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# NIES Annual Report 2011

AE - 17 - 2011

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

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# Foreword

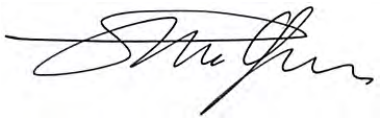
This annual report is an official record of research activities at the National Institute for Environmental Studies (NIES) in fiscal year 2010 (April 2010 to March 2011), the fifth year of our second five-year research plan as an incorporated administrative agency.

The massive earthquake and tsunami that occurred on March 11, 2011 and the subsequent accident at the nuclear power plant resulted severe environmental damage in the East Japan. NIES continue to extend our sincerest sympathies to all the victims of the disaster, and have, since March 29, been contributing to recovery efforts as the Disaster Rescue and Recovery Headquarters on the three fronts of disaster waste management measures, cooperation with local environmental research institutes and timely and appropriate information provision. The “Great East Japan Earthquake Information Page” in our homepage introduces the initiatives which our institute is undertaking towards rescue and recovery efforts for the disaster.

This fiscal year, all research units have pursued research in various fields based on the five-year plan formulated in 2006. About half of NIES’s researchers have been involved in four priority programs: Climate Change, Sustainable Material Cycles, Environmental Risk, and the Asian Environment. The other half have performed fundamental and pioneering studies in the six research divisions – Social and Environmental Systems, Environmental Chemistry, Environmental Health Sciences, Atmospheric Environment, Water and Soil Environment, and Environmental Biology – as well as in the Laboratory of Intellectual Fundamentals for Environmental Studies.

Through collaboration with researchers both nationally and internationally, we have produced a number of outcomes for a wide range of environmental issues at the local, national, regional, and global levels. Our research activities and our outreach activities, such as the dissemination of research findings and other environmental information through press releases, our homepage, public symposia, and open campus days, have given us a high reputation as a government-funded institute.

It is my sincere hope that the readers of this report will maintain an interest in NIES and will offer comments and suggestions on our activities; such input is invaluable for the continuous improvement of our work.



OHGAKI, Shinichiro.
President
October, 2011

# 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, understanding that research on environmental sciences was necessary and could address public needs, the Environment Agency established the National Institute for Environmental Studies (NIES) in Tsukuba Science City, about 50 km north of Tokyo. NIES is now Japan's primary institute for comprehensive research in environmental science.

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, depletion of the stratospheric ozone layer, acid deposition, destruction of tropical rain forests, and desertification attracted greater concern worldwide.

NIES underwent a major reorganization in 1990 to enable it to conduct more intensive research on conservation of the natural environment and on 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 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 incorporated administrative agency, giving it a degree of independence from the national government. The change from government institute to non-governmental 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 2006, NIES embarked on its second five-year (2006–2010) plan and reorganized its research system to focus its resources on four priority research areas: climate change, sustainable material cycles, environmental risk, and the Asian environment. NIES also renewed its resolve to engage in fundamental research in order to respond to emerging and potential environmental issues. In collaboration with many institutions in Japan and abroad, it continues to engage in scientific research on environmental issues.

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 performed, particularly in the context of our priority research projects. NIES has various types of experimental facilities and remote research stations, such as the Lake Kasumigaura Water Research

Laboratory, the Fuji Hokuroku Flux Observation Site, and the Global Environmental Monitoring Stations in Hateruma and Cape Ochi-ishi.
As of March 31, 2011, the total number of NIES regular permanent staff was 257 (including 5 foreign researchers). There were also 637 non-permanent researchers, including 75 foreign researchers. The total budget for FY 2010 was 16,513 million yen.

**Table 1** Number of Permanent Staff

| | | |
|---|---|---|
| Research | 190 | 73.9% |
| Administration | 52 | 20.2% |
| Environmental Information Center | 10 | 3.9% |
| Executive | 5 | 1.9% |
| Total | 257 | 100% |

(As of March 31, 2011)

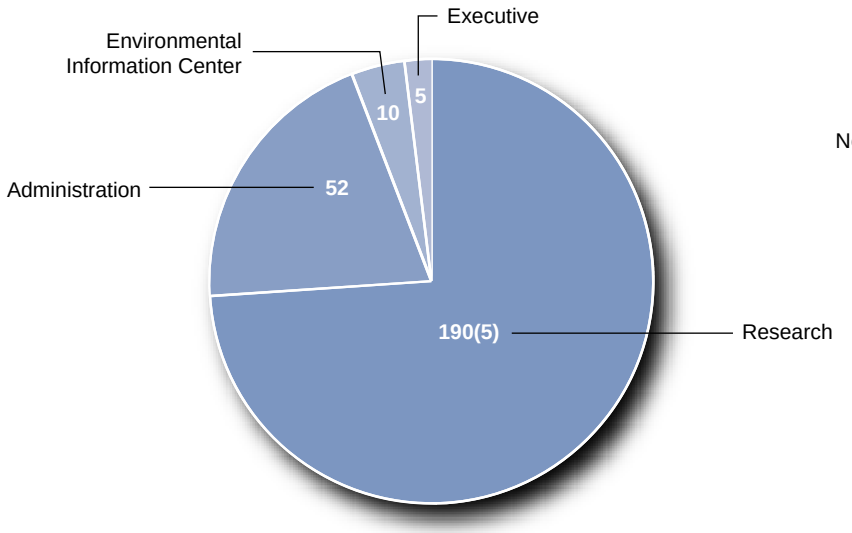
**Table 2** Budget for the Second Medium-Term Plan

(Unit: million yen)

| | Category | 2006-2010 Budget (5 years) | Fiscal 2010 Budget |
|---|---|---|---|
| Revenues | Grant for Operating Costs | 51,253 | 12,127 |
| | Subsidies for Facilities | 2,470 | 292 |
| | Commissioned Work | 20,275 | 4,055 |
| | Others | 70 | 39 |
| | Total | 74,068 | 16,513 |
| Expenditures | Project Costs | 33,843 | 8,610 |
| | Facility Improvements | 2,470 | 292 |
| | Expenses for Commissioned Work | 20,275 | 4,055 |
| | Personnel Expenses | 14,907 | 3,067 |
| | General Administrative Expenses | 2,573 | 489 |
| | Total | 74,068 | 16,513 |

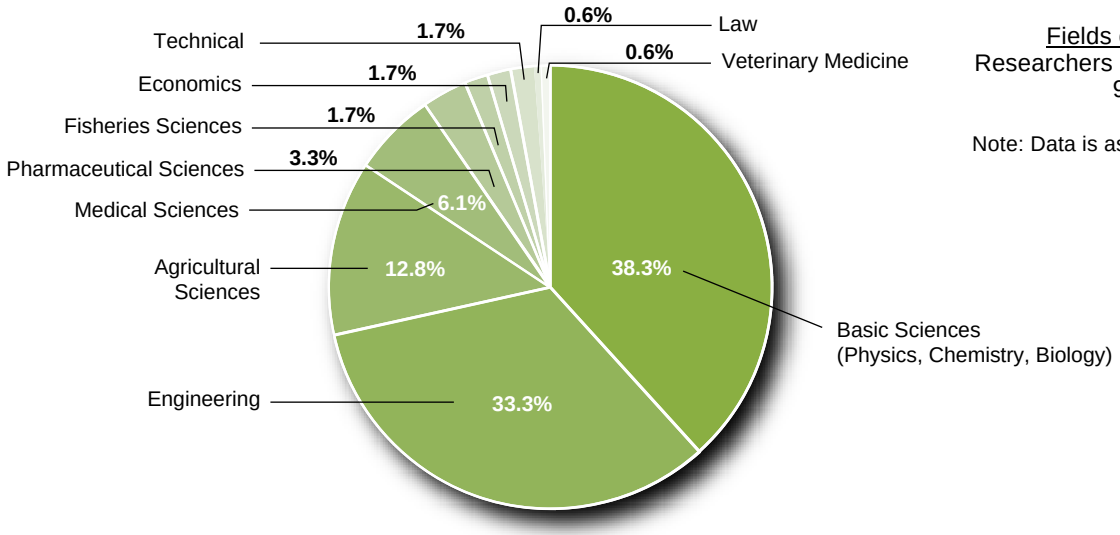
Note: The budget for each annual work plan will be requested and decided each fiscal year, based on the second medium-term (five-year) plan.

## Human Resources



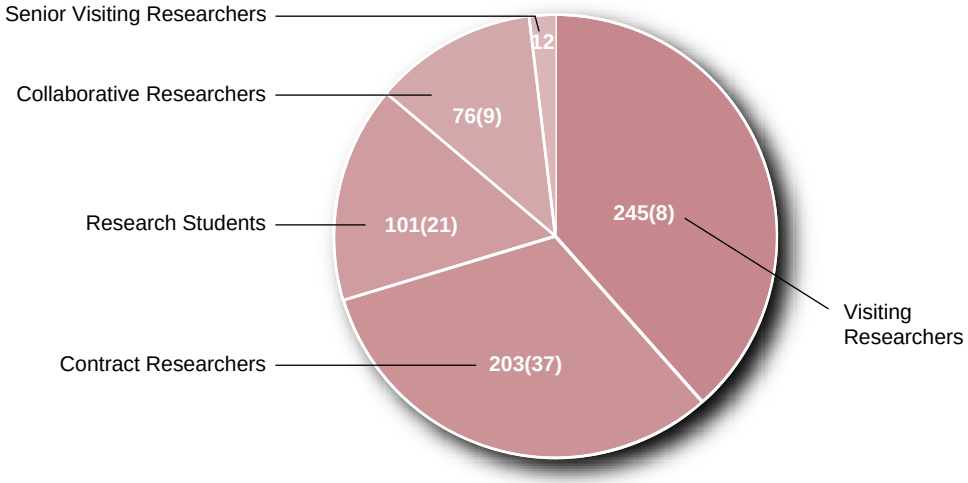

Number of Permanent Staff
257 (5)

Notes: 1. Data is as of March 31, 2011.
2. Figures in parentheses indicate number of foreign researchers.




Fields of Expertise
Researchers holding doctorates
94.7%

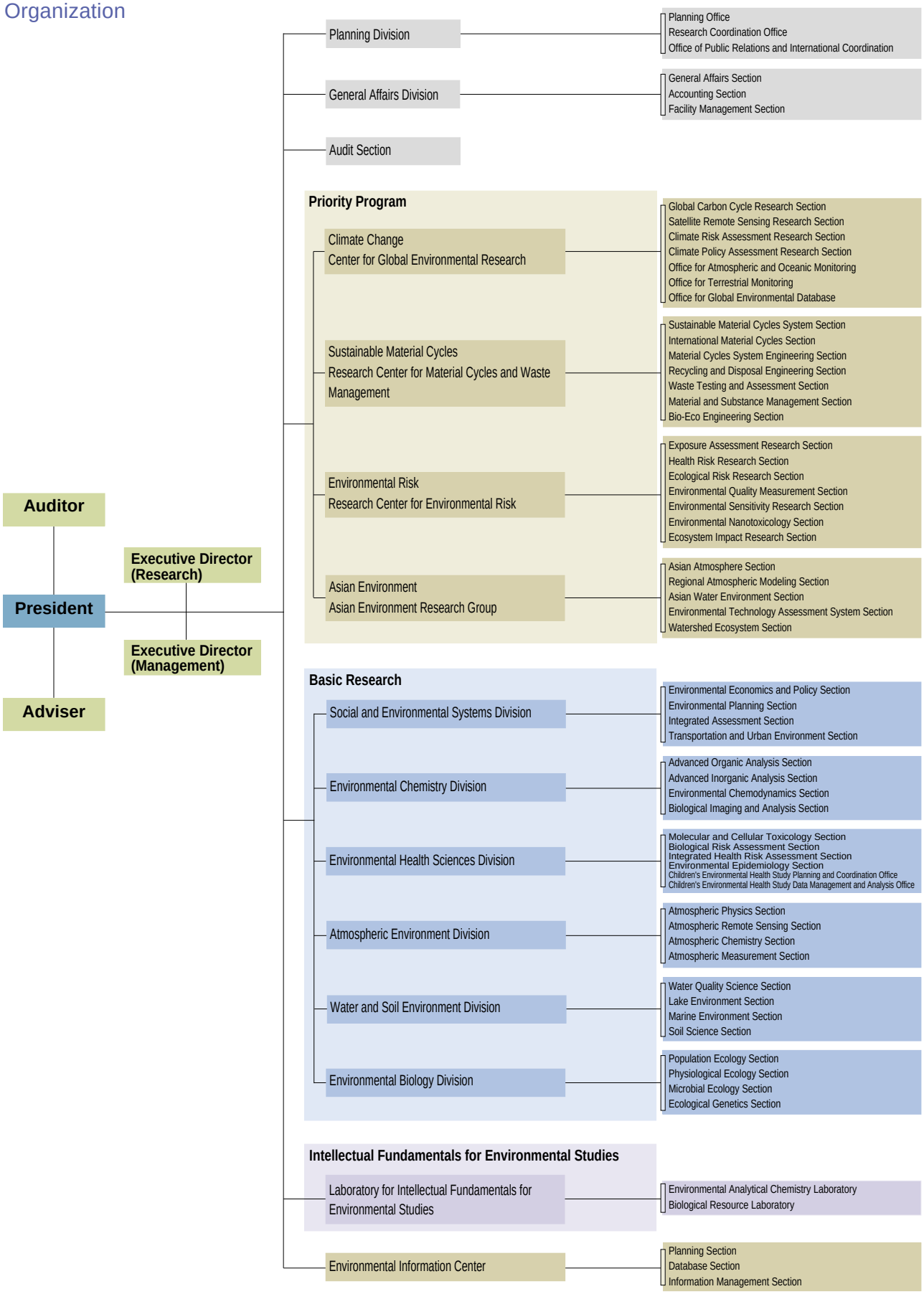
Note: Data is as of March 31, 2011




Number of Visiting Researchers, etc
637 (75)

Notes: 1. Data for "Contract Researchers" is as of March 31, 2011.
(Data for Limited-Term Researchers, NIES Fellows, NIES Post Doctoral Fellows, NIES Assistant Fellows, NIES Research Assistants reflects the total number accepted in FY2010).
2. Figures in parentheses indicate number of foreign researchers.

## Organization



# Center for Global Environmental Research

The tower at Berezorechka, in West Siberia, used for continuous measurement of the greenhouse gases $CO_2$ and $CH_4$.

The Center for Global Environmental Research (CGER) was established in 1990 as a focal point for Japan's contribution to global environmental research. To create a foundation for measures targeted at environmental preservation, it has been working to clarify, from a scientific perspective, the effects that humanity has on the environment. As the core organization for research on climate change at NIES, CGER performs research ranging from greenhouse gas (GHG) observations to climate change predictions, risk assessments, and future scenarios involving a low-carbon society. This research, "Climate Change," as one of the four Priority Programs, is performed through the following four core research projects:

- Project 1 Long-term variation mechanisms of greenhouse gas concentrations and their regional characteristics
- Project 2 Greenhouse gas observations from space and use of the observations to estimate global carbon flux distribution
- Project 3 Assessment of climate risk based on integrated climate, impact, and land-use models
- Project 4 Developing visions of a low carbon society and integrated analysis of climate policies

In addition to the climate change research, CGER helps to effectively implement research at the national and international levels and to create a network of researchers through strategic monitoring, creation of a global environmental database, and integration and support of global environmental research. The results of these activities are made available not only to other researchers and related organizations, but also to the general public. Some of the main topics covered by CGER activities are introduced below.

**Observational studies of GHGs (Core research project 1)**

This project consists of a large variety of atmospheric, oceanic, and terrestrial observations of GHG concentrations and their fluxes in the Asia-Pacific–Russia region. We have set up two domestic stations for the precise measurement of GHGs. To investigate GHG sources in the Southeast Asian and Indian region, since last year there have been observations from two Asian cruise ships, as well as a new investigation in India. JAL (Japan Airlines) passenger aircraft were used to observe the vertical distributions of $CO_2$ over many of the world's international airports (CONTRAIL: Comprehensive Observation Network for Trace gases by AIrLiner).

We summarized these data to clarify the spatial distribution of GHGs in the Asia-Oceanic region and to determine the patterns of interhemispheric mixing of $CO_2$. In this region, effects of Chinese GHGs emissions were often found in samples collected in winter, especially in the case of $CO_2$ and halogenated hydrocarbons; this agreed with the fact that Chinese $CO_2$ and HCFC (hydrofluorcarbon) emission rates have increased greatly in recent years. Although global anthropogenic $CO_2$ emissions recently increased to beyond 8 Pg-C/year, the atmospheric $CO_2$ growth rate is still about 2 ppm/year.

It seems that the increased atmospheric $CO_2$ levels may accelerate terrestrial photosynthesis and the oceanic $CO_2$ sink. We found small increases in atmospheric $CH_4$ concentration in 2007–2008 and 2009 at some sites, including in Siberia. The reasons for these re-increase phenomena after level flattening since 2000 were unclear, but some may be attributable to emissions from biomass burning in the tropics and/or increases in emissions from arctic wetlands.

To explain these observation results we developed a new coupled model comprising a global Eulerian model and a global Lagrangian particle dispersion model. This model performed well in simulating variations in the concentration of $CO_2$ and other components in the atmosphere in the areas studied (Figure 1).

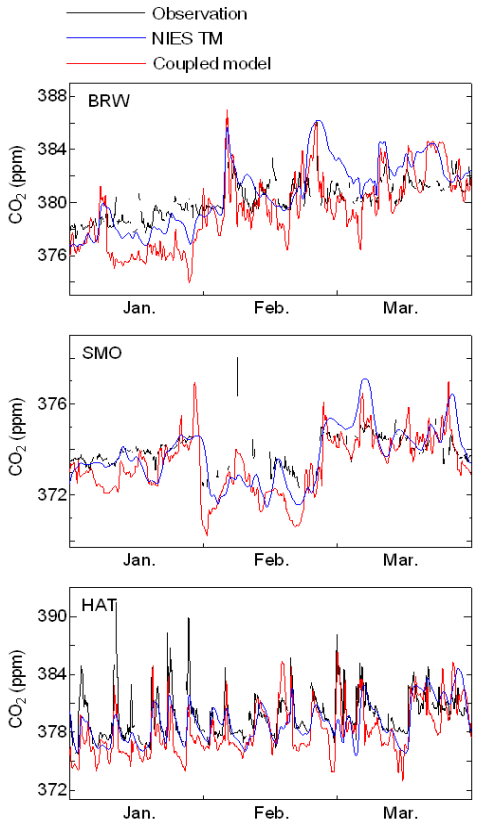



**Fig. 1** Comparison of $CO_2$ concentrations among a new coupled model, the NIES transport model, and observations at Barrow (BRW, top), Samoa (SMO, middle), and Hateruma (HAT, bottom) from January to March 2003..

**GHG observations from space (Core research project 2)**

Nearly two and a half years have passed since the Greenhouse Gases Observing Satellite (GOSAT) was placed in orbit in early 2009. GOSAT Level 2 data products, which store the column-averaged volume mixing ratios of $CO_2$ and $CH_4$ ($XCO_2$ and $XCH_4$) derived from GOSAT observational data, and the Level 3 maps, which are obtained by applying a geostatistical interpolation technique to the Level 2 data products, are now available to both registered researchers and general users (see Figure 2 for examples of Level 3 data products that have been released). These data products are based on our latest research results. We are conducting research to further improve the accuracy of the Level 2 $XCO_2$ and $XCH_4$ data. The research effort includes improving the current Level 2 data-processing algorithms. Also ongoing are our data product validation

activities, in which we compare the Level 2 column concentrations with reference values obtained from *in-situ* instruments onboard NOAA (National Oceanic and Atmospheric Administration) and CONTRAIL aircraft and from ground-based high-resolution Fourier transform spectrometers (FTSs) participating in the TCCON (Total Carbon Column Observing Network). We found that the Level 2 $XCO_2$ values (ver. 01.**) were negatively biased by 2% to 3% when compared with the ground-based FTS and aircraft data. The outcomes of the retrieval algorithm research and the data product validation activities will be reflected in the next version of the Level 2 data-processing algorithm. We are also preparing the Level 4 data product. The strengths of monthly $CO_2$ sources and sinks in 64 global regions are inferred from the space-based Level 2 column concentration data and ground-based concentration data obtained over the network of flask sampling stations.

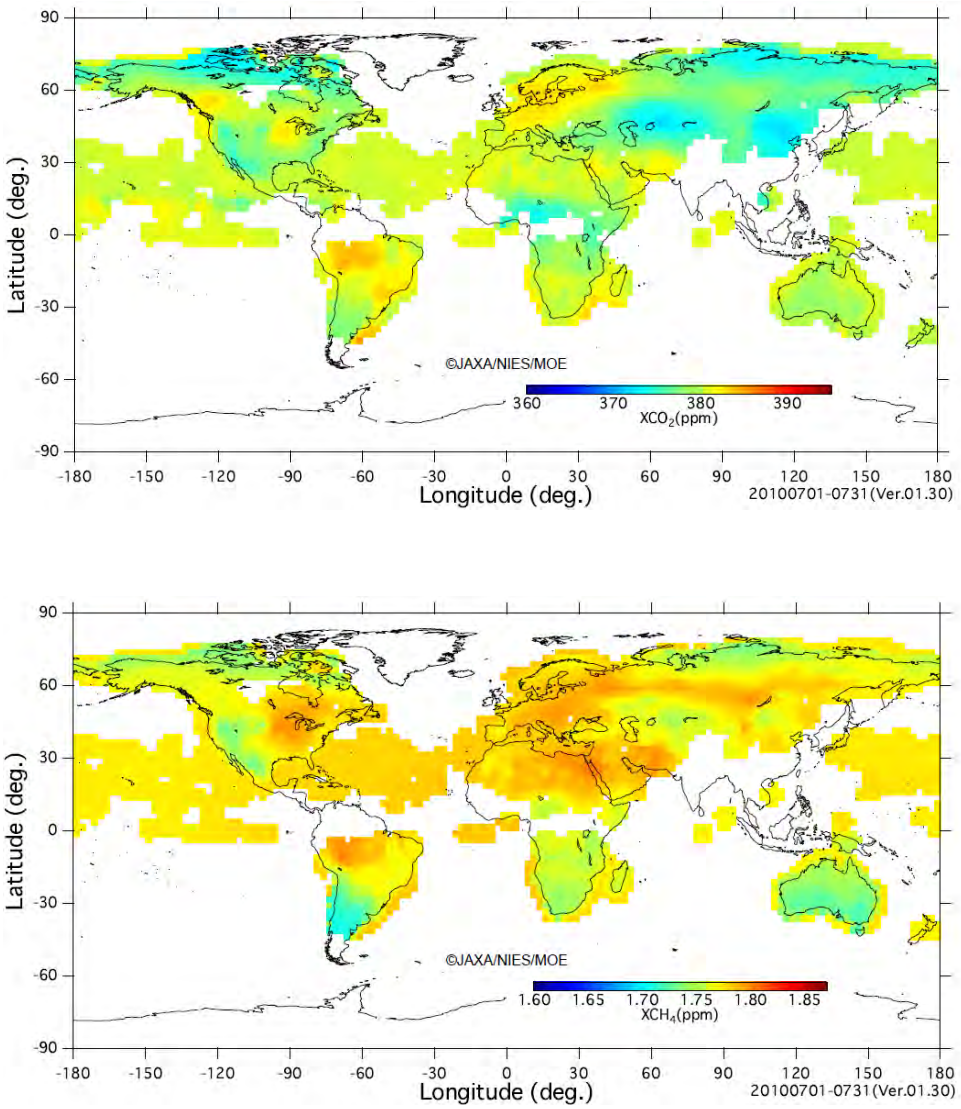



**Fig. 2** Examples of monthly global maps of $CO_2$ (upper panel) and $CH_4$ (bottom panel) column-averaged volume mixing ratios in July 2010 (GOSAT Level 3, ver. 01.30) in a 2.5° × 2.5° mesh. The $CO_2$ concentrations are lower over the high-latitude regions of the Northern Hemisphere because of active photosynthesis by terrestrial vegetation. The north-to-south $CH_4$ concentration contrast is obvious in the bottom panel. This is mainly due to the fact that major methane emission sources are located in the Northern Hemisphere.

**Assessment of climate risks (Core research project 3)**

Climate warming due to human activities will be accompanied by hydrological cycle changes. The economies, societies, and ecosystems of South America are vulnerable to such water resource changes. To inform adaptation and mitigation policies for future climate change, we need reliable water resource assessments. However, substantial uncertainties remain in current water resource assessments based on multiple coupled Atmosphere Ocean General Circulation models (AOGCMs). These uncertainties vary from substantial wetting to catastrophic drying. Water resource management decisions are usually based on the consensus formed by many climate models. However, there is no evidence that the creditability of an impact assessment can be established by majority voting from AOGCMs based on the 'one-model, one-vote' assumption. To move beyond this widely used, but naive, approach, climate scientists have been actively exploring how to evaluate the reliability of climate change projections from AOGCMs. Although there have been a few successful examples, the problem is still significant.

To consider the uncertainty ranges of climate projections, we utilized climate projections (changes from the 1980–1999 period to the 2080–2099 period under the A2 emissions scenario) according to 14 AOGCMs evaluated in the fourth assessment report of the IPCC (Intergovernmental Panel on Climate Change). We performed ensembles of hydrological simulations by using a global water resource model, for which the inputs were changes in temperature and precipitation from the 14 AOGCMs. By applying a singular value decomposition analysis, we characterized the uncertainty and identified global-scale metrics for measuring the reliability of water resource assessments in South America. We showed that although the ensemble mean assessment suggested wetting across most of South America, the observational constraints indicated an increased probability of drying in the Amazon basin (Figure 3). It is suggested that naive over-reliance on the consensus of models can lead to inappropriate decision making.

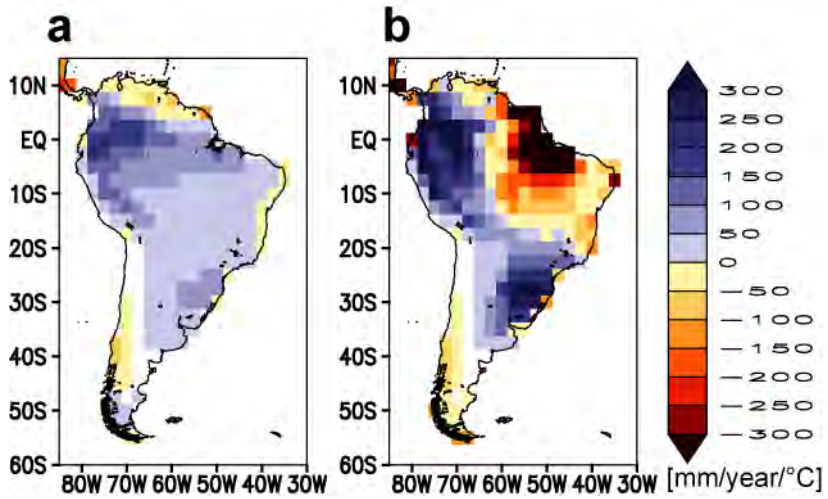



**Fig. 3** a) Changes in runoff [mm/year/°C] (ensemble mean). (b) Changes in runoff [mm/year/°C] (observationally constrained best estimate).

**Climate policy assessment (Core research project 4)**

Realizing the target of reducing GHG emissions by half by 2050 is an international challenge. The key is to achieve a low-carbon society in Asia, which has a growing economy and diversified background. In this project, a vision towards a low-carbon society is being developed by considering country-specific environmental and developmental concerns; pathways for realizing the vision are quantified, along with solid countermeasures, by using a backcasting methodology in collaboration with researchers in Asian countries such as China, India, Thailand, and Indonesia.

We contributed to the work of the Mid- and Long-term Roadmap Subcommittee, part of the Global Environmental Committee of the Central Environmental Council organized by the Ministry of the Environment, Japan. We used a bottom-up model to estimate the features that characterized a 25% GHG reduction target in 2020 compared with the 1990 level in Japan (Figure 4). A large amount of emission cuts are required in the commercial, residential, and transport sectors to achieve this target. The reductions estimated in these three sectors account for about 80% of the total GHG reductions compared to the 2008 levels. It is therefore important that we implement mitigation measures in our daily lives. We also evaluated the additional investments that would be required to introduce the necessary countermeasures, as well as the economic impacts.

We have also been studying the positions of major countries such as the United States, European Union, China, India, and Russia in international negotiations and policy-making processes. Factors at the domestic level in each of these countries or regions have made it difficult to take positive action towards climate mitigation. For instance, the fall 2010 mid-term election in the United States worked against that country's implementing any climate change policies. The European Union has been struggling with an economic crisis since 2008, and Russia is one of the largest fossil fuel exporting countries and is opposed to any meaningful measures to reduce $CO_2$ emissions. The COP (Conference of the Parties) 16 meeting in Cancun succeeded in anchoring the Copenhagen Agreement to a formal negotiating process, but it failed to clarify the legal nature of the expected agreement.

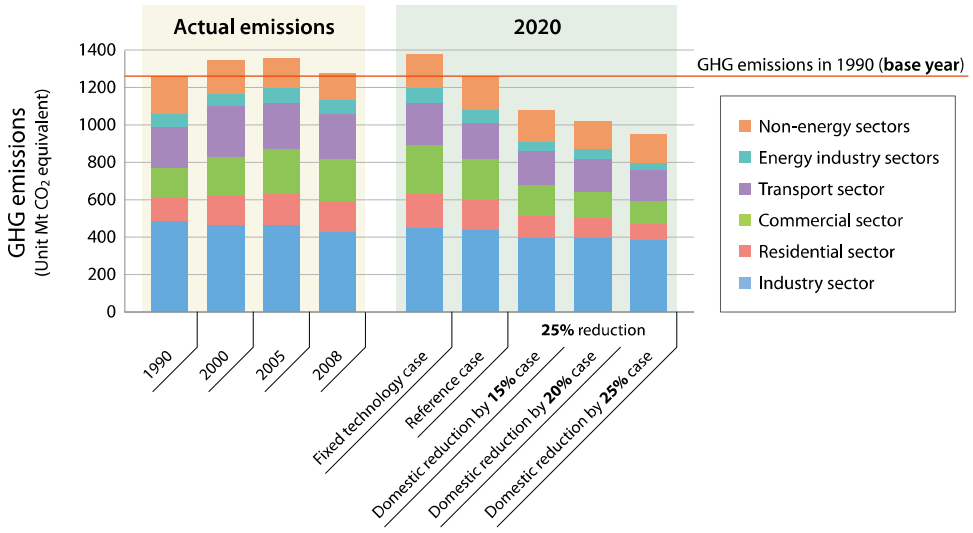



**Fig. 4** Features of the 25% GHG reduction target in 2020 in Japan provided to the Mid- and Long-term Roadmap Subcommittee

**Notes:**

1) This analysis shows the sector-wise features of a 25% GHG emissions reduction in 2020 compared with the 1990 level by considering three levels of domestic reduction: 15%, 20%, and 25%. It was assumed that the residual amount required to increase the reduction from 15% or 20% to 25% would be achieved by other measures, such as international reduction efforts.

2) The fixed technology case is based on the assumption that the energy share and energy efficiency in each sector will be fixed at the same level as in 2005. The reference case is based on the assumption that the energy efficiencies of standard technologies will be improved.

3) $CO_2$ emissions from the power sector are allocated to each sector in proportion to the amount of electricity consumed by each sector.

## Long-term monitoring of GHGs and other trace gases

Atmospheric GHGs (e.g., $CO_2$, $CH_4$, and $N_2O$) and other chemical species (CO, $NO_x$, and $SO_x$) are monitored from various platforms to find the long-term variations and spatial distributions of these gases. We have two ground-based stations, at Hateruma Island (over 1000 km southwest of the Japanese mainland) and at Cape Ochi-ishi (in northeastern Hokkaido). Commercial ships operating between Japan and Australia, New Zealand, North America, and Asian countries are used to observe the latitudinal or longitudinal distributions of greenhouse gases and the partial pressure of $CO_2$ in the surface waters of the Pacific. Routine samplings are conducted from aircraft over three sites in Siberia to measure the vertical distributions of greenhouse gases. UV-A and UV-B on the ground are monitored, and real-time UV indexes obtained at 16 sites in Japan are available to the public via our web page. To detect the effects of global warming on the marine environment, the distributions of tropical reef corals and of species of zooxanthella around Japan are monitored.

Long-term trends in the $CH_4$ mixing ratio observed in the western Pacific are

shown in Figure 5. A large $CH_4$ increase was observed in 1997–1998. The $CH_4$ increase leveled off from 1999 to 2006 at all latitudes. The $CH_4$ growth rate was enhanced in 2007 but diminished thereafter; however, strong growth in the $CH_4$ mixing ratio was observed in 2009 over the north tropics. These observations, combined with our model simulation results, suggest that explaining the $CH_4$ increase in 2007 would require an increase in surface emissions of about 20 ± 3 Tg-$CH_4$/year globally, assuming no change in OH(hydroxyl radical) concentrations.

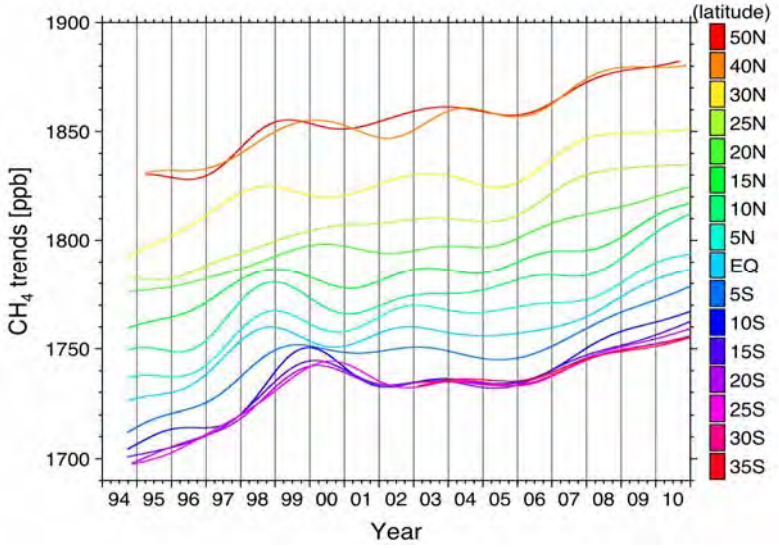



**Fig. 5** Time series of long-term trends in the $CH_4$ mixing ratio in the western Pacific, as observed from commercial ships. EQ, equator

**Carbon dioxide flux monitoring of terrestrial ecosystems**

Long-term monitoring of carbon, water, and energy exchange between larch forests and the atmosphere, as well as that in biological processes, has been conducted at three larch forests in Japan to determine how the forests respond to climate change and how the responses depend on the processes of recovery from natural and artificial disturbances. The Fuji Hokuroku Flux Observation Site is located in a mature larch forest at the foot of Mt. Fuji. Here, clear seasonal changes in carbon uptake were observed, depending on the phenology of the larch trees. At the Teshio Carbon Cycle and Larch Growth Experiment Site in Hokkaido, 14 ha of forest was clear-cut and larch saplings were planted in 2003. The clear-cutting resulted in decreased photosynthesis and increased decomposition of dead roots and soil organic carbon. It took 5 years for the annual carbon balance to stabilize.

Data obtained at these larch forest sites, as well as at other forest sites in East Asia, were analyzed to clarify how meteorological anomalies affect spatiotemporal variations in photosynthetic photon flux density (PPFD) and gross primary production (GPP). Figures 6a and 6b show the spatial distributions of PPFD, as obtained by satellite images, and GPP, as estimated by using a regression-type model validated by ground observational data. The data showed how East Asian forest productivity responded to large-scale meteorological anomalous patterns. The correlation between year-to-year changes in PPFD and

GPP was positive in the mid and high latitudes, because incoming radiation was an essential factor controlling GPP in these regions. On the other hand, PPFD and GPP were negatively correlated in the lower latitudes, under the influence of the severe drought stress caused by the enhanced incoming radiation.

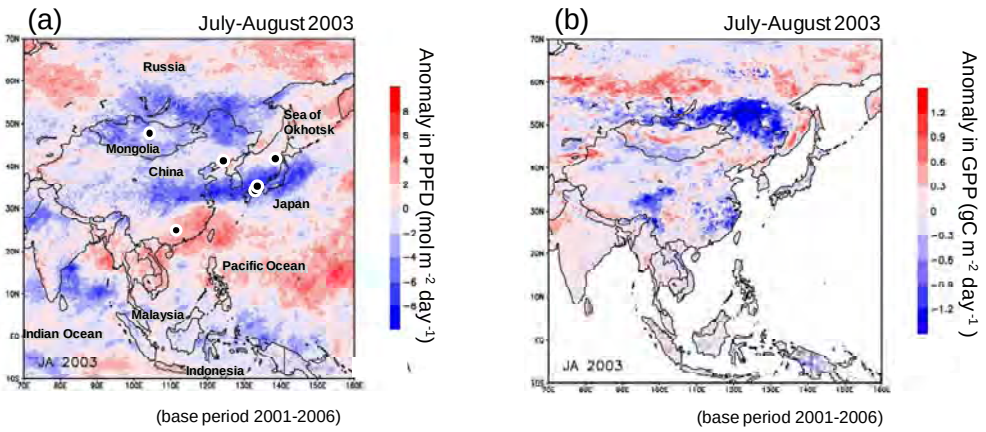



**Fig. 6** Spatial distribution of anomalies in (a) PPFD and (b) GPP in summer (July–August) 2003 (base period 2001–2006).

**Global environmental database**

We are developing and managing various databases, websites, and data analysis tools for global environmental research and making them available to the public. The following five database projects were conducted in FY 2010:

1. Development of a global environmental monitoring database and related tools
2. Development of a terrestrial carbon sink model database and related tools
3. Development of a GHG emission scenario database and related tools
4. Development of a GHG emission database and related tools
5. Development of a carbon flow database and related tools.

We classified grasslands by using high-resolution satellite images; improved land-cover classifications in urban areas by using optical and radar images; and improved country-scale land-cover maps by using optical images taken at night.

The four representative scenarios that cover the scenario variation shown in AR4 (the IPCC's *Fourth Assessment Report: Climate Change 2007*) were collected in preparation for AR5.

We updated the database of large point sources in Asia and the 1995–2000 emission maps of, for example, $CO_2$ and $SO_2$ for the whole of Asia. We also newly released emission maps for 2005.

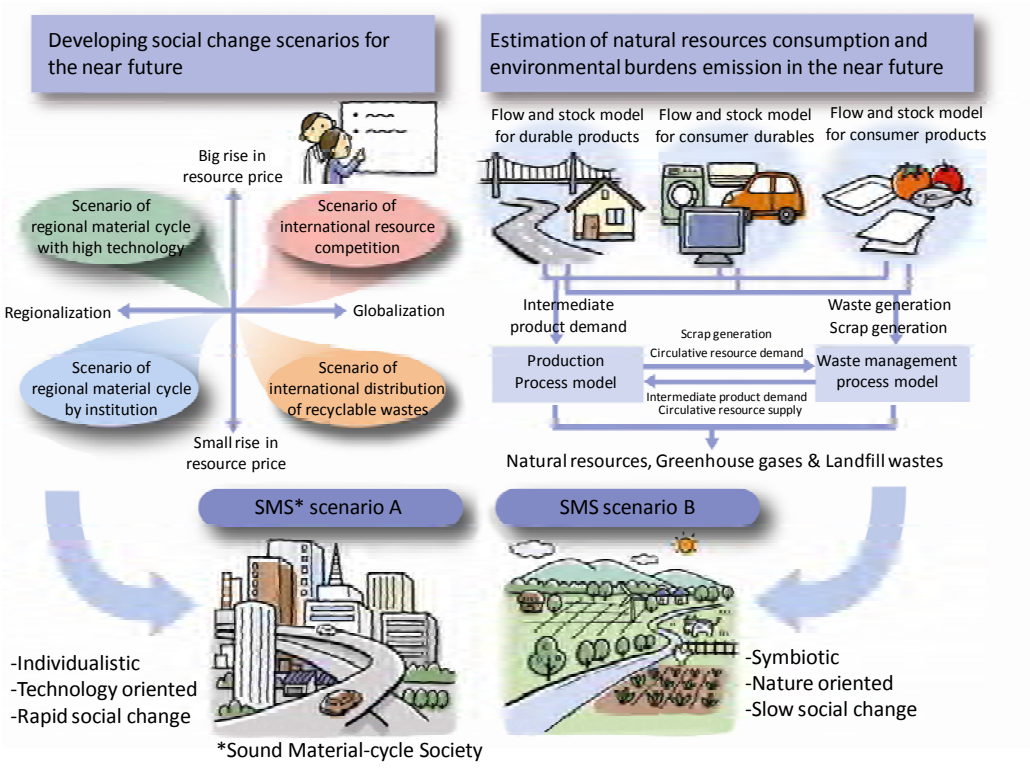
Non-energy-origin emissions of $CO_2$ and $CH_4$ for each sector were estimated by using input–output tables.

In addition, the performance of GOSAT RCF, a new supercomputer dedicated to GOSAT data processing, was improved; GOSAT RCF was ranked 10th in Green 500, the world ranking of high–energy-performance supercomputers.

**NIES GOSAT Project Office**

Ever since GOSAT was launched in early 2009, the GOSAT Data Handling Facility has been routinely processing large amounts of data for the production of the GOSAT data products. Its major functionality includes receiving data from JAXA (the Japan Aerospace Exploration Agency), producing higher level data products (see Core research project 2), archiving data, and distributing the data products to users via the GOSAT User Interface Gateway, the official GOSAT data product distribution site (http://data.gosat.nies.go.jp/). The activities of the GOSAT Project Office include validating the GOSAT data products, organizing research announcement activities, publishing official Project documents such as brochures and newsletters, maintaining the GOSAT Project website, and other outreach activities.

# Research Center for Material Cycles and Waste Management




Designing and evaluating material cycle systems, policies and management techniques for the near future (Core research project 1)

Since its foundation in 2001, the Research Center for Material Cycles and Waste Management has aimed to realize a society with desirable material cycles, i.e., reduced usage of natural resources, reduced generation of waste, increased recycling of materials, and appropriate waste management. In accordance with the second 5-year plan of NIES (covering the period 2006–2010), the center is playing a main role in promoting a research program on "Sustainable Material Cycles" as one of the four Priority Programs. The program comprises four core research projects and other research activities that aim to ensure appropriate waste management.

**1. Designing and evaluating material cycle systems, policies and management techniques for the near future (Core research project 1)**

To create a sound material-cycle society (SMS) for the near future (i.e. 10 to 20 years from now), this research project aims to develop transition scenarios and specific plans for technological and socioeconomic systems. For this purpose, we have developed several social change scenarios, focusing on material flows and waste management systems in particular and based on scenario planning methodology. We have also been creating a model for quantitative assessment of these scenarios and of the effects of various political interventions, and we have evaluated existing and potential schemes for waste management and recycling.

We estimated material flows in the near future on the basis of two typical social scenarios that we developed: (A) a technology-oriented, individualistic society and (B) a nature-oriented, symbiotic society.

On the basis of these analyses, we developed two preliminary visions for creating an SMS. These visions were comparable with two typical social scenarios. Rapid introduction of new recycling technologies is expected in SMS vision A. On the other hand, the emphasis is on lifestyle changes in SMS vision B. These visions are still preliminary, but in developing them we are taking into consideration their compatibility with the visions for a Low Carbon Society developed under the NIES climate change program; by integrating these two activities we can tackle waste and climate issues.

At the same time, we made an analytical model of the influence of social-system changes and the introduction of technological measures on material flows. We used the model to estimate the quantity of natural resources consumed and the environmental load under each of the two scenarios. Furthermore, we created a scenario aimed at reducing natural resource consumption and environmental loads by using various measures packages, and we estimated the effect of these packages. The results of the scenario planning were introduced at a workshop of the UNEP (United Nations Environment Programme) International Resource Panel and contributed to discussions at the workshop. Results such as the estimated environmental load reduction were used in a follow-up examination of The Ministry of the Environment's The Fundamental Plan for Establishing an SMS, and some of the results were published on the *Annual Report on the Environment and a Sound-material Society in Japan* in Japan. In addition, the

visions and scenarios from this study were reflected in the outcomes of the Ministry of the Environment "medium-and-long-term grand design study meetings for the SMS."

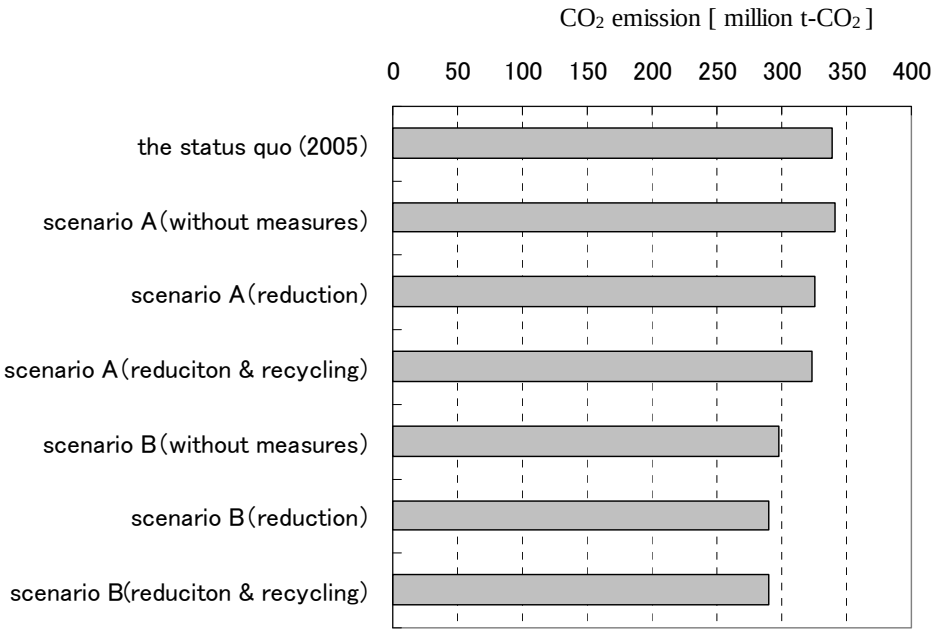



**Fig. 1** $CO_2$ emissions under each of the two social scenarios, namely a technology-oriented, individualistic society (A) and a nature-oriented, symbiotic society (B), with and without various measures.

**2. Management of hazardous and valuable substances in the life cycles of materials and products (Core research project 2)**

In Core research project 2, we first presented a case study of the substance flows of metals in the processes used for treating waste electrical and electronic equipment in Japan. We then attempted to classify and characterize the treatment options required for materials management. The ultimate aim was to summarize the project's results and develop perspectives for future research into sound material management that deals with both valuable resources and toxic substances appropriately.

*Substance flows of metals in waste electrical and electronic equipment during waste-treatment processes*

We investigated the flows of various metals contained in waste electrical and electronic equipment (WEEE) during municipal waste-treatment processes. We performed a WEEE shredding and separation experiment at a Japanese municipal bulk-waste plant. We also investigated municipal waste incineration and ash vitrification processes in the same plant. The output fractions of the processes were sampled and the contents of 55 kinds of metal contained in WEEE were analyzed. We used the results to estimate the substance flows of these 55 kinds of metal in the processes investigated. In the shredding and separation process, approximately 75% of the aluminum and 50% of the copper contained in WEEE was distributed to the large-grain-size fraction (>30 mm) after magnetic separation; this fraction was incinerated through normal waste treatment at the

plant. Through the incineration and ash vitrification processes, a large part of this 50% copper fraction was distributed to molten metal. The molten metal was sent to a copper smelter; therefore, some of the copper contained in the WEEE could be recovered. However, the rest of the copper was distributed to the magnetically separated fraction or the small-grain-size fraction (<30 mm) and never recovered. Most of the incinerated aluminum was eventually distributed to molten slag, which was landfilled. Over 80% of each of most of the other kinds of metals was distributed to the small-grain-size fraction (< 30 mm) after magnetic separation (Figure 2); therefore, under the current waste-treatment system most of these metals were directly landfilled.

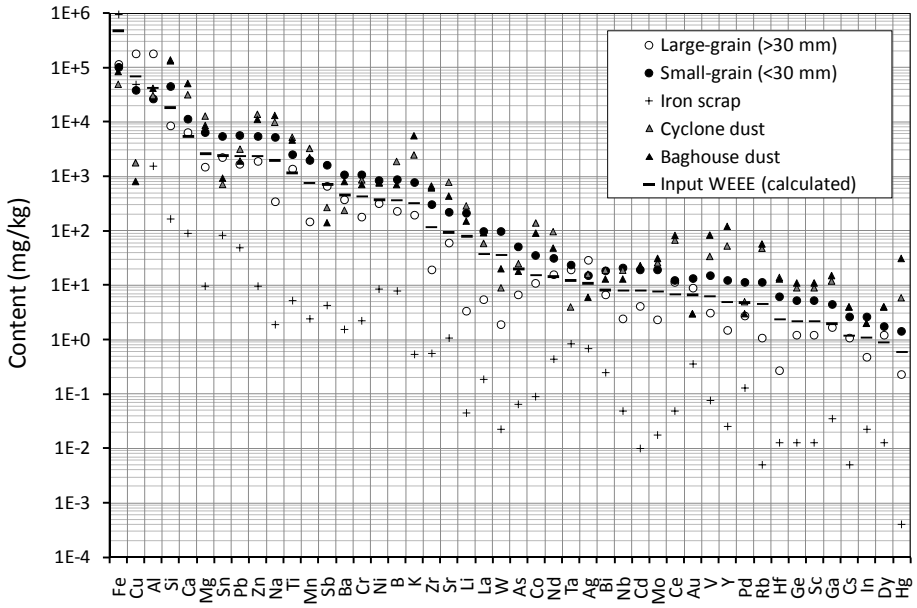



**Fig. 2** Metal contents of sampled output fractions and input WEEE in the shredding and separation experiment. Metals are arranged according to their calculated average content in the input WEEE. Metals that were not detected in any of the sampled fractions (Be, Eu, Ir, Pt, Rh, Ru, Se, Te, and Tl) do not appear in the figure.

*Classification and characterization of treatment options for materials management*

We reviewed 151 Acts in Japan relating to materials management, and we found three major historical trends: expansion of the scope of materials subject to management; expansion of the scope of subjects to be protected; and expansion of the number of the life stages of materials. A detailed review of 829 Articles from 44 Acts identified six groups (and seven subgroups) of treatment options for materials management: (1) exposure prevention; (2) closure of flows; (3) gate-checking; (4) information management (notification and traceability); (5) resource supply/use; and (6) establishment of management systems. We demonstrated that the applicability of gate-checking and notification to the post-consumer stages was lower in the downstream stages of the life cycle. Exposure prevention and closure of flows were poorly applicable to the use stage. These findings increased the importance of information management at the use stage. Finally, establishment of management systems was widely applicable to all of the life stages.

**3. Developing a win–win resource recycling technology for waste biomass (Core research project 3)**

Project 3 aims to develop recycling technologies that recover energy and materials from biomass and to systematize these technologies. Parametric tests were performed in a bench-scale gasifier to determine gas composition and tar levels in the gas produced in cedar wood gasification. The results are indispensable for identifying reliable operating conditions in a further step toward the commercialization and sustainability of biomass gasification processes. In addition, an Ni-based catalyst promoted with ceria has been developed. It was successfully demonstrated in a tubular reactor in the catalytic cracking of a model tar component.

High-rate and stable conversion of food wastes into $H_2$ and $CH_4$ in a continuous two-stage fermentation process with internal digested sludge recycling was achieved by adding micronutrients ($FeCl_2$100 mg/L, $CoCl_2$10 mg/L, and $NiCl_2$10 mg/L) that are essential to *methanogenic archaea*. In a demonstration experiment using real kitchen waste, this process showed a 12.4 kg/$m^3$-reactor/day conversion rate of $COD_{Cr}$ in the kitchen waste into $H_2$ and $CH_4$—four times the processing rate without the addition of micronutrients. Furthermore, we evaluated the applicability of various biomass resources to this process. The results indicated that the fat–carbohydrate balance played an important role in hydrogen production.

In another study, we conducted advanced phosphorus removal and recovery from domestic wastewater. The results of a full-scale *Johkasou* (household wastewater system) experiment showed that about 90% of phosphorus in domestic wastewater was removed as ferric phosphate. Efficiency of alkali extraction from this sludge was higher than that from sewage sludge. Effective conditions for elution and recovery of phosphorus from the ferric phosphate–containing sludge were obtained.

We investigated the mechanism of aggregation of immobilized lipase resins during their use in biodiesel fuel (BDF) synthesis and proposed synthesis conditions that would prevent this aggregation. Use of our new method gave a higher yield (93%). A series of chemical analyses of the fuel components obtained by heating low-quality greases revealed that the fuel components were relatively clean in terms of S, Cl, and N contamination. Furthermore, thermal analysis of actual grease samples indicated that the energy required for recovery of the fuel components was less than 1% of the heating value of the fuel. Finally, we developed a wet-washing technique that reduced the content of alkaline and alkaline-earth metals from about 100 - 10 ppm to 5 ppm or less.

Integrated systems were designed on the basis of data developed on elemental technologies in our project. A process simulator (ASPEN Plus, Aspen Technology Inc.) was used to confirm the suitability of the systems for specific regions.

Various regions were classified as urban, suburban, or rural in light of their waste-generation profiles in the simulation. The amount of waste generated was estimated in the cases of waste cooking oil, food waste as wet biomass, waste wood as dry biomass, refuse-derived fuel, and refuse paper and plastic fuel. In addition, appropriate processing conditions were determined by examining designs for the three technologies of gasification and reforming, hydrogen-methane fermentation, and BDF production. Each area was then characterized in terms of the conversion efficiency of each technology, the scale merit, and the heat balance. An integrated system (Figure 3) that included the three technologies was developed.

We compared the abovementioned data between independent processes and the integrated system, and we explained the results by using as an example the processing of 100 t/day total wastes in an urban area. Use of the integrated system could reduce heat consumption, because surplus heat from gasification and reforming was used in the processes of hydrogen-methane fermentation and BDF production, and waste heat was reused to dry the sludge generated from wastewater treatment. In addition, dried sludge could be inputted to the process of gasification and reforming, and waste glycerin generated from BDF production could be used in hydrogen-methane fermentation. The results suggested that use of the integrated system could effectively enhance gas production.

Finally, we evaluated the economic and business characteristics of the independent processes and the integrated system. The integrated system had a greater earning capacity than the independent processes, with a payback period of 10 years and potential for practical application.

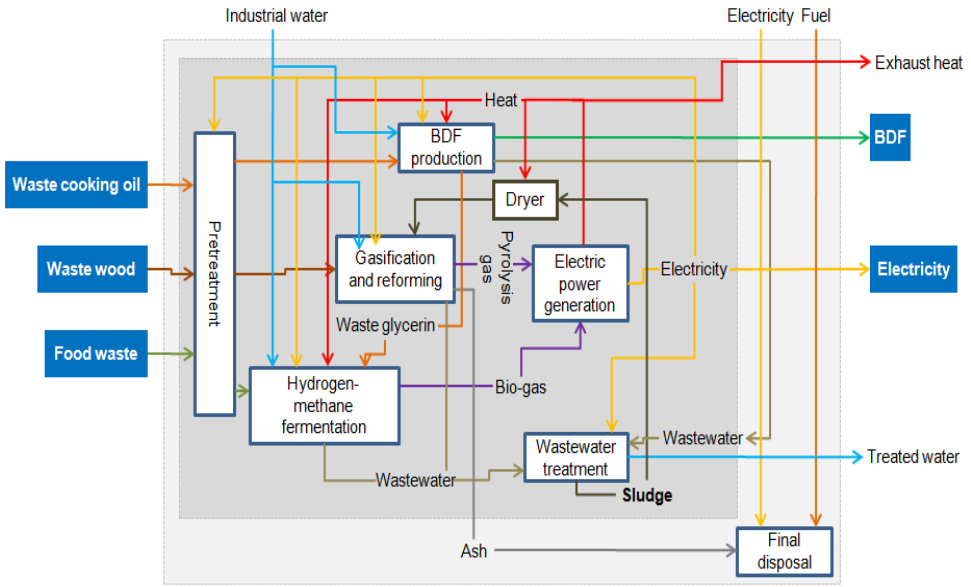



**Fig. 3** Flow sheet of integrated system for gasification and reforming, hydrogen-methane fermentation, and biodiesel fuel (BDF) production.

**4. Establishing appropriate management networks and technological systems to support sound international material cycles (Core research project 4)**

To promote appropriate material cycles in developing Asian countries, we examined the current transboundary movements of recyclable resources and the related recycling in each country. In addition, we designed, applied, and evaluated waste-management technologies and systems that mitigate disposal and global warming.

To obtain more information on the movements of mixed metal scrap for export from Japan, we developed a questionnaire survey for domestic transactions. We were thus able to uncover several cases of default, including charging for disposal without a permit, and collecting air conditioners without CFC (chlorofluorocarbon) confirmation.

By making several field trips to Indonesia, the Philippines, and Vietnam, we were able to characterize techniques of e-waste recycling by the informal sector. Precious-metal recovery by this sector was reviewed in a thermodynamic study. Analysis of the environmental pollution in the areas where informal recycling was being conducted revealed high concentrations of heavy metals in the dust and soils. There is a need to formalize this recycling so as to achieve environmentally sound management in developing countries.

Polybrominated diphenyl ethers (PBDEs) are additive flame retardants widely used in plastics, textiles, and electronic appliances, including computers and televisions. PBDEs are of concern because of their persistence, bioaccumulation, and possible adverse effects on wildlife and humans. We conducted an extensive survey of the available scientific literature in order to gather hard data on workplace and environmental pollution, human exposure to PBDEs, and the adverse effects of primitive e-waste recycling. The results revealed serious environmental pollution by toxic chemicals, including PBDEs, in e-waste-recycling villages. There is growing evidence that primitive e-waste recycling in developing Asian countries is resulting in high PBDE body burdens in local residents and could threaten human health.

We developed a methodological model for estimating methane emissions from landfills in order to express simultaneous waste degradation under anaerobic and aerobic conditions. Nitrous oxide emission from landfills was rarely observed (Figure 4); the amount of nitrous oxide emitted was 1/10 to 1/100 of that of methane. Lysimeter experiments revealed that the initial semi-aerobic management exhibited a trend similar to that of using an anaerobic process; the transition to an aerobic process then began to reveal a different type of waste degradation. Test-cell experiments in Thailand revealed that waste degradation in a semi-aerobic cell stagnated during the initial year of operation. However, water was discharged effectively from the waste layer. Control of water input and output is a critical driver of degradation in semi-aerobic landfills in tropical regions.

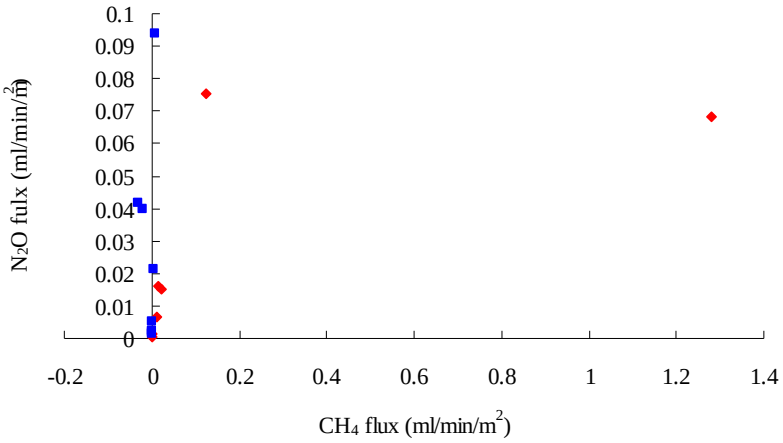



**Fig. 4** Relationship between $CH_4$ flux and $N_2O$ flux in tropical and temperate landfills.($N_2O$ flux was detected at only 21 of 516 points.) $N_2O$ was considered to be emitted by :■ aerobic processes and ◆:anaerobic processes.

We also investigated the regional characteristics of domestic wastewater in China, including pollutant load and the quality, quantity, and biomass of wastewater. The results indicated large regional differences in the characteristics of domestic wastewater. Low-cost constructed-wetland systems could be suitable for processing domestic wastewater with low global gas emission rates and high wastewater treatment performance. In addition, we established a basis for selecting appropriate treatment technologies under a variety of constraints in different regions.

**5. Research to ensure appropriate waste-management practices**

To obtain parameters for predicting the stabilization of wastes in three new categories of landfill according to quality of receivable wastes; stockpiling type landfill, land reclamation type of landfill, and enhanced bio-stabilization landfill, and to clarify the influence of the ratio between length and width of column on the experimental results, we set up seven columns with different length-to-width ratios.

As part of a numerical landfill process model, we combined a multi-component transport and equilibrium model with a model of multi-phase flow coupled with thermal transport. Numerical simulation of leachate quality in seashore landfills was conducted by considering long-term leaching behavior, which was modelled from serial batch tests, as a concentration boundary condition. We calculated that it takes decades to decrease the pH of the leachate.

We examined factors obtained from last year's work revealing the energy-and materials-recovery performance of municipal solid waste incinerators (MSWIs) that had greater power-generation efficiencies than that averaged over all MSWIs in Japan. A few top MSWI were selected and their performances were analyzed in minute detail. The volatile organic compound (VOC) concentrations were measured in a brand-new recycling facility for waste plastics; this facility is equipped with a photocatalytic decomposer and activated carbon adsorber for exhaust air purification. We obtained many data on VOCs and other compounds and found that the concentration of aldehyde compounds in the exhaust air was increased by passage through the photocatalytic unit.

A full-scale *Johkasou* experiment revealed that $CH_4$ and $N_2O$ concentrations

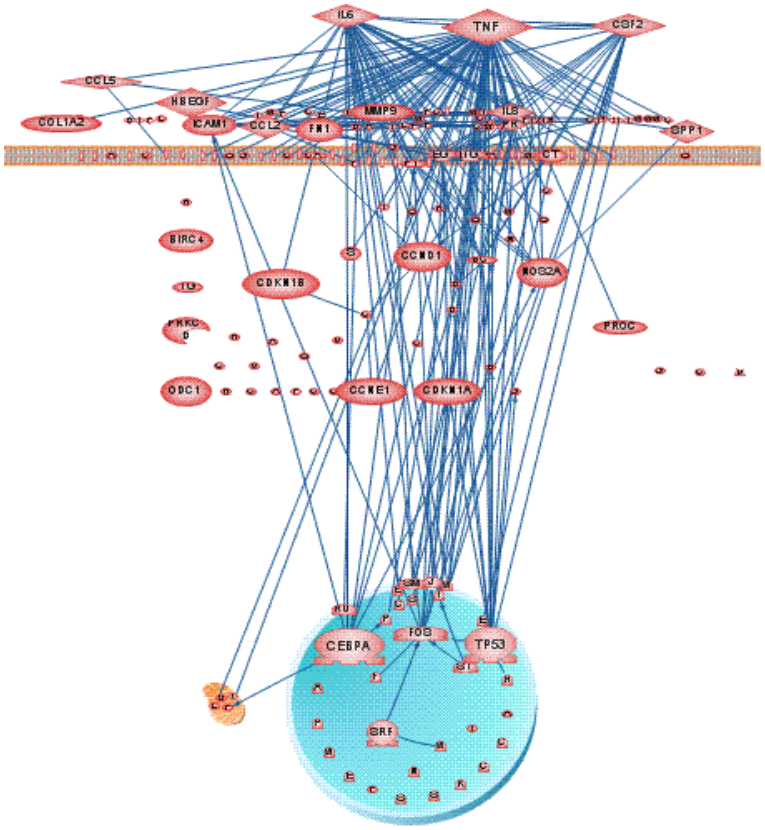
fluctuated with the inflow of domestic wastewater. The maximum $CH_4$ and $N_2O$ concentrations were, respectively, about 5 and 7 times the minimum concentrations. Therefore, evaluation of GHG emissions from *Johkasou* systems requires careful observation of the variations in $CH_4$ and $N_2O$ concentrations with time. Optimum operating conditions for $CH_4$ and $N_2O$ reduction were also determined; introduction of anaerobic–aerobic circulation was quite effective for reducing these emissions. Under these conditions, emissions were reduced by 68% ($CO_2$eq).

**6. Promotion of fundamental research**

As part of a study of the appropriate management of the risks posed by waste asbestos, we examined a method for analyzing low-concentration samples. We developed a preconcentration procedure for collected fibrous materials and found that asbestos fibers present in low concentration could be detected by electron microscopy (EM), the analytical sensitivity of which is less than that of phase-contrast microscopy (PCM). In a study of quality control measures in asbestos analysis, we conducted round-robin tests of asbestos analysis using PCM and EM. The PCM tests revealed that feedback on the practices used by participants was effective in reducing analytical error. The EM tests revealed that differences among participants in the criteria used for asbestos fiber identification were an important error factor. We investigated a municipal solid waste treatment facility to understand the behavior of asbestos in waste-treatment processes. We found that emission of asbestos from home appliances is still occurring; asbestos fibers were found in exhaust-gas-treatment dust that might have been from these appliances.

In addition, we have been creating several databases on material cycling and waste disposal processes, material flows, and the chemical characteristics of recyclable resources and wastes. In FY 2010 a database on the environmental safety of recycled materials for building and construction was developed. It includes physical characteristics, results of leaching tests, and photographs of approximately 190 recyclables (e.g. ash, sludge).

# Research Center for Environmental Risk




Gene set enrichment analysis of rotenone models of rat hyperactivity.
Exposure to rotenone during development significantly altered the level of expression of 131 genes. The array data were further processed by using gene set enrichment analysis.

The Research Center for Environmental Risk (RCER) is conducting an Environmental Risk Priority Program based on the second 5-year plan of NIES, covering the period 2006–2010. In this program, we perform comprehensive research on how to assess environmental risks, such as the effects of chemical substances, invasive species, and nanoparticles on human health and the ecosystem.

The Environmental Risk Priority Program incorporates the following four core research projects:

1. Integrated exposure assessment analysis of the complex factors involved in chemical exposure.
2. Methods for assessing the health risks posed by environmental chemicals that cause sensitivity reactions.
3. Assessment of health risks associated with environmental nanoparticles.
4. Development of environmental risk assessment methods that take into account biodiversity and ecosystem functioning.

We are also conducting the following research activities on issues that may have future applications in environmental decision-making:

- fundamental research to improve environmental risk assessment methodologies
- collection and dissemination of information on environmental risks
- environmental risk assessment practices for regulatory objectives.

**1. Integrated exposure assessment analysis of the complex factors involved in chemical exposure (Core research project 1)**

We aim to establish an exposure assessment process that effectively and comprehensively considers the complex nature of exposure to chemicals. The project will integrate a number of exposure variables, including chemical composition and spatial and temporal scales, to provide a more comprehensive view of the status of exposure to multiple chemicals for future risk assessment. This year the project has focused on two main topics that are related to fate modeling and are based on the revised research plan applying after 2009: (1) development of methods of hierarchical exposure analysis based on a geographic information system (GIS), from the regional to the global scale; and (2) development of methods for estimating pesticide emissions that vary over time, and expansion of the application of these estimates to general chemicals.

Through the use of fate-modeling methods to model the natural and environmental dynamics of chemicals, the development of hierarchical exposure analyses will help us to understand exposure to multiple chemicals. This year we explored the integration of the new global multimedia fate model FATE (the Finely Advanced Transboundary Environmental model), on which we have been working in cooperation with Ehime University since 2008. The FATE model is a 3-dimensional atmospheric and oceanic transport and multimedia fate model with 2.5° and 0.5° resolution respectively; we can use it to strengthen our hierarchical exposure analysis of globally distributed chemicals. This year we completed an 80-year simulation (from 1930 to the present) for 7 PCB congeners. The

simulation results were in good agreement with the levels observed in the atmosphere. We also plotted examples of substantial oceanic transport of simulated PCB congeners from the surface to the deep sea (Figure 1).

We continued our study of the G-CIEMS (Grid-Catchment Integrated Environmental Modeling System) multimedia GIS model. This year we expanded our study of the estimation of pesticide emissions and their temporal variability to cover more pesticides, with a continuing case study of paddy field application. Among 26 pesticides, 66% of the simulated maximum concentrations fell within one order of the measured maximum levels. This result suggested that the pesticide concentrations and their variability in river waters were well simulated by combining the emission estimates and the G-CIEMS model to produce a detailed distribution of pesticide concentrations in river water at the individual catchment scale and of temporal fluctuations at a days-to-weeks scale (Figure 2). We also continued to expand the MuSEM model to enable us to estimate the emissions of more general chemicals.

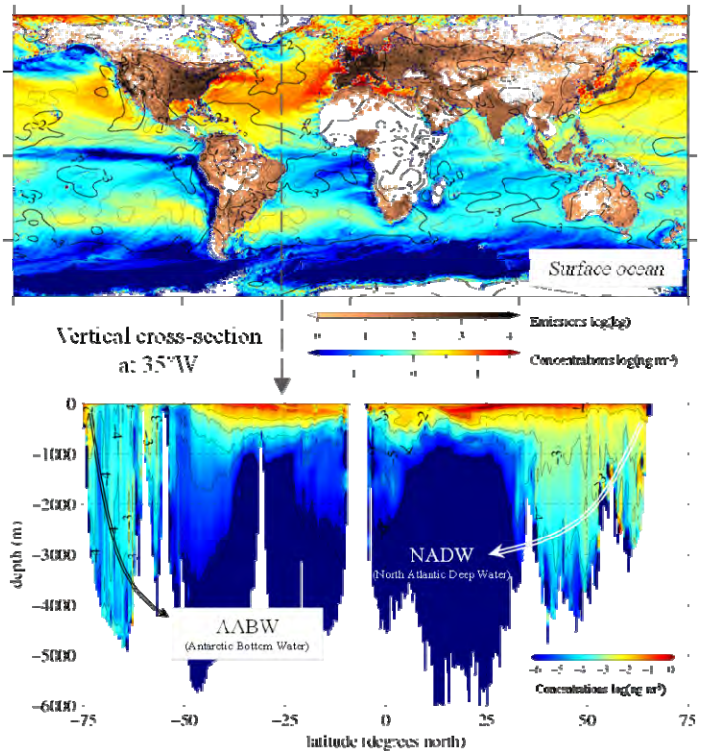



**Fig. 1** FATE-predicted PCB153 concentrations in the oceans in 1990

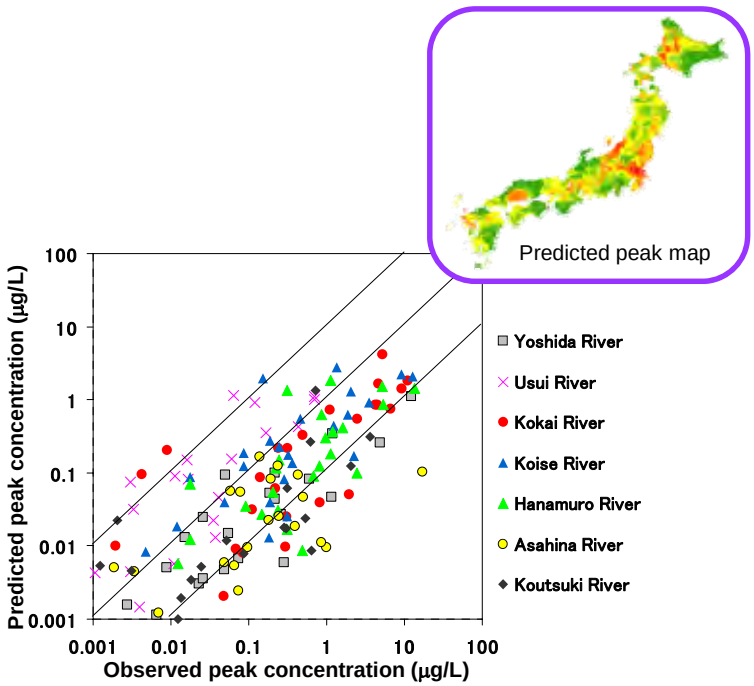



**Fig. 2** 66% of predicted peak concentration in river water by combining emission estimates and G-CIEMS model fell within one order of measured maximum levels.

**2. Methods for assessing the health risks of environmental chemicals that cause sensitivity reactions (Core research project 2)**

We aim to establish experimental models and biomarkers for assessing the health risks posed by environmental chemicals at low doses in susceptible individuals.

Individuals with different immunogenetic backgrounds have different sensitivities to toxic chemical exposure. In a brain cell injury model, activation of TLR4 and NF-κB may be neuroprotective, either increasing cell resistance or removing toxic molecules via an increase in the phagocytic capacity of activated microglia. However, little is known about the role of TLR4 in neurogenesis following environmental exposure to toxic chemicals. We investigated the possible involvement of TLR4 in the expression of nerve growth factor (NGF) and related signal transduction pathways in the mouse hippocampus following toluene exposure. Male C3H/HeN and C3H/HeJ (TLR4 defective) mice were exposed to 0 or 50 ppm of toluene for 6 weeks. We observed different regulatory mechanisms in C3H/HeN and C3H/HeJ mice, such as the upregulation of NGF and CREB1 mRNA expression in C3H/HeN mice and their downregulation in C3H/HeJ mice in response to ovalbumin immunization after toluene exposure. Our results suggest that TLR4 signaling is involved in neurogenesis and neuronal survival through activation of the NGF-CREB1 signaling pathway following exposure to toxic chemicals.

We then investigated the critical window of susceptibility to toluene exposure during brain development and the effects of fetal and neonatal toluene exposure on the expression of NMDA (N-methyl-D-aspartate) receptor subunits and related transduction pathways in infant mice hippocampus. Pregnant mice (gestation day

14) or male offspring (postnatal day 2 or 8) were exposed to either a filtered air control (0 ppm), or 5 or 50 ppm of toluene for 6 h a day for 5 consecutive days. We found that early toluene exposure induced persistent alteration of memory function–related gene expression in infant mice and memory deficits in later life via the modulation of synaptic morphology and function.

Dopaminergic neurons are vulnerable to the pesticide rotenone, which leads to behavioral abnormalities in the rat. In the developing brain there were critical windows for the induction of hyperactivity, which was elicited by exposure to rotenone (3 mg/kg) at 5 days of age, but not at 6, 14, or 21 days of age. In contrast, exposure of adult dopaminergic neurons to rotenone at the same concentration caused rat hypoactivity. To gain insights into the mechanism of neuronal disorders caused by rotenone, we performed DNA array analyses, followed by gene set enrichment analyses. Inflammatory pathways that included IL-6 and TNF were revealed in both rotenone models, suggesting that the chemical caused neurodegeneration.

Pyrethroids are among the most widely used classes of insecticides and show neurotoxic effects that induce oxidative stress in the neonatal rat brain. However, little is still known about the effects of prenatal exposure to permethrin on vascular development in the fetal brain and on CNS development. Permethrin was administered orally to pregnant female mice on gestation day 10. Thalidomide- or fumagillin-treated mice were used as positive controls. The brains of chemical-treated fetuses showed altered vascular formation, involving shortening of vessels, increased numbers of small branches, and (in some cases) insufficient fusion of the anterior communicating arteries in the area of the circle of Willis (Figure 3). These results suggest that prenatal exposure to permethrin causes insufficient development of the brain by altering vascular development.

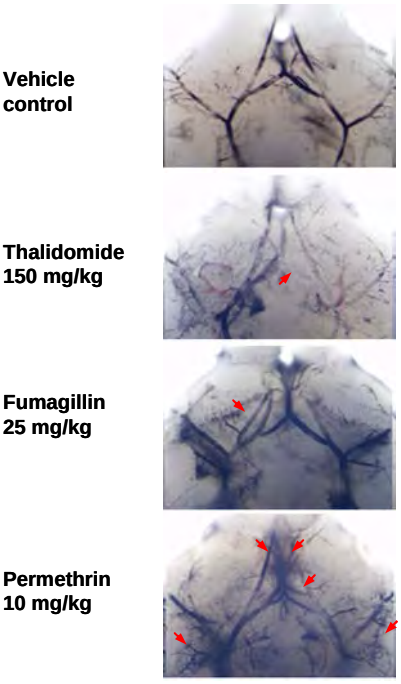



**Fig. 3** Representative photographs of the anterior half of the circle of Willis in the fetal mouse brain. Prenatal exposure to thalidomide, fumagillin, or permethrin causes various malformations in the circle of Willis in the fetal brain. Vascular networks were filled with a four-fold dilution of Chinese liquid ink. Arrows indicate malformation sites detected.

**3. Assessment of health risks associated with environmental nanoparticles (Core research project 3)**

We have completed the first phase of a nanotoxicology project on the biological impacts of ultrafine particulate matters and nanoparticles. Our final goal was to establish health-risk assessment methods that are geared to these kinds of particles rather than to regular chemicals. Nanoparticles are defined as small particulate substances having one or more dimensions of the order of 100 nm or less. In this project asbestos was also included, because the width of a single fiber of asbestos is within the nanosize. The major part of this project is to be continued in the second phase of a nanotoxicology project (FY 2011–2015) in which ecotoxicology is included.

On the basis of a preliminary acute study, we studied the effects of long-term exposure of several strains of mice (A/J, BALB/C, and CB6F1-Tg rasH2) to nanoparticle-rich diesel exhaust. Exposure continued for up to 18 months. We examined the effects of the exhaust on the lungs, heart, and several other tissues both histopathologically and biochemically. The number of tumor-bearing animals and the concentration of 8-OHdG (8-oxo-2'-deoxyguanosine) in the lung were increased by exposure to nanoparticle-rich diesel exhaust. We also analyzed the size and concentration of nanoparticles, the fluctuations in their concentration, and their chemical composition, as well as gaseous compounds such as nitrogen dioxide and carbon monoxide in the exhaust. We found that the chronic effects of nanoparticle-rich diesel exhaust were caused by both the particulate and the gaseous fraction of the exhaust.

We developed a novel and high-throughput method to measure cellular uptake of carbon nanotubes (CNTs) by using turbidimetry. BEAS-2B, a human bronchial epithelial cell line, was used to investigate the cellular uptake, cytotoxicity, and inflammatory effects of multi-walled CNT. Over the course of 5 to 8 hours, BEAS-2B cells took up 17% to 18% of multiwall CNTs. The cells were exposed to 2, 5, or 10 μg/mL of multiwall CNTs, and total RNA was extracted for cytokine cDNA primer array assays. The culture supernatant was collected for cytokine antibody array assay. Levels of proinflammatory cytokines such as IL-6 and IL-8 were increased in a dose-dependent manner at both the mRNA and protein levels. A phosphokinase array study indicated that phosphorylation of the proteins p38, ERK1, and HSP27 increased significantly in response to the CNTs. Reporter gene assays indicated that NF-κB was activated following CNT exposure, whereas activator protein-1 (AP-1) was not changed.

We investigated the toxicity of heat-treated asbestos in both an *in vivo* animal model and an *in vitro* cell-culture system. We compared the effects of asbestos with those of CNTs to determine whether biopersistent nanofibers could have the same effects in the lung tissue and cells. The inhibitory concentration $(IC)_{50}$ of CNT was 12 μg/mL, whereas that of asbestos (crocidolite) was 678 μg/mL in human bronchial cells, suggesting that the cytotoxicity of the CNTs was higher than that of asbestos fibers. We found that refractory fibrous particles damaged the integrity of the lysosome membrane and finally caused cell death.

**4. Development of environmental risk assessment methods that take into account biodiversity and ecosystem functioning (Core research project 4)**

This project aims to assess ecological risks and to develop effective risk management methods that take into account biodiversity and ecosystem functioning, using field surveys, laboratory and field experiments, and theoretical approaches.

Events affecting mortality during the early life stages are generally considered important factors in the determination of year-class strength, guiding the population size of the species. Results of an analysis of field studies into early life history traits of marbled sole in Tokyo Bay, Japan, suggested that water temperature in winter and bottom-dissolved oxygen levels (DO) in summer would be key factors causing mass mortality in early (pelagic larval) and late (demersal juvenile) life stages, respectively. Laboratory experiments with various water temperature ranges (6, 9, 12, 13 and 15 °C) were conducted to evaluate effects of water temperature on the period until hatching, hatching success, body size of larvae at birth, and the subsequent mortality rate of larvae. The optimal water temperature for hatching success was estimated between 9°C and 13°C. During the early larval period (18 days after hatching), mortality rates significantly increased as water temperature increased. Meanwhile, 24-hour lethal concentration 50 ($LC_{50}$) was estimated at 1.5 mg/L for 0.5-year juvenile marbled sole. Thus, high water temperature in winter and bottom hypoxia in summer could be important environmental factors in the high mortality in early life stages of the marbled sole population of Tokyo Bay.

In order to assess impacts of ongoing and rapid biodiversity losses, it is important to clarify how the potential causes affect each taxonomic group having different ecological functionalities. Focusing on agricultural pond ecosystems, we classified the animal communities into five groups: 1) fish, 2) crustaceans, 3) mollusks, 4) large insects, and 5) small insects and sludgeworms. We then statistically analyzed the relationships between the species numbers of those groups and the environmental stress factors measured. The analysis indicated negative effects by pesticides, alien fish and concrete revetment, on the total species number, in which their strengths in individual groups vary significantly. In particular, pesticides significantly decrease the total species numbers, while small insects and sludgeworms seemed not to be affected, resulting in poor communities dominated by small insects and sludgeworms. Our results contribute to furthering the understanding of how environmental stress factors can cause destruction of ecosystem services and functions through biodiversity losses.

We investigated how the functional diversity of communities changed with environmental disturbances as a general framework of ecosystem risk assessment based on community properties. Specifically, we assumed that there was variation in traits among species that conferred tolerance or sensitivity to environmental disturbances. When a disturbance occurred, variation in species tolerances caused changes in the relative abundances of species, which in turn changed the average tolerance of the community. Despite this expectation, ecological interactions among species can affect the average community response. Similarly, when

disturbances affect multiple traits, the covariance in the distribution of trait values among species may restrict the response of any one trait; if two traits provide tolerance to the same disturbance but negatively covary among species, the response of one trait will limit the response of the other trait at the community level. Using a Lotka-Volterra model for competitive communities, we derived general formulae that generated explicit predictions about the changes in average trait values in a community subject to environmental disturbances including these factors. The result was

$$\Delta\bar{Z} \cong I_z \mathrm{Var}_p(Z)\left\{1-\frac{1.8}{\beta}\left(1+\frac{2}{s}-\frac{60}{s^2}\right)\sum_{k=1}^{D_N}\alpha_k\rho_k^2\right\}$$ , where Varp(Z) is the abundance-weighted trait variance, αk is the interspecific competition coefficient for the k-th resource, ρk is the correlation coefficient between the species trait values and the ordered niche position (natural numbers) of the species, s is the number of species, β is the intraspecific competition coefficient (which is assumed to be the same among species), and DN is the number of resources. We further illustrated the applicability of the analytical results using phytoplankton data from a whole-lake experiment in which manipulation to the zooplankton community created a disturbance to the phytoplankton that changed the selective consumption of large vs. small phytoplankton.

In the following study, we further aim to investigate the invasion route and the process of expansion of distribution of Cryptic Invisible Alien Species (CIAS) such as ants, mites, mussels, and fungi. We are also developing methods for decreasing impacts caused by the CIAS on natural ecosystems, native species and human lives.

We tested the sensitivity of the Argentine ant to the anticides fipronyl and hydramethylnon in comparison with that of Japanese native ants. The Argentine Ant was so much more sensitive to these anticides that we can expect native ant populations to recover sooner than this alien ant after anticide application. We developed a stochastic model for deciding on how to devise a way to control the golden mussel. Moreover, laboratory testing of chytridiomycosis infection, in which we surveyed the virulence on the Japanese native amphibians, showed that all of the Japanese native amphibians tested showed resistance to the fungus. Furthermore, even the fungus on the Japanese sword-tail newt disappeared during the infection tests, strongly suggesting that the Japanese amphibians possess some kind of antifungal peptide. We constructed a global risk map of chytridiomycosis based on occurrence data from both its native and its invasive range, with consideration of multicollineality and spatial autocorrelation (Figure4).


**Fig. 4** Global risk map of amphibian chytridiomycosis. Risk levels are indicated by the numbers 0 to 1: infection risk increases as the values approach 1.

**5. Development of ecotoxicity tests and ecological risk assessment for management of chemicals**

The OECD (Organisation for Economic Co-operation and Development) adopts test guidelines for chemical safety for the mutual acceptance of data among OECD countries for the registration of chemical substances. The aim of this study is to apply ecotoxicity information to chemical regulation through the application of various tests and risk assessments in our country. The following ecotoxicity testing was explored in FY 2010:.

(1) We investigated the application of a test method that uses algal delayed fluorescence to a water sample containing hazardous substance. Adverse effects on algae were successfully detected by using the method.

(2) We developed a new water management method that uses bioresponse (WET: whole effluent toxicity), as well as a new OECD test guideline for endocrine disrupting chemicals. In conjunction with this, an OECD workshop to develop a guidance document the frames of fish test was held, and an examination of zebra fish embryo toxicity tests was performed.

(3) In regard to the proposed revision of the *Daphnia magna* reproduction test (OECD-TG211), the results of an analysis performed in Japan were discussed by an association of specialists from OECD countries.

(4) A preliminary investigation was performed to determine whether a Japanese species of midge (*Chironomus yoshimatsui*) was applicable to the chironomid life cycle test (OECD-TG233). The number of egg rope produced by a female was varied so much that the test procedure needs to be improved, but it clearly and repeatedly came close to satisfying the validity criteria described in TG233.

**6. Web database on “Invasive Species of Japan”**

We are constructing an open-access website, “Invasive Species of Japan” (http://www.nies.go.jp/biodiversity/invasive/). The website provides a variety of information on invasive alien species in Japan from a factsheet database and a systematic list of external online information resources in Japan.

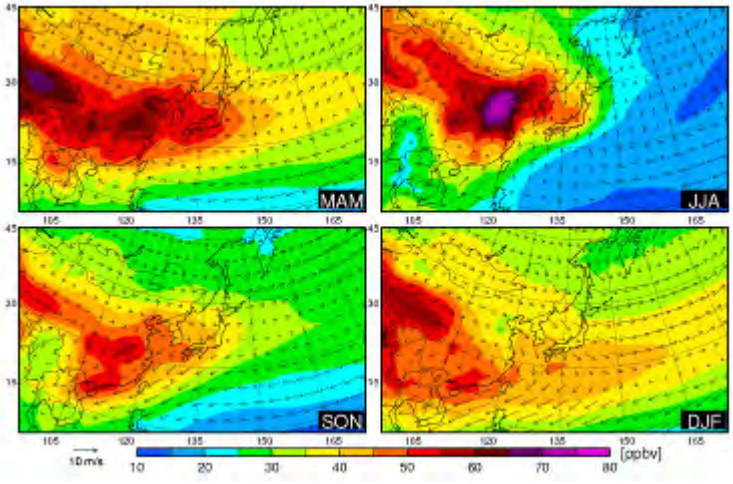
As of 20 May 2011, the species factsheet database contained information on 515 taxa in Japanese and English. Each species factsheet contains information on basic biology (taxonomy, natural distribution, and ecology) and invasion characteristics (e.g. non-native distribution, date and route of introduction, impact, and control method). The information can be referenced through taxonomic lists and a search system. The content can be searched from various perspectives, including taxonomy, distribution, habitat, date and route of introduction, and impact.

Of the 515 taxa in our database, 418 are already established in Japan whereas 97 taxa have not been established. The 418 established taxa are selected from various taxonomic groups with various habitats, origins, dates and routes of introduction, impacts, and control methods, representing an entire picture of the alien species problem in Japan. The remaining 97 taxa are selected from several blacklists as potential invasive species. Thus, our database provides information of ongoing invasions as well as alerts for potential risks.

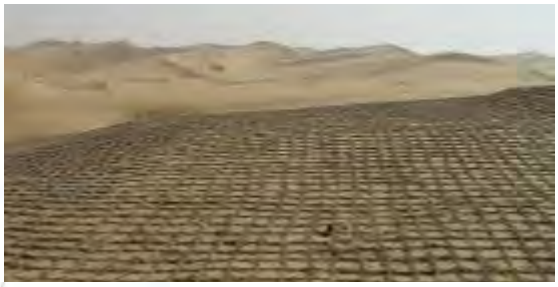
The online resource list contains links to useful websites in Japan, including other local databases or species lists, eradication manuals, and websites of monitoring networks. Currently, a preliminary edition in Japanese is up and working. The listed resources are searchable by type of website, target taxon, target region, and class of information content. A worldwide version is currently being developed and will be published in the near future.

Our website is the most comprehensive database and information portal for alien species in Japan. It will accelerate the sharing of various types of information among many parties, including researchers, practitioners, and the public, and it will help in the management of, and education about, invasive alien species problems in Japan.

# Asian Environment Research Group



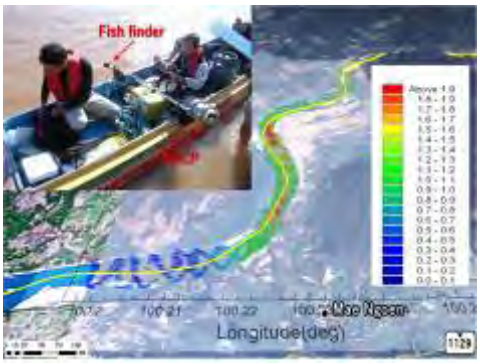

Simulated seasonal mean surface ozone (ppbv, colors) and wind vectors (m/s, arrows) in East Asia, averaged over the 6 years from 2000 to 2005.



Rehabilitation from desertification using a “straw checkerboard” to create a sustainable society in arid/semiarid region: Tenguri Desert, China.

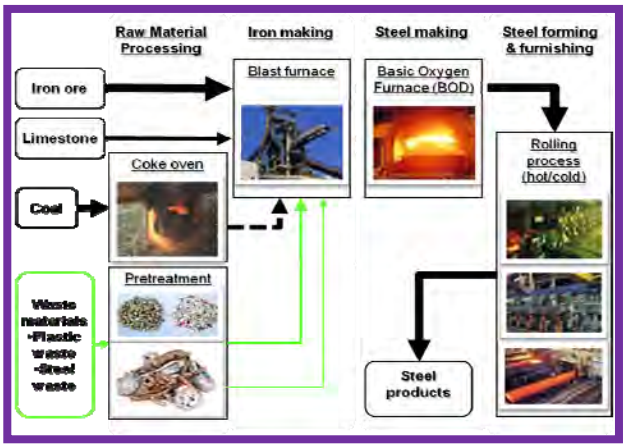
CHAAMS (Cape Hedo Aerosol and Atmosphere Monitoring Station), Okinawa, Japan.

Xitang in the Yangtze River Delta of China. This is an ancient town with a history of harmony between humans and water that goes back more than 1000 years.




Distribution of flow velocity in the Mekong River’s main channel, overlaid on a Landsat satellite image: Chiang Saen, Thailand.

Symbiotic steel-production process in Kawasaki Eco-town, Japan, showing circular material flows.



Japan is closely connected to Asia both geographically and economically, and rapid future development is expected in Asia. Therefore, preservation of the environment and the creation of a society in harmony with nature are crucial to environmental security and a sustainable society throughout Asia. In this context, the Asian Environment Research Group conducts research on air quality; long-range trans-boundary air pollution; sustainable management of water environments in terrestrial, coastal, and oceanic areas; and ecosystem management and conservation in catchments of large rivers. In the second 5-year plan at NIES (covering 2006–2010), we have been running three core research projects and other research activities as part of our Asian Environment Priority Program. The Asian Environment Research Group has five research sections, an independent senior research scientist, and two collaborative research sections. The core research projects promote Asian environmental management and will help to establish the scientific knowledge and foundations for the policy recommendations needed to create a society in harmony with nature through international cooperation.

**1. Developing methods for evaluating the atmospheric environment of East Asia (Core research project 1)**

The regional air quality (e.g., ozone, anthropogenic aerosols, mineral dusts) of East Asia is being investigated through comprehensive field monitoring, development of an emissions inventory, and transport modeling. The final goal of this project is to develop an integrated method, based on observation and modeling, that will give us an understanding of the current status of the air quality of East Asia and allow us to predict future changes in the atmospheric environment. Under this project, three sections are working on the following sub-projects: (1) the study of regional-scale air quality in East Asia; (2) evaluation and projection of the future atmospheric environment in East Asia; and (3) application of dust and sandstorm data measured by the lidar (light detection and ranging) observation network in East Asia.

***Study of regional-scale air quality in East Asia***

The **Asian Atmosphere Section** has continued comprehensive observations of the chemical, physical, and radiative properties of aerosols and gases at Cape Hedo Aerosol and Atmosphere Monitoring Station (CHAAMS) in Okinawa, Japan. At the Fukue station in Nagasaki Prefecture, ozone, $NO_x$, volatile organic compounds, and total reactive nitrogen are continuously measured. In October 2010, continuous measurement of aerosol chemical components using a Q-AMS (quadrupole aerosol mass spectrometer) was begun. In winter 2010, an intensive research campaign was performed in the cities of Fukue and Fukuoka on Kyushu: two Q-AMSs were used to study the impact of trans-boundary air pollution on these cities. In the same period, lidar measurements and filter sampling for inorganic species, heavy metal species, and organic species (including elemental carbon and polycyclic aromatic hydrocarbons: PAHs) were performed at CHAAMS and Fukue.

Using a photo-acoustic spectroscopy method (TGA310, Omnisens), progress has been made in analyses for ammonia ($NH_3$) in samples taken at Cape Hedo, Okinawa, in spring 2008. The average concentrations of $NH_3$ and ammonium ions ($NH_4^+$) in spring were 0.56 ppbv and 2.2 μg $m^{-3}$, respectively (Figure 1). $NH_4^+$ was transported over long distances, whereas $NH_3$ was not. $NH_4^+$ accounted for more than 80% of NHx (=the total of $NH_3 + NH_4^+$ ) associated with sulfate ($SO_4^{2-}$).

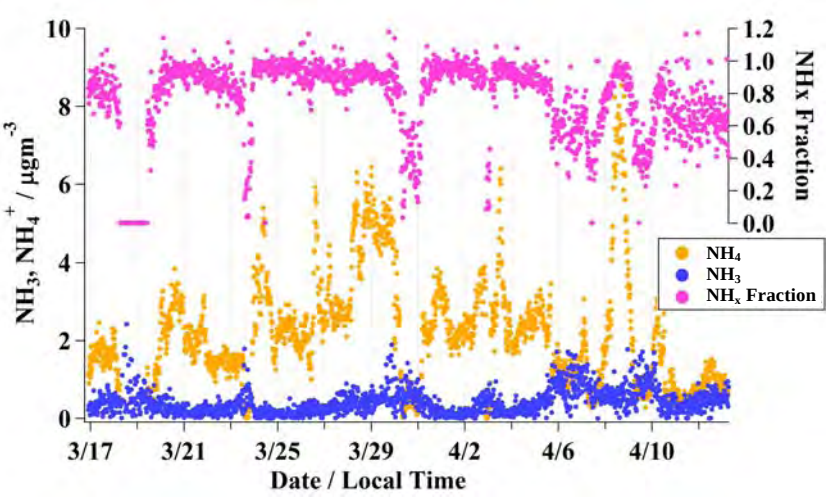



**Fig. 1** Concentrations of ammonia and ammonium ions measured at CHAAMS in spring 2008.

Elemental carbon (EC) was analyzed in fine and coarse aerosol particles collected at Fukue in spring 2010; the average EC mass fraction in the coarse particles was about 5%. TEM (Transmission Electron Microscope) observations revealed that the EC had coagulated. The coagulated EC was combined with coarse particles of dust and/or sea salt to make aerosols of large particles. Thus the EC was not uniformly adsorbed onto the coarse particles; this information is important for model simulations.

Particle-associated PAHs and *n*-alkenes were measured in spring (at Cape Hedo, Fukue, and Fukuoka), summer (at Cape Hedo), and autumn (at Cape Hedo and Fukue) in 2010. The average concentrations of total PAHs present in total suspended particles (TSPs) were 0.22 ± 0.29 ng $m^{-3}$ (Cape Hedo), 1.44 ± 0.99 ng $m^{-3}$ (Fukue), and 3.00 ± 1.71 ng $m^{-3}$ (Fukuoka). Only long-range transport from East Asia was likely to have affected the PAH levels observed at Fukue and Cape Hedo, whereas both long-range transport and local emissions would have affected the levels in Fukuoka. During the autumn observation at Fukue, we measured the concentrations of PAHs present in $PM_{2.5}$ and in TSPs. Here, $PM_{2.5}$ represents particles less than 2.5 μm in aerodynamic diameter. The concentration of PAHs present in $PM_{2.5}$ (1.11 ± 0.93 ng $m^{-3}$) was close to that of PAHs present in TSPs (0.93 ± 0.61 ng $m^{-3}$), showing that most of the PAHs were present in fine-mode particles.

Lidars (laser radars) have been operating at Cape Hedo and Fukue throughout the year. The depolarization ratios measured by the lidars revealed that the dense haze observed in February 2011 over western Japan was composed of

anthropogenic spherical particles.
Information on CHAAMS, including a research outline and a list of instruments/PIs(Principal Investigators), is available on the CHAAMS home page (http://www.nies.go.jp/asia/hedomisaki/home-e.html). Currently, some preliminary results are provided as graphs.

***Evaluation and future projection of the atmospheric environment in East Asia***

The **Regional Atmospheric Modeling Section** has developed an integrated research system for ground, lidar, aircraft, and satellite observations; chemical transport modeling; and emission inventory development. This research system was used to analyze the current status, historical trends, and future outlook of urban, regional, and trans-boundary air pollution in East Asia.
We conducted long-term simulations of air quality in the East Asian region during 1980–2008 by using a regional-scale chemical transport model (Community Multi-scale Air Quality Modeling System, CMAQ) and the year-by-year Regional Emission Inventory in Asia (REAS). By using simulated tropospheric ozone, anthropogenic aerosols, and acid depositions, we analyzed historical and interannual variations and spatial variations in regional-scale air pollution and the impacts of transboundary pollution on air quality in Japan.
To evaluate temporal variations in nitrogen wet deposition across Japan during 1989–2008, we analyzed the results of CMAQ/REAS and observational data. The model successfully reproduced the general patterns of spatial and temporal variations in observed $NO_3^-$ wet deposition rates. Wet deposition rates of $NO_3^-$ across Japan increased during 1989–2008, with rates of increase of 2% to 5% a year. Sensitivity simulations indicated that the increase in $NO_3^-$ wet deposition rates was mostly (61% to 94%) explained by the increased emission of atmospheric pollutants in China. The contribution of China's emissions increased from 29%–35% during 1989–1993 to 43%–61% during 2004–2008, suggesting that transboundary pollution had a large impact on $NO_3^-$ wet deposition in Japan. The contribution of observed $NO_3^-$ to total nitrogen wet deposition (i.e., $NO_3^-$ + $NH_4^+$) has increased in southwestern Japan, and currently $NO_3^-$ and $NH_4^+$ make similar contributions to nitrogen wet deposition across Japan. Interannual variation in $NO_3^-$ wet deposition was further evaluated by using a meteorological index, namely the area-weighted surface pressure anomaly (ASPA). When ASPA was negative, air masses from the Asian continent were more directly transported to Japan and $NO_3^-$ concentrations across Japan increased. Thus, anomalies in $NO_3^-$ concentrations were negatively correlated with ASPA. In contrast, anomalies in $NO_3^-$ wet deposition rates showed a weak positive correlation with ASPA, reflecting a positive correlation between anomalies in precipitation rates and ASPA. This result strongly suggests that precipitation patterns have a large impact on the interannual variation of $NO_3^-$ wet deposition across Japan.
We updated the REAS inventory for $SO_2$, $NO_x$, CO, and $PM_{10}$ during 2000–2008. Asian emissions for each species showed rapid growth over the period, by 40% for $SO_2$, 67% for $NO_x$, 37% for CO, and 42% for $PM_{10}$. The rate of growth in emissions of these pollutants from China was high but tended to decrease toward

the end of the period, especially in the case of $SO_2$. This suggests that emission control measures in China are becoming effective. Emissions from Southeast and South Asia also showed large rates of growth, but those from Japan generally decreased, reflecting the effects of emission control and recent relatively weak economic conditions. We also estimated the trends and seasonal variations in $NO_x$ emissions over East Asia by using a simple top-down method based on the CMAQ and satellite-observed data on $NO_2$ vertical column density. The top-down results suggest that the trend in the REAS for China has been overestimated. The top-down estimated trend and seasonal variation for Japan were quite consistent with those from the emission inventory.

Other research activities were (1) estimation of $NO_x$ emissions from China by using inversion modeling systems and the tropospheric $NO_2$ column density obtained by satellite observation; (2) collaboration with Chinese researchers to improve Asian emission inventories; and (3) dispatch of a short-range forecast of regional air quality in six regions of Japan via the NIES environmental GIS (geographic information system) site (http://www-gis.nies.go.jp/) (in Japanese).

***Application of dust and sandstorm data measured by the lidar observation network in East Asia***

The **Collaborative Research Section** continued its observations of Asian dust using the lidar dust-monitoring network, including one lidar in Beijing and three in Mongolia. Data from the network were processed in real time to derive the vertical profiles of the extinction coefficient estimates for Asian dust and air pollution aerosols. The results were used for analysis of dust events and for real-time validation of dust transport models. Real-time dust extinction coefficient data were also provided for the *kosa* web information service (http://soramame.taiki.go.jp/dss/kosa/) of the Ministry of the Environment.

Surface observation data from Mongolia, China, Korea, and Japan during the Asian dust event of 29 March to 2 April 2007 were compared with those from a regional dust transport model assimilated with the lidar network data. The assimilated model reproduced the reported dust event in Mongolia and the observed $PM_{10}$ concentrations in Korea and Japan very well. The mass/extinction conversion factor (MEF) obtained from the lidar dust extinction coefficient and the $PM_{10}$ concentration was also compared with the results from the assimilated model in Seoul and Tsukuba, where both lidar and $PM_{10}$ data were available. The model reproduced the MEF well. The modeled MEF for $PM_{10}$ showed spatial and temporal variation reflecting the variation in dust particle size distribution (Figure 2). The modeled MEF for $PM_{2.5}$ showed much less variation. This indicated that the dust extinction coefficient was more highly correlated with the dust $PM_{2.5}$ concentration, which should therefore be a useful index of the effect of dust on human health.

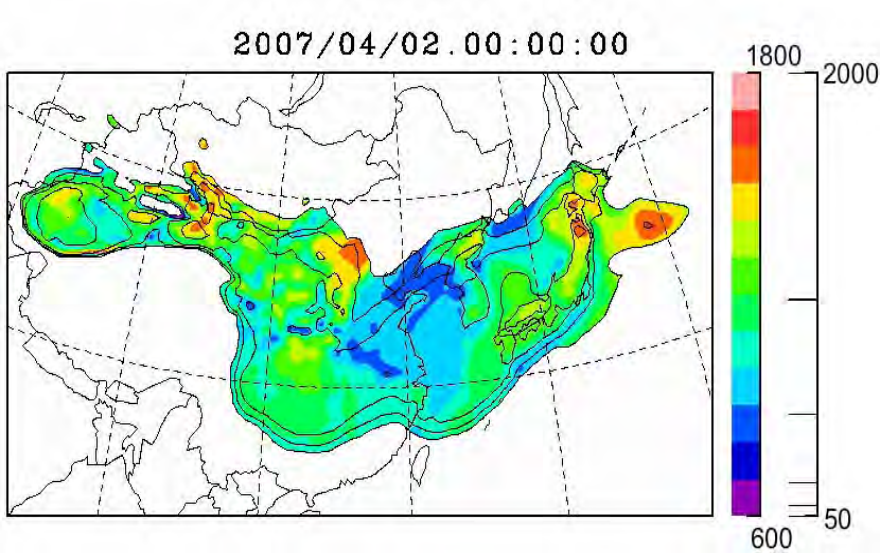



**Fig. 2** Spatial distribution of the mass/extinction conversion factor for $PM_{10}$ (color scale [(μg/m$^3$)/km$^{-1}$]) and $PM_{10}$ concentration (contours [μg/m$^3$]) at surface.

**2. Development of systems for evaluating regional water and material cycles in East Asia (Core research project 2)**

The comprehensive tools needed for sustainable management of the water environment and water resources of East Asia are developed by gathering scientific knowledge and information through strategic international collaborative research. This core research project has been developing a system for the observation and evaluation of water and material cycles in catchment ecosystems by coupling satellite monitoring with an integrated catchment model. The aim is to investigate the health status of catchment ecosystems, oceanic ecosystems, and Asian cities. The research progress in each sub-theme in 2010 is as follows:

***Development of a system for the observation and evaluation of water and* material cycles in a catchment ecosystem**

The **Asian Water Environment Section** has developed an integrated observation and evaluation system for water and material cycles in a catchment ecosystem. We used this system to conduct research to: (1) develop an information database covering water, thermal, and material cycles based on satellite, GIS, and observation data in large catchments in East Asia; (2) develop a catchment environment management model to assess how human-induced changes in climate, land use, and management affect water cycles (e.g. water shortages) and material cycles (e.g. carbon and nitrogen cycles) in a large catchment in East Asia; and (3) to evaluate how human-induced changes in climate, land use, and land cover affect water cycles (e.g. water shortages and floods) and material cycles (e.g. carbon and nitrogen cycles), as well as to evaluate the effects of both technology systems and policy programs on water resources and water qualities (Figure 3).

As a case study, the nitrogen and phosphorus dynamics in the Hanjiang River basin, the largest tributary of the Changjiang River, with a length of 1577 km and

a watershed area of 159 000 km$^2$, were modeled. We successfully integrated factors such as dams, land-use, and soil properties, as well as management factors, into the model to simulate the daily, monthly, and annual distribution of both water-resource variables such as ET (evapotranspiration), SURF Q (surface runoff), and LAT Q (lateral flow) and water quality factors such as SED (sediments), BCOD (biochemical oxygen demand), $NH_4$-N (nitrate nitrogen), $NO_3$-N (ammonium nitrogen), DO (dissolved oxygen), and T-P (total phosphorus).

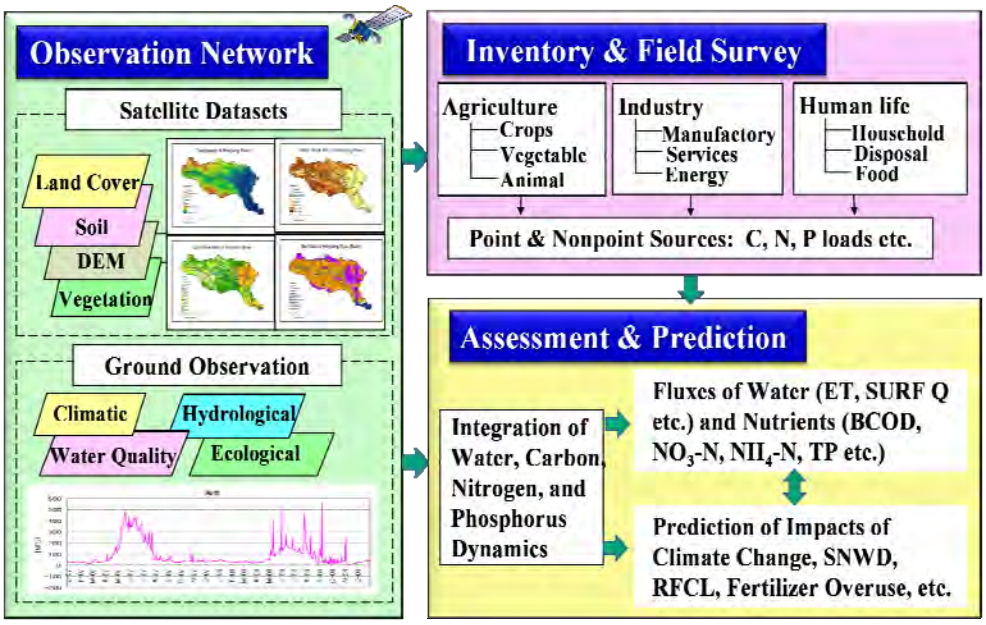



**Fig. 3** Integrated observation and evaluation system for water and material cycles in a catchment ecosystem.

The model requires sufficient data to be defined, in cooperation with international institutions. Meteorological data were collected from the Climatic Data Center of the National Meteorological Information Center of China. Hydrological data were measured by the Changjiang Water Resources Commission of China. Land cover maps were obtained from MODIS satellite data that were validated by a high-resolution map developed in about 2000 by the IGSNRR (Institute of Geographical Sciences and Natural Resources Research) of CAS (the Chinese Academy of Sciences). The DEM (digital elevation model; 90 × 90 m) was obtained from the SRTM (Shuttle Radar Topography Mission) located within the USGS website (seamless.usgs.gov).

The accuracy of the model was validated by monitoring data on river discharge, sediment, $NH_4$-N, and total nitrogen and T-P over the Hanjiang River. The validated model was then used to evaluate the effects of climate change and of human activities such as the SNWD (South-to-North Water Diversion) project, the RFCL (Reforestation of Cultivated Land) initiative, fertilizer overapplication, and increased atmospheric deposition. The simulation results, as an example, showed that RFCL would cause an obvious decrease in surface runoff (–23.6%, $P < 0.01$) but an increase in groundwater table (71.8%, $P < 0.01$) and percolation

out of the soil (24.7%, $P < 0.01$). The total water yield would not change significantly (–4.4%), but the decrease in total sediment loading would be substantial (–56.2%, $P < 0.01$). The simulation results also showed that RFCL would greatly decrease organic N in surface flow (–42.6%, $P < 0.01$), $NO_3$ yield in surface flow (–37.1%, $P < 0.01$), and $NO_3$ yield in sub-surface flow (–25.5%, $P < 0.01$), whereas the $NO_3$ yield in groundwater flow would increase (107%, $P < 0.01$). RFCL would cause both organic phosphorus (–38.2%, $P < 0.01$) in surface flow and total phosphorus yield from the soil (–33.3%, $P < 0.01$) to decrease.

These results suggest that RFCL is an effective policy for watershed environment management, which might have a relatively small effect on river discharge but a marked effect on river water quality..

***Investigation of the influence of water from the Changjiang River on the marine ecosystem of the continental shelf of the East China Sea***

The **Asian Water Environment Section** also studies the influence of freshwater from the Changjiang River, which contains large amounts of terrestrial N and P, on the oceanic environment and ecosystem of the East China Sea. We have continued periodic investigative cruises in the East China Sea in cooperation with the Seikai National Fisheries Research Institute. Over the past 4 years we have found that *Prorocentrum dentatum* (a dinoflagellate) often dominates on the continental shelf in the East China Sea, especially around the area diluted by water from the Changjiang River. In our July 2010 cruise we detected a great predominance of this dinoflagellate in this area. Because this species is a major component of the red tides formed in Chinese coastal areas over the last decade, we presume that its emergence on the continental shelf is related in some way to environmental changes in Chinese coastal areas.

To demonstrate this relationship, we have developed and modified a numerical simulation model coupled with hydrodynamic and pelagic–benthic biogeochemical cycle models based on the available observed data, which included not only the East China Sea but also Ise Bay and Tokyo Bay, Japan. To refine the simulation model, we measured the vertical profiles of microturbulence and nitrate, together with that of chlorophyll, in the East China Sea to clarify their correlations with vertical shear stress, vertical nutrient transport, and the vertical distribution of phytoplankton. We performed a large-scale incubation test of *Prorocentrum dentatum* using a Marine Microcosm to analyze the diel characteristics of vertical migration and to introduce these characteristics to our biogeochemical cycle model.

We performed a passive tracer simulation using the numerical model to investigate the impacts of the Changjiang River, the Kuroshio, and the Taiwan Warm Current on the nutrient environment of the continental shelf in the East China Sea. The simulation results indicated that the Taiwan Warm Current was the main source for the water mass in the region where we had detected the predominant dinoflagellate. (Figure 4).

To gain a better understanding of the recent environmental changes occurring in Chinese coastal areas, we have been promoting a collaborative program with

Zhejiang Oceanic University, China. The joint research program, entitled "Development of an Adaptive Management System for the Marine Ecosystem and Fishery Resource in the East China Sea," began in 2007.

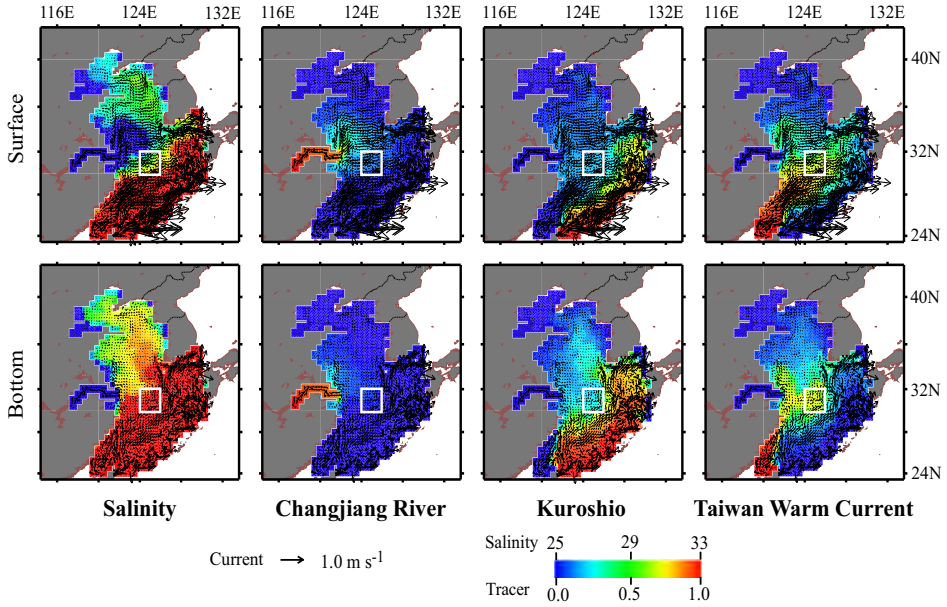



**Fig. 4** Example of results of the numerical tracer experiment to evaluate the relative impacts of three water inflows (Changjiang River, Kuroshio, and Taiwan Warm Current) on the water mass of the continental shelf in the East China Sea. Each tracer concentration (dimensionless) has a range of 1 (at its source point) to 0 (at the other source points).

***Development of a comprehensive circular economy urban simulator to design and evaluate alternative environmental technology and policy scenarios***

The **Environmental Technology Assessment System Section** aims to develop an evaluation system to quantitatively assess environmental flux considering the spatiotemporal distributions of water, resources, heat, and GHG emissions derived from urban and industrial activities. The simulation system can be used to evaluate the present status and future potential for ecosystem services under the constraints and interactions of urban and industrial activities. The main focus of this research is to develop an urban- and regional-scale environmental GIS database that can be used to quantitatively evaluate the environmental impacts of urban and industrial activities. The aim is also to develop an integrative urban environmental spatial model for quantitative analysis of the spatial distribution and migration of resource flow and stock. By combining the database and the model, it will be possible to establish an integrated system for use by decision-makers in evaluating environmental flux. In FY 2010, the research was focused on integrative evaluation of catchment regions in the following two case studies.

(1) Evaluation of the impacts of industrialization in a catchment region

After establishing an international research network among Asian and Japanese cities, Liaoning Province and its capital city Shenyang, a heavy industrial base in northeast China, were chosen by Chinese and Japanese research stakeholders as focal demonstration research projects among Chinese and Japanese research

stakeholders. Sustainable water resource management in the Shenyang regions, both in Liaoning Province was investigated and sustainable solid waste management was investigated from a circular perspective.

Among the research findings in Shenyang and Liaoning Province, the simulation results obtained by applying the NICE (National Integrated Catchment-based Eco-hydrology) model showed that more benefits could have been realized by introducing multiple technologies with appropriate policies. The model reproduced well the hydrothermal budgets after the construction of a reservoir in the middle reaches of the Liao He River The potential environmental gains of a given set of technologies depend not only on the technologies themselves but also on the local conditions, such as the energy structure and the carbon intensity of electricity. Development of clean energy and promotion of recycling programs would contribute to additional GHG emission reductions. The technological simulations revealed the maximum potential of different management options as a scientific reference for planning and policy-making.

(2) Scenario evaluation of circular policies

We also investigated the potential environmental impacts of transferring waste-plastic recycling technologies from Japan to the city of Shenyang. Shenyang is the capital of Liaoning Province in northeastern China, which has a total population of 7.8 million in 2009. The Shenyang Sanitation Research Institute reported that about 3 million tons of municipal solid waste was generated in Shenyang in 2008; of this amount, 2.13 million tons was generated within the urban central district. Waste plastics can be converted through mechanical recycling, chemical recycling, or energy-recovery processes into products that can be substituted for virgin materials such as plastic resins, lumber, fossil fuels, and feedstocks in industrial processes (Al-Salem et al., 2009; JCPRA, 2007). The results of eight scenarios are summarized in Figure 5. Among the individual technologies, the NF board production scenario had the greatest potential to reduce GHG emissions (by 254 kt $CO_2$e/year).

Given that reliable supplies of separated waste and demand for recycled products are factors that influence the choice of appropriate technologies, increased recycling would provide an increase in environmental benefits. However, in the recycling of one unit of waste different recycling technologies would realize different benefits. Their efficiencies vary because of variations in the properties of the treated waste (e.g. composition or contamination level), the properties of the substituted products (embodied environmental impacts), the efficiency of processing, the emission factors, and the current practices usually taken as baselines in the calculation of reductions.

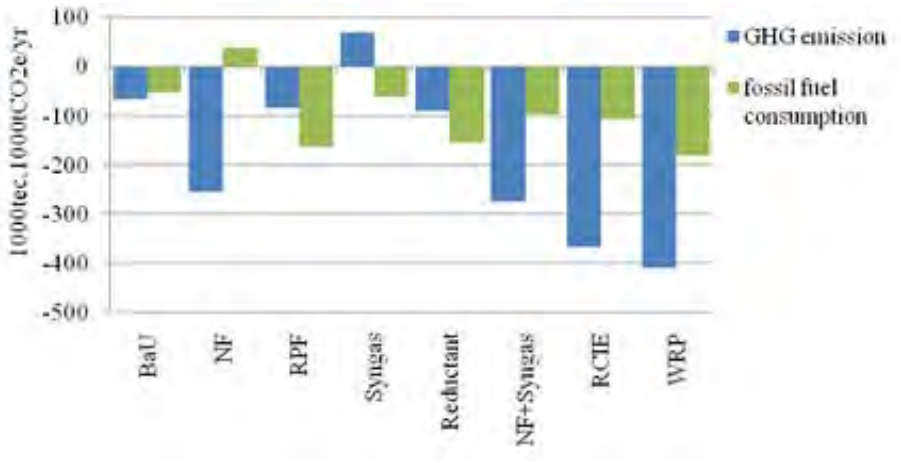



**Fig. 5** GHG emissions and fossil fuel consumption of scenarios.
BaU, business as usual; NF, NF board production; RPF, refuse plastic fuel; RCIE, reduced carbon intensity of electricity; WRP, launch of waste recycling program.

**3. Developing methods for environmental impact assessment of catchment ecosystems in Southeast Asia and Japan (Core research project 3)**

The Mekong River is the largest international river in East Asia, with a watershed area of 795 000 km$^2$ and a main channel 4800 km long. Within this watershed, traditional social and industrial activities have long been conducted in harmony with the ecological services associated with the river. In recent years, however, demand for electric power and water resources has been increasing to meet rapid population growth and economic development, and large-scale watershed development, including dam construction and land-use changes, has affected many parts of the watershed. In the upper Mekong River watershed and its main channel, dam construction projects were started in the 1950s. Dams called the Mekong Cascade were completed on the Mekong River in China (the Manwan Dam in 1996 and the Dachaoshan Dam in 2003).

***Model simulation of seasonal water discharge and sediment transport to assess impacts on Mekong River watershed development***

The **Watershed Ecosystem Section** evaluated the impact of the Manwan Dam and its related watershed development on seasonal water discharge and suspended sediment transportation by using hydrological simulations of the target years 1991 (before dam construction) and 2002 (after dam completion). Our study area was the main channel of the Mekong River in northern Thailand, extending about 100 km downstream from the intersection of Myanmar, Thailand, and Laos.

We used the MIKE SHE and MIKE11-Enterprise models (developed by the Danish Hydraulic Institute) to calculate seasonal changes in water discharge and sediment transport at five points 15 to 35 km apart in this interval. Sediment load was calculated from a regression equation between sediment load and water discharge, using suspended sediment concentrations in monthly river water samples taken between November 2007 and November 2008. Finally, we estimated annual sediment load along the study reach by using both the simulated annual hydrograph and the regression equation.

(1) Change in water discharge as a result of dam construction

We simulated the annual process of runoff to the study watershed by using the 1991 and 2002 watershed models under the same (2002) precipitation (Figure 6). The black thin line shows the water discharge data collected at Chiang Sean. The red line shows 2002 simulation. The blue line shows a virtual simulation that calculated using 2002 precipitation and 1991 watershed parameters. The difference between the two hydrographs (red line and blue line) is the effect of structural changes in the watershed that included dam construction.

Over the whole year, the simulated water discharge varied from approximately 1000 -10 500 $m^3/s$. In the months after the last discharge peak, discharge in the virtual 2002 simulation (1991 watershed model with 2002 precipitation) was larger than in the 2002 simulation by about 1000 to 1500 $m^3/s$. We interpreted this difference in water discharge during the receding phase as a delay in the reduction of flow because of land-use change and some modulating effects of the dam.

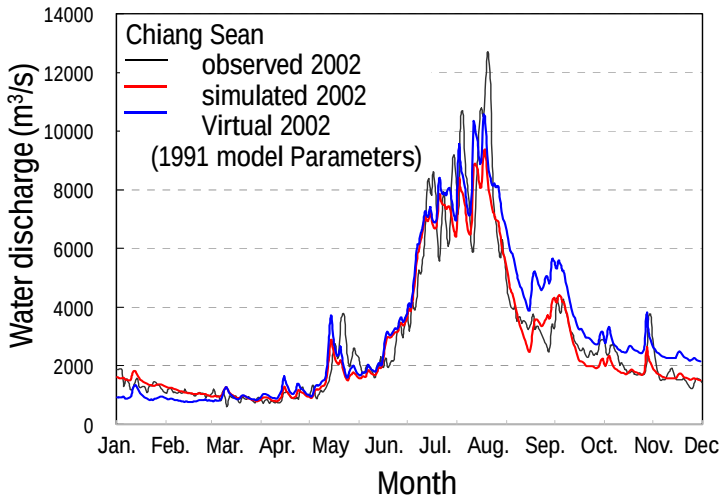



**Fig. 6** Hydrographs at Chiang Sean. The virtual 2002 hydrograph (blue line) was generated by combining 2002 precipitation data with the 1991 watershed model. The red line shows 2002 simunlation.

(2) Changes in monthly sediment transport in Chiang Sean

We examined the seasonal changes in suspended sediment load at Chiang Sean using the 2002 and 1991 watershed models under 2002 precipitation (= virtual 2002 simulation ) (Figure 7). The red and blue bar in the graph shows the results of 2002 and virtual 2002 simulation respectively. The sediment load ranged from $200 \times 10^3$ - $11\ 200 \times 10^3$ t/month. The trend in sediment load was similar to that of water discharge, given that the sediment concentration and water discharge were correlated. The difference between the two models was notably large from August to December. The difference in water discharge could be attributed to a delay in the post-rainy-season recession after dam construction and to land-use change. The monthly sediment transportation from August to December in the 2002 simulation decreased to about 40% in comparison with 2002 virtual simulation.

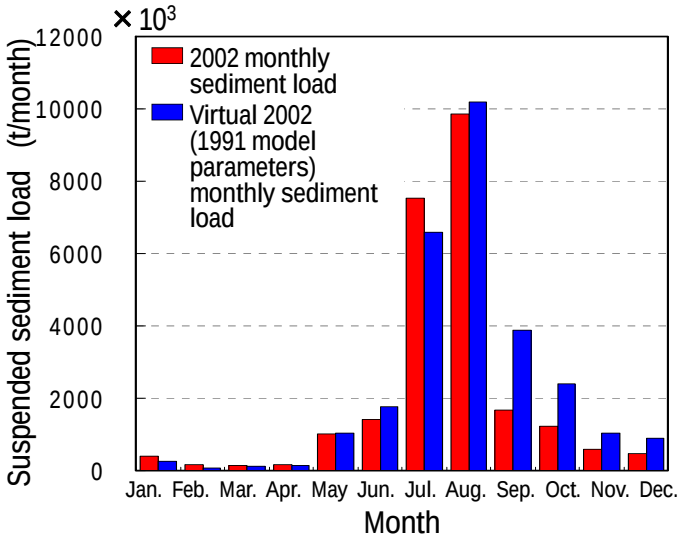



**Fig. 7** Comparison of seasonal dynamics of suspended sediment load at Chiang Sean. The red bar and blue bar shows 2002 estimated load and virtual 2002 estimated load respectively.

We estimated that this decrease in sediment transportation amounted to a total of approximately 6000 $\times 10^3$ t in the post-rainy-season period. We considered that the change in sediment transportation had a cause similar to that of the changes in the seasonal hydrograph.

(3) Change in annual sediment budgets in the study reach

We examined the sediment transport loads and their changes downstream in the 95-km study reach from near Chiang Sean to the Thailand–Laos border beyond Chiang Khong (Figure 8). The annual sediment transport volumes at Chiang Sean were 27.90 $\times 10^6$ t/year in the virtual 2002 simulation with 1991 parameters and 21.13 $\times$ $10^6$ t/year in the 2002 simulation. At successive check points downstream, the transport volume increased in both simulations. Comparison of the watershed before and after dam construction revealed that the estimated annual sediment transport volume at Chiang Sean using the 2002 parameters was approximately 24.27 % lower than that using the 1991 parameters of virtual 2002 simulation.

Our model considered differences in the sediment budget due to both dam construction and overall watershed development, including land-use changes and channelization of tributaries in the upper catchment. However, the main reason for the decrease in annual sediment transport volume was the effect of water discharge changes in the months after the rainy season. The delay and prolongation of this period of declining discharge was directly related to changes in the sediment transport regime.

This relationship implies that the operations of dams that will be constructed in the Mekong Cascade have potential to change the seasonal hydrodynamics of the river water and sediment movement immediately downstream.

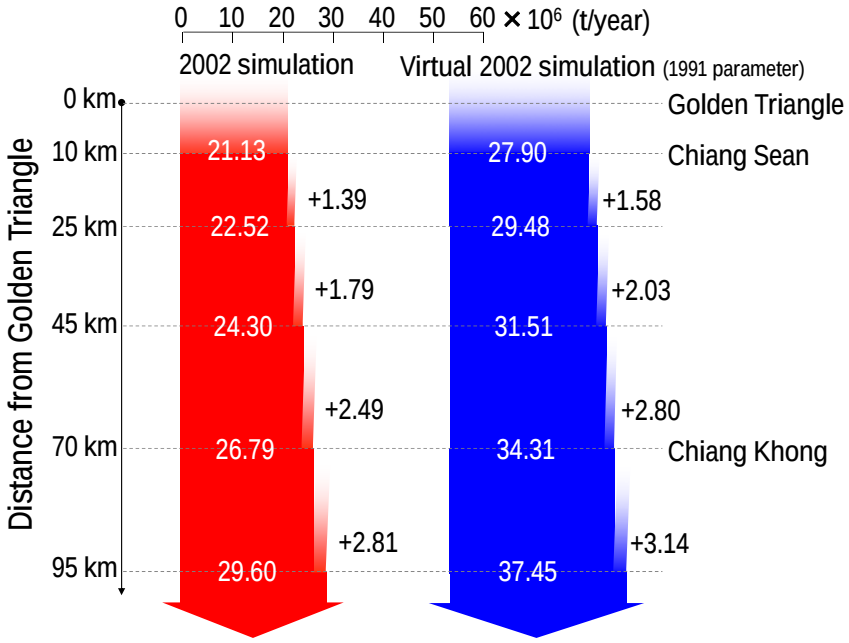
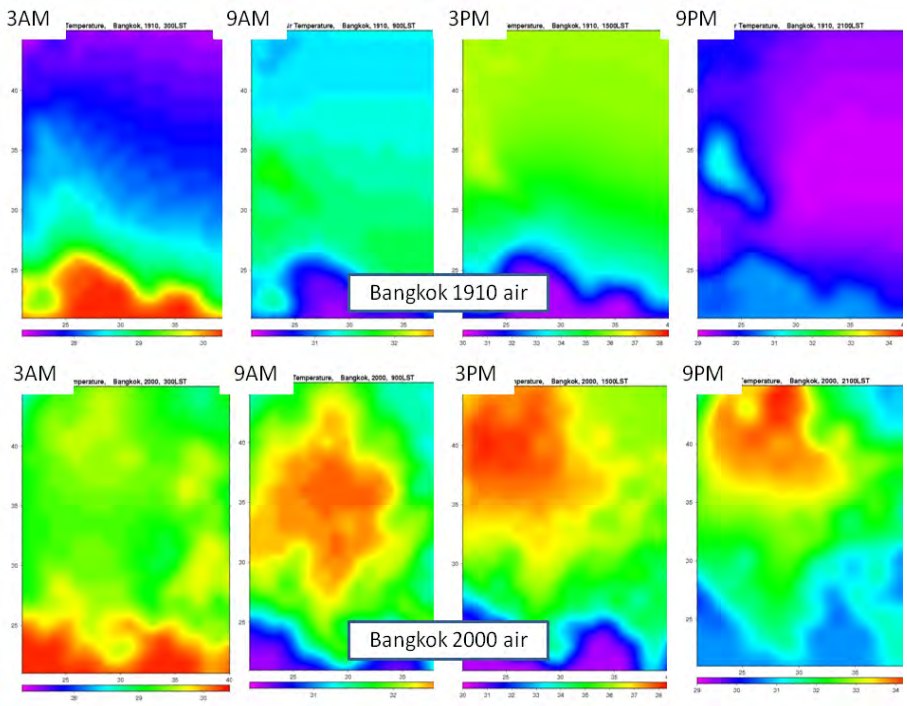



**Fig. 8** Suspended sediment budget at the study site, from the golden triangle to the Laos border. Numbers beside the arrows are values for the suspended sediment budget.

# Social and Environmental Systems Division




Diurnal changes in surface air temperature maps of Bangkok (1910 and 2000)

Numerical simulations of the urban warming caused by urban expansion in the 20th Century were performed in seven Asian megacities. Digital land-use data sets in three stages of the 20th Century were input to a climate model as the surface boundary conditions. The computed warming of soil temperatures was compared with the vertical profiles of the subsurface temperatures used to record historical warming.

This Division targets linkages between human activities and the natural environment in order to clarify the relationships between socioeconomic systems and environmental issues. The work of the Division results in proposals for environmental policies. It covers a broad area, from global environmental issues such as global warming to local issues like recycling and lifestyle. There are four research sections:

**1. The Environmental Economics and Policy Section** studies the economic and policy aspects of environmental conservation and analyzes the economic and political effectiveness of environmental policies.

**2. The Environmental Planning Section** works on planning and evaluation techniques and applications relating to environmental conservation, including local goal-setting of environmental policies, and on the prediction and assessment of climate change impacts.

**3. The Integrated Assessment Section** develops integrated environment– economy models to assess environmental policies, such as those on global warming mitigation and adaptation, and sustainable development policies.

**4. The Transportation and Urban Environment Section** analyzes environmental issues such as urban air pollution and climate change caused by automobiles.

Our main research outcomes in FY 2010 were as follows.

**1. Environmental Economics and Policy Section**

To investigate a wide range of environmental issues we are studying the interactions between current social and environmental systems by using approaches from social science, natural science, and systems analysis. In addition, we are analyzing the economic impacts of environmental policies such as carbon taxes and emissions trading. We are also analyzing the environmental policy decision-making processes in use by various countries and investigating the possibility of international cooperation on global environmental conservation.

***(1) Study of the effect of carcinogenic risk arising from the release and transfer of chemical substances on the Japanese housing market***

The policy instruments that provide information on a firm's or facility's environmental performance, such as the USA's TRI (Toxic Release Inventory) and the PRTR (Pollutant Release and Transfer Register) systems used in some European countries and Japan, play important roles in encouraging firms or facilities to improve their environmental performance, provided that investors, consumers, and residents recognize this environmental performance. This study used a hedonic approach to explore how the Japanese rental housing market responds to the carcinogenic risk arising from the release and transfer of chemical substances produced and used at facilities close to housing. We found that residents did not perceive the risk of potential carcinogens generated more than 1.0 km away from their residences, but that they seemed to recognize increased carcinogenic risk at distances from 0.5 to 1.0 km away: a 1% increase in potential carcinogenic risk reduced the average rent by 0.0007%. The distance at which

residents perceived the risk arising from such facilities was less than that in previous studies. This suggests that the risk perception recognized in previous studies may have captured other externalities in addition to chemical risk, because the risk was measured by distance in the previous studies.

***(2) Role of the principles of international environmental law in policy for adaptation to the climate regime after 2012***

The principles of international environmental law, especially equity and CBDR (Common But Differentiated Responsibility), which are provided in Article 3 of the UNFCCC (United Nations Framework Convention on Climate Change), are relevant to adaptation to climate change. Adaptation raises important equity issues in relation to determining responsibility and the capability of countries to address it, although the obligations concerning adaptation can be found mainly in the provisions of general obligation. It is valuable to examine how the climate regime after 2012 will respond legally to adaptation and where the problems will lie. We undertook the following tasks: (a) analysis of the meaning and role of the principles of equity and CBDR in the context of the UNFCCC process; and (b) identification of the extent to which these principles are applied to adaptation in global climate law and policy. Our main findings were that the role of the principle in the UNFCCC was to convey and facilitate debate over the different dimensions of equity, and that CBDR played a guiding role in the negotiation process. We also found that the broad nature of the language concerning adaptation policy in treaties gives the Parties to such treaties discretion as to the precise boundaries of CBDR.

***(3) Study of perceived flood damage cost in the Tokyo Metropolitan Area***

Future climate change is likely to bring an increased frequency of natural disasters, including flooding. Much attention has therefore been paid to flood adaptation policy. Estimating the benefits of reducing flood damage is important in developing cost-effective adaptation policies. In previous estimates of such benefits there has been concern about the omission of variable bias in estimating flood damage. In this study, we developed a hedonic land price model by employing two-step procedures to correct the bias in flood hazard estimate. We found that the previous studies were likely to have underestimated the perceived flood damage. In addition, flood risk was estimated to lower land prices by 17.1% (an average reduction of 220,770 yen/$m^2$ [approximately US $2,810], and the perceived flood damage was estimated to be 7,483,723 yen/$m^2$ (approximately US $95,268/$m^2$). This estimate was larger than the estimate produced by the Tokyo metropolitan government, indicating that the indirect damage cost is likely to be much higher than the direct damage cost (i.e. the cost estimation based on physical damage alone).

**2. Environmental Planning Section**

We are studying the development and assessment of regional plans and basic environmental plans for environmental conservation. In this research, we are investigating new methods of understanding and assessing regional environments by using GIS (geographic information systems) and numerical simulations. We are also investigating the current status of public environmental awareness and promoting voluntary action by individuals.

***(1) Theory and effects of voluntary environmental actions taken by individuals and enterprises***

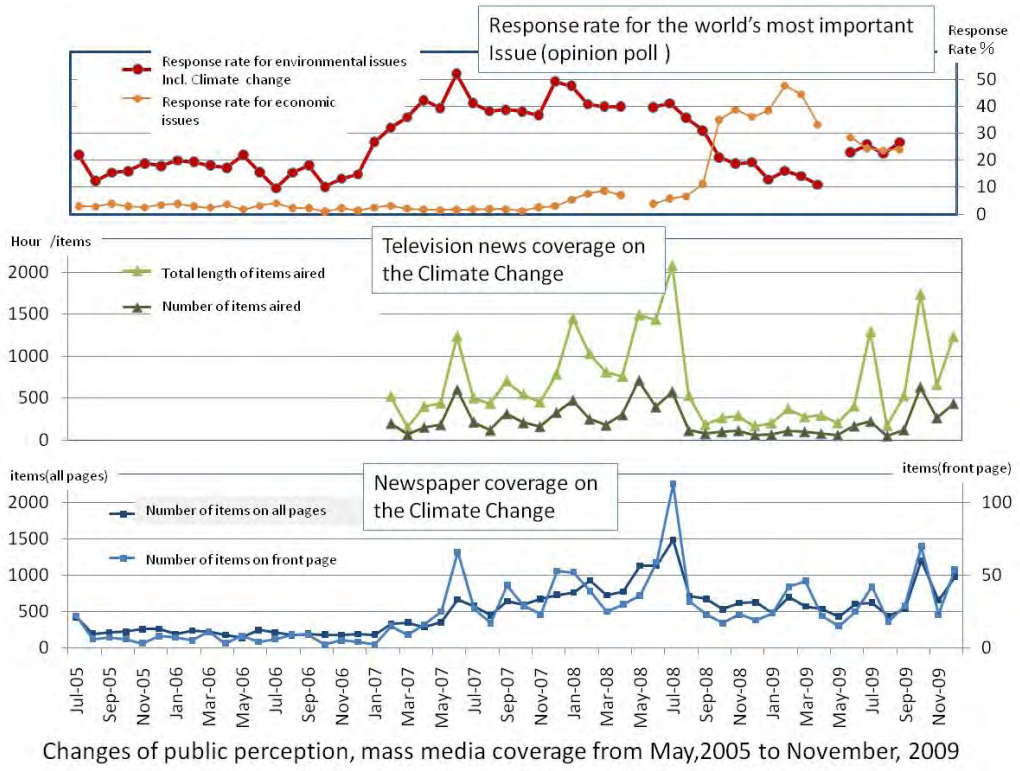
Although evaluation of environmental communication is indispensable for effective communication of this type, many components of the evaluation techniques remain to be developed. We introduced "valuation modeling" to the eco-program of the Kashima Antlers Football Club. Promotion of participation in environmental activities and the changes in consciousness after this participation were evaluated. Moreover, the "effect of environmental communication on $CO_2$ emission reduction" was proposed as a new communication evaluation criterion. The results of this research can be applied immediately to environmental communications planning and will also be developed further for the implementation of ISO 14063, *Environmental management – Environmental communication – Guidelines and examples*.

***(2) Study of national trends in public interest in environmental issues***

We conduct ongoing monthly public opinion surveys to evaluate the levels of public support for environmental policies. Our questionnaires cover the "World's most important issues" and "Japan's most important issues." Our sample populations consist of 4000 men and women aged at least 20 years and drawn from across the nation. These respondents are randomly selected every month.

This year, we conducted the survey every 2 months from April 2010 to January 2011(Figure 1).

The response rate for "environmental/pollution" issues remained constant around 20% from 2010 to January 2011. The mass media coverage of environmental issues also remained constant in this period, indicating that the mass media did not focus on significant topics in the environmental field during this period.




Changes of public perception, mass media coverage from May,2005 to November, 2009

**Fig. 1** Changes of public perception and mass media coverage from May 2005 to January 2011.

***(3) Study of strategic urban planning and assessment of low-carbon cities***

In the planning and building of low-carbon cities, the use of architectural methods that take into account global environmental conservation generally involves a reduction in the heat load of buildings.

The shading effects of neighboring buildings in residential building clusters in the hot summer and cold winter zone of China were estimated with the building energy simulation tool eQUEST. A generic building that represented the prevailing residential buildings in an area was established. Cooling, heating, and total electricity energy consumption were estimated, with and without the presence of neighboring buildings. We found that when the generic building was shaded by a neighboring building the recommended distance away, consumption of electricity for cooling in the five case-study cities was reduced by about 10% to 20%. Consumption of energy for heating, in contrast, was increased by 18% in the most affected case (Shanghai). The total reduction in energy consumption from shading was greatest in the cities of Changsha, Chengdu, and Chongqing.

We have also used energy simulations to study the relationship between distance between buildings in the north–south direction and energy requirements. In all five cities studied, as the north–south distance increased, the energy required for cooling decreased and that needed for heating increased. Optimum north–south distances for energy conservation have been determined for Shanghai, Wuhan, and Chengdu. In Shanghai, 1.5 times of the building height as the north–south distance would contribute to savings in building energy. In Chongqing and Chengdu, the smaller the north–south distance the greater the amount of energy conserved. As

validation of parameters used in this simulation, we performed field surveys on residential utilization of air conditioners in Shanghai and Wuhan (Figure2).

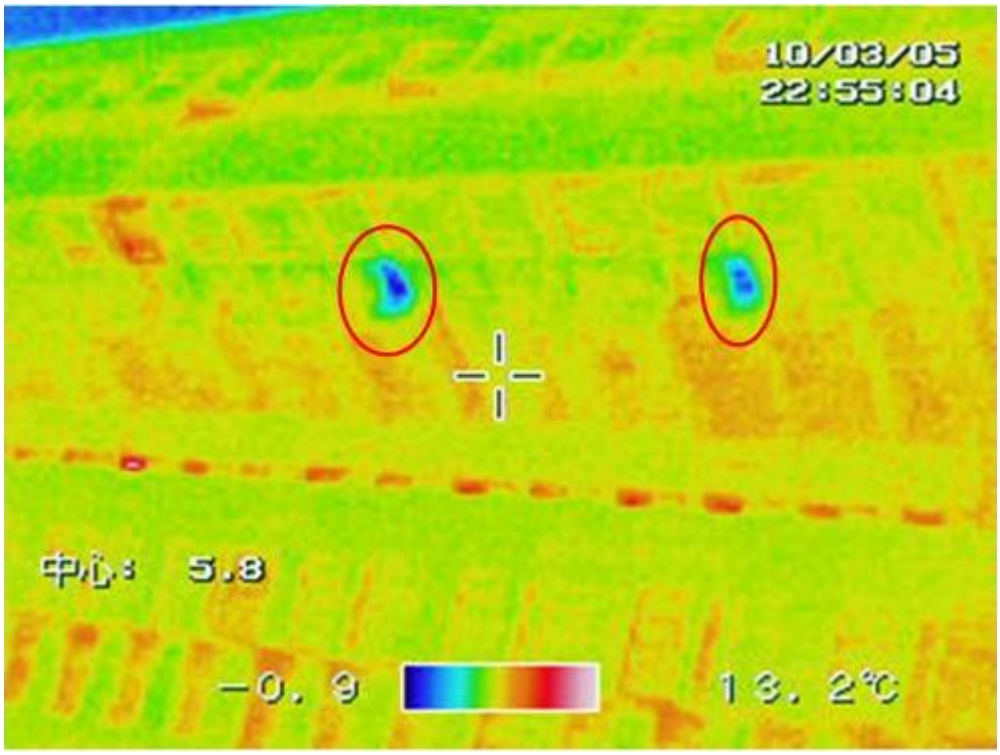



**Fig. 2** Thermal image of a residential building on a winter night in Wuhan, China. Blue indicates the low surface temperatures of outdoor reverse-cycle air conditioner units heating the indoor space.

**3. Integrated Assessment Section**

"Integrated assessment" is a framework for linking the policymaking process with scientific knowledge from a wide range of disciplines. The core tool in integrated assessment is a model that evaluates policy options for solving various environmental problems. We have developed and modified the Asia–Pacific Integrated Model (AIM) to assess climate policy. The model results are provided to environmental policymakers in Japan. The model takes into account the fact that, in developing Asian countries, local environmental problems are more severe than global environmental issues such as climate change. We are expanding AIM to include not only climate problems, but also other environmental issues related to sustainable development. The following three topics were our main activities in 2010:

***(1) Research on climate change impact and adaptation***

This fiscal year, a simple tool for estimating climate change impact and adaptation, AIM/Adaptation [Policy], was developed. This system is equipped with a database function to store impact assessment results that have already been calculated. The aim is to develop a system that assumes the role of storing impact assessment results, implementing impact response functions, and calculating/displaying the assessment results. We also aim to make the tool available at the prefectural and municipal levels. In this light, using currently available information we have now developed the first edition of chronological,

mesh-type scenarios that cover the whole of Japan.
Another of our studies investigated the extent to which the existing policies for Tokyo are able to contribute to the city's climate change adaptation. The results indicated that the existing policies could be useful for climate change adaptation in many fields and for many indicators.

***(2) Assessment of the impact of climate change on global water resources by using a water scarcity index that considers seasonal water variability***

To assess the impact of climate change on global water resources by incorporating sub-annual-timescale phenomena, this study used a new daily water scarcity index termed the cumulative withdrawal-to-demand ratio (CWD). Our results indicated that global warming will increase the mean annual runoff in 61% of the total land area globally. In 22% of the area where runoff will increase, the CWD showed increased water stress. These regions included India, northern China, and Europe. For India, the increase in water stress was attributed to the seasonal gap between runoff and water demand. Increased runoff was concentrated over a few months, whereas the months of high demand for irrigation water differed and were much longer. For Europe, the increase in water stress was attributed to a shift in the timing of snowmelt, which will occur a few months earlier than at present, causing water shortages in early summer.

***(3) Economic impacts of a 25% greenhouse gas (GHG) emissions reduction in Japan in 2020 compared with the 1990 level***

The AIM model was used to assess the GHG emissions reduction target in Japan in 2020 compared with the 1990 level. The domestic target for emissions reduction in 2020 was set at 15%, 20%, or 25%, and in the case of the 15% and 20% reductions, we assumed that the remainder of the reduction required to make up 25% would be achieved by means of other measures, such as international reduction efforts. A bottom-up type model calculated the volumes of GHG emissions reductions and the costs of countermeasures to achieve the targets. An economic model was then used to estimate the economic impacts. The main simulation results were as follows. Compared with the reference scenario, the average GDP growth rate from 2010 to 2020 will slow slightly from 2.1% a year to 1.8% to 2.0% a year. The $CO_2$ price in 2020 will be about 14,600 to 41,400 yen/t $CO_2$ in the case of 15% to 25% reductions. By introducing a policy of carbon tax reduction and carbon tax revenue investment in expensive energy-efficient technologies, the economic impacts of GHG emissions reduction will be mitigated.

**4. Transportation and the Urban Environment Section**

This section pursues studies related to transportation and urban environmental problems. We use our vehicle test facility and onboard measurement devices to evaluate the environmental impacts of motor vehicles. We also formulate and evaluate environmental improvement scenarios for transportation and urban systems.

***(1) Evaluation of electrically powered transport for personal use***

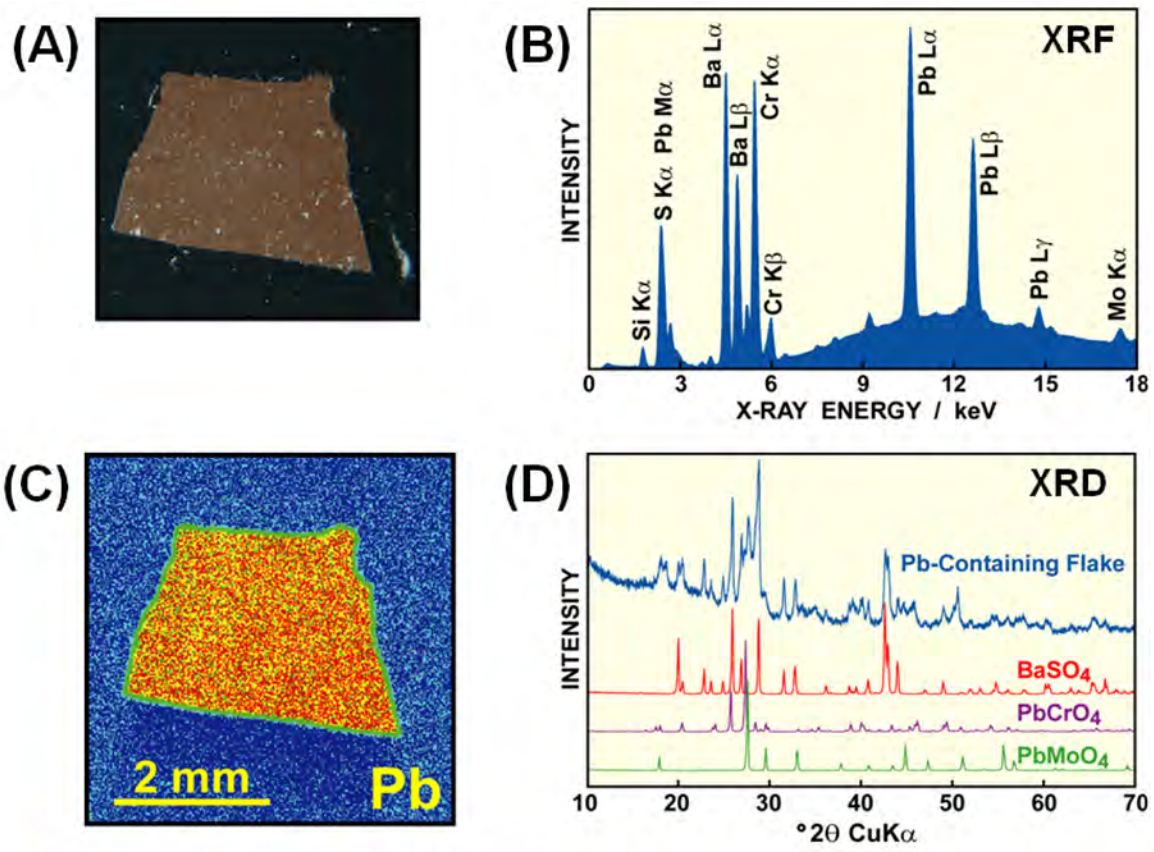
The use of electrically powered vehicles may be one way to reduce $CO_2$ emissions in the transportation sector. Using our vehicle test facility, we evaluated the performance of an electric vehicle (EV) newly developed by a small company and examined an electric motorcycle (EMC) that we improved so as to suit acceleration under real-world conditions. The EV had a significantly lower energy consumption rate than that of the EV now on sale. The EMC had a good energy consumption rate (30 Wh/km)—about half that of the original EMC. We also examined several packs of lithium-ion batteries made outside Japan and found them to have low performance. Calculation of the potential for EV introduction through an analysis of long-term vehicle travel activity data demonstrated that there was widespread potential for EV replacement.

***(2) Study of long-term $CO_2$ reduction strategies by the transport sector towards a low-carbon society***

As part of the transport section studies of the Japan Low Carbon Society 2050 Project, we used origin–destination data from the national road census to estimate $CO_2$ emissions from automobiles by municipality from 1980 to 2005 (Figure 3). Figure 3 shows the Environmental GIS Website for data publication; the colors mean motor vehicle $CO_2$ emissions per capita in 2005, the graph means the emissions changes of Tsukuba from 1980 to 2005. This estimation enabled us to analyze the regional characteristics of automobile $CO_2$ emissions, trip frequencies, and average trip lengths. A decrease in $CO_2$ emissions per capita from 1999 to 2005 was observed, especially in metropolitan regions. This study will help to establish national and local action plans for global warming countermeasures.

**Fig. 3** This motor vehicle $CO_2$ emissions map is available via the Environmental GIS Website of NIES (http://tenbou.nies.go.jp/gis/) (in Japanese). This system provides information on $CO_2$ emissions from passenger cars and freight vehicles.

# Environmental Chemistry Division




(A) micrograph, (B) X-ray fluorescence (XRF) spectrum, (C) XRF Pb map, and (D) X-ray diffraction (XRD) pattern of a Pb-containing flake in house dust.

The **Environmental Chemistry Division** has been working on the development of various methods for the analysis of organic chemicals and elements or isotopes; the monitoring of their environmental and biological fates and behaviors; and the analysis of biological responses to pollutant exposure. Various kinds of topics have been studied: global environmental change; the presence and transport of elements or chemicals on global, regional, and local scales; long-term environmental monitoring and specimen banking; the identification and apportionment of major sources of pollutants; the development of new methods of analysis, including nanoparticles and the central nervous system; behavioral and biochemical responses to chemicals; and scientific and technical support in various environmental issues (e.g., implementation of the Stockholm Convention; evaluation and treatment of groundwater pollution by organoarsenic compounds).

The **Advanced Organic Analysis Section** has developed methods for analyzing organic pollutants such as persistent organic pollutants (POPs) in the environment and applying these analyses to environmental monitoring. We have conducted special research on “Comprehensive analysis of trace environmental organic pollutants such as organohalogen compounds by using multidimensional separation” to develop next-generation analytical methods for organic pollutants in the environment on the basis of comprehensive multidimensional gas chromatography (GC×GC), high-resolution time-of-flight mass spectrometry (HR-TOF-MS), and quadrupole-type tandem mass spectrometry (MS/MS).

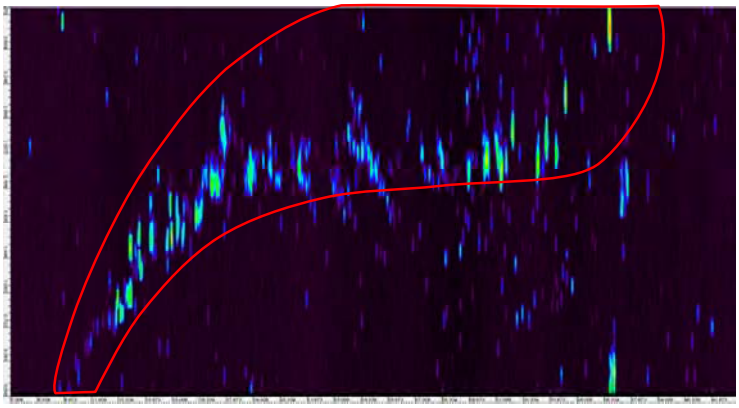


**Fig. 1**
Two-dimensional total ion chromatograms of a sediment sample (NIES CRM20), measured with a $^{35}$Cl-neutral-loss scan using GCxGC-MS/MS. The red encircled area is the area where organohalogens are expected to appear.

We successfully detected halogenated compounds in several kinds of environmental samples by using GC×GC-MS/MS. For the global detection/screening of organohalogens, fly ash extracts were directly assessed without any cleanup process. Other environmental samples such as soil and sediment were briefly cleaned up in a sulfuric acid–silica-gel column before measurement. Global detection of halogenated compounds was achieved by using neutral-loss scans of chlorine, bromine and/or fluorine with MS/MS (Figure 1). It was also possible to search for and identify compounds by using two-dimensional mass chromatograms and mass spectra obtained from measurements of the same samples with GC×GC-HR-TOF-MS under the same conditions as used for the GC×GC-MS/MS. Novel software tools were developed to find target

(halogenated) compounds in the GC×GC-HR-TOF-MS data. Many dioxin and polychlorinated biphenyl congeners and other halogenated compounds were found in the fly ash extract and sediment samples by using this method. Extraction of the desired organohalogen information from the huge amounts of data thus obtained revealed the possibility of total global detection of compounds by using one GC×GC or GC measurement of a sample, without any pre-treatment.

We applied thermal desorption GC×GC-MS/MS with multiple reaction monitoring to directly detect polycyclic aromatic hydrocarbons (PAHs) and PAH derivatives (oxy-, methyl-, and nitro-) in airborne particles. The results of analyses of trace amounts (about 10 to 20 μg) of Standard Reference Materials 1649a and 1650b agreed with the certified or reference values within a factor of about 2. We also applied this method to diesel exhaust nanoparticles and revealed their PAH compositions.

Oragnochlorine pesticides in bivalves and squid liver samples stored in the Time Capsule Facility, an environmental specimen bank at NIES, were analyzed together with the livers of squids collected from coastal areas in several Asian countries to reveal temporal and spatial trends in POPs around Japan and Southeast Asia. Hexachlorocyclohexane (HCH) levels in coastal bivalves dramatically decreased from the late 1980's onward at background sites in Japan, suggesting that regional-scale levels began to decrease after production and use of HCHs in China stopped. α-HCH is the most volatile of the HCHs. In the North Pacific Ocean, both the absolute α-HCH level and α-HCH as a proportion of all HCHs tended to be higher in squids in the cold water at high latitudes than in squids in warm water. This supports the concept of global circulation of this compound, i.e. evaporation in the southern tropical region and condensation in the northern cold waters.

The **Advanced Inorganic Analysis Section** has been investigating the precise measurement of stable-isotopic abundance of heavy metals in environmental and biological samples by multi-collector inductively coupled plasma mass spectrometry (MC-ICPMS). It was recently revealed that a risk of lead (Pb) to infants and children exists even at low exposure levels. In a case study of the source apportionment of the Pb to which Japanese children were exposed, we used MC-ICPMS to measure precise Pb isotope ratios in various samples (e.g. indoor dust, food, or blood and urine from children). Candidate sources of Pb were apportioned by using Pb isotope ratios and Pb concentrations. The results suggested that, in several cases, indoor dust was a major source of Pb exposure of Japanese children.

House dust is a source of indoor pollution that can contain harmful mites and toxic chemicals, but information on the chemical substances that contaminate Japanese house dust is lacking. We used X-ray fluorescence (XRF) and X-ray diffraction (XRD) analysis to characterize house dust samples with high Pb contents, and we were able to identify Pb-containing flakes in this dust (see Figure on the front page of this section). The XRF spectrum and XRD pattern showed that

the flakes consisted of pigments ($BaSO_4$, $PbCrO_4$, and $PbMoO_4$), suggesting that the flakes were chips of peeled-off paint. These analytical results suggest that one of the sources of Pb pollution in the indoor environment is paint.

Stable isotope food-web analyses of wild animal populations have become important tools in ecotoxicology for investigating both dietary exposure and biomagnification of toxic elements. We conducted stable isotope food-web analysis and analyses of mercury biomagnification in fishes and crayfishes in the Lake Mashu ecosystem in Hokkaido. Fishes with the higher carbon isotope ratios ($^{13}C/^{12}C$) tended to have greater bioaccumulation of mercury. These results, and those of the mercury analyses, suggest that bioaccumulation of mercury depends on the types of forage consumed.

Radiocarbon ($^{14}C$) is measured at the accelerator mass spectrometry (AMS) facility, NIES-TERRA. The AMS technique was applied to analyze black carbon (BC), total organic carbon (TOC), and PAHs in $PM_{10}$ aerosols from a residential area in suburban Tokyo to determine the natural abundance of $^{14}C$. This element is an ideal tracer for distinguishing fossil fuel sources ($^{14}C$-free) from modern biomass combustion sources of pyrolytic products. The $^{14}C$ concentration in BC was 42 pMC (percent Modern Carbon) in summer and 30 pMC in winter; these values were comparable to the $^{14}C$ concentrations in PAHs in the same samples (45 pMC in summer and 33 pMC in winter). The $^{14}C$ content in TOC was higher in summer, at 61 pMC (probably because of the higher contribution of plant activity in summer), and it was 42 pMC in winter.

The **Environmental Chemodynamics Section** has been investigating the chemodynamics of natural and anthropogenic volatile organic compounds, as well as carbon cycles, in the ocean.

(1) *In situ* high-frequency monitoring of halocarbons at Hateruma Island in Okinawa and Cape Ochi-ishi in Hokkaido has been done as a part of a "High-frequency and advanced monitoring study of the halogenated greenhouse gas inventory in East Asia." The following mean baseline concentrations in 2010 and rates of increase from last year were recorded for the following halocarbons : HCFC-22, 216.0 ppt at Hateruma Island (+2.0%) and 224.1 ppt at Cape Ochi-ishi (+5.8%); HCFC-141b, 22.4 ppt (+2.6%) and 22.4 ppt (+5.9%); HCFC-142b, 22.3 ppt (+4.3%) and 22.1 ppt (+4.2%); HFC-23, 24.7 ppt (+4.9%) and 23.9 ppt (3.4%); HFC-134a, 62.7 ppt (+10.6%) and 63.0 ppt (+9.4 ppt); HFC-152a, 8.1 ppt (+4.7%) and 9.1 ppt (+2.0%); HFC-32, 4.8 ppt (+14.5%) and 5.0 ppt (+27.5%); and $SF_6$: 7.3 ppt (+2.2%) and 7.2 ppt (+3.1%). Chloroiodomethane ($CH_2ClI$) and diiodomethane ($CH_2I_2$), which are highly photolyzed, showed remarkable diurnal variation in all seasons, with lower concentrations in the daytime, whereas methyl iodide ($CH_3I$) and ethyl iodide ($C_2H_5I$) showed no marked diurnal changes.

At Cape Ochi-ishi, all of the iodocarbons showed clear seasonal variations and were at their highest levels in summer and autumn, when algal blooms occur in the adjacent ocean. At Hateruma Island, which is surrounded by subtropical oligotrophic waters, there were no marked seasonal variations but $C_2H_5I$ and $CH_2I_2$ showed lower mixing ratios in summer than in winter. The night-time

mixing ratio of $CH_2ClI$ was strongly and positively correlated with wind speed throughout the observation period at Hateruma Island, suggesting the ubiquitous presence of $CH_2ClI$ sources (probably non-biogenic) in the subtropical ocean.

(2) An instrument that combines a cryogen-free preconcentration unit with a multi-dimensional gas chromatography–mass spectrometer–microelectron capture detection (multi-dimensional GC/MS/μECD) was developed to refine *in situ* measurements of atmospheric halocarbons with high sensitivity. The multi-dimensional GC worked well to separate PFC-14 (tetrafluoromethane, $CF_4$), the lowest-boiling-point analyte, from its interfering compound (krypton) by using a combination of a thick-film-wall-coated open tubular column and a porous-layer open tubular column (Figure 2).

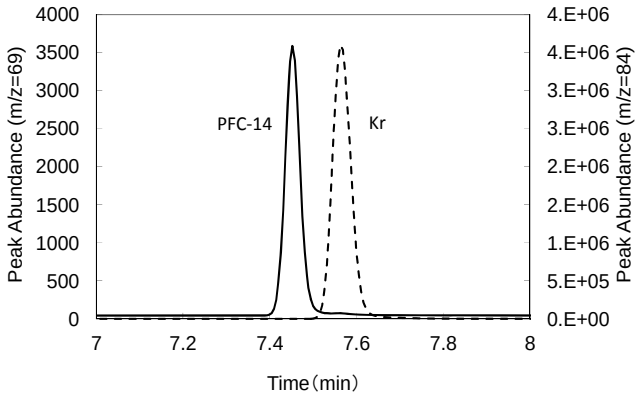



**Fig. 2** Ion chromatograms for PFC-14 (m/z = 69) and krypton (m/z = 84), obtained from an analysis of a standard gas mixture.

(3)Simultaneous quantification method of chlorofluorocarbons (CFC-11, CFC-12, CFC-113) and sulfur hexafluoride ($SF_6$) in 300mL of seawater was developed to investigate the origin and the circulation mechanism of Japan Sea Bottom Water. We also carried out the observation of CFCs and radiocarbon in the Japan Basin and the Yamato Basin of the Japan Sea during summer and autumn of 2010. The results suggested that all of the water mass from a 500m depth to the bottom of the sea may have been affected by the bottom water newly formed in 1985.

The **Biological Imaging and Analysis Section** has been developing methods and instruments for detecting and analyzing *in vivo* responses of biological systems to various environmental factors. The long-term objective of this section is to establish methods for monitoring human health in non-invasive and non-destructive ways.

In a human study, we have been focusing our efforts on studies of the human brain by using a high-field magnetic resonance imaging (MRI) spectrometer with a 4.7-T superconductive magnet. One of the themes is whole-brain anatomical imaging and we have collected images from over 300 healthy human subjects aged from 19 to 76 years. These images have been successfully segmented into typical tissue types of gray and white matter and cerebrospinal fluid for volumetric evaluation, and in each type we have evaluated gender differences and age-dependent changes. We have also been performing a semi-longitudinal

evaluation: the same subjects' brains are measured at intervals of about 5 years to follow volumetric changes of brain tissues. These changes have been consistent with the abovementioned age-dependent changes.

Quantification of regional ferritin iron ([Fe]) in the brain is another subject of our MRI observations of the human brain. We have found that $R_2^\dagger = 1/T_2^\dagger$ in the live human brain using 4.7-T high-field MRI. This is described by using a linear combination of brain regional [Fe] and macromolecular mass fraction ($f_M$), defined as 1 – water fraction ($f_w$); thus $R_2^\dagger = \alpha[Fe] + \beta f_M + \gamma$, where $\alpha$, $\beta$, and $\gamma$ are coefficients. We have already confirmed that this relationship applies at 1.9 T, 3 T, and 7 T, and this year we evaluated it in a clinical field of 1.5 T. The multiple regression coefficient of the correlation in this field (0.99) was as high as that obtained at 4.7 T. This finding may lead to accurate iron quantification *in vivo* through the use of ordinary clinical MRI systems. $f_M$ is essential for accurate [Fe] mapping, so $f_w$ mapping is required.

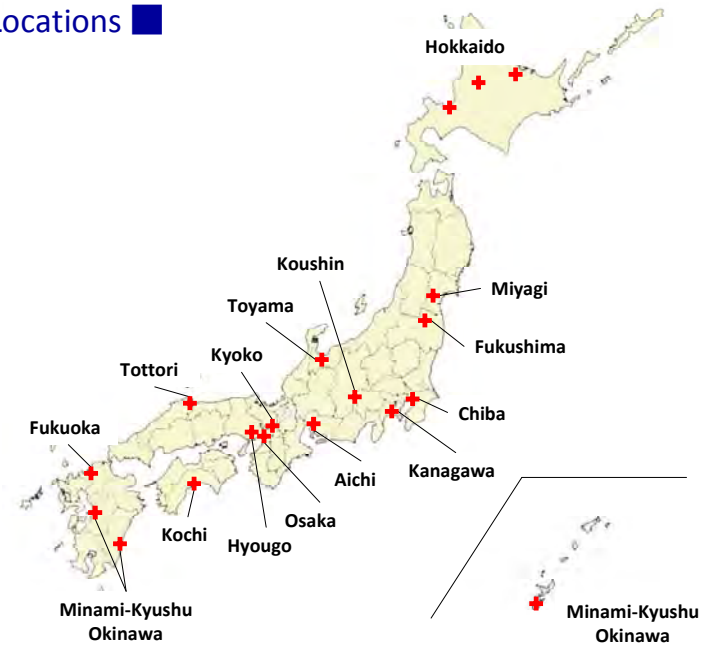
However, we acquired non-uniform images in high fields owing to a lack of homogeneity of the transmission and reception RF field maps of the human brain, so we developed a method for correcting for this non-uniformity. In our method, the reception field is calculated as a product of the transmission field and a ratio map, which can be applied for each subject. This year we developed a method of obtaining this ratio map more accurately. By using this method, we were able to calculate an [Fe] map of the human brain by using the abovementioned relationship $R_2^\dagger = \alpha[Fe] + \beta f_M + \gamma$.

In a study of the health effects of organic arsenic in experimental animals, we examined the toxicity of diphenylarsenic acid (DPAA) administered daily to mice. We examined the mice's behavior and the amounts of various molecules involved in cerebellar functions. The results of the behavior tests indicated that DPAA selectively inhibited coordinated motor abilities. In the animals' cerebellums, the amounts of $pGluR2^{ser880}$ and GluRδ increased, whereas the amount of GAD65/67 decreased, suggesting that DPAA affects neurotransmission by glutamate and gamma aminobutyric acid (GABA) and that such changes in neurotransmission by glutamate and GABA in the cerebellum are involved in the behavioral effects of DPAA. By developing a highly sensitive new analytical method of sampling with microdialysis followed by liquid chromatography MS-MS analysis, we were able to detect rapid increases and gradual decreases in DPAA levels within the brain tissues of a mouse after it had ingested DPAA-containing water. The data clearly showed that DPAA rapidly entered the brain tissues via the blood-brain barrier after ingestion.

We found that dragonflies were useful bioindicator organisms for monitoring environmental levels and identifying major emission sources of perfluorosurfactants, notably PFOS (perfluorooctane sulfonate), in the terrestrial environment. By careful examining PFOS levels in dragonflies after emergence, we found that mature males of several common species may have comparable accumulation capability and thus may be used together for terrestrial monitoring.

# Environmental Health Sciences Division

## Study Locations




The Japan Environment and Children's Study (JECS), which is a birth cohort study of 100 000 children, was launched in January 2011 at 15 regional Unit Centers.

The JECS is led by the National Institute for Environmental Studies, which acts as the National Core Center. The National Center for Child Health and Development participates as the Medical Support Center, contributing medical knowledge to support the study. The National Core Center is conducting the study in cooperation with regional Unit Centers recruited or selected through public advertising. Regional Unit Centers have been established by universities and/or research institutions at 15 locations nationwide. The regional centers provide local recruiting grounds and are responsible for conducting follow-up.

The mission of the Environmental Health Sciences Division is to study the potential effects of environmental chemicals (e.g., endocrine-disrupting chemicals, dioxins, arsenite, phthalate plasticizers, metals, and air pollutants) and physical agents (e.g., heat stress) on human health. We aim to use the information as a scientific basis for the risk assessment of these agents, alone or in combination with other factors, including allergens. We perform both epidemiological and experimental studies. In the latter, we use laboratory animals as experimental models, and we use organs and cells to elucidate the mechanisms underlying toxicities. In particular, we are interested in hypersensitive populations that are susceptible to the harmful effects of environmental stress. Below, we highlight our progress in several study areas.

In the **Molecular Toxicology Section,** we have been studying the effects of environmental chemicals on biological and physiological functions and the molecular mechanisms of these effects. In terms of molecular mechanisms, our recent focus has been particularly on epigenetic effects, such as DNA methylation changes and histone modifications.

In FY 2010, we studied the effects of maternal arsenite exposure in C3H mice. We found that maternal arsenite exposure causes an increase in body weight and high blood glucose with insulin resistance in male pups at about 1 year old. We also found that maternal arsenite exposure induces expression changes in several genes in the livers of the male pups in a late-onset manner. The relationship between the metabolic changes and the changes in expression of genes in the liver is under investigation.

Male C3H mice are prone to hepatic cancer. Previous studies by others and us have shown that maternal exposure to arsenite increases the incidence of hepatic cancer. To explore epigenetic markers for detecting the specific effects of arsenic in causing cancer, we conducted a methylated DNA immunoprecipitation-array assay and methylation-specific PCR on normal and cancerous tissues from the livers of male control mice and mice maternally exposed to arsenite. We detected regions where DNA methylation status was changed in the cancer tissues compared with that in the normal tissues. Further studies are in progress to identify in detail the regions where DNA methylation status differs between cancer tissues from arsenite-exposed pups and from control pups.

Both arsenic intake and a diet deficient in methionine and choline (MCD diet) are reported to cause oxidative stress. Oxidative stress causes DNA damage, which is commonly assessed as an increase in the amount of 8-hydroxy-2’-deoxyguanosine (8OHdG). DNA methylation occurs at cytosine residues and produces 5-methylcytosine (5meC). To determine the relationship between oxidative stress and altered DNA methylation status, we measured the amounts of 8OHdG and 5meC in the livers of C57BL/6 mice fed a control diet or an MCD diet with or without drinking water containing arsenite. The MCD diet with or without arsenite increased hepatic 8OHdG levels and reduced 5meC levels, and the two factors were significantly negatively correlated. These results suggest that oxidative stress affects DNA methylation status through oxidative DNA damage.

Toward the establishment of a highly sensitive system to detect the negative impact of environmental chemicals on intelligence in animal models, we developed a behavioral flexibility test in mice by using an IntelliCage (NewBehavior AG, Zurich, Switzerland) (Figure 1), which enables us to measure spatial learning ability under group-housing conditions.

We also used a ChIP on chip (chromatin immunoprecipitation on chip) method to perform a genome-wide analysis of the arylhydrocarbon receptor (AhR) binding regions in the livers of mice exposed to dioxins. Further study to accumulate data on the AhR binding region in various tissues will be important in helping us to understand the mechanisms of tissue-specific toxicity of dioxin in more detail.

Diphenylarsinic acid (DPAA) was detected in well water in the city of Kamisu in Ibaraki Prefecture, Japan, in 2003. We examined the distribution and biliary excretion of DPAA and its metabolites in rats given DPAA orally (Figure 2). DPAA was excreted mainly as the chemical form DPAA-glutathione (GSH) complex in bile. The hydrolyzed products of DPAA-GSH may be more toxic than DPAA (Figure 3).

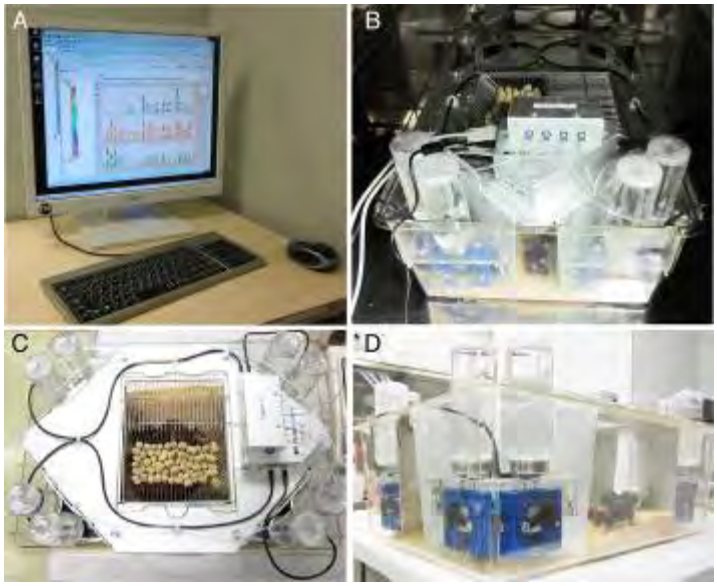



**Fig. 1** IntelliCage, a system dedicated to the automated assessment of mouse behavior for toxicological testing. A: Computer used to contro the IntelliCage. B: The IntelliCage. C: Top view, demonstrating that the IntelliCage provides four programmable operant corners. D: A corner at high magnification.

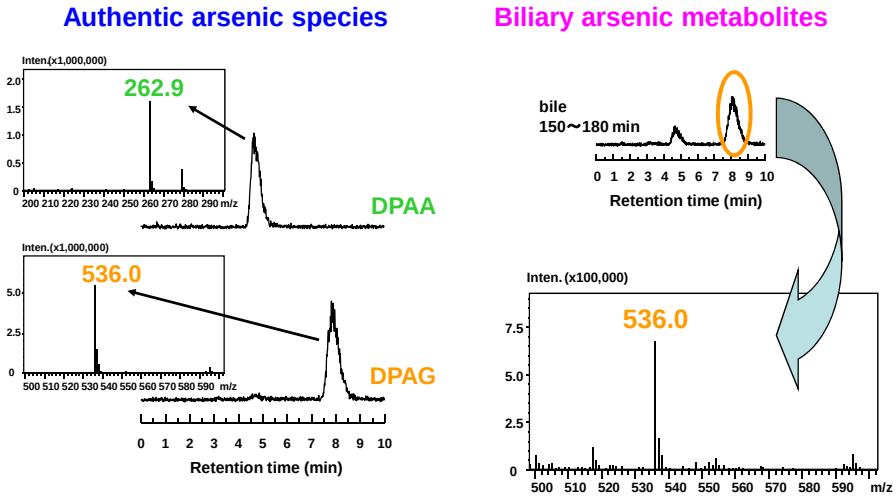



**Fig. 2** Molecular speciation of arsenic compounds in bile.

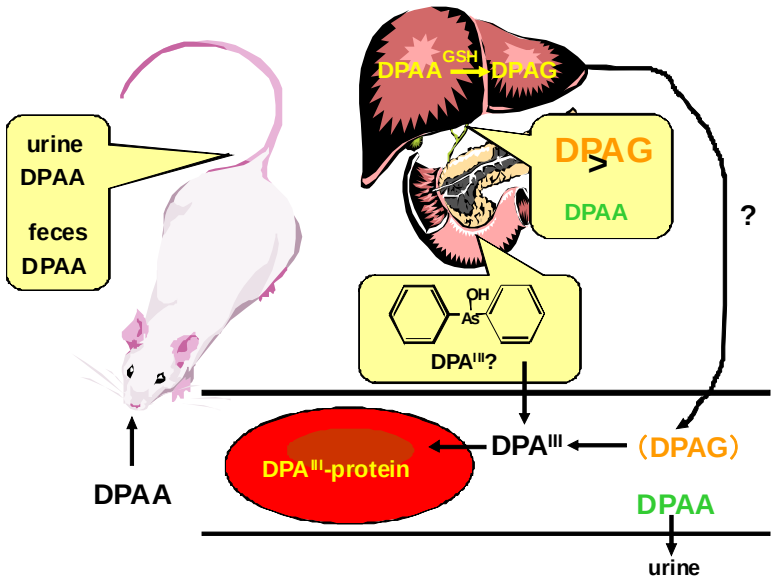



**Fig. 3** Speculated metabolic pathway of DPAA.

In the **Biological Risk Assessment Section**, we have been studying how environmental pollutants affect immune systems. In our *in vivo* studies, we have been investigating the effects of environmental pollutants such as chemicals and air pollutants on preexisting sensitivity disorders such as allergic diseases and inflammatory lung diseases. In our *in vitro* studies, we have been assessing the effects of environmental pollutants on immune cells, including antigen-presenting cells and lymphocytes, and on epithelial cells. In 2010, we obtained some interesting and substantial findings:

1) Intratracheal exposure to benzo[a]pyrene exaggerates allergic airway inflammation in a murine model (Figure 4). The enhancing effects may be accounted for by T-helper type 2 (Th2)-biased immune responses.
2) Oral exposure to γ-benzene hexachloride, an organochlorine pesticide, during childhood exaggerates allergic airway inflammation in female mice, but not in male mice. The enhancing effects may be accounted for by Th2-biased immune responses.
3) Peroxiredoxin I, a ubiquitous antioxidant enzyme, initiates acute lung injury following ozone exposure in mice via the expression of inflammatory molecules.
4) *In vitro* exposure to di-(2-ethylhexyl)phthalate and diisononyl phthalate stimulates the expression of genes associated with immunological reaction and biological defense in mouse bone marrow–derived dendritic cells (BMDCs).
5) *In vitro* exposure to quinoid or hydroxylated polycyclic aromatic hydrocarbons (PAHs) as ambient particulate matter components induces inflammation-related activation of mouse immune cells (splenocytes and BMDCs) and human bronchial epithelial cells, although the effects of phenanthrene and naphthalene as basic structures are weak (Figure 5). The biological effects of PAHs may be related to aspects of chemical structure such as functional groups and isomers.
6) *In vitro* exposure to brominated flame retardants induces the production of inflammatory cytokines and the expression of mucin-1 in human bronchial epithelial cells.

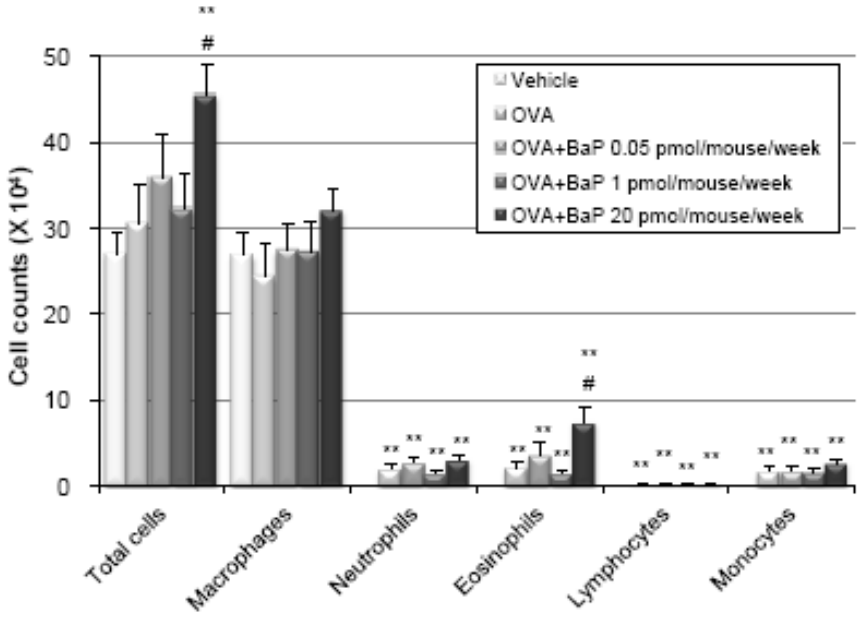



**Fig. 4** Cellular profiles of bronchoalveolar lavage fluid following exposure of mice with allergic airway inflammation to benzo[a]pyrene (BaP). ** $P < 0.01$ vs. vehicle group; # $P < 0.05$ vs. OVA group. Data are the mean ± SEM of 15 or 16 animals per group.

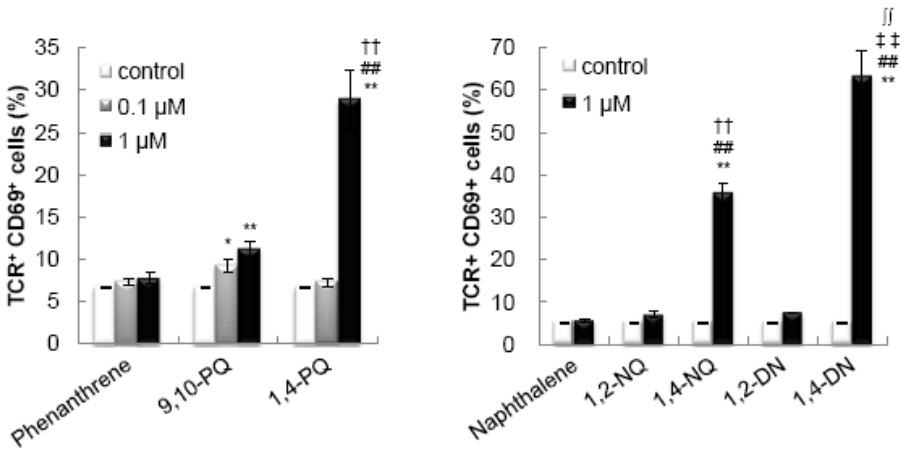



**Fig. 5** Expression of T cell activation markers TCR and CD69 on mouse splenocytes after exposure to phenanthrene, naphthalene and their derivatives. Left panel: *p<0.05, **p<0.01 vs. control; ##p<0.01 vs. Phenanthrene; ††p<0.01 vs. 9,10-Phenanthrenequinone (PQ). Right panel: **p<0.01 vs. control; ##p<0.01 vs. Naphthalene; ††p<0.01 vs. 1,2-Naphthoquinone (NQ); ‡ ‡p<0.01 vs. 1,4-NQ; ∬p<0.01 vs. 1,2-Dihydroxynaphtalene (DN). Data are the means ± SEM of three individual cultures from three animals and are representative of two independent experiments.

The **Integrated Health Risk Assessment Section** conducts epidemiological and experimental research with the financial support of the Japan Society for the Promotion of Science (JSPS) and the Ministry of the Environment (MOE).

We continued an epidemiological study of male and female university students in the city of Wuhan, China. The $PM_{2.5}$ concentrations that we measured with personal samplers inside and outside their dormitories over four seasons were highly correlated. $PM_{10}$ concentrations measured outside the closely dormitories were correlated with, but did not precisely match, the concentrations calculated from the air pollution index measured at the nearest municipal monitoring station. We analyzed the carbon content in $PM_{10}$ samples collected at the same time and found more total carbon (TC) in $PM_{2.5}$ than in $PM_{10–2.5}$ in all seasons, both indoors and outdoors. We also found that the percentage of elemental carbon in the TC in $PM_{2.5}$ was higher outdoors than indoors in all seasons, as has been found in Beijing.

We engaged in research conducted by MOE on short-term morbidity and mortality in relation to air pollution, as well as an epidemiological study of traffic-related air pollution exposure and respiratory health.

The Japan Environment and Children's Study (JECS), which is a birth cohort study of 100 000 children, was launched in January 2011. NIES is the national center for the study; as the scientific lead office we hold seminars, participate in committees, and perform monitoring work during the year.

The **Environmental Epidemiology Section** has been engaged in epidemiological studies of the health effects of environmental exposure. Listed below are the projects with which we have been involved and the findings of the analyses.

We are working with projects organized by MOE to assess the health effects of air pollutants; in one of these projects a proposal has been formulated for an

epidemiological study to examine the effects of air pollutants on children's pulmonary function. We also conducted a reanalysis of the short-term effects of air pollutants on mortality, using data from 20 cities in Japan. In this reanalysis, the period of study was extended from 3 years (2002–2004) to 6 years (2002–2007).

We have also been involved with the Study On Respiratory disease and Automobile exhaust (SORA) project organized by MOE since 2005 to examine the adverse effects of traffic-related air pollution on respiratory health. In the SORA project we are using a newly developed model to estimate each participant's exposure to traffic air pollutants (elemental carbon and nitrogen oxides) on the basis of traffic volumes, vehicle emission rates, meteorological conditions, types of road construction, and distance to roadways. We have also applied a two-stage case-control design to evaluate the exposure–effect relationship.

There has been increasing concern about the health effects of exposure to Asian dust aerosols and related air pollutants. A literature review that we performed indicated that evidence was limited in Japan and Asia. In a study conducted in Fukuoka, we found that an increase in suspended particulate matter was associated with increased asthma hospitalization of children (Figure 6).

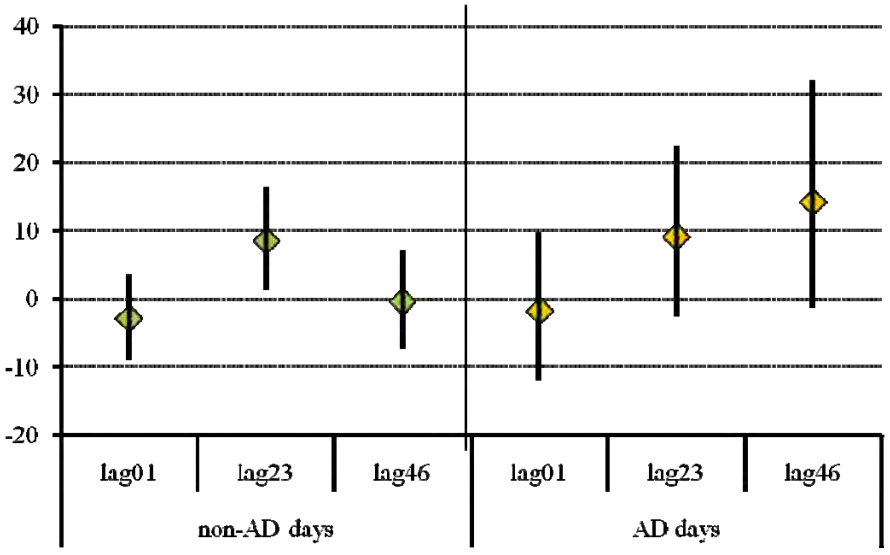



**Fig. 6** Percent change (with 95% confidence intervals) in relative risk of asthma hospitalization per interquartile range (19.9 μg/m$^3$) increase in mean suspended particulate matter concentration during lag 0 to lag 1 (lag 01), during lag 2 to lag 3 (lag 23), and during lag 4 to lag 6 (lag46) for non-Asian dust (non-AD) days and Asian dust (AD) days.

The **Planning and Coordination Office** and the **Data Management and Analysis Office of the Children's Environmental Health Study** have played key roles in the JECS. In FY 2010, these offices began preparing standard operating procedures for participant recruitment; facilities/equipment/personnel for transport, storage, and management of collected data and specimens; support for regional Unit Centers; a system of communication between the Centers and participants; and various advertisements. JECS is a nationwide newborn cohort study that involves the recruitment of women in early pregnancy and follow-up of their children until the age of 13. The goal of the study is to help us to understand the roles of various environmental factors in children's health and development.

# Atmospheric Environment Division

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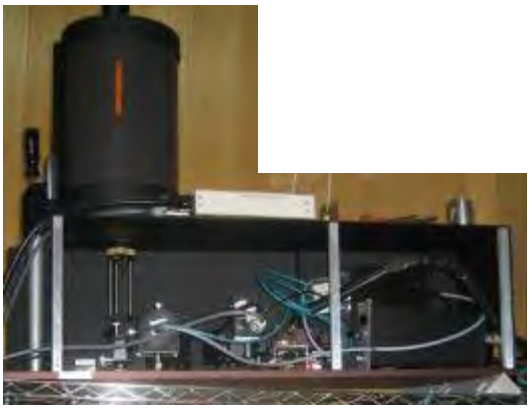
(II)



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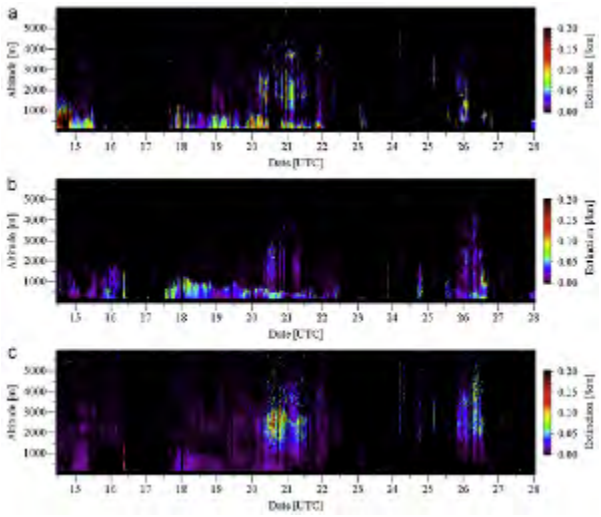


(I) Research Vessel (RV) *Mirai* of the Japan Agency for Marine-Earth Science and Technology Center
(II) NIES Mie-scattering lidar installed on RV *Mirai*
(III) Time–height cross-sections of (a) water-soluble particles, (b) sea-salt particles, and (c) dust retrieved from aerosol data measured in the *Mirai* observations.

(Photos: T. Nishizawa)

The aim of the Atmospheric Environment Division's research is to understand and solve atmospheric environmental problems ranging from urban air pollution to trans-boundary and global issues. The Division consists of four sections: the Atmospheric Physics Section, which conducts research on numerical modeling and data analysis of atmospheric dynamics and climate systems; the Atmospheric Remote Sensing Section, which studies the atmospheric environment by using remote-sensing techniques such as lidar (laser radar); the Atmospheric Chemistry Section, which conducts research on the temporal and spatial distributions and reactions of reactive organic compounds in the atmosphere; and the Atmospheric Measurement Section, which conducts field research on natural and anthropogenic trace species. Observation of ozone-depleting species and the polar stratospheric cloud over Antarctica is being tackled independently. Many of the members of this Division also work for Priority Research Programs such as the Climate Change and Asian Environment programs.
Following are brief accounts of some of the important results of our research in FY 2010.

**Future changes in tropospheric ozone under Representative Concentration Pathways**

Recently, a new set of emission and concentration scenarios called "Representative Concentration Pathways" (RCPs) was released for phase 5 of the Coupled Model Intercomparison Project (CMIP5) in the World Climate Research Programme. The RCPs have four scenarios, each of which corresponds to a specific pathway for reaching a target in 2100 for radiative forcing (RF) due to long- and short-lived greenhouse gases (GHGs). The target RFs are 2.6, 4.5, 6.0, and 8.5 $W/m^2$ for the RCP2.6, RCP4.5, RCP6.0, and RCP8.5 scenarios, respectively. These new scenarios employ different $O_3$ precursor emissions and a wider range of GHG concentration pathways compared with the previous scenarios. We evaluated future changes in tropospheric $O_3$ concentrations under the RCP scenarios by using a chemistry–climate model, CHASER, and analyzed the factors causing them.
Under RCP2.6, $O_3$ precursor reductions would contribute substantially to the decrease in tropospheric $O_3$ concentrations; the global annual mean tropospheric column $O_3$ (TCO) in 2100 would be 3.5 Dobson units (DU) lower than that in 2005 (Figure 1). Under RCP4.5 and RCP6.0, increased stratosphere–troposphere (STE) exchange due to changes in the residual circulation, together with $O_3$ precursor reductions, affect the changes in tropospheric $O_3$ concentration. Because these effects and the additional effect of stratospheric $O_3$ recovery roughly compensate for each other, RCP4.5 and RCP6.0 show similar TCO levels in 2100 to that in 2005 (Figure 1). However, two maxima of $O_3$ reduction exist near the surface in the Northern Hemisphere and around the tropical tropopause because of enhanced STE, the moistening of air, and emission reductions. In contrast, RCP8.5 shows a substantial increase in tropospheric $O_3$; the global annual mean TCO in 2100 is 6.3 DU higher than that in 2005 (Figure 1). The enhanced residual circulation causes a large increase in $O_3$ concentration in the

middle and upper troposphere, and an increase in $CH_4$ concentration plays a vital role in the dramatic increase in $O_3$ levels in the entire troposphere. Hence, a $CH_4$ control strategy is essential to reduce both tropospheric $O_3$ and $CO_2$ levels.

Stratospheric $O_3$ recovery, which affects the future changes in tropospheric $O_3$, is influenced by the concentrations of both GHGs and ozone-depleting substances. Compared with our stratospheric $O_3$ dataset, the standard CMIP5 stratospheric $O_3$ dataset (http://pcmdi-cmip.llnl.gov/cmip5/forcing.html), which includes the impact of GHGs, shows a decrease in lower-stratospheric $O_3$ concentration in the tropics and an additional increase in lower-stratospheric $O_3$ concentration in the mid-latitudes in 2100. This indicates that the changes in STE and tropospheric $O_3$ level would become larger than in our results if we were to employ the CMIP5 stratospheric $O_3$ dataset. In addition, because the interplay among climate change, stratospheric $O_3$ recovery, and tropospheric $O_3$ is highly complex, a multi-model study involving more comprehensive models, such as coupled ocean–atmosphere global climate models including stratospheric and tropospheric chemistry processes, would be needed to explore this issue further.

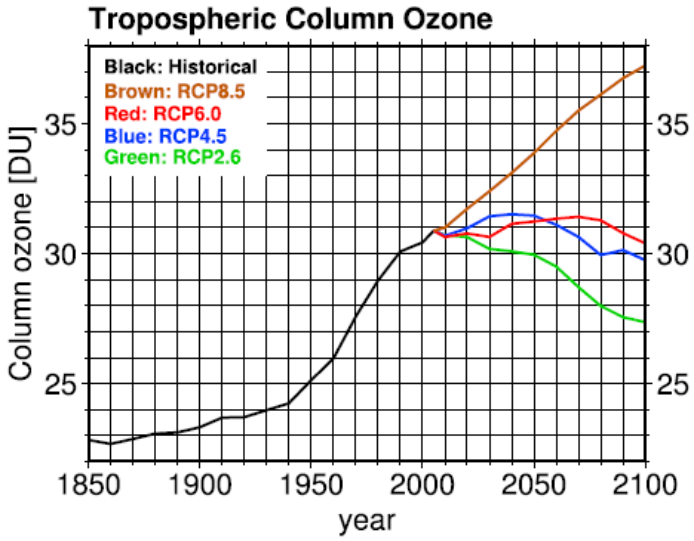



**Fig. 1** Temporal evolutions of tropospheric column $O_3$, calculated by using a chemistry-climate model for the troposphere, CHASER.

## Development and validation of an air pollution forecast system

In conjunction with the Asia Environmental Research Group, we developed the air pollution forecast system VENUS (Visual atmospheric ENvironment Utility System). VENUS calculates concentrations of nitrogen dioxide and photochemical oxidants for the current day and the following day automatically every night; it then displays maps of the concentrations every morning on a web. The system consists of an integration of the meteorological model RAMS (Regional Air Quality Model System) and the air quality model CMAQ (Community Multiscale Air Quality).

The photochemical-oxidant reproducibility of VENUS was verified. The distributions of the concentration and time changes in several prefectures were investigated for a wide-ranging high-oxidant-concentration event that occurred in

Japan in May 2009. The distribution, as well as the movement of the high-concentration area, was reproduced well.
We also investigated skill scores, such as correlation coefficients, between the simulated and observed values in May and August of the same year, using the hourly averaged concentration of photochemical oxidants and the daily top 5% concentration in each prefecture. The correlation coefficient for the top 5% concentration was particularly high.
These validation results demonstrated that VENUS is sufficiently accurate to be helpful in predicting the daily highest photochemical-oxidant concentration in each prefecture in Japan.

**Algorithms for retrieving the optical properties of three component aerosols from two-wavelength backscatter and one-wavelength polarization lidar measurements considering the nonsphericity of dust**

We developed backward and forward types of algorithm for estimating the vertical profiles of extinction coefficients at a wavelength of 532 nm for three component aerosols (water-soluble, dust, and sea salt) by using three-channel Mie-scattering lidar data with backscatter ($\beta$) at 532 and 1064 nm and a depolarization ratio ($\delta$) of 532 nm. Whereas the water-soluble and sea-salt particles were reasonably assumed to be spherical, the dust particles were treated as randomly oriented spheroids to account for their nonsphericity. The introduction of spheroid models enabled us to more effectively use three-channel data (i.e. $2\beta+1\delta$ data) and to reduce the uncertainties caused by the assumption of dust particle sphericity in our previously developed algorithms. We also performed an extensive sensitivity study to estimate retrieval errors. The study showed that the errors in the extinction coefficient for each aerosol component were smaller than 30% (60%) for the backward (forward) algorithm when the measurement errors were ±5%. By applying the algorithms to shipborne lidar data, we demonstrated the ability of the algorithms to partition aerosol layers consisting of three aerosol components. The optical thickness and Angström exponent of the aerosols, retrieved by using the algorithms that we developed, agreed well with the sky radiometer measurements (Figure 2).

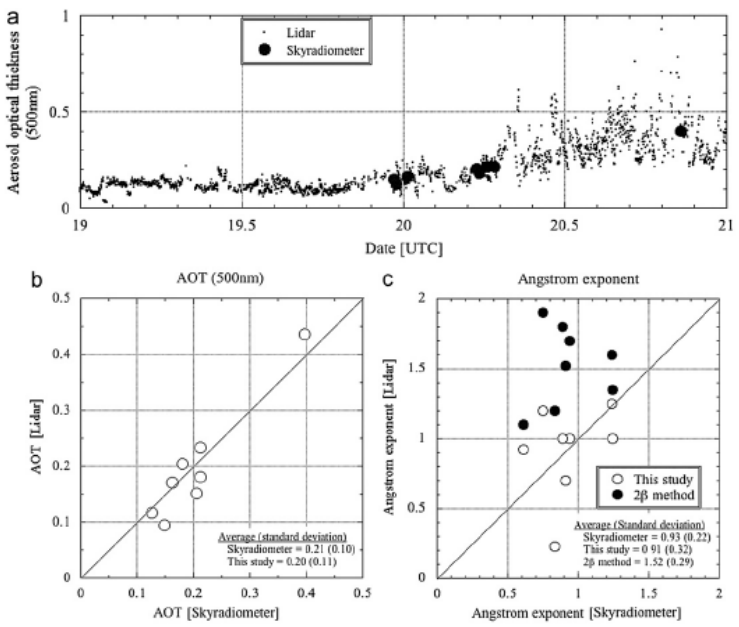



**Fig. 2** Comparison of aerosol optical thickness (AOT) at 500 nm and the Angström exponent, retrieved from lidar measurements by using the forward algorithm, with those obtained from sky radiometer measurements. (a) Temporal distribution of AOT. (b) AOT retrieved from lidar measurements vs. AOT obtained from sky radiometer measurements. (c) Angström exponent retrieved from lidar measurements vs. that obtained from sky radiometer measurements. The values of the Angström exponent estimated by using the 2 method are also presented in (c).

**Application of an equilibrator inlet-proton transfer reaction mass-spectrometry method for detection of DMS dissolved in seawater**

We developed an equilibrator inlet – proton transfer reaction – mass spectrometry (EI-PTR-MS) method for fast detection of dimethyl sulfide (DMS) dissolved in seawater. Dissolved DMS was extracted into DMS-free carrier gas (ultrapure $N_2$). The carrier gas and the sample seawater stream in the equilibrator flowed in opposite directions, and part of the extracted gas was continuously directed to the PTR-mass spectrometer at ambient pressure without pretreatment. The equilibration of DMS between seawater and the carrier gas, and the response time of the system, were evaluated in the laboratory. DMS reached equilibrium with an overall response time of 1 min. DMS in the sample gas was ionized by proton-transfer reactions in the drift tube of the PTR-mass spectrometer, because of the higher proton affinity of DMS (198.6 kcal $mol^{-1}$) than that of $H_2O$ (165.2 kcal $mol^{-1}$):

$$H_3O^+ + CH_3SCH_3 \rightarrow CH_3SCH_3 \cdot H^+ + H_2O$$

The detection limit (50 pmol $L^{-1}$ at 5 s integration) was sufficient for detection of DMS concentrations in the open ocean.

The EI-PTR-MS instrument was deployed during a research cruise in the western North Pacific Ocean. Comparison of the EI-PTR-MS results with the results obtained by means of membrane tube equilibrator – gas chromatography/mass spectrometry (ME-GC/MS) revealed that they agreed reasonably well on average. Furthermore, EI-PTR-MS succeeded in capturing the large temporal variations in dissolved DMS concentrations in surface seawater (Figure 3), including peaks associated with patches of high biogenic activity. These results demonstrated that the EI-PTR-MS technique was effective for highly time-resolved measurement of DMS in the open ocean. Further measurements will improve our understanding of

the biogeochemical mechanisms of production, consumption, and distribution of DMS on the ocean surface and, hence, the air–sea flux of DMS, which is a climatically important species.

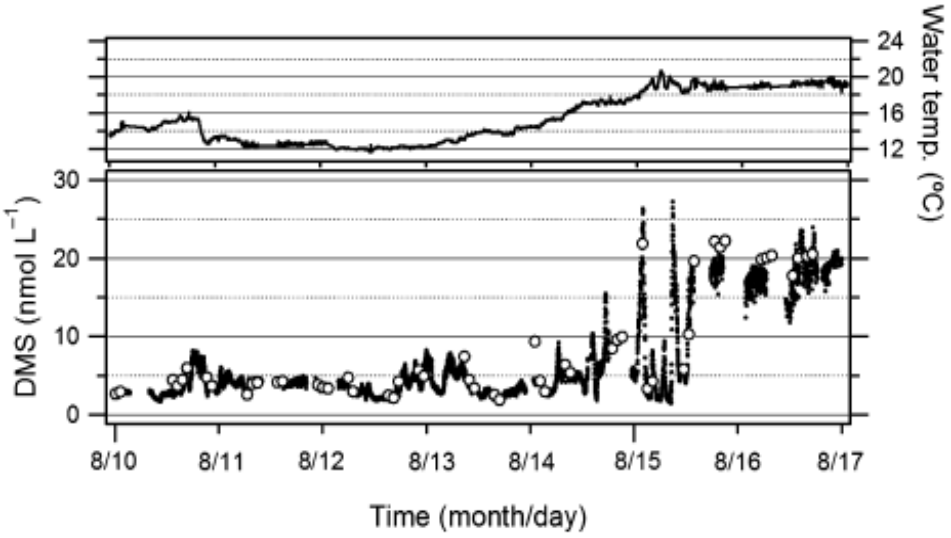



**Fig. 3** Example of temporal variation in concentration of dimethyl sulfide (DMS) dissolved in surface seawater, together with surface seawater temperature, during the SPEEDS/SOLAS 2008 cruise. EI-PTR-MS data collected at 5-s integration were plotted at 1-min intervals (●) and overlaid with ME-GC/MS data (○).

**Analysis of $\Delta O_2/\Delta CO_2$ ratios in pollution events observed at Hateruma Island, Japan**

In-situ observations of atmospheric $CO_2$ and $O_2$ concentrations at Hateruma Island (24ºN, 124ºE) often show synoptic-scale pollution events when air masses are transported from East Asian source regions. We calculated the regression slopes ($-\Delta O_2/\Delta CO_2$ molar ratios) of the correlation plots between $O_2$ and $CO_2$ for selected pollution events observed between October 2006 and December 2008. The observed $-\Delta O_2/\Delta CO_2$ ratios varied from 1.0 to 1.7. Categorizing the air mass origins of the pollution events by using back trajectory analysis, we found that there was a significant difference in the average $-\Delta O_2/\Delta CO_2$ ratios between events from China (1.14±0.12, $n$ = 25) and Japan/Korea (1.37±0.15, $n$ = 16). These values are comparable to the $-O_2$:$CO_2$ molar exchange ratios, which are estimated from the national fossil fuel inventories from CDIAC (the Carbon Dioxide Information Analysis Center in the USA). Simulations using a particle dispersion model revealed that the pollution events at Hateruma Island are predominantly $CO_2$ emissions from the combustion of fossil fuels in East Asian countries; this is consistent with the above observational results. Although the average value of the model-predicted $-\Delta O_2/\Delta CO_2$ ratio of Japan/Korea origin was underestimated in comparison with the observed value, that of Chinese origin agreed well with the observed value. The results of the sensitivity experiment suggested that the $-\Delta O_2/\Delta CO_2$ ratio at Hateruma Island reflects about 90% of the change in the $-O_2$:$CO_2$ exchange ratio for fossil carbon emissions from China.

# Water and Soil Environment Division

Collaborative study in Southeast Asia to develop appropriate organic wastewater treatment technology


(a) An anaerobic lagoon system used for treatment of vinasse (bioethanol distillery wastewater). Such treatment ponds cause both pollution of the aquatic environment and emission of greenhouse gases.


(b) Proposed methane fermentation system operating at Khon Kaen University, Thailand. Methane energy can be recovered by this system during the treatment of vinasse. Also, effluent water quality maintained satisfactory.

(c) and (d) Use of treated vinasse as fertilizer for sugarcane. (c) Investigation of growth of sugarcane by fertilization of treated vinasse; (d) Field measurement of greenhouse gases emitted from soil.


The Water and Soil Environment Division uses a variety of approaches to study the environmental pollution and ecological changes that occur via the media of water and soil. This research includes the long-term monitoring of rivers, lakes, and coastal seas to assess these changes, and the development of technologies to mitigate environmental deterioration.

**Effect of redox mediators in microbial arsenic mobilization**

One of the tasks of the **Water Quality Science Section** is to develop novel, environmentally benign remediation techniques for water and soil pollution. Arsenic (As) has become one of the most prevalent soil contaminants, and its remediation has therefore become an important environmental concern. The main techniques currently available for the treatment of As-contaminated soils are containment and solidification/stabilization, but these are expensive and require long-term monitoring and management to prevent leaching.

Anaerobic microbes can play an important role in As mobilization from soils and sediments by both reduction of arsenate (As(V)) to mobile arsenite (As(III)) and reductive dissolution of the Fe(III) (hydr)oxides associated with As (Figure 1). This mobilization can be an important route of contamination of the aquatic environment. However, under well-controlled conditions, it might be possible to use these microbial processes to remove As from contaminated soils.

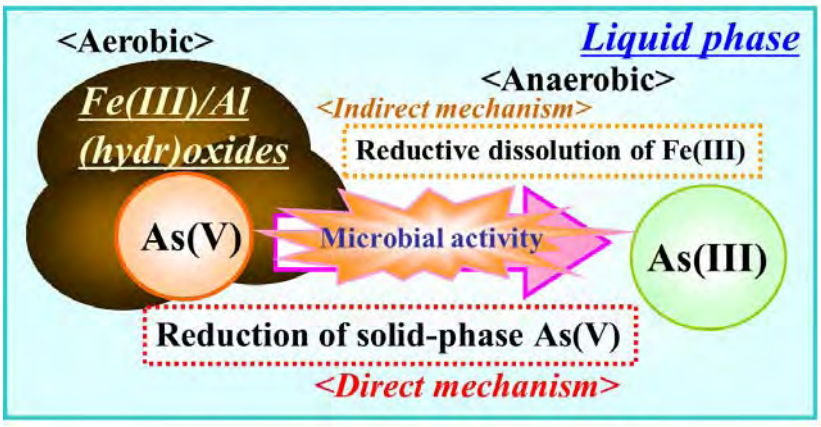



**Fig. 1** Proposed mechanisms of As mobilization by anaerobic microbes. Direct mechanism: As(V)-reducing bacteria mediate As(III) dissolution from either Fe(III) or Al minerals via reduction of As(V) to less adsorptive As(III). Indirect mechanism: Fe(III)-reducing bacteria mediate As(V) dissolution from Fe(III) minerals via reduction of Fe(III) to soluble Fe(II). As(V) mobilized via the indirect mechanism is also reduced to As(III) by As(V)-reducing bacteria in the liquid phase.

Our previous study revealed that a synthetic redox mediator, anthraquinone-2,6-disulfonate (AQDS), could accelerate As mobilization catalyzed by dissimilatory As(V)-reducing bacteria (DARB) via enhanced reduction of solid-phase Fe(III). In this study, we compared the abilities of redox active vitamins as alternatives to AQDS in increasing rates of microbial As mobilization. The rate and extent of DARB-mediated As mobilization was much greater in the presence of riboflavin than without it (Figure 2), but cobalamin had no noticeable effect. In contrast, when similar experiments were conducted with non-As(V)-reducing bacteria, very little As mobilization occurred (Figure 2),

whereas addition of riboflavin greatly enhanced reductive dissolution of Fe(III). The results suggest that simultaneous use of DARB and riboflavin could be a desirable strategy for effective removal of As from contaminated soils.

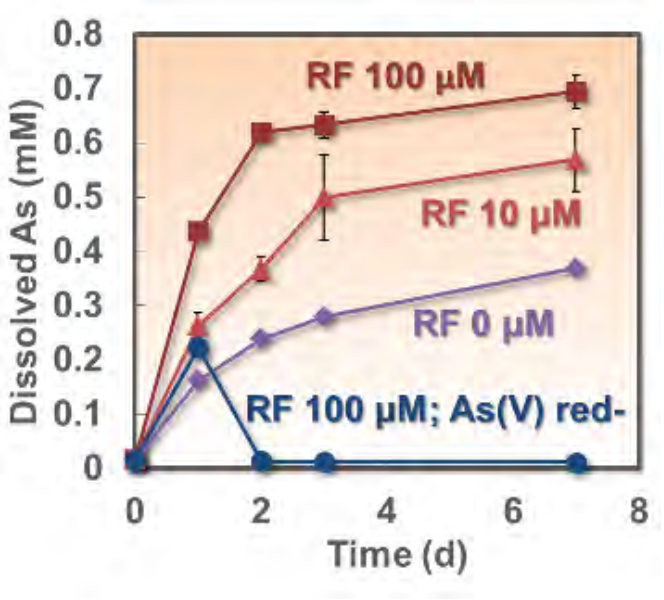



**Fig. 2** Mobilization of As from As(V)-laden Fe(III) precipitates. Liquid cultures containing solid-phase As(V) and Fe(III) were incubated with a well-characterized DARB, *Bacillus selenatarsenatis*. Symbols represent concentrations of As dissolved into solution in the presence of riboflavin (RF) at various concentrations. Identical cultures were also incubated with *Bacillus jeotgali*, which is unable to reduce As(V) [As(V) red in the diagram], in the presence of 100 µM RF.

**Distribution pattern of dissolved carbohydrate in the bottom sediments of Lake Kasumigaura**

One of the studies being performed by the **Lake Environment Research Section** is a detailed evaluation of the distribution patterns of dissolved carbohydrate (DCHO) in the water and sediment-pore water of Lake Kasumigaura. DCHO is the most abundant fraction chemically identifiable in freshwater dissolved organic matter (DOM), and it functions as a carbon source for bacterial activity in aquatic systems. The biogeochemical fate of DCHO in the aquatic environment is an important issue and needs to be understood to ensure the soundness of freshwater ecosystems and the security of water resources. We found a substantial change in the depth profile of the carbohydrate content of the sedimentary pore water DOM (described here as the DCHO yield) between 2005 and 2007 (Figure 3a). In the first half of 2005, sediments with high DCHO yields were limited to within 2 cm of the surface. However, the high-yield depth expanded downward from July 2005 until June 2006 and then vanished rapidly. The increase in DCHO yield in the lower layer of the pore water suggests that glycolysis of sedimentary organic matter occurred, leading to the leaching of large amounts of water-soluble carbohydrates. This pattern of carbohydrate consumption in the lake sediments is likely to promote upward motion of the oxic–anoxic interface and thus contribute to substantial discharge of nutrients, such as nitrogen and phosphorus, into the bottom water of the lake (Figure 3b, c). Notably, the release and consumption of DCHO occurred not gradually but suddenly.

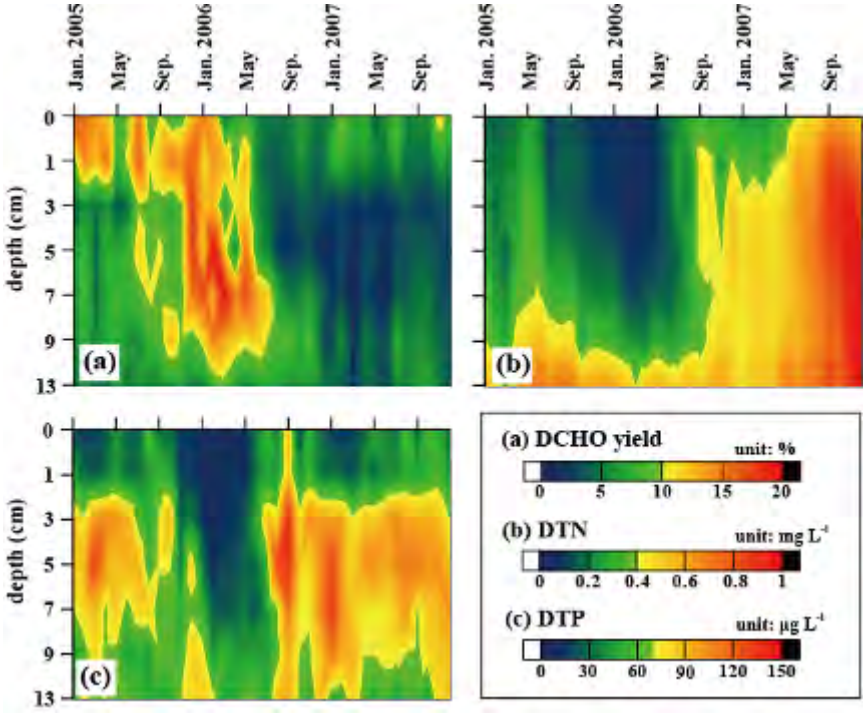



**Fig. 3** Distributions of (a) DCHO yield; (b) dissolved total nitrogen (DTN) concentration; and (c) dissolved total phosphorus (DTP) concentration as a function of depth and time in the bottom sediments of Lake Kasumigaura. DCHO yield is given as % of dissolved organic carbon.

**What made the clam *Meretrix lusoria* (*hamaguri*) disappear from Tokyo Bay?**

One of the tasks of the **Marine Environment Section** is to find ways to restore or recover coastal environments in terms of the species that characterize them. The clam *Meretrix lusoria*, which lives in the sandy sediments of tidal flats, used to be an important fishery resource in parts of Japan, such as Ariake Sound and Tokyo Bay. However, the catch of this species has declined dramatically since the 1970s, and the natural population in Tokyo Bay has almost entirely disappeared. We suspected that deterioration of the coastal environment (e.g., from frequent intrusions of hypoxic waters into the tidal flats) caused this disappearance. To confirm this scenario, we caged *M. lusoria* collected from Ariake Sound, as well as other clam species (*Ruditapes philippinarum* [*asari*], *Mercenaria mercenaria* [*quahog*], and *Mactra veneriformis* [*shio-fuki*], all abundant species in Tokyo Bay), on a hypoxia-prone tidal flat in Tokyo Bay (Figure 4). We then monitored the survival and growth of the clam species. Contrary to our expectation, the survival rate of *M. lusoria* was higher than that of *R. philippinarum* and *M. veneriformis* and comparable to that of *M. mercenaria* (Figure 5) during summer–autumn, when hypoxic waters often intruded into the tidal flat. In addition, the growth rate of *M. lusoria* (assessed as the increase in shell length) was rapid (~1.5 mm month$^{-1}$). These findings indicate that the vulnerability of *M. lusoria* to unfavorable conditions was not responsible for the disappearance. We then examined the reproductive cycle of *M. lusoria* in Tokyo Bay and found that spawning occurred from late summer to early autumn. Intrusion of hypoxic waters in this period could therefore have negatively affected spawning and larval development and/or settlement, instead of adult survival, and thus could have caused a rapid decline in population through recruitment failure.

**Fig. 4** Caging experiments: clams were caged in 40 x 40 x 20-cm cages.

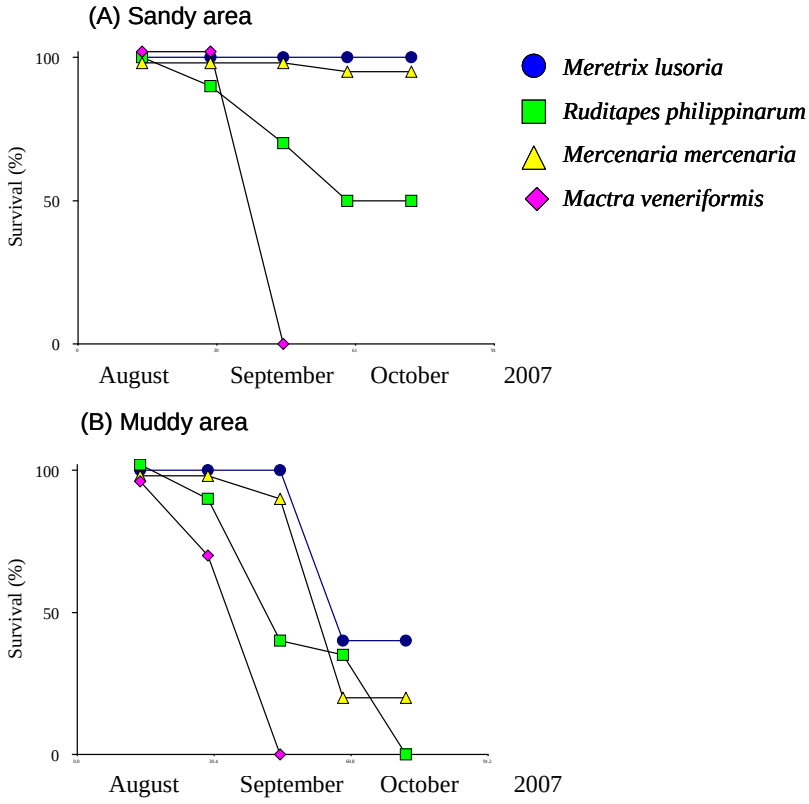



**Fig. 5** Survival of *Meretrix lusoria* and other clams in (A) sandy sediments and (B) muddy sediments.

**Effect of forest environment on nitrogen leaching in a highly nitrogen loaded mountainous area**

Under baseflow conditions, mountain streams on the margins of metropolitan regions tend to contain high concentrations of nitrate-nitrogen derived from groundwater discharge to the streams. This occurs because of the chronically high nitrogen load originating from artificial atmospheric deposition. However, it is often reported that nitrate-nitrogen concentrations are not uniformly high in every

stream and vary widely among closely located catchments in these areas. Also, in the forested area of Mt. Tsukuba, in Ibaraki Prefecture, the annual average concentrations of nitrate-nitrogen in the 40 headwater catchments range from 0.5 to 4.2 ppm under baseflow conditions. Under the assumption that these variations in nitrate-nitrogen concentration could be caused by a lack of appropriate management of the conifer plantation that covers over 50% of the forest area on Mt. Tsukuba, the **Soil Science Section** investigated the relationship between nitrogen leaching properties and the in-canopy environment formed by forest management in two small coniferous forest catchments with different nitrate-nitrogen concentrations in their baseflows (annual average concentration of nitrate-nitrogen: 1.3 ppm in catchment H and 0.50 ppm in catchment L). First, to quantitatively evaluate the in-canopy environments in these two catchments, we measured the ratio of the mean distance between stems to the mean height of the tree (relative spacing) as an index of overcrowded condition of timbers (namely, the degree of devastation of the coniferous plantation), in 10 circular plots (100 $m^2$) in catchment H and 19 in catchment L. Then, to determine the effect of the in-canopy environment on the leaching of nitrogen from the rhizosphere, we estimated the inorganic nitrogen content of the surface soil (A horizon) in every plot. Moreover, fortnightly for 2 years, we measured the concentrations of nitrate-nitrogen in leachates sampled from both catchments. With the exception of one plot in which the soil probably suffered from contamination with organic matter from the overlying O horizon at sampling, there was a significant positive correlation between the relative spacing and the inorganic nitrogen content of the A horizon (Figure 6). Also, nitrate-nitrogen concentrations in the collected leachate tended to be higher at sampling points located downstream of areas with high relative spacings. These results suggest that devastation of the coniferous plantation increases the inorganic nitrogen content of the surface soil layer and enhances the leaching of nitrate-nitrogen from the rhizosphere; this causes a rise in the nitrate-nitrogen concentration in streams under baseflow conditions.

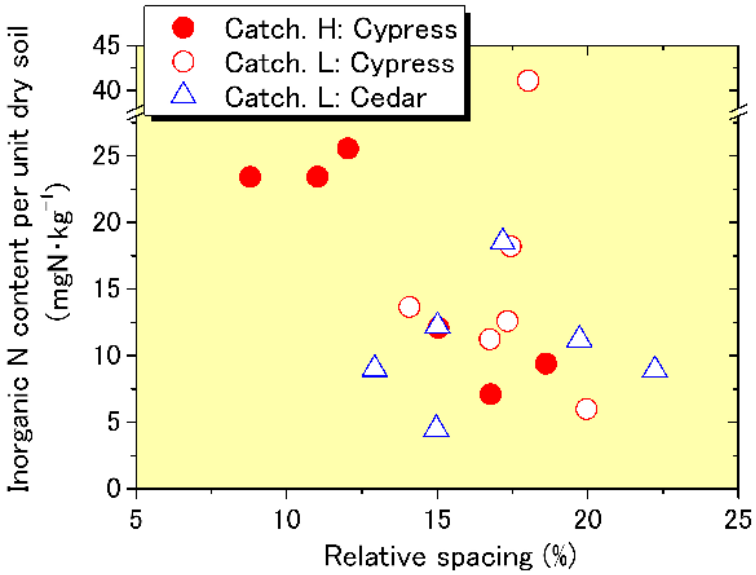



**Fig. 6** Relationship between relative spacing in forest and inorganic nitrogen content of surface soil (A horizon) in the survey plots in catchments H and L. Generally, coniferous plantations with relative spacing values lower than 17% were considered to be overcrowded because of delays in thinning.

# Environmental Biology Division

Biodiversity is the variation in living organisms on Earth. It includes variation among ecosystems, among species, and in genetic characteristics within species. We can easily see the diversity of flowering plants and animals, but biodiversity is not always so apparent. Some variations, such as those in ecosystems, are too large to observe at a glance, and some are too small to see with the naked eye. Shown here are examples of the latter. With eye of the microscope we can find an astonishingly diverse world of aquatic microalgae. Top left: *Chattonella marina* var. *antiqua*; top right: *Porphyridium* sp.; bottom left: *Volvox aureus*; bottom right: *Spirulina subsalsa*. Strains of all of these species are available from the NIES Microbial Culture Collection. The research activities of NIES cover both macro- and microscopic biodiversity.

The mission of the Environmental Biology Division is to help conserve biodiversity and ecosystem functions. In the pursuit of this mission, our activities include ecological, physiological, and molecular genetic studies. The Division consists of four sections: Population Ecology, Physiological Ecology, Microbial Ecology, and Ecological Genetics. Staff of the four sections are collaborating in the following tasks.

**Studies of conservation of biodiversity**

Nowadays, biodiversity is under the risk of rapid loss, and its conservation is an important global environmental issue. The most serious drivers of species extinction are changes in land use. To predict the future impact of land-use change on biodiversity in Japan and to find the optimum, cost-effective strategy of land-use design for biodiversity conservation, we developed spatial distribution models of vascular plant species listed in the Japanese national Red List of Threatened Species. It is not easy to map species distributions throughout the country by means of ground surveys. Distribution models are useful for suggesting unsurveyed sites that are highly likely to contain rare species. The model prediction was based on environmental factors, including climatic (e.g. rainfall, snow accumulation), geographic (e.g. elevation, distance from the seashore), and land-use (e.g. paddy field, urban area) parameters. From the distribution models, the simple sum of the number of Red List species was estimated to be high in the south of Japan and near the Pacific coast, and generally low in the Tohoku and Hokkaido districts (Figure 1).

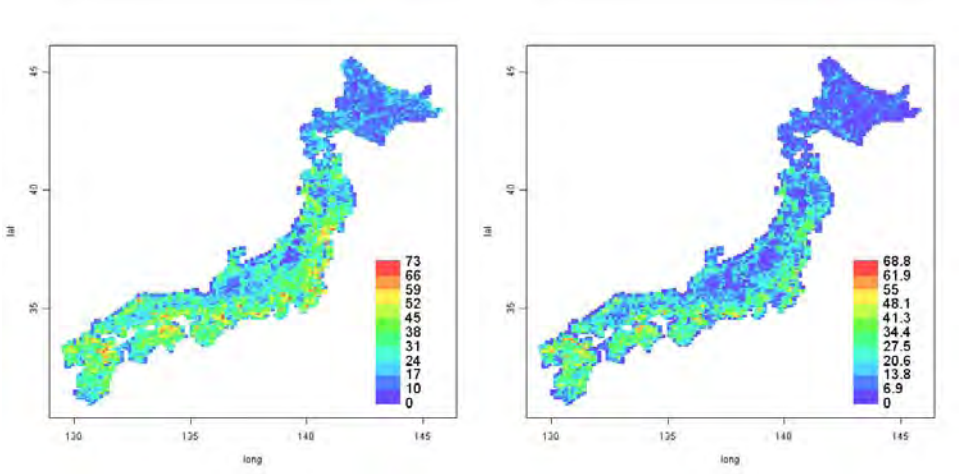



**Fig. 1** Left: Simple sums of species numbers in 10 km by 10 km grid cells , estimated by using the distribution model. Right: Sums of species numbers in the grid cells weighted by extinction risk.

The freshwaters of the Japanese Archipelago are composed of many river systems separated by mountains and seawaters. One of the major barriers lies between eastern–central Japan and western Japan on the island of Honshu. The barrier, which is the mountain ranges on the graben called 'Fossa Magna', was formed no later than about 1 million years ago. The freshwater fish fauna of eastern Japan is different from that of western Japan. However, some species of freshwater fish are distributed over both areas. As a result of a long period of geographic isolation, the populations of these fish on the two sides of Japan are considered

likely to differ genetically. The topmouth gudgeon *Pseudorasbora parva* is a freshwater fish species distributed from the Kanto region of eastern Japan to the island of Kyushu in western Japan. Variations in the DNA sequence of a mitochondrial gene in these fish from the Kanto region showed that most of the sequence types belonged to the East-Japan group and could be clearly distinguished from those of the West-Japan group (Figure 2). We found that a few fish from the Kanto region possessed sequence types belonging to the Asian-Continent group. It is likely that these fish originated from ones artificially introduced from the Asian Continent.

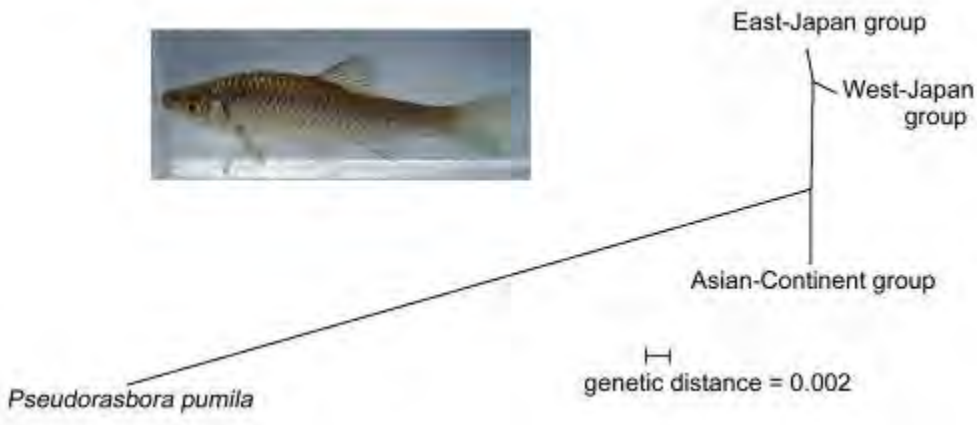



**Fig. 2** Phylogenetic tree of the DNA sequence types of a mitochondrial gene from the topmouth gudgeon. Branch lengths of the tree indicate genetic distances between the genetic groups. Details from a closely related fish, *Pseudorasbora pumila*, are included for comparison.

**Studies of the structure and function of ecosystems**

*Ulva* spp. are major seaweeds that form green tides along coasts worldwide. The green tide is a new environmental problem that has the potential to seriously affect ecosystem functions and ecological services. To understand the dynamics of the blooming of green tides, seasonal changes in the biomass and species composition of *Ulva* spp. were studied on seven tidal flats in Tokyo Bay. In autumn, green tides were observed on all tidal flats. No green tides were observed in the other seasons, except on the Yatsu tidal flat. On this flat, green tides were observed all year round, with a large accumulation of *Ulva* spp. detected at winter. On all tidal flats, the green tides were composed mainly of *Ulva ohnoi*. This species is thought to have invaded Tokyo Bay from other sea areas. Although green tide blooms are generally considered to be caused by nutrient enrichment, invasion by *Ulva ohnoi* is also an important factor promoting green tides in Tokyo Bay.

Alpine meadow is one of the most extensive grasslands on the Qinghai-Tibetan plateau. The meadow ecosystem develops at high elevations (often above 4000 m) and is considered highly vulnerable to climate change. In previous field investigations, we have demonstrated that the grassland ecosystem on the plateau stores large amount of soil carbon. We have also found that Qinghai-Tibetan alpine meadow is currently an important net sink for atmospheric $CO_2$. We now

focused our attention on the relationship between plant species richness and community productivity of alpine meadow. We hypothesized that, at small spatial scales, high species richness may contribute to high plant productivity, mainly by favoring high photosynthetic $CO_2$ uptake. To test the hypothesis, we built an automatic ecosystem $CO_2$ flux–measurement system (Figure 3) and measured ecosystem photosynthesis and ecosystem respiration under dark conditions on a typical alpine meadow, at Haibai, Qinghai, China.

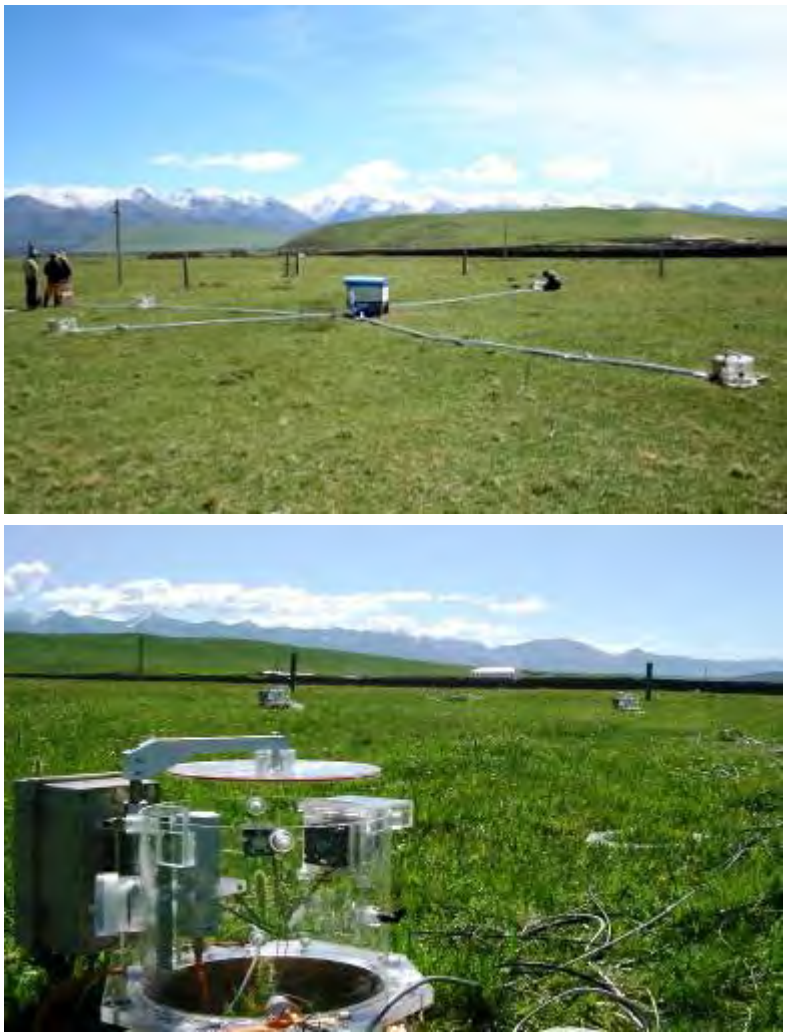


**Fig. 3** Automatic system for measuring ecosystem $CO_2$ exchange (top); and a chamber used to cover the ground surface (bottom).

We examined daily maximum photosynthetic $CO_2$ uptake, dark ecosystem respiration, and net ecosystem $CO_2$ exchange to assess the potential physiological capacity of the meadow ecosystem. We found the number of species at a study site was significantly correlated with daily maximum photosynthetic $CO_2$ uptake and maximum net ecosystem $CO_2$ exchange (Figure 4). Interestingly, ecosystem dark respiration was not significantly correlated with species richness but was highly correlated with aboveground biomass. These results suggest that any factors in the alpine ecosystem—such as warming, drought, and grazing—that reduce species richness can potentially decrease net $CO_2$ absorption, which in turn will reduce carbon sink strength.

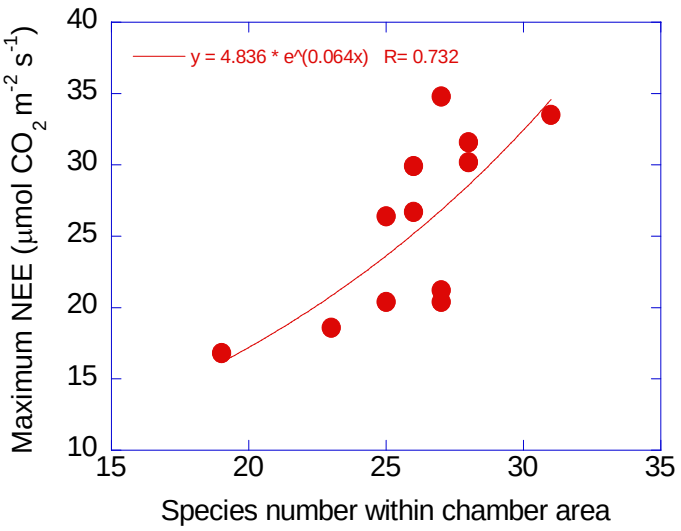



**Fig. 4** $CO_2$ exchange relationship between number of species within the chamber and the maximum net ecosystem $CO_2$ exchange (NEE) in a *Kobresia* meadow, Haibei, Qinghai. Two outliers of extremely high photosynthesis were excluded.

**Effects of environmental stress and climate change**

Tropospheric ozone is produced by photochemical reactions between nitrogen oxides and volatile organic compounds originating from the combustion of fossil fuels. Ozone in the troposphere is a health hazard to humans and animals and can damage plants. Plants exposed to high concentrations of ozone show visible leaf injury. Plants suffer reductions in photosynthesis, growth, and crop yield under low ozone concentrations, even when no visible symptoms are observed. Both temperatures and tropospheric ozone concentrations are increasing globally. Climate models forecast rapid increases in ozone concentrations in Asian countries, where rice production is the basis of nutrition. As the thermal environment affects gas exchange between plant leaves and the atmosphere in various ways, it is likely that the effects of ozone on plants will be affected by global climate change. We have therefore started an analysis of the combined effects of ozone and high temperatures on rice plants. We have identified many molecular markers for assessing the sensitivity of rice cultivars to high temperatures and/or ozone by using DNA microarray analysis of gene expression. We found various gene-expression markers associated with visible injury in rice seedlings exposed to ozone. We also developed a novel method for evaluating the sensitivity of rice cultivars to high temperatures and/or ozone by using gene expression markers selected on the basis of their correlation with effects on yield, biomass, grain sterility, or quality (Figure 5).

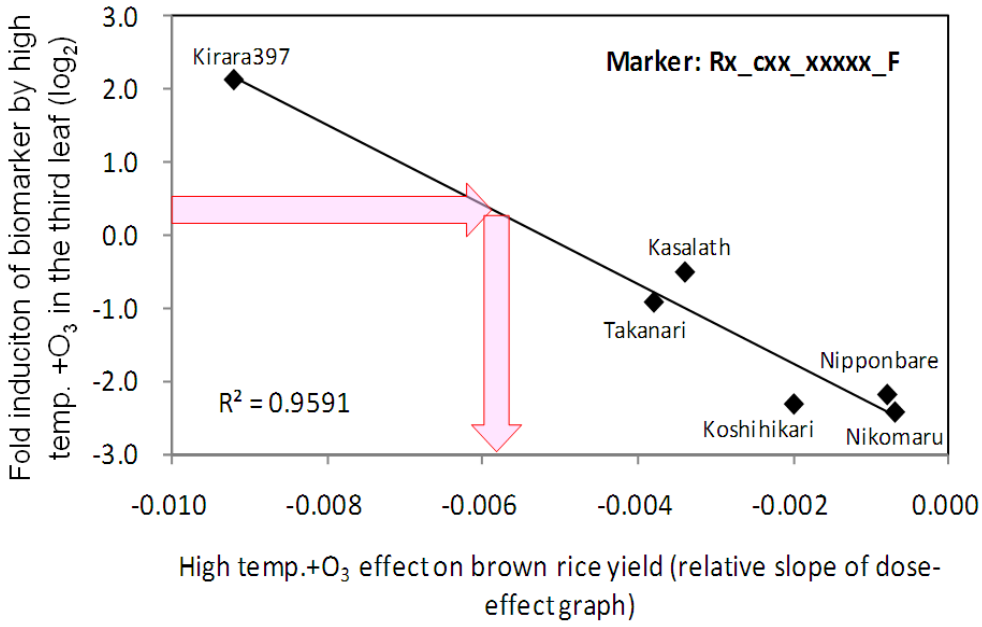



**Fig. 5** Example of the correlation between biomarker and effect among six rice cultivars. Arrows show how to predict the effect of biomarker expression on a rice cultivar.

We tried to develop DNA macroarrays (DNA segments spotted on nylon membrane) of Arabidopsis (an often-used model plant species) and rice marker genes to detect ozone stress in field-grown plants under normal or elevated temperature conditions. We previously found that a gene named At2g17210 from Arabidopsis specifically responded to ozone in controlled-environment growth chambers. To test whether this gene could be used as an ozone marker in plants grown outdoors, the DNA segment corresponding to the gene was spotted on a nylon membrane to which we applied RNA isolated from Arabidopsis plants grown in open-top chambers controlled for ozone levels. DNA array of this gene could detect chronic ozone stress caused by ozene exposion as well as acute ozone stress. The obtained results indicate that the diagnostic DNA array could be applicable to plants grown in the field.

**Studies of invasive alien species and genetically modified organisms**

Millions of tonnes of agricultural products are imported into Japan annually. About one-tenth of the total is oilseed rape (*Brassica napus* L.) seeds, and about half of the imported rapeseed has been genetically modified for resistance to herbicides. Some of these imported seeds are likely to be dispersed unexpectedly during transport within Japan. Since 2005 we have been conducting a periodic survey of oilseed rapes growing along Route 51 (a major road in the Kanto district). In 2010, twice as many oilseed rape plants were found as in 2009, but more than four times as many herbicide-resistant plants were found (Figure 6).

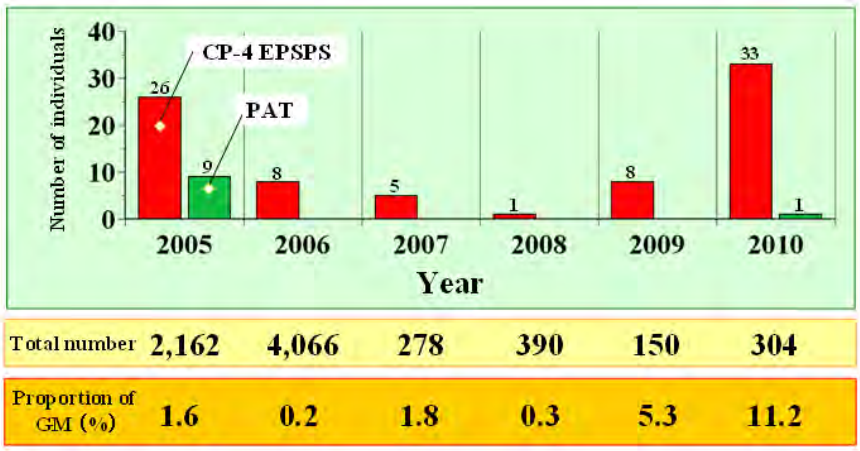



**Fig. 6** Total numbers of sampled plants and numbers of herbicide-resistant individuals detected along Route 51 from 2005 to 2010.

On the roadside, a herbicide-resistant plant that possesses CP4 EPSPS proteins is now dominant. These plants are likely to have had their origins in seeds spilled during transportation of cargo from the port, because there are no potential natural *B. napus* seed-source plants along this road. Recently, we started a census of oilseed rapes growing along Route 23, a major road in the Tokai area of central Honshu, Japan. In 2010, the number of oilseed rapes growing along this roadside began to increase in early February and peaked in early May. The number then suddenly decreased after a roadside weeding in June. About 80% of the oilseed rapes growing in this area had one protein conferring herbicide resistance and about 3% had both herbicide-resistance proteins, namely CP4 EPSPS and PAT. Further long-term monitoring is needed to find the origin of these double herbicide-resistant plants.

Biological invasions are among the most serious threats to freshwater biodiversity. Analysis of long-term data can be a first step toward properly identifying the ecological and economic damage caused by invasive species. Lake ecosystems provide vital ecosystem services such as recreation and food production. However, many lakes continue to be degraded at an alarming rate owing to invasion by non-native species. In Lake Kasumigaura, invasion by channel catfish (*Ictalurus punctatus*) is suspected to be the major cause of population declines of native species and the cause of serious damage to commercial fisheries. In cooperation with Ibaraki Prefectural Freshwater Fisheries Experimental Station, we used long-term monitoring data (1993–2007) to assess the potential impacts of the invasive channel catfish on native fish and shrimp and the commercial fishery (Figure 7). We found that the populations of nine of 18 native species declined significantly through time. Most of those species had narrow dietary ranges. The species declines included all four commercially important species. We have been monitoring water quality, sediments, plankton and benthos in Lake Kasumigaura since 1977. In 2005, we started fish monitoring using stationary nets. We are trying to examine the food web–level impacts of channel catfish and their spatiotemporal changes by using carbon and nitrogen stable isotope techniques.

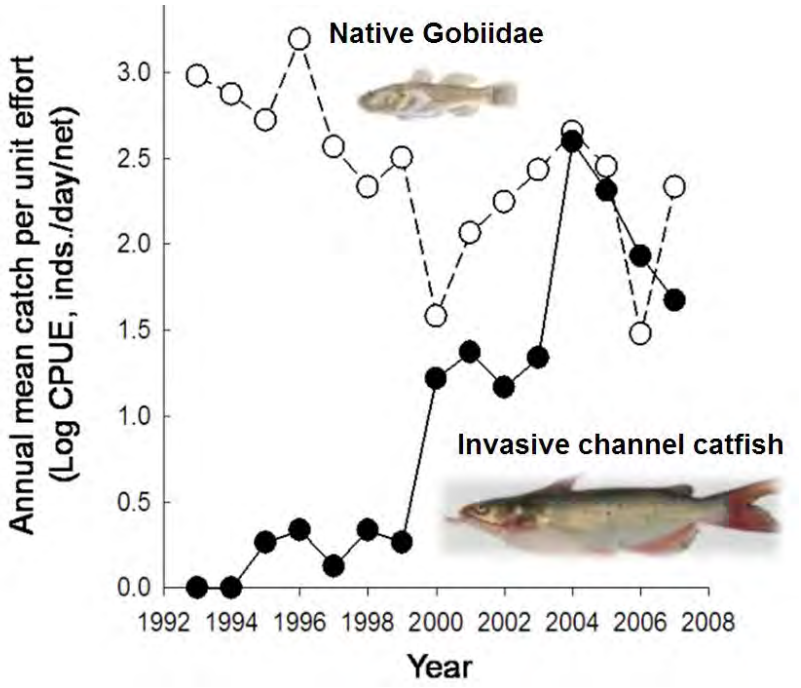



**Fig. 7** Trends in annual mean catch per unit effort (CPUE), and indicator of channel catfish abundance (solid line) and native Gobiidae abundance (broken line), from 1993 to 2007.

# Laboratory of Intellectual Fundamentals for Environmental Studies

A: Damselfly (*Ischnura senegalensis*)

B: Daphnid (*Daphnia magna*)

C: Zebrafish (*Danio rerio*)

Examples of experimental aquatic animals used in environmental risk evaluation

The Laboratory of Intellectual Fundamentals for Environmental Studies (LIFES) incorporates two research laboratories: the Environmental Analytical Chemistry Laboratory (ACLab) and the Biological Resource Laboratory (BRLab). The aim of LIFES is to promote environmental research, not only in NIES but all over the world, through the provision of environmental Certified Reference Materials, microbial cell strains, and experimental animals for environmental risk evaluation, and through the development of databases related to environmental biology. In addition to the major topics summarized below, both laboratories conduct research that has both fundamental and frontier themes.

ACLab has been evaluating the quality assurance and quality control (QA/QC) of environmental monitoring, developing new environmental analysis methods, and comparing methods for monitoring TBT (tributyltin) and TPT (triphenyltin) in marine organisms. Some of the results are being applied to the monitoring of blue algae in Kyushu, Okinawa, and other areas in southwestern Japan, using NIES CRM (Certified Reference Material) No. 26 (Blue Algae); this monitoring has been performed in a joint research project by NIES and several prefectural institutes. Also, NIES CRM No. 15 (Scallop) has been used for QA/QC in the monitoring of organotin compounds and trace elements in seawater, sediments, and marine organisms.

BRLab has been working on several biotechnologies. With the aim of developing new technologies in the field of bioscience, we are studying primordial germ cells (germline stem cells) in the Amniota (mainly in the Aves). We have made germline chimeras by transplanting primordial germ cells, and we have obtained offspring originating from these introduced primordial germ cells by backcrossing. We are now trying to put this method to practical use in the proliferation of threatened bird species. Our techniques should be useful in cleaning up infections transmitted via eggs and in the recovery of populations from inbreeding depression by the transplantation of primordial germ cells in the early embryonic stages (Figure 1).

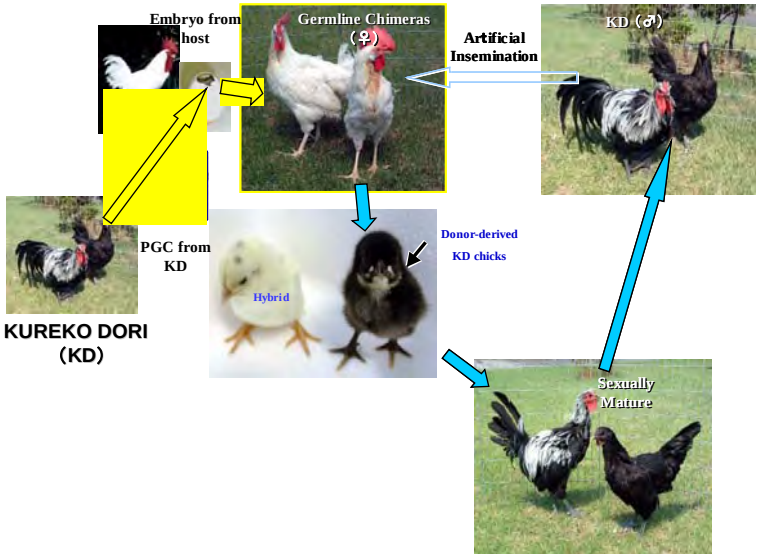



**Fig. 1** The *Kureko Dori*, an endangered domestic fowl breed of the Kureko region of Kumamoto Prefecture in Kyushu. By strict screening criteria, in 1965 the *Kureko Dori* was designated a prefectural natural treasure. Offspring of the *Kureko Dori* can be obtained from germline chimeras by using reproductive stem cells—the so-called PGCs (primordial germ cells).

LIFES functions as a reference laboratory for environmental research in Japan by improving methods of ensuring analytical QC and cross-checking analytical techniques; improving methods of classifying and culturing microalgae and other laboratory organisms; and preserving and supplying organisms as standards for classification, standard strains for bioassay tests, and strains with special functions.

**Management and operation of key analytical equipment**

ACLab has been working to improve the sensitivity and accuracy of analysis of environmental specimens at NIES through the use of key analytical equipment. An on-demand analysis service has been established and is operated by personnel technically trained in the use of 10 instruments (Figure 2). In FY 2010 over 50 researchers made requests for analyses on about 30 research themes, and we provided them with useful data derived with a high level of QC.

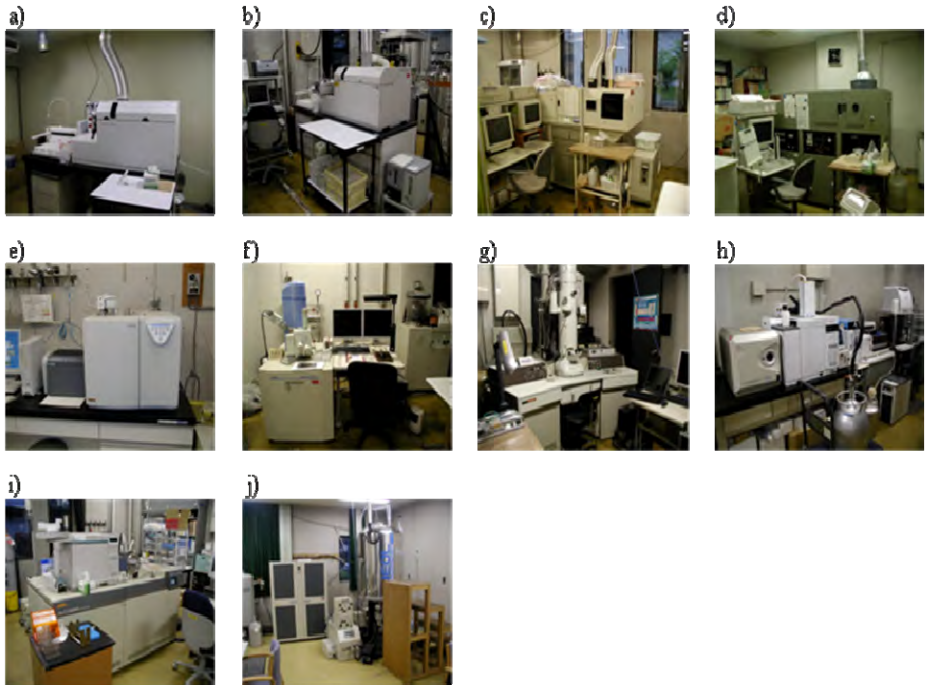



**Fig. 2** Photos of key instruments. a), b): ICP-MS (inductively coupled plasma mass spectrometer; c), d): ICP-AES (inductively coupled plasma atomic emission spectrometer); e): elemental analysis (carbon, hydrogen and nitrogen) apparatus; f): SEM (scanning electron microscope); g): TEM (transmission electron microscope); h): P&T-GC/MS (purge-and- trap gas chromatograph–mass spectrometer); i); GC-MS (gas chromatograph–mass spectrometer); j): NMR (nuclear magnetic resonance) machine

**Environmental Certified Reference Materials**

Environmental CRMs are used to evaluate new analytical methods and to control the accuracy of pretreatment and instrumental analyses. We have been preparing and distributing environmental and biological CRMs since 1980. Over 150 CRMs were distributed to researchers worldwide during FY2010, and a new CRM No. 15 for organotin compounds (TBT and TPT) in scallop has been released. (Information on NIES CRMs can be found at http://www.nies.go.jp/labo/crm-e/index.html.)

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

We have 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. Our time-capsule facility accommodates various items of equipment for low-temperature preparation of environmental specimens for long-term storage. The facility can store specimens for 50 years under an atmosphere of liquid nitrogen vapor at about –150 °C. About 160 samples of bivalves and stingray livers have been added, and the total number of time-capsule samples under liquid nitrogen vapor is now about 2300. In addition to these, several thousand biological specimens and atmospheric samples have been stored in freezers (–80 °C) and freezing rooms (–60 °C) (Figure 3).


**Fig. 3** Environmental specimen banking. Clockwise from top left: stingray liver *in situ* after excision, coarse and fine crushing, bottling, and cryopreservation in cold $N_2$ vapor (below –150 °C) over liquid $N_2$.

**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 the cells (including germline cells) and tissues of such animals for genetic analysis, with the support of the National Time Capsule Program for the Environment and Threatened Wildlife. As at March 2009, 3365

kinds of samples (tissues, cultured cells, and sperm) had been cryopreserved. From April 2010 to March 2011, we accepted another 224 individual threatened wild animals (20 mammals, 148 birds, one reptile, and 55 fishes) from all over Japan. In addition, we cryopreserved threatened Russian wildlife under a joint research project with the Bolonsky Nature Reserve in Russia (Figure 4). We collected samples (skin and blood) from 20 individuals, namely the oriental white stork (*Ciconia boyciana*, 18 individuals) and the white-tailed eagle (*Haliaeetus albicilla*, 2 individuals). In total, in 2010 we cryopreserved 1021 kinds of samples (tissues, DNA, and cultured cells) from 244 individuals of Japanese and Russian wildlife. Since 2004 we have preserved 4386 kinds of samples as part of the National Time Capsule Program.

**Fig. 4** A joint research project with Bolonsky Nature Reserve was conducted to cryopreserve the genetic resources of Russian endangered bird species.

It is very possible that the Okinawa rail (*Gallirallus okinawae*) will become extinct. We are therefore focusing on cryopreservation of the cultured cells and genetic resources of this species. As at the end of 2010, cultured cells and genetic resources from 229 individuals had been stocked at –160 °C. In addition to cryopreserving genetic resources, we started genetic diversity research into this species by using mitochondrial DNA and microsatellite markers. Fewer than 1000 living Okinawa rails remain (Figure 5).

**Fig.5** This young Okinawa rail on a road in the Yambaru area of Okinawa Island runs a high risk of being killed by a car.

***(2) Threatened algae***

We have been surveying the status of threatened algal species in Japan. During FY 2010 we surveyed 27 potential habitats of Charales algae in Hokkaido and Kagawa prefectures. Members of the Charales grew at 23 of the sites. We carefully collected several thalli (algal bodies), without disturbing the populations, so that we could establish culture strains. During FY 2010, we newly established 2 species and 15 strains of the Charales, and 1 species and 1 strain of freshwater red algae. We now maintain a total of 363 strains of endangered algae (28 species and 92 strains of the Charales, and 14 species and 271 strains of freshwater red algae); 159 of the strains of freshwater red algae are preserved in liquid nitrogen only, whereas others are preserved by subculturing.

Recently, Charales algae has been successfully restored from oospores buried in the bottom mud of eutrophic lakes such as Lake Kasumigaura and Lake Teganuma, where several Charales algae were present until the 1960s but are now extinct. In FY 2010, we had great success in restoring 5 species of Charales from buried oospores in Lake Tataranuma (Figure 6), where 10 species were also present until the 1960s but are now extinct.


**Fig. 6** Cultures of restored Charales from Lake Tataranuma.

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

In FY 2010 at the Microbial Culture Collection (NIES-Collection), we:

- received 57 strains of microbes from scientists within and outside NIES
- distributed 923 algal strains for education, research, and development
- improved the Microbial Culture Collection website by making CSV (Comma Separated Values) files available for search results
- determined the DNA sequences (mostly 18S and 16S rDNA) of strains for which there were no molecular phylogenetic data, in order to ensure the taxonomic positions of these strains.

We now maintain a total of about 2900 strains, of which 2331 are available as NIES strains. To minimize the risk of loss of culture strains in the event of a disaster, the NIES Collection has duplicated some of the cryopreserved strains in the Kobe University Macroalgal Culture Collection. These activities are being conducted as part of the National Bio-Resource Project.

**Provision of experimental aquatic animals for environmental risk evaluation**

We supply 12 aquatic animals used mainly in eco-toxicity tests (Figure 7): egg masses of two species of midge (*Chironomus dilutus*, formerly known as *C. tentans*, and *C. yoshimatsui*); larvae of damselfly (*Ischnura senegalensis*); scud (*Hyalella azteca*); three species of daphnid (*Daphnia magna*, *Moina macrocopa*, *Ceriodaphnia dubia*); a shrimp (*Paratya improvisa*); medaka (*Oryzias latipes*); zebrafish (*Danio rerio*); guppy (*Poecilia reticulata*); and fathead minnow (*Pimephales promelas*). In FY 2010, there were 62 requests for 150 samples of 8 species.

**Fig. 7** Aquaria for culturing experimental animals used to assess the environmental hazards of chemicals.

# Environmental Information Center

The Environmental Information Center provides the public with various kinds of environmental information through websites.

The Environmental Information Center provides information technology (IT) support for the research and related activities at NIES; carries out public relations activities for NIES, including the publication of NIES research reports; and performs miscellaneous other activities, including collecting and processing environmental information and disseminating it to the general public, performing tasks commissioned by the Ministry of the Environment (MOE), and acting as the national focal point for UNEP-Infoterra. These tasks are described in detail below.

**1. IT support for research and related activities at NIES**

The Center manages and operates the computers and related systems at NIES, uses IT to improve the work efficiency of NIES, and runs a library service.

***a. Management and operation of computers and related systems***

A new computer and network system started operation in March 2007. The 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 supercomputer (NEC SX-8R/128M16), which is equipped with a FORTRAN compiler with high-level debugging capability and high-efficiency optimization, executes the large-scale programs needed to model global environmental problems.

A local-area network called NIESNET was established at NIES in 1992. File transport was upgraded in March 2007. 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 wide-area network via the Science Information Network (SINET) connection to the Internet.

***b. Use of IT to improve work efficiency***

The Center gives IT support to the management sector of NIES, with the aim of increasing work efficiency. It also provides NIES researchers with processed research data and helps them to disseminate their data through the NIES home page. In FY 2010, the Center supported:

- the development of an electronic application and registration system at NIES
- the operation of a thin-client PC management system for the administrative section
- the development of the NIES research information database
- the modification and operation of a database of basic information on each member of staff at the Institute.

***c. Library service***

As of March 2011, the NIES library held 57 101 books, 421 journals (including electronic resources), 122 268 microfiches, and various other technical reports and reference materials. These materials can be searched by using OPAC (Online Public Access Catalog) via the Intranet.

In addition to these materials, researchers at NIES can use abstracts and full-text articles through scientific and technical information databases such as ISI Web of Knowledge (including Web of Science, Medline, and Journal Citation Reports), JDreamII, G-Search, and CiNii.

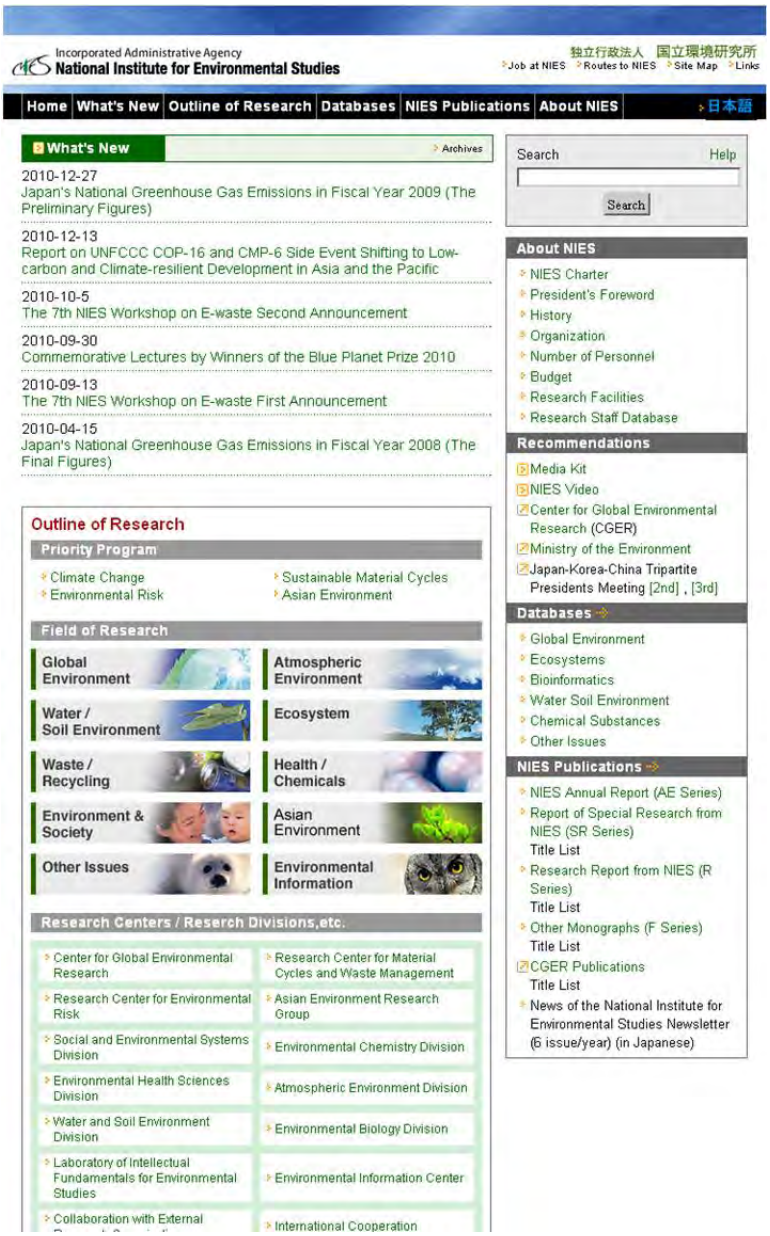
Library facilities include separate rooms for reading books, journals, reports, and microfiches.

**2. NIES public relations activities**

The Center manages the NIES website. It also edits and publishes 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 started the second stage of its medium-term plan in April 2006, a newly designed website was prepared in accordance with the new organization and activities. The new site was designed to offer improved usability, including improved accessibility for people with disabilities.




***b. Editing and publication of NIES reports***

Reports on 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**

***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 provides various kinds of environmental information to the public through websites; processes and manages environmental information databases; and provides environmental information via GIS (geographic information system).

*Environmental Observatory (Information Platform for Environmental Outlook)*

The Environmental Observatory (Information Platform for Environmental Outlook) is a multimedia site providing integrated environmental information to promote wider involvement in environmental conservation. It gives users broad access to a range of systematically organized environmental information aimed at creating a sustainable society. The site offers a quick search facility, domestic and global news updates, descriptions of key environmental technologies, information on policies and laws in environmental fields, environmental information via GIS, and other content helpful for environmental learning. This site is an evolution of the former Environmental Research and Technology Portal.

*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 collected by local government and reported to MOE. These processed data can be accessed through the database on the NIES website. Duplication and lending services are also available.

*Provision of environmental information via GIS*
The Center, with the cooperation of MOE, has been using GIS to develop an environmental data provision system. This system helps users to easily understand the status of the environment by showing data on environmental quality and other information on maps. The system has been publicly available through the Internet since September 2002 and was revised in March 2011.

***b. Tasks commissioned by the Ministry of the Environment***
In FY 2010, in tasks commissioned by MOE, GIS was used to evaluate the following three datasets against quality standards:

- living environment data, covering noise, vibration, and offensive odors
- a survey of the concentration distributions of hazardous air pollutants
- a dioxin-monitoring survey.

***c. National focal point of UNEP-Infoterra***
UNEP-Infoterra is the Global Environmental Information Exchange Network of the United Nations Environment Programme. The network operates through a system of government-designated national focal points. The Center has been the designated Japanese national focal point since 1975. These focal points provide a wide range of environmental information, including directories of information sources.

## Climate Change Effects on Fish and Fisheries: Forecasting Impacts, Assessing Ecosystem Responses, and Evaluating Management Strategies

April 26-29, 2010
Sendai International Center
Sendai, Japan

The symposium was organized to provide a forum for scientists and policymakers to discuss the potential impacts of climate change on marine ecosystems and the uses of these ecosystems; and to consider the strategies that can be taken by society in order to be prepared for anticipated impacts. We committed to organizing a workshop entitled "Potential Impacts of Ocean Acidification on Marine Ecosystems and Fisheries". At the workshop, recent research covering issues from species impact of ocean acidification to the social implication of this impact was discussed. The report from the symposium can be viewed at the following PICES web page,

http://www.pices.int/publications/pices_press/volume18/v18_n2/pp18_2010_Sendai_Ocean_Acidification_W2%20Wsh.pdf

## 15th International Workshop on Atmospheric Science from Space using Fourier Transform Spectrometry

May 11-13, 2010
Nara Women's University
Nara, JAPAN

The 15th International Workshop on Atmospheric Science from Space using Fourier Transform Spectrometry was held on 11-13 May, 2010 at Nara Women's University in Nara, Japan. The workshop was sponsored by the Japan Aerospace Exploration Agency (JAXA) and organized in cooperation with Nara Women's University and NIES. This workshop purpose is information exchanges of researches and mission status of the satellite FTS sensors such as ACE, MIPAS, TES, IASI, and GOSAT. Gathering worldwide researchers and engineers involved in the satellite projects whose sensors are/were Fourier Transform Spectrometers (FTS). Series of this workshop is held once in 1.5 years regularly.

## 8th Workshop on GHG Inventories in Asia (WGIA8)

July 13-16, 2010
Lao Plaza Hotel,
Vientiane, Lao PDR Lao People's Democratic Republic

The Ministry of the Environment of Japan (MOEJ) and the National Institute for Environmental Studies (NIES), jointly with the Water Resources and Environment Administration (WREA), convened the 8th Workshop on Greenhouse Gas Inventories in Asia (WGIA8) on 13-16 July 2010 in Vientiane, Lao P.D.R., as a Capacity building workshop for Measurability, Reportability and Verifiability (MRV). The workshop was attended by 93 experts from thirteen WGIA-member countries (Cambodia, China, India, Indonesia, Japan, the Republic of Korea (RoK), Lao P.D.R., Malaysia, Mongolia, Myanmar, Philippines, Thailand, and Viet Nam), as well as the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), the United Nations Development Programme (UNDP), the United States Agency for International Development (USAID) and the Regional Capacity Building Project for Sustainable National Greenhouse Gas Inventory Management Systems in Southeast Asia (SEA GHG Project). The Greenhouse Gas Inventory Office of Japan (GIO) under the Center for Global Environmental Studies (CGER), NIES functioned as WGIA Secretariat.

The attending experts discussed various subjects of interest to Asian countries, including the recent progress made by member countries, possible future activities in each member country and the WGIA itself, and sector-specific issues. Through discussions of these subjects, the experts reaffirmed the importance of the inventory as a key tool for promoting mitigation actions in a MRV manner. They also recognized the usefulness of mutual learning that can be conducted among member countries in order to improve their inventories in a more efficient manner, and the importance of making continuous efforts in improving inventories even after the completion of their latest national communications (NCs). They stressed the necessity of WGIA's continuation, as it provides a good opportunity for government officials and researchers who are in charge of national inventory development in the member countries, and experts from international organizations to get together and exchange updated information with each other.

## The 7th Meeting of the Tripartite Presidents Meeting among NIES, NIER and CRAES

September 12-17, 2010
Qingdao Huiquan Dynasty Hotel
Qingdao, China

The Tripartite Presidents Meeting among NIES, NIER and CRAES (TPM) has worked to expedite joint efforts in environmental research among Japan, Korea and China, while seeking further cooperation on issues of common interest. At the TPM7, the three presidents exchanged information on the recent developments in each institute and discussed global environmental challenges. They agreed to strengthen cooperation to address these issues. The theme of the parallel workshop was biodiversity and solid waste management and presentations were made on related topics by researchers from each institute.

## Northeast Asia Eco-forum on Low Carbon Cities/Regions

September, 15-16 2010
Sheraton Lido Hotel
Shenyang, China

The Northeast Asia Eco-Forum was organized by the International Cooperation Dept of the Chinese Academy of Sciences (CAS). Shenyang Environmental Protection Bureau, and CAS-Institute of Applied Ecology (IAE), and co-organized by NIES. Over 80 participants attended the forum, including 20 international participants from Japan, Korea, Mongolia, North-Korea, the US, Canada, Norway, Australia, and the Philippines. The forum had as its focus the theme "building low carbon society (LCS)". Participants discussed management, simulation, and decision making systems for low carbon development, low carbon policy, carbon, nitrogen, and water circulation in terrestrial systems, low carbon economy and circular economy, and low carbon cities and regions.

## The 7th NIES Workshop on E-waste

October, 18-19 2010
National Institute for Environmental Studies
Tsukuba, Ibaraki, Japan

Approximately 70 people attended the workshop, including 12 invited foreign experts from seven countries (China, Malaysia, Mongolia, Philippines, South Korea, Thailand, Vietnam) and approximately 30 general participants from local governments, industries, and NGOs. The workshop focused on three topics: e-waste recycling/treatment processes; toxicity and resource recovery potentials; and inventory and appropriate management systems. Some results of field surveys in Metro Manila were reported: high concentration of heavy metals in soils were identified at unregulated recycling sites, such as junkshops, wire burning area and unregulated precious metal recovery sites. In addition, a high concentration of Indium in the hair of workers at formal recycling facilities was also identified. Reports on the current situation in each country in regards to unregulated recycling; recent related legislation; and environmental and human health impacts were presented. A fruitful question and answer session, as well as productive discussions were conducted amongst the participants.

## The Official Side Event of COP 10
## Think and Eat: A Workshop on Invasive Alien Species – Invasive Alien Species Management in Japan

October 20-23, 2010
Nagoya International Congress Center
Nagoya, Aichi, Japan

In accordance with rules 3 and 4 of the rules of procedure for meetings of the Conference of the Parties to the Convention on Biological Diversity and decision IX/35 adopted at its ninth meeting, the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity was held at the Nagoya Congress Centre in the City of Nagoya, Aichi Prefecture, Japan, from October 18-29, 2010. Among the most notable outcomes of the 10$^{th}$ conference were the adoption of the Nagoya Protocol on ABS (Access and Benefit Sharing) and the Aichi Targets on Biodiversity Conservation.

At the conference, three side-events, taking as their theme Prevention of Biological Invasion, were held in cooperation with the Ministry of the Environment. On October 21-22, an international symposium entitled "Think and Eat: A Workshop on Invasive Alien Species ~Invasive Alien Species Management in Japan~" was convened, targeting mainly specialists and politicians. The Invasive Alien Species Act system, and specific activity for control of IAS in Japan, was introduced. All participants displayed a keen interest in the Japanese-specific IAS Act and asked many questions concerning the process by which the law was activated and details of its implementation in Japan. "Large-Mouse Bass Burger", made from fish caught in Biwako Lake were served to all participants in order to demonstrate practical outcomes of IAS. There were more than 100 participants on both days.

On October 23, a public symposium "Look, Listen and Think: A Workshop on Invasive Alien Species" was held, targeting the general public. A picture card story entitled "The History of Mongoose in Okinawa Islands" was used to illustrate the process by which alien species are introduced into Japan. Questions from participants were fielded and the scientific mechanism of biological invasions and its threat to biodiversity were explained. There were more than 300 participants at the meeting.

## NIES Commemorative Lectures by the Blue Planet Prize Winners

October 28, 2010
National Institute for Environmental Studies
Tsukuba, Ibaraki, Japan

Dr. James Hansen and Dr. Robert Watson, winners of the 18th Blue Planet Prize, who have made outstanding achievements in providing solutions to global environmental problems, gave special lectures to NIES researchers and local residents of Tsukuba.

## Capacity Building Workshop on Carbon Governance in Asia: Bridging Scales and Disciplines

November 1-3, 2010
United Nations University - Institute of Advanced Studies (UNU-IAS)
Yokohama, Kanagawa, Japan

The capacity building workshop invited young researchers from the Asia Pacific regions and key senior scholars from around the world to present on and discuss the multiple aspects of carbon governance in Asia. The workshop also discussed various social science frameworks and methodologies to analyze the governance questions. The case studies presented covered global climate regimes, regional, national and city carbon governance issues, and the emerging REDD regime. The workshop was attended by 40 people from 11 countries including key scholars from Japan. The workshop was funded by the Asia Pacific Network for Global Change Research.

## 7th Annual Industrial Symbiosis Research Symposium 2010

Industrial Symbiosis-CONTRIBTING TO CO-BENEFIT CITIES AND REGIONS-
November 5-6, 2010
Institute of Industrial Promotion Kawasaki
Kawasaki, Kanagawa, Japan

The 7th Annual Industrial Symbiosis Research Symposium (2010) - convened in order to address progress in research and practices concerning industrial symbiosis and eco-industrial development around the world - was held on November 5th and 6th in Kawasaki, Japan, attracting 47 attendees from 11 countries. It is the first Annual Industrial Symbiosis Research Symposium held in Asia and was scheduled to precede the International Society for Industrial Ecology (ISIE) Asia-Pacific Meeting and ISIE Material Flow Accounting (MFA)-ConAccount Meeting in Tokyo, Japan.

## COP 16/CMP6 Side Event: Shifting to Low-carbon and Climate-resilient Development in Asia and the Pacific

December 3, 2010
Cancunmesse
Cancun, Mexico

The official side event during UNFCCC COP16/CMP6 “Shifting to low-carbon and climate-resilient development in Asia and the Pacific” highlighted concrete steps Asia’s policymakers are making to integrate climate considerations into development processes and build climate resilience. The panel presented low carbon scenarios and options to achieve low carbon societies together with partner institutes in China, India and elsewhere in Asia. The event was jointly organized by the Institute for Global Environmental Strategies (IGES) and the Asian Development Bank (ADB), and it was attended by over 150 people.

## Advances in Science for the Sustainable Management of the Mekong River

January 18-19, 2011
Ubon Ratchathani University Hotel
Warin Chamrab, Thailand

This workshop was jointly organized by National Institute for Environmental Studies (NIES) and Ubon Ratchathani University (UBU). Opening remark was given by UBU President Dr. Nongnit Teerawatanasuk and NIES Executive Director Dr. Yoshifumi Yasuoka. On the first day (January 18) of the workshop, a total of six oral presentations were given mainly with regard to fisheries management in the Mekong basin. On the second day, three oral presentations about ecology, biology and conservation of some commercially important Mekong fishes were made. In addition, there were about 15 poster presentation not only on fish and fisheries of the Mekong River but also on the other organisms and topics related to limnological studies in the river. Organizations which contributed to these presentations include: Mekong River Commission, World Fish Center, IFReDI, LARReC, Yunnan University, WWF, JIRCAS in addition to UBU and NIES. The riparian countries of the Mekong River are now faced with rapid development of hydro-electric dams and its environmental impacts on fishes and fisheries. Many of the speakers of the workshop raised this issue and in-depth discussion by participants followed after each presentation. Closing remark was given by NIES Asian Environment Group Leader, Dr. Hideaki Nakane, and once again by UBU President Dr. Teerawatanasuk.

## 7th Asia Pacific Eco-business Forum

February 14-15, 2011
Institute of Industrial Promotion Kawasaki
Kawasaki, Kanagawa, Japan

The 7th Asia-Pacific Eco-Business Forum co-organized by Kawasaki City and NIES was held in Kawasaki on February 14 and 15, 2011.As has been the case over the seven consecutive years it has been held, this year's forum continued the tradition of providing a platform for corporate and governmental interests, research institutes, and the public to exchange information on the latest practices and ideas concerning the sustainable and harmonious development of environment and industry. In addition to the depth of experience of participants and the advanced technologies to be found in Kawasaki and Japan, participants from the United Nations Environment Program, International Environment technology Centre (UNEP-IETC), China, Malaysia, and Korea also provided valuable insights and feedback at the event.
For more details see: :http://eri-kawasaki.jp/modules/pico/index.php?content_id=52

## The 16th AIM International Workshop

February 19-21, 2011
National Institute for Environmental Studies
Tsukuba, Ibaraki, Japan

In order to stabilize the global climate, the Intergovernmental Panel on Climate Change (IPCC) AR4 reports suggested a normative reduction target for global carbon dioxide as 2 tC per capita by 2050. Realization of this target is an international challenge, with the key to this being the achievement of a low carbon society (LCS) in Asia – a region with growing economies and diverse backgrounds. The adoption, in this region, of a new social infrastructure leading to an LCS, based on sustainable and low carbon technologies is imperative - with these scenarios replacing the conventional resources and energy-intensive economic development patterns traditionally pursued by developed countries. The 16th AIM workshop was held from February 19 to 21, with both researchers from Asian countries such as China, India, Thailand and Malaysia, and international collaborators from the U.S., Australia and other countries. Through the workshop, it was clearly shown that a Low-Carbon Asia is a feasible aspiration and that Asian countries are now taking steps towards the realization of a low-carbon society.

## Towards Asia low-Carbon Society
## Progress report on Asia Low-Carbon Society Research Project (S-6) and the Introduction to Asia Low-Carbon Society Scenario Development (SATREPS)

February 22, 2011
International Conference Hall, JICA Research Institute
Tokyo, Japan

The symposium “Towards Low-Carbon Society in Asia - Asia LCS scenarios and actions: How to achieve sustainable low-carbon society” was successfully co-organized by the Climate Policy Assessment Research Section of the Center for Global Environmental Research (CGER) with the Ministry of Environment, Japan (MOEJ), and Japan International Cooperation Agency (JICA), in association with the Japan Science and Technology Agency (JST) at the International Conference facilities, of the JICA Research Institute, Tokyo on February 22, 2011. 213 Participants, including government officials, researchers, corporate delegates, and officers of NGOs from 12 different countries took part in the symposium.

During the symposium, researchers from Japan and overseas presented their findings from the “Research Project to establish a Methodology to Evaluate Mid- to Long-Term Environmental Policy Options toward Asian LCS” (S-6) and introduced the concept of a “Research Project on Development of LCS Scenarios for Asian Region” under the aegis of the Science and Technology Research Partnership for Sustainable Development (SATREPS).

## A3 Foresight Program "CarboEastAsia Workshop 2011"

February 22-23, 2011
Hotel Blue Wave Inn Asakusa
Tokyo, Japan

36 CarboEastAsia program members from ChinaFlux, JapanFlux, and KoFlux gathered in Asakusa.

CarboEastAsia (see: http://www.carboeastasia.org/) is an international project started in 2007 for an initial term of three years (1st phase), and extended for a further two years (2nd phase), with financial support from the Japan Society for the Promotion of Science (JSPS), the National Natural Science Foundation of China (NSFC), and the National Research Foundation of Korea (NRF). CarboEastAsia aims at building capacities to respond to climate change protocols by synthesizing measurement, theory and modeling in the quantification and understanding of carbon fluxes and storages in East Asia.

The objectives of the Asakusa workshop were:

1) to discuss research proposals submitted by the project members for the 2nd phase

2) to create a standardized CarboEastAsia dataset based on the observed data provided by the three member networks

3) to conduct uncertainty assessment on the dataset using different gap-filling programs provided by member networks

4) to conduct comparisons of respective model-data obtained and to integrate these in order to quantify magnitude ,uncertainties, and mechanisms of terrestrial carbon budgets in Asia

On the morning of the first day, participants gave presentations on their research proposals for the 2nd phase of CarboEastAsia. The afternoon of the first day and the morning of the second day were dedicated to in-depth discussions by two subgroups – group 1: networking flux measurements (inter-site comparison), and group 2: model development; parameterization and validation; up-scaling; and integration.

CarboEastAsia is the first international joint program amongst China, Japan, and Korea for the study of carbon flux. Through a number of program activities over the past three years, the members have succeeded in strengthening not only their research collaborations but also their mutual rapport and friendship. Despite language and cultural barriers, such collaborative relationships have led to a significant amount of productive research work - and the outlook for further collaborations continuing after the program period has finished looks promising. The program promotes international collaboration based on data sharing data from more than 30 sites in East Asia. CarboEastAsia is set to continue to play an increasingly important role in AsiaFlux. The engaging discussions and significant achievements of this workshop will undoubtedly contribute to further scientific advances in the field.

## The workshop on Energy and Carbon Modeling in Rapidly Urbanizing World

March 10-11, 2011
International Institute for Applied System Analyses (IIASA)
Vienna, Austria

The workshop brought together leading scientists from the National Institute for Environmental Studies, IIASA, the Potsdam Institute for Climate Impact Research(PIK), University of Colorado Denver, Hiroshima University, Technical University of Berlin, Imperial College London, Asian Institite of Technology and the *Congrès International des Réseaux Electriques de Distribution* (CIRED) who discussed modeling techniques for the accurate representation of system boundaries in urban energy and carbon emissions; and the quantification and assessment of the urbanization effect in relationship to demographics or land use at multiple scales (i.e. global, national and city). Key researchers from the field debated the optimal methods to adopt in modeling approaches, and compared notes on results obtained through different methods.

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
   Department of Chemistry, University of British Columbia
   Environmental Chemistry Division

CHINA

1. 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
2. Advanced wastewater treatment processes for China
   Research Institute for Environmental Engineering & Department of Environmental Engineering, Tsinghua University
   Research Center for Material Cycles and Waste Management
3. 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
4. Research on the development of water pollution control techniques for the Taihu Lake in China by bio/eco engineering
   Chinese Research Academy of Environmental Sciences
   Research Center for Material Cycles and Waste Management
5. Development of eco-engineering technologies for the control of eutrophication in the drainage area Hongfeng Lake and Baihua Lake in China Guizhou
   Guizhou Provincial Environmental Protection Bureau
   Research Center for Material Cycles and Waste Management
6. 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
7. Research on VOCs and ammonia emissions in China
   Chinese Research Academy of Environmental Sciences
   Atmospheric Environment Division
8. Environmental impact assessment of dams & floodgates and river ecosystem restoration in Huai River, China
   Key Laboratory of Water Cycle and Related Land Surface Processes, Institute of Geographical Science and Natural Resource Research, Chinese Academy of Sciences
   Asian Environment Research Group
9. Realization of a style of urban development that considers urban thermal environment based on Klimaatlas (Climate atlas) in China
   Dalian Nationalities University
   Social and Environmental System Division
10. Study of an urban simulation system for circular economy technologies and policies in Asian industrial cities and regions
    Research Center for Circular Economy, Institute for Applied Ecology, Chinese Academy of Science, CAS)
    Asian Environment Research Group
11. Monitoring and data analysis of atmospheric greenhouse gas in Asian region
    Chinese Academy of Meteorological Sciences
    Center for Global Environmental Research
12. Study on Urban Environmental Simulation for Technologies and Policies
    Institute for Applied Ecology, Chinese Academy of Science
    Asian Environment Research Group
13. Study on role of environmental hormones in the osteoporosis and its mechanisms
    Second Military Medical University
    Research Center for Environmental Risk

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
   French National Center for Scientific Research
   Environmental Biology Division

KOREA

1. Analysis of environmental changes by corals distributed around Japan and Korea
   Korea Ocean Research and Development Institute
   Center for Global Environmental Research
2. Korea–Japan information exchange and cooperative survey on invasive alien species in both countries
   National Institute of Environmental Research
   Research Center for Environmental Risk
3. Establishment of real-time data exchange system of Asian dust observations between Korea and Japan (Joint research on the monitoring of Asian dust using a LIDAR system)
   Korea Meteorological Administration
   Atmospheric Environment Division
4. Evaluation on organotin pollution and its effects on marine organisms in Korea and Japan
   National Fisheries Research & Development Institute
   Research center for Environmental Risk
5. Genetic resource bank for endangered animal species
   Seoul National University
   Laboratory of Intellectual Fundamentals for Environmental Studies
6. Extra-Habitat Conservation of Endangered Avian Species
   Seoul National University
   Laboratory of Intellectual Fundamentals for

Environmental Studies

## RUSSIA

1. Measurement of methane emission rates from permafrost areas
   Permafrost Institute
   Center for Global Environmental Research
2. Modeling of methane emission rates from natural wetlands
   Institute of Microbiology
   Center for Global Environmental Research
3. Airborne measurement of greenhouse gases over Siberia
   Central Aerological Observatory
   Center for Global Environmental Research
4. Measurements of greenhouse gases affected by Siberian ecosystems
   V.E. Zuev Institute of Atmospheric Optics, SB RAS
   Center for Global Environmental Research
5. Greenhouse gases budget of land ecosystems in Siberia
   Winogradsky Institute of Microbiology, Russian Academy of Sciences
   Center for Global Environmental Research
6. Conservation of genetic resources on wild animals in Khabarovsk region
   Russian Federation Ministry of Ecology and Natural Resources Bolonsk y Nature Reserv
   Laboratory of Intellectual Fundamentals for Environmental Studies

## SWEDEN

1. Health risk assessment of heavy metal exposure: effects of increase in human activity
   Karolinska Institute
   Environmental Health Sciences Division
2. Underway measurement of $pCO_2$ in the surface water of the Arctic Ocean
   Göteborg University
   Climate Change Research Project

## USA

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, NASA
   Center for Global Environmental Research

## Notes:

1. The number of projects is subject to change, as the adoption of certain projects is still under discussion.
2. Names of collaborating institutions are shown as they were at the time of approval of the joint research project.

AUSTRALIA Consultancy Agreement between NIES and the University of Wollongong (2008)

CANADA Agreement between NIES and the Institute of Ocean Sciences (1995)

CHINA Agreement for Cooperative Study on Water Resources and Water Environment Management in Haihe River Basin (2006)

MoU between NIES and Zhejiang Ocean University, China for Cooperative Research on Adaptive Management for the Marine Ecological Environment and Biological Resources of East China Sea (2007)

Implementation Plan for a Water Quality Automatic Monitoring System and Watershed Environmental Management Modeling in the Middle and Low Reaches of the Hanjiang River (2007)

Implementation Agreement for "Establishment of an Early Observation Network for Global Warming Impacts", a Cooperative Project of the Sino–Japanese Science and Technology Joint Committee (2008)

MoU on Joint Research implemented by NIES and the Sino–Japan Friendship Center for Environmental Protection, China, on the Characteristics of Aerosol Pollution in Northern China during the Dust and Sandstorm Season (2008)

MoU on Joint Research on Integrated Assessment of Water Environment in Liaohe Watershed between NIES and Lioning Academy of Environmental Sciences, China (2008)

Joint Research Agreement on the Observation and Modeling of Water and Biogeochemical Cycles in Subtropical Rice Paddy Ecosystems between the Asia Water Environment Research Group, NIES and Taoyun Experimental Station for Agricultural Ecosystems, Institute of Subtropical Agriculture, Chinese Academy of Sciences, China (2008)

General Agreement on International Collaborative Research on Environmental Resources and Related Fields between NIES and Institute of Geographic Science and Natural Resources Research, Chinese Academy of Sciences, China (2009)

MoU between NIES and North Research Center for Rural Wastewater Treatment Technology, Ministry of Housing and Urban-Rural Development, China for Collaborative Research on Development of Rural Wastewater Treatment Technology (2009)

MoU between the Iinstitute of Applied Ecology, Chinese Academy of Science, Shenyang, China and NIES for the Establishment of a Cooperative Program of Academic and Scientific Exchange (2009)

Joint Research Agreement on the Observation of Permafrost in East Asia between Asia Water Environment Section, Asian Environment Research Group, NIES and Cryosphere Research Station on the Qinghai Xizang Plateau, Cold and Arid Regions Environment and Engineering Research Institute, Chinese Academy of Sciences, China (2009)

MoU between Department of Ecology, Peking University, China and Center for Global Environmental Research, NIES for Joint Research on Response and Feedback of Alpine Grassland Carbon Cycle to Global Change on the Tibetan Plateau (2010)

MoU between NIES and Xinjiang Institute of Ecology and Geography, Chinese

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| | Academy of Sciences, China (2010) |
| ESA (European Space Agency) | Globemission project (2010) |
| FRANCE | Development and application of a software to estimate carbon dioxide and methane sources and sinks from the GOSAT observations, and initial validation of the GOSAT-FTS data products" (the "Field")(2010) |
| GERMANY | Contract for the Research Support between NIES and University of Bremen (2008) |
| INDIA | MoU between Anna University, Chennai, India and NIES for Collaborative Research on Atmospheric Science (2007) |
| ITALY | Cross-validation of IASI/METOP-A and TANSO-FTS/GOSAT level 2 products for carbon dioxide.(2009) |
| | Definition, implementation and validation of a prototype software system aimed at the atmospheric corrections for the retrieval of solar-induced fluorescence.(2009) |
| KOREA | Implementing Agreement between NIES and the National Institute of Environmental Research of the Republic of Korea to Establish Cooperative Framework regarding the Environmental Protection Technologies (1994) |
| MALAYSIA | MoU between Forest Research Institute Malaysia (FRIM), University Pertanian Malaysia (UPM) and NIES for collaborative research on Tropical Forest Ecology and Biodiversity (1991) |
| MONGOLIA | MoU on Joint Research on Quality Assurance/Quality Control (QA/QC) of the Dust and Sandstorm (DDS) Monitoring Network System in Mongolia and the Data Analysis for early warning implemented by NIES and The National Agency for Meteorology, Hydrology and Environment monitoring, Mongolia (2007) |
| NEW ZEALAND | Independent Contractor Agreement between NIES and the National Institute of Water and Atmospheric Research Limited (2008) |
| RUSSIA | Agreement on Cooperative Research Projects between the Central Aerological Observatory, Committee for Hydrometeorology and Monitoring of Environment, Ministry on Ecology and Natural Resources of the Russian Federation and NIES (1992) |
| | Agreement on Cooperative Research Projects between NIES and the Institute of Microbiology, Russian Academy of Sciences (1994) |
| | Agreement on Cooperative Research Projects between NIES, Environment Agency of Japan, and Institute of Atmospheric Optics, Russian Academy of Sciences (1997) |
| | MoU on Joint Research concerning the Evaluation of Genetic Diversity and Cell Preservation of Rare Birds between NIES and Bolonski State Nature Reserve (BSNR) (2009) |
| SWEDEN | MoU on Joint Research on Product and Waste Oriented Environmental Management and Policy between NIES and International Institute for Industrial Environmental Economics at Lund University, Sweden (2008) |
| TAIWAN | MoU on Joint research to the application of chicken primordial germ cells for protein production between NIES and ABNOVA corporation Taiwan (2009) |
| THAILAND | MoU on Research on Appropriate Landfill Operations in Thailand between NIES and Kasesart University, Thailand （2009） |

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| | MoU on Research on Appropriate Landfill Operations at Laemchabang Landfill between NIES and Laemchabang Municipality, Thailand (2009) |
| | MoU on Joint Research on Development of Co-benefit Treatment System of Molasses-based Waste Water between NIES and Khon Kaen University Thailand (2009) |
| | MoU on Research on Greenhouse Gas Emissions from Solid Waste Disposal Sites and Waste Management between NIES and The Joint Graduate School of Energy and Environment, Kings's Mongkut University of Technology Thonburi, Thailand (2009) |
| | MoU between NIES and Ubon Rajathanee University, Thailand on Joint Research on Alternative Dam Construction Schemes and Their Effects on Freshwater Fish Diversity in the Mekong (2009) |
| | MoU on Joint Research related to the Cryo-phoenix Project between NIES and Kasetsart University, Thailand (2010) |
| | MoU between Asian Institute of Technology, Thailand and NIES (2010) |
| | MoU Joint Research on Development of Co-benefits Treatment System of Molasses-based Wastewater, Utilization of Wastewater as Fertilizer for Sugarcane between NIES and Mitr Phol Sugarcane Research Center CO., LTD. Thailand (2010) |
| | MoU Joint Research on Development of Co-benefits Treatment System of Molasses-based Wastewater, Optimization of Treatment Technology between Water and Soil Environment Division, NIES and Department of Environmental Engineering, King Mongkut's University of Technology Thonburi Thailand (2010) |
| | MoU on Research Collaboration between NIES and Sirindhorn International Institute of Technology, Thammasat University, Thailand (2010) |
| USA | Technical Assistance Agreement between NIES and the California Institute of Technology at the Jet Propulsion Laboratory (2008) |
| | Technical Services Agreement between NIES and the California Institute of Technology (2008) |
| | MoU agreement between Advanced Global Atmospheric Gas Experiment (AGAGE) and NIES (2009) |
| UNEP | MoU referring to the establishment and operation of a GRID-compatible Center in Japan (1991) |
| VIETNAM | MoU on Joint Research on Development of Future Visions for Municipal Solid Waste Management Systems in Vietnam between NIES and Institute of Science for Environment Management, Vietnam (2009) |
| | MoU on Joint Research on Accumulation of Municipal Solid Waste Data in Vietnam between NIES and Institute for Urban Environment and Industry of Vietnam, Vietnam (2009) |
| | MoU on between NIES and the Institute of Ecology and Biological Resources Vietnam Academy of Science and Technology, Vietnam (2010) |

**GOSAT-Research Announcement Joint Research Agreements**

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| AUSTRALIA | Assimilating GOSAT CO2 into a combined weather/climate model (2011) |
| | Integrated mapping and modeling of water and carbon footprints of Australian irrigated agricultural systems (2011) |
| BELGIUM | Atmospheric Composition and Chemistry-Climate interactions with GOSAT (2009) |
| BRAZIL | Assimilation and validation in Coupled Aerosol Tracers and Transport model to the Brazilian developments on the Regional Atmospheric Modeling System and the version of CPTEC General Circulation Atmospheric Model Including chemistry and aerosol. (2009) |
| CANADA | Validation of GOSAT Measurements Using Ground-Based and Satellite Data (2009) |
| | Evaluation of Applicability of GOSAT Data for Monitoring of Green House Gases (GHG) Emissions from Tailing Ponds and Upgrader Operations in the Oil Sands Production Area, Alberta, Canada (2009) |
| | Chemical Data Assimilation and Inverse Modeling of Atmospheric $CO_2$ (2009) |
| | Assimilation of GOSAT observations in the Environment Canada Carbon Assimilation System (EC-CAS) and complementary systems (2011) |
| | Estimation and attribution of global $CO_2$ surface fluxes using satellite observations of $CO_2$ and CO from TES, GOSAT, and MOPITT (2011) |
| CHINA | Analysis of Spatial and Temporal Relationship between Greenhouse Gases and Landuse/Landcover in China (2008) |
| | The validation of GOSAT $CO_2$ flux product over the grasslands (2011) |
| | Spatial and temporal dynamics detection of the greenhouse gas emissions from the Three Gorges region of China (2011) |
| CZECH REPUBLIC | Modeling of the CO2 and CH4 fluxes using advanced mathematical techniques (2009) |
| FINLAND | Validation of GOSAT/TANSO GHG observations through surface-, tower- and FTIR measurements at the Sodankylä-Pallas Satellite pixel (67ºN, 27ºE) (2009) |
| | Co2 Balances using Remote Sensing, FTIR spectroscopy, In Situ Measurements and Earth System Modeling (2009) |
| | Carbon balance of selected agricultural soils in southern Finland estimated using GOSAT/FTS satellite sensory data - effect of soil type and management practices on CO2 and CH4 vertical flux estimates (2011) |
| FRANCE | Geophysical Parameters Derived from TANSO/FTS and CAI Data (2008) |
| | Correlative TIR, SWIR, and NIR Measurements for GOSAT (2008) |
| | Quality Control of Radiances, Validation of Greenhouse Gas Products, and Study of $CO_2$ Diurnal Cycle (2009) |
| | Estimation of $CO_2$ and $CH_4$ Surface Fluxes (2009) |
| | Transport processes over the Mediterranean Basin as diagnosed from the evolution of long-lived species: Spaceborne measurements and modeling studies (2011) |
| GERMANY | Cloud Remote Sensing using GOSAT Instruments (2008) |
| | Towards Consistent Long-term SCIAMACHY and GOSAT Greenhouse Gas Data Sets (CONSCIGO) (2008) |

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| | Distributions of $CO_2$ and $CH_4$ over Eurasia between 30°N and 90°N (2008) |
| | Non-standard Cloud, Aerosol, and Albedo Products (2008) |
| | Quantification of the Carbon Cycle in Europe and Western Africa by the Top-down Method (2008) |
| | Validation of TANSO $CH_4$ Columns and Profiles by Ground-based Solar Absorption FTIR (2008) |
| | Validation of GOSAT Methane, Carbon Dioxide, and Water Vapor at the Ground-Truthing Facility Garmisch / Zugspitze (2009) |
| | Validation of Vertical Profiles and Column Densities Retrieved from Nadir Infrared Sounders (2010) |
| INDIA | Interaction Between Atmospheric Greenhouse Gases & Terrestrial Biospheric Processes Over Indian Subcontinent(2009) |
| | Estimation of tropical forest biophysical parameters using near UV and NIR reflectance from GOSAT TANSO-CAI sensor (2011) |
| INDONESIA | REDD Plus and Estimation of land-atmosphere carbon exchange using ground-based and GOSAT data in Industrial Plantation Forest: Paser-East Kalimantan and Jambi (2011) |
| KOREA | Quantification of radiative forcing of CO2 and black carbon from GOSAT measurements with the aid of Asia Carbon Tracker and numerical models(2009) |
| | Evaluation of long-range transport of greenhouse gases (hereinafter refer to as "GHGs")(CO2 and CH4) and estimation of GHGs emission sources using GOSAT data and atmospheric chemistry model for the better understanding of carbon cycle (2011) |
| THE NETHERLANDS | Retrieval of Methane, Carbon Dioxide, and Water Vapor from GOSAT Near-infrared Spectra (2008) |
| | Intercomparison of $CO_2$ Fluxes Estimated using Inverse Modeling of GOSAT and OCO Measurements (2008) |
| | Study of Aerosol and Cloud Properties by using Polarization of the $O_2$A band (2008) |
| | Retrievals of Atmospheric $CO_2$ from GOSAT Observations Based on Accurate Vector Radiative Transfer Modeling of Scattering Atmospheres (2009) |
| | Retrieval of $CH_4$ from GOSAT-FTS measurements using a full physics approach based on accurate radiative transfer and an approach using the $CO_2$ column as a light path proxy (2011) |
| NEW ZEALAND | Southern Hemisphere Validation of GOSAT $XCO_2$ and $XCH_4$ from TCCON Solar FTS Measurements in Australia and New Zealand (2008) |
| NORWAY | Greenhouse Gas Emissions in South Asia using Inverse Modeling (2009) |
| RUSSIA | Simulation of Cirrus Clouds and Humidity in UTLS by using a Coupled Cirrus/Trajectory Model, and Modification of the Transport Models used for the Purposes of Greenhouse Gas Inversion (2008) |
| | Development of Methods and Software for Retrieval of $CO_2$ and $CH_4$ Spatial Distributions from TANSO-FTS and TANSO-CAI Sensor Data, and Application of these Methods to Analysis of the Atmosphere over Western Siberia (2008) |
| | Development of Radiative Transfer Technique for Arbitrary 3K Geometry with |

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| | Consideration of Polarization Effects (2008) |
| | Development of Column Amounts and Concentration Profiles for Retrieving Algorithms for $CO_2$ and $CH_4$ from Satellite Data using A Priori Information (Neural Network Approach) (2008) |
| SINGAPORE | Satellite-Borne Quantification of Carbon Dioxide Emissions from Volcanoes and Geothermal Areas(2009) |
| SPAIN | Space-based analysis of the relationship between vegetation functioning and atmospheric CO2 and CH4 greenhouse gases.(2009) |
| | The role of oceanic mesoscale structures in the air-sea fluxes (2011) |
| TAIWAN | Comparing path radiances estimated using GOSAT CAI images and Formosat II images (2011) |
| UK | Application of GOSAT Data in a 4D-Var Data Assimilation System, in Combination with Other Greenhouse Gas Observations, to Better Estimate $CO_2$ and $CH_4$ Fluxes (2008) |
| | The UK Universities' Contribution to the Analysis of GOSAT L1 and L2 Data: Towards a Better Quantitative Understanding of Surface Carbon Fluxes (2008) |
| | Validation of TANSO FTS Spectra Using RFM Line-by-Line Model (2010) |
| | Using Envisat MERIS MTCI to Characterize the Response of the Terrestrial Biosphere to Spatio-temporal Variability in Atmospheric Carbon Dioxide as Measured by GOSAT FTS (2009) |
| | Using GOSAT to Help Improve the Representation of Wetlands and Associated $CH_4$ Cycle in the next Generation Global Land Surface Models (2009) |
| USA | Early Detection of Leakage from Siberian and Alaskan Gas Pipelines (2008) |
| | Infrared Validation and Mid-tropospheric $CO_2$ from the FTS GOSAT Sensor (2008) |
| | Trace Gas Remote Sensing using Near IR and Longwave IR (2008) |
| | Validation of a Lidar System for the Measurement of $CO_2$ (2008) |
| | Evaluation and Validation of GOSAT CAI Vegetation Index Products using MODIS, AVHRR, and In Situ Data over the Conterminous United States and Hawaii (2008) |
| | Assessment of GOSAT TIR FTS Absolute Calibration through Validation (2008) |
| | Validation of GOSAT Data Products (2009) |
| | GOSAT and Oceanographic Observations of $CO_2$ and $CH_4$ on the Laptev and East Siberian Shelf Seas (2009) |
| | Comparison of GOSAT $CH_4$ and $CO_2$ with NOAA/NESDIS Operational Trace Gases Products Retrieved from AIRS, IASI and CrIS and Use of CAI Aerosol Product for NOAA Synergy Studies of Using Satellite Data for Air Quality Applications (2009) |
| | Assessment of GOSAT Radiance Responses to the Lower Atmospheric $CO_2$ Concentration Change and Impact of Aerosols and Clouds on $CO_2$ Concentration Retrievals (2009) |
| | Comparison of GOSAT Retrievals of the $CO_2$ and $CH_4$ Column Mole Fractions with In-Situ Data and Estimates Produced by the Carbon Tracker Data Assimilation System (2009) |
| | Application of GOSAT/TANSO-FTS to the Measurement of Volcanic $CO_2$ |

Emissions (2009)
Global Analysis of Carbon Sources and Sinks with a Comprehensive Model Optimized with GOSAT/TANSO Observations (2009)
GOSAT Synergies for Ground-Reference of $CH_4$-Emissions from Geologic and Biologic Mid-Latitude and Arctic Sources (2009)
Tracing and quantifying power plant $CO_2$ emissions with GOSAT: Validation and Modeling in the Four Corners New Mexico to Oklahoma Region (2010)
Assessment and monitoring of $CO_2$ and $CH_4$ in wildfire and healthy boreal forest, Interior Alaska (2011)
Assessment of GOSAT/TANSO-FTS $CO_2$ variations in relation to biomass burning and vegetation fires (2011)
Validation of satellite-derived methane budgets from fugitive fossil fuel industrial emissions (2011)

## Host Division

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

## Center for Global Environmental Research

**Schutgens**, Nicolaas Alexander Johannes, NETHERLAND, 2010.4.1～2011.3.31
Development, improvement and validation of an aerosol transport model for the GOSAT data processing (Yokota, T.)

**Kim, Heon-Sook**, KOREA, 2010.4.1～2011.3.31
Application of transport modeling for inverse estimation of methane fluxes with GOSAT product (Maksyutov, S.)

**Go**, Ensyun, CHINA, 2010.5.1～2011.3.31
Visualization and assessment of policies towards low carbon society(Kameyama,Y.)

**Sung**, Sun Yong, KOREA, 2011.1.11～2011.2.17
Research on projection of climate change impacts on climate change (Takahashi, K.)

**Park**, Chan, KOREA, 2011.1.11～2011.2.21
Implication of policy measures with low carbon society for Korea (Kainuma, M.)

## Research Center for Material Cycles and Waste Management

**Li**, Yu-you, CHINA, 2010.4.1～
Studies on the development of the technology for hydrogen and methane fermentation from biomass (Xu, K.)

**Lu**, Xi-wu, CHINA, 2010.4.1～
Studies on development of appropriate treatment technology for decentralized liquid wastes (Xu, K.)

**Kong**, Hai-nan, CHINA, 2010.4.1～
Studies on advanced treatment and energy recovery from liquid wastes using Bio-eco technology (Xu, K.)

**Ju**, Mun-sol, KOREA, 2010.6.1～
Analysis on the cut of the environmental impact according to the change of consumer behavior in food lifecycle system (Osako, M)

**Wang**, Heming, CHINA, 2010.8.30～
Study on material flows and resource productivity (Hashimoto, S.)

**Deng**, Heng-wei, CHINA, 2010.9.27～2011.3.31
Study on methane fermentation technology with membrane separation (Xu, K.)

**Wu**, Ya-pen, CHINA, 2010.9.27～2011.3.31
Bio-fuel production from food waste by two-phase hydrogen and methane fermentation System (Xu, K.)

**Lu**, Zhijiang, CHINA, 2010.9.27～
Studies on the purification and growth function of aquatic plants and its effective utilization (Xu, K.)

**Tang**, Qiang, CHINA, 2010.11.22~2011.3.21
Control of environmental impact from landfill site (Endo, K.)

## Research Center for Environmental Risk

**Pak**, Jeong-Che, KOREA, 2010.4.1～
Analysis of causal factors for declining the star-spotted dogfish population in Tokyo Bay (Horiguchi,T.)

**Li**, Jialin, CANADA, 2010.6.7～2011.3.31
Toward a Multi-sense Framework on Conservation of Irrigation Ponds -Case Study in Nishikanki Area, Kakogawa City, Hyogo Prefecture- (Takamura, N.)

**Puzyn**,Tomasz, POLAND, 2010.6.10～2010.7.31
Collaborative study of integrated approach of QSPR and multimedia model for selected POPs and pharmaceuticals (Suzuki, N.)

**Gaworski**, Kamil, POLAND, 2010.6.10～2010.7.31
Collaborative study of integrated approach of QSPR and multimedia model for selected POPs and pharmaceuticals (Suzuki, N.)

**Kim**, Hyun-Young, KOREA, 2010.11.1～2011.3.31
Study of effects of new persistent organic pollutants on differentiation of neuronal cell lineages derived from mouse ES cells (Sone, H.)

**Sukketsiri**, Wanida, THAILAND , 2011.1.4～2011.3.31
Effects of heavy metals on human cells (Hirano,S)

**Joo**, Sung Bae, KOREA, 2011.1.11~2011.2.17
Monitoring of phytoplankton community structure using molecular methods (Tanaka,Y.)

## Asian Environment Research Group

**Liu**, Chen, CHINA, 2010.4.1～
Development of the systems for evaluating regional water and material cycles in East Asia(Wang, Q.)

**Tang**, Changyuan, CHINA, 2010.4.1～2011.3.31
Degradation of ground water resources in river basin (Murakami, S.)

**Phomikong**, Pisit, THAILAND, 2010.4.1～2011.3.31
Scenario-based assessment of the potential effects of alternative dam construction schemes on freshwater fish diversity in the Lower Mekong Basin (Fukushima, M.)

**Jiang**, Ping, CHINA, 2010.9.1～
Proposal to Establish Low carbon Communities Using the Online Management System in Japan and China (Fujita, T)

**Dreyfus**, Magali Isabelle, FRANCE, 2010.9.10～
Integrating Climate Change actions in the provision of essential services in cities of developing countries (Fujita, T.)

## Social and Environmental Systems Division

**Deshpande**, Aashish, INDIA, 2010.7.1～2011.3.31
Development of Asia Low Carbon Society Scenario (Masui, T.)

**Ki**, Moon-Bong, KOREA, 2010.7.1～
Comparative Study on Japanese and Korean Environmental Policy (Hibiki, A.)

## Environmental Chemistry Division

**BLEI**, E. Manuel, GERMANY, 2010.9.1～
Quantification of UV-induced methane and methyl halide fluxes from tropical vegetation (Yokouchi, Y.)

## Environmental Health Sciences Division

**Bao**, Jinhua, CHINA, 2009.6.1～2010.3.31
Studies on epigenetic effects of arsenic (Nohara.K.)

## Atmospheric Environment Division

**Xing**, Jia-hua, CHINA, 2010.4.1～2011.3.31
Studies on variability of stratospheric processes and uncertainties in the prediction of future change of

stratospheric ozone (Imamura, T.)

**Huang**, Zhongwei, CHINA, 2010.10.1～
Observational study on optical properties and distributions of aerosols and clouds using lidars (Sugimoto,N)

**Bi**, Jianrong CHINA, 2010.11.4～2011.1.22
Technical training and application of Two-Wavelength Mie-Scattering Lidar (Sugimoto, N)

**Kim**, Nakyung, KOREA, 2011.2.21~2011.3.31
Improvement of emission inventories of atmospheric pollutants in East Asia (Ohara,T)

## Water and Soil Environment Division

**Choeisai**, Pairaya Kucivilize, THAILAND, 2010.5.1～
Development of treatment technology for Vinasse wastewater (Syutsubo, K.)

**Yoochatchaval**, Wilasinee, THAILAND, 2010.5.1～
Investigation of anaerobic degradation mechanism of Vinasse (Syutsubo, K.)

## Environmental Biology Division

**Cho**, Kyoungwon, KOREA, 2010.4.1～2011.3.31
Study on evaluation of effects of high temperature and ozone on rice by analysis of molecular markers in panicles and seeds (Kubo, A.)

**Choi**, Sung Ho, KOREA, 2011.1.11～2011.2.17
Development of Terrestrial Ecosystem Model for Forest Management in Vulnerability Assessment of Climate Change (Tang, Y.)

Abe O., Watanabe A., Sarma V.V.S.S., Matsui Y., Yamano H., Yoshida N., Saino T., 2010, Air-Sea gas transfer in a shallow, flowing and coastal environment estimated by dissolved inorganic carbon and dissolved oxygen analyses, J.Oceanogr., 66(3), 363-372

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Aramaki T., Nojiri Y., Mukai H., Kushibashi S., Uchida M., Shibata Y., 2010, Preliminary results of radiocarbon monitoring in the surface waters of the North Pacific, Nucl. Instrum. Methods Phys.Res.,B, 268(7/8), 1222-1225

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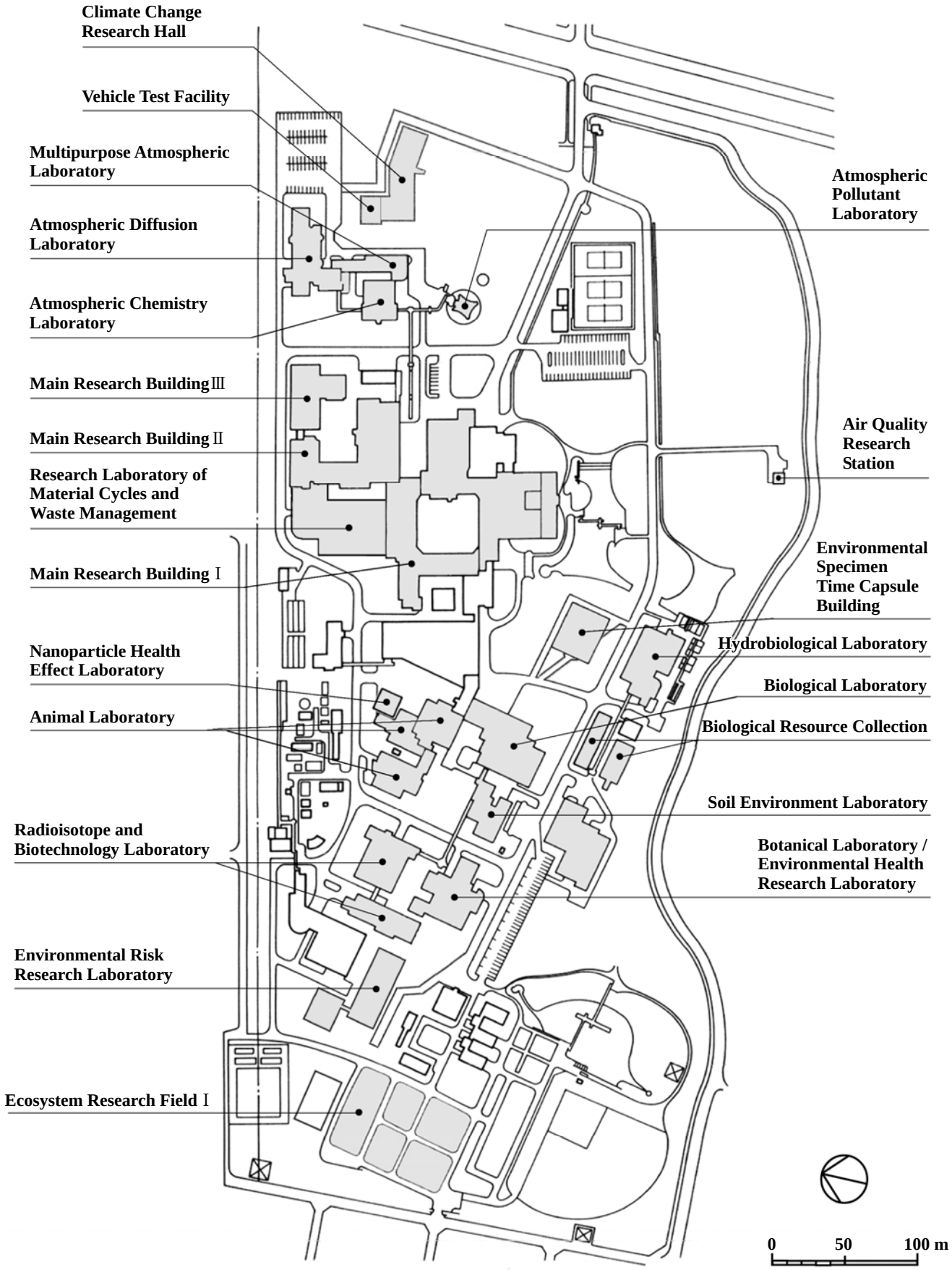
Climate Change Research Hall
Vehicle Test Facility
Multipurpose Atmospheric Laboratory
Atmospheric Diffusion Laboratory
Atmospheric Chemistry Laboratory
Main Research BuildingⅢ
Main Research BuildingⅡ
Research Laboratory of Material Cycles and Waste Management
Main Research BuildingⅠ
Nanoparticle Health Effect Laboratory
Animal Laboratory
Radioisotope and Biotechnology Laboratory
Environmental Risk Research Laboratory
Ecosystem Research FieldⅠ
Atmospheric Pollutant Laboratory
Air Quality Research Station
Environmental Specimen Time Capsule Building
Hydrobiological Laboratory
Biological Laboratory
Biological Resource Collection
Soil Environment Laboratory
Botanical Laboratory / Environmental Health Research Laboratory
0 50 100 m

**Air Quality Research Station**

Automatic instruments for monitoring the concentrations of eight atmospheric constituents ($NO_x$, $SO_2$, $O_3$, methane and non-methane hydrocarbons, suspended particulate matter and PM2.5, and gaseous Hg) are operated at this station. Wind speed, precipitation, atmospheric pressure, visible and UV radiation, temperature, and other atmospheric characteristics are also measured. The stability and accuracy of the automated measurements and the factors that interfere with them have been studied. The monitoring results are made available to NIES researchers as fundamental data for various studies, and simplified processing data are also opened in the NIES Home page.

**Animal Laboratory**

The animal laboratory has three controlled-environment facilities. Facility I has complex gas or diesel exhaust particle (DEP) exposure chambers for investigating the health effects of $PM_{2.5}$ and DEPs. Facility II has a conventional laboratory animal breeding unit and laboratories for studying the effects of chemicals, including dioxins and heavy metals. Facility III was built in 2004 as a nanoparticle health effects research facility; it has exposure chambers and two diesel engines for generating nanoparticles. Research on the health effects of nanoparticles began in FY 2005 using experimental animals.

**Atmospheric Chemistry Laboratory**

This laboratory has a 6-$m^3$ evacuable chamber with an inner surface coated with Teflon. The chamber is used to study atmospheric chemical reactions. This facility is essential to our research on atmospheric pollution, including photochemical ozone formation, degradation of volatile organic compounds, secondary aerosol formation, and other important atmospheric phenomena.

**Atmospheric Diffusion Laboratory**

A wind tunnel is housed in this laboratory. Our wind tunnel is exceptional in that wind velocity (down to 0.2 m $s^{-1}$), air temperature, and floor temperature can be controlled independently to create various atmospheric conditions. Temperature and wind-velocity sensors on a computer-controlled gantry can be positioned at arbitrary locations to obtain three-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 in a variety of real-world situations.

**Biological Laboratory**

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 facilitates the exposure of experimental plants to pollutant gases under these controlled conditions.

**Biological Resource Collection**

The collection is equipped with various standalone incubators (5 to 50 ºC), culture rooms (10 to 22 ºC), a programmable freezer, a liquid nitrogen supply system with sixteen 245-L tanks, a scanning electron microscope, various types of light microscopes, and molecular taxonomy equipment. Two projects are conducted in the collection. One is the Microbial Culture Collection (known as NIES-Collection) and the other is *ex situ* conservation of endangered algae. In these two projects, the collection maintains a total of about 2900 strains of microalgae, protozoa, and endangered macroalgae. Among them, 2351 strains are available to researchers inside and outside NIES. In FY2010, researchers were supplied with 923 strains.

**Climate Change Research Hall**

The hall was completed in March 2001 and has three floors with a total area of 4900 $m^2$. Three major research programs are conducted in this facility: (1) development and implementation of climate change models based on various socioeconomic 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. The hall also contains equipment to evaluate low-emission vehicles.

**Ecosystem Research Field**

The main field on the NIES campus and the branch field, 4km to the west, have experimental plots for various types of plant-dominated ecosystems, lysimeters, greenhouses, observation towers, and laboratories. These facilities are used to study ecosystem processes under regulated outdoor conditions; to develop remote-sensing techniques from small-scale ground-truth data; and to supply plants, particularly for bioassays and mitigation studies.

**Environmental Risk Research Laboratory**

This laboratory is the core research facility of the Research Center for Environmental Risk. Its staff conduct extensive studies of ecological effects, human health effects, and environmental exposure, and they collect, analyze, and disseminate related information. The building is equipped with several special facilities, including freshwater and marine exposure systems for ecotoxicological research, a room for breeding laboratory animals, and instruments such as a liquid chromatograph – tandem mass spectrometer for qualitative and quantitative analysis of environmental chemicals and a confocal laser scanning microscope for cell biology.

**Environmental Specimen Time Capsule Building**

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 long-term storage of environmental specimens such as mussels and air particulates, as well as cells and the genetic material of threatened species.

**Forest ecosystem sites for monitoring carbon sequestration**

These monitoring facilities were established to study the carbon balance of terrestrial ecosystems and to evaluate the methods used to monitor this balance. All three sites are located in planted larch forests: one in Yamanashi Prefecture and two in Hokkaido, Japan's northernmost prefecture.

1) Fuji Hokuroku Flux Observation Site

This site was established in January 2006 in a forest composed mainly of planted larches in the foothills of Mt. Fuji in Yamanashi Prefecture. It is used to investigate the magnitude of the carbon sources and sinks in terrestrial ecosystems. It also serves as the principal monitoring site of the AsiaFlux network, an organization that promotes cooperation and the exchange of information on carbon flux observation in Asia.

2) Teshio Carbon Cycle and Larch Growth Experimental Site

This site, established in 2001, comprises one catchment in Hokkaido University's Teshio Experimental Forest in Horonobe, Hokkaido. At this site, we are focusing our research on the transition of carbon flow during tree growth periods. After the felling of a natural forest of coniferous and broad-leaved trees in February 2003, we planted larch saplings in October of the same year. We are now using standard forestry practices to manage these saplings and are monitoring the carbon flux.

3) Tomakomai Flux Research Site

This site was established in August 2000 in a planted larch forest in the foothills of Mt. Tarumae, near Tomakomai, in Hokkaido. Unfortunately, it was destroyed by a typhoon in September 2004. Since June 2005, we have been using the restored site to study the transition of the carbon balance in the devastated forest.

**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 the island. Cape Ochi-ishi Station is located in the eastern part of Hokkaido. These stations use automated systems for high-precision monitoring of greenhouse gases (e.g., $CO_2$, $CH_4$, $N_2O$, $O_3$) and other atmospheric species ($NO_x$, $SO_2$, suspended particulate matter). Long-term monitoring data are archived and distributed through the Center for Global Environmental Research home page and the World Data Centre for Greenhouse Gases.

**Hydrobiological Laboratory**

The Hydrobiological Laboratory was established to study organism-related environmental problems in water bodies. The toxicity testing system is suitable for long-term exposure studies. Other associated facilities include temperature- and light-controlled culture rooms, axenic culture rooms, large autoclaves, and an outdoor experimental pond. Some laboratories can be used for chemical and biological experiments on water and soil environment restoration and liquid waste treatment.

**Main Research Building**

The building houses analytical instruments and support facilities such as clean rooms. These instruments permit accurate, highly sensitive, and selective detection of harmful substances in environmental samples. Stable isotope analyses facilitate research on global warming and the origins of pollutants. Among the instruments (listed below) are some that are used for research and development of new analytical methods.

**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) |
| X-ray diffractometer |

**Main Research Building II**

**Preservation Laboratory**

This facility includes –20 ºC, 5 ºC, and 20 ºC temperature-controlled rooms where various environmental samples collected by field researchers are stored until they are put to practical use. The facility was previously used for environmental specimen banking; samples collected previously for long-term environmental monitoring have now been transferred to the Time Capsule Building.

**Main Research Building III**

1) Tandem mass spectrometer (MS/MS)

Two double-focus-type mass spectrometers are connected serially (in tandem). The resolution of the first is $6.5 \times 10^4$ and that of the second is $5 \times 10^3$. Ions selected by the first MS are passed through the collision cell, where they yield fragments that are analyzed by the second MS. The chemical structures of complex molecules can be determined with this instrument.

2) NIES-TERRA: accelerator mass spectrometer (AMS) facility

An electrostatic tandem accelerator of 5 MV (max.) terminal voltage is interfaced with two ion sources and an analytical mass spectrometer. Isobaric atomic ions can be distinguished by the electrical charges of their nuclei. The AMS is a very sensitive and selective tool 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.

3) Hazardous Chemicals Area

Experiments using highly toxic substances such as dioxins (chlorinated dibenzodioxins), polychlorinated biphenyls, and polychlorinated dibenzofurans are conducted in this area. The air pressure inside the area is maintained below atmospheric pressure to prevent leakage of hazardous substances. 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 and a microcosm, as well as facilities for microorganism-related research, animal exposure experiments, and measurements of the physical and chemical properties of substances.

4) GOSAT Data Handling Facility

The Greenhouse Gases Observing Satellite (GOSAT) Data Handling Facility (DHF) processes GOSAT data. The facility's tasks include data acquisition from JAXA (the Japan Aerospace Exploration Agency), processing, reprocessing, and storage; validation of the processed products; and data distribution. The major part of GOSAT DHF is located at NIES, but there are some external facilities that contribute to the overall function. After the successful launch of GOSAT on January 23, 2009, GOSAT DHF has been operating to perform the tasks mentioned above. The revised level 2 Version 01.** data products (column abundances of carbon dioxide and methane) have been released to the general users since August 24, 2010. The Level 3 data products of global distribution of concentrations of carbon dioxide and methane have been released to the general users since November 10, 2010.

5) Millimeter-wave spectrometer 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 ozone emission spectra on altitude. The spectrometer was installed in 1995. Since then, ozone has been monitored continuously, except on rainy days and heavily humid days.

6) Facility for receiving and processing NOAA satellite data

Advanced Very High Resolution Radiometer (AVHRR) instruments orbit Earth on US National Oceanic and Atmospheric Administration (NOAA)

satellites. They monitor five electromagnetic wavelength bands from the visible to the thermal infrared region with high temporal and moderate spatial resolution (about 1 km × 1 km). The AVHRR facility of NIES was able to receive these data up to March 2004. The data received up until that time are being processed and archived by the facility.

7) Global Resource Information Database (GRID)-Tsukuba information processing center GRID-Tsukuba is a part of the CGER Global Environmental Database. The GRID information processing system was introduced at NIES in 1994. This remote-sensing image-processing system and geographic information system processes GRID data and produces original datasets. Several software packages, including ERDAS/IMAGINE, ARC/INFO, IDRISI, and GRASS, are installed on workstations and PCs.

**Nanoparticle Health Effect Laboratory**

This laboratory is equipped with experimental facilities to provide new information on the health effects, chemical and physical properties, behavior, and translocation of nanoparticles. There are four whole body inhalation chambers designed for chronic toxicological studies on environmental nanoparticles and one nose-only inhalation chamber designed to investigate acute toxicity of carbon nanotubes.

**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 peptide and DNA sequencers, are available on the first floor. The second floor is a radioisotope-controlled area used for 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**

NIES established this laboratory in March 2002. The laboratory supports research on resource circulation and waste management, including resource recovery and recycling of waste. It also develops technologies for testing, evaluation, and monitoring to reduce environmental risk and to restore polluted sites.

**Research Station for 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 researchers in universities and private companies as well as in NIES. The station's location allows *in situ* studies of pollution, water quality recovery, lake ecosystem dynamics, and elemental cycles in this heavily eutrophicated lake.

2) Bio-Eco Engineering Research Laboratory

This laboratory studies, develops, and field-tests liquid waste treatment and resource recovery systems such as the Johkasou system, hydrogen-methane fermentation systems, phosphorus recovery systems, and aquatic plant-soil purification systems. Actual domestic wastewater samples are used to develop and evaluate liquid waste treatment technologies. Air and wastewater temperatures are controlled to simulate the four seasons in Japan and the climates of Asian countries. Many people employed in research institutes, universities, government, and private companies visit the laboratory. The laboratory also plays an important role as a core facility for international cooperative research.

**Rikubetsu Stratospheric Monitoring Station**

NIES has been monitoring the ultraviolet radiation in a room of Hokkaido's Rikubetsu Astronomical Observatory, which is run by the Rikubetsu town council. The observatory monitors long-term change in harmful ultraviolet radiation that reaches the earth's surface due to stratospheric ozone depletion by UV-A radiometer, UV-B radiometer, UV

grating spectrometer and Brewer spectrometer. Since parts of the polar vortex sometimes arrive over Hokkaido in winter or spring, Rikubetsu is one of the sites used to study the effects of ozone depletion in the Arctic.

**Soil Environment Laboratory**

The Soil Environment Laboratory contains unique large and small monolithic lysimeters in which the behavior of pollutants such as heavy metals, nitrates, and sulfates are investigated. The effects of pollutants on soil ecosystems (including the soil– organism–plant system) are also investigated.

**Vehicle Test Facility**

The Vehicle Test Facility is equipped with an environment simulation room, a chassis dynamometer, conventional exhaust measurement systems, and the devices developed by NIES, including an exhaust gas dispersion chamber and a dilution tunnel with high dilution ratio capacity as well as onboard fuel economy and emission measurement systems to measure and evaluate real-world vehicle exhaust and performance.

**Number of personnel**

| | |
|---|---|
| President | 1 |
| Executive Director | 2 |
| Auditor | 2 |
| Planning Division | 11 |
| General Affairs Division | 32 |
| Audit Section | 2 |
| Center for Global Environmental Research | 30 |
| Research Center for Material Cycles and Waste Management | 19 |
| Research Center for Environmental Risk | 24 |
| Asian Environment Research Group | 20 |
| Social and Environmental Systems Division | 13 |
| Environmental Chemistry Division | 14 |
| Environmental Health Sciences Division | 17 |
| Atmospheric Environment Division | 14 |
| Water and Soil Environment Division | 16 |
| Environmental Biology Division | 21 |
| Laboratory of Intellectual Fundamentals for Environmental Studies | 9 |
| Environmental Information Center | 10 |
| Total | 257 |

**Fields of expertise**

| | |
|---|---|
| Basic Sciences | 69 |
| Engineering | 60 |
| Agricultural Sciences | 23 |
| Medical Sciences | 11 |
| Pharmaceutical Sciences | 6 |
| Economics | 3 |
| Fisheries Sciences | 3 |
| Philosophy | 3 |
| Law | 1 |
| Veterinary Sciences | 1 |
| Total | 180 |

| Division<br>Section/Team | Position | Staff Member |
|---|---|---|
| **Headquarters** | President | OHGAKI, Shinichiro |
| | Executive Director (Research) | YASUOKA, Yoshifumi |
| | Executive Director (Management) | KABURAGI, Yoshiro |
| | Auditor | FUNABASHI, Motohisa |
| | Auditor | KOBAYASHI, Nobuyuki |
| **Planning Division** | Director | SAITO, Makoto |
| | Deputy Director | OSAKO, Masahiro |
| | Deputy Director | TAKIMURA, Akira |
| | Principal Research Coordinator (*) | TANABE, Kiyoshi |
| | Principal Research Coordinator (*) | KORESAWA, Yuji |
| Planning Office | Chief (*) | TAKIMURA, Akira |
| | Research Coordinator | YAMANE, Masanori |
| Research Coordination Office | Chief | MORI, Yasufumi |
| | Research Coordinator (*) | TASAKI, Tomohiro |
| | Research Coordinator (*) | ITO, Tomohiro |
| | Research Coordinator (*) | IWASAKI, Kazuhiro |
| | Research Coordinator (*) | MURATA, Tomoyoshi |
| | Research Coordinator | KUME, Hiroshi |
| Office of Public Relation and International Coordination | Chief | MURAKAMI, Masaharu |
| | Research Coordinator (*) | HIROKANE, Katsunori |
| **General Affairs Division** | Director | KASAI, Toshihiko |
| General Affairs Section | Chief | ISHITSUKA, Fumihiko |
| Accounting Section | Chief | NAKAGOME, Akira |
| Facility Management Section | Chief | KUME, Hideyuki |
| **Audit Section** | Chief | SAKAMOTO, Fumio |
| **Center for Global Environmental Research** | Director | SASANO, Yasuhiro |
| | Deputy Director | NOJIRI, Yukihiro |
| | Special Senior Researcher | Shamil Maksyutov |
| | Special Senior Researcher | YAMAGATA, Yoshiki |
| Global Carbon Cycle Research Section | Chief | MUKAI, Hitoshi<br>LIANG, Naishen<br>TAKAHASHI, Yoshiyuki |
| Satellite Remote Sensing Research Section | Chief | YOKOTA, Tatsuya |

(*) Multiple roles

| | | |
|---|---|---|
| | | MORINO, Isamu<br>YAMANO, Hiroya<br>YOSHIDA, Yukio |
| Climate Risk Assessment Research Section | Chief | EMORI, Seita<br>TAKAHASHI, Kiyoshi<br>OGURA, Tomoo<br>ITO, Akihiko<br>YOKOHATA, Tokuta |
| Climate Policy Assessment Research Section | Chief | KAINUMA, Mikiko<br>KAMEYAMA, Yasuko<br>FUJINO, Junichi<br>HANAOKA, Tatsuya<br>ASHINA, Shuichi |
| Office for Atmospheric and Oceanic Monitoring | Chief | MACHIDA, Toshinobu<br>SHIRAI, Tomoko |
| Office for Terrestrial Monitoring | Chief | SAIGUSA, Nobuko<br>OGUMA, Hiroyuki |
| Office for Global Environmental Database | Chief | MATSUNAGA, Tsuneo |
| | (*) | MORIGUCHI, Yuichi |
| | (*) | NAKANE, Hideaki |
| | (*) | YOKOUCHI, Yoko |
| | (*) | TOHJIMA, Yasunori |
| | (*) | IMAI, Akio |
| | (*) | TANIMOTO, Hiroshi |
| | (*) | ICHINOSE, Toshiaki |
| | (*) | TANAKA, Atsushi |
| | (*) | ARAMAKI, Takafumi |
| | (*) | KOMATSU, Kazuhiro |
| **Research Center for Material Cycles and Waste Management** | Director | MORIGUCHI, Yuichi |
| | Deputy Director | ― |
| | Research Coordinator (*) | YAMANE, Masanori |
| Sustainable Material Cycles System Section | Chief (*) | MORIGUCHI, Yuichi<br>HASHIMOTO, Seiji<br>NANSAI, Keisuke |
| International Material Cycles Section | Chief | TERAZONO, Atsushi<br>YOSHIDA, Aya<br>NAKAJIMA, Kenichi |
| Material Cycles System Engineering Section | Chief(*) | OSAKO, Masahiro |

(*) Multiple roles

| | | |
|---|---|---|
| | | TASAKI, Tomohiro |
| Recycling and Disposal Engineering Section | Chief | KAWAMOTO, Katsuya<br>YAMADA, Masato<br>ENDO, Kazuto<br>ISHIGAKI, Tomonori |
| Waste Testing and Assessment Section | Chief | KURAMOCHI, Hidetoshi<br>YAMAMOTO, Takashi |
| Material and Substance Management Section | Chief | TAKIGAMI, Hidetaka<br>SAKANAKURA, Hirofumi<br>WATANABE, Mafumi<br>KAJIWARA, Natsuko |
| Bio-Eco Engineering Section | Chief | XU, Kaiqin<br>EBIE, Yoshitaka |
| **Research Center for Environmental Risk** | Director<br>Deputy Director<br>Special Senior Researcher<br>Special Senior Researcher<br>Research Coordinator(*) | SHIRAISHI, Hiroaki<br>AOKI, Yasunobu<br>HORIGUCHI, Toshihiro<br>GOKA, Kouichi<br>SUGAYA, Yoshio |
| Exposure Assessment Research Section | Chief | SUZUKI, Noriyuki<br>SAKURAI, Takeo<br>IMAIZUMI, Yoshitaka |
| Health Risk Research Section | Chief(*) | AOKI, Yasunobu<br>SONE, Hideko<br>MATSUMOTO, Michi<br>FURUHAMA, Ayako<br>KAWAHARA, Junko |
| Ecological Risk Research Section | Chief | TANAKA, Yoshinari<br>SUGAYA, Yoshio<br>YOKOMIZO, Hiroyuki |
| Environmental Quality Measurement Section | Chief | SHIRAISHI, Fujio<br>TATARAZAKO, Norihisa<br>NAKAJIMA, Daisuke |
| Environmental Sensitivity Research Section | Chief | FUJIMAKI, Hidekazu<br>ISHIDO, Masami<br>KUROKAWA, Yoshika |
| Environmental Nanotoxicology Section | Chief | HIRANO, Seishiro<br>FURUYAMA, Akiko |

(*) Multiple roles

| | | |
|---|---|---|
| | | FUJITANI, Yuji |
| Ecosystem Impact Research Section | Chief | TAKAMURA, Noriko |
| **Asian Environment Research Group** | Director<br>Deputy Director<br>Special Senior Researcher | NAKANE, Hideaki<br>―<br>SHIMIZU, Hideyuki |
| Asian Atmosphere Section | Chief | TAKAMI, Akinori<br>SATO, Kei<br>SHIMIZU, Atsushi |
| Regional Atmospheric modeling Section | Chief | OHARA, Toshimasa<br>NAGASHIMA, Tatsuya<br>MORINO,Yu |
| Asian Water Environment Section | Chief | WANG, Qinxue<br>MIZUOCHI, Motoyuki<br>KOSHIKAWA, Hiroshi<br>HIGASHI, Hironori<br>OKADERA, Tomohiro |
| Environmental Technology Assessment System Section | Chief<br>(*) | FUJITA, Tsuyoshi<br>XU, Kaiqin<br>NAKAYAMA, Tadanobu<br>FUJII, Minoru |
| Watershed Ecosystem Section | Chief | NOHARA, Seiichi<br>KAMEYAMA, Satoshi<br>FUKUSHIMA, Michio<br>INOUE, Tomomi |
| **Social and Environmental Systems Division** | Director | HARASAWA, Hideo |
| Environmental Economics and Policy Section | Chief | HIBIKI, Akira<br>KUBOTA, Izumi<br>OKAGAWA, Azusa |
| Environmental Planning Section | Chief<br>(*) | AOYAGI, Midori<br>MORI, Yasufumi<br>ICHINOSE, Toshiaki |
| Integrated Assessment Section | Chief | MASUI, Toshihiko<br>HIJIOKA, Yasuaki<br>HANASAKI, Naota<br>KANAMORI, Yuko |

(*) Multiple roles

| | | |
|---|---|---|
| Transportation and Urban Environment Section | Chief | ―<br>SUGA, Shinsuke<br>KONDO, Yoshinori<br>MATSUHASHI, Keisuke |
| **Environmental Chemistry Division** | Director<br>Principal Senior Researcher | SHIBATA, Yasuyuki<br>TANABE, Kiyoshi |
| Advanced Organic Analysis Section | Chief (*) | TANABE, Kiyoshi<br>HASHIMOTO, Shunji<br>TAKAZAWA, Yoshikatsu<br>FUSHIMI, Akihiro |
| Advanced Inorganic Analysis Section | Chief | SEYAMA, Haruhiko<br>TANAKA, Atsushi<br>UCHIDA, Masao |
| Environmental Chemodynamics Section | Chief | YOKOUCHI, Yoko<br>ARAMAKI, Takafumi<br>SAITO, Takuya |
| Biological Imaging and Analysis Section | Chief | MITSUMORI, Fumiyuki<br>UMEZU, Toyoshi<br>WATANABE, Hidehiro |
| **Environmental Health Sciences Division** | Director<br>Deputy Director<br>Deputy Director<br>Special Senior Researcher | TAKANO, Hirohisa<br>NITTA, Hiroshi<br>KORESAWA, Yuji<br>MOCHITATE, Katsumi |
| Molecular and Cellular Toxicology Section | Chief | NOHARA, Keiko<br>KOBAYASHI, Yayoi<br>SUZUKI, Takehiro |
| Biological Risk Assessment Section | Chief | ―<br>KOIKE, Eiko<br>ITO, Tomohiro |
| Integrated Health Risk Assessment Section | Chief(*)<br>(*) | TAMURA, Kenji<br>SATO, Yuki |
| Environmental Epidemiology Section | Chief(*) | NITTA, Hiroshi<br>UEDA, Kayo |
| Children's Environmental Health Study Planning and Coordination Office | Chief | NAKAMURA, Kunihiko |

(*) Multiple roles

| | | |
|---|---|---|
| Children's Environmental Health Study | Chief | TAMURA, Kenji |
| Data Management and Analysis Office | | SATO, Yuki |
| **Atmospheric Environment Division** | Director | IMAMURA, Takashi |
| | Special Senior Researcher | NAKAJIMA, Hideaki |
| Atmospheric Physics Section | Chief | NOZAWA, Toru |
| | | AKIYOSHI, Hideharu |
| | | SUGITA, Takafumi |
| | | HIGURASHI, Akiko |
| | | SUGATA, Seiji |
| Atmospheric Remote Sensing Section | Chief | SUGIMOTO, Nobuo |
| | | MATSUI, Ichiro |
| Atmospheric Chemistry Section | Chief | TANIMOTO, Hiroshi |
| | | INOMATA, Satoshi |
| Atmospheric Measurement Section | Chief | TOHJIMA, Yasunori |
| | | UCHIYAMA, Masahiro |
| | | YAMAGISHI, Hiroaki |
| **Water and Soil Environment Division** | Director | KOHATA, Kunio |
| Water Quality Science Section | Chief | INABA, Kazuho |
| | | IWASAKI, Kazuhiro |
| | | TOMIOKA, Noriko |
| | | SYUTSUBO, Kazuaki |
| | | NAGANO, Masaaki |
| | | YAMAMURA, Shigeki |
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| | | KOZU, Ayato |
| Marine Environment Section | Chief | HARASHIMA, Akira |
| | | NAKAMURA, Yasuo |
| | | MAKI, Hideaki |
| Soil Science Section | Chief | HAYASHI, Seiji |
| | | MURATA, Tomoyoshi |
| | | KOSHIKAWA, Masami |
| **Environmental Biology Division** | Director | TAKENAKA, Akio |
| Population Ecology Section | Chief | TAKAMURA, Kenji |
| | | SATAKE, Kiyoshi |
| | | TADA, Mitsuru |

(*) Multiple roles

| | | |
|---|---|---|
| | | YOSHIDA, Katsuhiko<br>KONDO,Natsuko<br>KADOYA, Taku<br>MATSUZAKI, Shinichiro |
| Physiological Ecology Section | Chief | SAJI, Hikaru<br>NATORI, Toshiki<br>KUBO, Akihiro<br>TANG, Yanhong<br>AONO, Mitsuko |
| Microbial Ecology Section | Chief | KASAI, Fumie<br>KAWACHI, Masanobu<br>HIROKI, Mikiya<br>UENO, Ryuhei |
| Ecological Genetics Section | Chief | NAKAJIMA, Nobuyoshi<br>TAMAOKI, Masanori<br>YABE, Tohru<br>ISHIHAMA, Fumiko |
| **Laboratory of Intellectual Fundamentals for Environmental Studies** | Director | KUWANA, Takashi |
| Environmental Analytical Chemistry | Chief | NISHIKAWA, Masataka<br>SANO, Tomoharu<br>TAKAGI, Hiroo |
| Biological Resource Laboratory | Chief(*) | KUWANA, Takashi<br>SHIMIZU, Akira<br>TAKAHASHI, Shinji<br>TOBE, Kazuo<br>KAWASHIMA, Takaharu<br>ONUMA, Manabu |
| | (*) | KASAI, Fumie |
| **Environmental Information Center** | Director | KISHIBE, Kazumi |
| Planning Section | Chief | KIMURA, Kyoko |
| Database Section | Chief | KUBO, Tsuneo |
| Information Management Section | Chief | HIROKANE, Katsunori |

(*) Multiple roles

| | |
|---|---|
| AhR | arylhydrocarbon receptor |
| AIM | the Asia–Pacific Integrated Model |
| AOGCMs | Atmosphere Ocean General Circulation models |
| BaP | benzo[a]pyrene |
| BDF | biodiesel fuel |
| BMDCs | bone marrow-derived dendritic cells |
| CBDR | Common But Differentiated Responsibility |
| CDIAC | the Carbon Dioxide Information Analysis Center in the USA |
| ChIP on chip | chromatin immunoprecipitaion on chip |
| CIAS | Cryptic Invisible Alien Species |
| CMAQ | Community Multi-scale Air Quality Modeling System |
| CMAQ | Community Multiscale Air Quality |
| CNTs | carbon nanotubes |
| CONTRAIL | Comprehensive Observation Network for Trace gases by AIrLiner |
| COP | Conference of the Parties |
| CWD | the cumulative withdrawal-to-demand ratio |
| DN | dihydroxynaphtalene |
| DNA | deoxyribonucleic acid |
| DPAA | diphenylarsenic acid |
| DPAA | diphenylarsinic acid |
| EM | electron microscopy |
| EMC | electric motorcycle |
| EV | electric vehicle |
| FATE | the Finely Advanced Transboundary Environmental model |
| FTSs | Fourier transform spectrometers |
| FY | fiscal year |
| G-CIEMS | Grid-Catchment Integrated Environmental Modeling System |
| GHG | Greenhouse Gases |
| GIS | geographic information system |
| GOSAT | Greenhouse Gases Observing Satellite |
| GPP | gross primary production |
| GSH | glutathione |
| IL | interleukin |
| IPCC | Intergovernmental Panel on Climate Change |
| IT | information technology |
| MCD diet | diet deficient in methionine and choline |
| MeDIP-array | methylated DNA immunoprecipitation-array |
| MOE | the Ministry of the Environment |
| MRI | magnetic resonance imaging spectrometer |
| MSP | methylation specific PCR |
| NOAA | National Oceanic and Atmospheric Administration |
| NQ | naphthoquinone |
| OPAC | Online Public Access Catalog |
| PAHs | polycyclic aromatic hydrocarbons |
| PCM | phase-contrast microscopy |
| PCR | polymerase chain reaction |
| PM10 | fine particulate matter less than 10 μm in aerodynamic diameter |
| PM10-2.5 | fine particulate matter larger than 2.5 μm and less than 10 μm in aerodynamic diameter |
| PM2.5 | fine particulate matter less than 2.5 μm in aerodynamic diameter |
| POPs | persistent organic pollutants |
| PPFD | photosynthetic photon flux density |
| PQ | phenanthrenequinone |
| PRTR | Pollutant Release and Transfer Register |

| | |
|---|---|
| QA/QC | quality assurance and quakity control |
| Q-AMS | quadrupole aerosol mass spectrometer |
| RAMS | Regional Air Quality Model System |
| SINET | the Science Information Network |
| TCCON | Total Carbon Column Observing Network |
| Th2 | T helper type 2 |
| TRI | Toxic Release Inventory |
| UNEP | the United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VENUS | Visual atomospheric Environment Utility System |
| VOC | volatile organic compound |
| WEEE | waste electrical and electronic equipment |
| WWW | Worldwide Web |
| XRD | X-ray diffraction |
| XRF | X-ray fluorescence |

*Request for reprints of papers and NIES publications listed in this report:*
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