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NIES Annual Report 2006

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National Institute for Environmental Studies
http://www.nies.go.jp/

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Foreword

This annual report is an official record of research activities at the National Institute for Environmental Studies (NIES) for the 2005 fiscal year (April 2005 to March 2006). This year concluded our first five-year research plan as an independent administrative institution.

Throughout the year, we worked to reach the goals of research projects which covered a wide range of environmental issues at the local, national, and global levels. We received an "A" grading from the External Evaluation Committee on our six special priority research projects and all other research activities carried out by the six research divisions, two policy-response research centers, and three centers for research fundamentals. In addition, our contribution to Japanese and international environmental policy-making met with success. These achievements must be attributed to the strenuous efforts of our staff in collaboration with our colleagues in Japan and other countries.

We devoted a great deal of time to the preparation of our second five-year (2006-2010) research plan in cooperation with the Ministry of the Environment. In this new plan, we gave particular focus to solving/mitigating serious environmental problems and upgrading our research capabilities. We designated four topics as priority programs: climate change, sustainable material cycles, environmental risk, and the Asian environment. About half of the NIES researchers are involved in these programs, while the other half are implementing fundamental research in our six research divisions (Social and Environmental Systems, Environmental Chemistry, Environmental Health Sciences, Atmospheric Environment, Water and Soil Environment, and Environmental Biology) and the Laboratory of Intellectual Fundamentals for Environmental Studies.

It is my sincere hope that the readers of this report will maintain an interest in our activities and offer comments and suggestions on our efforts, which we consider to be most helpful in advancing our work.

Ryutaro Ohtsuka, D.Sc.
President,
National Institute for Environmental Studies

Contents

During the 1950s and 1960s, Japan experienced serious environmental pollution problems that accompanied rapid economic growth. In 1971, the Environment Agency was established within the Japanese government to develop measures to counteract serious environmental pollution problems such as Minamata disease, caused by poisoning from organic mercury in factory wastewater, and chronic bronchitis and asthma, caused by sulfur oxides emitted from factories in large industrial complexes. In 1974, based on the understanding that research on environmental sciences was necessary and that it had the potential to address public needs, the Environment Agency established the National Institute for Environmental Studies (NIES) in Tsukuba Science City, about 50km north of Tokyo. NIES is now the primary national institute for comprehensive research in environmental science in Japan.

During the two decades following the establishment of NIES, rapid technological progress, structural changes in industry, and lifestyle changes created additional issues for environmental science to confront. Moreover, global environmental problems such as climate change, the depletion of the stratospheric ozone layer, acid deposition, destruction of tropical rain forests, and desertification became a more prominent concern worldwide.

NIES underwent a major reorganization in 1990 to enable it to conduct more intensive research on conservation of the natural environment and global environmental changes and their effects. The new structure included two research project divisions, six fundamental research divisions, and the Center for Global Environmental Research. In addition, the Environmental Information Center was given the task of providing access to research publications and environment-related databases.

In January 2001, the Environment Agency became the Ministry of the Environment as a part of structural changes within the Japanese government. At the same time, NIES established a Waste Management Research Division.

In April 2001, NIES became an independent administrative institution, giving it a degree of independence from the national government. The change from government institute to independent status allowed more flexibility in operations, thus enabling the institute to respond with more agility to the demands of society. At the same time, NIES prepared a five-year (2001-2005) plan that corresponded to the objectives of the Ministry of the Environment.

In 2005, the final year of the first five-year plan, NIES researchers focused on concluding the research goals they set out in the plan. From 2006, NIES will embark on its second five-year (2006-2010) plan and, in collaboration with many institutions in Japan and abroad, it will continue to engage in scientific research on environmental issues including climate change, sustainable material cycles, environmental risk, and the Asian environment.

Researchers at NIES are skilled in various fields, such as physics, chemistry, biology, health sciences, engineering, agricultural and fisheries sciences, law, and economics. Interdisciplinary studies are also carried out, particularly in the context of major

research projects. NIES has various types of experimental facilities and remote research stations such as the Lake Kasumigaura Water Research Laboratory, the Oku-Nikko Field Research Station, and the Global Environmental Monitoring Stations in Hateruma and Cape Ochi-ishi.

As of the end of the 2005 fiscal year, the total number of NIES regular permanent staff was 263 (including 6 foreign researchers). There were also 656 non-permanent researchers including 62 foreign researchers. The total budget for FY 2005 was 14,129 million yen.

Table 1 Number of Permanent Staff

(As of March 31, 2006)

Researchers	206	78.3%
Administrative & Management	46	17.5%
Environmental Information Center	11	4.2%
Total	263	100%

Table 2 Budget for Medium-Term Plan of NIES

(Unit: million yen)

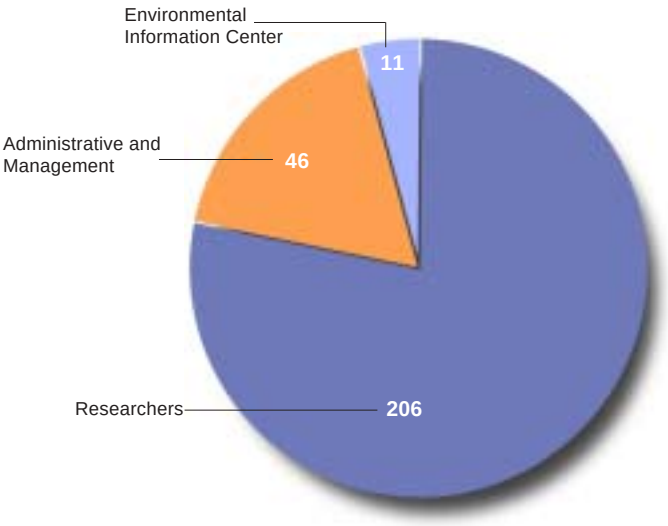
	Category	5-years Plan (2001-05)	FY 2005
Revenues	Grant for Operating Costs	48,849	9,254
	Subsidies for Facilities	3,093	415
	Loan without Interest	1,850	615
	Commissioned Work	17,576	3,845
	Total	71,368	14,129
Expenditures	Project Costs	31,873	5,863
	for Special Priority Research Projects	7,050	606
	for Policy-Response Research Areas	4,109	578
	for Environmental Information	2,132	358
	Facility Improvements	3,709	415
	Expenses for Commissioned Work	17,576	3,845
	Personnel Expenses	14,545	2,928
	Redemption Expenses	1,234	615
	General Administrative Expenses	2,431	463
	Total	71,368	14,129

Note: The budget for each annual work plan will be requested and decided each fiscal year, based on the Medium-Term Plan (5-year plan).

Human Resources

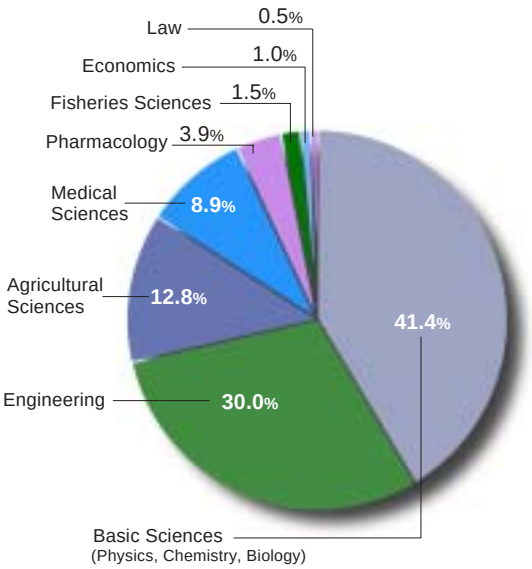
Number of Permanent Staff

263(6)



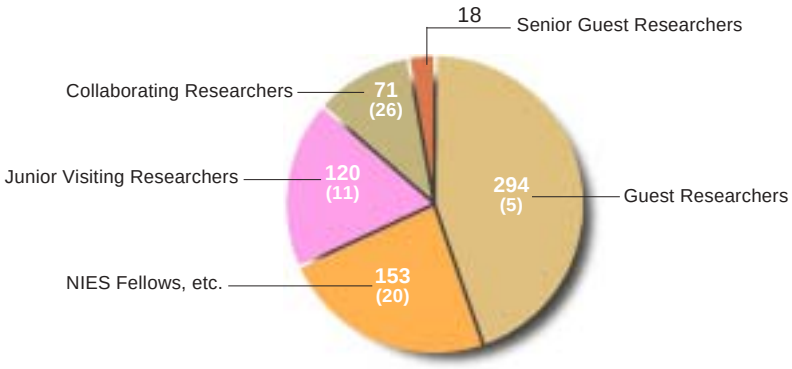
Fields of Expertise

Researchers holding doctorates
92.6%



Number of Non-Permanent Researchers

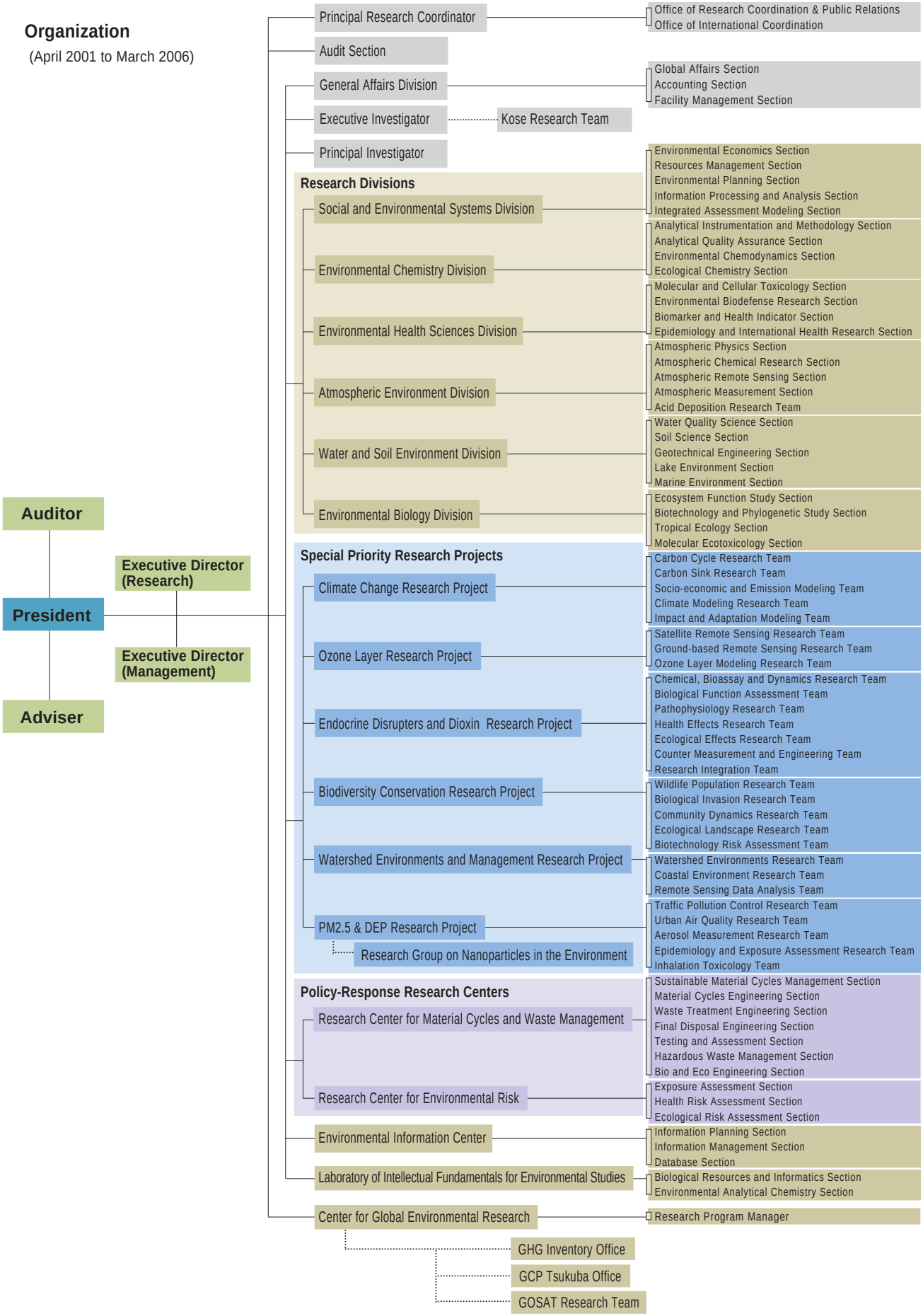
656(62)



Notes: 1.Data is as of March 31, 2006.
2.Figures in parentheses indicate number of foreign researchers.

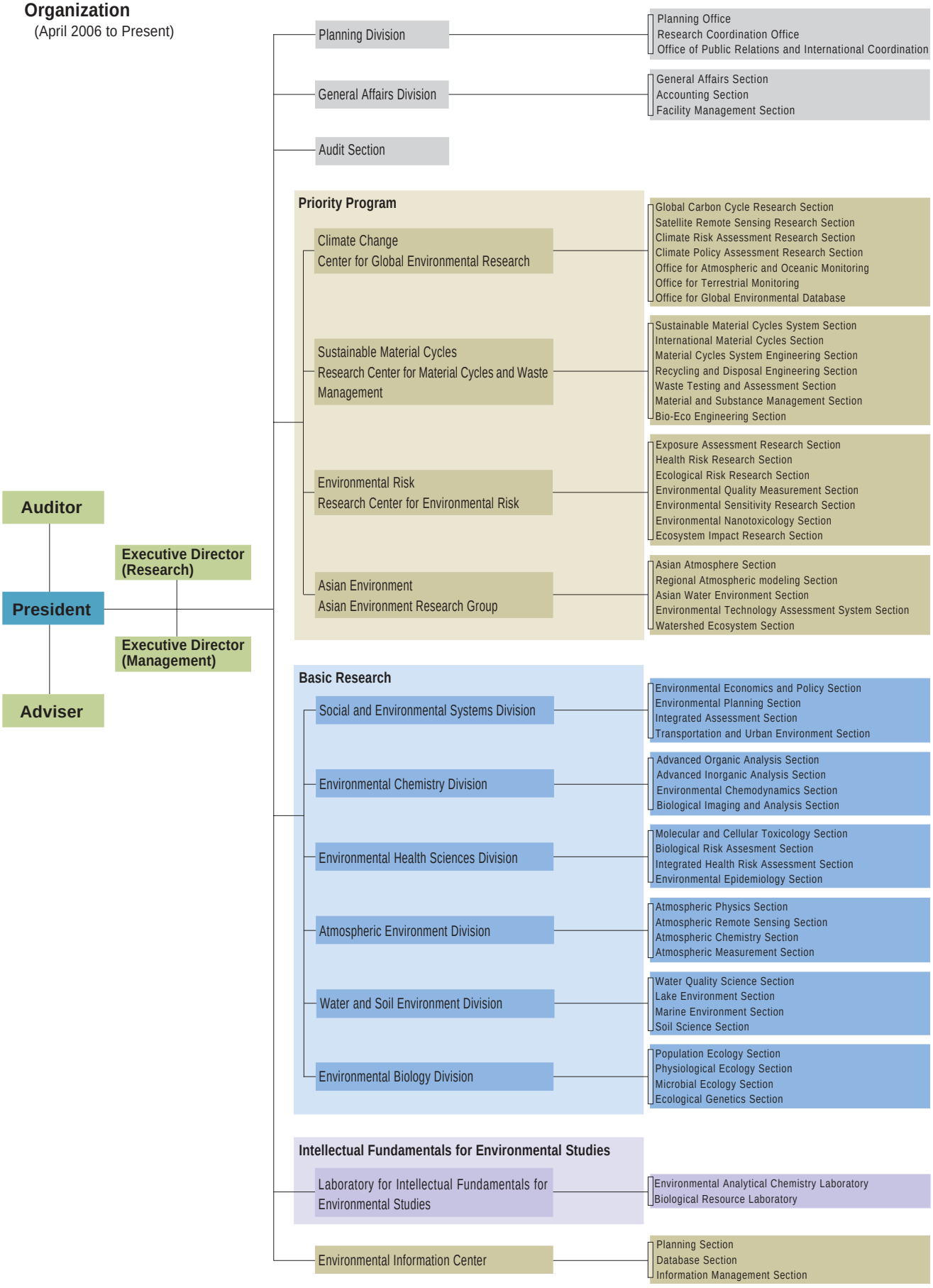
Organization

(April 2001 to March 2006)



Organization

(April 2006 to Present)

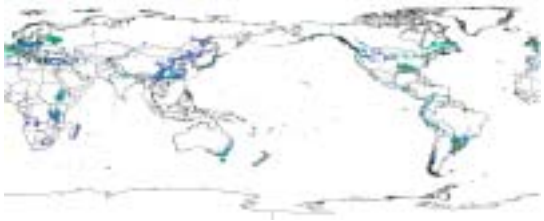


Climate Change Research Project

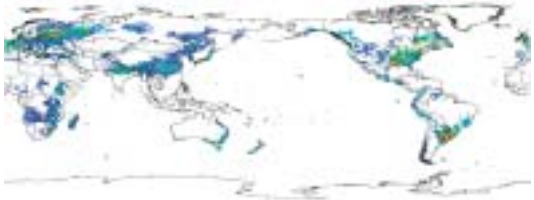
Aircraft with GHG-measuring instruments onboard

Measuring equipment installed on the aircraft

(A) Potential productivity of wheat in 2000



(B1) Potential productivity of wheat in 2050
(No adaptation case)



(B2) Potential productivity of wheat in 2050
(Adaptation case)

Background and objectives

Nowadays, it is widely known that we have changed, and will continue to change, the Earth's climate system by GHG (Greenhouse Gas) emissions through fossil fuel consumption and by deforestation. Analysis of the carbon cycle between the atmosphere, biosphere, and ocean is one of the key approaches predicting future GHG concentrations and developing strategies to stabilize GHG concentrations in the atmosphere. Another approach is joint model studies that involve the prediction of climate change under different emission scenarios, the assessment of impacts on the basis of these predictions, and socioeconomic analyses to identify the most effective strategy for a sustainable society.

Sub-project on carbon cycle research

Two research teams involved in this sub-project are the **Carbon Cycle Research Team** and the **Carbon Sink Assessment Team**. The research activities of the Carbon Cycle Research Team cover regional and global observation of GHGs and related geochemical processes. The development of a novel technology for GHG observation is one of the key matters needed to clarify the geochemical processes of GHGs in the global environment. The target of the Carbon Sink Assessment Team is to accurately evaluate the terrestrial carbon sink by a remote sensing approach and an ecosystem modeling approach.

Frequent measurements of atmospheric CO_2 and trace species using commercial airlines

A research project started in 2003 to measure CO_2 and other trace species in the upper air with a high sampling frequency and wide coverage, using commercial airliners. We developed continuous CO_2 measurement equipment (CME) and improved automatic air sampling equipment (ASE) for commercial aircraft operated by Japan Airlines. The CME consists of a single-cell NDIR (non-dispersive infrared CO_2 analyzer), flow controller, pressure controller, pump, drier, data logger, and two high-pressure cylinders for standard gas. The air sample is taken from the air-conditioning duct upstream of the recirculation fan. The ASE has twelve 1.7-L titanium flasks, each equipped with two solenoid valves at both ends. The small onboard computer operates valves at a preset latitude, longitude, or altitude, and records flight data. The air samples are later analyzed for CO_2, CH_4, CO, N_2O, H_2, SF_6 mixing ratios, and the stable isotope ratio of CO_2.

A Supplemental Type Certificate (STC) to install CME and ASE was issued by the United States Federal Aviation Administration and the Japan Civil Aviation Bureau in October 2005. The first series of observations, by a Boeing 747-400, was carried out in November 2005 on the routes to Bangkok, Jakarta, and Beijing from Narita. Figure 1 shows the vertical distributions of the CO_2 mixing ratio over Narita, as measured by CME. Except in the contaminated air near the surface, the CO_2 data show slightly higher mixing ratios at lower altitudes, a reasonable structure for late autumn in the northern mid-latitudes. The tight reproducibility of each profile indicated the high reliability of CO_2 measurement by the CME onboard the commercial aircraft.

CMEs are planned to be installed on two Boeing 747-400 aircraft and three Boeing 777-200 aircraft. Initially, the aircraft will fly mainly to South East Asia and East Asia with a frequency of 60 to 70 times per month. Another 50 to 60 flights will head to Europe, North America, the Pacific, and Australia. Routine air sampling by improved ASE will be done twice a month between Japan and Australia.

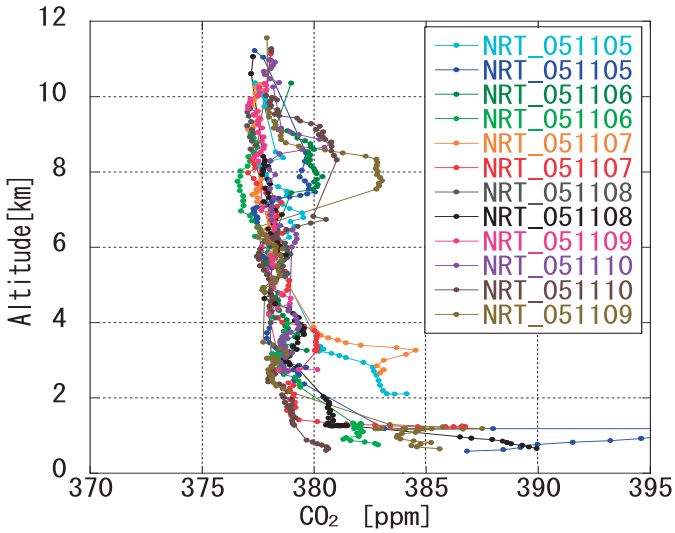


Fig. 1
Vertical distributions of CO_2 mixing ratio over Narita (NRT).

Remote sensing approach to monitor the amount of CO_2 absorption

When we evaluate the amount of carbon absorbed by a forest, the most important information is that which pertains to the photosynthetic activity of forest vegetation. In recent years, the use of the PRI (photochemical reflectance index) to reflect xanthophyll cycle activity and light-use efficiency in photosynthesis in a leaf has been proposed. PRI is used as an index to estimate photosynthetic activity on a time scale much shorter than that of the NDVI (normalized difference vegetation index). The PRI calculation is based on a partial light reflex (wavelengths 531 nm and 570 nm). In this research, we investigated the relationship between PRI and photosynthetic activity in larch trees from summer to autumn as part of a study of the feasibility of putting remote sensing to practical use for monitoring the amount of CO_2 absorption in boreal forests. Moreover, since it has become clear that these changes are related to the seasons, we expect that applying the PRI data collected by remote sensing to process models will help estimate seasonal changes in the amount of photosynthesis.

Ecosystem modeling approach to estimate total absorption of CO_2 in forest

A terrestrial eco-system model of carbon stock changes was developed using various measurements of biomass and photosynthesis in Japan. The dynamics of litter and soil carbon were also calculated by inputting the age structure of forests into the ecosystem model. The change of total absorption of CO_2 in forests resulting from

changes in human activities was also estimated by using the ecosystem model. The ecosystem model was then applied to a variety of tree species in various areas by assimilating the inventory data of forests in Japan into the model. This carbon sink model can be used as a "full carbon accounting" system, which will be useful as a carbon sink accounting method in the second commitment period of the Kyoto Protocol. Using the carbon sink model, we were able to develop a land-use change model to estimate the carbon fluctuation induced by human activity. In this model, global distributions of land cover, population, net primary production, and vegetation type are used as input data, and terrestrial carbon management potential is estimated. Although there are many economic land-use change models, this approach is unique, as it uses real spatial information on ecosystem and land cover obtained from satellite remote sensing. Moreover, the model is integrated as a geographic information system for assessing carbon sinks at both national and global scales.

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

This sub-project aims to address new policy needs arising from the Kyoto Protocol and post-Kyoto negotiations, and to assess 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 the impact of growth on the environment. These models will then be used to help estimate the effects of the Kyoto Protocol as well as long-term intervention scenarios 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 for climate change mitigation under alternative paths of future development.

The three research teams involved in this sub-project—the Climate Modeling Team, the Impact and Adaptation Modeling Team, and the Socioeconomic and Emission Modeling Team—achieved the following outcomes in FY 2005.

The **Climate Modeling Team** analyzed climate change simulations for the 20th and 21st centuries. These simulations were conducted in collaboration with the Center for Climate System Research (CCSR) at the University of Tokyo and the Frontier Research Center for Global Change (FRCGC) at the Japan Agency for Marine-Earth Science and Technology. To investigate the uncertainty of climate sensitivity, two versions of a coupled atmosphere–ocean general circulation model with different climate sensitivities were tested on global cooling following the Pinatubo volcanic eruption. The higher-sensitivity version, with climate sensitivity of 6.3K for doubled CO_2 forcing, overestimated the cooling due to the volcanic eruption, whereas the lower-sensitivity version (4.0K) produced results consistent with the observations (Fig. 2). We devised a simple scheme for climate feedback analysis, and we found that the difference between the two versions was attributable to cloud-albedo feedback. This validation method is expected to provide additional constraints on climate sensitivity and will possibly lead to reduced uncertainty in climate prediction.

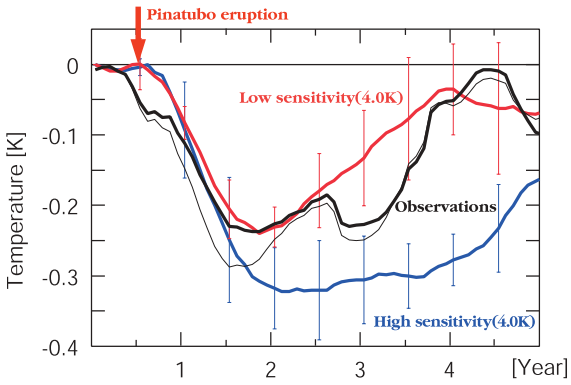


Fig. 2
Anomaly time series of global mean surface air temperature after the Pinatubo volcanic eruption.

The **Impact and Adaptation Modeling Team** developed a tool for analyzing long-term climate stabilization targets. The tool integrates scientific knowledge of potential climate change impacts on sensitive sectors and knowledge of GHG reduction paths for achieving prescribed stabilization targets (AIM/Impact [Policy]). Figure 3 shows (a) GHG concentrations and (b) GHG emission paths for achieving GHG concentration stabilization targets (BaU = SRES-B2; GHG-475 ppm /550 ppm =GHG concentration does not exceed 475 ppm- CO_2 eq / 550 ppm- CO_2 eq), and consequent (c) global mean temperature increase, (d) sea level rise, (e) rice productivity change in India, and (f) wheat productivity change in India. As a result of application of the model, we found that the atmospheric GHG concentration needs to be stabilized at a level lower than 475 ppm- CO_2 eq to maintain a global mean temperature increase of less than 2.0 °C above the pre-industrial level. This necessitates reducing GHG emissions markedly in the near future. However, even if we achieve this tough target, we cannot avoid serious impacts in some sectors and countries. Adaptation measures as well as mitigation measures will need to be applied effectively if we are to avoid serious impacts.

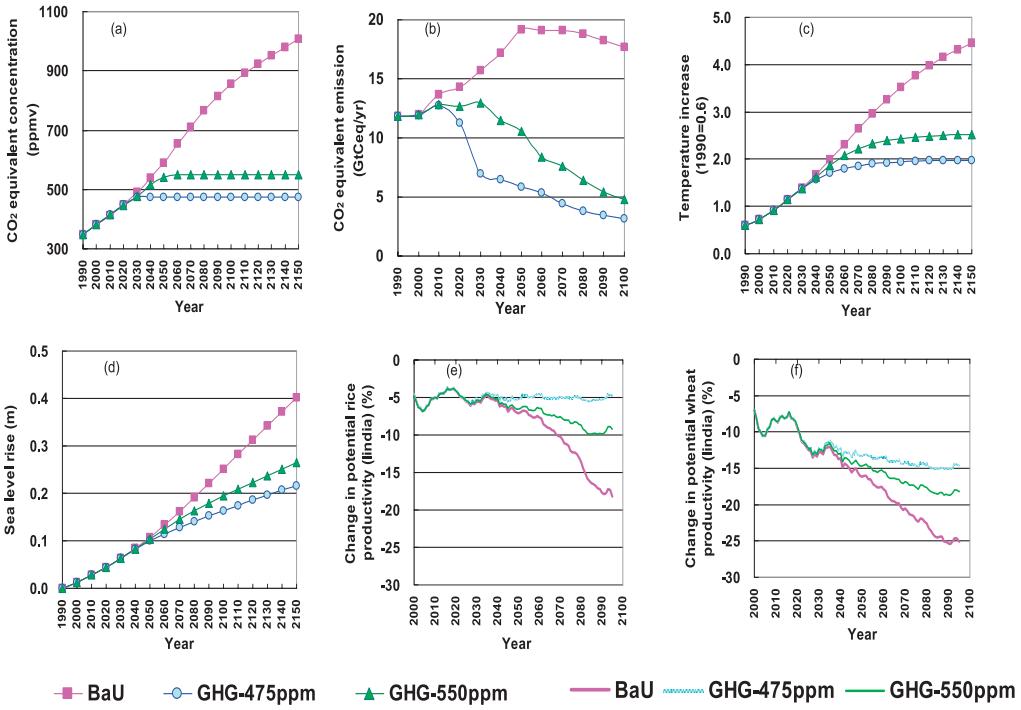


Fig. 3
Results of AIM/Impact [Policy] application.

The **Socioeconomic and Emission Modeling Team** used emission models for GHGs and air pollutants for scenario and policy analyses in Japan, China, India, Korea, Thailand, Indonesia, and Vietnam. Scenarios for reduction of GHG emissions in Japan through 2050 were developed by using various models on population, building, transportation demand, and so on.

The AIM/Enduse Global model has been developed to estimate global GHG reduction potentials. AIM/Enduse Global can estimate marginal abatement cost and redction potentials; for example, Figure 4 shows the marginal abatement cost curves in an F-gas (fluorinated gas) emission sector. This result shown in Figure 4 and our previous results on marginal abatement costs and reduction potentials of CO_2 are extremely useful for prioritizing investments and other policies for supporting desired technology options.

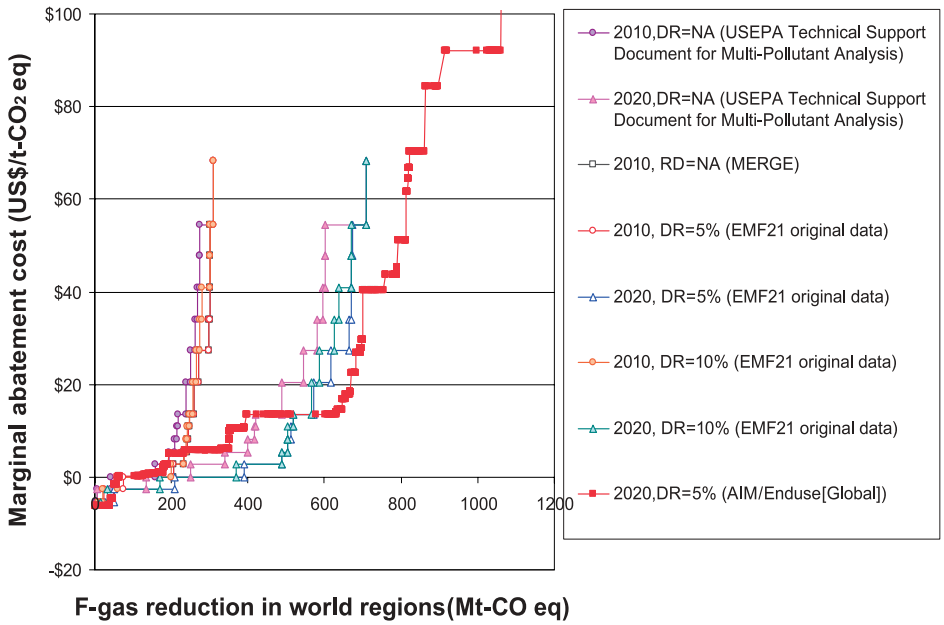
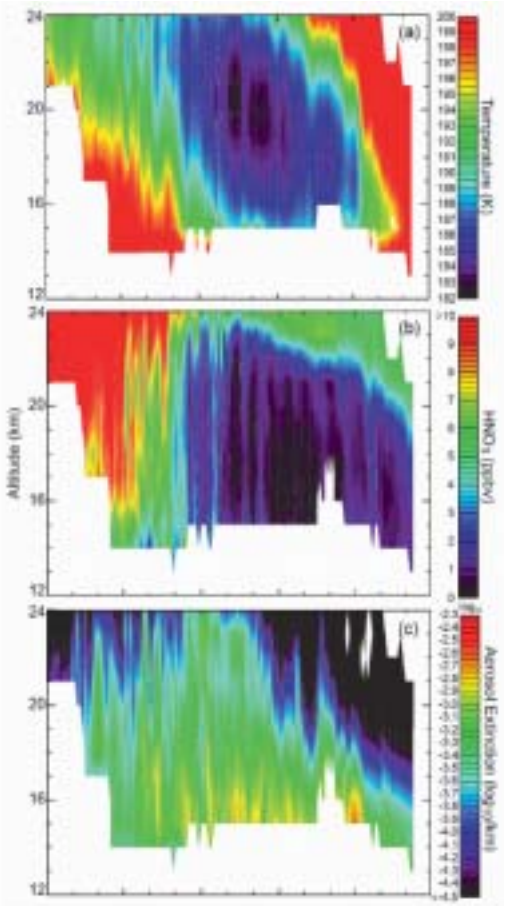


Fig. 4
Marginal abatement cost and reduction potential of F-gas: comparison of simulation results with other results.

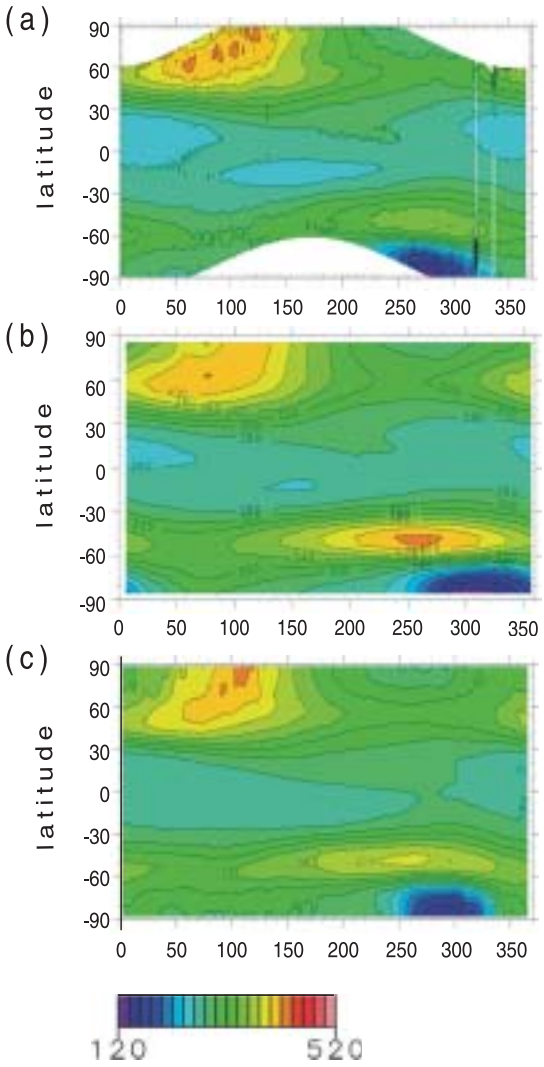
The global dynamic optimization model, which includes the technology change induced by climate policy to stabilize CO_2 concentration, has been developed to quantify the energy-saving investment under various CO_2 concentration targets.

We updated an integrated top-down and bottom-up model and used it to simulate carbon tax policy in Japan. In 2005, the Ministry of the Environment proposed a carbon tax (2400 JPY/t C) to reduce CO_2 emissions. We assessed CO_2 reduction by this policy, and its economic impact, by using both the AIM/Enduse and AIM/Material models for Japan. This tax policy could reduce CO_2 emissions in Japan during the first Kyoto commitment period by about 9 Mt compared with the reference case. The GDP loss during the first commitment period could be about 0.041% compared with that in the reference case.

Ozone Layer Research Project



Time-height cross-sections of (a) daily mean temperature data at ILAS-II measurement locations, (b) daily mean ILAS-II HNO_3, and (c) daily mean values of ILAS-II aerosol extinction coefficient data in the Southern Hemisphere.



Time-latitude cross-section of zonal mean column ozone: (a) observed by TOMS; and calculated by (b) the old and (c) new versions of the chemical climate model.

Background and Purpose

Thanks to the regulation of ozone-depleting substances such as chlorofluorocarbons and bromofluorocarbons, the stratospheric abundance of organic chlorine and bromine compounds appears to have started to decrease. Stratospheric concentrations of halogens (chlorine and bromine) are expected to return to 1980s levels during the middle of this century. Nevertheless, the Antarctic ozone hole still appears to be growing larger, 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 from chlorine content alone. Continuous monitoring of the stratospheric ozone layer is required to explore how the ozone layer is changing in response to the decreasing concentrations of halogens 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.

The state of the stratospheric ozone layer over both poles (high-latitude regions) is strongly related to the occurrence of polar stratospheric cloud (PSC) particles and aerosols, as well as to the strength of the polar vortex. Polar ozone concentrations are influenced by these ozone-depleting factors through the direct and indirect effects of chlorine and bromine compounds and nitrogen oxides on ozone layer chemistry. To predict future changes in the polar ozone layer, we need to conduct detailed observations to gain an understanding of the detailed chemical and physical processes in the polar regions, including the mechanisms of PSC formation. Using satellite-borne sensors, we monitored stratospheric ozone and species relevant to ozone layer destruction in the high-latitude regions. The stratospheric ozone layer over the mid-latitudes is also 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 in the mid-latitudes by using ground-based remote-sensing equipment. We have gathered data from both inside and outside Japan to help monitor and identify mechanisms of change in the ozone layer. As part of this project we are also conducting data analysis and numerical modeling to accumulate scientific knowledge on mechanisms of change in the ozone layer, thus contributing to the prediction and validation of future ozone layer changes.

Objectives

The five main objectives of this project are: 1) provision of validated Improved Limb Atmospheric Spectrometer (ILAS) data products to the scientific community; 2) data processing and validation of ILAS-II observations; 3) continued ground-based ozone layer monitoring at Tsukuba (NIES) and Rikubetsu (Rikubetsu Integrated Stratospheric Observation Center, Hokkaido) for registration of the data obtained in the Network for Detection of Stratospheric Change (NDSC) international database; 4) identification of the roles 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 2005

1. Data processing and validation of ILAS-II observation

ILAS-II was launched on board the Advanced Earth Observing Satellite (ADEOS)-II on 14 December 2002. It was pre-operational between January and early April 2003, and then operational by the time ADEOS-II ceased operation on 24 October 2003 as a result of failure of the satellite's power supply. During these periods, ILAS-II obtained 5890 observations, ranging in latitude from 54°N to 71°N and from 64°S to 88°S, depending on the season. Measurements were made 14 times about every 24 h at sunrise, as seen from the satellite in the Northern Hemisphere, and at sunset, as seen from the satellite in the Southern Hemisphere. Vertical profiles of atmospheric constituents, such as ozone, nitric acid, nitrogen dioxide, methane, nitrous oxide, and water vapor, were processed from the spectral data by using the ILAS-II retrieval algorithm Version 1.4. Aerosol extinction coefficients were observed at a wavelength of 780 nm and at the wavelengths of four infrared window spectral elements. Temperature and pressure profiles were also observed. Here, the results for methane (CH_4) are described as an example of validation analysis of ILAS-II data. The quality of ILAS-II version 1.4 CH_4 data was compared with the results obtained from the HALOE (Halogen Occult Experiment) onboard the Upper Atmosphere Research Satellite in the Southern Hemisphere and to the results obtained from balloon-borne instruments, Michelson Interferometer for Passive Atmospheric Sounding Balloon-borne version (MIPAS-B) and Mark-IV Fourier Transform Infrared Interferometer (MkIV), and HALOE in the Northern Hemisphere. A comparison of the vertical profiles of ILAS-II CH_4 with HALOE data in the Southern Hemisphere is shown in Figure 1. The ILAS-II data agreed well with the HALOE data below 30 km, and although the ILAS-II CH_4 values were larger than the HALOE ones above 30 km, they were still in agreement within the combined error bars. The accuracy of the ILAS-II CH_4 volume mixing ratio (VMR) was estimated to be about 9%. In the Northern Hemisphere, the ILAS-II CH_4 profile was in good agreement with the MkIV data below 19 km, where MkIV data are available. Although the ILAS-II data also agreed well with the MIPAS-B and HALOE data when the VMR of CH_4 was higher than 1 ppmv, ILAS- II CH_4 were significantly smaller than the reference data when the VMR of CH_4 was lower than 1 ppmv. In summary, the ILAS-II Version 1.4 data quality for CH_4 when the CH_4 VMR is 1 to 1.6 ppmv in the Northern Hemisphere and 0.3 to 1.4 ppmv in the Southern Hemisphere (with the exception of the CH_4 values when the N_2O VMR ranged 30-100 ppb is sufficient for most scientific purposes such as studies of polar stratospheric phenomena.

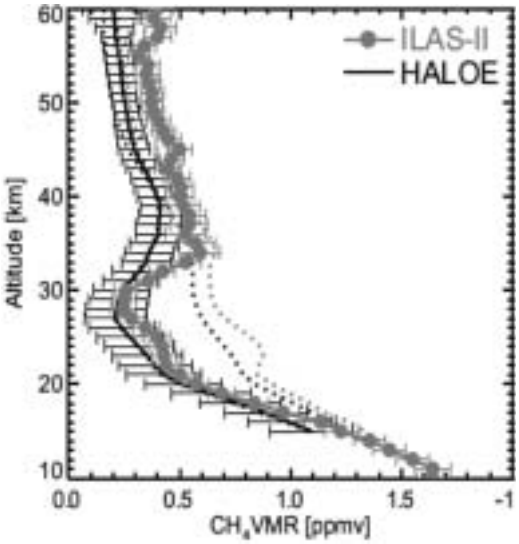


Fig.1
Vertical profiles of ILAS-II Version 1.4 CH_4 and HALOE Version 19 data in the Southern Hemisphere.

2. Variation in polar stratospheric cloud occurrence observed by ILAS-II over the Antarctic in 2003

ILAS-II observed polar stratospheric clouds (PSCs) in the Southern hemisphere throughout the southern winter of 2003. ILAS-II simultaneously observed the aerosol extinction coefficient at a wavelength of 780 nm, nitric acid, and water vapor, making it possible to investigate the ambient thermodynamic conditions of the observed PSCs. We defined two probabilities of PSC formation: the frequency of PSC occurrence (P_{PSC}) and the probability of the temperature at ILAS-II measurement locations being colder than the nitric acid trihydrate (NAT) saturation temperature, TNAT ($P_{T(NAT)}$). If the PSC is formed when the temperature is lower than TNAT and the temperature is the only the factor determining PSC formation, then the behavior of P_{PSC} is expected to be same as that of $P_{T(NAT)}$. Figure 2a shows time-series plots of the daily mean temperature (blue) and PPSC (dashed black) at 20 km. The daily mean gaseous nitric acid concentration and $P_{T(NAT)}$ are also shown in the figure by the red line and the dashed green line, respectively. The P_{PSC} values increased obviously from late July through August, reaching values as high as about 80%. P_{PSC} and $P_{T(NAT)}$ were mostly well correlated, which means that PSCs existed at about 20 km with a high probability when temperatures were sufficiently below T_{NAT}. Figure 2b shows time-series plots of temperature, P_{PSC}, nitric acid concentration, and $P_{T(NAT)}$ at 22 km. It is clear that, from late August to early September, P_{PSC} was low even when $P_{T(NAT)}$ was high. This would be due to the cleansing of aerosols; i.e., the concentrations of background aerosol particles are reduced in the ozone hole. The frequency of PSC occurrence may depend on the degree of denitrification and/or the concentrations of background aerosols that can act as nuclei for PSCs. Therefore, T_{NAT} is not always a good indicator of the occurrence of PSCs, especially at altitudes above 20 km in late winter.

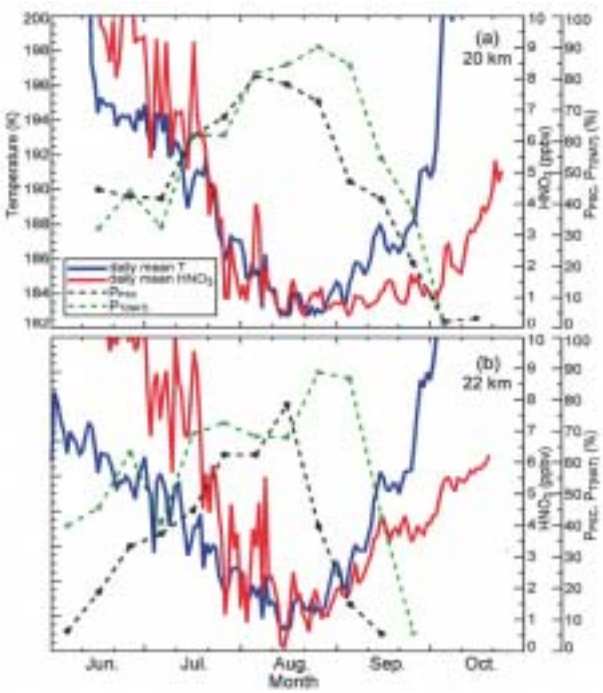


Fig.2
Time-series plots of daily mean temperature (solid blue line), daily mean nitric acid concentration (solid red line), P_{PSC} (dashed black line), and $P_{T(NAT)}$ (dashed green line) inside the polar vortex.

3. Improvement of stratospheric chemical climate model

To investigate future changes in the ozone layer, we have been improving our stratospheric chemical climate model (CCM), which is an on-line, three-dimensional stratospheric model with fully interactive chemistry, based on the framework of the Center for Climate System Research (CCSR) and NIES Atmospheric General Circulation Model (AGCM). In the chemical module, we included heterogeneous reactions on supercooled ternary solution, along with reactions on NAT and ice. We also included gaseous and heterogeneous reactions related to bromine species, as well as chlorine chemistry. To accurately estimate photolysis rates in the polar stratosphere, we incorporated the effects of atmospheric sphericity into the plane-parallel radiative transfer scheme. The horizontal resolution of the model was improved from T21 to T42 resolution (longitude × latitude about 2.8° × 2.8°). Furthermore, we performed gravity wave parameterization in order to include the effects of dynamics that are not resolved with the T42 model.

To validate the new version of the CCM, we compared the time-latitude cross-section of the zonal mean column ozone calculated by the new CCM (Fig. 3c) with the one observed by TOMS (Total Ozone Mapping Spectrometer) (Fig. 3a). The result obtained with the old version of the CCM is also shown (Fig. 3b). Whereas the old CCM version shows a delayed appearance of the Antarctic ozone hole, the new version reasonably reproduces the observed timing of ozone hole formation. Furthermore, the amount of ozone in the southern mid-latitudes is overestimated to a lesser extent with the new version than with the old version. The cold temperature bias in the winter polar lower stratosphere is also improved, with a zonal mean minimum temperature of 180 K. The future evolution of the ozone layer is now being calculated by the new model.

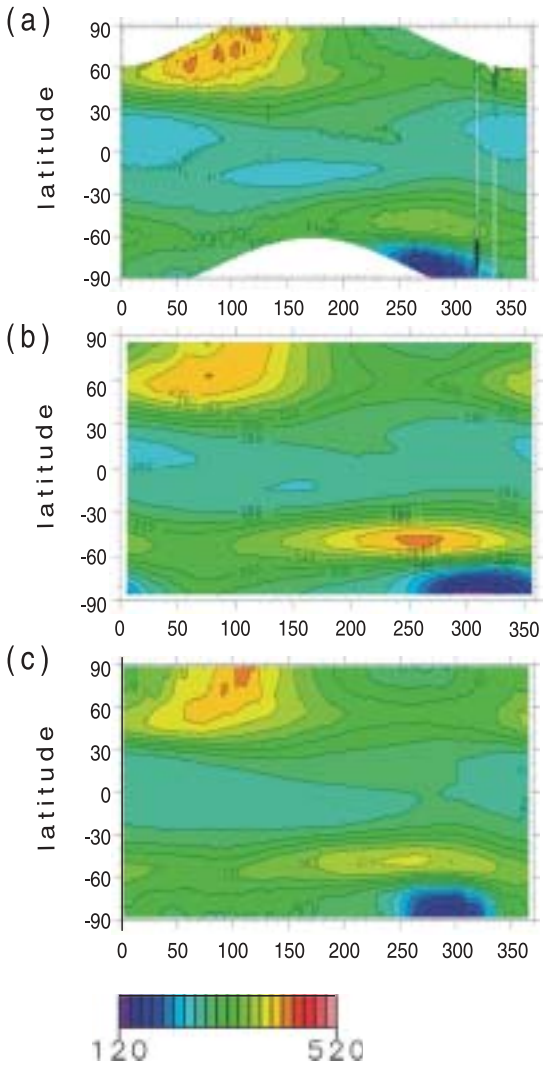


Fig.3
Time-latitude cross-sections of zonal mean column ozone: (a) observed by TOMS; and calculated by (b) the old and (c) new versions of the chemical climate model.

Endocrine Disrupters and Dioxin Research Project

「Photo:N. Tatarazako」

Daphnia magna as a test species for endocrine disrupting chemicals in crustaceans.

The work of the Endocrine Disrupters and Dioxins Research Project 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 effect assessments; and 4) development of countermeasures and integrated information technologies. In FY 2005, we made major advancements in the following areas.

1) Agonist activities of 91 monohydroxylated-PCBs to retinoid X receptor (RXR) were measured by yeast two-hybrid assay. The hydroxylated PCBs included three mono-, six di-, 33 tri-, 16 penta-, and two hexa-chlorinated compounds. Thirty-seven were *ortho*- phenols, 24 were *meta*-, and 30 were *para*-. Twenty compounds had measurable activity, with the most active compound having 5.6% of the activity of 9-*cis*-retinoic acid itself. Thirteen of the active compounds, including the eight most active, were *ortho*-phenols; four were *meta*-phenols, and only three were *para*-phenols. For the *ortho*-phenols, it appeared that a chorine substituent *para*- to the hydroxyl group in the phenol ring favored activity, whereas a chlorine *ortho*- to the hydroxyl group diminished the likelihood of activity. All of the active compounds had 0 or 1 *ortho*- (waist) chlorine atoms, despite their likelihood of activity; the degree of chlorination of the non-phenol ring varied from 0 to 4 chlorines. It thus appeared that specific features of the hydroxylated PCBs rendered them active in this assay, but it was difficult to relate the properties conferred by these features to the structure of the 9-*cis* retinoic acid molecule itself.

2) On the basis of the results obtained in our laboratory, in April 2004 Japan proposed the enhancement of OECD Test Guideline (TG) 211, "*Daphnia magna* Reproduction Test", as a screening method for endocrine-disrupting chemicals in crustaceans. The revised TG 211 (Fig. 1) includes new endpoints, such as the offspring sex ratio, and can be used to identify chemicals with juvenile hormone-like effects on crustaceans. In 2005, reproductive toxicity tests were conducted on seven strains of *Daphnia magna* from six laboratories in five countries as a pre-validation test. Results of the tests suggest that induction of male sex in neonates by a juvenile hormone analog is universal among genetically different strains. As a leading laboratory, we are now preparing for the ring-test validation tests, with the participation of 12 laboratories around the world.

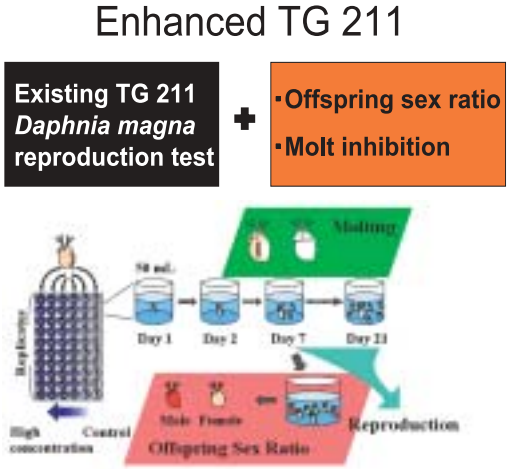


Fig. 1
Enhanced TG 211: "*Daphnia magna* Reproduction Test" as a screening method for endocrine-disrupting chemicals in crustaceans.

3) In the chain of study to clarify the physiological role of the *RXR* on the development of imposex caused by organotin compounds in gastropods, we used real time RT-PCR to analyze *RXR* gene expression in various tissues (ctenidium, testis or ovary, digestive gland, penis or penis-forming area, and head ganglia) of male or female rock shells (*Thais clavigera*) exposed to 500 ng/L of triphenyltin chloride (TPT) via a flow-through exposure system for 1 month. Significant induction of *RXR* gene expression was observed in the ovary (6.0 times higher than in control females; $p < 0.01$) and head ganglia (3.1 times higher; $p < 0.01$) among all the tissues analyzed in female rock shells exposed to TPT; the incidence of imposex was 62.5%. Although no significant differences in *RXR* gene expression were observed in the penis-forming area, ctenidium, or digestive gland between control and TPT-exposed females, markedly high induction was observed in the penis-forming area of those females exposed to TPT that were exhibiting the initial stage of imposex. No significant induction of *RXR* gene expression was observed among any analyzed tissues of the males exposed to TPT. These results support our hypothesis that *RXR* plays an important role in differentiation and growth of the penis and *vas deferens* in female gastropods exposed to organotins. Further studies are needed to clarify the relationship between expression of *RXR* in the ganglia, the induction of imposex via *RXR* gene expression, and the linkage of *RXR* gene expression in the ovary with ovarian spermatogenesis in imposex.

4) We previously showed that intracisternal administration of some endocrine disrupters such as bisphenol A (87 nmol) in 5-day-old Wistar rats caused hyperactivity at 4 to 5 weeks of age, concomitantly with the impairment of mesencephalic tyrosine hydroxylase immunoreactivity (Fig. 2). We examined the effects of oral administration of endocrine disrupters in order to evaluate this route of exposure to chemicals. An endocrine disrupter (12–60 mg/kg) was given orally to 5-day-old rats during suckling and led to hyperactivity at 4 to 5 weeks of age. It was also confirmed that the immunoreactivity of mesencephalic tyrosine hydroxylase was largely reduced. Thus, endocrine disrupters might cause hyperactivity in rats upon environmental exposure.

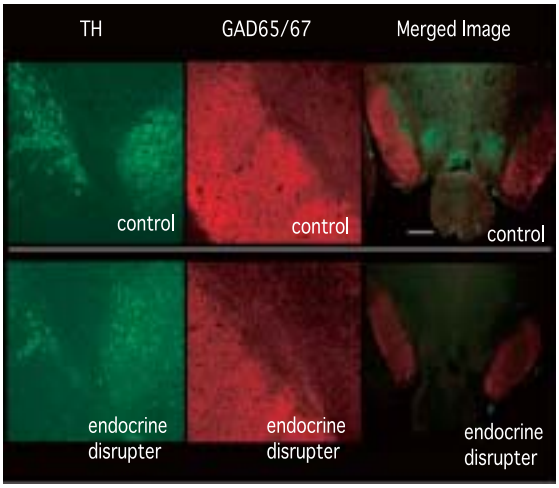


Fig. 2
Endocrine disrupter-induced loss of immunoreactive tyrosine hydroxylase.
After oral administration of vehicle alone (control) or an endocrine disrupter (12–60 mg/kg) into 5 day-old rats, coronal sections of the brain tissues at 7 weeks of age were stained with anti-tyrosine hydroxylase (TH) antibody or anti-glutamic acid decarboxylase (GAD65/67), as indicated.

5) We examined the effects of 17-beta estradiol (E2) and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), separately and combined, on telomerase activity in human choriocarcinoma (BeWo) cells. We attempted to elucidate the mechanisms underlying the interaction of estrogen and TCDD and the subsequent activation of the human telomerase catalytic subunit (hTERT) mediated through c-Myc.

Telomerase activation, known to be stimulated by estrogen, is essential for cellular immortalization and transformation, both of which play roles in tumorigenesis. Dioxin and dioxin-like compounds have been shown to induce endometriosis and promote estrogen-dependent tumors. In this study we showed that either TCDD or a combination of TCDD and E2 increased telomerase activity and the expression of hTERT in BeWo cells. Compared with estrogen or TCDD alone, combination treatment did not have an additive effect. Likewise, treatment with either E2 or TCDD increased DNA synthesis and the cell population in S phase, as detected by fluorescence-activated cell sorter (FACS) analysis. However, following treatment with the E2 and TCDD combination, the proportion of cells in S-phase was actually lower than in cells treated with TCDD alone (Fig. 3). These results suggest that TCDD alone mimics estrogenic action in telomerase activation and cell proliferation, but in the presence of estrogen, TCDD-induced actions were partly counteracted. E2 and TCDD also induced c-Myc, which is a transcriptional activator of hTERT in BeWo cells, but neither of these agents induced telomerase activity in HO15.19 *c-myc*-null cells. In contrast, only TCDD upregulated telomerase in TGR-1 cells, which express c-Myc but lack estrogen receptor (ER) expression. These findings suggest that TCDD induces telomerase activity mediated through AhR signaling and/or ER-independent c-Myc signaling. They provide insight into the mechanism of the promoter activity of TCDD in estrogen-related tumors.

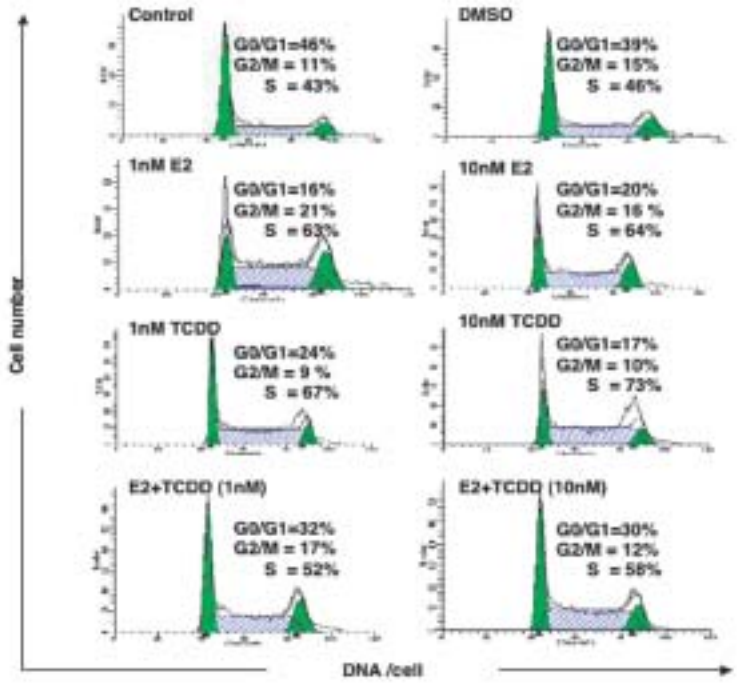


Fig. 3
Representative flow cytometric data of effects of E2 and TCDD on BeWo cells. The first peak (green area at left) indicates the percentage of cells in G1/G0 phase, the middle peak (blue diagonally hatched area) indicates the percentage of cells in S phase, and the third peak (green area at right) indicates the percentage of cells in G2 phase.

6) Among the manifestations of the toxicity of TCDD, hydronephrosis is the most sensitive indicator. We conducted an experiment to elucidate the etiology of TCDD-induced hydronephrosis. Mother mice were given a single oral dose of 10 μg TCDD/kg on one day after delivery, and pups exposed to TCDD through milk from postnatal day (PND) 1 were sacrificed on PNDs 7, 14, and 21. Histopathological study clearly showed that TCDD produced neither hyperplasmic lesions of the renal tubular epithelium nor occlusion of the lumen. Abnormalities of the electrolyte levels in urine were detected in TCDD-exposed pups. The effects of TCDD on several genes expressed in, and involved in salt handling in, the distal tubules, including the renal outer medullary K+ (ROMK) channel and the sodium potassium 2 chloride cotransporter (NKCC2), were thus examined. We also examined the effects of TCDD on cyclooxygenase-2 (COX-2), which has been suggested to regulate the expression of these genes and to play an important role in nephrogenesis. Dramatic induction of COX-2 mRNA was observed in the developing kidney (PND 7) in response to TCDD exposure. Immunohistochemical examination demonstrated COX-2 protein to be restricted in the macula densa and in the distal tubular cells, with greater staining intensity in TCDD-treated pups. Induction of the genes controlling both the NKCC2 and ROMK was inhibited markedly by TCDD on PND 7. These results suggest that the main mechanism of TCDD-induced hydronephrosis occurs primarily by impairment of the salt transport pathway via the induction of COX-2. This leads to loss of NKCC2 and ROMK activity, resulting in hydronephrosis in the early developing kidney exposed to TCDD (Fig. 4).

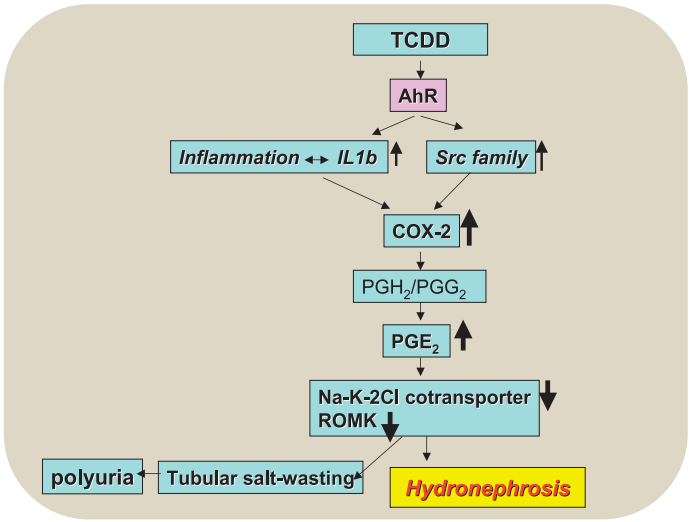


Fig. 4
Schema of how COX2 induction by TCDD disrupts the salt transport pathway in the developing mouse kidney.

7) We have been studying the effects of endocrine-disrupting chemicals on the central nervous system. To monitor the human brain over various generations we collected three-dimensional anatomical images from 70 healthy subjects using high-field magnetic resonance imaging (MRI). Volumetric analysis of those images after tissue segmentation demonstrated that the volume of gray matter in males decreased at 3.2 mL/year, whereas in females it did not show a significant change. Corresponding to this result, the volume of the lateral ventricles in males showed a much larger increase than in females. We developed a technique to extract a mid-sagittal plane image of the corpus callosum semi-automatically from the three-dimensional brain image.

Evaluation of the area of corpus callosum on the mid-sagittal plane, normalized to the size of the brain, indicated that the female has a larger corpus callosum than the male. The results of these volumetric analyses can be used as baseline data for detecting irregular brain development or aging caused by endocrine-disrupting chemicals. We also established a method of quantifying nine endogenous metabolites in a localized region of the working brain. They included N-acetylaspartate, an active neuron marker; inositol, a glial marker; and glutamate, a representative excitatory neurotransmitter (Fig. 5).

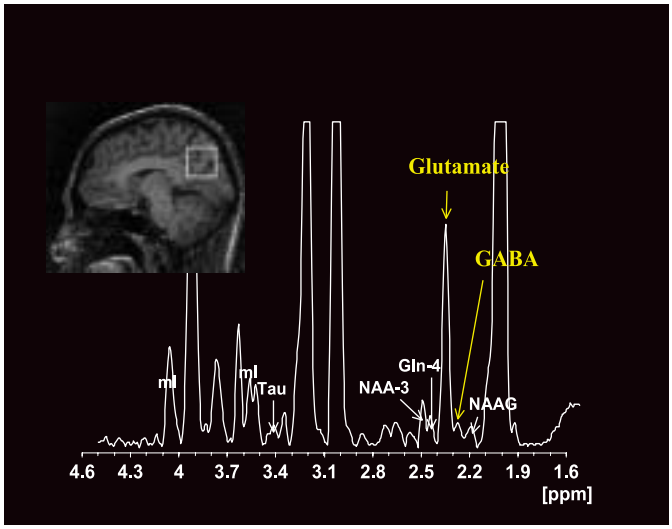


Fig. 5
Representative MRI spectrogram of endogenous metabolites in a localized region of the working brain.

8) We have continued to develop an integrated risk assessment and management framework for endocrine-disrupting chemicals and other environmental contaminants by the comprehensive integration of information and methodologies into an assessment scheme. These efforts have resulted in the development of a "Virtual World" geographic information system (GIS). We developed the grid-catchment integrated modeling system (G-CIEMS)—a multimedia fate model for geo-referenced and spatially resolved fate simulation on a GIS—for the entire Japanese land environment and surrounding ocean. Our FY 2005 study—a modeling module for fate simulation of contaminants in a sewage collection and treatment system—was developed, and geographic information on the sewage collection area was collected and prepared as a GIS database for the sewage modeling module, continuing our FY 2004 efforts. Model validation by international model comparison study was performed continuously in collaboration with the Meteorological Synthesizing Center – East under UNECE, and the G-CIEMS model showed good agreement with other models in the case of the more detailed integrated fate results. Using the output of the FY 2005 study, basic development of the G-CIEMS model has been completed, and we will now attempt a more practical application in the next 5-year period.

Biodiversity Conservation Research Project

「Photo:K. Goka」

Mating between a Japanese native bumblebee queen (right) and an exotic bumblebee male (left).

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 the incursion of invasive species and the production and release of genetically modified organisms has become a new problem. In the Biodiversity Conservation Research Project, which is composed of the five research teams described below, we have developed methodologies to assess changes in biodiversity on a variety of spatial scales, and we are studying 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 mechanisms of population colonization and extinction, which form part of the process of species persistence. This fiscal year, we used DNA genetic markers not only to monitor the viability of wild populations, but also to outline the population structures of species that need to be conserved. Furthermore, we predicted the suitability of habitats for those species across landscapes. In one example based on the National Survey of the Natural Environment conducted by the Japanese Ministry of the Environment, we developed GIS-based habitat suitability models of 77 species of land birds for the Kanto–Koshin'etsu district. A map of potential species numbers was obtained from the overlaid habitat suitability maps of the bird species (Fig. 1a). Areas with unique species sets were also identified from the degree of irreplaceability of the species composition, with the aim of surveying important areas missing from conservation plans (Fig. 1b).

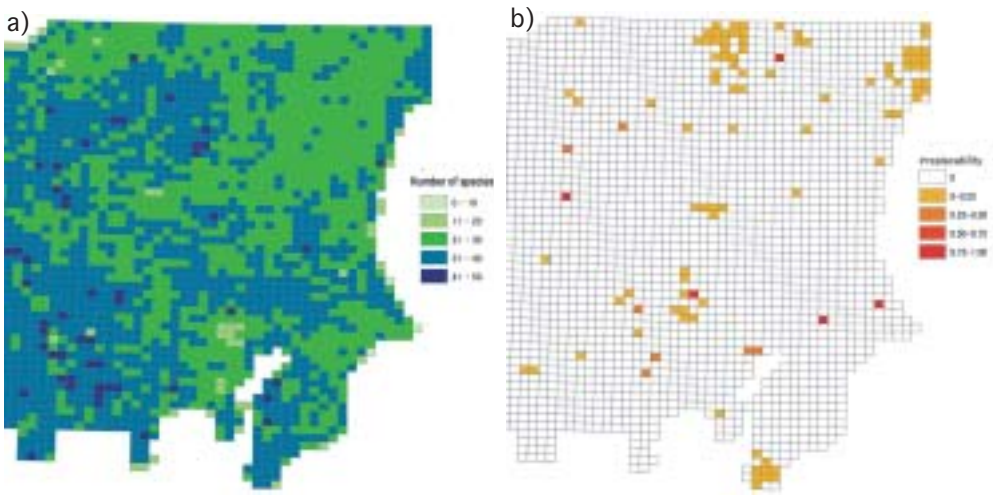


Fig. 1
a) Map of potential bird species numbers in the Kanto–Koshin'etsu district. b) Irreplaceability indices of species in each grid cell (ca. 5 km × 5 km), derived from an analysis of habitat suitability maps and additional information on rare species.

Biological Invasion Research Team

Biological invasion is a serious cause of decreasing biodiversity. We investigated the ecological impact caused by naturalization of the commercial bumblebee *Bombus terrestris*. In recent years, the bumblebee has been introduced into Japan for pollination of greenhouse tomato, and many commercial colonies are now in use throughout Japan.

We accumulated data on, and assessed the risks of, *B. terrestris*, and decided that the bee was invasive on the basis of the following information:

• *Bombus terrestris* has become naturalized and has increased its distribution in Japan. *Bombus terrestris* is now observed and captured in about one-fourth of cities, towns, and villages in Hokkaido, and more than five heavily naturalized regions have been identified. In these regions, many overwintered queens have been collected continuously in the last 2 or 3 years, and the number of natural colonies is increasing year after year. Establishment of naturalized populations in Hokkaido is highly probable. In addition, about 70 000 commercial hives are being used in virtually open conditions, and continuous escape of bees from these hives is having the same effect as naturalized populations on the ecosystem.

• *Bombus terrestris* is competing with species native to Japan. We confirmed that there has been a quick and dramatic decline in populations of native bumblebees. As native bumblebee populations have not decreased in the vicinity of study areas where *B. terrestris* is not heavily naturalized, we concluded that the native bumblebee is becoming replaced through expansion of the naturalization range of *B. terrestris*.

• *Bombus terrestris* is having negative impacts on the native flora of Japan. We tried to elucidate the effects of nectar-robbing by *B. terrestris* on reproduction of a native plant species. Our results indicated that visits by *B. terrestris*, unlike those by native bumblebees, dramatically decreased seed production by the plant species.

• In the field, *B. terrestris* is crossing with species native to Japan. Under laboratory conditions, males of two Japanese native bumblebees in Japan (*B. ignitus* and *B. hypocrita*) could copulate with new *B. terrestris* queens. However, our cytological studies confirmed that the hybrid eggs could not develop normally and ceased development within a few days after egg laying. This evidence strongly suggests that interspecific mating could cause the death of diploid offspring and the breakdown of native colonies in the field because of the loss of the diploid worker force.

The DNA of sperm stored in the spermatheca of the queens of a Japanese native species (*B. hypocrita*) caught in the field was sequenced for analysis of paternal species. We found that inter-species mating between *B. terrestris* and *B. hypocrita* was occurring in the field.

From these results, we established the following regulations for using the introduced bee:

• It may be used only for pollination in glasshouses with the permission of the Ministry of Environment of Japan.

• Users must cover their glasshouses with nets to prevent the bee from escaping.

• At the end of its useful life, users must spray each hive with insecticides before disposing of it.

Ecological Landscape Research Team

Over the past 5 years, we have been investigating the influences of various human activities on the habitats of freshwater fishes in rivers and odonates in agricultural ponds in order to identify the causes of loss of biological diversity and to prioritize areas for diversity conservation.

Analyses were performed using predictive habitat models for individual fish species. These models were based on more than 6700 survey data obtained in Hokkaido over the past half-century. Coupled with GIS analyses, our models revealed that: 1) both fish species richness and species occurrence are significantly affected by the building of dams; small migratory species are particularly sensitive to damming, and their habitats are easily lost above dams; 2) the existing conservation areas for freshwater fishes in Hokkaido are effective in protecting only commercially important salmonids such as the masu salmon (*Oncorhynchus masou*), and habitats of endangered species such as the Sakhalin taimen (*Hucho perryi*) are poorly protected; and 3) the majority (27 species) of the 37 dominant freshwater fishes are significantly less likely to occur in the existing conservation areas, than in other areas, suggesting that additional conservation areas are definitely needed to better protect aquatic ecosystems and therefore biodiversity. We also assessed the magnitude of channelization of streams in Hokkaido by quantifying and comparing the morphological complexity of channels in the 1950s and the 2000s. In the intervening period, channel complexity has declined on average by 27% because of the straightening and shortening of once-meandering streams.

Multiple regression analysis showed that over 81% of the variation in species richness of adult odonates inhabiting the agricultural ponds of southeast Hyogo Prefecture could be explained by four variables: positively in the case of the species richness of aquatic plants, the presence of a forested area within a 200-m radius of the pond, and the absence of a concrete edge around the entire pond; and negatively in the case of the concentration of total nitrogen in the water. Ordination by detrended correspondence analysis (DCA) revealed that the axis explaining the greatest proportion of the variation for adult odonates represented species-specific forest preference, voltinism, and mobility, and that explaining the second-greatest proportion represented breeding substratum and larval habitat. The environmental variables selected with highly correlation with the first axis were the presence of a forested area within a 200-m radius of the pond and the presence of a grassland area within a 10-m radius. Those selected with highly correlation with the second axis were the presence of an emergent plant area and the species richness of aquatic plants. For larval odonates, the axis explaining the greatest proportion of the variation represented breeding substratum and larval habitat, and that explaining the second-greatest proportion was forest preference. The environmental variable selected for larval odonates was the abundance of exotic crayfish or bluegill sunfish, suggesting that the larval community received stronger impacts than the adult one. Our results demonstrated some of the key properties of habitat selection by odonates, as well as the environmental elements required for the conservation of biodiversity in a district with abundant ponds.

Community Dynamics Research Team

Numerous hypotheses for the mechanisms of coexistence of tree species within a forest have been proposed. Many of these hypotheses are not mutually exclusive. Evidence of the contribution of one of the mechanisms does not reject the contributions of other possible mechanisms, and each mechanism should be tested independently. In 2005, we searched for patterns of forest structure that emerge when individual mechanisms of species coexistence are at work. We tested the effects of two mechanisms, i.e., of temporal fluctuation of reproduction and species-specific mortality of juveniles around conspecific mother trees. A simulation experiment using an individual tree-based model of forest dynamics showed that both mechanisms facilitate species coexistence. However, detectable patterns of forest structure specific to each of the mechanisms were not found. Further, the contributions of the two mechanisms were not linearly additive. When two mechanisms are at work it is hard to define the relative contribution of each one.

We constructed a food web model that incorporated the evolution of hypothetical species. In the web, several types of species (plants, herbivorous, carnivorous, and omnivorous animal species) coexisted, and several trophic levels were established (Fig. 2). Using this model, we conducted a computer simulation of biological invasion. We found that a model food web that had evolved without invasion during its development was vulnerable to biological invasion. Many species disappeared from the system after experimental invasion by other species. Invasion by plant species, rather than animal species, caused the extinction of a large number of species. In this food web before invasion, a small number of plant species supported a large number of animal species. Thus, the disturbance of flora by the invasion of alien plant species caused mass extinction of animals. This result may help us to understand the vulnerability of insular ecosystems that have evolved without biological invasion.

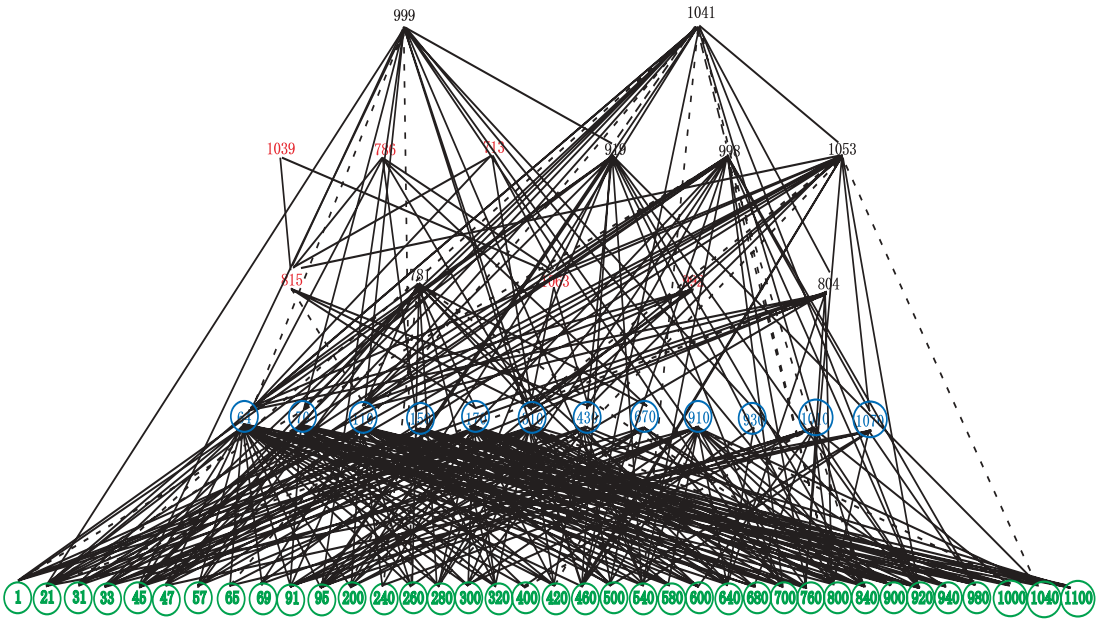


Fig. 2
Example of a simulated food web consisting of plants, herbivores, omnivores, and carnivores. Five trophic levels evolved in this example.

Biotechnology Risk Assessment Team

Millions of tonnes of genetically engineered (GE) or "transgenic" products have now been generated, and imported to Japan, about one-fifth of which is oilseed rape (*Brassica napus* L.) seed. It has been estimated that about half of these imports have two herbicide-resistance genes (for glyphosate and glufosinate resistance). During the transport of this seed to factories for use in food and feed production, seed can escape. Propagation of escaped GE oilseed rape has been confirmed along Route 51 in Chiba prefecture. In 2005, we conducted a more detailed survey than last year and found that 1150 oilseed rape seedlings had propagated along Route 51. Twenty-six of them had the glyphosate resistance gene and 9 of them had the glufosinate resistance gene. The current distribution density of these GE oilseed rape plants indicates that they are not yet having a marked impact on the biodiversity around Route 51. However, we should continue to survey the propagation of GE oilseed rape.

To evaluate the potential risks associated with the escape and successful establishment of GE microorganisms in the environment, we examined the effect of GE or wild-type (WT) *Pseudomonas putida* strains on indigenous bacteria and their genes in water from Lake Kasumigaura. After 20 days of co-culture, the population density of the GE or WT bacteria had decreased to 10^3 CFU mL^{-1}, whereas the concentration of the indigenous bacteria had not changed. It seemed that the concentration of indigenous culturable bacteria did not differ significantly between the microcosm that had not been inoculated and those inoculated with GE or WT. To reveal the relative changes in microbial community structure in samples from each microcosm, we analyzed their DGGE (denaturing gradient gel electrophoresis) profiles by nonmetric multidimensional scaling. At the end of 96 days, the structures of the microbial communities in the samples from all microcosms were similar. This suggested that genetically engineered *P. putida* did not affect either the number of indigenous bacteria or the total genetic diversity of the microbial community.

Watershed Environments and Management Research Project

Slope, riverbank and floodplain in the upper of Changjiang basin.

Introduction

In recent years, the occurrence of large-scale flood disasters in the Changjiang (Yangtze River) basin in China has become frequent, as illustrated by the severe flood of 1998. The Three Gorges Dam (Fig. 1) is expected to control the flood. One of the main causes of this increased flooding is the increase in direct runoff volume and sediment load resulting from the loss of forest cover in the mountains of the upper Changjiang and its main tributaries. In Sichuan Province, in the upper Changjiang basin, the forest cover declined from 20% in 1949 to 12% in 1980, and it is now only 4%. The change in land use from forest to farmland in steep mountainous areas has increased soil erosion by rain, as well as gully formation and the incidence of landslides. The transported material has reduced the flood-buffering capacities of dams, reservoirs, and lakes such as the Dongting and Poyang, and has raised the riverbed in the middle and lower reaches of the main stream of the Changjiang, where the average riverbed slope is only 0.002%. Sedimentation has now elevated the riverbed in the middle reach to such an extent that the formerly protected lowlands are now exposed to the threat of overflow every flood season. Furthermore, the flood-control capacity of the Three Gorges Dam, which began filling in 2003 and will be completely filled by 2009, is already being severely reduced because of the huge amounts of sediment being deposited—despite the fact that flood control was one of the main reasons for building the dam (Fig. 2). As part of a national flood control project to control the runoff and sediment loads from the upper catchment, the Chinese Government has decided to retain the remaining forests in the mountains and convert cultivated land on the steeper slopes back to the original forests or grasslands.

Fig. 1
Three Gorges Dam Construction.

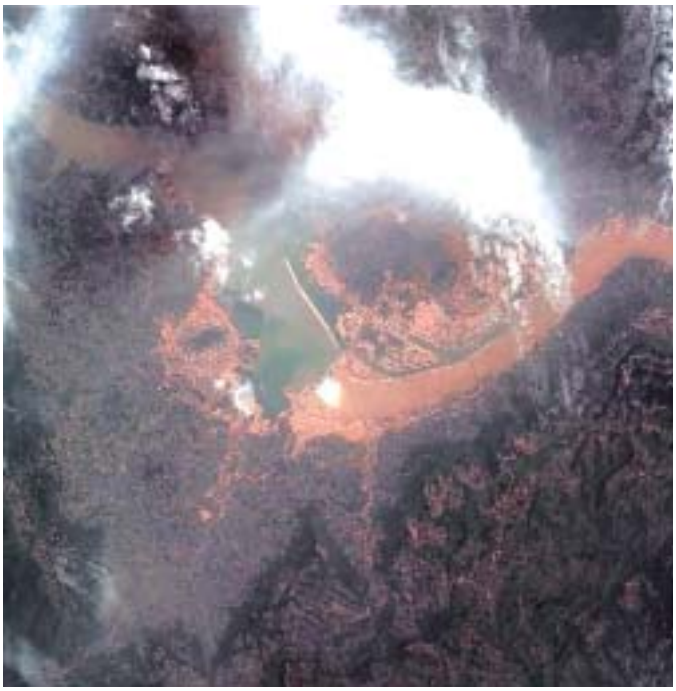


Fig. 2
After closure by TGD body.

Model application and verification

We modeled the effects of the afforestation of cultivated land in the Jialingjiang basin, which is one of the main tributary catchments in the Changjiang basin, on runoff and sediment loads. For this evaluation, we used the Hydrological Simulation Program – FORTRAN (HSPF) as a spatially distributed catchment hydrologic model. Sediment production model and hourly precipitation data disaggregated from the gauged daily precipitation data for 1987 were used as inputs. Before we applied the model we confirmed its applicability as a tool for evaluating the processes of runoff and sediment loading.

To apply the modified HSPF to the Jialingjiang basin, we created hydrological response units (HRUs) by lumping together polygon data with the same land cover type in each of the 29 delineated sub-catchments. After analyzing the digital land cover data, we classified the land covers into seven types: forest, bush and shrub, grassland, farmland, paddy field, urban area, and wasteland. Using a GIS we then calculated the total area, mean elevation, and mean slope of each land cover type in each sub-catchment. To calculate the volume of surface runoff from each HRU, HSPF requires the slope length of each HRU. The length of one side of an HRU was used as the slope length by assuming each HRU to be a square.

Data on the spatial distribution of soil texture and organic matter content are required to estimate a representative diameter of soil particles. To generate these data we digitized thematic maps (developed by the Nanking Institute of Soil Science for soil texture and organic matter content) with a scale of 1:14 000 000 and overlaid them on the land-use polygon data for each sub-catchment using GIS.

For the simulation we used 6-h air temperature, wind speed, dew point temperature, and solar radiation data for 1987 with a regular spacing of 1° (lat and long): these values were developed by the International Satellite Land Surface Climatology Project (ISLSCP) as meteorological input data. Spatially distributed potential evaporation data were generated by using Penman's equation and the ISLSCP 1° meteorological data. These data were converted from raster to vector format by overlaying each sub-catchment polygon on the 1° grid data using the area-weighted mean method. The time interval was changed from 6 h to 1 h for model calculation by linear interpolation of all items.

Rainfall is concentrated in summer (June to September) in the upper Changjiang basin, and localized heavy rainfall lasts for 5 to 6 h. Precipitation intensity plays an important role as an erosive force. Therefore, we disaggregated the data on daily precipitation into those on hourly precipitation in a way that reflected the above properties, instead of simply dividing the daily precipitation data into 24 equal parts and using them as the hourly input data. We then disaggregated these spatially distributed daily data into hourly data by using the following equation:

$$r_T = R_{24} / 24 \cdot (24 / T)^k$$

where r_T is the average precipitation intensity during T (h) ($mm \cdot h^{-1}$); R_{24}, the daily precipitation intensity ($mm \cdot day^{-1}$); and k, a coefficient indicating the climate zone, season, elevation, and landform.

Figure 1 shows the results calculated for the Beibei Hydrological Station, which is in an area thought to be influenced by the whole Jialingjiang basin. Comparison of daily flow discharge, daily sediment flux, and monthly sediment load between the observed data and the calculated results indicates the applicability of our proposed model.

In addition, the differences between the simulated annual runoff volumes and the observed values were within ± 10% in all catchments. The high daily R^2 values (0.88 at Mengduxi, 0.87 at Xiaohedi, 0.94 at Wusheng, and 0.89 at Beibei) indicated that the modified HSPF adequately simulates the daily runoff process over the entire Jialingjiang basin, although it tends to underestimate the peak flow rate at all four hydrologic stations: the ratios of the simulated to observed values were between 0.76 and 0.93 for the 10 highest average peak flow rates.

The model underestimated the annual sediment loads a little in comparison with the observed data. This was mainly because it was difficult to estimate the rates of load reduction achieved as a result of protection works, countermeasures, cropping, and the various management factors for every land-use type in this basin. The annual ratio of slope-derived sedimentation to total sedimentation ranged from 12% to 50% in the main tributary catchments, with a value of 38% over the entire basin; this implies that the other source of sedimentation—pick-up from riverbanks—is the dominant constituent of the sediment load from each catchment.

Although a few previous reports have verified that riverbanks are the main sources

of sedimentation in the study area, the rapid expansion of river channel width observed during the floods might also support this conclusion. As shown in Figure 3, the model adequately simulated the concentrated production of sediment load during the flood period (June to September). However, it underestimated the daily peaks of the sediment flux during the flood period, although the timings of peak generation were mostly correct.

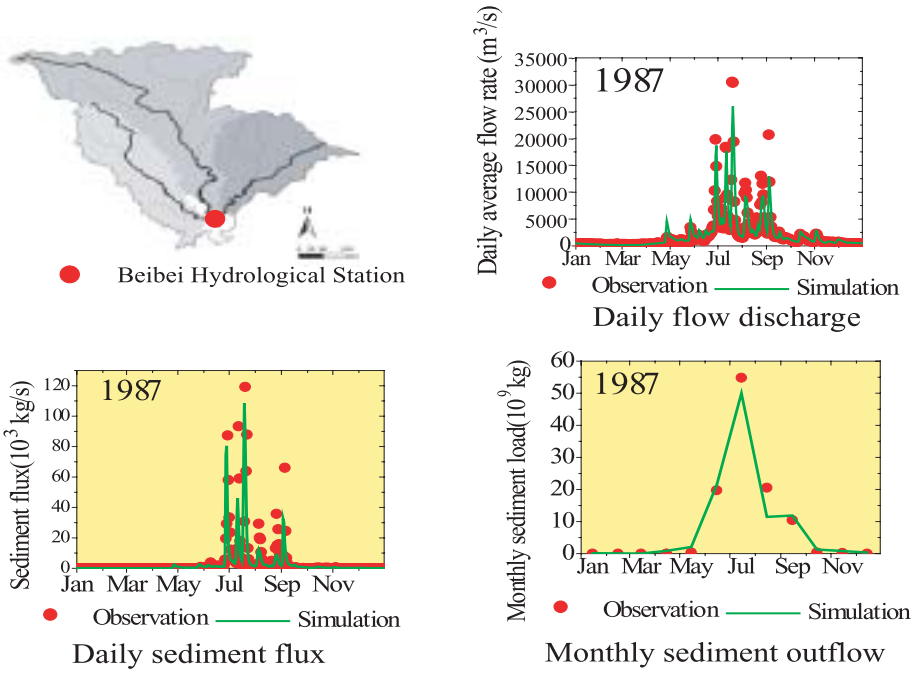


Fig. 3
Verification of results of our modified HSPF simulation.

Simulation based on land-use-change scenario

To evaluate the effect of land-use change on sediment loads from the Jialingjiang catchment, we examined the effect of the afforestation of farmland on steep slopes, which was one of the main policies introduced by the Chinese Government for flood protection. The examination was based on the mitigation of flood peaks and decrease in sediment loads. In each of the sub-catchments considered in the simulation, GIS identified farmlands with catchment slopes exceeding a particular threshold and altered them to forests by adjusting the area, slope, and slope length. For the steep slope threshold, we assumed four grades: 25°, 20°, 15°, and 10°. A slope value of 25° was adopted in accordance with the Chinese Government's policy. We then generated maps of the detected distribution of farmland with catchment slope values exceeding each threshold value. These detected areas covered 0.6%, 1.5%, 3.2%, and 6.3% of the entire area, and 1.6%, 3.8%, 8.2%, and 16% of the entire farmland area in the basin.

When farmlands with catchment slopes > 25° were altered to forests, the average of the 10 highest flood peaks decreased by 4.3% in comparison with that obtained from the simulation of the original farmland before afforestation in the entire Jialingjiang basin. The simulated peak flow rate during the largest flood, recorded on 19 July,

was reduced by only 2.2% (about 600 $m^3 \cdot s^{-1}$) with a slope threshold of 25°. This reduced peak rate corresponds to a lowering of the water level by 0.35 m at Beibei. In contrast, as shown in Figure 4, the model simulated a reduction of 10.7% (4.17×10^9 $kg \cdot y^{-1}$) in the annual sedimentation load from the slopes over the entire basin, even in the case of the minimum afforestation of farmland at a slope threshold of 25°; however, the reduction in sediment pick-up volume from the river banks was only 1.2%. Moreover, lowering the threshold to 10° reduced sedimentation from the slopes by 53.3% (20.7×10^9 $kg \cdot y^{-1}$). The slight change in the sediment pick-up volume from the riverbanks is caused by the small effect of the afforestation of farmland on simulated streamflow rates during flood peaks. In other words, the change was caused by the slight shift in simulated river channel width and river bed shear stress, which are the main variables used to calculate the sediment pick-up volume.

The total reductions in annual sedimentation (slopes + flood plain) as simulated by the model were 4.8% (4.91×10^9 $kg \cdot y^{-1}$) at 25°, 9.8% (10.0×10^9 $kg \cdot y^{-1}$) at 20°, 18% (18.4×10^9 $kg \cdot y^{-1}$) at 15°, and 24% (24.3×10^9 $kg \cdot y^{-1}$) at 10° over the entire Jialingjiang basin.

These simulations were performed to evaluate the effect of farmland afforestation on sedimentation in the Jialingjiang basin. Restoration of forests clearly reduces sedimentation, even in the case of minimum restoration at a slope threshold of 25°. However, the effect of restoration on the reduction in peak flow rate in the river channels was small. Increasing the area of restored forest by lowering the slope threshold decreased the sedimentation rate further.

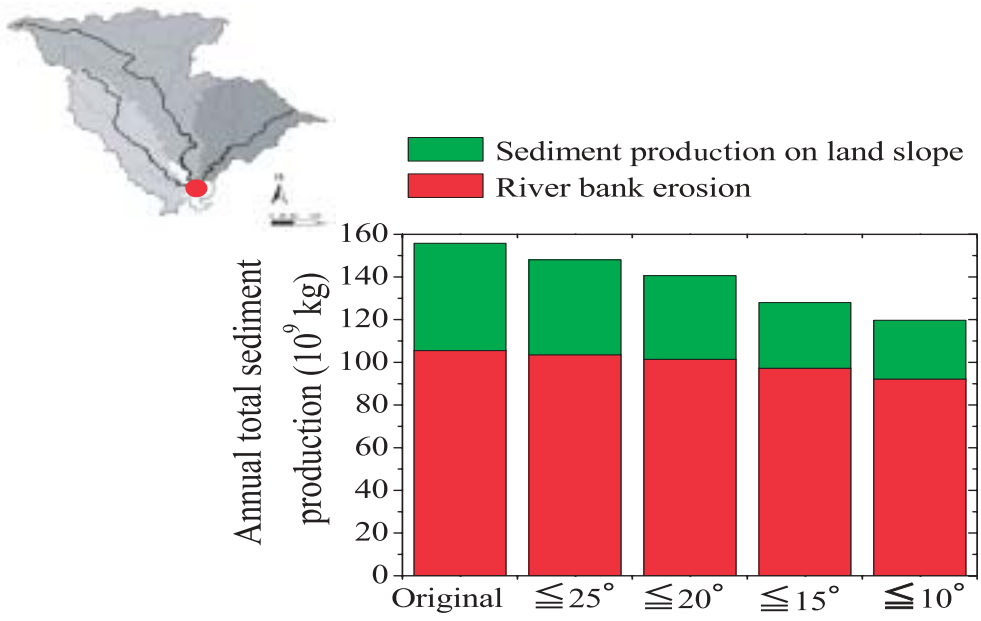
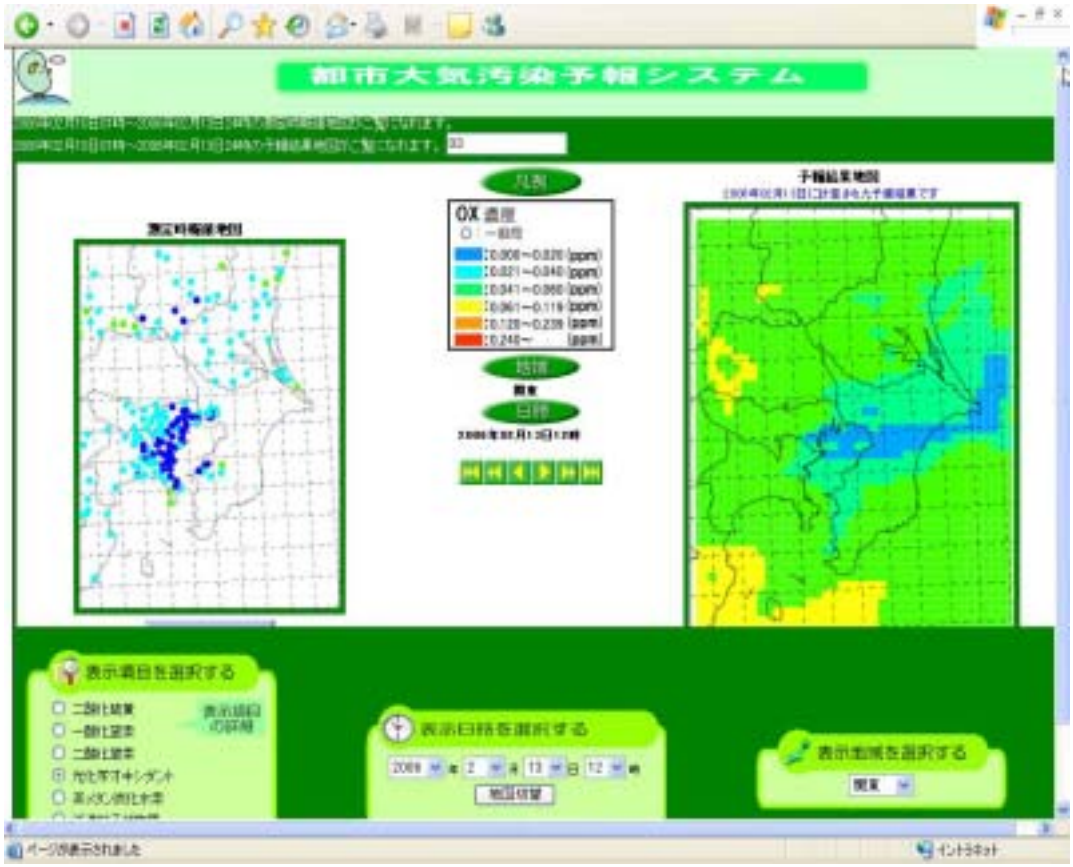


Fig. 4
Reduction of sediment production in the Jialingjiang basin by afforestation.

PM2.5 & DEP Research Project



Urban Air Pollution Forecast System

The SORAMAME* air pollution forecasting system shows the results of the forecast (at right), along with the corresponding surface observations (at left).
The pollutant species, day, time, or area displayed can be chosen by selecting the buttons on the lower panels.

* SORAMAME, the Area-wide Atmospheric Environmental Monitoring System, monitors the area-wide status of air pollution and collects real-time data. These data are made available on the Internet at a site operated by Ministry of the Environment (http://soramame.taiki.go.jp/).

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 & DEP Research Project Group is carrying out investigations to better understand the characteristics of pollution sources, the environmental fates of fine particulate matter ($PM_{2.5}$) and diesel exhaust particles (DEP), and the effects of these substances on human health.

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 motor vehicles. 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 FY 2005, we used a chassis dynamometer to measure the concentration and size distribution of ultrafine particles emitted from diesel vehicles under transient operating conditions in a full-flow dilution tunnel and in an exhaust gas dispersion chamber. Additionally, we clarified the behavior and chemical composition of ultrafine particles in the atmosphere at five observation sites (three roadside sites, one urban site, and one suburban site) (Fig. 1).

We made progress in constructing a GIS-based integrated system for assessing the effectiveness of various policy measures: it consists of numerical sub-models of traffic flow, particulate emission and dispersion. We carried out a simulation of DEP concentrations in the greater Tokyo area to compare the geographic distribution of the population's exposure to DEP before and after implementation of road pricing policy.

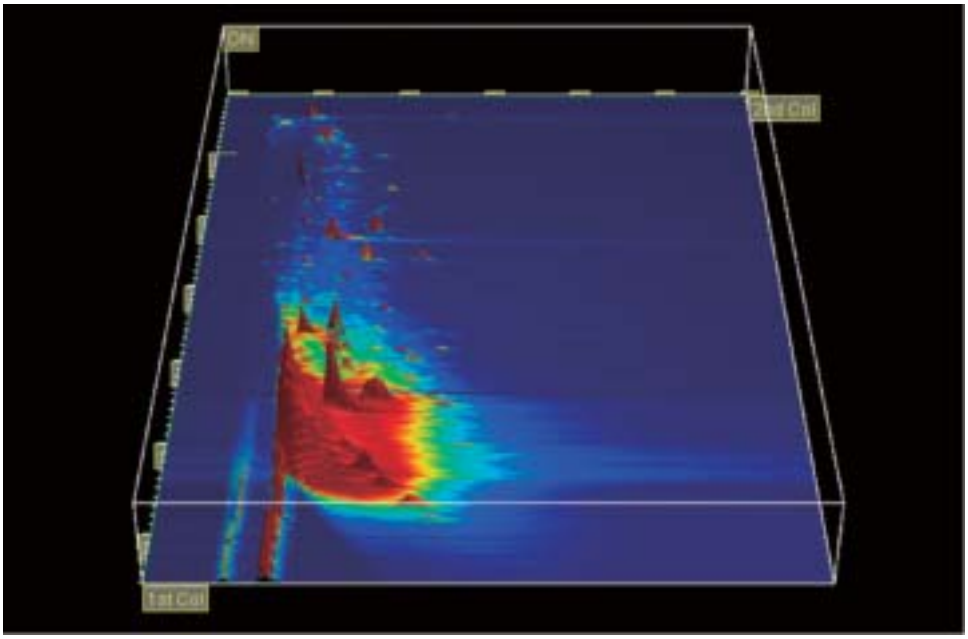


Fig. 1
Three-dimensional total ion chromatogram of nanoparticles in roadside atmosphere by thermal desorption-GCxGC/qMS (Less volatile hydrocarbons probably originated from the lubricating oil of diesel vehicles, and trace compounds such as polycyclic aromatic hydrocarbons were also detected.).

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 distributions of urban air pollution. To clarify the behavior of airborne particulate matter—such as $PM_{2.5}$ and DEP—and gaseous air pollutants, we have conducted wind tunnel experiments, field observations, data analyses, and computer model simulations. In FY 2005, the principal research topics were as follows:

(1) To provide verification data for numerical prediction models for roadside air pollution, dispersion experiments were conducted in a wind tunnel for three types of real cityscape: moderately packed mid-rise buildings with a surface arterial road; moderately packed mid-rise buildings with both a surface arterial road and an elevated arterial road; and densely packed low-rise buildings with a surface arterial road and an elevated arterial road. Reasonably good agreement with the NOx concentrations observed at roadside air monitoring stations was obtained.

(2) To reduce the numerical cost of conventional computational fluid dynamics (CFD) methods of roadside air pollution prediction, a new model that combines the mass-conservation law and information from wind-tunnel experiments is being developed. The interface with 3-D maps and the fluid dynamics part of the core program have been coded. Coding of the geometric part, which is based on the wind-tunnel results, is in progress.

(3) Local and regional contributions to springtime ozone levels were estimated in an urban area of Osaka on the basis of a ground-based and aircraft observation datasets in spring 2001 and 2003. The vertical and horizontal distributions of size-resolved particles were analyzed to determine the behavior of these particles in the urban atmosphere. Simultaneous field observations in Japanese and Chinese metropolitan areas in summer and winter were also performed to compare the concentrations and compositions of elemental and organic carbon in the two areas.

(4) Using environmental monitoring data for the period 1992–2003, we examined the effect of Asian dust or 'yellow sand' (*kosa* in Japanese), on the rate of attainment of the SPM (suspended particulate matter) air quality standard in Japan. A clear reduction in the attainment rate was detected in 2002; this was caused mainly by a massive dust episode observed from 8 to 11 April 2002.

(5) An automatic forecasting system for urban air pollution was developed by cooperative research with local governmental environmental research institutes, and it has been routinely tested since December 2005. Concentrations of air pollutants such as ozone are calculated and visualized, along with surface observational data, which is nicknamed SORAMAME, by the system.

Aerosol Measurement Research Team

In our study we have been attempting to summarize the instrumental evaluation of various aerosol monitors on the basis of parallel testing methods.

We evaluated the performance of various $PM_{2.5}$ monitoring methods, namely the beta-ray attenuation method, the tapered element oscillating microbalance method (TEOM), the gravimetric filtration method, and a hybrid method that combines light scattering photometry and the beta-ray attenuation method. We performed parallel monitoring tests of these methods in comparison with the US EPA Federal Reference

Method (a gravimetric filtration method) in winter and summer. The hybrid method was less influenced by atmospheric humidity than the beta-ray attenuation method. The TEOM method exhibited the most sensitivity, although it demanded electrical stability of the power supply for good performance.

To evaluate the performance of various black carbon (BC) monitors we performed parallel measurement testing. We compared our monitoring data with the criterion data based on a thermal analysis method with an optical reflectance correction function using filter samples collected by a low volume sampler in conformity to the FRM method. The results of monitoring using the BC monitors of four companies tended to be about 20% to 70% lower than those data by the criterion for thermal analysis. The correction factor or improvement of each BC monitor was determined from the results of the fundamental experiments described above, and we were able to confirm the improvements practically by follow-up parallel testing of the improved BC monitors in a field campaign at one of the same roadside sites.

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 concentration of PM (calculated from a diffusion model using concentrations of air pollution emitted from roads and other sources) superimposed on the population distribution. We have also completed the second-phase model. The components of the second-phase model can include concentrations of PM in typical microenvironments (e.g. homes, roadsides, vehicles). The final-phase model consists of numerical models of traffic flow, particulate emission and dispersion, and exposure assessment. We examined the integration of a dynamic traffic flow simulation model into the system to compare the effectiveness among several traffic demand management policies in terms of exposure to pollutants.

We analyzed the data on vital statistics in various regions, looking for statistical correlations between PM exposure level and mortality rate. We analyzed mortality rates in 13 large Japanese cities and provincial cities to investigate the short-term effects of particulate matter on mortality. These results suggest a positive relationship between PM concentration and daily mortality in Japan, in agreement with many reports in the USA and Europe. We are now engaged in a prospective cohort chronic exposure study and in short-term morbidity studies conducted by the Ministry of the Environment.

Inhalation Toxicology Research Team

The Toxicity and Impact Assessment Research Team has designed toxicological studies to clarify the effects of DEP—major components of particulate pollutants—on cardiac, respiratory, and immunological functions *in vivo* and *in vitro*.

Cardiac function

To clarify the substances responsible for the effect of diesel exhaust (DE) on the nervous function regarding the cardiac function, we examined nitrophenol derivatives. PNMC (3-methyl-4-nitrophenol) activated the parasympathetic nervous system, leading to significant decreases in heart rate (HR) and blood pressure. The results suggested that the vasodilatation and the decrease in HR and blood pressure seen in response to DE exposure were probably responses to the nitrophenol component.
We also attempted to clarify the effects of nanoparticle-rich DE exposure on rats. The DE exposure increased abnormal electrocardiogram and decreased the HR variability, suggesting that exposure to nanoparticles had cardiac effects through effects on the autonomic nervous system.

Respiratory and immunological function

We used a comprehensive microarray analysis to examine the effects of nanoparticle-rich DE exposure on the rat lung. Rats were exposed for 12 h to DE-containing nanoparticles emitted under high-idling conditions at 0.3 mg/m^3, or to filtered air. In the lung, 71 genes were up-regulated more than 1.5-fold and 6 genes were down-regulated less than 1/2-fold significantly. The genes whose expression was induced were categorized functionally into drug metabolism, cell cycle/apoptosis, immune system, coagulation/fibrinolysis, and cytoskeletal organization. These results suggest that nanoparticle-rich DE has effects on the lung.
We also examined the effects of inhalation of DE on lung inflammation in relation to challenge with lipopolysaccharide (LPS), a bacterial endotoxin. Mice were exposed for 12 h to clean air or DE at a soot concentration of 0.3 to 3.0 mg/m^3 after intratracheal challenge with LPS. Lung inflammation and lung expression of proinflammatory chemokines were evaluated. DE inhalation decreased LPS-elicited inflammatory cell recruitment into the bronchoalveolar lavage fluid. Histological examination demonstrated that exposure to DE did not affect LPS-enhanced neutrophil recruitment into the lung parenchyma. DE exposure did not increase, but instead suppressed, lung production of chemoattractant protein-1 and keratinocyte chemoattractant in the presence of LPS. These results suggest that short-term exposure to DE does not exacerbate lung inflammation related to bacterial endotoxin.

Disrupting reproductive function

To elucidate the substances responsible for the effects of DE on the reproductive system, we examined nitrophenol derivatives such as 4-nitrophenol (PNP), 3-methyl-4-nitrophenol (PNMC), and 4-nitro-3-phenylphenol (PNMPP) from DEP. We showed that these compounds have estrogenic and anti-androgenic activity in female and male rats; and PNMC causes atrophy of the testes in adult male Japanese quail (Fig. 2). The results demonstrated that the dysfunction of the reproductive system induced by DE exposure was similar to the effect of nitrophenols. PNP and PNMC are known

degradation products of insecticides. PNP and PNMC from diesel emissions may exist in large amounts in the environment and could have serious deleterious effects on wildlife and human health.

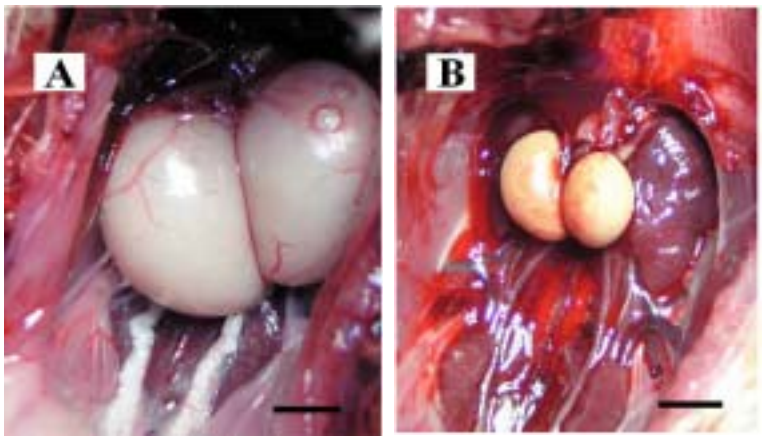


Fig. 2
Atrophy of testes in Japanese quail.
A: Testes of control.
B: Atrophy of the testes of PNMC-treated quail.
Bar: 6 mm

In vitro assay for toxicity of DEP

To elucidate the effects of DEP on the cardiovascular system, we examined the effects of organic extracts of DEP on rat pulmonary fibroblasts, rat aorta smooth muscle cells, and rat heart microvessel endothelial cells *in vitro*. Exposure to organic extracts of DEP increased type I collagen production by fibroblasts and enhanced the proliferation of smooth muscle cells. Endothelial cells exposed to organic extracts of DEP showed suppression of cell growth, endothelial nitric oxide synthase (eNOS) activation, and plasminogen activator inhibitor-1 (PAI-1) production, as well as the induction of heme-oxygenase-1(HO-1) production. Treatment with N-acetyl-L-cysteine ameliorated these effects. These results suggest that organic extracts of DEP have the potential to cause oxidative stress to cells, thus inducing thickening and contraction of vessels and impairing the function of endothelial cells.

Research Center for Material Cycles and Waste Management

A recycling process of plastic containers and wrapping under the Containers and Packaging Recycling Law

Introduction

To change the current economic and social trend of mass production, mass consumption, and mass disposal, actions are needed to realize a sound material-cycle society. The comprehensive road map that we need for such actions is, however, still not clear.

The Research Center for Material Cycles and Waste Management was established at NIES in April 2001 to support such a social transition, and it has worked on various research programs for 5 years. We focus particularly on three areas of research: 1) material cycle systems, 2) material cycle technologies, and 3) material cycles and risk management.5

(1) Material Cycle Systems Research

As a basis for supporting the transformation to a sound material-cycle society, it is essential that we synthesize various statistical data related to the physical flows of resources, products, wastes, and other environmental burdens and develop tools to systematically analyze these data. Using Japanese economic input–output tables we have made progress in an empirical analysis of environmental burdens in terms of the final demands of the economy. We found that a consumption pattern designed to minimize the final disposal of solid waste could result in an increase in some environmental burdens, whereas another pattern, aimed at minimizing CO_2 emissions, could contribute to a reduction in all of the environmental burdens that we considered. We have also improved the framework and database for economy-wide material flow accounting.

One of the foci of our studies is the application of life-cycle assessment (LCA) to various technologies for recycling plastics other than PET bottles whose classification is stipulated in the Japanese Container and Packaging Recycling Law. In addition to our previous studies of systems for recycling such plastics as reductant substitutes in the iron and steel industry, we have collected inventory data for other recycling technologies, such as mechanical recycling to secondary plastic products and thermal recovery by RPF (refuse paper and plastic fuel). We have also developed a numerical model to simulate the environmental burdens and costs of separate refuse-collection systems. Using these data and the model, we have assessed the effectiveness of different recycling systems in CO_2 emissions reduction.

The institutional and legislative aspects of recycling systems at various spatial scales are also our concerns. This year we published an evaluation report of the effectiveness of the Recycling Law for Electrical Home Appliances in Japan. We also continued investigating the transboundary movements of recyclable resources and recycling activities within Asian countries. To share and discuss our findings on material cycles with those countries, in November 2005 we hosted an international workshop on e-waste.

Regional flows of wastes and secondary resources throughout Saitama Prefecture, Japan, were estimated and the results were integrated into a GIS. Cluster analysis of bulky construction and demolition waste migration revealed that resource-recovery technologies, mainly by crushing and selection, have been developed in areas away from the disposal sites and close to demand for secondary resources. A net transport analysis of waste plastics and debris showed that optimization of the geographical

combination of supply and demand could reduce the traffic volume of these wastes by more than 30%. Waste generation and an administrative district's in- and out-flows induced by its own and other districts' demands were estimated using our improved waste input–output framework. We also presented a Location Force Model for industrial waste facilities and a marginal WTP for municipal waste facilities by conjoint analysis.

In addition, to assess the environmentally safe and effective use of secondary and recycled products, we investigated the long-term leachability of toxic metals from secondary materials made from waste molten slag, including asphalt concrete, road base, and cement concrete. In particular, using accelerated exposure tests, we experimentally confirmed the effect of deterioration of secondary product quality on leachability, as imposed by external environmental changes. We also conducted basic studies, not only to improve bioassay methods such as the luminous *umu* test for evaluating the toxicity of secondary products, but also to clarify PAH behavior in the process of carbonization of waste wood.

(2) Material-cycle Technologies

In terms of thermal and biological processes, we have been investigating the technical solutions required to dispose of wastes and to recover energy and materials in the context of an environmentally sound material-cycle society.

Thermal process

A technique of monitoring halogenated organic compounds in flue gas has been developed in recent years, and we used it to semi-continuously monitor pollutants in the flue gas of an industrial incineration plant. We investigated the relationships between the measurement data and operational parameters such as the temperature of the bag filter. The technical data that we obtained can be used extensively for the sophisticated control of facilities for the thermal disposal of municipal solid waste.
To establish an effective recycling system that includes an energy-recovery process, we examined hydrogen production from solid wastes, employing a Ni catalyst and CaO in the reforming process. We demonstrated that hydrogen could be efficiently produced at quite low temperatures (923K to 1023K). We also experimented with the production of hydrogen-rich synthesis gas using refuse-derived fuel (RDF) and RPF. We found that short-term deactivation of the reforming catalyst could be significantly prevented by parking CaO upstream of the catalyst, and we observed a considerable improvement in catalytic performance for hydrogen generation and a reduction in environmental impacts.

Development of organic waste recycling system

We developed food waste databases that include the unit generation of organic waste per worker in food processing, food sales, and restaurant businesses. The databases also include the food composition and chemical components of wastes generating at most establishments grouped by groups and details industries in Japan Standard Industrial Classification, and they should be useful in the basic design of organic waste recycling systems and in the detailed design of local systems. We also developed a new engineering system for zero-emission-type lactic acid fermentation that recovers L(+)-lactate from fermented liquids and produces animal feed from fermented solid residues. We demonstrated the effecttivness of the fermented feed to pig.

Risk reduction and stabilization enhancement in landfill

Several diagnostic technologies for landfill stabilization have been proposed (Fig. 1). We developed several methods for estimating whole-surface methane emissions. We showed that resistivity and electromagnetic exploration can be used to monitor the movement of internal water and changes in waste quality. The genotypic and phenotypic community structures of microorganisms in the soil, leachate, and waste were proposed as biological indexes of stabilization. We estimated the pollutants in leachate treatment plants and the ecotoxicity reduction by unit processes. We also developed an automated *in situ* well- and land-burial sensor system that can continuously monitor internal temperature, soil moisture, and the differential pressure and quality of landfill gas.

We found that hydrothermal treatment of waste before disposal could lead to carbonization and hydrolysis of organic matter and thus promote heavy metal trapping by carbonized polymer. We also conducted test cell experiments to investigate how to accelerate landfill stabilization. We showed that the pH of waste is a critical factor in initiating microbiological activity and that aeration and leachate circulation are also effective.

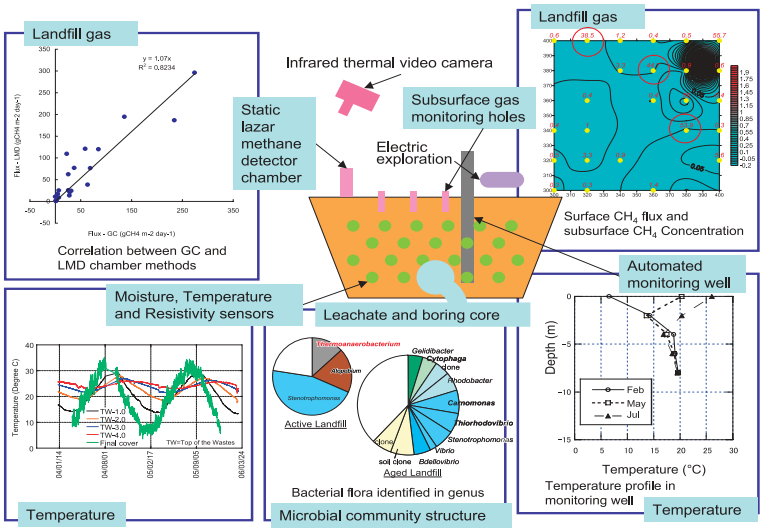


Fig. 1
Diagnostic technologies for landfill stabilization.

Advanced treatment of liquid waste

We investigated the optimum operational conditions for increasing nitrogen-removal efficiency and the effects of circulation ratio on the removal of nitrogen from domestic wastewater. The results indicated that the optimum circulation ratio was 5 to 6 for stable and high rates of removal, although the ratio had previously been set at 3 to 4. Estimation of functional microbial activity and quick detection of microbes in nitrification and denitrification processes were also investigated. We found that analytical techniques for detecting key microbes by combining gene analysis with substrate-characteristic analysis were useful.

We investigated the performance of the iron electrolysis process for removing phosphorus in an advanced Johkasou system. The process could remove phosphorus effectively in the Johkasou system, and a fundamental examination showed that the concentration of effluent phosphorus could be reduced to as low as 1 mg/L.

Moreover, we developed a simultaneous methane fermentation and nitrogen removal system for the appropriate treatment of organic waste and for energy recovery. The

fundamental system that we examined consisted of a USB (up-flow sludge blanket) and an aerobic biofilm process that could simultaneously produce methane and remove nitrogen.

(3) Material Cycles and Risk Management

Risk management of brominated flame retardants

We estimated the atmospheric emissions of deca-brominated diphenyl ether (DeBDE) in Japan on the basis of the material flow of DeBDE products and their emission factors (Fig. 2). In 2002, demand for DeBDE was 2200 t/year and the stock level was about 33000 t. The DeBDE flow into the waste stream was estimated to be about 6000 t/year, and the flow-out through second-hand product exports was more than 700 t/year. Emission factors from plastics processing, textile processing, home appliance recycling, and waste incineration were estimated using field measurement data. In addition, the DeBDE emission rate through house dust during the service lives of final products was estimated from the DeBDE concentration in dust and the amount of dust in used televisions. Emission factors for DeBDE production and other processes from previous studies were also used. The estimated total DeBDE emission from the life cycles of DeBDE products was 170 to 1800 kg/year. These results suggest the necessity of characterizing emissions during the service lives of products; this is essential information for formulating an appropriate e-waste recycling strategy.

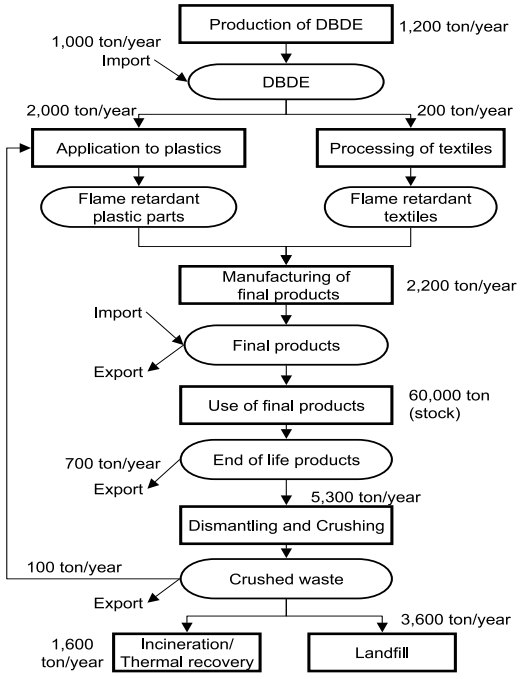


Fig. 2
Simplified life cycles of DeBDE products in Japan.

Bio/chemical analysis of dioxin-like compounds in sediment samples

We conducted a combinatorial bio/chemical investigation of sediments (six surface samples and one core sample) from Osaka Bay, Japan, to clarify the horizontal and vertical distribution profiles of persistent organic pollutants (POPs) in the sediments. Concentrations of polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), polychlorinated biphenyls (PCBs), polybrominated dibenzo-*p*-dioxins and dibenzofurans (PBDD/Fs), and polybrominated diphenylethers (PBDEs) were determined by chemical analysis and compared with bioassay results using H4IIE-luc/Dioxin Responsive- Chemical Activated LUciferase eXpression (DR-CALUX).

For surface sediments, World Health Organization–toxicity equivalent (WHO-TEQ) values ranged from 1.8 to 92 pg g^{-1} dry weight, and the bioassay-TEQ (CALUX-TEQ) values ranged from 3.7 to 140 pg g^{-1} dry weight; there was a significant correlation between the two sets of values (r^2 = 0.96). The correlation between the two sets of TEQ values for the core samples was not as good (r^2 = 0.46). Comparison of the vertical profiles of the two sets of TEQ values showed that they differed in that the WHO-TEQ values peaked in the 1957 core section, whereas the CALUX-TEQ values peaked in the 1984 section. The CALUX-TEQ values were 1- to 5-fold greater than the WHO-TEQ values in all samples. The existence of unknown active compounds has been suggested as an explanation for the higher bioassay estimates. CALUX-TEQ values were calculated for PBDE and PBDD/F concentrations, employing their CALUX toxicity equivalent factors (CALUX-TEFs). The estimated CALUX-TEQ values obtained for the brominated compounds could account for 11%, on average, of the experimentally obtained CALUX-TEQ values in the surface sediments investigated.

Monitoring of non-volatile and/or polar chemicals in wastes by LC/MS

We have developed an LC/MS-related analytical methodology for comprehensively measuring non-volatile and/or polar contaminants in wastes and waste-related samples. In 2005, we improved screening methods of high-priority chemicals and elemental composition elucidations (ECEs) for identifying unknown organic chemicals. We made the small change of not adding salt in the solid extraction process and were able to measure 86 chemicals. The mass spectra of 127 compounds in four different instruments, and their retention indices, were collected in the database. We also made another small change in the ECE method to reduce the number of elemental composition candidates by narrowing the mass errors in Q-TOFMS measurement. With this change, the percentage of compounds for which the numbers of elemental composition candidates were fewer than five was increased from 72% to 93%.

Destruction of PCBs by four methods

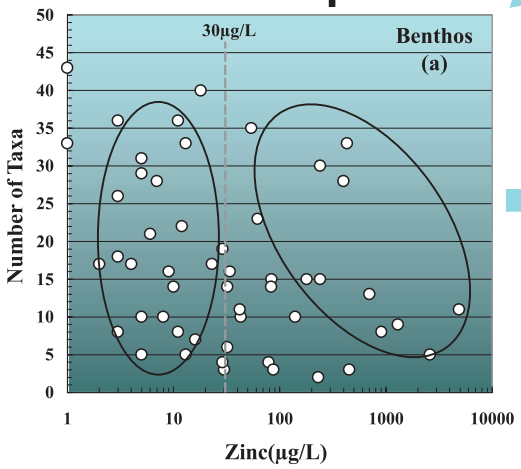
To confirm that PCB destruction systems are being managed well, it is important not only to ascertain the disappearance of PCBs, but also to understand the degradation mechanism and to check for the absence of other harmful by-products. In this way, we were able to explain the differences in the reaction mechanism among four methods: photochemical dechlorination (PCD), catalytic hydro-dechlorination over palladium/carbon catalyst (CHD), sub-critical water oxidation (SCWO), and sodium dispersion (SD). Furthermore, we identified the structures of dechlorinated products and polymerized products and found that no organic chlorinated compounds remained at the end of the degradation process. Moreover, we investigated the pathways of degradation of 13 PCB congeners by SCWO. The reaction runs were carried out at a constant temperature (300 °C) and pressure (8 MPa) in a SUS316 stainless steel micro-autoclave filled with water. The kinetic constants increased in order of the total number of chlorine atoms. Decachlorobiphenyl (DeCB) was transformed to lower congeners by hydrothermal reaction. Approximately 60% of the DeCB was converted into zero- to nona-CBs over a period of 120 min. Increasing the reaction time to 240 min led to about 80% degradation. The reactivity of the chlorine substituents was thought to decrease in the order of *para* > *meta* > *ortho*.

Research Center for Environmental Risk

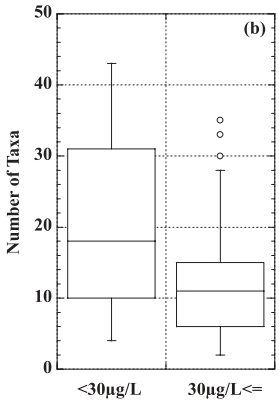
Sampling

Sorting

Selection of relevant endpoint



Statistical analysis



Statistical analysis of field data reveled that a decrease of number taxa of benthos was significant above 30 µg/L of Zinc in river water

This Center promotes research projects on environmental risk assessment. Currently, there are seven project themes, covering the development of methodologies for: 1) assessment of exposure to environmental risk in light of exposure variability, 2) exposure assessment on the basis of limited information, 3) assessment of health risks in light of individual variations in susceptibility to chemical substances, 4) bioassay systems for environmental monitoring, 5) assessment of health risks from concurrent exposure to a number of chemical substances, 6) assessment of ecological risks 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 2005.

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

As part of this sub-theme, we built numerical models that could predict the concentration of a chemical in the environment from limited information. We developed a one-dimensional unsteady-flow river model using unsteady flow and advection–diffusion; a steady flow system with a branched river structure; a non-equivalent steady-state multimedia model, MuSEM, coded into a spreadsheet (MS Excel); and a coupled three-dimensional hydrodynamic and ecotoxicological Tokyo Bay model.

This financial year, we performed verification studies of MuSEM by comparing predicted concentrations with the results of environmental surveys by the Ministry of the Environment. The predicted concentrations were calculated by MuSEM on the basis of PRTR emission data. Comparison of the concentrations in each compartment (air, surface water, seawater, sediment in surface water, and sediment in sea water) revealed that the predicted concentrations in air were more accurate than those in the other compartments, because of the high detection ratio and high predictability of components in the air compartment.

We performed additional verification studies of our Tokyo Bay model by comparing measured surface and bottom water concentrations of 4,4′-bis(2-sulfostyryl)biphenyl (DSBP) in Tokyo Bay with the simulated values (Fig. 1). The simulated results for dissolved DSBP were well correlated with the observed values (R^2 = 0.7108). The results of a sensitivity analysis showed that photodegradation rate and the coefficient of light absorption were the most important parameters determining the concentration of dissolved DSBP.

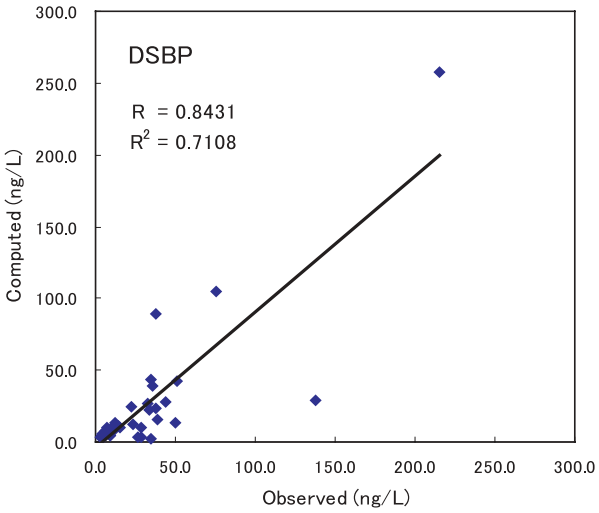


Fig. 1
Relationship between observed concentration and computed concentration of dissolved DSBP in Tokyo bay.

Development of a methodology to assess exposure variability in humans and ecosystems

Environmental exposure to chemicals apparently has marked variability in terms of time, space, and other factors. We developed a geo-referenced and spatially resolved multimedia fate model, G-CIEMS (Grid-Catchment Integrated Environmental Modeling System) using GIS databases. The model combines the methodologies of a well-developed multimedia fate model and geo-referenced river models to simulate multimedia fate processes among air, soil, rivers, lakes, sediments, and sea areas with the geographical reality of a river-networking structure under Japanese environmental conditions. The basic geographical resolution was around 5 km × 5 km for all media, with a different geographical shape depending on each medium. We continued to perform case studies of dioxins, VOCs, and nonylphenol. The case studies estimated the spatial variability of the target compounds by using the G-CIEMS model, PRTR release estimation data for Japan, and selected monitoring data. The results showed that exposure distributions in Japan may range over several orders of magnitude. We performed additional validation studies by collecting additional emission and monitoring data for several selected rivers, and we improved the predictability of our river model after tuning the model parameters.

We studied the assessment of exposure to dioxins in seafood by using production statistics for fish-catches and nationwide fish monitoring data. The results of this study were well correlated with exposure estimates made by a market-basket method.

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

Susceptibility to environmental toxicants is an important factor in determining the safe level of each chemical in the environment. Susceptibility is a function of many variables, such as sex, age, disease history, and genetic background. Single nucleotide polymorphism (SNP) analysis is one of the most popular methods of studying

differences in the genetic backgrounds of human populations. We extracted genomic DNA from blood (1827 samples) and investigated an SNP that appeared to exist in the coding region for arsenic methyltransferase (As3MT, EC 2.1.1.137, previously Cyt19). The polymorphism causes a change in an amino acid in position 287 of As3MT (Met287Thr). Of the 1827 samples, 1739 were wild type (t/t), 63 were heterozygous (t/c), and one sample was homozygous (c/c). The remaining 24 samples were unable to be analyzed (Table 1). As3MT plays a crucial role in the metabolism and detoxification of arsenicals, and this polymorphism of the gene encoding As3MT may be implicated in variations in susceptibility of humans to arsenicals.

Table 1
Single nucletide polymorphism in human arsenic methyltransferase (As3MT).

104628681 (Met287Thr)
atggaggaattacaggacatgaaaaagaactaa(t/c)gtttgatgccaattttacatttaaggaaggtgaaattgtt
gaagtggatgaagaaacagcagctatcttgaagaattcaagatttgctcaagattttctg

	Wild	Hetero	Homo
Type of SNP	t/t	t/c	c/c
Frequency	1739/1803	63/1803	1/1803

Development of a methodology to assess health risk from exposure to chemical mixtures

We are exposed to many kinds of pollutants or toxic substances in the environment. We would like to assess the total health risk from exposure to mixtures of such chemicals, but the effects of complex exposure—in particular the synergistic effects of mixtures of many chemicals—have not been clarified in the past and are still not able to be determined accurately.

In this study, we proposed a method to assess the risk of carcinogenesis by exposure to chemical mixtures in the air. We assumed that the action of each chemical in the mixture was separate when the mechanism of carcinogenesis and the target organs differed among chemicals, and/or when the concentration of each chemical was low enough to neglect interactive actions. Accordingly, the total risk of mixtures was expressed as the sum of the risk of each chemical. We selected 10 chemicals that PRTR data indicate are released in large quantities to the atmosphere, and we calculated their unit risks for carcinogenesis. We estimated carcinogenic risk by using monitoring data collected by municipal corporations on toxic air pollutants. The carcinogenic risk in areas with large populations was higher than in areas with small populations because the concentrations of benzene and formaldehyde are higher in urban areas (Fig. 2). The carcinogenic risk from chemicals in the air tended to decline gradually from FY2001 to FY2002.

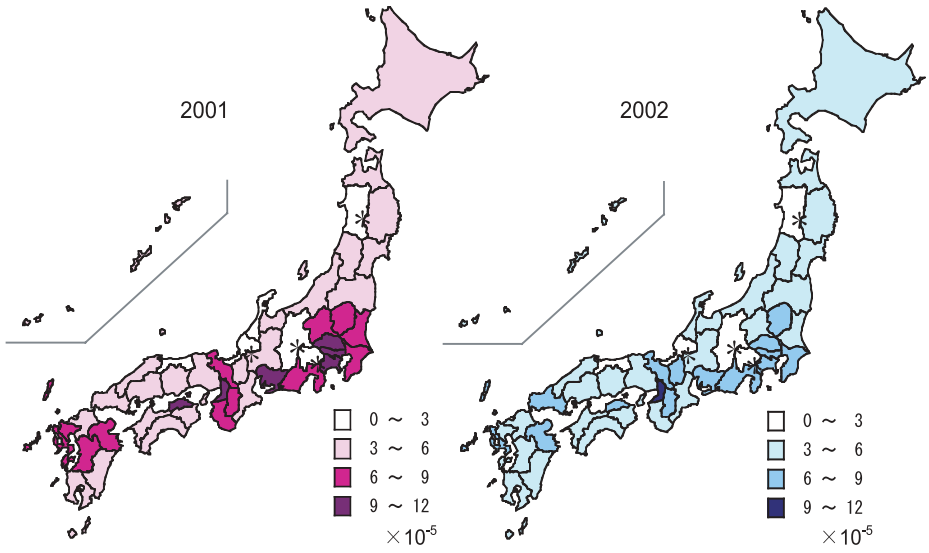


Fig. 2
The carcinogenic risk for exposure to mixtures of benzene, trichloroethylene, tetrachloroethylene, dichloromethane, and formaldehyde in the air. --The life-time cancer incidence by life-long exposure in each prefecture of Japan. There was no monitoring data of formaldehyde in the asterisk–attached prefectures on the map, so the risk for exposure of other four chemicals was expressed in these prefectures.

New attempt to establish a quantitative structure–activity relationship for chemicals with aquatic toxicity

The quantitative structure–activity relationship (QSAR) has become a powerful theoretical tool for the prediction of chemical toxicity on the basis of molecular descriptors. We gathered data from several existing databases and reference sources on the ecological hazards of chemicals. The data were compiled and analyzed to examine intra- and interspecies variations in sensitivity to chemicals and to clarify the relationship between aquatic toxicity and chemical structure.

This study dealt with the classification of acute toxicity predictions on the basis of fragments of molecule and descriptors related to the mode of action of the toxin. We built several QSAR models and investigated the definition of domain identifications for QSAR modeling in consideration of functional cluster, mode of toxic action, and relationship between descriptor variables and toxicity. This technical approach was applied to 96-h LC_{50} values for two fish species (fathead minnow and medaka) by using a dataset of more than 600 chemicals investigated by the Japanese Ministry of the Environment or selected from the literature.

The QSAR models of the classified categories describe the relationship between toxicity and the logarithm of the octanol–water partition coefficient (log K_{ow}). We have started to develop a web-based toxicity prediction system using this QSAR model of fish 96-h LC_{50}s. The output of the system is a chemical classification using fragments of chemical structure, assignment of QSAR equation, predicted toxicity, and applicant domain of QSAR.

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

We conducted a ring test with three private laboratories in Japan to fine-tune the procedure for the new OECD Test Guideline 221, *Lemna* sp. Growth Inhibition Test. The results showed no significant deviations in toxicity by different measurements (frond number, frond area, root number, and total dry/wet weight). The inter-laboratory variation in toxicity values based on frond number ranged from 2.9 to 3.7 mg/L.

Several experiments were conducted in accordance with OECD Test Guidelines 207 (Acute Toxicity) and 222 (Reproduction Test) for earthworms to finalize a draft standard procedure for these earthworm tests. We are participating in an international ring test as part of the OECD test guideline project on soil toxicity in springtails. The results will be summarized by the end of 2006.

Chemical database

To promote chemical management based on risk communication, we are trying to provide the public with adequate risk-related information via a web-based database through the Internet. So far, we have developed the Webkis-plus chemical database, which includes pesticide structures and quantities of shipments into each prefecture, an Environmental Fate Model database, and the EnvMethod environmental analytical methods database (Fig. 3).

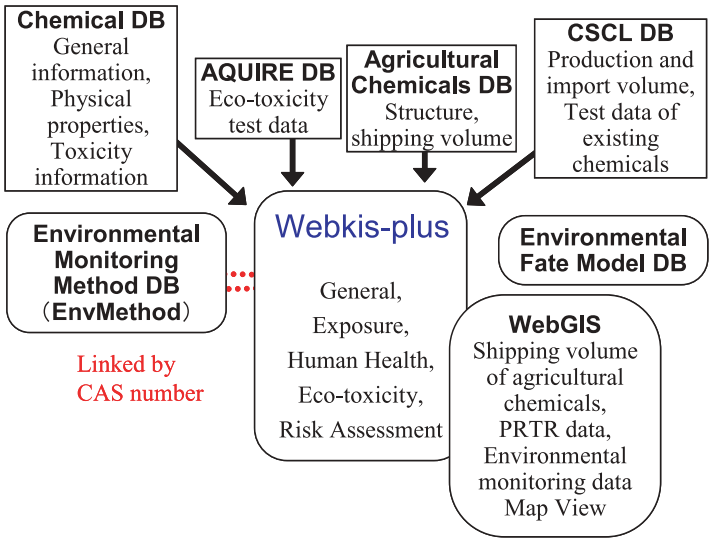
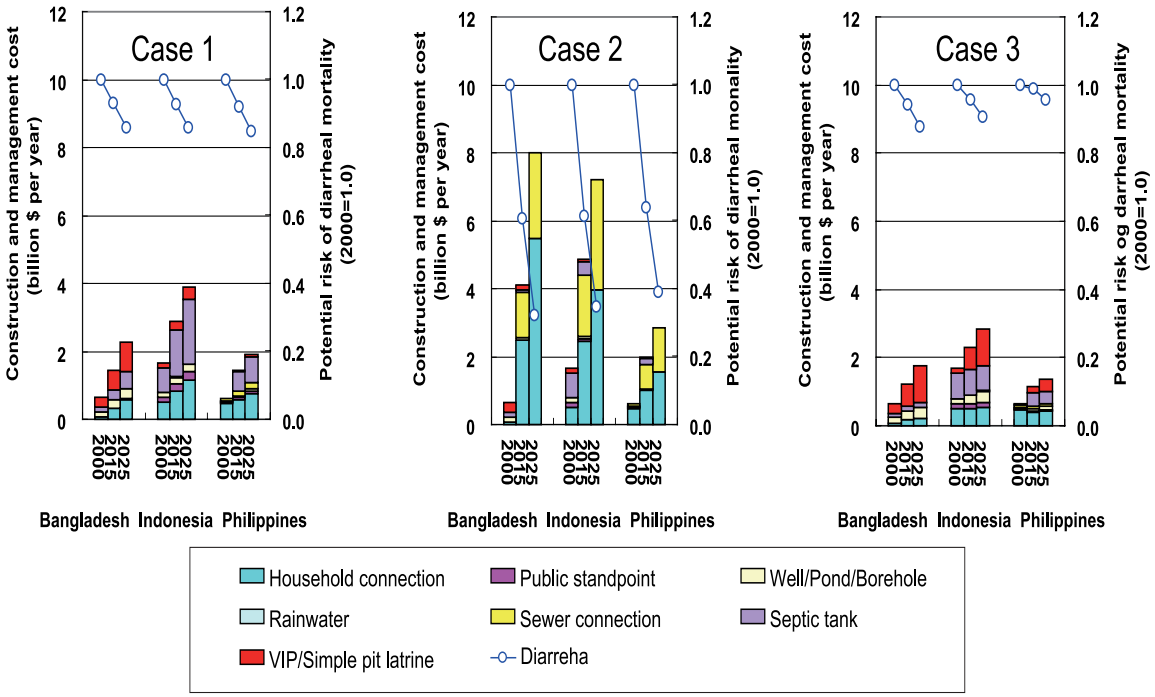


Fig. 3
Webkis-plus; multi-information chemical database constructed with exposure, human health, ecoptoxicity, and risk assessment information.

This financial year, we improved the Webkis-plus chemical database and web page design to make them more convenient and efficient. On the new Webkis-plus web page, users can search for information on a target chemical from categories such as chemical regulation lists, a risk assessment list, and exposure-related information. Users can obtain all the information related to a target chemical at the same time. We have also developed a WebGIS page to provide various items of geographical information related to emission data and environmental monitoring data.

Social and Environmental Systems Division



Case 1: coverage composition ratios classified by technologies in the base year remain fixed in the future

Case 2: universal access to the most advanced technology (household connection)

Case 3: widespread coverage of the least expensive technology (well) in the future

Annual cost of introduction of safe water and sanitation and potential risk of diarrhea mortality in Bangladesh, Indonesia and Philippines in 2000, 2015, and 2025.

Environmental problems can 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 five research sections: Environmental Economics, Resources Management, Environmental Planning, Information Processing and Analysis, and Integrated Assessment Modeling. In addition, there is one Independent Senior Researcher. In FY 2005, the Division conducted the following research.

Environmental Economics Section

(1) People's support for climate change action

In May 2004 we surveyed the audience of a preview of the movie "The Day After Tomorrow" to analyze the movie's influence on people's attitudes toward climate change. Most of the respondents were embarrassed that one of the consequences of global warming was shown as snow storms and freezing, and they also pointed out scenes that they knew were inaccurate from their knowledge of science. Apart from those things about which they felt embarrassed because of lack of knowledge, most respondents were aware of the risks of climate change portrayed by this movie.

(2) Study of effects of unit pricing on waste generation

To explore the effect of unit pricing on waste generation more precisely, we extended the standard econometric model to a model that we consider specializes in autocorrelation. Our main findings were: (a) generation of waste is significantly and negatively correlated with the price of garbage bags; and (b) the effect of the price on waste generation is small.

(3) Study of effects of international moves for sustainable development on Japanese domestic policy

This study focused on how Japanese domestic policymaking on climate change evolved after the Kyoto Protocol came into force in 2005. The Protocol's enforcement gave a strong signal to Japanese policymakers that the 6% emission reduction target was real. On the other hand, contrary to the situation in many other industrialized countries, emissions trading is not yet popular among Japanese stakeholders as a way of achieving the emissions target.

Resources Management Section

The Resources Management Section studies methodologies for quantifying the environmental burdens and impacts associated with various socioeconomic activities. (1) Material flow accounting/analysis (MFA) is one of the key tools used for this purpose. Physical input–output tables (PIOTs) are designed to describe the flows of natural resources, the materials produced, and solid waste and recycled materials. We examined linkages among MFAs and similar analytical tools on various scales. (2) We analyzed the incentives for, and effects of, adoption of the ISO 14001 environmental management standard by firms in Japan and the USA. We used models based on economic and political economic theory to help us understand what factors would encourage firms to adopt ISO 14001 and how the environmental management

systems of these firms work. (3) Another issue was the application of life-cycle assessment (LCA) to the use of underutilized energy sources to reduce CO_2 emissions. (4) We also applied other comprehensive environmental assessment methods, such as conjoint analysis and cost–benefit analysis, to transportation and waste management scenarios.

Environmental Planning Section

We are studying techniques for the planning and evaluation of environmental conservation policies. Our study includes the setting of local environmental policy goals, as well as the prediction of global warming and the assessment of its impacts. In 2005, we conducted the following research. (1) As global warming progresses, so the impacts of temperature increase are being widely detected in Japan and the Asian region (Fig.1 & Table 1). Using future climate scenarios developed by the Japan Meteorological Agency and the Meteorological Research Institute, we estimated future impacts on river runoff and on human health, such as mortality due to heat stress. (2) To prevent future global warming impacts, it is essential to set a long-term target and then consider how to reduce GHG emissions from various sectors. We have developed an integrated assessment model that can analyze GHG emissions, GHG concentrations in the atmosphere, and temperature increase and speed. Using this model, if we set a target temperature increase of 2 °C, then the GHG concentration in the atmosphere should be 475 ppm or lower. This concentration level will be attained by reducing GHG emissions by 2050 to almost half those in 1990.

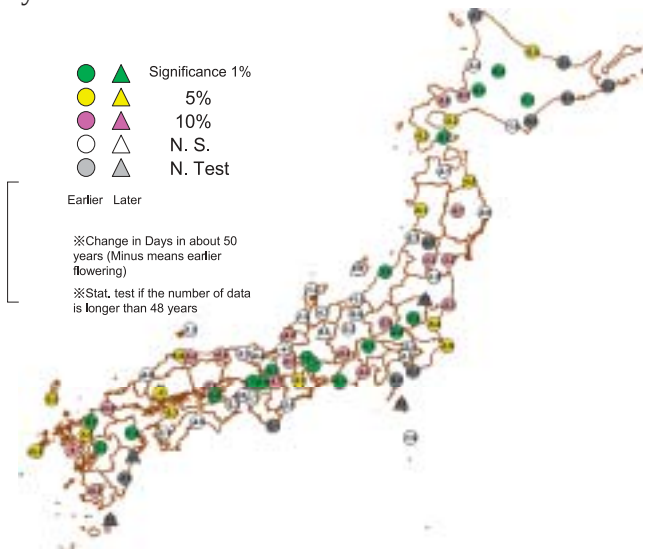


Fig. 1
Predicted earlier flowering of cherry trees in Japan.

Table 1
Identified global warming impacts in Japan.

- rise in sea level of 2 mm per year observed over the past 30 years.
- reduction in the thickness of snow in the ravine at Tsurugidake in Toyoma Prefecture
- *Omiwatari* (‘the divine pathway’, observed at Lake Suwa in winter) seen only infrequently in recent years because of a series of warm winters
- decreased alpine flora in Hokkaido, the northernmost island of Japan, and on high mountains in other areas
- expanded distribution of southern broadleaved evergreen trees such as the Chinese evergreen oak
- appearance of the Nagasakiageha butterfly (*Papilio memnon thunbergii*), whose northern limit was previously the Kyushu and Shikoku Islands, in Mie Prefecture in the 1990s and in the Tokyo area in the early 2000s
- appearance of the southern tent spider, seen only in western Japan during the 1970s, in the Kanto Region in the 1980s
- expansion of the wintering grounds of the white-fronted goose to Hokkaido
- bleaching of coral reefs in the Okinawa islands
- shifting of ermine and grouse, inhabiting mountains such as Hakusan and Tateyama, to higher elevations.

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 from the atmosphere, land, and oceans; the non-destructive and sensitive discrimination of types of bird eggs; and the numerical simulation of diffusion of urban air pollution. We also process and analyze research data generated by the other sections of our Institute. In 2005, 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 investigation of a new method to precisely estimate CO_2 column density from nadir-looking satellite sensor data. In addition, we are applying multisatellite datasets to the prediction of urban heat islands by combining the datasets as a new methodology.

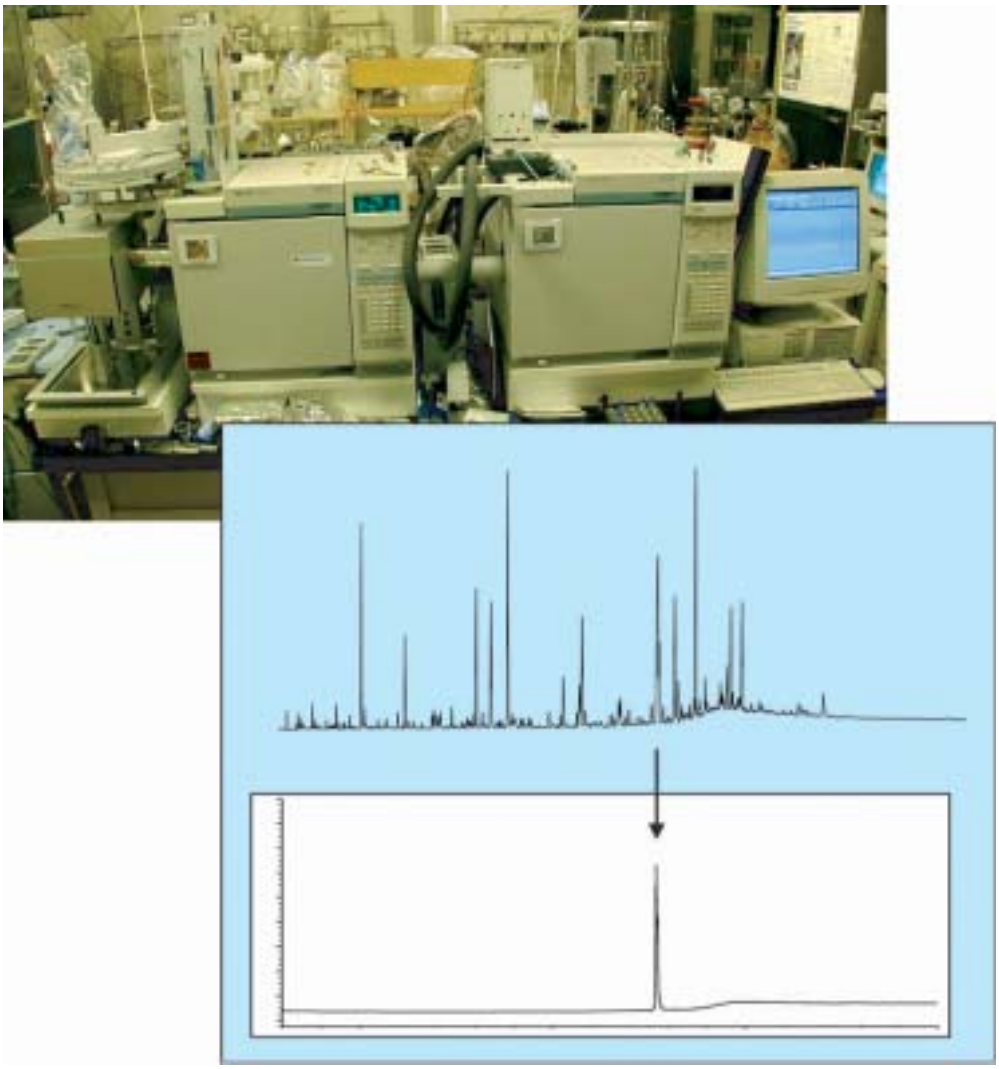
Integrated Assessment Modeling Section

The "Integrated Assessment Model" has been developed to evaluate environmental conservation and its socioeconomic impacts. This model covers a wide range of environmental problems, economic activities, land-use changes, and lifestyle changes. It evaluates the impact of environmental conservation measures on the economy. If we are to conserve the future global environment, it is essential that we cooperate with developing countries in the Asia-Pacific region, such as Korea, China, India, and Thailand. Presently, the priority of environmental conservation in developing countries is much lower than that in developed countries. However, it is essential that developing countries give importance to environmental conservation and include it in their lists of development priorities. We provide assessment tools for air pollution and analysis of its health impact. An integrated assessment framework linking a computable general equilibrium model for macroeconomic assessment, an end-use model for selection of technologies and geographic distribution of air pollutants, a pollutant concentration model, and a physical health impact assessment model is used to estimate the impacts of air pollution under several scenarios. Air pollution policy analysis using several innovative options in China could help to prioritize environmental protection and determine feasible and effective environmental interventions. The model was also applied to the issue of carbon tax in Japan, which is considered to be an economic incentive to accelerate CO_2 reduction countermeasures and thus achieve the target of the Kyoto Protocol.

Report of the Independent Senior Researcher

Landscape appreciations by Western visitors to Japan between 1549 and 1900 was summarized and published in NIES Research Report No. 185. The report described the natural beauty of Japanese landscapes in local areas of Japan. Foreign researchers who stayed in our section described their experiences of Japanese landscapes in NIES Research Report 190. They described the beauty of Japanese landscapes and the weak points of landscape planning by local government.

Environmental Chemistry Division



Purification of a polycyclic aromatic hydrocarbon (PAH) in atmospheric particulate matters by preparative capillary gas chromatography for compound-specific radiocarbon analysis

The Division, with its four Research Sections and an Independent Senior Research Scientist, has been developing analytical, bioanalytical, and geochemical methods and revealing various chemical aspects of the environment.

The **Analytical Instrumentation and Methodology Section** has been developing new analytical methods and instrumentation. Currently a new portable X-ray tube for X-ray fluorescence analysis is being developed for measuring aerosols, so as to give a more accurate understanding of their environmental behavior. The device is intended to measure aerosol concentrations by an electron transmission method and to analyze their components by an X-ray fluorescence method. Graphite is treated with hydrogen plasma to make numerous nanometer-sized craters, called GRaphite-NanoCraters (GRANCs), on its surface; these craters have field electron emission properties comparable to those of carbon nanotubes. The newly developed X-ray tube uses a GRANC as its electron source, making it possible to achieve a device size sufficiently small for both portability and energy efficiency.
The Oceanic Wind Farm Project started in 2003 and is now in progress. The original schematic design has been refined to avoid interference between wind turbines in the front row and those in the rearmost (third) row. The new mega-float measures about 2000 m × 75 m. It has 11 wind-turbines with a total power-generation capacity of 55 MW and a seawater electrolysis system to generate hydrogen.
A study of the dynamics of organic carbon transported to the ocean via rivers was continued by taking carbon isotope measurements of riverine particulate and dissolved matter. To estimate the local sources of halocarbons, the concentration of HCFC-22 was simulated by the regional meteorological model RAMS (Regional Atmospheric Modeling System). As input data, the time constant emission field was taken from the existing GEIA (Global Emissions Inventory Activity). The tagged simulation was conducted with 20 independent tracers by dividing the East Asia region into 20 areas. When compared with observed time series obtained by our in-situ high-frequency monitoring system at Hateruma Island, the calculated values gave one or more corresponding peaks for each observed peak at the same time, assuring the validity of the transport model simulation. We plan to estimate the source distribution by finding the input emission field that best reproduces the observed peaks.

The **Analytical Quality Assurance Section** has been developing methods of analytical quality control by determining the most appropriate environmental analytical methods and preparing certified reference materials. We investigated methods of sample preparation and high-resolution gas chromatography – high resolution mass spectrometry (HRGC-HRMS) analysis of polychlorinated-*p*-dibenzodioxins/furans (PCDD/Fs), co-planar polychlorinated biphenyls (co-PCBs), and polybrominated-*p*-dibenzodioxins/furans (PBDD/Fs) in various environmental samples. We successfully performed analytical quality assurance of environmental PCDD/Fs monitoring by using the certified environmental reference material (CRM) NIES CRM-No. 25, “Soil 2”. We used liquid chromatography – mass spectrometry (LC-MS) to perform environmental monitoring of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and related perfluorochemicals (PFCs), which have

characteristics similar to those of persistent organic pollutants (POPs). POPs in the ambient air at Hateruma Island were monitored continually, and back-trajectory analysis has been applied to the data. We also studied thermal desorption – GC-MS (TD-GC-MS) for the organic microanalysis of fine particles in the atmosphere.

The **Environmental Chemodynamics Section** has been investigating the application of surface analytical methods such as secondary ion mass spectrometry (SIMS) and analyzing stable isotopes by isotope ratio mass spectrometry (IRMS) and multi-collector inductively coupled plasma mass spectrometry (MC-ICPMS). The accelerator mass spectrometry (AMS) facility, NIES-TERRA, conducted about 1800 radiocarbon measurements this financial year. Samples included airborne particles, coral skeletons, and organic compounds from marine sediments. A newly designed gas-ionization detector and its control system were installed for ^{10}Be and ^{36}Cl analysis.
Plant damage was found around a factory that produced boron-containing materials. The chemical compositions of source pollutants (airborne boron compounds) and their pathways from the source were investigated. Coexisting elements such as alkaline metals may form borates with boron, thus increasing the volatility of the pollutant particles. The temperature and humidity of flue gas presumably control the formation and hydration of boron compounds.
Pebbles coated with a thin black layer were found in a river system draining strongly acidified water from tea plantations. The coating consisted of manganese oxides deposited by Mn(II)-oxidizing microorganisms. It was analyzed by powder X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS) to elucidate the chemical and mineralogical characteristics of the biogenic manganese oxides.
Samples of hazardous chemicals in surface seawater were collected from the Mediterranean Sea, the Northern Atlantic Ocean, and the Pacific Ocean between Japan and the USA. We detected parts per quadrillion (ppq) levels of hexachloro cyclohexanes (HCHs) and chlordanes in almost all samples.

The **Ecological Chemistry Section** analyzed f water and bivalves collected along the coastline of Japan for perfluorochemicals, particularly at several points in Ibaraki and Ishikawa prefectures, where high concentrations of these chemicals were found. Research continued on arsenic—especially diphenylarsinic acid (DPAA) and related chemicals, including phenylmethylarsinic acid (PMAA)—as well as endocrine-disrupting chemicals. Ten PMAA-containing rice samples were homogenized, and their concentrations were analyzed to select rice suitable for producing reference materials for method development and analytical quality control.
Fundamental research to develop an ecotoxicological assay method and to harmonize methods for the use of medaka fish for bioassay in Japan and Korea was conducted. Our initial risk assessment of pharmaceuticals in the aquatic environment continued.

The Independent Senior Research Scientist continued high-frequency monitoring of atmospheric halocarbons on Hateruma Island. Rates of emission of HFCs from China were estimated from these observations. In a survey of methyl chloride-emitting plants on Iriomote Island, 32 species (17 families) were found to be methyl chloride

emitters among 214 species (85 families) tested. Measurement of the methyl chloride distribution over the island suggested an emission rate of about 5 to 100 $\mu g \cdot m^{-2} \cdot h^{-1}$ from the subtropical forests.

Radiocarbon (^{14}C) analysis for the source apportionment of carbon and polycyclic aromatic hydrocarbons (PAHs) in atmospheric samples was conducted in collaboration with other researchers as part of special research on fluorinated and other persistent organic compounds. ^{14}C is present in biological tissues and products but absent in fossil fuels such as coal and oil. Thus, ^{14}C is expected to be a good tracer for identifying and quantifying carbon from biological sources among carbon from fossil fuels. Atmospheric particulate matter (APM) was collected from various locations, including Tsukuba and central and western Tokyo. pMCs (percentages of modern carbon = contribution of biomass-derived carbon) varied from less than 10% along the side of the road to Kawasaki to 80% in Tsukuba, showing the dominant nature of fossil fuel carbon (from automobile exhaust gas) at the Kawasaki site and of biomass carbon (from biomass burning and/or secondary particles made by plant VOCs) at the Tsukuba site. The pMC was about 40% in central Tokyo. PAHs were extracted, cleaned, and purified from APM from western Tokyo by a combination of liquid chromatography and preparative capillary gas chromatography (PCGC; see Figure). The pMCs in these samples ranged from 20% to 40%, showing the presence of varying amounts of PAHs derived from biomass burning. Biomass carbon thus contributed considerably to the APM and PAH fractions, even in the Tokyo area. More research is needed to clarify the major sources and production mechanisms of biomass-derived PAHs.

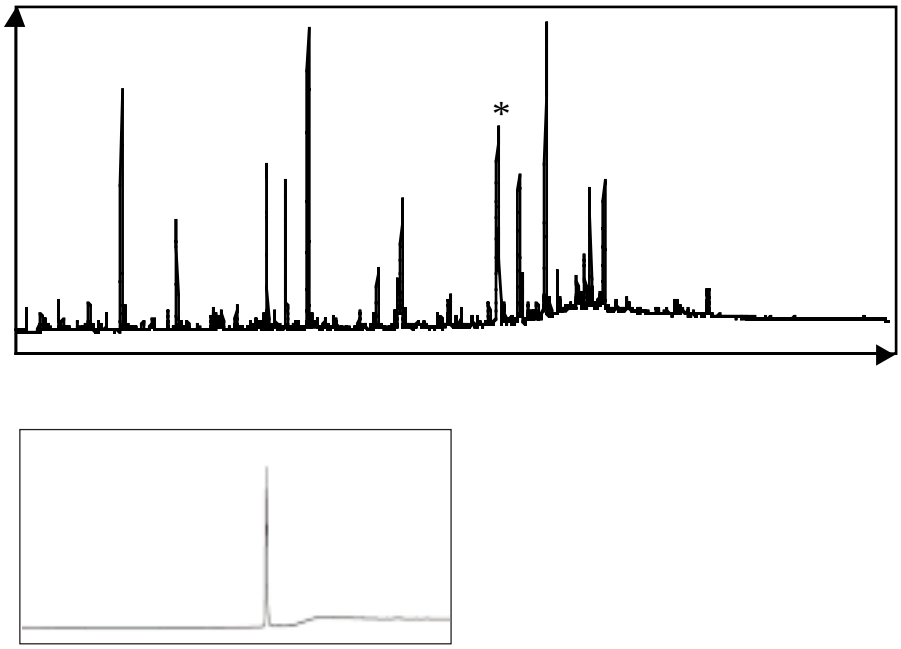
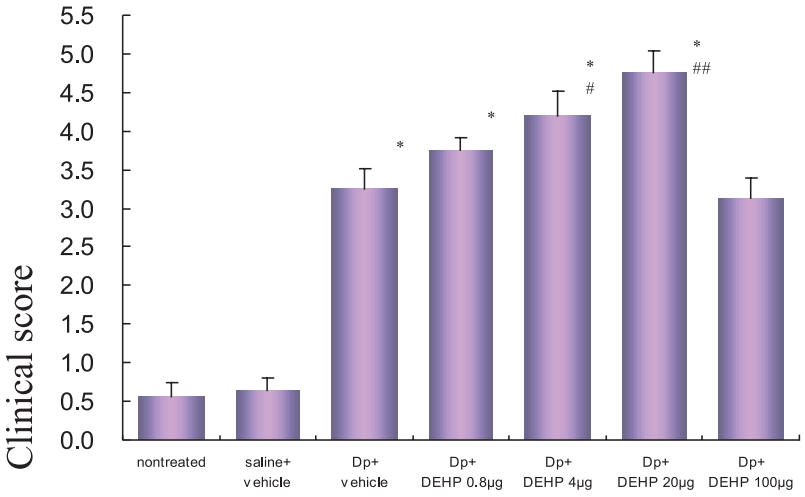


Fig. 1
Gas chromatography – flame ionization detection (GC-FID) chromatograms of a PAH mixture (top) and a particular compound isolated by PCGC (below).
* in the top figure corresponds to the isolated peak.

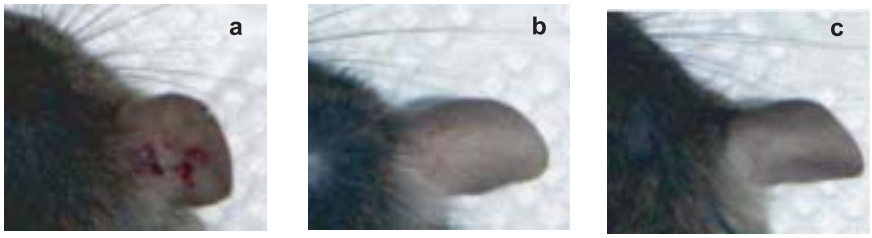
Environmental Health Sciences Division

Di-(2-Ethylhexyl) phthalate (DEHP) enhances symptoms of atopic dermatitis-like skin iesion



*; p<0.05: Dp treated groups vs. nontreated group and saline+vehicle group
#; p<0.05: Dp+DEHP 4 μg/body group vs. Dp+vehicle group
##; p<0.01: Dp+DEHP 20 μg/body group vs. Dp+vehicle group

DEHP: Di-(2-Ethylhexyl) phthalate , Dp: house dust mite allergen



DEHP enhances macroscopic findings of atopic dermatitis-like skin lesion in mice

a: ear of mice treated with house dust mite allergen +DEHP (20 μg/animal/week)
b: ear of mice treated with house dust mite allergen alone
c: ear of mice with no treatment

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. heat stress; noise stress; ultraviolet radiation; the blue components of LED light; and extremely low frequency 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.

The **Director** elucidated the mechanisms by which environmental chemicals enhance the effects of allergic diseases. To our knowledge, his study is the first to report that di-(2-ethylhexyl)phthalate can enhance atopic dermatitis-like skin lesions. Furthermore, he examined the effects of nanoparticles on health—especially on the respiratory, cardiovascular, and immunological systems, and on the skin.

The **Principal Senior Researcher's** aim was to elucidate the relationship between the chemical characteristics of the organic compounds adsorbed on diesel exhaust particles (DEP) and their biological effects (heme oxygenase-1 protein expression, viability of rat epithelial cells, and infiltration of inflammatory cells). The results suggest that the polar fraction of the organic compounds has high oxidative ability and many functional groups related to oxygenation, and that this oxidative ability contributes to oxidative stress, cytotoxicity, and the inflammatory response.

In the **Molecular and Cellular Toxicology Section**, we are conducting studies to clarify the biological pathways and mechanisms of effect of environmental pollutants—mainly on immune function—by utilizing a toxicogenomics approach. Various environmental chemicals induce thymic atrophy and/or cause immune suppression. Because some of them are known to activate transcription factors or nuclear receptors to exert their biological functions, characterization of the changes in gene expression in thymuses exposed to this category of chemicals might effectively reveal the distinctive and common biological pathways involved in thymic atrophy and possibly in immune suppression. Mice were exposed to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), sodium arsenite ($NaAsO_2$), perfluorooctane sulfonate (PFOS), β-estradiol (E2), and a synthetic glucocorticoid (GC) dexamethasone (DEX) at doses that reduce thymus weight by 30% to 50%. Total RNAs were prepared from the thymuses 24 h after administration, and changes in gene expression were examined by using Affymetrix oligonucleotide microarrays. $NaAsO_2$ downregulated a group of genes involved in a pathway regulating the cell cycle. DEX upregulated the GC-induced leucine zipper (GCLZ) gene, which is reported to be responsible for glucocorticoid-induced thymic atrophy. Upregulation was also recorded in some other genes that are known to interact with the GCLZ. On the other hand, TCDD affected only a small number of genes, including *cyp1a1*. E2

and PFOS induced very few prominent changes in gene expression. These results suggest that $NaAsO_2$ and DEX induce thymic atrophy by affecting individually distinctive pathways. However, TCDD, E2, and PFOS either do not induce thymic atrophy through direct gene expression changes, or they affect so few thymocytes that changes in gene expression cannot be detected in analyses of whole thymocyte populations.

In the **Environmental Biodefense Research Section**, we sought to investigate whether the effects of carbon black (CB) particles and lipoteichoic acid (LTA) on early pulmonary inflammation were additive or synergistic. BALB/c mice were subjected to intratracheal instillation of CB particles, CB particles (14- or 95-nm diameter) + LTA, or LTA alone. Levels of some proinflammatory indicators and TLR2-mRNA expression were significantly increased 4 h after instillation of both 14- or 95-nm CB particles and low-dose LTA, compared with CB or LTA alone. Notably, 4 h after the instillation, PMN levels and production of IL-6 and CCL2 in the 14-nm CB + LTA group were significantly higher than in the 95-nm CB + LTA group. These results suggest that the administration of ultrafine CB particles with LTA may potentiate LTA induced-pulmonary proinflammatory responses. In our second study, to examine the hippocampal neurobiological responses of mice to chronic toluene exposure, we exposed C3H/HeN female mice to 50 ppm toluene or filtered air for 6 h a day, on 5 consecutive days of the week for 6 or 12 weeks. Long-term exposure of mice to 50 ppm toluene caused a significant upregulation of NMDA receptor subunit 2B expression in association with simultaneous induction of CaMKIV and CREB-1 production in the hippocampal tissues. Our data indicate that *in vivo* transcriptional upregulation of these genes in the hippocampus of our mouse model following chronic exposure to toluene may be an NMDA receptor-related neuroprotective mechanism of gene expression. This experimental model should help future studies to understand the *in vivo* mechanisms of the central nervous system response to toluene at the molecular and cellular levels (Fig. 1).

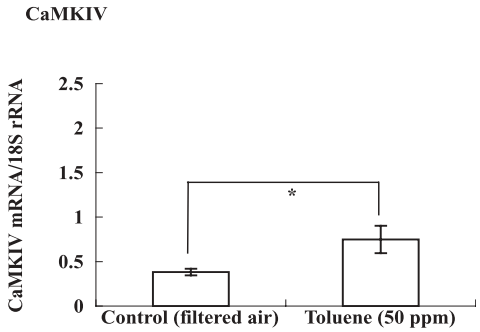
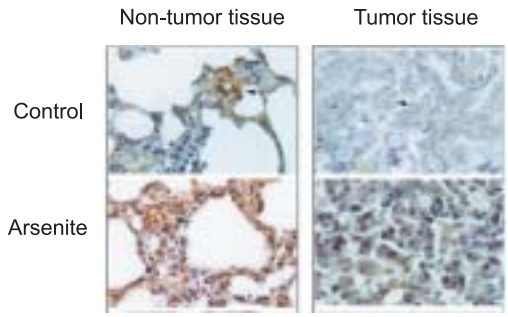


Fig. 1
Induction of CaMKIV expression in the hippocampus of mice exposed to toluene for 6 or 12 weeks.

In the **Biomarker and Health Indicator Section**, we investigated (1) the mechanism of detoxification of inorganic arsenicals; (2) the carcinogenicity of arsenate; and (3) the synergism between the effects of airborne particulate materials and endotoxin. Inorganic arsenicals are worldwide environmental contaminants, and chronic exposure to arsenic is known to cause skin lesions, vascular diseases, and cancers. Rats were treated with inorganic arsenicals, and arsenic metabolites in the bile were measured by high-performance liquid chromatography – inductively coupled plasma mass

spectrometry (HPLC-ICPMS). The biliary metabolites were found to be highly toxic trivalent arsenicals. However, hydrogen peroxide was excreted in the bile fluid of arsenic-treated rats, and the toxic trivalent arsenicals appeared to be converted to less toxic pentavalent arsenicals. The oxidation of trivalent arsenicals by hydrogen peroxide is at least one of the mechanisms of detoxification of inorganic arsenicals. Lung adenocarcinoma and liver cancer occur at high incidence in A/J mice and C3H mice, respectively. We found that chronic intake of arsenate via drinking water changed the cancer rate and tumor size. Arsenate intake seemed to modify the DNA methylation of the anticancer genes in these tissues, which may regulate the tumor production. Inhaled particulate materials are implicated in host susceptibility to infectious diseases. We observed that intratracheal or inhalational administration of urban particles or ultrafine carbon materials to mice exacerbated bacterial endotoxin-induced pulmonary inflammation and the production of proinflammatory cytokines and chemokines (Fig. 2).



Expression of RASSF1A in arsenite-exposed mouse lungs

Fig. 2
Production of tumor suppressor protein RASSF1A in lung of an arsenite-exposed mouse

The **Epidemiology and International Health Research Section** conducted a number of epidemiological studies. One was a series of field studies in Japan and China and another was a statistical analysis of trends in various health phenomena, with special reference to environmental factors. With the financial support of the Japanese Ministry of the Environment, we conducted field research on the measurement of fine particulate matter ($PM_{2.5}$) using personal $PM_{2.5}$ samplers, and assessed residential exposure to $PM_{2.5}$ in seven cities in Japan. We selected 20 households as participants in each city, and measured $PM_{2.5}$ concentrations inside and outside the participants' houses and personal exposure over 1 week in summer. As a field survey in the city of Shenyang, in Liaoning Province in China, we continued earlier health investigations (pulmonary function testing and a questionnaire survey of schoolchildren), environmental monitoring, and exposure assessment of air pollutants (in particular, $PM_{2.5}$). Results from the three cities of Shenyang, Fushun, and Tieling, where the survey had been conducted in previous years, confirmed elevated levels of atmospheric pollutants both outdoors and indoors from the combustion of fossil fuels, as well as personal exposure. Pulmonary function values among children were significantly depressed at the end of the winter heating period. This result suggests that winter air pollution has subacute effects on pulmonary function. We also conducted research on the effects of heat stress on human health. We established a system of using an emergency transportation network to monitor patients affected by heat shock in 13 major cities. We also started a study on air pollution exposure during road travel, and we conducted pilot surveys in Tokyo and Shenyang.

Atmospheric Environment Division

Atmospheric measurements at Tarawa, Kiribati (lat 1°N, long 173°E)

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 four sections and one team: the Atmospheric Physics Section, which conducts research on numerical modeling and data analysis of atmospheric dynamics and climate systems; the Atmospheric Chemical Reaction Section, which conducts research on chemical processes taking place in the atmosphere; the Atmospheric Remote Sensing Section, which studies the atmospheric environment using remote sensing techniques such as lidar (laser radar); 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 and DEP Research, and the Center for Global Environmental Research.
Following are brief accounts of some of the important results of our research in FY 2005.

Detecting natural influences on surface air temperature change in the early 20th Century

We are analyzing surface air temperature datasets simulated by a coupled climate model forced with different external forcings, to diagnose the relative importance of these forcings to the warming observed in the early 20th century. The geographical distribution of linear temperature trends in the simulations forced only by natural contributions (combined effects of solar irradiance changes and recovery from large amounts of volcanic activity) showed better agreement with observed trends than in the simulations forced only by well-mixed greenhouse gases. Using an optimal fingerprinting technique, we detected a significant natural contribution to early 20th century warming. In addition, the amplitude of our simulated natural signal was consistent with the observations. We further partitioned the responses to the natural external factors, detecting both solar and volcanic signals in the observed early warming. Over the same period, however, we could not detect a greenhouse gas signal in the observed surface temperature in the presence of the external natural forcings. Hence, our analysis suggests that external natural factors caused more warming in the early 20th century than did anthropogenic factors.

Continuous measurement of aerosol chemical composition at Cape Hedo, Okinawa

The chemical compositions of aerosols have been monitored continuously with an aecome possible. A nitrate monitor, a tapered element oscillating microbalance (TEOM) particle monitor (for measuring mass concentration), and a lidar system have been added to the station. Not only these chemical analysis systems but also many kinds of instruments to monitor the physical and radiative parameters of aerosols have been set up in collaboration with other research institutes, including universities. A large-scale Asian dust storm, Kosa, reached Okinawa in November 2005. This Kosa phenomenon was observed by both the lidar system and the chemical analysis systems. Fine anthropogenic particles rich in sulfates arrived earlier than the large particles.

Development of a fast and sensitive detector for volatile organic compounds

A proton transfer reaction time-of-flight mass spectrometer has been developed for the real-time measurement of volatile organic compounds (VOCs) in air. The instrument is operated with a DC discharge ion source and an ion drift tube. The detection limits for propene, acetaldehyde, acetone, isoprene, benzene, toluene, and p-xylene are estimated to be in the range of 10 to 100 pptv over a 1-min integration time. The potential to detect oxygenated VOCs (aldehydes, ketones, and alcohols), halocarbons, and amines has been demonstrated. The instrument shows a good linear response at ppbv levels and can be used for on-line detection of large variations in emission sources in real-time.

Latitudinal distribution of atmospheric potential oxygen across the western Pacific during 2001–05

Atmospheric potential oxygen (APO) is a new tracer, defined as a combination of O_2 and CO_2 ($APO = O_2 + 1.1 \times CO_2$). Because it is conservative with respect to terrestrial biotic exchanges, APO is useful for studying air–sea gas exchanges related to physical and biological oceanic processes. Although coupled ocean–atmosphere models have predicted the equatorial elevation of annual mean APO [Stephens et al. 1998; Gruber et al. 2001], this distinct distribution had not been validated, because of the lack of regular APO observations in equatorial regions. To observe the latitudinal distribution of atmospheric APO across the western Pacific, we have been collecting air samples on board cargo ships sailing between Japan and the USA and between Japan and Australia or New Zealand since December 2001. The observed APO distribution for each year shows good agreement with the model-simulated APO distribution of Gruber et al. (2001) (Fig. 1). Note that the individual latitudinal distributions for 2002, 2003, 2004, and 2005 have been shifted to visually fit the model-simulated distribution, because the absolute value of APO is arbitrary. The density of our data, which were based on regular shipboard sampling, is significantly higher than that of the results of previous studies. Accordingly, our results, which were based on 4-year records, strongly support the existence of the equatorial APO elevation predicted by models.

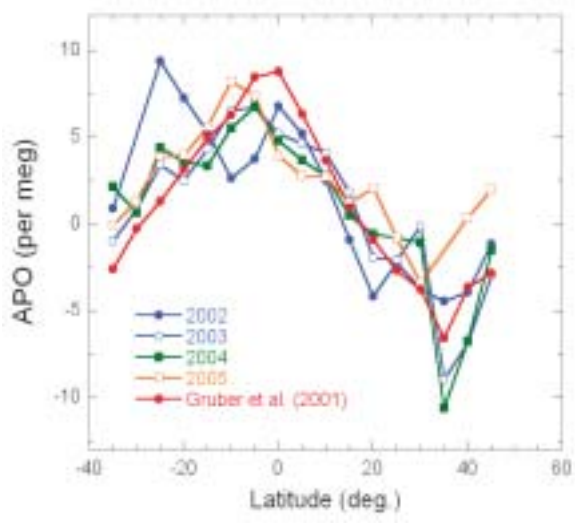


Fig. 1
Comparison of latitudinal distributions of annual mean APO (atmospheric potential oxygen) observed during a 4-year period from 2002 to 2005 with the model simulation results of Gruber *et al.* (2001). Profiles of the observed APOs for individual years were shifted to visually fit the model-simulated APO profile.

Observations of Asian dust and air pollution aerosols using a network of automated lidars

A network of automated two-wavelength dual-polarization lidars has been formed in collaboration with universities and research institutes in China, Korea, Thailand, and Japan. At present, lidars are operated continuously at 15 locations, including Beijing, Hohhot, Suwon, Nagasaki, Toyama, Matsue, and Tsukuba. Movement of Asian dust and anthropogenic aerosols was clearly revealed by using a data analysis method to separately estimate the extinction coefficient profiles of non-spherical particles (mineral dust) and spherical aerosols (mostly air-pollution aerosols). The lidar network data were used for validation of chemical transport models (Fig. 2). Lidar observations were also performed at Tarawa (on Kiribati) and from the Research Vessel *Mirai* to study the characteristics of aerosols and clouds.

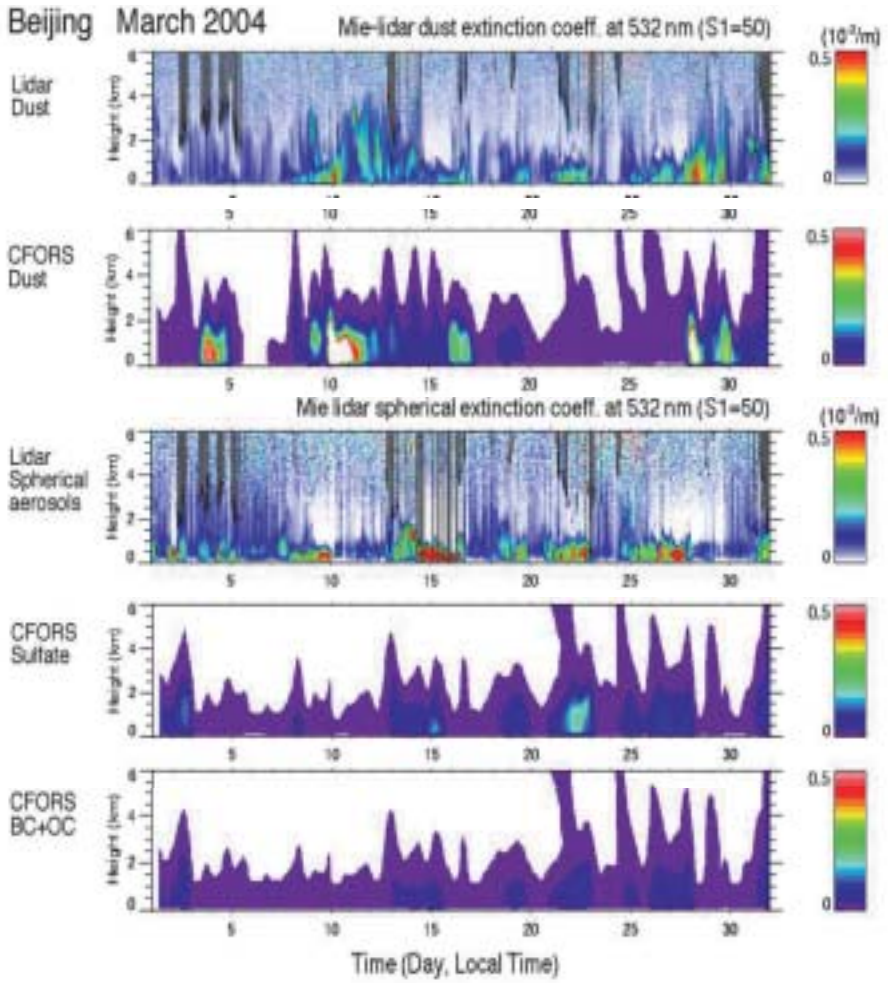
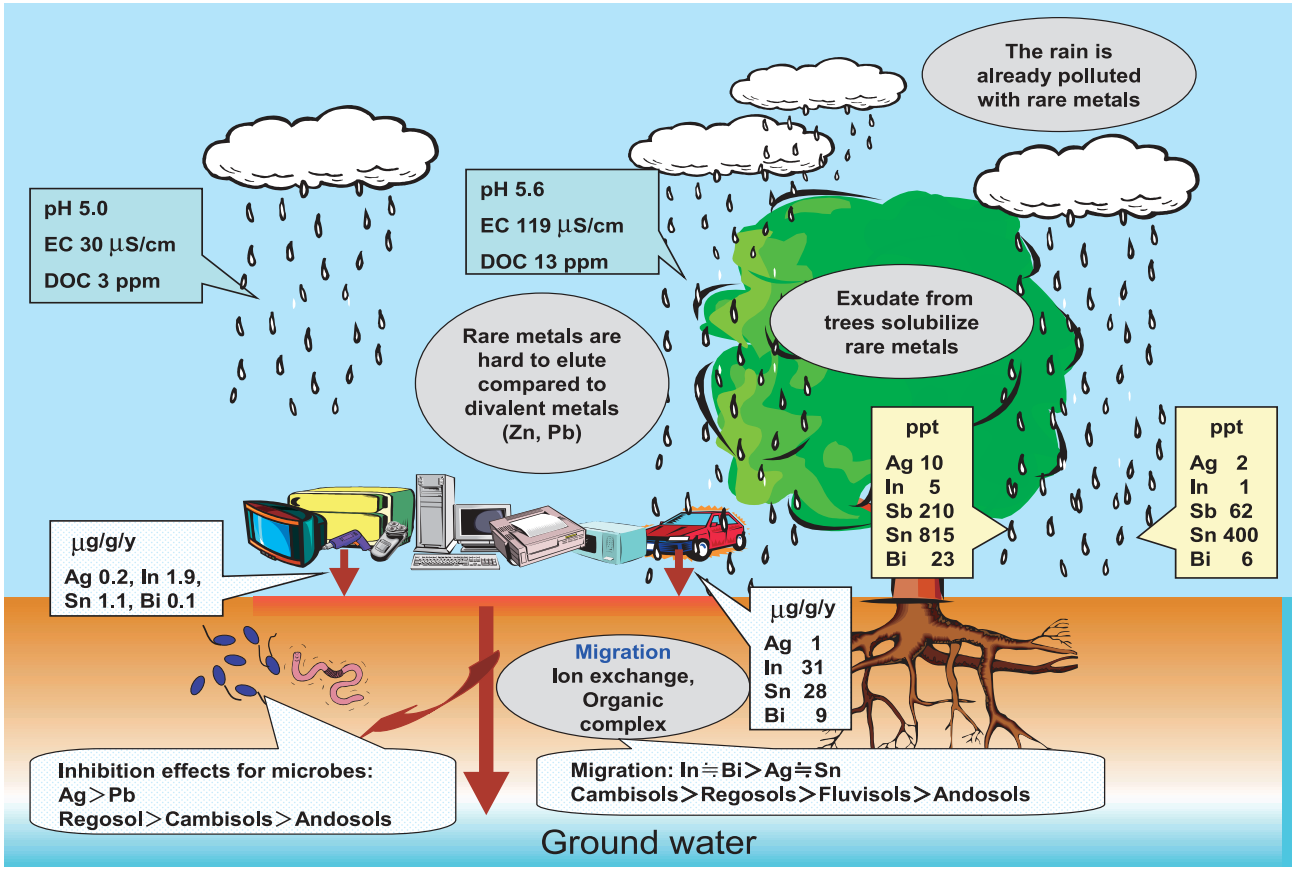


Fig. 2
Example of comparison between a lidar observation and the model forecast. The extinction coefficients of Asian dust and air-pollution aerosols observed with the lidar in Beijing are compared with the extinction coefficients of dust, sulfate, and carbonaceous (black carbon and organic carbon) aerosols, as calculated by the Chemical Weather FORecast System (CFORS).

Water and Soil Environment Division



Study on conservation of the soil environment: hypothetical diagram of diffusion paths of rare metals from solders and wastes.

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 water quality management

Microorganisms play a major part in various important biogeochemical transformations, such as mineralization of organic compounds and degradation or removal of pollutants. We are studying the community structure and biological activity of microorganisms in the natural environment and their application to water treatment and remediation strategies.

We are continuously researching the following two themes: analysis of bacterioplankton in a eutrophicated lake in response to seasonal change, and development of an appropriate methane fermentation technology for the treatment of low-strength wastewater under ambient temperature conditions.

This year, we began a study of technologies for the bioremediation of arsenic-contaminated environments. Arsenic (As) has become one of the most prevalent soil contaminants in Japan; therefore, its remediation is now an important environmental concern. We proposed a novel technique for the extraction of arsenic from contaminated soil or sediment using dissimilatory arsenate-reducing bacteria (DARB), and we performed preliminary examinations. The proposed concept is based on the fact that arsenite (As(III)), which is the product of microbial reduction of arsenate (As(V)), is much more soluble or less adsorptive to soil than As(V); thus, reduction could promote leaching of As from the soil. In batch tests, DARB were inoculated into a slurry of model As-contaminated soil and a basal salt medium, and As extraction was tried under anoxic conditions, with lactate as the electron donor, in sealed vials. The DARB could successfully extract As from the model soil up to a concentration of 20% in the slurry, whereas a slight decrease in efficiency was observed in 50% slurry. Furthermore, we filled a column with the model As-contaminated soil, inoculated DARB and fed lactate-containing medium into the column for continuous As extraction. This bioreactor achieved approximately 42% removal of As from the soil during a 2-week operation, whereas the control test without the DARB resulted in less than 7% removal.

Study on the solubility of rare metals (Ag, In, Sn, Sb, and Bi) from lead-free electronics waste and their mobility in soils

Because of recent concerns about the toxicity of lead to living organisms, materials once made of lead are now increasingly being made of lead-free materials. As a result, there have been increases in the use of bismuth (Bi), silver (Ag), antimony (Sb), indium (In), and other materials (Cu or Zn), as these materials have replaced lead in many types of solder and in other applications. Thus, in future, heavy metal contamination by these replacement metals is expected to become a serious problem.

We tried to obtain further information about the solubility of rare metals from lead-free solders and their mobility in soils. Several kinds of solder were exposed to precipitation under the canopies of trees (*Cryptomeria japonica*, *Pinus densiflora*, *Quercus myrsinaefolia*) and in open spaces. Furthermore, rare metals were added to surface soils in columns, and the soils were then exposed to precipitation for 18 months. Upon exposure of the solders to precipitation, rare metals leached out to a much smaller extent from the lead-free solders than did Pb from the lead solder. The solubility of the metals from the solders was in the order In > Sn > Bi > Ag > Pb. Rare metals were leached out to a much greater extent under the tree canopies, because the exudates released from trees have the ability to solubilize rare metals. The mobility and chemical fractions of the metals added to the soils were analyzed by an eight-step sequential extraction. Most of the metals were retained in the uppermost (0–2 cm) soil layers, but small portions (exchangeable, carbonate-bound and metal – organic complex-bound) moved to the sub-layers. The capacity of the soils to retain the metals was in the order Andosol > Fluvisol > Regosol = Cambisol. The mobility of the metals was in the order In = Bi > Sb > Ag = Sn (See the front page of this division).

Study on the formation of bromo-substituted triclosan derived from antimicrobial soap and toothpaste, with the aim of conserving the aquatic environment

Triclosan (2,4,4′-trichloro-2′-hydroxydiphenyl ether; TC) is a major ingredient of antimicrobial soap and toothpaste, and it is often detected in aquatic environments. TC is known to form three chloro-derivatives, 2′,3,4,4′-tetrachloro-2-hydroxydiphenyl ether (3-Cl-TC), 2′,4,4′,5-tetrachloro-2-hydroxydiphenyl ether (5-Cl-TC), and 2′,3,4,4′,5-pentachloro-2-hydroxydiphenyl ether (3,5-Cl_2-TC) during chlorination for sterilization of wastewaters, but information on its reactions in real aquatic environments is limited. Hence, we investigated the effects of several coexisting materials on chlorination efficiency of TC to estimate the true behavior of TCs in aquatic environments.

TC decreased faster when the reaction was carried out in the presence of sodium chloride; moreover, four new peaks appeared in the HPLC chromatogram of the reaction mixture, in addition to the abovementioned three chloro-derivatives. The newly formed chemicals were assigned as 3-bromo-2′,4,4′-trichloro-2-hydroxydiphenyl ether (3-Br-TC), 5-bromo-2′,4,4′-trichloro-2-hydroxydiphenyl ether (5-Br-TC), (3 or 5)-bromo-2′,4,4′, (5 or 3)-chloro-2-hydroxydiphenyl ether ((3,5)-(BrCl)-TC), and 3,5-dibromo-2′,4,4′-trichloro-2-hydroxydiphenyl ether (3,5-Br_2-TC) by GC-MS and ^{1}H-NMR. Commercially available sodium chloride contains about 0.01% bromide; the bromide ion was determined to be the source of the side reactions. The reaction route of the decrease in TC was changed by the presence of 80 μg L^{-1}, or higher, of bromide; these levels of bromide are sometimes found in environmental waters. The formation of such bromo-derivatives may occur in the real environment and may cause changes in the behaviors and effects of chemicals in aquatic environments.

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; this may be a new type of lake-water pollution. The accumulation of recalcitrant DOM in lake water—a phenomenon that has not been considered before—will clearly influence the ways in which lakes are managed for environmental protection. It also presents a serious challenge for drinking-water management, because recalcitrant DOM could be a major precursor of the trihalomethane produced during chlorination in water treatment.

In lake water, one of the most important sources of autochthonous DOM (i.e. DOM produced within the lake itself) is extracellular DOM released from phytoplankton. To examine the characteristics of DOM released from phytoplankton, we grew an axenic culture of Microcystis aeruginosa, a typical bloom-forming cyanobacterium, in the laboratory and applied to the culture a DOM resin-adsorption fractionation method that divides DOM into five fractions: aquatic humic substances (AHS), hydrophobic neutrals, hydrophilic acids (HiA), bases, and hydrophilic neutrals (HiN).

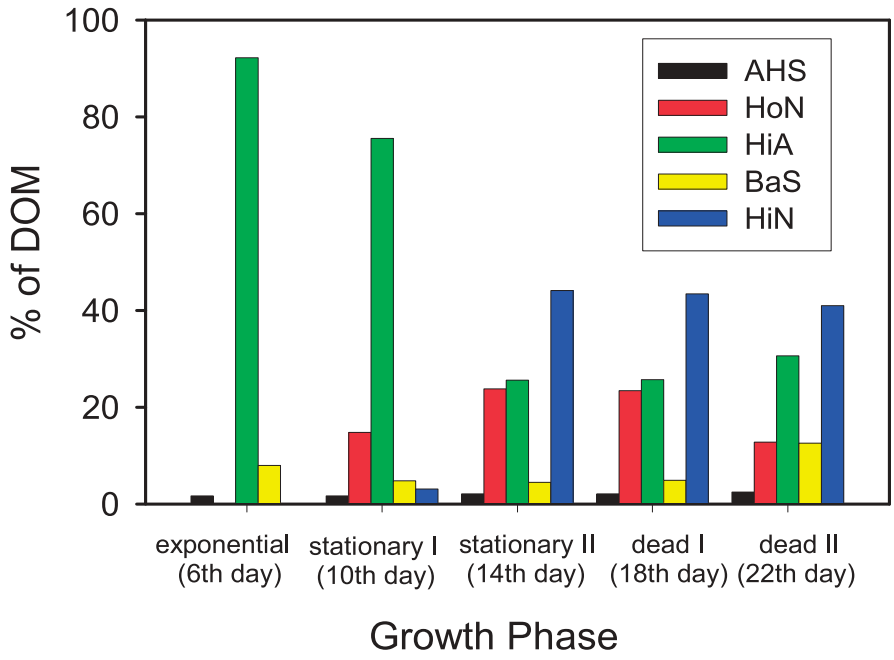


Fig. 1
Fractionation of algal dissolved organic matter (DOM) released from *Microcystis aeruginosa*. DOM fractions are AHS (aquatic humic substances), HoN (hydrophobic neutrals), HiA (hydrophilic acids), BaS (bases), and HiN (hydrophilic neutrals).

The fraction distribution of the DOM released from *M. aeruginosa* varied depending on the growth phase (Fig. 1). HiA was predominant during the exponential and early stationary phases, accounting for more than 70% of the DOM, whereas HiN became a dominant fraction during the stationary and dead phases, accounting for about 30% of the DOM. This HiN dominance is reasonable, since phytoplankton under senescent and decaying conditions are known to excrete a substantial amount of polysaccharides, which are categorized as HiN. However, it is surprising that *M. aeruginosa* produced a negligible amount of AHS as extracellular DOM. This implies that algal-derived AHS may not exist in significant quantities in eutrophic lakes where *M. aeruginosa* dominates as phytoplankton.

Numerical simulation study on the transport and dispersion of coral larvae with the aim of selecting a prioritized marine protected area (MPA) around a coral reef

Not only the quality of seawater, but also many dynamic processes—physical, biological, and chemical—characterize the marine environment. Among the works under way at the Laboratory of the Marine Environment, the following study aims to clarify the mechanism of transport of coral eggs and larvae by water flow and their settlement on shallow water and how it contributes to the maintenance of biological diversity of a coral reef. The study is based on a numerical simulation model of water flow and the trajectories of floating particles in the Sekisei Reef Lagoon, Okinawa, Japan. This study also intends to contribute to the identification of prioritized MPAs, which include those spawning areas from which the coral particles can most efficiently reach the recruitment area after several days without being flushed out to the open sea. We found that a continuing wind is effective in transporting the coral particles over such a time span. Under the southerly wind conditions that prevail in summer in this area, the particles released from the southern part of the lagoon tend to settle efficiently within the lagoon (Fig. 2). Therefore, the southern part of this lagoon would be considered a prioritized MPA. On the other hand, under variable winds the particles released from the central part of the lagoon tend to settle efficiently, but those from the outer rim of the lagoon tend to be flushed out.

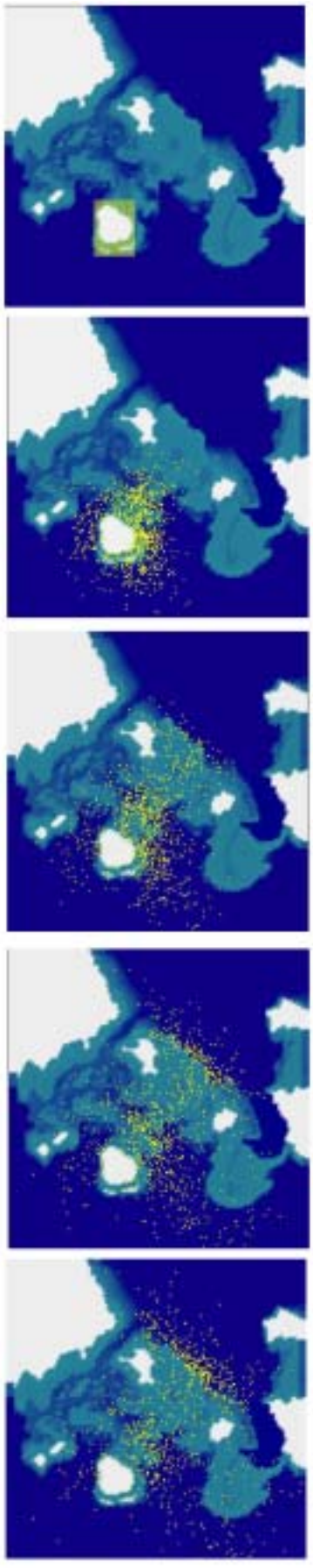


Fig. 2
Transport and dispersion of coral larvae spawned from the lagoon around Kuroshima in the Yaeyama Islands of Okinawa, Japan. Top to bottom: computer simulations under a southerly wind 0, 2, 4, 6, and 8 days after spawning.

Environmental Biology Division

「Photo;NIES」

The Kirakotan Headland in the Kushiro Wetlands.

「Photo;Microbial Culture Collection at NIES」

Flocculate colonies of *Microcystis* accumulated on the surface of a pond and *Microcystis* cells (inset).

「Photo;T. Okuda」

Seeds of a dipterocarp species, *Dryobalanops aromatica.*

「Photo;A. Kubo」

Phenotypes of wild-type and mutant *Arabidopsis* plants after ozone exposure
Fourteen-day-old plants were exposed to ozone at 0.2 ppm under a photosynthetic photon flux density of 100 μE m^{-2} s^{-1} for 2 days.

The Environmental Biology Division consists of four 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 various types of biodiversity, including genetic (species) and ecosystem diversity. In 2005, the Division performed 12 studies funded by NIES, four supported by the Global Environmental Research Fund (Ministry of the Environment), five funded by the Ministry of Education, Culture, Sports, Science and Technology, and three funded by other ministries.

Ecosystem Function Study Section

Estimation of spring water discharge in Kushiro Wetland

Environmental impacts such as an increase in the extent of the alder forest in the Kushiro Wetland in northeast Hokkaido as a result of increased eutrophication were evaluated in terms of the importance of discharge of river water, and especially spring water, from the Tsuruwashinai River catchment. Luminance distribution data from the land surface and water temperatures around Kirakotan Headland in the Kushiro Wetland were collected by air on two occasions using an infrared remote-sensing technique (Thermal Airborne Broadband Imager: TABI 320). The surface temperatures were observed by TABI and the ground compensation was determined in the afternoon of 4 April and the morning of 5 April 2005. The surface resolution was 2 m and the temperature resolution was 0.1 °C.

Comparison of temperature distribution images revealed the following results (Fig. 1):

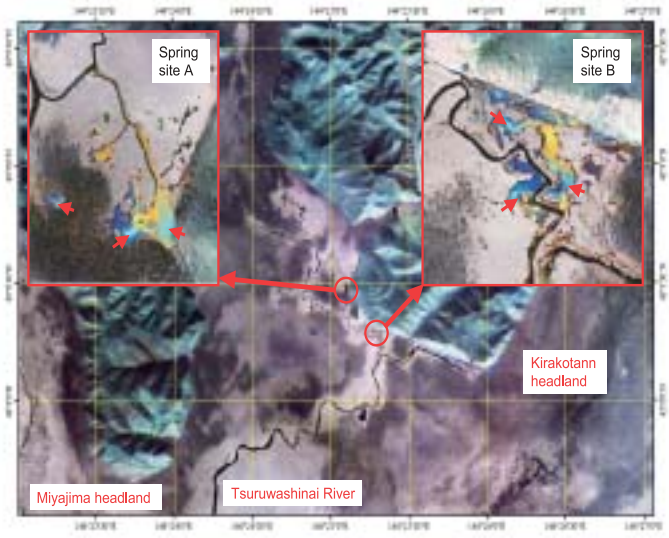


Fig. 1
Surface temperature observations by infrared sensor.
Symbol
Water colors: light blue ■, morning and afternoon temperatures > 0 °C and small temperature range (spring); yellow ■, afternoon temperature >> morning temperature (non-spring, stationary water); royal blue ■, morning temperature > afternoon temperature and small temperature range (non-spring, melting snow water).

1) The water and ground surface temperature range in the afternoon was approximately –1.2 to 18.7 °C, and that in the morning was –2.2 to 14.8 °C. 2) The temperature range of the river surface was 0.8 to 6.2 °C in the morning and 2.5 to 6.3 °C in the afternoon. 3) The water temperature of the river was warmer than that of the springs at sites A and B. There were some warm patches in the mire. 4) The type of water area could be deduced from the difference between the image of surface temperature and that of absolute temperature. 5) At spring site A, the difference in water surface temperature increased moving from the east side (on top of the headland) to the west

side. In this area we discovered several sites on the margins of the wetland and by the riverside that had the same temperature features as spring site A.

Biodiversity and Phylogenetic Study Section

We conducted fundamental research on the diversity of microorganisms and benthic animals.

Here, we introduce two of our studies on the genetic and physiological diversity of the waterbloom-forming cyanobacterium *Microcystis aeruginosa*. 1) We have developed a multilocus DNA genotyping protocol for *M. aeruginosa*, one of the most common agents of toxic waterblooms worldwide. This protocol is very convenient, and has proved to be very useful for diagnosing the potential productivity of cyanotoxins such as microcystins. By applying this protocol, we have genotyped about 150 strains of *M. aeruginosa* maintained in the Microbial Culture Collection at NIES (MCC-NIES). We have used the results of genotyping to compose a database that can be used as a reference for characterizing any strain isolated elsewhere. We expect that our genotyping protocol will be used broadly by many researchers to investigate the genetic backgrounds underlying mass occurrences of toxic waterblooms. 2) We also analyzed the UV-absorbing compounds in *M. aeruginosa* collected from all over Japan and maintained at MCC-NIES. Since colonies of *M. aeruginosa* accumulate near the water surface of lakes, the occurrence of this species is presumed to be influenced by UV radiation. Among about 150 strains of *M. aeruginosa* examined, one-third accumulated mycosporine-like amino acids (MAAs) such as shinorine and porphyra-334 in their cells, to varying extents (Fig. 2). The fact that almost all strains that contain MAAs have been collected from low latitudes and high altitudes seems to indicate that *M. aeruginosa* has adapted to protect itself from UV radiation.

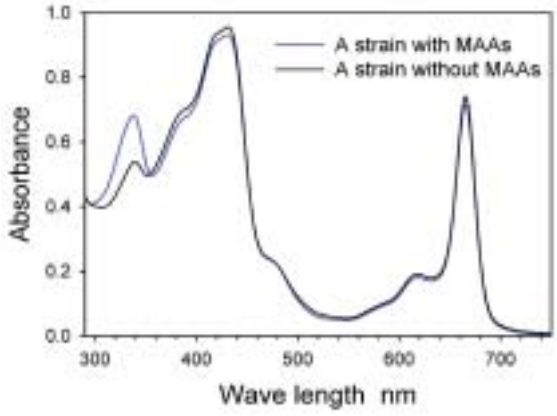


Fig. 2
Absorption spectra of methanol extracts from two cultures of *Microcystis aeruginosa* with and without mycosporine-like amino acids (MAAs).

Tropical Ecology Section

1) Ecosystem management in the tropics

The goal of this project is to introduce an ecosystem management approach to land-use and natural resource planning in the tropics, so as to maintain healthy ecosystems and balance the needs of society, the economy, and the environment. Toward this end, we have developed new ecosystem assessment tools for viewing the current degradation status of forests and forecasting future environmental threats to forests from landscape change, and have conducted studies in a pilot study area of Peninsular Malaysia. First, we reviewed the ecosystem services that could be derived from tropical rain forests and established a database related to these services and the

alternative values provided by secondary vegetation. Second, we developed a risk assessment tool that could provide a baseline for the costs and benefits of different land-use changes. This served to optimize ecosystem service values and goods and will eventually contribute to the making of hazard maps and ecosystem service maps at the national level. Finally, we studied how local participation contributes as a key element in developing ecosystem management plans to promote incentives for sustainable forest management.

2) Carbon dynamics and global warming monitoring in grasslands

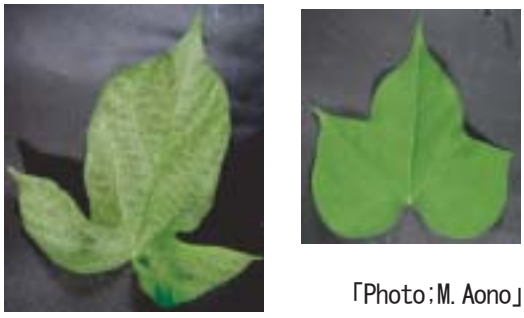
We are examining CO_2 storage and fluxes in grasslands on the Tibetan Plateau. Major research activities include: (1) estimation of the carbon storage and budget of these alpine grassland ecosystems; (2) studies of the ecological and biological mechanisms underlying the carbon cycle in alpine ecosystems; and (3) the assessment of possible impacts of global warming on GHG emissions from grassland ecosystems. Our studies shows that alpine grasslands currently hold important stocks of carbon, and their average CO_2 absorption from 2002 to 2004 was about 120 g C m^{-2} $year^{-1}$. We launched a long-term monitoring project on global warming and its effects on alpine ecosystems. Focusing on the world's highest plateau, we have set two vertical transects, one ranging from 4300 m to 5500 m above sea level and the other from 3200 to 4200 m, to monitor the physical and biological indicators of global warming.

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 involved in these protection mechanisms and are conducting molecular biological studies with various stress-related mutants of *Arabidopsis thaliana*.

In an ozone-sensitive *Arabidopsis* mutant, *ozs1-1* (shown in the Figure at the front of this chapter), expression of the *OZS1* gene is inhibited due to the insertion of T-DNA at the locus of this gene. Through a survey of DNA-microarray databases, we found that expression of the *OZS1* gene in wild-type plants is enhanced under conditions such as senescence, nematode infection, heat-shock, osmotic stress, and genotoxic stress. This suggests the possible involvement of this gene in tolerance of plants to various stressors.

In exploring a plant material suitable for environmental monitoring, we compared the ozone sensitivities of different strains of morning glory and found that the cultivar Scarlet O'Hara (which has been used as an indicator plant for photochemical oxidants) showed more severe visible damage than the cultivar Tokyo Kokei Standard (for which genomic information is being accumulated) in response to ozone treatment (Fig. 3).



「Photo;M. Aono」

Fig. 3
Difference in ozone sensitivity between two cultivars of morning glory. Visible foliar injury caused by ozone in the third leaves of 'Scarlet O'Hara' (left) and 'Tokyo Kokei Standard' (right). Plants 31 days old were exposed to 200 ppb ozone for 6 h and then incubated in fresh air for 18 h under continuous light.

Environmental Information Center

The Environmental Information Center provides various kinds of environmental information for public through web sites.

The Environmental Information Center (1) provides information technology support for research and related activities at NIES, and (2) carries out public relations activities for NIES, including publication of NIES reports. In addition to these activities, the Center (3) collects and processes environmental information and disseminates it to the general public, and performs tasks commissioned by the Ministry of the Environment. To implement these tasks more efficiently, the Center was reorganized in April 2003.

1. Information technology support for research and related activities at NIES

The activities of the Center in this field comprise: (a) management and operation of the computers and related systems at NIES; (b) improvement of work efficiency of NIES using information technology; and (c) running a library service.

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, including 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 the large-scale programs needed 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 the same time. Registered users outside NIES can use the supercomputer system through the Tsukuba-WAN via the Science Information Network (SINET) connection to the Internet.

b. Improvement of work efficiency using information technology

The Center gives information technology support to the management sector of NIES, with the aim of increasing work efficiency. The Center also provides NIES researchers with processed research data and helps them to disseminate their research data through the NIES homepage. In FY 2005, the Center supported the following activities:

- modification and daily operation of the research project database
- preparation of an automatic typesetting system, using XML, for issuing the NIES research program and NIES annual report
- modification and daily operation of a database of basic individual information about each member of staff at the Institute
- construction of database system for storage samples
- installation and operation thin client PC management system for administrative section
- installation of a directory services system
- setup of wireless LAN in the conference rooms at NIES
- construction of an investigation and input system for PRTR data
- processing of various research data to be provided through the NIES website

c. Library service

As of March 2006, the NIES library held 50,189 books, 395 technical and scientific serials, 9,688 maps, 118,616 microfiches, and various other reports and reference materials.

In addition to these materials, researchers at NIES can access documentary information through commercial databases such as Web of Science, Science Direct, JOIS, STN International, G-Search, and the British Library Inside Web.
Library facilities include separate rooms for reading books, journals, indexes and abstracts, reports, maps, and microfiche.

2. NIES public relations activities, including publication of NIES reports

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

a. Management of NIES WWW

NIES began to provide public information on its research activities and results via the Internet (http://www.nies.go.jp/) in March 1996. The website was completely renewed and improved in accordance with the restructuring of NIES in April 2001 as an independent administrative institution. Because NIES starts the second stage of its medium-term plan in April 2006, a newly designed website has been prepared in accordance with the new organization and activites. The new site is also designed to have improved usability, including improved accessibility for people with disabilities.

b. Editing and publication of NIES 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.

3. Other activities

In addition to the activities mentioned above, the Center (a) collects, processes, and disseminates environmental information for the general public, (b) conducts tasks commissioned by the Ministry of the Environment, and (c) acts as the national focal point of UNEP-Infoterra (see 3.c. below).

a. Collection, processing, and dissemination of environmental information

NIES is required to carry out "the collection, processing, and dissemination of environmental information" as one of its major tasks. The Center (a-1) provides various kinds of environmental information to the public through websites, (a-2) processes and manages environmental information databases, and (a-3) provides environmental information using GIS (geographic information systems).

(a-1) EIC Net and Environmental Technology Information Network

The EIC Net (Environmental Information and Communication Network, http://www.eic.or.jp/) provides various kinds of environmental information, such as news and topics on the environment, and a chronology of environmental issues in Japan. This fiscal year, information on household chemicals and environmental issues in China was newly added. The site was updated, with the addition of web accessibility tools such as a screen reader and a screen magnifier.

The Center opened the Environmental Technology Information Network (http://e-tech.eic.or.jp/) in August 2003. It contains pages of environmental technology news on ministries and companies; research reports and review papers by environmental specialists; and seminar and event information on environmental technology. In FY 2004 we improved the homepage of the Environmental Technology Information Network and added more menus for easier operation.

At present, these sites are available only in Japanese.

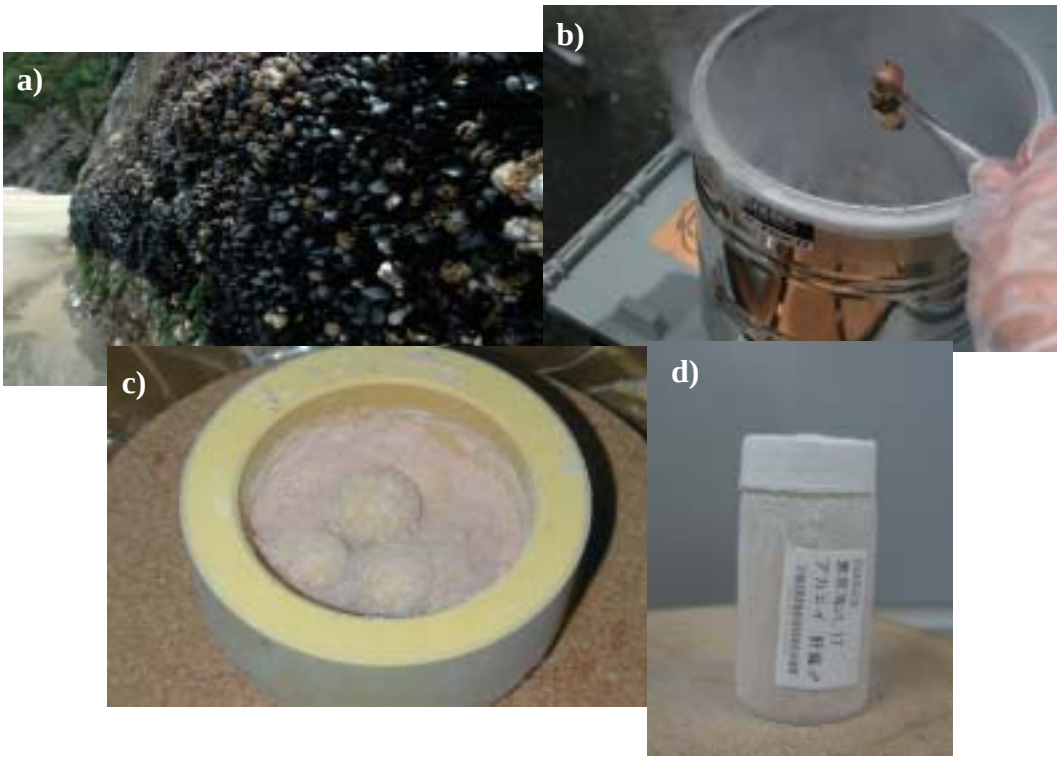
(a-2) Processing and management of environmental information databases
Various environmental data are needed for research, policy decisions, and policy enforcement. The Center compiles and processes air quality and water quality data as monitored by local governments and reported to the Ministry of the Environment. These processed data can be accessed through the database on the NIES WWW, and duplication and lending services are also available.

(a-3) 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 a GIS. This system helps users to easily understand the status of the environment by showing data on environmental quality, together with other information on maps. The system has been publicly available through the Internet since September 2002.

b. Tasks commissioned by the Ministry of the Environment
The Center performed the following nine tasks commissioned by the Ministry of the Environment in FY 2005.
- development of an information system for the total management of aquatic environments
- management of display systems for wide-area air pollutant surveillance
- management of display systems for pollen observation
- development of an information management system for noise, vibration, and offensive odors
- analysis of the results of a national survey of aquatic animals
- examination of methods of expression of traffic noise survey data by GIS
- development of a database for the movement of dioxins in ambient air
- development of a GIS to publicly release the results of monitoring of hazardous air pollutants
- construction of a system to display data from the monitroring of environmental radiation

c. National focal point of UNEP-Infoterra
UNEP-Infoterra is the global environmental information exchange network of the United Nations Environment Program. The network operates through a system of government-designated national focal points. The Center has been the designated national focal point of UNEP-Infoterra since 1975. These focal points provide a wide range of environmental information, including directories of information sources.
One of our staff has participated in the international meeting held by UNEP, in 13th to 16th of April 2004 at Geneva, and has discussed about a plan for the future activities and so on.

Laboratory of Intellectual Fundamentals for Environmental Studies



Preparation of marine biological samples for the Environmental Specimen Banking (ESB: long-term storage of environmental samples) and the Environmental Certified Reference Materials (ECRM)

a) Mussels thickening on littoral rocks

b) On-site freezing of a mussel soft body by liquid nitrogen for ESB

c) Pulverization of stingray liver by a ball-mill in liquid nitrogen

d) Prepared ECRM from stingray liver

The Laboratory of Intellectual Fundamentals for Environmental Studies (LIFES) consists of two research sections: the Environmental Analytical Chemistry Section and the Biological Resources and Informatics Section. The Laboratory is responsible for organizing all of the intellectual research fundamentals accumulated since NIES began, and for developing basic research techniques that will be needed in future. These fundamentals and techniques are used for effective implementation of research and to form research networks.

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 culturing microalgae and other laboratory organisms, and preserving and supplying these organisms to provide standards for classification, standard strains for bioassay tests, and strains with special functions.

Preparation of environmental certified reference materials

Environmental certified reference materials (CRMs) are utilized for the evaluation of new analytical methods and for the accuracy control of pretreatment and instrumental analyses. NIES has been preparing and distributing environmental and biological CRMs since 1980. This fiscal year over 140 CRMs were distributed to researchers around the world. New CRM No. 27, Typical Japanese Diet, began distribution in this year (Fig. 1).

Fig. 1
New Typical Japanese Diet certified reference material, supplied as NIES CRM No. 27.

Management and operation of key analytical equipment

The laboratory has been working to improve the sensitivity and accuracy of analyses of environmental specimens at NIES and has been managing and operating commonly used key analytical equipment. An on-demand analysis service has been established and is operated by personnel technically trained in the use of 10 instruments. The ICP (Fig. 2) and CHN instruments were renewed this spring. Requests for analyses on about 30 research themes were made by over 50 researchers, and we provided them with useful data derived under high levels of quality control.

Fig. 2
A new ICP/AES instrument was reinforced for research into recent environmental problems.

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

We continued to collect and prepare environmental samples for long-term, low-temperature storage as part of our expanded program to make samples available for retrospective analysis of pollutants. The environmental specimen time-capsule facility is capable of accommodating various items of equipment for the low-temperature preparation of environmental specimens for long-term storage, and it can store such specimens for 50 years in an atmosphere of liquid nitrogen vapor at about –150 °C. This year 339 samples were added to storage, and the total number of registered time-capsule samples is now 1384 (Fig. 3).

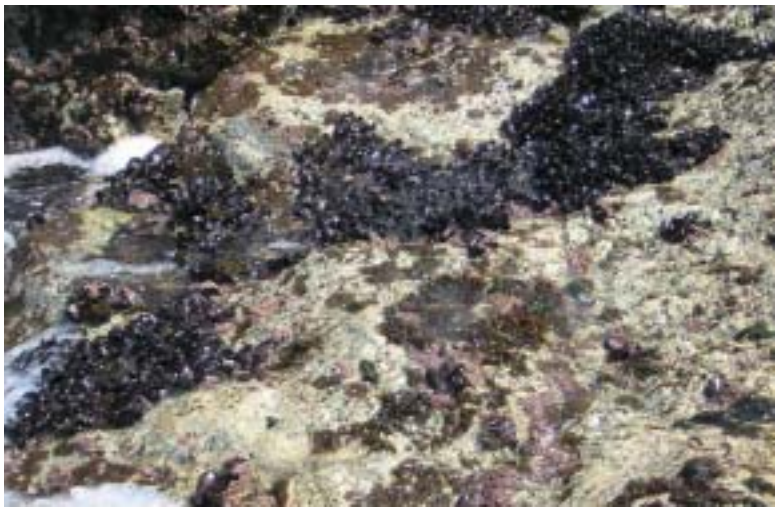


Fig. 3
The black mussel *Septifer virgatus*, a filter-feeding bivalve on intertidal rocks, was collected for cryopreservation.

Fundamental studies of germline stem cells using biotechnology

With the aim of developing new technologies in the field of bioscience, we are studying germline stem cells (primordial germ cells) in the Amniota (mainly in the Aves subclade). We have made germline chimeras by transplantation of primordial germ cells, and subsequent backcross analysis has revealed that we have obtained offspring originating from the introduced primordial germ cells. We are now trying to put this method to practical use for the proliferation of threatened bird species. Our techniques should be useful in cleaning up vertical infections via eggs and also in the recovery of populations from inbreeding depression by transplantation of primordial germ cells in the early embryonic stages (Fig. 4).

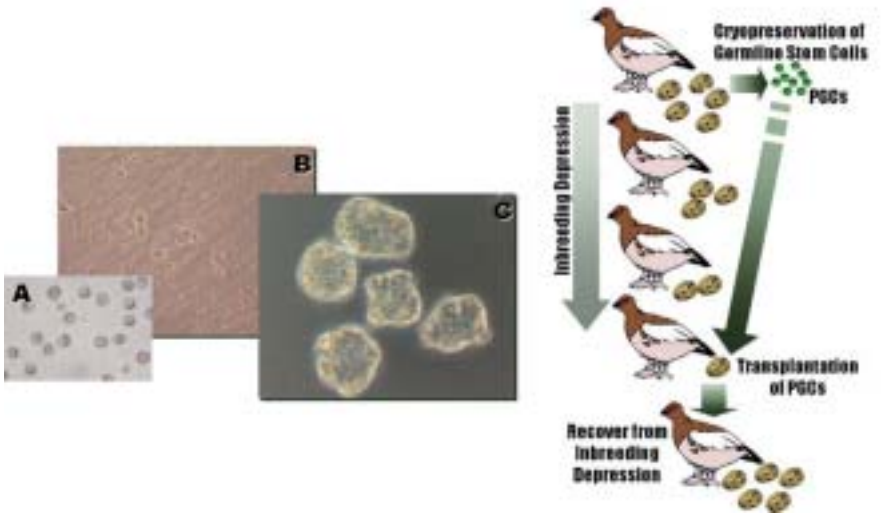


Fig. 4
Left: *In vitro* long-term culture of chick primordial germ cells (PGCs):
A: Isolated PGCs at the early embryonic stage.
B: Initial phase of PGC cultivation on feeder cells.
C: PGC clusters after 2 weeks' incubation.
Right: Utilization of frozen germline cells Populations could be rescued from inbreeding depression by transplantation of frozen-stored primordial germ cells originating from younger generations.

Preservation of cells and gene resources of threatened wildlife species

(1) Threatened wild animals

In the hope of making future contributions to the conservation of threatened wild animals, we cryopreserve their cells (including germline cells) and their tissues for genetic analysis, with the support of the National Time Capsule Program for the Environment and Threatened Wildlife. Three hundred and thirty-three kinds of samples (tissues, cultured cells, and sperm) had been cryopreserved as at March 2005. From April 2005 to March 2006, we accepted 93 individual threatened wild animals (mammalian species: 24 individuals; avian species: 69 individuals) and cryopreserved their tissues and cultured cells. During this period, 312 kinds of samples (tissues and cultured cells) were cryopreserved. The following species are currently accepted: Kuril harbor seal (*Phoca vitulina*), Steller's sea lion (*Eumetopias jubatus*), Asian particolored bat (*Vespertilio superans*), Ryukyu flying fox (*Pteropus dasymallus daitoensis*), *Ryukyu long-haired rat (*Diplothrix legata*), *Ikonnikov's bat (*Myotis ikonnikovi ikonnikovi*), *fraternal myotis (*Myotis frater kaguyae*), *red-crowned crane (*Grus japonensis*), white-tailed eagle (*Haliaeetus albicilla albicilla*), Okinawa rail (*Gallirallus okinawae*; Fig. 5), Steller's sea eagle (*Haliaeetus pelagicus pelagicus*), goshawk (*Accipiter gentiles fujiyamae*), ptarmigan (*Lagopus mutus japonicus*), ancient auk (*Synthliboramphus antiquus*), Japanese night heron (*Gorsakius goisagi*), Japanese wood pigeon (*Columba janthina*), crested serpent eagle (*Spilornis cheela*), spoonbill (*Platalea leucorodia*), Pryer's woodpecker (*Sapheopipo noguchii*), *Matsudaira's

fork-tailed petrel (*Oceanodroma matsudairae*), *Ryukyu robin (*Erithacus komadori*), *Blakiston's fish-owl (*Ketupa blakistoni*), *Amami woodcock (*Scolopax mira*), *bittern (*Botaurus stellaris stellaris*), *sparrow hawk (*Accipiter nisus nisosimilis*), Ryukyu ayu-fish (*Plecoglossus altivelis ryukyuensis*), deep-bodied bitterling (*Acheilognathus longipinnis*), Sakhalin taimen (*Hucho perryi*), Ogasawara-Yoshinobori goby (*Rhinogobius sp.*), Metropolitan bitterling (*Tanakia tanago*), striped bitterling (*Acheilognathus cyanostigma*), spot-ear brook perch (*Coreoperca kawamebari*), *green chub (*Aphyocypris chinensis*), small scale bitterling (*Acheilognathus typus*), and Formosan landlocked salmon (*Oncorhynchus masou formosanus*). (* newly cryopreserved species)

In total, 645 kinds of samples have been cryopreserved since the National Time Capsule Program was started in 2004.

Fig. 5
The Okinawa rail (*Gallirallus okinawae*), a threatened Japanese endemic species.

(2) Threatened algae

We have been surveying the status of threatened algal species in Japan since 1995. During FY2004–05 we surveyed 78 potential habitats of the Charales, where certain Charales species had been reported between 1940 and 1960 (Fig. 6). We found Charales algae at only 14 of these sites. In the course of these surveys, we collected and maintained strains of threatened algal species in the Biological Resource Collection. We now maintain 64 strains of Charales and 200 strains of freshwater red algae.

Fig. 6
Survey of Charales algae in Kagawa Prefecture. Two species of *Nitella* were found.

Investigation, collection, and storage of microbes useful for environmental conservation and development of laboratory organisms

At the Microbial Culture Collection (MCC-NIES), we (1) accepted 144 strains deposited by scientists inside and outside NIES after evaluation by the Committee for Evaluating Microbial Culture Strains; (2) froze samples of 96 strains of cyanobacteria and green algae, which are now entirely preserved in liquid nitrogen (we now have a total of 556 frozen strains); (3) distributed 752 algal strains to researchers and engineers; and (4) continued to renew the MCC database system. We now maintain more than 2000 strains, of which more than 1700 strains are NIES strains. These activities are conducted in collaboration with five institutes as part of the National Bio-Resource Project (Fig. 7).

Fig. 7
Organization of the National Bio-Resource Project “Algae.” The Microbial Culture Collection at NIES collects, preserves and distributes algal strains as part of the core culture collection of Algae in Japan.

Center for Global Environmental Research

The volunteer observation ship MS *Skaubryn* services the area between Japan and the west coast of the USA and Canada.

The volunteer observation ship MS *Trans Future 5* services the area between Japan, Australia, and New Zealand.

Atmospheric observation room installed on the compass deck of MS *Trans Future 5*

Atmospheric sample inlets for greenhouse gas measurement, installed above the wheelhouse of MS *Trans Future 5*

The Center for Global Environmental Research (CGER) was established in 1990 to promote and support global environmental research from both national and international viewpoints, with the aim of reducing the uncertainties of future climate prediction. CGER has three missions: monitoring of the global environment, support for global environmental research, and synthesis of global environmental studies.

1. Monitoring of the Global Environment

Long-term monitoring of greenhouse gases and other air pollutants

Greenhouse gases (GHGs; e.g., CO_2, CH_4, and N_2O) and other chemical species (CO, NOx, and SOx) are monitored by using several platforms. We have two remote stations: Hateruma Island, over 1000 km southwest of the Japanese mainland, and Cape Ochi-ishi, in northeastern Hokkaido. Also, airplanes flying over Siberia and commercial ships that operate in the Pacific are used to measure GHGs and collect air samples.

At both monitoring stations, GHGs are continuously monitored and related species (e.g., CO, O_3, NOx, and SOx) are measured with the aim of furthering our understanding of global warming and atmospheric transport processes. In 2005, our old 10-m sampling tower at the Hateruma station was replaced by a new sampling tower with a line made of glass tube especially for the measurement of reactive gases (e.g. O_3, NO) and suspended particulate matter (SPM). Most species are measured automatically, and the data are transferred to NIES at Tsukuba by dedicated network lines. Bottle samplings are also performed to measure some species, such as halocarbons, oxygen, and isotopes. Over the last 10 years, the average CO_2 concentration measured at both stations has increased from about 360 ppm to 382 ppm, with a growth rate of over 1.9 ppm/year (Fig. 1). In 2005, the rate of increase was comparatively moderate (1.5 to 1.8 ppm/year). N_2O concentrations at both stations increased continuously between 1996 and 2005, but CH_4 concentrations seemed to decrease slightly last year.

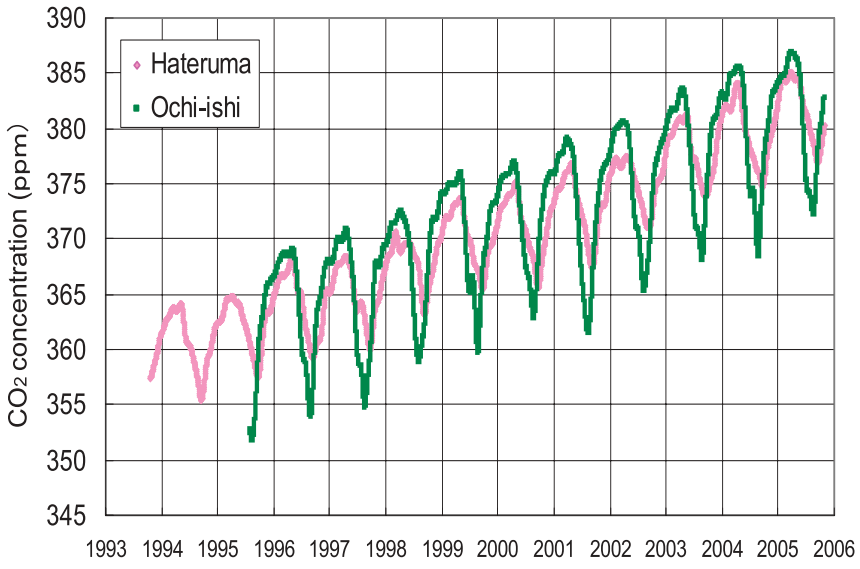


Fig. 1
CO_2 concentration time series at Hateruma Island and Cape Ochi-ishi.

In the Pacific, the vessel *Fujitrans World* (Kagoshima Senpaku), which had thus far been used for our air observations, changed its route from Oceania to Asia. We therefore moved our air sampling equipment to *Fujitrans Future 5* (Toyofuji Co. Ltd.) to continue our observations. Pyxis (Toyofuji) was used to collect air samples and to measure oceanic pCO_2 along the shipping routes between Japan and the USA. For sampling at latitudes higher than 40°N, another ship (*Skaubryn*; Seaboard Int. Shipping Co) was used. Latitudinal distributions and long-term trends of GHGs were observed, together with trends in oxygen and isotope levels.

In Siberia, the vertical distribution of CO_2 was measured over three 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 large sources of CH_4.

Integrated carbon dioxide flux monitoring

Carbon exchange between the atmosphere and the terrestrial ecosystem is monitored at two remote stations in a larch forest. (Larch is the one of the most widely distributed species in Asia.) To gain a better understanding of the mechanisms behind CO_2 balance, we are carrying out integrated observations using not only basic micrometeorological methods, but also a physioecological approach.

In 2005, the FujiHokuroku Flux Observation Site, in the foothills of Mt. Fuji, was established specifically to elaborate the results of measurements of carbon balance. This site is an alternative to the Tomakomai Flux Research Site, which was destroyed by a tropical storm in 2004.

At the Teshio CC-LaG (Carbon Cycle and Larch Growth) Experimental Site in Hokkaido, established in 2001, we are focusing on the transition of carbon flow during the arboreal growing period. After the felling of natural forest, we planted larch seedlings in 2003 and are now using standard forestry practice to manage them.

Recently, important progress has been made in forest measurement studies using a laser scanner. With this technique, we have developed a method of evaluating forest growth and NPP over a wide area. The laser survey data were collected in 1999, 2001, and 2003 at the Tomakomai Flux Research Site. The average increase in height of the forest stand (about 0.23 to 0.25 $cm \cdot year^{-1}$) and the average increase in forest stand volume (11 $m^3 \cdot year^{-1}$) were calculated. On the basis of these results, using the laser survey data we estimated the NPP as 352 g C m^{-2} $year^{-1}$: this agreed well with the NPP calculated on the basis of a ground survey (396 g C m^{-2} $year^{-1}$).

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 acousto-optical spectrometers (AOS) with a bandwidth of 1 GHz. In the case of the instrument at Tsukuba, it has two spectrometers with bandwidths of 60 MHz and 1GHz, allowing

measurement of the vertical profiles of ozone at altitudes from 14 to 76 km. The variations in the ozone profile obtained at the Rikubetsu station were compared with the vertical profiles of ozone obtained by SBUV-2 satellite sensor, with good agreement.
In addition, we are organizing a voluntary network to monitor harmful UV radiation (UV-B) on a national scale and to evaluate the adverse effects of UV-B on human health.

Monitoring of the atmospheric environment from space
The Improved Limb Atmospheric Spectrometer II (ILAS-II) aboard the Advanced Earth Observing Satellite II observed the high latitudinal ozone layer from April to October 2003. The ILAS-II data-handling facility (DHF), which is under the management of CGER, has been used to process, reprocess, store, and distribute the ILAS-II data. The distribution of Version 1.4 ILAS-II data products from the DHF to general users began in February 2006. The distribution of Version 2.0 ILAS-II data products to registered ILAS-II researchers began in March 2006. To proceed with NIES's next satellite project, a Greenhouse gases Observing SATellite (GOSAT), which will be launched in 2008, is planned to observe atmospheric CO_2 and CH_4 from space. The GOSAT research team at CGER has been promoting research on the development of data retrieval algorithms for CO_2 and CH_4 column density, experimental airborne and *in - situ* measurements, and model studies of carbon source and sink estimations. Field experiments were performed with *in-situ* measurement of CO_2 and CH_4, using the GOSAT Bread Board Model, which was placed on an airship and on the top of Mt. Tsukuba, and the spectra obtained were analyzed.

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 eastern 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).
• **Lake Kasumigaura trend monitoring.** Since 1976, we have been conducting continuous field studies every month at Lake Kasumigaura, northeast of Tokyo, a representative Japanese eutrophic lake.

2. Support for Global Environmental Research
Establishment of standard gases
We have been developing standard gas systems for baseline monitoring of greenhouse gases (e.g. CO_2, CH_4, N_2O, and O_3) and other gases (e.g. NO, CO, and H_2). We have been studying the ozone scale by comparing the results obtained using the standard reference photometer (SRP) (constructed by National Institute of Science and

Technology (NIST); Fig. 2) and a gas phase titration method. CGER also participated in several international intercomparison activities, such as round-robin tests by the National Oceanic and Atmospheric Administration (NOAA) / World Meteorological Group (WMO), an intercomparison named “Sausage” under the Terrestrial and Atmospheric Carbon Observing System (TACOS) in the EU, and an inter-comparison named “Melon” with the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia.

Fig. 2
Standard reference photometer (SRP35) for measuring ozone concentration.

Global environment databases

CGER is creating original databases to improve our understanding of global environmental issues such as climate change and ecosystems. Databases are either created to support global-level modeling studies or created from the results of research activities. Current database projects include: 1) a greenhouse gas emission scenario database (IPCC); 2) an emission inventory of air pollutants in Asia (Asia-Pacific Integrated Model); 3) material flows based on LCA analysis; 4) a terrestrial ecosystem database for the tropics; and 5) post-Kyoto terrestrial carbon sink issues.

Greenhouse Gas Inventory Office of Japan

The Greenhouse Gas Inventory Office (GIO) of Japan was established in 2002. GIO’s primary mission is to prepare and develop national GHG inventories in accordance with 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. GIO’s other activities are to conduct trend analyses of GHG inventories in order to perform various tasks relevant to these inventories; to conduct

workshops and research activities to encourage countries in the Asia region to enhance their capacities for developing their own GHG inventories; and to contribute to the work of international environmental organizations such as UNFCCC and the IPCC by hosting international conferences or seminars related to GHG inventories.

Supporting the use of the supercomputer system

CGER shares the responsibility for operating a supercomputer system with the Environmental Information Center. The system is used by scientists in Japan to support their research on the prediction of global environmental change. Research results from 2004 are available in *"CGER's Supercomputer Activity Report"* (Vol. 13) and *"CGER's Supercomputer Monograph Report"* (Vol. 11).

3. Synthesis of Global Environmental Studies

International Research Cooperation—AsiaFlux

AsiaFlux was established in 2000 to develop a network of scientists studying the idiosyncratic character of carbon flux in the Asian region. The secretarial office is located at CGER and supports activities such as the publication of a quarterly newsletter, the hosting of an annual workshop and training course, and management of the mailing list and website.

Global Carbon Project

The key goal of the Global Carbon Project (GCP) International Office (Japan) is to contribute to integration of the human dimension into the integrated earth system science of the global carbon cycle by advancing research and scientific networking on carbon management. A high priority for the Japan office is to develop and coordinate a new flagship program entitled "Urban and Regional Carbon Management" (URCM), which focuses on a comparative and historical approach to urban and regional carbon footprints, as well as their determinants and trajectories, and opportunities for management. URCM is a place-based carbon management approach that focuses on diagnostic as well as solution-oriented research and scientific networking for urban and regional carbon management. To support these efforts, the GCP is engaged in a number of activities: organizing events such as conferences, workshops, and seminars; creating and facilitating well-focused and research-based international networks and groups to initiate new research; and making the GCP a global coordinating platform for research on urban and regional carbon management.

International Workshop on Social Network Approaches to Urban and Regional Carbon Management

5-7 April 2005
NIES
Tsukuba, Japan

This workshop explored the question of how social network analysis (SNA) can contribute to addressing the problem of climate change. Social scientists from Japan, the USA, and Europe reported on social network theory, applications, and methodology in order to envision their use in on-the-ground social change regarding carbon management. The workshop represented the broad array of research that exists within the SNA tradition from empirical studies to dynamic agent simulations. The workshop resulted in the urban and regional carbon management (URCM) framework that was drawn up subsequently in June 2005.

Science Journalism Forum and Workshop

2-4 June 2005
Shiba Park Hotel
Minato, Tokyo

One purpose of the workshop was to increase social understanding of how the long term ecosystem monitoring of Mekong River is important in riparian countries. By exploring ways to fill in the chasm between science and journalism, we developed relationships with our partners in the other fields. The proceedings of the workshop and some articles summarizing significant discussions have been published.

Asia Flux Workshop 2005

24-26 August 2005
Hotel Highland Resort
Fujiyoshida, Yamanashi

The aim of the workshop was to provide an opportunity to improve understanding of cycles of carbon dioxide, water vapor, and heat energy in terrestrial ecosystems. Topics included tower flux measurement, carbon cycle process models, remote sensing, general flux research, and other topics related to terrestrial material cycles, especially carbon. This workshop was organized by the AsiaFlux Steering Committee which includes NIES, the Forestry and Forest Products Research Institute (FFPRI), the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the Asia-Pacific Network for Global Change Research (APN).

Expert Meeting on Solid Waste Management in Asia and Pacific Islands

28-29 August 2005
Institute for International Cooperation(IFIC/JICA)
Shinjuku, Tokyo

Experts in solid waste management from 10 countries including China, Korea and India participated in this meeting. We discussed the current status and future tasks of waste management in each country, and the need for tackling this issue at a regional level. At the end of meeting, we adopted a declaration entitle “Towards Expert Networking in Asia and Pacific Islands” (MOTTAINAI Declaration).which will encourage networking of people involved in research on the 3R initiative and environmentally sound management of solid waste.

Symposium on Network of Asia Oceania Algal Culture Collection (AOAC)

1 November 2005
Rama Gardens Hotel
Bangkok, Thailand

The symposium was held during the Fourth Asia Pacific Phycological Forum in Bangkok, Thailand. The aims of AOAC are: 1) to foster synergy and links between culture collections; 2) to build the capacity of algal culture collections; 3) to preserve and improve knowledge of algal biodiversity; and 4) to integrate and disseminate knowledge and data on algal culture collections in the Asia Oceania region. Representatives of algal culture collections from Australia, China, Japan, Korea, Malaysia, New Zealand, Thailand and Vietnam introduced the current status of their culture collections and discussed the action plan of AOAC.

APN Scoping Workshop on Global Earth Observations and the Capacity Building Needs of the Region: Focus- Climate

17-18 November 2005
Mita Kaigisho
Minato, Tokyo

The key objectives of this workshop were to consider the capacity building necessary for research and monitoring related to climate change and its impacts, to discuss the role of APN in such research and underpinning systematic observations and to create road maps for designing ideas appropriate for capacity building activities in the Asia Pacific region. The discussions also focused on the exchange of information on observational data needs, experience and views on climate change and adaptation strategies among the countries in Asia and the Pacific and facilitating further activities to address the capacity building needs for climate change related issues in relation to the implementation of a 10-year plan for GEOSS in the region.

Symposium on Application of Ecosystem Approach towards Sustainable Resource Management in Tropics

21-23 November 2005
Pan Pacific Hotel, KL
Malatsia

The goal of ecosystem management is to formulate land-use and natural resource–use plans that maintain a healthy ecosystem and are acceptable to local communities, while balancing the needs of society, the economy, and the environment. A key attribute of the ecosystem approach in tropical forests is the incorporation of intensive and scientifically rigorous information on ecosystem services and goods provided by various types of landscapes. This workshop summarizes the past and ongoing studies and future plans of the joint project between NIES and Malaysian counterparts (FRIM, UPM, UTM) and explores the possibility of future collaboration with Asian countries. The workshop consisted of sessions on the evaluation of ecosystem service and its changes, scaling-up tools for the evaluation of ecosystem services and a general discussion on prospective studies and further collaboration within the Asian network employing the ecosystem approach.

Asia-Pacific Regional Inception Workshop on the Environmentally Sound Management of Electronic and Electrical Wastes

21-25 November 2005
Mita Kaigisho
Minato, Tokyo

This workshop was organized by the Ministry of the Environment, the Secretariat of the Basel Convention, and the National Institute for Environmental Studies, as the inaugural workshop on "Environmentally Sound Management of E-waste" that is planned under the Conference of the Parties (COP) to the Basel Convention. We discussed the need for information exchange on E-waste issues and for country projects, and we agreed on an action plan for this project, thus officially launching the project.

The 2nd NIES Workshop on E-Waste

23 November 2005
Hotel Villa Fontaine
Shiodome, Minato, Tokyo

This workshop focused on the existing domestic recycling system in each country, inventory, international trade and environmental effect regarding E-waste. The latest information was presented by 12 speakers from 10 countries. Participants confirmed that inapporopriate handling causes environmental pollution and that the market mechanism does serve the environment well. The need for research cooperation and information exchange was recognized.

3rd International Workshop on Mekong River Ecosystem Monitoring

28 November–2 December 2005
Angiang Univ. Vietnam

The objectives of the workshop were: 1) to affirm a common recognition of the progress and plans of the project; 2) to revise protocols for the base of monitoring manuals; and 3) to gain an understanding of the actual situation in each country for data and information sharing. The links with other international projects on the Mekong River was one outcome of the workshop. The proceedings of the workshop were published.

The 4th Japanese-German Meeting on Urban Climatology: Climate Analysis for Urban Planning

3-4 December 2005
Hotel Okura Frontier Tsukuba
Tsukuba, Ibaraki

The aims of this conference are to provide a Japanese-German Forum where the experts in these two countries can meet to showcase and discuss current developments in research, especially focusing the application of climatic knowledge to the design of better cities. This meeting was the continuation of a series starting in Karlsruhe, Germany in 1994, followed by ones in Kobe, Japan in 1997, and in Essen, Germany in 2000.

Global Challenges Toward a Low-Carbon Economy: Focus on Country-Specific Scenario Analysis (Official Side Event for UNFCCC COP 11/COP MOP 1)

3 December 2005
Room 5, Palais des Congrès de Montréal
Montreal, Canada

The objective of this side event was to explore strategies to pursue a transition toward a low-carbon economy focusing on policy packages integrating institutional and lifestyle changes, and technological development. The side event consisted of presentations and a panel discussion on scenario analysis with experts from Canada, China, France, Germany, UK and Japan. NIES, which was an officially registered NGO for UNFCCC COP, played the key role of organizing and coordinating this event and it was successful in promoting active discussion and involving many participants.

1st International Workshop of Cryo-Phoenix Project

8-9 December 2005
Tsukuba International Congress Center
Tsukuba, Ibaraki

To create a new international network for the cell-cryopreservation of endangered birds, the first International Workshop of the Cryo-Phoenix Project was held in Tsukuba by the Ministry of Education, Culture, Sports, Science and Technology (Special Coordination Funds for Promoting Science and Technology). Investigators from Russia, Korea, China and Japan were invited, and we discussed the current situation in each country and the cryopreservation of endangered birds' cells. Also, legal issues relating to cross-border sample transportation were discussed and we agreed to implement technology transfer among the countries.

The 9th ILAS-II Science Team Meeting

13-15 February 2006
KKR Hotel Atami
Atami, Shizuoka

To promote understanding and utilization of the Improved Limb Atmospheric Spectrometer-II (ILAS-II) data, the 9th (and final) ILAS-II Science Team Meeting was held in Atami, Shizuoka by the NIES ILAS-II project. In total, 47 people were in attendance including 12 overseas science team members, 16 domestic science team members, 1 person from MOE, 3 ILAS-II project advisory committee members, 1 from the wise, 12 people from contractor companies, and 2 office assistants. We discussed recent progress in scientific analysis using ILAS-II Version 1.4 data, and we gave an introduction to ILAS-II data products (Version 2.0). This meeting officially concluded the ILAS-II project.

Fourth International Symposium on Children's Environmental Health in Tokyo

24 February 2006
Mita Convention Hall
Minato-ku, Tokyo

To promote understanding of children's health and environment, an international symposium on children's environmental health was held in Tokyo sponsored by the Ministry of the Environment (MOE), Japan and operated by the Research Center for Environmental Risk (RCER), NIES.
Marike Kolossa-Gehring, Federal Environmental Agency, Germany, James J. Quackenboss, US Environmental Protection Agency, Masako Tanimura, National Research Institute for Child Health and Development, Makiko Kaga, National Institute of Neuroscience, National Center of Neurology and Psychiatry, and Tomoko Tawaragi, MOE, were invited as keynote speakers.
Current studies on children's exposure to environmental pollutants in Germany and national cohort study on environmental effects on children's health and development in the U.S., as well as related studies in Japan were introduced. Issues on children's environmental health were also discussed.

Workshop on Material Flows and Environmental Impacts Behind the International Trade of Japan

27 February 2006
Akihabara Convention Hall
Chiyoda, Tokyo

This workshop was organized as a part of a grant research project by the Global Environment Research Fund. The workshop was attended by approximately 250 participants, including four invited foreign speakers, from major natural resource exporting countries and an importing country. After the presentations by the invited speakers and the reports by our project members in Japan, we had a panel discussion. We came to reconfirm that it was important to exchange views and share common information with the experts from resources-rich countries regarding the "hidden" environmental and social impacts behind the cross-boundary trade of resources.

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

CANADA
1. Elucidation of the cycling and transformation of chemical substances in the North Pacific Ocean
Dept. Chemistry, University British Columbia
Environmental Chemistry Division
2. Monitoring of the atmosphere-ocean carbon dioxide exchange rate
Center for Ocean Climate Chemistry, Institute of Ocean Sciences
Global Environment Division

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 Environmental Sciences
Research Center for Material Cycles and Waste Management
5. Dioxins analysis and survey of dioxins sources in China
Sino-Japan Friendship Center for Environmental Protection
Environmental Chemistry Division
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 Center for Environmental Protection
Environmental Chemistry Division
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. Molecular epidemiological studies on the health effects of arsenic
Institution of Environmental Health and Engineering, Chinese Academy of Preventive Medicine
Environmental Health Sciences Division
10. Research on VOCs ans ammonia emissions in China
Chinese Research Academy of Environmental Science
Environmental Health Sciences Division

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

FRANCE
1. A molecular biological study for mechanisms of environmental adaptation plants
University of Picardie
Environmental Biology Division
2. Biodiversity of microalgae obtained from the Atlantic and the Pacific Ocean
University of Caen
Environmental Biology Division

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 Division
2. Cross-cultural comparison of landscape evaluation between Japanese and Korean People
KyungPook University
Social and Environmental Systems Division
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 marine pollution using ship-of-opportunity
Korea Ocean Research and Development Institute
Water and Soil Environment Division
5. Research on the prevention and management of environmental disease
National Institute of Environmental Research (NIER)
Environmental Health Sciences Division

POLAND
1. Molecular mechanisms of plant adaptation to atmospheric stresses
Plant Breeding and Acclimatization Institute
Biodiversity Conservation Research Project

RUSSIA

1. Airborne measurement of greenhouse gases over Siberia
   Central Aerological Observatory
   Center for Global Environmental Research
2. Modeling of methane emission rates from natural wetlands
   Institute of Microbiology
   Center for Global Environmental Research
3. Measurement of methane emission rates from permafrost areas
   Permafrost Institute
   Center for Global Environmental Research
4. 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
5. Greenhouse Gases Budget of Land Ecosystems in Siberia
   Institute of Microbiology RAS
   Center for Global Environmental Research
6. Greenhouse gas monitoring to estimate the sink and source distribution in West Siberia
   Institute of Atmospheric Optics
   Center for Global Environmental Research
7. Conservation of genetic resources on wild animals in Khabarovsk region
   Russian Federation Ministry of Natural Resources Bolonski State Natural Reserve Laboratory
   Laboratory of Intellectual Fundamentals for Enviromental Studies

SWEDEN

1. Underway measurement of *p*CO2 in the surface water of the Arctic Ocean
   Goteborg University
   Climate Change Research Project
2. Health risk assessment of heavy metal exposure: Effects of increase in human activity
   Karolinska Institute
   Environmental Health Sciences Division

U. K.

1. Cooperation on the development and application of coupled chromatography-accelerator mass spectrometry techniques
   University of Oxford
   Environmental Chemistry Division

U. S. A.

1. 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
2. Collaboration on greenhouse gas observation from space
   Jet Propulsion Laboratory
   Center for Global Environmental Research
3. 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
4. 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 the National Institute for Environmental Studies and the Institute of Ocean Sciences (1995).
CHINA	Memorandum of Understanding between the Changjiang Water Resources Commission, Ministry of Water Resources, People's Republic of China and the National Institute for Environmental Studies, for Collaborative Research on Developments of Monitoring Systems and Mathematical Management Model for Environments in River Catchment (1997).
	Memorandum of Understanding between the National Institute for Environmental Studies, and the 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 Northwest Plateau Institute of Biology, Chinese Academy of Sciences, P. R. China (NPIB) and National Institute for Environmental Studies, for Collaborative Research on Global Warming Effects and Carbon Budget in Alpine Grassland Ecosystem (2001).
CHINA & KOREA	The Second Tripartite Presidents Meeting among NIES, NIER and CRAES Joint Communique (2004).
INDONESIA	Memorandum of Understanding between the Research and Development Center for Biology, Indonesian Institute of Sciences (RDCP-LIPI), Bogor-Indonesia and the National Institute for Environmental Studies, concerning Scientific and Technical Cooperation on Biodiversity and Forest Fires (2001).
KOREA	Agreement between the National Institute for Environmental Studies and the National Institute of Environmental Research of the Republic of Korea to establish a cooperative framework regarding endocrine disrupting chemicals research (1999).
MALAYSIA	Memorandum of Understanding between the Forest Research Institute Malaysia (FRIM), the University Pertanian Malaysia (UPM) and the National Institute for Environmental Studies, for Collaborative Research on Tropical Forests and Biodiversity (amended in 2003).
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 (1992).
	Agreement on 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 (1992).
	Agreement on Cooperative Research Projects between the National Institute for Environmental Studies, Ministry of the Environment and the Institute of Atmospheric Optics, Russian Academy of Sciences (1997).
	Agreement on Cooperative Research Project between the Institute of Solar-Terrestrial Physics (ISTP), Siberian Branch, Russian Academy of Science and the National Institute for Environmental Studies, Ministry of the Environment.
UN	Memorandam of Understanding referring to the Establishment and operation of a GRID-compatible Center in Japan (1991).

<Host Division>
Researcher, COUNTRY, Research Period
Research Subject (Host Researcher)

<Social and Environmental Systems Division>

Arnberger, Arne, AUSTRIA, 2006. 3. 20~2006. 3. 31
Development of measuring system to estimate the crowding by photo montage (Aoki, Y.)
Chen, Mingsong, CHINA, 2005. 4. 1~2006. 3. 31
Studies of eight scenery in China and Japan (Aoki, Y.)
Chen, Ya-Wen, Taiwan, 2005. 4. 1~2006. 3. 31
Methods of landscape appreciation and their application (Aoki,Y.)
IDIP, David, PALAU, 2005. 4. 1~2006. 3. 31
Habitat Mapping in Coral Reef Using Satellite Remote Sensing (Matsunaga, T.)
Liu, Shu-Huei, TAIWAN, 2005. 4. 1~2006. 3. 31
Methods of landscape appreciation and their application (Aoki, Y.)
Wan, Yue, CHINA, 2005. 4. 1~2005. 9. 30
Model Analysis of Health impacts in China induced by climate change (Masui, T.)

<Environmental Chemistry Division>

Alam, Md. Jahangir, BANGLADESH, 2005. 11. 1~2006. 3. 31
Radiocarbon of riverine particulate organic matter (Aramaki, T.)

<Environmental Health Sciences Division>

Jin, Chunhua, CHINA, 2006. 1. 16~2006. 3. 31
Study on the factors affecting UV irradiance on the ground (Ono, M.)

<Atmospheric Environment Division>

Lun, Xiaoxiu, CHINA, 2005. 10. 28~2006. 3. 31
Studies on organic aerosols transported from East Asia (Hatakeyama, S.)
Murugesan, Verayutham, INDIA, 2005. 11. 27~2006. 1. 27
Chemical analysis of aerosols transported from southeast Asia (Hatakeyama, S.)
Tatarov, Boyan, BULGARIA, 2005. 4. 1~2006. 3. 31
Study for determining climatology of lidar ratio using a high-spectral-resolution lidar (Sugimoto, N.)
Yu-Tsang, Lu**,** TAIWAN, 2005. 7. 19~2006. 3. 31
Comparison to National System to prepare Greenhouse Gases inventories between Taiwan and Japan (Nakane, H.)

<Water and Soil Environment Division>

Mun, Jung Soo, KOREA, 2006. 1. 16~2006. 2. 18
Characterization of dissolved organic matter (DOM) removed by iron oxide (Imai, A.)

<Environmental Biology Division>

An, Ping, CHINA, 2005. 4. 6~2006. 3. 31
A pilot study in North-East Asia for Developing desertification Assessment and Constructing an Early warning System–Land Vulnerability Assessment by soil/Vegetation/Hydrological Analysis– (Shimizu, H.)
Chen, Jin, CHINA, 2005. 10. 1~2006. 3. 30
A study on the instantaneous and large-scale estimation of carbon absorption of the Qinghai-Tibetan plateau (Tan, Y.)
Chen, Lijun, CHINA, 2004. 7. 8~
A pilot study in North-East Asia for Developing desertification Assessment and Constructing an Early warning System–Land Vulnerability Assessment by soil/Vegetation/Hydrological Analysis– (Shimizu, H.)
Ibrahim, Abd Latif, MALAYSIA, 2005. 5. 31~2006. 3. 31
Mapping of ecosystem services in tropical landscapes (Okuda, T.)
Li, Renhui, CHINA, 2005. 6. 29~2005. 8. 27
Taxonomic and phylogenetic studies on toxic waterbloom forming cyanobacteria (Watanabe, M.)
Luo, Tianxiang, CHINA, 2005. 11. 15~2006. 2. 15
A modeling study on the effects of global warming on the soil carbon storage on the Qinghai-Tibetan plateau (Tan, Y.)
Noel, Mary-Helene, FRANCE, 2005. 4. 1~2006. 3. 31
Ecophysiological study on harmful phytoplankton cysts under simulated ballast tank environments (Kawachi, M.)
Parker, Kenneth Ross, CANADA, 2005. 4. 1~2006. 3. 31
Rapid assessment of wildlife habitat in tropical forest of Malaysia (Okuda, T.)
Rakwal, Randeep, INDIA, 2005.7. 1~2006. 3. 31
Systematic analysis of molecular responses of plants to air pollutants (Kubo, A.)
Yusop, Zulkifli, MALAYSIA, 2005. 12. 4~2006. 3. 31
Studies on Evaluation of Logging Impacts on Soil Erosion and Watershed Ecosystem:Results on Soil and Nutrient losses (Okuda, T.)

<Climate Change Research Project>

Shukla, Priyadarsh R, INDIA, 2005. 11. 1~2006. 3. 31
Development of AIM/India for analyzing the countermeasures of climate change (Kainuma, M.)

<Ozone Layer Research Project>

Griesfeller, Alexandra, GERMANY, 2005. 4. 1~2006. 3. 31
Studies on stratospheric trace species by comparison of ILAS-II and ground-based FTIR measurement (Nakajima, H.)
Griesfeller, Jan Juergon, GERMANY, 2005. 4. 1~2006. 3. 31
A research on stratospheric minor constituents using ground-based Fourier-transform spectrometer data (Nakajima,H.)
Zhou, Libo, CHINA, 2005. 8. 1~2006. 3. 31
A study on ozone trend in the northern hemisphere using a chemical climate model (Akiyoshi, E.)

<Endocrine Disrupters and Dioxin Research Project>

Alissara, Reungsang, THAILAND, 2006. 1. 4~2006. 3. 31
Bioassay of riversediments and comparative study with high resolutions GS/MS (Suzuki, N.)
Cho, Hongbin, CHINA, 2005. 7. 10~2006. 3. 31
Research on the relation between geographical distribution of human exposure and environmental levels for dioxins (Suzuki, N.)

<Biodiversity Conservation Research Project>

Jang, Min-Ho, KOREA, 2005. 4. 1~2006. 3. 31
Changes in toxin production by cyanobacteria exposed to food-web components (Takamura, N.)
Kyong, Ha, KOREA, 2004. 10. 21~
Prey-predator interaction focused on cyanobacterial toxin production (Takamura, N.)

<Watershed Environments and Management Research Project>

Li, Yan, CHINA, 2005. 12. 1~2005. 12. 30
Water and carbon cycles in the arid area in China (Murakami, S.)

<PM2.5 & DEP Research Project>
Li, Chunmei, CHINA, 2005. 4. 1~
Studies on the endocrine disrupter chemicals isolated from diesel exhaust particles (DEP) (Suzuki,A.)

<Research Center for Material Cycles and Waste Management>

Choi, Ki-In, KOREA, 2005. 11. 1~
Studies on Assessment Methodology for environmental safety of secondary Products (Osako, M.)
Fan, Bin, CHINA, 2005. 11. 6~
Informal landfill's remediation and groundwater contamination control (Inoue, Y.)
Huang, Yong Shun, CHINA, 2005. 8. 29~2005. 9. 29
Training of optimum wastewater operation affordable technology (Inamori, Y.)
Hu, Zhanbo, CHINA, 2005. 4. 1~2006. 3. 31
Development of technology to control greenhouse gas emissions from soil domestic wastewater treatment process (Inamori, Y.)
Kim, Juhyun, KOREA, 2005. 4. 1~
Development of Nitrogen, Phosphorus removal, recovery system for stock farm wastewater treatment (Inamori, Y.)
Xu, Chunlian, CHINA, 2005. 9. 5~2005. 9. 29
Evaluation of wastewater treatment system called advanced Johkasou (Inamori, Y.)
Yan, Li, CHINA, 2005. 4. 1~2006. 3. 31
Development of Technology to control greenhouse gas emissions from soil plant domestic wastewater treatment process (Inamori,Y.)

<**Laboratory of Intellectual Fundamentals for Environmental Studies**>

Lee, Christina Slimming, ENGLAND, 2006. 1. 1~2006. 3. 31
Determination of fundamental properties of the CRM's in NIES (Nishikawa, M.)
Manila, Sedqyar, AFGANISTAN, 2005. 4. 1~2006. 3. 31
Study on endocrinological control of gonad in the Japanese quail (Takahashi, S.)

<Center for Global Environmental Research>

Lee, Kwi Ok, KOREA, 2006. 1. 16~2006. 2. 18
Numerical Simulation on Urban Heat Island (Ichinose, T.)
Sha, Weiming, CHINA, 2005. 4. 11~2006. 3. 31
Development of non-hydrostatic numerical models for the geophysical fluid dynamics of the global and regional atmosphere (Inoue, G.)
Yang, Yufang, CHINA, 2005. 4. 1~2006. 3. 31
Establishment of long term monitoring on ecosystem in an international river in Asia (Ichinose, T.)

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Alexandrov, G. A., Yamagata, Y., Oikawa, T., Saigusa, N., 2005. Re-calibrating TsuBiMo with eddy-covariance measurements at Takayama, Agric. Forest Meteorol., 134(1/4), 135-142.

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Calli, B., Mertoglu, B., Roest, K., Inanc, B., 2006. Comparison of long-term performances and final microbial compositions of anaerobic reactors treating landfill leachate, Bioresour. Technol., 97, 641-647.

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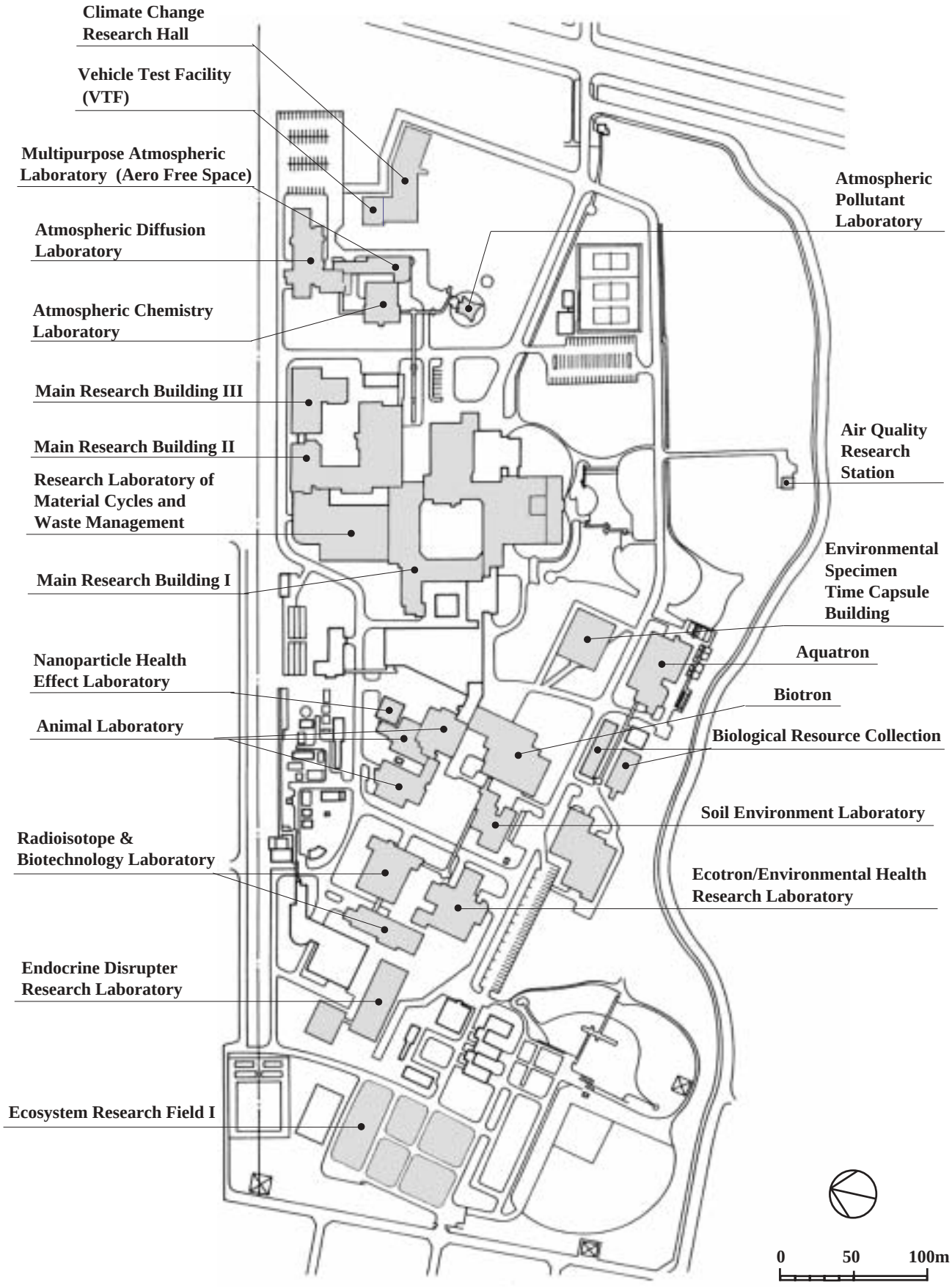
Climate Change Research Hall
Vehicle Test Facility (VTF)
Multipurpose Atmospheric Laboratory (Aero Free Space)
Atmospheric Diffusion Laboratory
Atmospheric Chemistry Laboratory
Main Research Building III
Main Research Building II
Research Laboratory of Material Cycles and Waste Management
Main Research Building I
Nanoparticle Health Effect Laboratory
Animal Laboratory
Radioisotope & Biotechnology Laboratory
Endocrine Disrupter Research Laboratory
Ecosystem Research Field I
Atmospheric Pollutant Laboratory
Air Quality Research Station
Environmental Specimen Time Capsule Building
Aquatron
Biotron
Biological Resource Collection
Soil Environment Laboratory
Ecotron/Environmental Health Research Laboratory
0 50 100m

Air Quality Research Station
Automatic instruments to monitor the concentrations of 7 atmospheric constituents (NOx, SO_2, O_3, CO_2, non-methane hydrocarbons, suspended particulate matter, and gaseous Hg) are operated at this station. Wind speed, precipitation, atmospheric pressure, visible and UV radiation, earth surface (soil and air) temperature and other atmospheric characteristics are also measured for data analyses, and the results are made available to NIES researchers. The stability and accuracy of the automated measurements and factors that interfere with them are studied, as is the evaluation of new instruments developed for atmospheric monitoring.

Animal Laboratory
The animal laboratory has three facilities in which environmental conditions are controlled. Facility I has breeding rooms for specific pathogen-free laboratory animals, and has complex gas or diesel exhaust particle (DEP) exposure chambers for investigating the health effects of PM2.5 or DEP. Facility II has a conventional laboratory animal breeding unit and has laboratories for studies on the effects of chemicals, including dioxins and heavy metals. Facility III was built in 2004 as a nanoparticle health effects research facility; it contains exposure chambers and two diesel engines for generating nanoparticles Research on the health effects of nanoparticles on experimental animals will begin in the 2005 fiscal year.

Aquatron
This hydrobiological laboratory includes several related facilities. The freshwater microcosm is particularly suitable for studies of the mechanisms and dynamics of phytoplankton bloom formation. 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 Chemistry Laboratory
This is a 6-m^3 stainless steel chamber, the inner surface of which is coated with Teflon. It permits studies of atmospheric photochemistry. This facility is essential to our research on the photochemistry of urban smog, mechanisms for secondary aerosol formation, and other important atmospheric phenomena.

Atmospheric Diffusion Laboratory
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.

Biological Resource Collection
Two projects are conducted in this facility. One is the Microbial Culture Collection (MCC-NIES), in which microalgae and protozoa have been maintained since 1983. About 1900 strains have now been preserved, and 600 to 800 strains are distributed to researchers inside and outside NIES each year. In 2002, MCC-NIES was made a center for the collection of algal resources in Japan. The second is *ex situ* conservation of endangered algae (as a part of the Environmental Specimen Time Capsule Program). About 200 strains of freshwater red algae and Charales algae are maintained.

Biotron
This facility consists of controlled greenhouses and growth cabinets used to evaluate the effects of various detailed environmental scenarios on organisms. It includes experimental chambers in which light, temperature, and humidity can be precisely controlled. It also facilitates exposure of experimental plants to pollutant gases under these controlled conditions

Climate Change Research Hall
The Climate Change Research Hall (CCRH), was completed in March 2001 with 3 floors and a total area of 4900m^2. The following major research programs are conducted in this new facility: (1) development and implementation of climate change models based on various socio-economic and emissions scenarios; (2) monitoring of atmospheric constituents to evaluate ocean and terrestrial carbon sinks; and (3) assessment of forest sinks by remote sensing, forest modeling and use of statistical data. In addition, the facility includes equipment to evaluate low-emissions vehicles. CCRH was constructed with various new energy-saving technologies. The effectiveness of the energy saving is continuously monitored and analyzed.

Ecosystem Research Field
The Ecosystem Research Field is composed of two fields: Main Field I is on the NIES campus and the Branch Field is located 4 km west of the campus. The facilities include experimental fields for various types of plant-dominated ecosystems, lysimeters, greenhouses, observation towers, and laboratories. These fields are used to test the results of laboratory and outdoor studies on ecosystems; to develop remote-sensing techniques from small-scale ground truth data; and to supply plants, particularly for bioassays and mitigation studies.

Endocrine Disrupter Research Laboratory
The Endocrine Disrupter 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 has 4 floors with a total area of 5200m^2, and is equipped with several special instruments, including a high-resolution nuclear magnetic resonance imaging (MRI) instrument for examining the activity of the living human brain, and a liquid chromatograph –tandem mass spectrometry (LC/MS/MS) for the qualitative and quantitative analysis of EDCs. The laboratory has all the 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 disrupters.

Environmental Specimen Time Capsule Building
The strategic and systematic storage of environmental samples and biological specimens provides an important knowledge base and is essential for environmental research. For example, such samples and specimens are needed to study long-term trends in environmental pollutants, and to verify past conditions when new types of pollution have been identified. NIES constructed this building to provide central facilities for the preservation of environmental specimens. The facilities are used for the long-term storage of environmental specimens such as mussels and air particulates, as well as cells and genetic material of threatened species.

Global Environmental Monitoring Stations (Hateruma and Cape Ochi-ishi)
These monitoring stations were set up mainly to monitor long-term changes in the baseline levels of greenhouse gases at remote sites in Japan. The island of Hateruma is located in Okinawa Prefecture and is the nation's southernmost inhabited island. The monitoring station was constructed on the eastern edge of Hateruma. Cape Ochi-ishi Station is located in the eastern part of Hokkaido, which is a northern district of Japan. These stations are automated systems for high-precision monitoring of greenhouse gases (e.g.CO_2, CH_4, N_2O, O_3,) and other atmospheric species (NOx , SO_2, SPM). Long-term monitored data are archived and distributed through the Center for Global Environmental Research (CGER) homepage and the World Data Center for Greenhouse Gases (WDCGG).

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
Preservation Laboratory

This facility includes –20˚C, 5˚C and 20˚C temperature-controlled rooms, where various environmental substances collected by researchers at this Institute are stored temporarily, until they are put to practical use. Some samples that are recognized as valuable for study are transferred to regular storage in the time capsule building.

Main Research Building III
1) Fourier-transform mass spectrometer (FT-MS)

The FT-MS has very high mass resolution, (more than 10^6 at m/z = 131), with a superconducting magnet rated at 3 T. 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 MSs are connected serially (in tandem). The resolutions of the first and second MSs are 6.5×10^4 and 5×10^3, respectively. Ions selected by the first MS are passed through the collision cell, where the ions yield fragments, which are then analyzed by the second MS. The chemical structures of complex molecules can be determined with this instrument.

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 electrical charges of their nuclei. The AMS is a very sensitive and selective method for atomic ion detection and is used for measuring long-lived radioisotopes such as ^{14}C and ^{10}Be. These radioisotopes are used as tracers and time-markers (dating agents) in environmental research.

4) Hazardous chemicals area

Experiments using highly toxic substances, such as dioxins (chlorinated dibenzodioxins), polychlorinated biphenyls (PCBs), and poly-chlorinated dibenzopfurans, are conducted in this area. The air pressure inside the area is maintained below atmospheric pressure to prevent leakage of hazardous substances in the analytical laboratory. Exhaust air is treated by high-efficiency particulate air (HEPA) filters and charcoal filters; discharge water is also treated with a charcoal filter system. The Hazardous Chemicals Area contains an analytical lab with 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 Improved Limb Atmospheric Spectrometer II (ILAS-II)

ILAS-II is a satellite-borne sensor used 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 was aboard the Advanced Earth Observing Satellite II (ADEOS-II: named "Midori II"), which was launched on 14 December 2002. ADEOS-II operated routinely from April to October 2003. The ILAS-II measurement data were processed, re-processed, archived, and distributed by the ILAS-II DHF. The ILAS-II data products are used for atmospheric research work by NIES researchers and by other registered researchers.

6) Millimeter-wave spectrometer system for observation of atmospheric ozone

The millimeter-wave spectrometer measures the emission spectra from rotational transition of ozone molecules in the stratosphere and mesosphere with extremely high resolution. Vertical profiles of ozone from 14 to 76 km are retrieved by using the dependence of the width of the emission spectra of ozone on altitude. The spectrometer was installed in 1995. Since then, ozone has been monitored continuously, except on rainy days and heavily humid days.

7) Receiving and Processing facility for NOAA satellite data

The Advanced Very High Resolution Radiometer (AVHRR) instruments orbit the earth on National Oceanic and Atmospheric Administration (NOAA, USA) satellites. They monitor 5 electromagnetic radiation wavelength bands from the visible to the thermal infrared region with high temporal and relatively medium spatial resolution (ca. 1 × 1 km). The AVHRR facility of NIES was able to receive the data, which are obtained by various AVHRRs, up to March 2004. The data received up until that time are being processed and archived by the facility.

8) Information processing center for Global Resource Information Database (GRID)-Tsukuba

GRID-Tsukuba is 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 datasets. 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.

Nanoparticle Health Effect Laboratory
This building is equipped with experimental facilities to provide new knowledge on the health effects, chemical and physical properties, behavior, and translocation of nanoparticles.

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

Radioisotope and Biotechnology Laboratory
This 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. The laboratory's specialized instruments, including a peptide sequencer and a DNA sequencer, are available on the first floor. The second floor is radioisotope-controlled area used to facilitate studies of the transport, accumulation, chemical conversion, and toxicity of environmental pollutants in plants, animals, soil, water, and the atmosphere.

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 created in January of the same year in connection with the national government's administrative reforms. The 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 the Preservation and Enhancement of the Water Environment
1) Lake Kasumigaura Water Research Laboratory

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

2) Bio-Eco Engineering Research Laboratory

Improving water quality in enclosed water bodies is an important environmental issue in many countries around the world. If water-cleaning technologies are used, it is essential that they be properly suited to the local conditions. In this laboratory, research, development, and actual field testing of new types of waste and wastewater treatment systems, such as the advanced Johkasou system and aquatic plant–soil application processes that use bio- and eco-engineering technologies, are being promoted. This laboratory will enhance research activities, including international cooperative research.

Rikubetsu Stratospheric Monitoring Station
NIES has been monitoring the stratospheric ozone layer over Hokkaido in collaboration with the Solar-Terrestrial Environment Laboratory (STEL) at Nagoya University. Monitoring is also performed in a room of the Rikubetsu Astronomical Observatory, which is run by the Rikubetsu town council. The center has been using various systems to monitor the vertical distribution of stratospheric ozone (by millimeter-wave radiometer); harmful ultraviolet rays (by Brewer spectrometer); and the vertical temperature distribution of stratospheric ozone (by laser radar). The aim is to reveal ozone depletion in the stratosphere and the effects of the Arctic ozone hole. Since parts of the polar vortex in the Arctic region sometimes arrive over Hokkaido in winter or spring, Rikubetsu is one of the sites used to study the effects of the Arctic polar delete one space vortex.

Soil Environment Laboratory
The soil laboratory contains unique small and large monolithic lysimeters in which the behaviors of pollutants such as heavy metals and synthetic organic compounds are investigated. The effects of pollutants on soil ecosystems (including the soil–organisms–plant system) are also investigated.

Tomakomai Flux Research Site
The main research objectives of this site are to evaluate observation systems for measuring the fluxes of CO_2 and energy in a woodland ecosystem at Tomakomai National Forest in Hokkaido. This comprehensive research has continuously monitored a larch forest to elucidate carbon cycle functions such as CO_2 flux. The observations have been implemented with the cooperation of universities, national research institutes, regional government, and the Hokkaido Regional Forest Office as the main site. Unfortunately, the Tomakomai Flux Research Site was badly damaged by a typhoon on 18 September 2004. We developed a new site to continue our observations. The Fuji Hokuroku Flux Observation Site opened in January 2006.

Vehicle Test Facility (VTF)
The VTF is equipped with an environment simulation room, an on-board measurement system, and a conventional exhaust measurement system, as well as devices originally developed by NIES, such as an exhaust gas dispersion chamber and a high-dilution-ratio tunnel, in order to measure and evaluate real-world vehicle exhaust.

Number of Personnel

President	1
Executive Director	2
Auditor	2
Planning Division	8
General Affairs Division	33
Audit Section	3
Center for Global Environmental Research	26
Research Center for Material Cycles and Waste Management	21
Research Center for Environmental Risk	28
Asian Environment Research Group	23
Social and Environmental Systems Division	14
Environmental Chemistry Division	15
Environmental Health Sciences Division	14
Atmospheric Environment Division	14
Water and Soil Environment Division	16
Environmental Biology Division	20
Laboratory of Intellectual Fundamentals for Environmental Studies	9
Environmental Information Center	11
Total	260

Fields of Expertise

Basic Sciences	80
Engineering	63
Agricultural Sciences	24
Medical Science	17
Pharmacology	7
Fisheries Science	3
Economics	2
Jurisprudence	1
Total	197

Division Section/Team	Position	Staff Member
Headquarters	President	OHTSUKA, Ryutaro
	Executive Director (Research)	NISHIOKA, Syuzo
	Executive Director (Management)	IIJIMA, Takashi
	Auditor	KOIZUMI, Hideaki
	Auditor	SADAKUNI, Mamoru
Planning Division	Director	MURAKAWA, Masamichi
	Deputy Director	KATO, Masao
	Deputy Director	OTSUBO, Kuninori
	Deputy Director	KISHIBE, Kazumi
	Principal Research Coordinator (*)	UEHIRO, Takashi
	Principal Research Coordinator (*)	TANABE, Kiyoshi
Planning Office	Chief (*)	KISHIBE, Kazumi
	Research Coordinator	KINO, Nobuhiro
	Research Coordinator	HIGASHIOKA , Reiji
Research Coordination Office	Chief (*)	OTSUBO, Kuniyori
	Research Coordinator (*)	HIGASHIOKA , Reiji
	Research Coordinator (*)	KONDO, Yoshinori
	Research Coordinator (*)	TASAKI, Tomohiro
Office of Public Relation and International Coordination		
	Chief (*)	UEHIRO, Takashi
	Research Coordinator	HIROKANE, Katsunori
General Affairs Division	Director	KASHIWAGI, Jyunji
General Affairs Section	Chief	UEKI, Ken
Accounting Section	Chief	KANAI, Nobuhisa
Facility Management Section	Chief	TAKEUCHI, Tadashi
Audit Section	Chief	HIRAO, Yoshinori
Center for Global Environmental Research	Director	SASANO, Yasuhiro
	Deputy Director	NOJIRI, Yukihiro
	Special Senior Researcher	MAKSYUTOV, Shamil
	Special Senior Researcher	YAMAGATA, Yoshiki
Global Carbon Cycle Research Section	Chief	MUKAI, Hitoshi
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		RYAN, Naishin
Satellite Remote Sensing Research Section	Chief	YOKOTA, Tatsuya
		YAMANO, Hiroya
Climate Risk Assessment Research Section	Chief	EMORI, Seita
		TAKAHASHI, Kiyoshi
		OGURA, Tomoo
		ITO, Akihiko
Climate Policy Assessment Research Section	Chief	KAINUMA, Mikiko
		KAMEYAMA, Yasuko
		FUJINO, Junichi
		HANAOKA, Tatsuya

(*) Multiple roles

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		SHIRAI, Tomoko
Office for Terrestrial Monitoring	Chief	FUJINUMA, Yasumi
		OGUMA, Hiroyuki
Office for Global Environmental Database	Chief	MATSUNAGA, Tsuneo
		SHIMURA, Junko
	(*)	MORIGUCHI, Yuichi
	(*)	NAKANE, Hideaki
	(*)	NOHARA, Seiichi
	(*)	YOKOUCHI, Yoko
	(*)	ONO, Masaji
	(*)	TOJIMA, Yasunori
	(*)	IMAI, Akio
	(*)	TANIMOTO, Hiroshi
	(*)	ICHINOSE, Toshiaki
	(*)	TANAKA, Atsushi
	(*)	ARAMAKI, Takahumi
	(*)	MATSUSHIGE, Kazuo

Research Center for Material Cycles and Waste Management

	Director	MORIGUCHI, Yuichi
	Deputy Director	INOUE, Yuzo
	Research Coordinator (*)	KINO, Nobuhiro
	(*)	GOTO, Sumio
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		HASHIMOTO, Seiji
		NANSAI, Keisuke
International Material Cycles Section	Chief	TERAZONO, Atsushi
		MURAKAMI, Shinsuke
		YOSHIDA, Aya
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		TASAKI, Tomohiro
		FUJII, Minoru
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		YAMADA, Masato
		ENDO, Kazuto
Waste Testing and Assessment Section	Chief	KIDA, Akiko
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		SAKANAKURA, Hirofumi
Bio-Eco Engineering Section	Chief	INAMORI, Yuhei
		EBIE, Yoshitaka
	(*)	XU, Kaiqin

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	Special Senior Researcher	HORIGUCHI, Toshihiro
	Special Senior Researcher	GOKA, Koichi
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		SONE, Hideko
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		TATSUTA, Haruki
Environmental Quality Measurement Section	Chief	SHIRAISHI, Fujio
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Environmental Sensitivity Research Section	Chief	FUJIMAKI, Hidekazu
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		YAMAMOTO, Syoji
		KUROKAWA, yoshika
		TSUKAHARA, Shinji
Environmental Nanotoxicology Section	Chief	HIRANO, Seishiro
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Ecosystem Impact Research Section	Chief	TAKAMURA, Noriko
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Asian Environmental Research Group	Director	NAKANE, Hideaki
	Deputy Director	MURAKAMI, Syogo
	Special Senior Researcher	SHIMIZU, Hideyuki
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		TAKAMI, Akinori
		SATO, Kei
		SHIMIZU, Atsushi
Regional Atmospheric modeling Section	Chief	OHARA, Toshimasa
		SUGATA, Seiji
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		NAGASHIMA, Tatsuya
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Integrated Assessment Section	Chief	MASUI, Toshihiko HIJIOKA, Yasuaki HANASAKI, Naota
Transportation and Urban Environment Section	Chief	KOBAYASHI, Shinji SUGA, Shinsuke KONDO, Yoshinori MATSUHASHI, Keisuke
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Biological Imaging and Analysis Section	Chief	MITSUMORI, Fumiyuki UMEDU, Toyoshi WATANABE, Hidehiro ITAYAMA, Tomoaki
Environmental Health Sciences Division	Director Principal Senior Researcher Principal Senior Researcher	TAKANO, Hirohisa KABUTO, Michinori KOBAYASHI, Takahiro
Molecular and Cellular Toxicology Section	Chief	NOHARA, Keiko ITO, Tomohiro SUZUKI, Takehiro

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Environmental Epidemiology Section	Chief	NITTA, Hiroshi YAMAZAKI, Shin
Atmospheric Environment Division	Director Special Senior Researcher	IMAMURA, Takashi NAKAJIMA, Hideaki
Atmospheric Physics Section	Chief	NOZAWA, Toru UEHARA, Kiyoshi AKIYOSHI, Hideharu SUGITA, Takafumi HIGURASHI, Akiko
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Atmospheric chemistry Section	Chief	MURANO, Kentaro INOMATA, Satoshi
Atmospheric Measurement Section	Chief	TOJIMA, Yasunori UTIYAMA, Masahiro
Water and Soil Environment Division	Director	KOHATA, Kunio
Water Quality Science Section	Chief	INABA, Kazuho DOI, Taeko IWASAKI, Kazuhiro TOMIOKA, Noriko SYUTSUBO, Kazuaki YAMAMURA, Shigeki
Lake Environment Section	Chief	IMAI, Akio MATSUSHIGE, Kazuo KOMATSU, Kazuhiro
Marine Environment Section	Chief	HARASHIMA, Akira NAKAMURA, Yasuo MAKI, Hideaki
Soil Science Section	Chief (∗)	KOHATA, Kunio HAYASHI, Seiji MURATA, Tomoyoshi KOSHIKAWA, Masami
Environmental Biology Division	Director	TAKENAKA, Akio
Population Ecology Section	Chief	TAKAMURA, Kenji NAGATA, Hisashi SATAKE, Kiyoshi TADA, Mitsuru YOSHIDA, Katsuhiko

(∗) Multiple roles

Physiological Ecology Section	Chief	SAJI, Hikaru NATORI, Toshiki KUBO, Akihiro TANG, Yanhong AONO, Mitsuko
Microbial Ecology Section	Chief	KASAI, Fumie KAWACHI, Masanobu HIROKI, Mikiya UENO, Ryuhei
Ecological Genetics Section	Chief	NAKAJIMA, Nobuyoshi MIYASHITA, Mamoru TAMAOKI, Masanori YABE, Toru ISHIHAMA, Fumiko
Laboratory of Intellectual Fundamentals for Environmental Studies		
	Director	UEHIRO, Takashi
Environmental Analytioal Chemistry Laboratory	Chief	NISHIKAWA, Masataka SANO, Tomoharu TAKAGI, Hiroo
Biological Resource Laboratory	Chief	KUWANA, Takashi SHIMIZU, Akira TAKAHASHI, Shinji TOBE, Kazuo KAWASHIMA, Takaharu
Environmental Information Center	Director	IWATA, Motokazu
Planning Section	Chief	ENDO, Yuichi
Database Section	Chief (∗)	SHIRAI, Kunihiko
Information Management Section	Chief	SHIRAI, Kunihiko

(∗) Multiple roles

^{1}H-NMR	Proton Nudear Magnetic Resonance
ADEOS-II	Advanced Earth Observing Satellite II
AGCM	Atmospheric General Circulation Model
AhR	Aryl hydrocarbon Receptor
AHS	Aquatic Humic Substances
APO	Atmospheric Potential Oxygen
As	Arsenic
As3MT	Arsenic Methyltransferase
BAL	Bronchoalveolar Lavage
BaS	Bases
BSO	Buthionine Sulfoximine
C&D	Construction and Demolition
CALUX	Chemically Activated Luciferase Expression
CaO	Calcium Oxide
CB	Carbon Black
CCM	Chemical Climate Model
CCSR	Center for Climate System Research, the University of Tokyo
CFORS	Chemical weather FORecast System
CFU	Colony Forming Unit
CHAAMS	Cape Hedo Atmosphere and Aerosol Monitoring Station
CHD	Catalytic Hydro-Dechlorination
COX2	Cyclooxygenase-2
DCA	Detrended Correspondence Analysis
DE	Diesel Exhaust
DeBDE	Deca-Brominated Diphenyl Ether
DeCB	Decachlorobiphenyl
DEP	Diesel Exhaust Particles
DGGE	Denaturing Gradient Gel Electrophoresis
DOC	Dissolved Organic Carbon
DOM	Dissolved Organic Matter
DR-CALUX	Dioxin Responsive- Chemical Activated LUciferase eXpression
E2	17-beta Estradiol
EC	Elemental Carbon
EC	Electric Conductivity
ECE	Elemental Composition Elucidations
EDCs	Endocrine-Disrupting Chemicals
EnvMethod	Environmental Analytical Methods Database
ER	Estrogen Receptor
FACS	Fluorescence-Activated Cell Sorter
G-CIEMS	Grid-Catchment Integrated Modeling System
GC-MS	Gas Chromatography-Mass Spectrometry
GCxGC/qMS	Two-dimensional Gas Chromatography Coupled with qadrupole Mass
GE	Genetically Engineered
GHG	Greenhouse Gas
GIS	Geographical Information System
HALOE	Halogen Occultation Experiment
HiA	Hydrophilic Acids
HiN	Hydrophilic Neutrals
HoN	Hydrophobic Neutrals
HPLC	High Performance Liquid Chromatography
HRUs	Hydrological Response Units
HSPF	Hydrological Simulation Program-FORTRAN
hTERT	Human Telomerase Catalytic Subunit
IL	Interleukin
ILAS	Improved Limb Atmospheric Spectrometer
ILAS-II	Improved Limb Atmospheric Spectrometer II
IPCC	Intergovernmental Panel on Climate Change
ISLSCP	International Satellite Land-Surface Climatology Project
JA	Jasmonic Acid
JMA	Japan Meteorological Agency
LAN	Local Area Network
LCA	Life Cycle Assessment
LC-MS	Liquid Chromatography/Mass Spectrometry
LPS	Lipopolysaccharide
LTA	Lipoteichoic Acid
MAAs	Mycosporine-like Amino Acids
MeJA	Methyl Jasmonate
MIPAS-B	Michelson Interferometer for Passive Atmospheric Sounding Ballo
MkIV	Mark-IV Fourier Transform InfraRed Interferometer
MPA	Marine Protected Area
MRI	Magnetic Resonance Imaging
MRI	Meteorological Research Institute
MSW	Municipal Solid Waste
MuSEM	Multimedia Simplebox-systems Environmental Model
NAT	Nitric Acid Trihydrate
NDSC	Network for Detection of Stratospheric Change
NIST	the National Institute of Standards and Technology in the USA
NKCC2	Sodium Potassium 2 Chloride Co-transporter
NOx	Nitrogen Oxide
NPP	Net Primary Production
OC	Organic Carbon
OECD	Organization for Economic Co-operation and Development
PAHs	Polycyclic Aromatic Hydrocarbons
PBDD/Fs	Polybrominated Dibenzo-*p*-Dioxins and Dibenzofurans
PBDEs	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PCD	Photochemical Dechlorination
PCDD/Fs	Polychlorinated Dibenzo-*p*-Dioxins and Dibenzofurans
PET	Polyethylene Terephthalate
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PNDs	Postnatal Days
POPs	Persistant Organic Pollutants
PRTR	Pollutant Release and Transfer Register
PSC	Polar Stratospheric Cloud
QSAR	Quantitative Structure–Activity Relationship
Q-TOFMS	Quadrupole Time-of-Flight Mass Spectrometer
RDF	Refuse Derived Fuel
ROMK	Renal Outer Medullary K+
RPF	Refuse Paper & Plastic Fuel
RT-PCR	Reverse Transcriptase-Polymerase Chain Reaction
RXR	Retinoid X Receptor
SCWO	Sub-Critical Water Oxidation
SD	Sodium Dispersion
SNP	Single Nucleotide Polymorphism

SPM	Suspended Particulate Matter
SUS	Stainless Used Steel
TC	Triclosan
TCDD	2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin
TEFs	Toxicity Equivalent Factors
TEOM	Tapered Element Oscillating Microbalance
TEQ	Toxic Equivalent
TG	Test Guideline
TGD	Three Gorges Dam
TOMS	Total Ozone Mapping Spectrometer
TPT	Triphenyltin Chloride
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Envrionment Programme
USB	Up-flow Sludge Blanket
VOC	Volatile Organic Chemical
VOCs	Volatile Organic Compounds
WAN	Wide Area Network
WHO	World Health Organization
WHO-TEQ	World Health Organization-toxicity equivalent
WT	Wild Type
WTP	Waste Treatment Plant
WWW	World Wide Web

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