES) side representative research had information exchange such as present freshwater lakes condition, function of Bio-Eco Engineering Technology and necessity of monitoring, modeling in lakes basin area. And the tripartite countries representation researcher agreed that next workshop will be held in china, general eutrophication countermeasures guidelines will be made be in Japan side, and joint lakes investigation will be implimented in China.

2nd International Toxic Algae Control Symposium—Strategies on Toxic Algae Control in Lakes and Reservoirs for Establishment of International Network

October 30-31, 2002
Tsukuba International Congress Center
Tsukuba, Ibaraki

Problems in water utilization due to toxic algae in lakes and dams are common in Japan and the Asia and Pacific region , a situation that urgently requires international approaches. At the same timing a project "Creating International Networks for Prevention of Toxic Algae Growth" was started. These studies, based on a development and an investigation of waste water treatment technology such as advanced combined type private sewerage systems, it aims at an establishment of bio-eco engineering system which combines cost effectiveness, and saving energy, cost, resources and maintenance suiting to the individual conditions in each of the countries. It is our hope that analytical evaluation be conducted actively in this international symposium to contribute to the normalization of the water environment.

International Symposium on Sustainable Material Cycles

November 5, 2002
NIES
Tsukuba, Ibaraki

Resources and waste issues have been becoming international concerns these days. Recent domestic waste disposal and recycling are closely related to the import/export of used products. This symposium consisted of two parts. In the first part, "International Seminar on Material Flow Analysis/Accounting", the trend of research on advanced material flow analysis/accounting under international cooperation was introduced. In the second part, "The 1st Workshop on Material Cycles and Waste Management in Asian Countries" was held, in order to sort out the existing statistics on wastes in Asian countries, and to deepen the understanding about the current situations of recycling and the import/export of used products such as electric appliances in each country.

2nd SSC Meeting of the Global Carbon Project

November 18-21, 2002
NIES
Tsukuba, Ibaraki

The purpose of the meeting is to discuss about the research challenges facing the coupling of the biophysical and human dimensions of the carbon cycle. Specifically, we tried to develop a list of topics and possible activities that the GCP office in Tsukuba may lead over a rather immediate future, and more in particularly, we wanted to select and discuss a topic for the first workshop that will take place late this year or early next one in Japan.

Workshop on Sustainable Management of Catchment Ecosystem in Asia-Pacific Region

November 25-26, 2002
United Nations University
Shibuya, Tokyo

The river basin is a basic unit of the environment necessary for supporting balanced development in East Asia. The objective of this workshop was to establish river basin environmental management models to evaluate the human impacts on river basin ecological functions as the basis for proposing environmental management policies that support sustainable river basin development.

Workshop on Environmental Monitoring of Persistent Organic Pollutants (POPs) in the East Asian Countries

December 2-3, 2002
Miel Parque Hall Tokyo
Minato-ku, Tokyo

December 4, 2002
NIES
Tsukuba, Ibaraki

In response to Article 16 of POPs treaty, both principal administrative officers and researchers were invited from East Asian countries to discuss about the regional monitoring of Persistent Organic Pollutants (contract work from the Ministry of the Environment).

Forest Fire and its Impacts on Biodiversity and Ecosystems in Indonesia

January 22-24, 2003
NOVUS Hotel
Puncak, Indonesia

The forest fire in Indonesia is not only a local problem but also regional and global environmental problems through the extensive amount of haze produced by the fires, due to mainly human activities and related to El Niño effect. The symposium organized by RCB-LIPI Indonesia and NIES Japan was held for dissemination of research results on this matter to promote the public awareness and for sharing the information with scientists and stakeholders who are related to forest fires in order to develop the countermeasure to use the results for the implementation. Main topics were; (1) Effect of forest fires on flora, fauna, micro-organisms and Ecosystems, (2) Urgent necessity of biodiversity study and its application, (3) Remote sensing, using for forest fires effect evaluation and (4) Forest fires: socio-economic aspects and management. More a hundred scientists and stakeholders were participated and addressed during the symposium.

International Workshop on Vehicle Exhaust Nanoparticles
—Implications in the future research—

January 14-15, 2003
NIES
Tsukuba, Ibaraki

Scientists working on nanoparticle emission, physical and chemical characterization of nanoparticles, and health effects of nanoparticles presented 10 papers on 14 and 15th of January, 2003 at the National Institute for Environmental Studies. In the final session of the international workshop, all the delegates discussed implications and directions of future research in nanoparticle sciences.

An International Forum "Measurement and Regulation Trend of Nano Particle"

March 20, 2003
Waseda University
Shinjuku, Tokyo

Recently, it is considered that nanometer size particles, that may be insignificant to the total mass of particulates, may be more significant in terms of health effects. The aim of this forum is to introduce a current status of research on the nano-particles in vehicle exhaust. The researchers from the US and EU introduced the number and size measurements of exhaust particulates and regulation trends of vehicle exhaust nano-particle.

COUNTRY
No. Title
Collaborating Institution
NIES Partner (As of Latest Review Meeting)

AUSTRALIA
1. Cooperative research on global environmental monitoring
CSIRO
Atmospheric Environment Div.
2. A comprehensive database of microbial diversity:cyanobacteria
University of NSW
Environmental Biology Div.
3. 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.

CHINA
1. Advanced wastewater treatment processes for China
Research Institute for Environmental Engineering/Dept. Environmental Engineering, Tsinghua Univ.
Research Center for Material Cycles and Waste Management
2. Advanced sewage treatment processes by soil system applicable to China
Institute of Applied Ecology, Chinese Academy of Sciences
Research Center for Material Cycles and Waste Management
3. Development of wastewater and water resources treatment processes applicable to China
Chinese Research Academy of Environmental Sciences
Research Center for Material Cycles and Waste Management
4. Research on the development of water pollution control techniques for the Taihu Lake in China by bio/ecoengineering
Chinese Research Academy of Environment Sciences
Research Center for Material Cycles and Waste Management
5. Dioxins analysis and survey of dioxins sources in China
China-Japan friendship Center for Environmental Protection
Environmental Chemistry Div.
6. 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
Research Center for Material Cycles and Waste Management
7. Study on transport mechanism of kosa aerosol to Japan by way of Beijing
Sino-Japan Friendship Environmental Protection Center
Environmental Chemistry Div.
8. Research on development of suitable technologies to control greenhouse gas emissions during the treatment of domestic wastewater using bio-eco engineering system
Shanghai Jiao Tong University
Research Center for Material Cycles and Waste Management
9. Satellite Monitoring of Environmental Resources Asia by means of EOS-MODIS data
Institution of Geografica Sciences and Natural Resources, Chinese Academy of Sciences
Water and Soil Environment Div.
10. Molecular Epidemiological studies on the health effect of arsenic
Institution of Environmental Health and Engineering, Chinese Academy of Preventive Medicine
Environmental Health Sciences Div.
11. Research on VOCs & Ammonia emission in China
Chinese Research Academy of Environmental Science
Environmental Health Sciences Div.

CZECH
1. Biogeochemical studies on the acidic deposition and pollutions
Institute of Landscape Ecology, Czech Academy of Sciences
Atmospheric Environment Div.
2. Perception of Landscape: from Landscape Appreciation to Landscape Planning
Institute of Landscape Ecology, Czech Academy of Sciences
Social and Environmental Systems 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.

GERMANY
1. Comparative study on total material flow balance between Japan and Germany
   Wuppertal Institute for Climate, Environment and Energy
   Research Center for Material Cycles and Waste Management
2. Studies on eutrophication and related problems in closed water bodies
   Nuclear Research Center, Karlsruhe
   Office of International Coordination
   (for Water and Soil Environment Div.)
3. Testing method of endocrine disrupting chemicals
   University Stuttgart, Institute for Sanitary Engineering
   Environmental Chemistry Div. / Endocrine Disrupters & Dioxin Research Project
4. Workshop on solid waste management
   Federal Environmental Agency
   Research Center for Material Cycles and Waste Management
5. Ground-based and satellite-borne studies of stratospheric ozone and trace gases (ADEOS-II project)
   Alfred-Wegener-Institute
   Ozone Layer Research Project

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
   Atmospheric Environment Div.
2. Cross-cultural comparison of landscape evaluation between Japanese and Korean
   KyungPook University
   Social and Environmental Systems Div.
3. Study on the monitoring of harmful algal bloom and effects of nitrogen and phosphorus
   National Institute of Environmental Research
   Research Center for Material Cycles and Waste Management
4. 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.
5. Study on the marine pollution using ship-of-opportunity
   Korea Ocean Research and Development Institute
   Water and Soil Environment Div.
6. Study on the long range transport of POPs by using ship-of opportunity
   Korea Ocean Research and Development Institute
   Environmental Chemistry Div.
7. Research on the prevention and management of Environmental Disease
   National Institute of Environmental Research (NIER)
   Environmental Health Sciences 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
   Biodiversity Conservation Research Project
2. Establishment of methodology of health risk assessment on air pollutants
   Institute of Occupational and Environmental Health
   Environmental Health Sciences Div.

RUSSIA
1. Research programs under the Baikal International Center for Ecological Research (BICER)
   Limnological Institute, Russian Academy of Sciences
   Office of International Coordination
   (for 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. Vertical profile measurement of greenhouse gases over Siberia
   Institute of Atmospheric Optics
   Center for Global Environmental Research
7. Study of measurements of atmospheric trace secies using FTIR and other methods in Siberia area
   Institute of Sollar-Terrestrial Physics (ISTP), Siberian Dep. Russian Academy of Science
   Atmospheric Environment 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. *In vivo* NMR spectroscopy method and its application to the field of environmental health
   Dept. Biochemistry, Univ. Cambridge
   Endocrine Disrupters & Dioxin Research Project
2. Effects of environmental pollution on the metabolism of trace elements in man
   Rowett Research Institute
   Environmental Health Sciences Div.
3. Algae and Protozoa
   CCAP, Institute of Freshwater Ecology
   Environmental Biology Div.
4. Cooperation on the development and application of Coupled Chromatography-Accelerator Mass Spectrometry Techniques
   University of Oxford
   Environmental Chemistry Div.
5. 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
   Laboratory of Intellectual Fundamentals for Environmental Studies
6. Studies on molecular biology and ecology of methanotrophs
   University of Warwick, Department of Biological Sciences
   Water and Soil Environment Div.

U. S. A.

1. Development of bioremediation technologies for cleanup of contaminated soil
   Center for Environmental Biotechnology, Univ. Tennessee
   Water and Soil Environment Div.
2. Precise measurement of the greenhouse gases in the global baseline atmosphere
   Climate Monitoring and Diagnostics Lab, NOAA
   Center for Global Environmental Research
3. Health impacts of climate change and environmental degradation on human morbidity in regional societies
   National Institute of Environmental Health Sciences
   Regional Environment Div.
4. Effects of logging on lakes ecosystems
   University of Alaska Fairbanks
   Regional Environment Div.
5. Human impacts on biodiversity and nutrient cycling in mire wetland
   Smithsonian Institute
   Environmental Biology Div.
6. Establishment of phytotron research network
   Duke University
   Environmental Biology Div.
7. Studies on standardization of measurement and health effect of particulates
   USEPA, National Center of Environmental Assessment
   Environmental Health Sciences Div.
8. Studies on the feasibility of the FTIR network for vertical profiling atmospheric trace species
   University of Denver
   Atmospheric Environment Div.
9. Development of an advanced regional climate change prediction model as part of emission-climate-impact integrated models
   Goddard Space Flight Center, NASA
   Atmospheric Environment Div.
10. Joint implementation of ocean surface CO_2 observation in the Pacific Ocean to understand the oceanic sink of CO_2
    Pacific Marine Environmental Laboratory, NOAA
    Climate Change Research Project
11. Joint implementation of CO_2 flux observations for the identification of carbon fixation ability of forests and the prediction of its fluctuation
    Department of Energy (DOE)
    Center for Global Environmental Research
12. Comparative, standardized and complementary measurement of atmospheric constituents for the evaluation of terrestrial/oceanic sources and sinks of carbon, other non-CO_2 greenhouse gases and aerosols
    Climate Monitoring and Diagnostics Laboratory, NOAA
    Center for Global Environmental Research

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 Sience and Enginering Shanghai Jiao Tong University for Collaborating Research on Eutrophicated lake and marsh water improvement using Bio-ecoengineering Technology (2000).
	Memorandum of Understanding Between Northwest Plateau Institute of Biology, the Chinese Academy of Sciences, P. R. China (NPIB) and National Institute for Environmental Studies, Japan (NIES) for Collaborative in Alpine Grassland Ecosystem (2001).
INDIA	Memorandum of Understanding between the Indian Council of Agricultural Research and the National Institute for Environmental Studies for Collaborative Research on Desertification (1993).
INDONESIA	Memorandum of Understanding between Research and Development Center for Biology, Indonesian Institute of Sciences (RDCP-LIPI), Bogor-Indonesia and National Institute for Environmental Studies, Tsukuba-Japan concerning Scientific and Technical Cooperation on the Biodiversity and Forest Fire (2001).
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 Naitonal Institute for Environmental Studies of Japan and National Insititute of Environmental Research of the Republic of Korea to establish a cooperative frameword 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).

Agreement on Cooperative Research Project between Institute of Solar-Terrestrial Physics (ISTP), Siberian Branch, Russian Academy of Science and National Institute for Environmental Studies, Environment Agency of Japan.

THAILAND Memorandum of Understanding between Kasetsart University, Bangkok, Thailand and National Institute for Environmental Studies, Japan (NIES) for Global Taxonomy Initiative, Toxic Cyanobacteria and Algal Diversity (2002).

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)

<Office of International Coordination>

An, Ping, CHINA, 2002. 4. 28~
Studies on monitoring and assessment of desertification (Shimizu, H.)

Yu, Yunjiang, CHINA, 2002. 10. 2~
Researches on the mechanism of influence of aeolian sand flow on the ecophysiology of plants and adaptability of these plants to aeolian sand flow (Shimizu, H.)

Zheng, Yuanrun, CHINA, 2001. 7. 27~
Evaluation of countermeasures to rehabilitate desertificated lands (Shimizu, H.)

<Social and Environmental Systems Division>

Bell, Simon, U. K, 2002. 9. 14~2002. 10. 14
The design and management of forest ecosystems (Aoki, Y.)

Kim, Yoonjae, KOREA, 2002. 1. 7~2002. 12. 27
"Derivation of aerosol properties using the ILAS and ILAS-II data" and "Retrieval of CO_2 mixing ratio using the ILAS-II data" (Yokota, T.)

Pandey, Rahul, INDIA, 2002. 1. 7~2003. 3. 31
Development of model, database and framework for environmental innovation strategy in Asia-Pacific region (Kainuma, M.)

Rana, Ashish, INDIA, 2000. 6. 1~
A Quantative Analysis of Policy Effects toward Recycle-based Society with Special Reference to Waste Management (Morita, T.)

Wan, Yue, CHINA, 2002. 11. 27~
Development of a model to assess the Health Impacts in China caused by Global Warming (Morita, T.)

Yang, Cuifen, CHINA, 2001. 3. 31~2003. 2. 26
Study on the land cover changes and its driving factors in the Lio River (Tamura, M.)

Yang, Hongwei, CHINA, 2001. 8. 17~2003. 3. 31
International collaborative studies for evaluating the effects of CDM (Clean Development Mechanism) (Kainuma, M.)

<Environmental Chemistry Division>

Allinson, Graeme, AUSTRALIA (Nationality:British), 2002. 5. 28~2002. 7. 26
Effect of clay amelioration on heavy metal contamination in non-wetting soil (Nishikawa, M.)

Chowdhury, Uttam kumar, INDIA (Nationality:Bangladesh) 2002. 7. 28~2002. 8. 29
Studies for plan to maintain the global environmental protection to the widely arsenic-affected groundwater (Shibata, Y.)

Ma, Wanhong, CHINA, 2002. 2. 28~2002. 5. 18
Studies on intermediary Species in Chemical Processes and Flames (Morita, M.)

Nyein, Nyein Aung, MYANMAR, 2002. 5. 16~
Environmental exposure pathways assessment of lead among the children residing in Tokyo metropolis (Tanaka, A.)

Treuner, A. B, U. K (Nationality:GERMANY), 2002. 11. 29~
Investigations into causes of decline in abalone (Haliotis spp.) populations in Japan, with special reference to effects of various endocrine disrupting chemicals present in coastal sediments and waters: Development of a novel sublethal bioassay employing juveniles and larvae of Haliotis spp. (Horiguchi, T.)

Zheng, Jian, CHINA, 2001. 3. 1~2002. 6. 5
Development of hyphnated technique for multi-element speciation analysis and its application to biological, medical and environmental sciences (Shibata,Y.)

<Atmospheric Environment Division>

Bellis, David Jhon, U. K, 2001. 3. 29~
Historical monitoring using bark pockets as pollution time capsules (Satake, K.)

Chen, Yan, CHINA, 2001. 8. 7~2002. 10. 31
Study of transportation of Asian dust utilizing lidar and optical measurement techniques (Sugimoto, N.)

Loukianov, Alexandre, RUSSIA, 2002. 4. 1~2003. 3. 31
Study on ozone depletion using the photochemical model (Nakane, H.)

Qi, Bin, CHINA, 2002. 1. 17~
Studies on the formation process of peroxides in photochemical reactions of hydrocarbons (Hatakeyama, S.)

Wang, Qiuquan, CHINA, 2002. 8. 26~2003. 3. 31
Monitoring of environmental pollution using tree bark (Satake, K.)

<Water and Soil Environment Division>

Hou, Hong, CHINA, 2002. 5. 16~
Study on the behavior of Bc in soil (Takamatsu, T.)

Zhang, Jiqun, CHINA, 2001. 4. 1~
Study on the estimation of the pollutant load from Changjian River Basin (Watanabe, M.)

<Environmental Biology Division>

Andersen, Robert A., U. S. A., 2002. 7. 1~2002. 8. 10
An investigation of the phytoplankton biodiversity in the Kuroshio Current using enrichment cultures (Kawachi, M.)

Bathula, Srinivas, INDIA, 2002. 2. 15~
Molecular cloning and characterization of ozone-tolerant genes using ozone-sensitive Arabidopsis mutants (Kubo, A.)

Cui, Xiaoyong, CHINA, 2001. 7. 10~
Combined effects of temperature and UV-B on leaf carbon gain of alpine plants in Qinghai-Tibet grassland (Tang, Y.)

Gu, Song, CHINA, 2001. 7. 9~
Characterization of temporal variations of bio-meteorological environment in a grassland ecosystem in Tibet- Qinghai Plateau (Tang, Y.)

Lee, Jae-Seok, KOREA, 2002. 7. 1~2003. 3. 20
Evaluation on storage speed of soil carbon in an alpine grassland (Tang, Y.)

Mazlan, Hashim, MALAYSIA, 2002. 12. 1~2003. 3. 31
Risk assessment on landscape development using GIS approaches (Okuda, T.)

<Climate Change Research Project>

Chierici, Melissa, SWEDEN, 2002. 9. 25~
Comparison of oceanic sink and source of carbon dioxide in the Pacific and Atlantic with data integration of observational data sets (Nojiri, Y.)

Fransson, Agneta Ingrid, SWEDEN, 2002. 9. 25~
Biological controls on the air-sea exchange of CO_2 during an iron fertilization experiment conducted in the subarctic Northwest Pacific Ocean (Nojiri, Y.)

<Ozone Layer Research Project>

Khosrawi, Farahnaz, GERMANY, 2002. 9. 30~
A study on stratospheric ozone loss using satellite tracer date and a chemical Lagrangian model (Nakajima, H.)

Oshchepkov, Sergey, RUSSIA, 2002. 5. 16~
A study on analytical method for ILAS and ILAS-II date retrieval for gases and aerosols (Nakajima, H.)

Rivière, Emmuanuel, FRANCE, 2001. 10. 15~2002. 10. 14
A study on polar stratospheric chemistry using photochemical Lagrangian model and satellite measurements (Nakajima, H.)

Zhou, Libo, CHINA, 2002. 3. 19~
A study on ozone transport processes using a chemical transport model (Akiyoshi, H.)

<Endocrine Disrupters and Dioxin Research Project>

You, Jae-Cheon, KOREA, 2002. 12. 25~2003. 2. 28
1) Comparison study of dioxin analytical method between Korea and Japan
2) Analysis of pollutants of a recent concern (Suzuki, N.)

Xu, Xiaobin, CHINA, 2002. 5. 29~
A study of the effects of organo tin compounds on central - nervous system (Imai. H.)

<PM2.5 & DEP Research Project>

Shannigrahi, Ardhendu Sekhar, INDIA, 2002. 5. 16~
A study on the emission and behavior of atmospheric particulate matter (Wakamatsu, S.)

<Research Center for Material Cycles and Waste Management>

Dass, Preeti, INDIA, 2001. 4. 1~2003. 3. 31
Study on the operation and management techniques to control CH_4 and N_2O for the natural wastewater treatment process using soil and vegetation (Inamori, Y.)

Ding, Guoji, CHINA, 2002. 6. 21~2002. 11. 13
Development of advanced biological wastewater treatment system using specific protozoa and metazoa based on ecological engineering (Inamori, Y.)

Kim, Juhyun, KOREA, 2002. 5. 24~2003. 3. 31
Development of enhanced N/P removal and recovery systems from livestock wastewater (Inamori, Y.)

Krishnakumar, Bhaskaran, INDIA, 2000. 10. 17~2002. 10. 16
Minimization of excess sludge production in activated sludge system by non-growth energy dissipation mechanism (Inamori, Y.)

Li, Xianning, CHINA, 2002. 6. 21~2002. 11. 13
Development of resource cycling water purification system using aquatic plant (Inamori, Y.)

Sun, Liwei, CHINA, 2001. 1. 13~2003. 1. 12
Establishment of the multiple-trophic level biological system in wastewater treatment to improve the quality of the effluents and minimize the biomass yields (Inamori, Y.)

Wui, Seonguk, KOREA, 2001. 2 .27~2003. 2. 26
Effect of pesticides to individual movement in the microcosm (Inamori, Y.)

Yang, Jianxin, CHINA, 2002. 3. 25~2003. 3. 24
Life cycle management of municipal solid waste and recycling strategies (Moriguchi, Y.)

Yang, Yufang, CHINA, 2002. 6. 21~2002. 11. 13
Development on the effective treatment technology of sludge produced from domestic wastewater and lake water purification process (Inamoir, Y.)

Zhu, Nanwen, CHINA, 2002. 7. 16~2003. 3. 31
Study on the operation and management techniques to control CH_4 and N_2O for the constructed wetland system (Inamori, Y.)

<Laboratory of Intellectual Fundamentals for Environmental Studies>

Gao, Yong, CHINA , 2001. 7. 16~2003. 3. 31
Evaluation of vegetation indicators for the monitoring and assessment of desertification (Tobe. K.)

<Center for Global Environmental Research>

Kotov, Vladimir, RUSSIA, 2002. 2. 25~2002. 4. 25
Possible Implication of Russian Economic Restructuring to its Climate Policy (Nishioka, S.)

Maksyutov, Shamil, RUSSIA, 2002. 4. 19~
Modeling of Green House Gases Flux (Inoue, G.)

Sha, Weiming, CHINA, 2002. 5. 21~
Development of finite-difference numerical model for studying the geophysical fluid dynamics in spherical polar coordinates (Inoue, G.)

Zhang, Qianbin, CHINA, 2002. 4. 8~
Lake Mashu baseline monitoring by GEMS/water (Fujinuma, Y.)

Zhou, Lingxi, CHINA, 2002. 3. 25~
Global Environmental Monitoring project–Global warming (Mukai, H.)

Adachi, H. (*1), Yamano, H., Kayanne, H. (*2) (*3), Matsuda, F. (*4), Tsuji, Y. (*4) (*1 Geoact, *2 Univ. Tokyo, *3 CREST, *4 Jpn. Natl. Oil) (2002)

A portable, electrical-based percussion coring system for use in deep water, *J. Sediment. Res.*, **72(5)**, 727-730

Adachi, T. (*1), Takanaga, H. (*2), Sakurai, Y. (*3), Ishido, M., Kunimoto, M. (*2), Asou, H. (*3) (*1 Natl. Inst. Minamata Dis., *2 Kitasato Univ., *3 Tokyo Metrop. Inst. Gerontol.) (2002)

Influence of cell density and thyroid hormone on glial cell development in primary cultures of embryonic rat cerebral hemisphere, *J. Neurosci. Res.*, **69**, 61-71

Agrawal, G. K. (*1), Rakwal, R. (*2), Yonekura, M. (*3), Kubo, A., Saji, H. (*1 Res. Lab. Agric. Biotechnol. & Biochem., *2 JST, *3 Ibaraki Univ.) (2002)

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Agrawal, G. K. (*1), Rakwal, R. (*2), Yonekura, M. (*3), Kubo, A., Saji, H. (*1 Res. Lab. Agric. Biotecnol. & Biochem., *2 JST, *3 Ibaraki Univ.) (2002)

Rapid induction of defense/stress-related proteins in leaves of rice (*Oryza sativa*) seedlings exposed to ozone is preceded by newly phosphorylated proteins and changes in a 66-kDa ERK-type MAPK, *J. Plant Physiol*., **159**, 361-369

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Chemistery and temperature perturbations due to Pinatubo aerosols calculated by a chemical-radiative coupled 1-D models, *J. Meteorol. Soc. Jpn.*, **80(3)**, 361-385

Akiyoshi, H., Sugata, T., Sugita, S., Nakajima, H., Hayashi, H., Kurokawa, J. (*1), Takahashi, M. (*2) (*1 Fujitsu FIP, *2 CCSR Univ. Tokyo) (2002)

Low-N_2O air masses after the breakdown of the arctic polar vortex in 1997 simulated by the CCSR/NIES nudging CTM, *J. Meteorol. Soc. Jpn.*, **80(3)**, 451-463

Alexandrov, G., Yamagata, Y. (2002)

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Behnisch, P. A. (*1) (*2), Hosoe, K. (*1), Brouwer, A. (*3), Sakai, S. (*1 Kaneka, *2 Kyoto Univ. Environ. Preserv. Cent., *3 Univ. Amsterdam) (2002)

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Behnisch, P. A. (*1) (*2), Hosoe, K. (*1), Shiozaki, K. (*3), Kiryu, T. (*4), Komatsu, K. (*4), Schramm, K. W. (*5), Sakai, S. (*1 Kaneka, *2 Kyoto Univ. Environ. Preserv. Cent., *3 Kaneka Techno Res., *4 Kawasaki Giken Eng. & Constr., *5 GSF, Natl. Res. Cent. Environ. & Health) (2002)

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Behnisch, P. A. (*1) (*2), Hosoe, K. (*1), Shiozaki, K. (*3), Ozaki, H. (*4), Nakamura, K. (*5), Sakai, S. (*1 Kaneka, *2 Kyoto Univ. Environ. Preserv. Cent., *3 Kaneka Techno Res., *4 Kawasaki Heavy Ind., *5 Kyoto Munic.Gov.) (2002)

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The potential of elemental and isotopic analysis of tree bark for discriminating sources of airborne lead contamination in the UK, *J. Environ. Monit.*, **(3)**, 194-197

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Evaluation of the historical records of lead pollution in the annual growth rings and bark pockets of a 250-year-old *Quercus crispula* in Nikko, Japan, *Sci. Total Environ.*, **295**, 91-100

Binkley, C. S. (*1), Brand, D. (*2), Harkin, Z. (*3), Bull, G. (*3), Ravindranath, N. H. (*4), Obersteiner, M. (*5), Nilsson, S. (*5), Yamagata, Y., Krott, M. (*1 Hancock Timber Resor. Group, *2 Hancock Nat. Group, *3 Univ. British Columbia, *4 Indian Inst. Sci., *5 Int. Inst. Appl. Syst. Anal.) (2002)

Carbon sink by the forest sector-options and needs for implementation, *Forest Policy Econ.*, **4**, 65-77

Bisby, F. A., Shimura, J., Ruggiero, M. (*1), Edwards, J. (*2), Haeuser, C. (*3) (*1 ITIS, *2 GBIF, *3 GTI) (2003)

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Chen, J., Gong, P. (*1), He, C. (*2), Luo, W. (*1), Tamura, M., Shi, P. (*2) (*1 Univ. California, *2 Beijing Normal Univ.) (2002)

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Choi, K. (*1), Kim, B. (*2), Imai, A., Matsushige, K. (*1 Cent. Ecol. Res. Kyoto Univ., *2 Kangwon Natl. Univ.) (2002)

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News of the National Institute for Environmental Studies (VOL. 21/1-6) (in Japanese)

NIES (2002)
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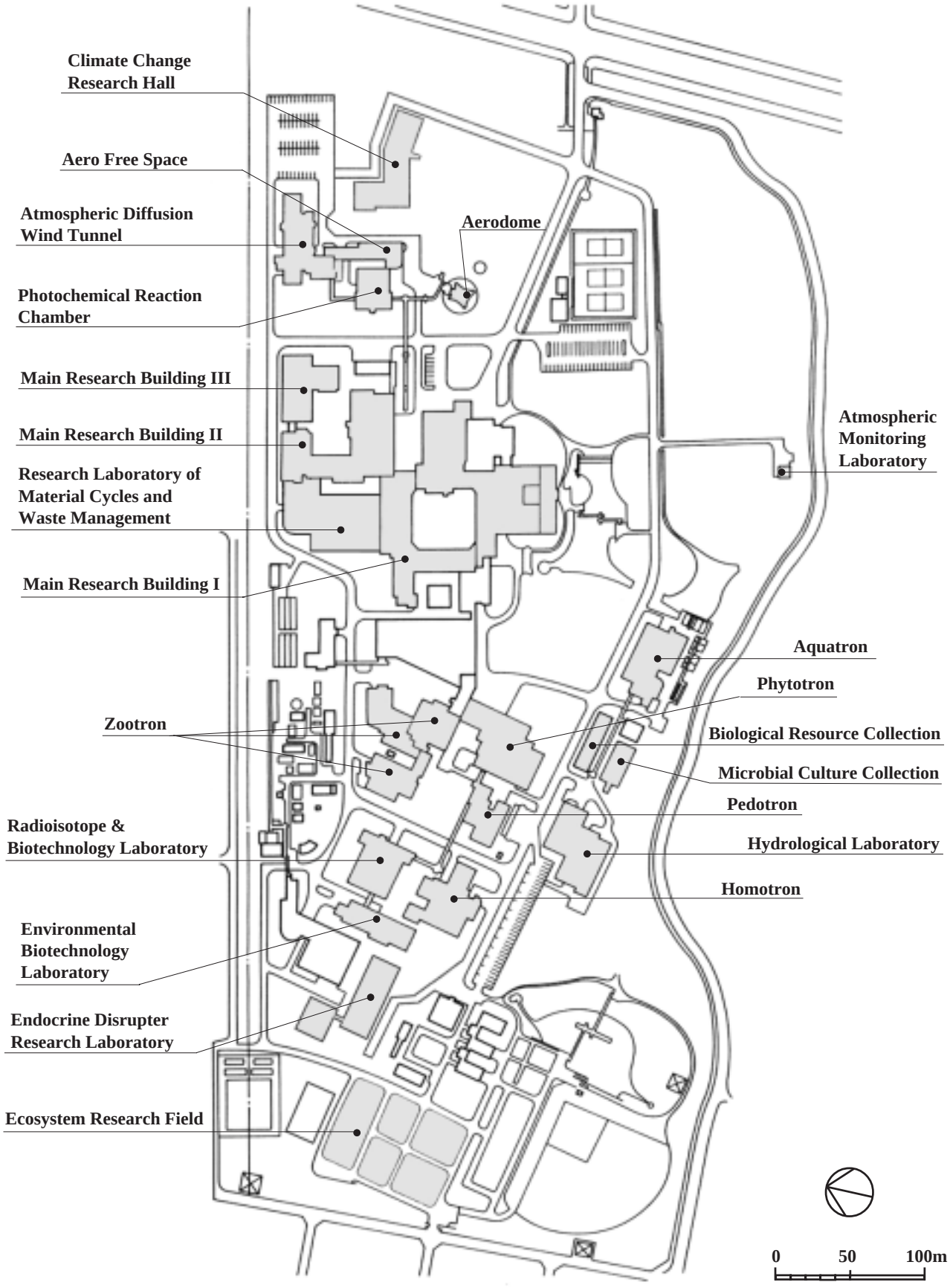
Climate Change Research Hall
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Aerodome
The aerodome is a facility both for remote monitoring of pollutant particles in the atmosphere (via a large-scale laser radar) and for study of the formation of secondary particulates from gaseous primary pollutants. 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.

Biological Resource Collection
In order to enhance research relating to microbes that are important for environmental studies such as hazardous substance decomposing microbes, and to preserve experimental materials for conservation studies, a new building is being constructed as an annex of the Microbial Culture Collection Building at NIES. The new facilities consist of rooms for cryopreservation, identification and classification, evaluation of functions, genetic analysis, and databases of environmental microbes.

Climate Change Research Hall
Climate Change Research Hall (CCRH), built especially for global warming research, was completed in March 2001 with 3 floors and 4,900m^2 total area. The following major research programs are conducted in this new facility: (1) development and implementation of the climate change models based on various socio-economic and emissions scenarios, (2) monitoring of atmospheric constituents to evaluate the ocean and terrestrial carbon sinks, and (3) assessment of forest sinks by remote sensing, forest models and statistical data. In addition, the facility includes equipment to evaluate low emissions vehicles. CCRH was constructed various new energy saving. The effectiveness of energy saving is being monitored and analyzed.

Endocrine Disrupter Research Laboratory
The Endocrine Disruptor Research Laboratory was founded in March 2001 for studies on the analysis, bioassay, and experimental hazard/risk assessment of endocrine disrupting chemicals (EDCs), as well as for carrying out field surveys and assessing management technologies for these substances. The building is of 4 floors with a total area of 5,200m^2, and is equipped with several special instruments including a high-resolution nuclear magnetic resonance imaging (MRI) instrument (800MHz) for examining the activity of the living human brain, and liquid chromatography-tandem mass spectrometry (LC/MS/MS) for the qualitative and quantitative analysis of EDCs. The laboratory has all necessary basic laboratory functions for chemical and biological research on EDCs and is also intended to strengthen research collaboration with domestic and overseas researchers for the further development of research on endocrine disruptor.

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.

Ecosystem Research Field
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 Monitoring 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.

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 (DHF) for the Limb Atmospheric Spectrometer II (ILAS-II)

ILAS-II is a satellite-borne sensor to measure atmospheric constituents such as ozone, nitric acid, and water vapor in the polar stratosphere. It was developed by the Ministry of the Environment of Japan. ILAS-II is aboard Advanced Earth Observing Satellite II (ADEOS-II named Midori II), which was launched on December 14, 2002. ADEOS-II is in routine operations from April 10, 2003. The ILAS-II measurement data are transferred from NASDA/EOC to ILAS-II DHF, and are processed, archived, and distributed at ILAS-II DHF. The ILAS-II data products are used for atmospheric research works at NIES and by other registered researchers.

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 Research 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 & Biotechnology 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.

Research Laboratory of Material Cycles and Waste Management
In April 2001 NIES established the Research Center for Material Cycles and Waste Management, as an expansion of the Waste Research Division that had been create in January in connection with national government's administrative reforms. Research

Laboratory of Material Cycles and Waste Management supports research on resource circulation and waste management, resource recovery and recycling, and technologies for environmental risk reduction and restoration after pollution, as well as testing, evaluation and monitoring.

Research Station for Preservation and Enhancement of Water Environment

1)Lake Kasumigaura Water Research Laboratory

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.

2)Bio/Eco-Engineering Research Laboratory

Improving water quality in enclosed water bodies is an important environmental issue in many places around the world. If water-cleaning technologies are used, it is essential that they be properly suited to the local conditions. NIES constructed a new laboratory for research, development, and actual field testing of new types of innovative waste and wastewater treatment systems such as advanced Johkasou, aquatic plant-soil application processes that use Bio-and Eco-engineering technologies. The new laboratories will enhance research activities, including international cooperative research.

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 various 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 larch forest to elucidate carbon cycle function such as CO_2 flux. With 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

President	1
Executive Director	2
Auditor	2
Research Coordinators	8
Audit Section	3
General Affairs Division	35
Executive Investigator	1
Principal Investigator	1
Social and Environmental Systems Division	20
Environmental Chemistry Division	16
Environmental Health Sciences Division	17
Atmospheric Environment Division	21
Water and Soil Environment Division	16
Environmental Biology Division	15
Climate Change Research Project	1
Ozone Layer Research Project	4
Endocrine Disrupters & Dioxin Research Project	15
Biodiversity Conservation Research Project	10
Watershed Environments and Management Research Project	9
PM2.5 & DEP Research Project	10
Research Center for Material Cycles and Waste Management	27
Research Center for Environmental Risk	9
Environmental Information Center	12
Laboratory of Intellectual Fundamentals for Environmental Studies	5
Center for Global Environmental Research	10
Total	270

Fields of Expertise

Basic Sciences	87
Engineering	62
Agricultural Sciences	25
Medical Science	17
Pharmacology	7
Fisheries Science	3
Economics	4
Total	205

Division Section/Team	Position	Staff Menber	Extension	E-mail (@nies.go.jp)
Headquarters				
	President	GOHSHI, Yohichi	2300	gohshi
	Executive Director (Research)	NISHIOKA, Shuzo	2301	snishiok
	Executive Director (Management)	IIJIMA, Takashi	2820	t-iijima
	Auditor	TOMIURA, Azusa	2822	tomiura
	Auditor	OTSUKA, Hiroshi	2823	hotsuka
Research Coordinators				
	Principal Research Coordinator	TAKAGI, Hiroaki	2302	htakagi
	Deputy Director (∗)	UEHIRO, Takashi	2220	uehiro
Office of Research Coordination & Public Relations				
	Director	MATSUMOTO, Kimio	2453	k-matsu
	Research Coordinator	YASUDA, Naoto	2303	nyasuda
	Research Coordinator	YOSHIGUCHI, Nobuaki	2304	yoshigu
	Research Coordinator	SUGIYAMA, Kenichirou	2307	kensugi
	Research Coordinator (∗)	KUME, Hiroshi	2305	kikaku-5
	Research Coordinator (∗)	YAMADA, Masahito	2306	kikaku-6
	Research Coordinator (∗)	TANABE, Kiyoshi	2657	kikaku-7
	Research Coordinator (∗)	OSAKO, Masahiro	2658	kikaku-8
Office of International Coordination				
	Director (∗)	UEHIRO, Takashi	2220	uehiro
	International Coordination Researcher	SHIMIZU, Hideyuki	2309	hshimizu
	International Research Coordinator	HIROKANE, Katsunori	2308	hirokane
Audit Section				
	Chief	HARA, Kenichi	2831	ken1hara
General Affairs Division				
	Director	TAKEUCHI, Tsuneo	2311	take
General Affairs Section				
	Chief	OTSUKA, Tetsuya	2312	t-otsuka
Accounting Section				
	Chief	MORI, Yutaka	2319	yutaka_m
Facility Management Section				
	Chief	TAKEUCHI, Tadashi	2410	ttakeuti
Executive Investigator				
		MORITA, Masatoshi	2332	mmorita
Principal Investigator				
		KABUTO, Michinori	2333	kabuto
Social and Environmental Systems Division				
	Director	MORITA, Tsuneyuki	2541	t-morita
	Deputy Director	TAMURA, Masayuki	2479	m-tamura
	Independent Senior Researcher	AOKI, Yoji	2389	yojiaoki
Environmental Economics Section				
	Leader (∗)	MORITA, Tsuneyuki	2541	t-morita
		AOYAGI, Midori	2392	aoyagi
		HIBIKI, Akira	2510	hibiki
		KAMEYAMA, Yasuko	2430	ykame
Resources Management Section				
	Leader	MORIGUCHI, Yuichi	2540	moriguti
		MORI, Yasufumi	2539	mori-y
		TERAZONO, Atsushi	2506	terazono
Environmental Planning Section				
	Leader	HARASAWA, Hideo	2507	harasawa
		TAKAHASHI, Kiyoshi	2543	ktakaha
		HIJIOKA, Yasuaki	2961	hijioka

(∗) Multiple roles

Information Processing and Analysis Section			
Leader	YOKOTA, Tatsuya	2550	yoko
	SUGA, Shinsuke	2456	sugas
	SHIMIZU, Akira	2452	ashimizu
	MATSUNAGA, Tsuneo	2838	matsunag
	YAMANO, Hiroya	2477	hyamano
Integrated Assessment Modeling Section			
Leader	KAINUMA, Mikiko	2422	mikiko
	MASUI, Toshihiko	2524	masui
	FUJINO, Junichi	2504	fuji
Environmental Chemistry Division			
Director (∗)	MORITA, Masatoshi	2332	mmorita
Independent Senior Researcher	YOKOUCHI, Yoko	2549	yokouchi
Analytical Instrumentation and Methodology Section			
Leader (∗)	UEHIRO, Takashi	2811	uehiro
	KUME, Hiroshi	2436	hkume
	NISHIKAWA, Masataka	2495	mnishi
	ARAMAKI, Takafumi	2124	ara
Analytical Quality Assurance Section			
Leader (∗)	TANABE, Kiyoshi	2478	tanabe
	ITO, Hiroyasu	2398	h-ito
	Choi, Jae, Won	2914	choi.jae.won
Environmental Chemodynamics Section			
Leader	SHIBATA, Yasuyuki	2450	yshibata
	KUNUGI, Masayuki	2434	kunugi
	SEYAMA, Haruhiko	2462	seyamah
	TANAKA, Atsushi	2476	tanako
	YONEDA, Minoru	2552	myoneda
Ecological Chemistry Section			
Leader (∗)	MORITA, Masatoshi	2332	mmorita
	HORIGUCHI, Toshihiro	2522	thorigu
	EDMONDS, John S.	2860	Edmonds.john.s
	TATARAZAKO, Norihisa	2887	tatarazako.norihisa
	IWANE, Taizo	2251	iwane
Environmental Health Sciences Division			
Director	TOHYAMA, Chiharu	2594	ctohyama
Deputy Director	KOBAYASHI, Takahiro	2353	takakoba
Molecular and Cellular Toxicology Section			
Leader	NOHARA, Keiko	2500	keikon
	OHSAKO, Seiichiro	2519	ohsako
	ISHIMURA, Ryuta	2397	ishimura
Environmental Biodefense Research Section			
Leader	FUJIMAKI, Hidekazu	2518	fujimaki
	KUROKAWA, Yoshika	2437	kurokawa
	MOCHITATE, Katsumi	2538	mochitat
	YAMAMOTO, Shoji	2548	snyamamo
	KAKEYAMA, Masaki	2767	kake
Biomarker and Health Indicator Section			
Leader (∗)	HIRANO, Seishiro	2512	seishiro
	YAMAMOTO, Megumi	2031	megumiy
	XING, Cui	2892	xing.cui
Epidemiology and International Health Research Section			
Leader	ONO, Masaji	2421	onomasaj
	TAMURA, Kenji	2520	ktamura
	ARAGAKI, Tazusa	2916	tazusa
	MURAKAMI, Yoshitaka	2254	ymura

(∗) Multiple roles

Atmospheric Environment Division			
Director	SASANO, Yasuhiro	2444	sasano
Deputy Director	NAKANE, Hideaki	2491	nakane
Independent Senior Researcher	MURANO, Kentaro	2537	murano
Atmospheric Physics Section			
Leader (∗)	NAKANE, Hideaki	2491	nakane
	EMORI, Seita		emori
	SUGATA, Seiji	2457	sugatas
	NOZAWA, Toru	2530	nozawa
	HIGURASHI, Akiko	2423	hakiko
	OGURA, Tomoo	2484	ogura
Atmospheric Chemical Reaction Section			
Leader	HATAKEYAMA, Shiro	2502	hatashir
	TAKAMI, Akinori	2509	takamia
	SATO, Kei	2414	kei
	INOMATA, Satoshi	2403	ino
	TANIMOTO, Hiroshi	2930	tanimoto
Atmospheric Remote Sensing Section			
Leader	SUGIMOTO, Nobuo	2459	nsugimot
	MATSUI, Ichiro	2526	i-matsui
	SHIMIZU, Atsushi	2489	shimizua
Atmospheric Measurement Section			
Leader	TOHJIMA, Yasunori	2485	tohjima
	UTIYAMA, Masahiro	2411	utiyama
	MACHIDA, Toshinobu	2525	tmachida
	TAKAHASHI, Yoshiyuki	2468	yoshiyu
Acid Deposition Research Team			
Leader	SATAKE, Kenichi	2447	ksatake
(∗)	TAKAMATSU, Takejirou	2469	takamatu
(∗)	NOHARA, Seiichi	2501	snohara
(∗)	HATAKEYAMA, Shiro	2502	hatashir
(∗)	MURANO, Kentaro	2537	murano
Water and Soil Environment Division			
Director	WATANABE, Masataka	2338	masawata
Deputy Director	OTSUBO, Kuninori	2417	kuninori
Water Quality Science Section			
Leader (∗)	WATANABE, Masataka	2338	masawata
	TOMIOKA, Noriko	2487	tomioka
	SYUTUBO, Kazuaki	2058	stubo
	URAKAWA, Hidetoshi	2119	urakawa
Soil Science Section			
Leader	TAKAMATSU, Takejirou	2469	takamatu
	MUKAI, Satoshi	2535	mukaisa
	HAYASHI, Seiji	2599	shayashi
	MURATA, Tomoyoshi	2413	tmurata
	KOSHIKAWA, Masami	2440	mkanao
Geotechnical Engineering Section			
Leader	INABA, Kazuho	2399	inabakz
	DOI, Taeko	2488	tdoi
Lake Environment Section			
Leader	IMAI, Akio	2405	aimai
	MATSUSHIGE, Kazuo	2527	matusige
Marine Environment Section			
Leader	HARASHIMA, Akira	2508	harashim
	NAKAMURA, Yasuo	2492	yasuo
Environmental Biology Division			
Director	WATANABE, Makoto	2555	mmw
Deputy Director	TSUBAKI, Yoshitaka	2482	tsubaki

(∗) Multiple roles

Ecosystem Function Study Section			
Leader	NOHARA, Seiichi	2501	snohara
	NATORI, Toshiki	2494	tnatori
	MIYASHITA, Mamoru	2534	miyasita
	SATAKE, Kiyoshi	2446	satanii
	YABE, Tohru	2533	yabet
Biodiversity and Phylogenetic Study Section			
Leader	KASAI, Fumie	2424	kasaif
	HIROKI, Mikiya	2513	hiroki-m
	UENO, Ryuhei	2408	uenor
	KAWACHI, Masanobu	2345	kawachi
Tropical Ecology Section			
Leader	OKUDA, Toshinori	2426	okuda
	TANG, Yanhong	2481	tangyh
Molecular Ecotoxicology Section			
Leader	SAJI, Hikaru	2445	hsaji
	KUBO, Akihiro	2435	kub
	AONO, Mitsuko	2391	maono
Climate Change Research Project			
Director (∗)	MORITA, Tsuneyuki	2541	t-morita
Deputy Director (∗)	INOUE, Gen	2402	inouegen
Carbon Cycle Research Team			
Leader	NOJIRI, Yukihiro	2499	nojiri
(∗)	MUKAI, Hitoshi	2536	lnmukaih
(∗)	TOHJIMA, Yasunori	2485	tohjima
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(∗)	TAKAHASHI, Yoshiyuki	2468	yoshiyu
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ADEOS-II	Advanced Earth Observing Satellite-II
AHS	aquatic humic substances
AlkB	alkane monooxygenase
AMS	accelerator mass spectrometry
BaS	bases
BCF	bioconcentration factor
CALUX	Chemical-Activated LU ciferase eXpression
CAS	Chemical Abstracts Service
CHD	catalytic hydro-dechlorination
Cl2O	catechol 1,2-dioxygenase
CTM	Chemical Transport Model
DE	diesel exhaust
DEP	diesel exhaust particles
DEP-OC	diesel exhaust particles of organic chemicals
DGGE	denaturing gradient gel electrophoresis
DMA	Dimethylarsinic Acid
DMI	direct material input
DOM	dissolved organic matter
DPO	domestic processed output
DSi	dissolved silicate
DSSAT	Decision Support System for Agro-technology Transfer
FPAR	Fraction of Photosynthetically Active Radiation Absorbed by Vegetation
GC/MS	Gas Chromatograph/Mass Spectrometer
GC-HRMS	gaschromatography-high resolution mass spectrometry
GCM	General Circulation Model
GC-MS	Gas Chromatography-Mass Spectrometry
GHG	Greenhouse Gas
GIS	geographical information system
HALOE	Halogen Occultation Experiment
HiA	hydrophilic acids
HiN	hydrophilic neutrals
HoN	hydrophobic neutrals
ICO	ILAS-II Initial Checkout
ILAS	Improved Limb Atmospheric Spectrometer
ILAS-II	Improved Limb Atmospheric Spectrometer-II
IOA	economic input-output analysis
IPCC	Intergovernmental Panel on Climate Change
IRMS	isotope ratio mass spectrometry
LAI	Leaf Area Index
LAN	Local Area Network
LC/MS	iquid chromatography-mass spectrometry
LCA	life cycle assessment
LC-ICPMS	liquid chromatography-inductively couped plasma mass spectrometry
lidar	light detection and ranging
MAP	magnesium ammonium phosphate
MFA	material flow accounting/analysis
MHP	magnesium hydrogen phosphate
MMA	Monomethylarsonic Acid
MODIS	Moderate resolution Imaging Spectrometer
MOE	Ministry of the Environment
MSW	municipal solid waste
MUE	material use efficiency
MUT	material use time
NDSC	Network for the Detection of Stratospheric Change
OECD	Organization for Economic Co-operation and Development
PBDEs	polybrominated biphenyl ethers
PCBs	polychlorinated biphenyls
PCD	Photochemical dechlorination
PCDDs	polychlorinated-p-dibenzodioxins
PCDFs	polychlorinated-p-dibenzofurans
PEC/PNEC	predicted environmental concentration/predicted no-effect concentration
PIV	particulate image velocimetry
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 microns
POAM II	Polar Ozone and Aerosol Measurement II
POPs	persistant organic pollutants
RRUP	recovery rate of used product
SAGE II	Stratospheric Aerosol and Gas Experiment II
SNP	Single Nucleotide Polymorphism
TEOM	tapered element oscillating microbalance
TG	Test Guideline
THMFP	The trihalomethane formation potential
UNEP	United Nations Environment Programme
URRUP	use rate of recovered used products
VOCs	volatile organic compounds
WAN	Wide Area Network
WWW	World Wide Web
XAFS	X-ray absorption fine structure
XPS	X-ray photoselection spectrometry
XRF	X-ray fluorescence

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