International Group of
Funding Agencies for
Global Change Research

IGFA

National Highlights

Biosphere 2 Center
Tucson, Arizona
October 14 - 17, 1997

The International Group of Funding Agencies for Global Change Research (IGFA) is an informal group of representatives of agencies and ministries of 21 countries and the EU, responsible for the funding of global change research.

The purpose of the Group is to facilitate international global change research in the natural, social and economic sciences by bringing the perspective of these national funding agencies to strategic planning and implementation of such research.

IGFA's goals are:

(i) internal communication about funding issues;
(ii) communication with the international organizations dealing with global research issues;
(iii) addressing specific issues related to global change research and its funding.

Once a year IGFA has a plenary meeting

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INTRODUCTION

In the IGFA plenary meeting 14-17 October 1997 in Tucson, Arizona, USA , IGFA members reported on highlights of their national programmes, recent changes and trends in areas such as:

- ***National policy related to GCR;***
- ***Organization of GCR funding and programmes and links with international programs (WCRP/IGBP/IHDP/START), their international committees and corresponding national committees;***
- ***Budget developments including recent trends on the funding of overall programmes and designated contributions to specific projects;***
- ***Trends, uncertainties and problems related to funding of international infrastructure and coordination including of WCRP, IGBP, and IHDP, and their core projects;***
- ***Exciting new research programs/groups/plans, including highlights of research findings; and***
- ***National strategies on communication of scientific results to the public, decision makers and the private sector.***

This volume contains the documents that were tabled.

From these documents and the oral presentations in the meeting shifts in the focus of research emerge from global to increased emphasis on regional relevance, a shift from understanding towards prediction and response options, and an increased interest in integrated assessment. Research priorities shift towards increased multidisciplinarity, and from single stress to multiple stress issues. International collaboration in research and links of national projects and programmes with WCRP, IGBP and IHDP are becoming more explicit. IGFA also notes a tendency to link research with the relevant global conventions. The transfer of results to other stakeholders like other ministries and agencies, as well as the private sector, is getting more attention at the national level.

The funding situation of global change research is more stable than IGFA assumed two years ago (Kyoto 1995). Regular funding mechanisms dominate. New institutional arrangements are being developed for international cooperation, such as bilateral and multilateral cooperation in setting up institutes, for example the institute for prediction of interannual variability. This enhances the embedding of global change research in the regular science system.

Table of Contents

AUSTRIA

Global Change Research

1. So far, no national priority program for GCR exists. The Austrian approach to GCR has been top-down oriented, e.g. situated between free and basic research. There are present efforts to structure this area and develop a network of projects in this area.

2. Austria is also involved in individual projects (core projects) for IGBP, WCRP and IHDP that can be seen as centered in above scheme. National strategies in this field have sofar been closely linked to strategies of international programs such as IGBP, WCRP and IHDP.

3. The field between applied and oriented GCR has a young tradition in Austria. Presently, feasibility studies for assessment and development of national strategies in GCR are worked out and a structured national research concept can be expected in the near future. Austria does not plan to establish a center for climate research. Instead, a Coordination and Information Center for networking will be developed. Austrian GCR will focus on spatial and timely disaggregation with concentration on impact assessments at regional and local scales.

The ***national organization*** of GCR funding is quite dispersed. Various ministries such as the Ministry for Agriculture and Forestry, the Ministry for Environment, Youth and Family Affairs and the Ministry for Science and Transport are involved in GCR and emphasize their particular political programs. In that context, certain topics such as forestry conservation and global change or CO_2 reduction and environmental impacts receive more attention than others. Efforts are presently undertaken to coordinate various political interests and develop common strategies and structures.

Budgetary developments: The major part of GCR is funded by public agencies. There is some individual project funding through private money (not known - not in the list of Austrian GCR).

Trends, uncertainties and problems relating to funding of international infrastructure and coordination

Austria is financial partner in a number of international funding organizations and programmes related to GCR such as IGBP, Center of Earth Observation, Joint Research Centers, European Union research programs, etc.

Nationally, funding is made available for international infrastructures. Due to the budgetary saving efforts national research funding resources have only slightly increased in this field. In long-term this can be seen as a problem for national and international Austrian research activities

New research programmes/plans, highlights of research findings

Plans for a structured strategic program in Austrian GCR have been described above. The Center for Coordination and Information in GCR will be set up by Prof. Helga Kromp-Kolb, Dept. for Meteorology and Physics, University of Agricultural Sciences, Türkenschanzstrasse 18, 1180 Vienna (e-mail: kromp-ko@tornado.boku.ac.at).

A number of Austrian GCR projects focus on alpine areas. Investigations of alpine mountain lakes have shown that changes in air temperature, rather than acid deposition seem to be the main factor influencing lake acidity in remote high-altitude locations. Climate warming by about 1C since 1985 has caused enhanced weathering and increased biological activity, resulting in elevated sulfate, base cation and silica concentrations in the lakes (Prof.dr. Psenner, Department of Zoology, University of Innsbruck. Article: Nature, 1 May 1997). Another study showed that plant species in high alpine regions in Austria and Switzerland have migrated upward at a more rapid pace than at any time in the last 70-90 years, between 6,5 and 13 feet a decade and that the number of species doubled in the last few decades. Prof.dr. Grabherr (Dept. for Plant Vegetation, University of Vienna) has linked these events to measured higher mean annual temperatures on mountain tops (Article Nature, 1994).

National strategies on communication of scientific results to the pubic, decision makers and the private sector

Austria has a number of intensive activities regarding public communication and awareness in the GC area. The Ministry for Environment launched a Climate and CO_2 reduction and information campaign. In addition a guideline for climate protection at municipality level has been set up and distributed with the aim of supporting local authority planning and decision making. The Austrian Council On Climate Change, a scientific advisory board to the Federal government, initiated an economical analysis and strategy plan to reach the Toronto Target.

At the research level, the Ministry for Science and Transport initiated 1996 an ‘Austrian Network for Environmental Research' that does not emphasize on GCS but does include GCR issues. Main focus of this network is the promotion of international research activities and the support of environmental scientists. It is also involved in the development of future-oriented concepts and international research cooperation and plays a vital role in the national cooperation of research politics, scientific program conception and organization (information folders are available).

BELGIUM

Global Change and Sustainable Development (1996 - 2000)

1. Introduction

The research programme ***Global Change and Sustainable Development*** is one of the five thematic programmes of the "Scientific support plan for a sustainable development policy". This plan was approved by the Council of Ministers on March 7th 1996. The research programme is planned to cover a period of 4 years, from December 1st 1996 to November 30th 2000 with a total budget of about 16 MECU. 14 MECU is already allocated. 2 MECU is still available for a second call of proposals which will mainly address the socio-economic aspects of global change.

The present research programme is based on a call for proposals. All proposals were submitted to external evaluation by foreign experts. In total 18 projects with 56 laboratories were finally selected.

The programme is a balanced mix of the basic research essential to reducing a series of uncertainties (understanding the fundamental processes of the Earth System, natural climate variability and the effect of anthropogenic or human-induced change) and the more urgent research needed to support policy decisions. It is targeted as a priority on the needs deriving from the Climate Convention.
It draws on the wealth of expertise developed out of the Global Change programme (1990-1996) in such varied areas as climate modelling, changes in the chemical composition of the atmosphere, the impacts of climate change on terrestrial ecosystems and hydrological cycles.

The nature and scale of the problem require that what has traditionally been disciplinary research should re-position itself in a wider framework. The present programme is therefore attentive to spatial and temporal patterns and a multidisciplinary focus.

2. Objectives

The programme's two general objectives are:

- **to reduce uncertainties** about the extent and patterns of global environmental problems through a better understanding of the ecosystem and its interaction with socio-economic systems to provide a firmer scientific basis for decision-making.
- help strengthen the scientific and technical basis needed to **make** (federal, European and international) and **implement** (federal and regional) policy on ***Global Change*** and ***Sustainable Development***, with particular reference to climate change.

The scientific objectives are:

- to **understand** the physical, chemical and biological **processes** of change in the Earth System and their **interactions**, particularly those implicated in climate change, stratospheric ozone change in the mid-latitudes, the oxidative capacity of the atmosphere (including tropospheric ozone creation) with particular attention to human-induced changes.

- to develop methods and **models to explain** the operation and evolution of the **climate system**, its influences, and **to project** potential climate changes (nature, magnitude, timing).
- **to understand the effects** of Global Change and especially the effects of climate change on terrestrial ecosystems, hydrological cycles, essentially in Belgium, including a risk or "vulnerability" assessment; The results must be compiled and globalized in a report relevant to Belgium;
- to develop tools (models, methods) with which to **evaluate** the consequences of **policy options**.

The strategic objectives are:
- to provide the information necessary to identify and understand the problems;
- to evaluate the policy options (effectiveness, cost, side effects, sustainability);
- to provide policy-makers with contextual information and knowledge.

The expertise developed must support Belgian international policy-making, and the national communications which Belgium is required to make under the Climate Convention, the European Council Decision for a monitoring mechanism of CO_2 and other greenhouse gas emissions, and in the framework of the CSD (***Council for Sustainable Development***).

3. Implementation and scientific content

The programme comprises two components: Sub-programme 1: **"reducing uncertainties"**, and sub-programme 2: **"scientific support for Belgian policy on climate change"**

The first sub-programme is to improve understanding the state and the evolution of the environmental system interacting with socio-economic activities in a context of climate change. Studies are be both descriptive (experimentation) and predictive (modeling). They focus on the priorities assigned (arbitrary) to 4 sections :
- atmospheric processes
- hydrological cycles
- terrestrial ecosystems
- the climate system

Research under sub-programme 2 aims to deliver concrete responses to the problems of making and implementing policy on Climate Convention commitments. It must facilitate the definition, implementation and evaluation of a national programme of preventive (control of greenhouse gas (a.o. CO_2) emissions) and adaptive measures. It must also support the national communications which Belgium is required to submit under the UN Climate Convention and the EU Council Decision on monitoring CO_2 and other greenhouse gas emissions.

CANADA

Organization of Global Change Research funding and programs links to international programmes

- The Canadian government uses its standard, established processes and structures to fund global change research.
- There are no special funds or mechanisms for research expenditures on global change most global change research in Canada emerges from a grassroots interest in a particular issue or area. Groups of scientists make use of existing funding channels within federal departments and, in particular, within the federal granting councils.
- This research funding regime supports:
  1. individual research projects with specific Canadian foci, undertaken by universities and by federal and provincial government laboratories, and
  2. Canadian components of major international initiatives, with participants usually drawn from both the federal government and universities. Canada is involved, in the three principal international global change research programmes IGBP, WCRP, and IHDP, and has National Committees for all three international programs.
- The Canadian Global Change Programme (CGCP) provides a forum for information exchange on global change research in Canada, and also serves the Canadian contact point for some international research programs. It is directed by a Board composed of representatives from government, university, business and non-governmental organizations, and administered by a small secretariat with funding provided principally through the federal government. The CGCP does not have the resources to fund research and acts purely in an advisory and planning capacity. However, it attempts to bring government and university researchers together to plan research, to make research findings known to the public, the media and decision-makers and to comment on the policy implications of global change issues.
- The CGCP serves as the Canadian National Committee for IGBP and IHDP.
- The Canadian Climate Programme Board (supported Environment Canada) provides the main linkages with the World Climate Research Program, and runs the WCRP Canadian National Committee
- Despite a significant amount of global change research being carried out in Canada, it has been very difficult to persuade the Canadian government that there should be a coordinated effort in global change research.

Budget developments

- In general, funds for Global Change have been declining - there have been cuts overall to government funding of research, and GCR has not been exempt.
- It is difficult to comment more specifically on recent trends, since funding for GCR is so dispersed in Canada. This made it particularly difficult for us to participate meaningfully in the Resource Assessment exercise. It would take significant time and effort to generate real numbers for the funding contributions to the international programmes outside the core project areas. It is difficult even to pin down real figures for the core projects themselves.

Trends/uncertainties/problems related to international programs

- Core funding for the CGCP has recently been cut significantly (by 80%). The CNCs continue to operate, essentially in maintenance mode, acting as a forum for information exchange. Other CGCP projects continue if funding is available from other sources.
- Canada played a significant role in the WCRP conference in Geneva last August, with Jim Bruce as the Chair of the organizing committee.
- Canada also continues to play a leading role in IHDP. SSHRC has provided a grant of $27,000 to Dr. Steve Lonergan of Univ. of Victoria to develop and promote the Global Environmental Change and Human Security (GECHS) research programme (Lonergan is the chair of the GECHS program). This programme was formally adopted in May 96 by the Scientific Committee of the IHDP and is being launched under the auspices of the CGCP and the Dutch national HDP program. The money was for an international scoping exercise to identify key researchers in other countries and to hold an international workshop to develop a research agenda with a select group of stakeholders which was held in March 1997.
- Environment Canada has just completed a Canada country study, with university and government scientists, on climate change impacts. This has been a Canadian contribution to a IPCC Special Report on regional climate impact studies. The Canada country study is now being released.

New programs/ groups/plans

Highlights from the last year or so include:

- Funding by NSERC and DFO of a Canadian GLOBEC program, with field programmes to be carried out on the East and West coasts;
- Excellent progress in the GEWEX/MAGS (Mackenzie GEWEX Study) program, which has been funded by Environment Canada and was recently awarded funding for a Canadian university component;
- Funding of the Canadian contribution to a major project on the North Water Polynya, which is located at a latitude that will be impacted early and most strongly by global warming. The central hypothesis of this project links the biological productivity of the North Water to local climate forcing and explores the response of the ecosystem to climate change through modeling;
- Climate research, such as that funded by AES through the Climate Research Network has been spared some of the government cuts and is producing excellent results - especially on the modeling side;
- Continued activity in CSHD, which contributes to IGBP core projects PAGES, GAIM and IMAGES. The group is currently preparing a group of seven substantive papers for submission to become a special issue of the Canadian Journal of Earth Sciences this autumn. It is also preparing a proposal for renewal of the project;
- The current phase of JGOFS is coming to an end, and this group is also preparing a proposal for renewal, for joint funding by NSERC and DFO;
- Renewal of the Canadian membership of the Ocean Drilling Programme for 1998-2003 (which has some global change objectives) - jointly funded by NSERC and NRCan.

Communications activities

- Environment Canada and other federal agencies are currently putting a lot of emphasis on the

communication of information on climate change to the public - e.g. forum to be held at the Fraser Institute

- Programme changes at NSERC have highlighted the necessity of linking research results to the end users. In the case of global change, this means policy and decision makers in the public and private sectors. Most core project research related to the international programmes is now funded through the Research partnerships Program, which requires the input at all levels (planning and research) offend-users and partners from other sectors.
- The CGCP has also played a role in bringing together global change researchers, funders and policy makers in an annual national forum. It also prepares communications products and services which interpret science to meet the needs of policy makers and the public - e.g. the recent report on Canada and the State of the Planet, published by OUP. (NB - with cuts to CGCP, it' s not clear how much of this activity could continue).

CHINA, BEIJING

Status Highlights of Global Change Research

I. China's Strategy Studies for Global Change Research

Based on the last 10 years research on global change and in order to face new challenge and chance in 21 century, National Natural Science Foundation of China (NSFC) has organized a scientific committee to draft China's strategy, policy and to set up main scientific issues for global change research in future as the following.

1. China's Strategy Goals for Global Change Research

The purposes of global change research in China are to give our contribution for sustainable development for China and all of the world and also to provide scientific basis for China's environment policy.

For above purposes, China's strategy goals for global change research are:

a. Understanding and distinguishing the impact of nature aspects and human activities in global environment change. Studying the interactive mechanism and promoting the understanding of nature aspects and human activities;

b. Analyzing the impact of global environment change in China on the environment, society, economy and public health and providing evaluation on global change issues on the national level;

c. Predicting the trend of future environment change in China and its impact on global change;

d. Providing scientific basis for the environmental issues in China.

2. Main Scientific Issues

a. Biogeochemical process;

b. Interaction between terrestrial ecosystem and climate;

c. Evolution history of earth environment and its cause;

d. Adaptation and dispatch of human on global change;

e. Integrated analysis and modeling of earth system.

3. Policy Recommendation

a. to set up interagency coordination committee of global change studies China;

b. to bring the role of CNC-IGBP into full play;

c. to coordinate different programs from different agencies;

d. to further strength international cooperation with other countries;

e. to enhance investment funds for global change studies;

f. to strength research, analysis, and data enhance information exchange;

g. to foster young scientists in global change information systems and to studies.

II. IGBP Progress in China

Over the past 3 years, Chinese scientific community coordinated by the Chinese National Committee for IGBP (CNC-IGBP) has made a lot of progresses on global environmental change studies. More than 100 research projects related to global environmental change studies, undertaken by the working groups of CNC-IGBP are going well on the way.

a. PAGES Working Group. It was established in 1988, Chaired by Prof. Liu, Dongsheng. Main studies are:(1) terrestrial evidence of the inception of the Asian monsoon systems, (2) changes of monsoon climate at orbital scale, (3) non-orbital behavior of the monsoon climate on time-scale of 104 year, (4) climate signals related to the Heinrich events, (5) climate signals related to the dansgaard-oeschger cycles, (6) millennial-scale climate changes during the last interglaciation, (7) variability of monsoon climate during the younger Dryas time, (8) prehistoric vegetation on the Loess Plateau, (9) dust emission from Chinese desert sources, (10) quantitative estimates of paleo-climate, (11) The South China Sea since the last 150 Ka, (12) paleo-climate records from Chinese historical documents.

b. CLIMATE Working Group. It was established in 1988 chaired by Prof. Fu, Zongbin. Main studies are: (1) integrated analysis of regional global change in East Asia; (2) monsoon climate change analysis from simulation and observation; (3) climate-ecosystem interaction in the Asia area; (4) simulation of a coupled climate/chemistry/ecology regional model for Asia.

c. DIS-Working Group. It was established in 1988 chaired by Prof. Chen, Shupeng. The study includes: (1) China vegetation classification and NPP estimation by NOAA Data, (2) regionalization of land cover change in China with remote sensing data(1983- 1992), (3) the relationship between land use/cover in China and geophysical driving forces by TM and AVHRR data, (4) possible impacts of global climate change on Chinese vegetation based on geo-information system (GIS). (5) vulnerability of forest in China to global climate change based on GIS.

d. JGOFS/LOICZ Working Group. It was formed in 1989 with chair by Prof. Hu, Dunxin. Three key projects have been supported by the National Natural Science Foundation of China (NSFC), a China-Japan joint program is going well on the way. Main scientific activities include:
(1) field experiment (three cruises in the East China Sea). (2) new thinking about the mechanism of riverine material transport on the shelf and to the deep ocean, (3) study on biogeochemical processes of biogenetic element in the East China Sea, including the East China Sea being a source for $C0_2$ primary production and new production estimation, etc.

e. GL0BEC-Working Group. It was founded in 1996 with chair of Prof. Tang Qisheng. The goal of the group is to identify how climate change affects the dynamics of coastal sea ecosystem, to understand the mechanism of influence of human activities and climate change on coastal ecosystem, and to predict fluctuation of coastal ecosystem and living resources in China seas.

f. GCTE-Working Group. It was founded in 1996 chaired by Prof. Zhang, Xinshi. The following fields are studied: (1) the responses of terrestrial ecosystems of China to CO_2 increase, (2) land use/land cover changes in the North-East of China, (3) the Plant Function Types (PFTs), (4) Classification and Zonalization of Biome, (5) Vegetation and Relationship to its Climate.

g. BAHC-Working Group. The group was created in 1996 chaired by Prof. Liu, Changming. The foci are on: (1) fields experiment on water transfer mechanism in soil-vegetation-atmosphere system, (2) one dimension SV AT model researches, (3) research on weather generator.

h. Qinghai-Xizang (Tibetan) Working Group. The group was developed in 1996 chaired by Prof. Zheng, Du. The foci are on: (1) uplift of the Qinghai-Xizang Plateau and climatic environmental change, (2) response of glacier, snow deposit, and permafrost on the Plateau to climatic change, (3) characteristics of temperature, precipitation of the Qinghai-Xizang Plateau during the last 2,000 years.

III. The Main Projects Being Developed Between 1996-2000

1. Global Climate Change and Environment Policy Study (WCRP, IHDP, IPCC) PI. Profs. Lin Erda, He Jiankun, Wang Gengchen Funding Agency. SSTC
2. China Short-Term Climate Prediction System (CLIVAR) PI. Prof. Zou Jingmeng Funding Agency. SSTC
3. Climatic Dynamics and Climate Prediction Theory (CLIVAR) PI. Prof. Zeng Qingcun Funding Agency. SSTC
4. The Predictive Study on Trends in Life-Supporting Environment in China over the next 20-50 Years (IGBP, WCRP, IHDP) PI. Prof. Fu Congbin Funding Agency. SSTC
5. Inner Mongolia Grassland-Atmosphere Surface Study (GCTE, BAHC ,GEWEX) PI. Prof. Lu Daren Funding Agency. NSFC
6. Huaihe River Basin Experiment on Energy and Water Cycle (GEWEX) PI. Prof. Zhao Bolin Funding Agency. NSFC
7. Ecosystem Dynamics and Sustainable Untization of Living Marine Resources in Buohai GL0B AC) PI. Profs. Su Jilan & Tan Qisheng Funding Agency. NSFC
8. Paleo-Environment Change in China Monsoon Region and its Dynamics Relation with Global Change (P AGES) PI. to be determined Funding Agency' . NSFC
9. Atmospheric Physics-Chemistry Process and Ecosystem Interaction in Yangtze Delta of China (IGAC, GCTE) PI. Zhou Xiuji Funding Agency. NSFC
10. Agro-Ecosystem and Global Change Interaction in China (GCTE, IHDP) PI. to be determined Funding Agency. NSFC
11. Asia Monsoon Climate Change and Global Change(PAGES) PI. An Zhisheng Funding Agency. CAS
12. China Resource Environment Information System (DIS, START) PI. Prof. Guo Huadong Funding Agency. CAS
13. Human Dimensions Effect on Eco-Diversity in Lanchangjiang(IHDP, DIVERSITAS) PI. Prof. Hao Xiaojiang Funding Agency. CAS
14. Studies on the Formation, Evolution, Environmental Change and Sustainable Development of the Qinghai-Xizang(Tibetan) Plateau (IGBP, IHDP) PI. Prof. Sun Honglie Funding Agency. CAS
15. Global Change Research in Antarctica and Arctic (IGBP) PI. Prof. Qin Dahe Funding Agency. CAS

l6. Studies on Ecosystem Productivity Information and Sustainable Development (DIVERSITAS) PI. Prof. Zhao Shidong Funding Agency. CAS
17. Land-Sea Interaction in China Sea and its Environmental Effect (LOICZ) PI. Prof. Hu Denxin Funding Agency. CAS

IV. About Resource Assessment:

We organized a working group on the resource assessment of global change research in the end of last year. The input of data was finished on the deadline.

CHINA, TAIPEI

Highlights of National Programmes on Global Change Research

1. Policy Changes

Geographically, Taiwan is located in an ideal position to observe the effects and interactions of monsoons, the Tibet Plateau, the Kuroshio Edge, and the Western Pacific Warm Pool. It has been experiencing rapid socio-economic change, and is witnessing serious human impact on the natural environment. As a newly industrialized economy, Taiwan presents an excellent case study area for research on sustainable development. A brief history of global change research (GCR) in Taiwan is shown in Table 1.

Two policy changes relating to GCR have been implemented in the past year. Firstly, the cabinet level Committee on Global Change Policy was restructured, becoming the National Sustainable Development Committee (NSDC). Secondly, as a member of the NSDC, the Chairman of the National Science Council (NSC), reorganized its Environment and Development Committee. A human dimension research working group was added, and the committee was renamed the Commission on Sustainable Development Research (CSDR). It is now convened by a Vice-Chairman of the NSC and has several directors of relevant NSC academic programme offices among its members.

2. GCR Funding Agencies, Programmes and Links

Several member ministries in the NSDC, such as the Environment Protection administration, Ministry of Economic Affairs, Council on Agriculture, and the Ministry of Transport and Communications, all have their own intramural or extramural programmes for global change related research. The NSC, however, is the major funding agency for GCR. The principal offices in the NSC running GCR funding programmes comprise the Natural Sciences and Mathematics Division, the Life Sciences Division, and the Humanities and Social Sciences Division, as well as the CSDR.

Taipei has membership in the IGBP. The National IGBP Committee and subcommittees for core projects, such as GCTE, IGAC, JGOFS, LOICZ, and PAGES, were formed under the auspices of the Academia Sinica, Taipei. The National IGBP Committee serves to coordinate the development of major national GCR programmes, as well as to interface with international GCR programmes. Figure 1 depicts the interactions between funding agencies, research programmes, the National IGBP Committee, and international organizations concerned with 'GCR.

Coordinated research on global change was first initiated in 1989 by a group of university scientists, with backing from the NSC. Currently, more than one hundred scientists are involved in GCR programmes. The basic philosophy for GCR programme implementation in Taiwan is 'think globally, act locally'.

The aim is to study changes occurring in Taiwan and its surrounding areas, as well as:
1) to understand the effects of global change on the local natural environment;
2) to collect regional data contributing to the understanding of the processes of global change;
3) to construct regional models of the environment and climate, with predictive capabilities;
4) to assist government and industry in complying with international requirements related to global change; and
5) to assess the impact associated with climatic and environmental change, and to outline viable strategies for sustainable development in the future.

In 1994, the NSC initiated an effort to plan global change research in Taiwan for the next five years. Special attention has been paid to several subject areas, including climate and environmental studies directly related to international global change programmes, and the development of national action plans for meeting international convention requirements, such as hat of the Framework Convention on Climate Change for counteracting the consequences of global warming. In accordance with the five year plan, the ten major areas of GCR research in Taiwan can be summarized as follows:
1) Atmospheric chemistry and radiation: studying regional environmental changes, focusing on the monitoring and modeling of local sources and sinks of greenhouse gases;
2) Ocean circulation: e.g. the World Ocean Circulation Experiment (WOCE) programme in Taiwan;
3) Oceanic flux: e.g. the Kuroshio Edge Exchange Processes (KEEP) programme of the Joint Global Ocean Flux Study (JGOFS);
4) Climate change and prediction: e.g. the East Asian Monsoon Study programme;
5) Past environmental change: e.g. the PAst Global changES (PAGES) programme in Taiwan;
6) Coastal change: e.g. the Land-Ocean Interactions in the Coastal Zone (LOICZ) of the Tseng-W en River and the Southeastern Coast Environmental Study programme;
7) Ecosystems: e.g. the Taiwan Long-term Ecological programme;
8) Hydrological cycles and global change: e.g. the Hydrological Cycles Local Climate Study programme;
9) Land use and environmental change: e.g. the Land Use and Coverage Change (LUCC) programme in Taiwan;
10) Human dimensions of global change: studying the costs and benefits of reduction in greenhouse gas emissions.

Information concerning global change activities and publications in Taiwan can be found on the World Wide Web site {http://sun.gcc.ntu.tw/indexeng.html}, established and maintained by the Global Change Center of National Taiwan University, and which serves to facilitate data exchange between local GCR communities.

3. Budget Development

Total budget allocated to GCR programmes by the NSC has increased from around US$ 1 million in FY 1990 to around US$ 5 million in FY 1998 (Figure 2). The distribution of this funding in terms of corresponding international programmes and projects for FY 1993 - 6 is illustrated in Tables 2, 3, and 4.

Funding for core projects of international programmes (category 1 projects) remained approximately constant at about US$ 2 million, while that for relevant (category 2) projects gradually increased to US$ 3 million in 1996.
The NSC has also funded other GCR related studies with no envisioned links to international programmes (category 3 projects) to the sum of about US$ 800,000 per year.

In FY 1997, other member ministries of the NSDC have also invested a further US$ 5 million on research relating to global change.

Scientists from Taiwan have actively participated in many meetings of international GCR programmes, such as the IGBP, WCRP, and IGFA, for developing core projects and other activities. The NSC recently resolved to make a contribution of US$ 20,000 to the Staff Bureau of START, and agreed to host an international workshop on greenhouse gas emissions, aerosols, and land use and cover change in Southeast Asia in November this year. In this way, Taiwan serves as a link between developed nations and the developing countries of Southeast Asia, in order to promote the common objectives of GCR.

4. Highlights of Major Findings and New Research Programmes

The Kuroshio Edge Exchange Processes (KEEP) programme has established an extensive data base and discovered important phenomena since its inception in 1989. With enormous nutrient input from subsurface Kuroshio intrusion and Changjiang runoff, the East China Sea is found to be an carbon sink with an estimated CO2 flux of 3x1012 mol/y.

The "LOICZ-Tseng-wen Estuary and Coastal Dispersal Zone" project has defined the boundaries and investigated the transport processes and pathways of terrestrial materials within the coastal zone from 1994 to 1997. By determining temporal and spatial variations of the hydrological, geological and biological distribution patterns. It was concluded that the biological resources are indeed abundant, but has been affected by anthropogenic factors.

The "Research on Atmospheric Environments in the Taiwan Area" project has focused on the flux of greenhouse gases in paddy soils, wetlands, uplands, forest soils, landfills, and river, and seashore and ruminant animals. Major findings include an estimation of total annual methane flux about 14,000 tons from around 200,000 ha of rice paddy in the first crop season, as compared to about 25,000 tons from around 170,000 ha of rice paddy in the second crop season.

The steady support of the government and coordinated efforts of the academic community have given Taiwan a good head start in its GCR programmes. The NSC is now formulating and reviewing a new plan for its GCR programmes. This diagram shows the structure of research areas anticipated under the draft programme. This includes plans for two new areas of exploration: i) Long Term Marine Ecological Research, and ii) Impact Assessment of Global Change in Taiwan. Funding for these programmes will be finalized by the middle of 1998.
An area requiring more attention is the management of data banks and their integration into an information network.

With the success of the National Information Infrastructure Project in Taiwan, GCR communities are able to make use of the network to integrate and synthesize an ever-increasing amount of data as the inputs for modeling and predictions. This field will be made indigenously as well as through international joint research projects.

5. Communication on Scientific Results

One of the ultimate goals of GCR is to make the public aware of the causes and consequences of global change, so they will be willing to adjust lifestyles and support the concept of sustainable future development.

The newly established NSDC has invited several distinguished GCR experts to sit as committee members. They join the heads of the Ministry of the Interior, Ministry of Foreign Affairs, Ministry of Education, Ministry of Economic Affairs, Ministry of Transport and Communication, the Council of Economic Planning and Development, the National Science Council, and others. The Advisory Panel consulted by the NSDC also includes scholars and professionals qualified to address the issues of global change and sustainable development, and the requirements of international conventions and protocols. Communication and dialogue channels in China Taipei for passing GCR results on to high-level public policy and decision makers are therefore reckoned to be well established.

A series of government supported activities entitled the “Forum on National Sustainable Development" has just completed its first year programme. Organized by the Sustainable Development Society in Taipei, this was attended by a wide range of celebrities from the public and private sectors. The second year programme is already under planning; its targets include more grass roots participation, methods of disseminating GCR results, and developing consensus for addressing sustainable development issues. It is to be hoped that the forum will continue to serve as a bridge between GCR communities, public decision makers, and the private sector in the future.

Table 1: Chronicle for the Global Change Research Related Events in Taiwan.

- 1988. National IGBP Committee established under auspices of Academia Sinica;
- 1989. First IGBP research program (JGOFS-KEEP) initiated;
- 1992. Attended Earth Summit Meeting activities at Rio de Janeiro, Brazil;
- 1993. Established Environment and Development Committee (CED) under National Science Council;
- 1994. Established Committee on Global Change Policy (CGCP), Executive Yuan;
- 1995. Hosted 6th SARCS Meeting;
- 1996. Published National Report on , Global Change Research in Taiwan;
- 1997. Restructured CED into the Commission on Sustainable Development Research (CSDR) in National Science Council;
- 1997. Restructured CGCP to form the National Sustainable Development Committee (NCDC), Executive Yuan also 1994 onwards Attended 7th, and 8th meetings of START-SARCS, the 4th IGBP SAC meeting, and the first IGBP congress.

Table 2: Number and Budget (in US$ 1,000) of Category 1 Global Change Research Projects in Taiwan.

	1993		1994		1995		1996	
	no.	Budget	no.	Budget	no.	Budget	no.	Budget
JGOFS	30	1446	21	1031	21	1111	27	1035
CLIVAR	0	0	0	0	19	512	16	318
GEWEX	0	0	0	0	0	0	8	261
TOGA	3	431	6	236	8	298	13	453
WOCE	6	467	3	218	3	170	5	344
Annual Budget		2344		1484		2091		2411
1993-1996 Total Budget		8331						

Table 3: Number and Budget (in US$ 1,000) of Category 2 Global change Research Projects in Taiwan.

	1993		1994		1995		1996	
	no.	Budget	no.	Budget	no.	Budget	no.	Budget
BAHC	0	0	0	0	0	0	4	83
GCTE	0	0	0	0	45	1497	60	1601
IGAC	10	430	5	192	36	943	36	794
LOICZ	0	0	0	0	11	299	11	237
PAGES	6	270	10	417	7	253	7	329
IHDP1	0	0	0	0	5	106	5	88
DIS	0	0	0	0	2	77	1	48
Annual Budget		700		609		3175		3179
1993-1996 Total Budget		7664						

Table 4: Budget (in US$ 1,000) for Category 3 Global Change Research Projects in Taiwan.

	1993	***1994***	***1995***	***1996***
Process studies which include aspects relevant to*	200	220	230	250
All other studies with no envisioned links to*	500	500	600	600

* international global change research programmes

Other ministries and Agencies 5000 in 1997

EUROPEAN UNION

Global Change Research

1. Institutional and Policy Framework for EU Research on Global Change

Global Change research in the European Union is supported within specific programmes of the EU Framework Programme for Research and Technological Development. The Union is approaching the end of the Fourth Framework Programme (1994-98) and is currently considering the potential structure and scope of the Fifth Framework Programme. All research activities must be within the context of one of the specific programmes of the Framework Programme. The lead Directorate-General for RT Framework Programme is DG XII, although other Directorate-Generals and the Joint Research Center (JR) have a considerable Interests in the content and implementation. In Framework Programme 4, Environment Research is implemented and managed by Directorate XII-D, the Director of which is Mr. Christian Patermann who also represents the Commission at IGFA.

The constitutional framework of the Union is based on the principle of separation of powers between the European Commission, the European Parliament, and the Council of Ministers. The European Commission proposes the Programme structure and content, and through a separation of powers both the Council of Ministers (representing Member State Governments) and the European Parliament (elected by direct universal suffrage) must approve, amend or reject the proposal. The Commission must then respond to proposed amendments or withdraw its proposal. The proposed structure of the EU Fifth Framework Programme was made by the Commission to the Parliament and Council in April 1997 (see section 2 below), and copies are available at the IGFA meeting or on request to the Commission.

2. European Union Fifth RT Framework Programme (1998 - 2OO2)

The most significant development in European science policy this year has been the Commission proposal to the European Parliament and Council of Ministers for a Fifth Framework Programme (known as FP V). The proposal has been the subject of much debate, including with the scientific community through a series of Informal Focused Consultation meetings held in Brussels to address each proposed action line in the thematic programmes.

The overall aim of FP V is to achieve greater concentration of effort on several key issues of vital importance to the future economic development of Europe, and to the well being and expectations of its citizens. It is proposed that FP V will have three thematic programmes and three horizontal activities.

The proposed thematic programmes are :

- Unlocking the resources of the living world and the ecosystem;
- Creating a user-friendly Information Society;
- Promoting competitiveness and sustainable growth.

The proposed “horizontal” programmes are :
- Confirming the international role of European research;
- Innovation and participation by Smells;
- Improving human potential.

Each of the thematic programmes will comprise of a series of key actions; activities for research and development of generic technologies; and activities in support of research infrastructure. Global change research is focused on a generic activity in the first thematic Programme, but it would likely have interactions with other actions and activities including :
- key actions on management and quality of water; environment and health; integrated development of rural and coastal areas;
- generic activities on development of generic earth observation technologies; and natural and technological hazards;
- support for research infrastructures (which includes marine facilities and computer centers for climate studies).The proposal is still the subject of detailed debate both within and between the Member States, and also within the European Parliament. A co-decision of the Parliament and the Council is expected by the end of 1997, and the Commission will then formally consider amendments to its proposal in the light of that co-decision.

3. Fourth Framework Programme (1994-98)

The Fourth Framework Programme (FP IV) consists of 15 Specific Programmes, with global change research concentrated in the Environment and Climate Programme and in the Marine Science and Technology (MAST) Programme. Both programmes are also sponsors, along with the International Cooperation (INC) Programme, of the European Network on Research in Global Change (ENRICH) (see section 4 and 6).

The total budget available for each Programme amounts to:
Environment and Climate - 567 MECU of which 248 MECU is allocated to natural environment, environmental quality and global change; 131 MECU to Environmental Technologies; 107 MECU to Space techniques applied to environmental monitoring and research; and 39 MECU to the human dimensions of environmental change.

MAST - 244 MECU

4. Highlights of new funding decisions - 1996/97

During 1996/97 both Environment & Climate and MAST have concluded major calls for research projects. The Environment and Climate call closed in January 1997 and the Commission received 1180 proposals requesting a total amount of ECU 974 million. Following evaluation by external experts in Feb/March and approval by the Commission in July 1997, 306 new research projects amounting to around ECU 200 million are currently subject to contract negotiation.

Although the exact figure is not yet known, a large proportion of these, particularly in Theme 1 and 4, will fall in the category 1 or 2 as defined in the harmonization process for the IGFA Resource Assessment exercise. The remainder of the projects in these themes along with the space theme, will mostly will fall in category 3 of the same exercise.

The projects cover the full range of global change issues; climate change modeling and impacts, greenhouse gas cycles, atmospheric physics and chemistry, social and economic aspects, changes in land use and land cover, ecosystem dynamics. Hence, the Union continues to make a considerable contribution to the ability of European scientists to play a leading role in international global change research.

Three examples are indicative of the type of projects approved for funding:
- **The Third European stratospheric Experiment on Ozone (THESEO),** which is a follow-up to the previous experiments EASOE and SESAME and is designed to improve our understanding and forecasting of the state of the ozone layer The focus this time is on ozone loss in the middle latitudes, along with a component addressing the subtropical region and how air masses originating from this region influence the abundance of the ozone layer in the mid-latitudes over Europe.
- **Eurosiberian Carbonflux** is a joint European-Russian research project which aims to develop a continental scale data assimilation system for the long term monitoring of climate -relevant, long lived greenhouse gases. The aim is to understand and predict the response of natural ecosystems to long- term increases in CO2 and to identify the so called " missing" CO2 sink which is believed to exist in the northern mid-latitude terrestrial ecosystems;
- **European Research Forum on Integrated Environmental Assessment (EFIEA)** which will establish a European network to address methodological issues related to the development of integrated assessment tools (e.g. example how to combine quantitative and qualitative information on societal, economic and ecological processes) and will evaluate the usefulness of these assessment tools in formulating policies, particularly in relation to major environmental issues. This follows on from a successful symposium in Toulouse, proceedings of which are currently being printed.

In addition, the EU concluded a separate call for proposals under its Centre for Earth Observation (CEO) initiative. This joint initiative between the Environment and Climate programme and the EU Joint Research Centre at Ispra aims to improve the distribution and utilization of earth observation data and information, including the large quantities of heterogenous in-situ observations. 20 projects were approved for funding out of the 72 submitted, including a project on satellite altimetry called DUACS, which seeks to improve access to altimetry data related to ocean climatology and global circulation.

The MAST call closed in Oct 1996 and following expert evaluation in November 1996 and approval by the Commission in June 1997, the European Union decided to fund 56 projects amounting to ECU 76 million. This call included little of relevance to global change, but the year did see approval to fund one important project from the previous reserve list, Variability of Exchanges in the Northern Seas (VEINS).

Veins builds upon the successes of the earlier ESOP-I and ESOP-II (see section 5 below) in seeking to understand the thermohaline circulation of the Greenland sea, its sensitivity and its impact via the Atlantic Ocean's circulation on global ocean circulation.

In addition, 1996 saw the re-launch in DG XII-D of ENRICH, with a call for proposals issued in October 1996 which closed In January 1997. This call produced 61 proposals requesting over ECU 7 million for a variety of accompanying and supporting measures aimed at dataset collation, scientific networking, research valorization and agenda formulation. After external evaluation in March 1997 and approval by the Commission in July 1997, contract negotiations are currently concluding on 20 projects amounting to around ECU 2.7 million. As a result of the lessons learnt from this first call and in response to the obvious demand indicated by the call, The European Union decided to issue a second call for ENRICH proposals in September 1997 (see section 6 below).

5. Research Highlights 1996/97

The previous year has seen a number of research highlights in all areas of the global change agenda.

In May 1997 the Climate and Natural Hazards Unit of DG XII-D produced a summary booklet - ***"Recent results of EC's Climate Research"*** - which summarizes some of the research highlights and current state of knowledge in respect to climate processes; modeling change impacts. Copes are available at the IGFA meeting and prediction; and climate

Six research projects on sea level rise were the focus of a successful workshop on sea level rise held in Barcelona on April 1997. Research has shown that sea level is rising currently by an average rate of 1 - 1.5 mm per year and concluded that, although some of this in some regions is due to vertical crustal movement, the broad pattern of rise cannot be explained by this alone. Future sea level rise associated with thermal expansion of the oceans and reductions in the extent of the cryosphere, along with changing storminess and land subsidence, will lead to greater risks of coastal inundation.

In relation to desertification, the role of EU research at both the EU level and beyond has been incorporated in a European Commission report produced as a submission to the First conference of the Parties to the International Convention to Combat Desertification held in Rome in September 1997. Copies of this report are available from the Office for Official Publications of the European Communities, L-2985 Luxembourg. One major Environment and Climate initiative in this area has been Mediterranean Desertification and Land Use (MEDALUS). This initiative is now in its third phase and policy relevant results include confirmation that climate has become more variable since 1940 and that water resources are at crisis point.

Stratospheric and tropospheric studies continued to prove fruitful in the last year. On stratospheric ozone, European research sponsored through the EU and member states, found evidence of up to 40% ozone depletion in the Northern Hemisphere. For the third winter in succession, record low temperatures in the Arctic's lower stratosphere, coupled with the presence of man-made pollutants, resulted in extensive destruction of the ozone layer. An associated major highlight was the use of "Geophysika" (a converted Russian spyplane) as part of the Airborne Polar Experiment.

1997 also saw the publication of a major book outlining "European research in the stratosphere - The contribution of EASOE and SESAME to our current understanding of the ozone layer.

A major conference on European tropospheric studies was held in Venice in October 1996, entitled the Oxidising Capacity of the Troposphere. The 716 page report of that meeting has recently been published and copies are available from the European Commission. Several of the projects are classified as category 1 or 2 relevance to IGAC in the recent Resource Assessment exercise. One of the projects is the Aerosol Characteristics Experiment (ACE-2) which in July 1997 carried out a major field campaign to collect substantial data on the polluted atmosphere of the North East Atlantic in order to determine the radiative forcing of climate by anthropogenic aerosols from the European continent.
July 1997 saw the publication of an "Overview of Selected Projects in Marine Science and Technology". Copies of this report are available at the IGFA meeting. One of the projects mentioned, the European Sub-Polar Ocean Programme (ESOP-2), has also reported some surprising results this year (see publicity leaflet available at IGFA meeting). ESOP-2 is a consortium of 21 laboratories in 8 European countries. The goal of ESOP-2 is to understand thermohaline circulation in the Greenland Sea. An experiment to release significant amounts of an inert artificial tracer to the Central Greenland Sea has produced new insights into both deep water formation Including at least one previously unknown mechanism. In the area of **social and economic research** into environmental change, the year has seen a significant innovation in the holding of three workshops pre- and post- Kyoto which bring together EC officials involved in the negotiation of the FCCC with leading European social scientists supported through Theme 4 of FP 1V and specializing climate change policy issues, including Policies and Measures; Joint Implementation and Tradable Permits; and involving a Stakeholders workshop to be held just after Kyoto. This has assisted policymakers in constructing a cohesive and comprehensive European position for the Kyoto negotiations in December of this year and its follow up, including the EU Communication " Climate Change : The EU Approach to Kyoto".In December 1996 the European Commission also commissioned a team of European social scientists to highlight the key findings of the human dimensions research efforts up to 1996. Their draft report (also available at the IGFA meeting) ,outlines some major issues, including the ingraining of environmental culture into human activity. the role of social networking; the ambivalence of large, sections of the business community; technological innovation very active in clean technology area; and the slow adoption of green accounts.

6. European Network for Research in Global Change (ENRICH) - Second Call for Proposals

The First Call for ENRICH proposals which closed in January 1997 clearly demonstrated the demand for such an initiative, but also indicated that the scientific community had not fully appreciated the scope and objectives of either ENRICH or the call itself Hence, it was decided that a second call would be held and this call was launched in September 1997. The deadline for proposals is 16 December 1997. However, unlike the first call, the second call focuses on a number of geographical, thematic and structural issues on which proposers must focus. Detailed Technical Guidelines are available on request from the ENRICH Secretariat (see details at end of this paper). These include specific provisions for EU participants in either APN or IAI projects. Full details will be given in the specific ENRICH presentation at IGFA.

7. Contact details for DG XII-D

The following address and fax number applies for all the named individuals below.

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Director: Christian Patermann, SDME 7 /62

Goffredo Del Bino, SDME 7/46, (Head of Unit D- 1 responsible for atmospheric research, and for ecosystem studies)

Anver Ghazi, SDME 7/45 (Head of Unit D-2 responsible for Climate change and natural hazards research, including desertification)

Jean Boissonnas, SDME 7/76 (Head of Unit D-3 responsible for Marine Science and Technology Programme)

Michel Paillon, SDME 4/76 (Head of Unit D-4 responsible for earth observation from space)

Andrew Sors, SDME 7/69 (Head of Unit D-5 responsible for social and economic environmental research)

Pierre Mathy, SDME 7/21, (responsible for ENRICH)

FINLAND

Global Change Research

1. Introduction

In Finland, global change research, monitoring and technology development is carried out by the national research institutes and universities. The large national research programme, Finnish Research Programme on Climate Change (SILMU), ended in 1995. After the evaluation of the programme, the Board of the Academy of Finland nominated ***The Finnish Global Change Support Group***, which main task is to coordinate the global change research in Finland.

The work of the Finnish Global Change Support Group began in May, 1997. The group is composed of the researchers and experts from the different areas of global change research. The group has defined its main tasks:

- to activate and coordinate the Finnish global change research;
- to act as a national contact point for the Finnish researchers working in the projects of e.g. IGBP, IHDP and WCRP;
- to identify the strengths and weaknesses of the Finnish global change research;
- to make proposals for developing Finnish global change research and its funding.

2. Past and present research activities

Climate observations

In Finland, meteorological observations are made at three meteorological observatory stations, 46 synoptic stations, 87 climatological stations and 57 automatic stations. Long-term climatological time series form a necessary basis not only for the actual climatological research but also for estimates on the effects of climate change. Finnish climate observations have been included in the international ***North Atlantic Climatological Data Set (NACD***) database, which is a collection of reliable long-term observations for climate change research.

Finland also participates in the ***Global Atmosphere Watch (GAW) Programme of the World Meteorological Organization (WMO)***. The GAW observes greenhouse gas concentrations and long-range transport of pollutants in the atmosphere. In 1994, the WMO accepted the Passas-Sodankylä station in Finnish Lapland as a part of the global GAW network.

The Finnish Meteorological Institute is also involved in various development cooperation projects in meteorology, the most important ones being regional projects with the African SADCC countries and with the Central American isthmus. During the last ten years, Finland's total contribution to cooperation projects concerning meteorological technology has totaled about US$ 30 million. Projects have been carried out in some 40 countries all over the world.

Finnish Research Programme on Climate Change (SILMU) 1990-1995)

An interdisciplinary research programme called ***The Finnish Research Programme on Climate Change (SILMU)*** was initiated in 1990 to coordinate the majority of all climate change research in Finland.

The principal goals of SILMU were:
- to increase our knowledge about climate change, its causes, mechanisms and results;
- to promote research on climate change;

- to further opportunities for Finnish scientists to participate in international research projects;
- to prepare and disseminate information to form a bases for decisions on adaptation to and prevention of climate change.

The key research areas in the programme were:
- the climate changes anticipated in Finland;
- estimation of the effects of changing climate on ecosystems;
- the development of adaptation and prevention strategies.

The programme was scheduled to take six years (1990-1995) and the total budget was US$ 15 million. The programme was funded by the Academy of Finland. Altogether, the programme comprised over 80 research projects and involved some 200 researchers. Approximately 30% extra funding was taken place through other funding (mainly research institutes and universities) for climate change research during SILMU.

Some research projects under SILMU were included in international research programmes on climate change, such as the ***World Climate Change Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP)***.

The SILMU Programme was evaluated by an international committee in autumn 1996. In general, the committee found the research performed in SILMU of high quality and relevance. Critical remarks were mainly presented concerning the insufficient integration of subprogrammes.

As for the continuation of climate change studies in Finland, the committee identified five important areas of SILMU research:
- Continuation of work establishing past and existing climate variability, and climate analysis/ modeling studies;
- Further work on aerosols;
- Integrated Assessment studies;
- Continuing work on ozone/UV exposure;
- Sociology and socio-economic studies on climate change.

The advisory body mentioned in recommendations research areas to be initiated or strengthened in Finland:
- Impact of climate change on high latitude areas;
- Agricultural economics;
- Mitigation options and costs.

3. Present funding of the global change research

After The Finnish Research Programme on Climate Change SILMU (1990-1995) the climate change research continues in the research institutes and universities. The funding for the research comes mostly from the budgets of the research organizations. Some of the research groups have reached good results in a competition for getting funding e.g. in EU research programmes.

At the moment, there is no data on the total funding for global change research in Finland. It is supposed that after the SILMU programme, the total funding for the global change research is reduced remarkable.

4. Present highlight of the Finnish global change research

At the moment, the stratospheric ozone research and UV research is a developing research area in Finland. There are several projects going on in this research area at the ***Finnish Meteorological Institute***: e.g. Scientific UV data management, National ozone and UV research, use of satellites for ozone and UV research.

Forest research is an important area of global change research in Finland. In 1995, the Ministry of the Education nominated 12 national centers of excellence. One of them was ***Research team investigating climatic change, its silvicultural and economic implications in forestry*** at the University of Jyväskylä. The team was chosen due to excellent work done during the SILMU-programma.

5. Future activities

After SILMU there is no national programme for the climate change research in Finland. Some of the research programmes planned by the Academy of Finland are dealing in a way or another climate change research. For example the ***Finnish Research programme on Environment and Health*** (1998-2001) has one theme (Health impacts of environmental changes and nature in Finland), which is dealing with the global change research. Anyway, the main objective of the programme is to generate information for the assessment of connections between the environment and human health, and to develop procedures, methods and techniques for the promotion of environmental health.

In can be supposed that ***The Finnish Global Change Support Group*** makes in future a concrete proposal for developing Finnish global change research and its funding.

6. Financial assistance and technology transfer

Developing countries

Since the early 1970's Finland has actively participated in the building up of a global meteorological network to observe and monitor the physical and chemical elements of the atmosphere by providing systems for measuring the basis variables. Major programmes have been launched in cooperation with WMO.

Some examples of the ongoing projects:

In 1997-1997 the development of the basic meteorological and climatological applications of the National Meteorological Services in the Central American Isthmus were further strengthened based on investments and achievements during the five year international development cooperation project in early 1990's in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. In November 1996, as a cooperative venture between Finland and Nicaragua, a programme called ***'Finalization of National Programme for Implementation Convention on Climate Change and Montreal Protocol'*** was initiated.

The Finnish expertise is participating in the feasibility study of the ***Ibero-American Climate Project*** 1997-1998 in Argentina, Bolivia, Ecuador, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Paraguay, Peru, Uruguay and Venezuela.
Cross-sectoral linkages between forestry and climate change require a lot of further study and research. Finland is one of the major donors to the UN WIDER institute, which has, in cooperation with the European Forestry Institute, carried out research projects on the role of forests in the implementation of international conventions of climate changes and biological diversity.

7. Research and policy

It is important to facilitate the flow of information between researchers and policy-makers. There should be an opportunity for a regular dialogue between researchers and policy-makers. One mechanism is a national committee consisting of practicing/informed experts and "end-users".

In Finland, the National Climate Committee is the expertise organization for the climate politics. The committee is composed of the representatives from different ministries, universities, trade and industry, communities, research institutes, the Academy of Finland and the organization of citizens. The role of research is important. The committee assists Finnish policy-makers at the international negotiations dealing with emissions reductions or developing adaptation and prevention strategies to climate change.

In the discussions between researchers and policy makers several alternatives has emerged for slowing down the increasing emissions in Finland. These included for example investing in research and technology, joint implementation, technology transfer, and measures that also serve other social purposes. More disputable measures include energy and carbon taxes, the selection of appropriate forms of energy and carbon taxes, the selection of appropriate forms of energy production, the preservation of carbon sinks and reservoirs, and solutions involving community planning and transport policy.

GERMANY

National Highlights for 1997

The German Government has passed a new programme "Research for the Environment" in September 1997, which will provide the framework for environmental research in Germany over the next years.

A small increase in the total budget for the Federal Ministry of Education, Science, Research and Technology (BMBF) is expected for 1998. Priority fields of research will be among others biotechnology, multimedia, molecular medicine and clean technologies. The support for environmental research as a whole will also slightly go up. This, however, will mainly strengthen research into technological aspects, while the climate and atmospheric aspects will decrease. Global Change Research as a whole will remain at a high level in 1998.

The level of funding of Global Change Research by the DFG has slightly increased in 1996/97. Besides a number of smaller projects a new programme on the North Atlantic Oscillation, contributing to CLIVAR/ACSYS has been implemented. The DFG expects a 5% increase of its budget in 1998 but the increase and amount of proposals will be significantly higher. Therefore, the funding for Global Change Research will face increasing competition. The Max-Planck-Society, one of the leading research institutions, will also expect a 5% increase of its budget in 1998. It has increased its contribution to Global Change Research significantly by the establishment of a new institute for biogeochemical cycles at Jena.

BMBF and DFG are the major funding agencies for Global Change Research in Germany with concentration on problem-oriented and basic research, respectively. A National Committee on Global Change Research (NKGCF) has been established by the DFG with close participation of the BMBF. Its main tasks are the coordination and strengthening of the German contribution to the international Global Change Research Programmes, to develop concepts for the closer cooperation and integration of these programmes and to identify key issues for future research strategies. The NKGCF has a chair (Professor Ehlers) and four co-chairs for connecting the national programmes with the corresponding international programmes of WCRP, IGBP, IHDP and DIVERSITAS. The Committee is supported by a secretariat located at the University of Bonn.

A National Global Change Colloquium was carried out by the new National Committee on July 3-15 in Bonn. It functioned as a major milestone in defining future strategies by:

a) analyzing the scientific strengths of the German research community within the framework of the international programmes;
b) identifying the key issues and themes for future research foci; and
c) providing a conceptual framework for a coherent and highly integrated national programme complementing the successful integration of existing programmes.

The results will be published. Based on the results of this Colloquium the National Committee will propose a new framework for the future orientation of Global Change Research in Germany.

ICELAND

Global Change Program

There is a considerable research activity in Iceland in the field of global change. Currently there is no global change program. However, the Icelandic Research Council (IRC) has taken steps to establish such a programme and in 1995 a task force was established. The task force will present its report in November 1997. A resolution by the IRC is expected to follow. Two ministries (Environment and Industry) were represented in the task force. Consultation with these ministries as well as the ministries of education, agriculture and fisheries are planned.

The approach

- **A national committee will be formed which will function as a link to IGBP, WCRP, IHDP and IASC. IASC is included due to the fact that significant parts of the IASC science plan relate to global change;**
- **The programme will included the human dimensions of global environmental change as well as Earth System Science;**
- **The programme will contribute directly to the implementation of the National Climate Action Programme for the UN Framework Convention on Climate Change;**
- **The programme will stimulate activities by universities, research institutes and operational agencies;**
- **The participation in the European Union framework programme will be stimulated. At the same time co-operation with the US and Canada will be strengthened.**

The funding

- **EU framework program;**
- **Competitive grants from the IRC;**
- **Programme funding from ministries (to be negotiated).**

The issues

The issues prioritized in Iceland reflect the fact the Icelandic economy is highly dependent on both living resources and hydropower. The interest in regional impact assessment is strong. Such assessments are made difficult by the fact that the uncertainty about the future climate development in the region around Iceland is quite high. Iceland in an excellent platform for the study of several important global change processes of global importance.

Below are examples of some of the research issues identified as being of key importance:

- Glacier mass balance **has significant implications for hydropower development in Iceland. Icelandic glaciers can also provide insights into the link between glacier mass balance and climate with global implications;**
- Sustainable harvesting of living resources in the future. **The levels of sustainable harvesting of fish stocks has profound impact on the Icelandic economy. Some of the stocks are migratory and respond to variations in conditions in the ocean. Capabilities to predict future conditions are of major economic importance;**
- Ocean currents and future climate **are of key importance in this regard. The second assessment report of IPCC predicted reduction in the thermohaline circulation of**

the North Atlantic. This could have serious consequences for Iceland;

- Deep sea formation **taking place north of Iceland is of major importance for global ocean circulation patterns. There are some indications that the rate of deep sea formation has been reduced;**
- Paleoclimate reconstruction **is of special interest for Icelandic scientists. This has been achieved through active involvement in the Greenland Ice Drilling project GRIP, sedimentary studies in Iceland and through studies of past glaciations in Iceland;**
- Impact of large scale volcanic eruptions on radiative forcing and ozone layer dynamics. **There are several volcanoes in Iceland that have thought history produced large scale eruptions with global consequences. The potential impact on radiative forcing is significant. The impact on ozone layer dynamics from an eruption now could be qualitatively different due to the chlorine loading of the stratosphere;**
- Soil erosion and desertification **is a significant problem in Iceland. Half of the soil has been lost during the 1100 years of settlement of the island. Rangeland desertification is a global problem addressed by the UN Convention to Combat Desertification;**
- Carbon sequestration **is significant component of the Icelandic action programme for the UNFCCC. Means to ensure effective build-up of carbon in low organic matter soils and through reforestation are important topics of study;**
- Extreme weather events **are of special interest for Iceland and the citizens. Changes in atmospheric circulation patterns and sea level could have significant implications;**
- Depletion of the ozone layer **is of special concern in Iceland in particular due to potential impacts on marine primary productivity. Long term records (from 1957) of total ozone levels are available for Reykjavik;**
- Economic incentives to reduce carbon dioxide emissions **are needed to find ways to reduce carbon dioxide emissions from Iceland. Research is needed in this area.**

Report on Global Environmental Change Research in Iceland

1. Background

There is no formal global change research programme in Iceland. In the fall of 1995 the Iceland Research Council (RANNÍS) decided to prepare a programme for research and research collaboration on global environmental change. A task force was established to formulate a programme with broad coverage ranging from natural sciences to the social sciences.

The task force is now in the final stages of its work. The Research Council has had a first reading of the outcome. The final decision is pending until the report has been finalized. This is expected to take place in November. Below is a summary of the conclusions of the task.

Members of the task force:
Halldór Thorgeirsson, Agricultural Research Institute (Chairman)
Axel Björnsson, Nordic Volcanological Institute
Flosi Hrafn Sigurdsson, Icelandic Meteorological Office
Jón Ólafsson, Marine Research Institute
Jón Ingimarsson, Ministry of Industry
Ingimar Sigurdsson, Ministry for the Environment
Árn_ E. Sveinbjörnsdóttir, Science Institute, University of Iceland
Kristján Kristjánsson, head of the Science Division of the Iceland Research Council, worked with the above committee and was also its Secretary.

The mandate of the task force:

1. To make a summary of research in Iceland related to global environmental change;
2. To relate of this research to international research programmes in this field;
3. To explain the nature of predicted changes and their impacts on Icelandic society and the economy;
4. To make proposals on how to stimulate research in Iceland relating to this field through:
   - coordination of current research;
   - capacity building;
   - better facilities; and
   - organized participation in international research programmes.
5. To make proposals to the Iceland Research Council on publishing the status of knowledge of the nature of changes in the environment and how enlightened discussion of impacts on Icelandic society and the economy can be promoted.

2. Introduction

Mankind stands at a cross road. Now, the cumulative human impact on the Earth's atmosphere has reached the point that man has changed the Earth's weather patterns. This was confirmed in a recent finding of a committee of experts working for the United Nations that has monitored climatic changes and their causes. It has been known for some time that man-made substances have depleted the atmosphere's ozone layer, and that this has led to an increase in ultraviolet radiation.

Pollution of the air and oceans has increased, and pollutants originating from low latitudes have been shown to accumulate in the Arctic. Desertification is a global problem and the decrease in biological diversity threatens many ecological systems.

Nations of the Earth have responded to these problems with both domestic measures and concerted international efforts. International agreements in the field of environmental affairs are rapidly multiplying, and more are being prepared.

Research into global environmental change has increased greatly in the last few years. Such research, due to the nature of its subject matter, calls for active international collaboration. Therefore research councils and international scientific associations and institutions have become active in these matters. Extensive international research programmes and formal consultation on their focus have been initiated. Many countries have implemented special research programmes, and the EU has prioritized research on global environmental change in its research programmes. It is time, therefore, for the Iceland Research Council to act, and to formulate a policy for this set of issues. The Icelandic Government has assumed international obligations through membership in agreements and conventions that, among other things, entail special obligations for increased research on the nature and consequences of global environmental change. This calls for collaboration among many institutions. At the same time, the organization of applied research institutes in Iceland is being re-examined, and in this context, it is natural to take these subjects into account.

6. Proposals

It is the view of the task force that this research is important and that the Iceland Research Council can increase results in this field by exerting leadership and coordinating efforts. The task force recommends that an effort be made over the next five years (1998-2002) to conduct research into the causes and consequences of global environmental change, especially with respect to Icelandic circumstances. The goals of this effort shall be:

1. To intensify research in Iceland into global environmental change with regards to inhabitation, natural resources and future prosperity;
2. To increase links between researchers in this field in Iceland;
3. To integrate research in Iceland on global environmental change with international research programmes;
4. To facilitate the government's access to information on the nature of global environmental change and their consequences for Icelandic society and the economy.

6.1 Coordination of current research

The Research Council shall appoint a consultative committee to promote links between researchers in Iceland and increased links with international programmes. This consultative committee shall also be a "national committee" for IGBP, WCRP, IASC and comparable parties.

The committee shall have funding to host conferences and invite lecturers to Iceland. This group shall consult closely with the executive board of the Icelandic Climate Change National programme under the UN Framework Convention on Climate Change, the collaborative Committee for Arctic Research, the consultative group on ocean bottom research and other relevant parties.
The head of the Science Division of the Iceland Research Council shall supervise RANNÍS's service to the committee.
The consultative committee is responsible for Iceland's participation in the International Group of Funding Agencies for Global Change (IGFA). Regular consultation should be with a representative of Iceland on the management committees for the EU research programmes on Marine Science and Technology and on Environment and Climate. It is suggested that research on global environmental change will be specially analyzed in the current re-examination of the organization of research for the benefit of the economy. The establishment of a network is recommended. It would include the Icelandic Meteorological Office, the National Energy Authority, the Marine Research Institute, the Agricultural Research Institute, the Institute of Freshwater Fisheries, the State Forestry Research Center at Mógilsá, the Environmental & Food agency of Iceland, the Icelandic Museum of Natural History, the Nordic Volcanological institute and the University of Iceland in addition to others, such as independent laboratories, that the matter affects.

A special effort shall be made to increase research and development work aimed at increasing the utilization of energy and reducing the emission of greenhouse gases. Research shall also be conducted on energy sources and fuel that does not release CO_2. An attempt shall be made to mobilize researchers in the fields of economics and sociology since there are many research issues in these fields.

6.2 Capacity building

The discussion of global environmental change shall be a part of research and teaching at the University of Iceland, the University in Akureyri and at the Agricultural College of Hvanneyri, Interdisciplinary courses on global environmental change shall be established in connection with a masters programme in environmental studies at the University of Iceland. The Continuing Education Institute of the University of Iceland should also offer a course on this subject. Within the main branches of science, great developments related to research on global environmental change have occurred, among other things, toward interdisciplinary collaboration and the scaling up in space and time. This demands simplification and procedures for transferring findings from one organizational level to another. Ways for active scientists to stay current in the field must be ensured along with normal renewal through young people who have been educated abroad.

6.3 Improved facilities

The task force has not separately evaluated the need for new facilities for research on global environmental change. In most instances, facilities for research into global environmental change goes hand in hand with the general improvement of facilities. The group, however, especially wants to call attention to the important role played by remote sensing in research on global environmental change.

A committee under the auspices of the Minister for the Environment is now working on the formulation of a policy on matters concerning remote sensing. The committee is encouraged to take into account the needs of global change research in their policy making.

6.4 Organized participation in international research programmes

Organized participation in international research programmes can lead to increased funding for research on global environmental change in Iceland and attract foreign scientists to do research in Iceland. The consultative committee shall work as a national committee of the IGBP and exercise leadership in relation with the IGBP office. The committee shall also promote participation in the sub-programmes of the IGBP, on a case-by-case basis. Relations with the sub-programmes of the IGBP, in other respect, will be the responsibility of the scientists, who are urged to register their projects with the IGBP core projects and to send information about such registration to RANNÍS.

A description of Icelandic projects linked to the goals of ACSYS and other programmes under the auspices of WCRP shall be sent to the relevant programme offices as a contribution from Iceland. An inquiry shall be made into whether Icelandic participation in WCRP administration must be increased.

The consultative committee shall follow the progress of the HDP programme and facilitate participation by Icelandic research groups as much as appropriate.

6.5 Financing and manpower

The submission of proposals to the EU's Environment and Climate and Marine Science and Technology Programmes shall be facilitated. Efforts shall also be made to continue such research as a part of Nordic scientific collaboration.

The Research Council shall facilitate collaboration with scientists in the USA and Canada through discussions with parties in these countries and collaboration agreements, if necessary. The financing of joint research projects with US or Canadian participation should be more difficult that financing joint projects with European collaborators.

During this five-year period, grant applications to RANNÍS in this field of emphasis that have received a satisfactory professional evaluation shall be given priority in the experts councils of the applied and scientific Funds.

This will be published in a notice about grants, but no funds will be earmarked for this field in advance. The needs in this field shall also be taken into consideration. Collaboration with ministries and other parties shall be sought for joint financing that, among other things, facilitate the fulfillment of research needs in relation to international agreements, In this regard, the consultative committee shall work with the executive board of the government's programme for the UN Framework Convention on climate Change. The Research Council sees to the allocation of these additional funds on the basis of applications to the council's funds in a manner similar to what has been done in the collaboration of the Technical Fund with the Agricultural Productivity Fund and the State Housing Board. In this way, the ministries obtain assurance of processional allocation of research funds and monitoring of results.

6.6 Publicity

Efforts shall be made to publish global environmental change and their consequences for both the public and the economy. Collaboration with oil distributors and other parties shall be sought concerning these efforts. The consultative group shall facilitate publicity of the findings from the IPCC and others. This will be done, among other things, through the publication of two status reports for Iceland (for example, in 1998 and 2002).

JAPAN

FY1997 Comprehensive Programme for Promotion of Global Environmental Research, Monitoring and Technology Development

Council of Ministers for Global Environmental Conservation 17 June 1997

In Japan, global environmental research, monitoring and technology development to be carried out by the relevant government ministries and agencies is directed by the Comprehensive Programme for Promotion of Global Environmental Research, Monitoring and Technology development which is formulated by the Council of Ministers for Global Environmental Conservation in each fiscal year. The summary of the Programme for FY1997 is as follows:

1. Basic Point

The Programme sets out priority areas which the Japanese government should deal with, and comprehensively promotes global environmental research, monitoring and technology development.

2. Promotion of global environmental research, monitoring and technology development

(1) Basic principles

Global environmental research, addressing environmental problems which involve global phenomena, will be comprehensively promoted under the following categories:

a) research on various global phenomena relating to global environmental problems;
b) research on impacts of human activities on the global environment, and impacts on human health and ecosystems, etc., caused by global environmental change; and
c) research for development of policies for conservation of the global environment.

In particular, research will be promoted into human and social dimensions of global environmental issues; integrated academic research in natural sciences and social sciences, and socio-economic systems; and pioneering research which offers innovative methods to promote global environmental conservation policies.

Monitoring and observation of the global environment covers wide regions and will be conducted with appropriate task sharing in international monitoring and observation programmes. In particular, and especially, development of methods to effectively use satellite sensors will be actively promoted.

In order to promote sustainable development, the Programme will develop technologies to mitigate global environmental change, including not only direct treatment of pollutants but also efficient resource and energy use, etc.

Participation and cooperation will be conducted in international research programmes, and monitoring and observation programmes.

(2) Priority Fields

Research, monitoring and technology development will be promoted in such fields as global warming, ozone layer depletion, acid deposition, marine pollution, tropical deforestation, desertification, biodiversity loss, and transboundary movement of hazardous wastes, as well as human dimensions of global environmental change.

(3) Others

The Programme will promote international cooperative research on priority topics relating to global change in the Asia-Pacific region, identified in the inter-governmental activities of the region such as the Asia-Pacific Network for Global Change Research (APN).

The Programme will promote improvements and strengthening of capacity at the Institute for Global Environmental Strategies which will implement international and multidisciplinary policy research for sustainable development, and at universities, etc, which implement global environmental research.

Budget in FY1997 (% of FY1996)

Research	57.4 billion yen (113 %)
Monitoring	52.2 billion yen (99 %)
Technology Development	467.9 billion yen (98 %)
Total	577.5 billion yen (100 %)

THE NETHERLANDS

Global Change Research and Policy

Policy

Climate change, sea level rise and ozone depletion are a matter of concern at the government level. In 1996, the Second Assessment Report of the IPCC draw much political attention. An extensive parliamentary inquiry was held to investigate the meaning of this report for Dutch policy. All Dutch leading scientists were interviewed. CO_2 emission levels have become a standard item in the Queen's annual address to the parliament at the opening of the new parliamentary year in September.

Until recently, the Netherlands government policy on global change was aimed to be in the vanguard of environmental protection. However, the finding that the country is unable to meet its own CO2 emission reduction target of -3% in 2000 as compared to 1990 has shown that policy targets are easier formulated than be met. This has its explanation in increased economical growth including increased traffic. Actually, the year 2000 level of CO2 emissions is expected to be 10% above the 1990 level. The Netherlands' emissions of CH4 are comparatively high (but slowly declining) due to the high density of cattle.
Considerable efforts were spent in preparing the Second National Communication for the meeting of the CoP of the FCCC in Kyoto.

Research infrastructure

About half of the global change research is performed at universities, the other half at research institutes. The number of people actively involved is about 400 including both senior scientists and PhD students.
There are strong research groups on various areas of global change, in particular on ocean and climate modeling, coastal research, marine biogeochemistry, paleoclimatology, measurement and modeling of fluxes of water, energy and trace gases. Small groups are working on glaciology, on atmospheric chemistry and on aerosols. Important contributions are being made in the field of human dimensions research. The continuous development of the integrated model for the assessment of global change IMAGE (used for IPCC) serves as a focal point for results of many research activities. A more comprehensive overview of the research infrastructure is given in the Second Netherlands' National Communication (see pre-distributed documents).

Organization of GCR funding and programmes; links with international programmes and their committees; national committees

Over the last ten years GC research used to be funded through special programmes of the science foundation NWO at the level of US$ 1M/year. Additionally, a considerable stimulus was given by the 1st national programme on climate change research with US$ 35 M ministerial funds over 1990-1995. This national programme funded only 50 % of the costs of projects. As a consequence, GC research is increasingly being funded by own institutional budgets and by EU-grants. The present 2nd national programme on climate change has a lower funding level than the first (US$ 27 M 1996-2001, including USD$ 6 M from NWO).

The national research programme on climate change has a steering committee with representatives of ministries, industry and NGOs (one of the aspects of the so called Polder Model). Their interest in research is influenced by political questions rather than scientific ones. International cooperation is advocated.

The Ministry of Education, Culture and Science has an active policy on global change research. Last year the Minister triggered reinforcement of international cooperation between Dutch and German research institutes by extra amounts of funding. This mainly relates to global change research in the fields of oceanography and atmospheric research.

The Netherlands Institute for Sea Research is hosting the CPO of the LOICZ. The main part of the funding (US$ 500 k/y) is provided by the Ministry of Education, Culture and Science and the Ministry of Public Works, Traffic and Water Management. The present commitment expires by the end of 1997. The functioning of the CPO was evaluated early 1997. The NWO Research Council for Biosphere and Geosphere Sciences and the Royal Academy's IGBP committee recommended the Ministry of Education, Culture and Science to continue the funding for another period of five years. Decisions have not yet been made, but there is confidence that the Ministry follows the advises.

The three national committees for WCRP, IGBP and IHDP operate under the aegis of the Royal Academy of Arts and Sciences. These committees and in particular subcommittees for IGBP projects are active in programming new Dutch research initiatives in the framework of the international projects. Most of the top 10% of the global change researchers are involved in the Academy's committees, in the NWO funding processes and in the international projects as well.

Trends in budgets and designated contributions

In view of OECD figures, the Dutch research budgets should amount over 2% of the global spending level. In reality it is about 1.5 %. National research budgets are stable after severe cuts in the last few years.

The Dutch figures for the Resource Assessment are attached. The figures include overhead costs. The typical costs of a 4 years research project are $ 250- 500 k. The figures do not include the considerable amount of funds ($ 10-15 M/y?) obtained by Dutch scientist from the EU-framework programme.

The figures show a maximum spending level in 1993-94 ($ 26-27 M), when two special programmes were fully deployed. The lower figure of 1996 is partly due to the slow start of the 2nd phase of the national climate research programme (1996-2001), but also to the lower funding level of this programme.

It is not expected that funds will be reserved for a 3rd phase national programme. In the future GC research will increasingly depend on own budgets of institutes. In the open competition for funds a tendency emerges to propose initiatives on special parts of the GC research programmes in smaller, more focused plans. This has already been successfully attempted: in September 1997 the NWO board approved a $ 4 M multidisciplinary 5 year programme for coastal marine research (relevant for LOICZ focus 4); in October the Research Council approved funding of $ 2.3 M for a 5 year Dutch CLIVAR programme.

Exciting new research, highlights

A wide variety of Dutch global change research activities is contributing to the core research of the international projects.

The influence of aerosols on regional climate is a critical factor in the closure of the radiation budget. Preliminary results of a Dutch research group indicate that this may be at least of the same magnitude as the antropogenic greenhouse effect.

Upscaling is one of the key words of several research lines in the Netherlands: upscaling sources of CH4 and N2O to regional emissions; upscaling of interactions in the water and energy budgets of coupled vegetation-atmosphere systems; upscaling of the influence of gyres on ocean circulation. Modeling is a key activity in these subjects.

A research programme on the role of the abundant algae Emiliania Huxleyi on the carbon budget of the ocean is being extended to a programme covering the whole continuum from molecular genetics, cell-level, population, ecosystem and global level.

The NWO foundation on Tropical Research WOTRO funds core activities of the SARCS/WOTRO/LOICZ programme, including two programmes in Indonesia which are aimed at developing Decision support systems for sustainable management of coastal zones.

National strategies on communication

In 1993, the science foundation NWO invited Bert Bolin for the prestigious Huygens lecture, which is a joint activity with the city of The Hague and the leading Dutch quality newspaper. At 12 November 1997 the Huygens lecture will delivered by the paleo-ecologist Prof. Paul Colinvaux of the Smithsonian Tropical Research Institute, and will deal with the background of biodiversity in Amazonia.

The Dutch committees for IGBP and WCRP are preparing to issue a series of short (24 pages) communications on various items of global change research.

The national research programme on climate change publishes a quarterly newsletter ‘Change’ which is widespread.

NORWAY

Global Change Research 1997
National Global Change Committee

In 1997 The Research Council of Norway established a National Global Change Committee. This was done in agreement with The Norwegian Academy of Science. The Norwegian Global Change Committee is going to continue the work of the former National HDP committee and the IGBP committee.

The Norwegian Global Change Committee is chaired by Professor Ivar Isaksen, former chair of the Norwegian IGBP committee, and Professor Arild Underdal, who was the former chair of the National HDP committee is vice-chair.

The committees objective is to strengthen and coordinate Norwegian research on Global Change and to be a contact point between Norwegian and international scientists within Global Change research and with the international research programmes and their steering committees.

The Norwegian Global Change committee aims to bring further the work of the Norwegian IGBP-committee and that of the Norwegian HDP committee. The Global change committee is also an advisory body for the Norwegian participation in EUs Climate and environment programme (in the 4th Framework programme), and to the Norwegian participation in IIASA (International Institute of Applied Systems Analysis).

An important objective of the committee is to strengthen the scientific collaboration between social science and natural science within global change research. This will be done through collaboration with national research programmes and through collaboration and contact with international programmes and organizations as IGFA, IGBP, IHDP, WCRP, START, IIASA, EUs 4th and the coming 5th framework programme for research.

With respect to IHDP related research the committee will follow the recommendations by a Working Group appointed by the Research Broad for Environment and Development of the Research Counsel of Norway. The recommendations are published in booklet "Causes and Consequences of Global Environmental Problems: Social Science and Interdisciplinary Research".

The Research Council of Norway supports the IHDP annually with US$ 7000 in core support. The Norwegian government and The Research Council of Norway puts emphasis on dissemination of results to the public, the private industry and the authorities. As a follow-up The Research Council has developed a strategy on this.

Funds - trends?
The IGFA resource assessment "exercise" shows that the total research effort is enormous, at least according to the Norwegian level of support, and represents approx. 150 projects, 200M NOK (32 M US$) and 300 man years (some salaries including in the sum.

The "core" support is estimated to approx. 14 M NOK and 12 M NOK in 1994 and 1995 respectively. In addition, Norway is hosting the core project offices for Arctic Climate System (ACSYS) under WCRP and Joint Global Ocean Flux Study (JGOFS) under IGBP.

In Norway the funds available for global change research are at the same level as last years, possibly with a change of focus to more weight on climate change research and biodiversity in order to follow up the conventions. A new national programme on Biodiversity research is recently established.

The Norwegian collaboration programme with the Eastern- and Central European countries also focus on environmental research and specially on health and environment in North Western Russia. The strategy for the programme is available.

Highlights From 1 January 1997
Norway was a member of IIASA. A lot of the national research activity related to IIASA activity is on Global Change related activities.

The Ministry of Foreign Affairs has developed a Strategy for Environment in Development Cooperation of clear relevance to global change research. The Strategy states that the main objective of environmental assistance is to contribute to a "sound management of the global environment and biological diversity".
The following areas have been given priority:
Development of sustainable production systems; Conservation and sustainable use of biological diversity; Reduced pollution of soil, air and water and Preservation of cultural heritage and management of he natural environment's cultural values. The Ministry of Foreign Affairs is also just now formulating a strategic plan to strengthen human resource development and research related to Norway’s relations with developing countries in which there is a strong emphasis on environmental issues.

In February 1997 the IGBP-committee organized and funded a workshop aimed at sounding interest in the Norwegian Scientific community for launching projects and initiatives within International Global Atmospheric Chemistry project IGAC. A report from the workshop is available.

The IHDP committee organized and funded a workshop within the are: Landuse/landcover change, with focus on social factors causing loss of biological resources. 25 scientists participated. A report will be available later this year.

The JGOFS core project office was established in February 1996 at the University of Bergen. The Research Counsel of Norway funds the core Office for a four year period. The office is well established and well integrated with the rest of the University.

SPAIN

Third National R & D Plan
1996 - 1999

The promotion of the scientific research and technological development and the overall co-ordination of the resources devoted to it, is carried out by the Spanish Administration through the National R&D Plan, which is now in its third phase, and will extend from 1996 to 1999.

The Plan III will concentrate on enhancing the coordination of R&D activities and linking up the scientific-technical and productive environments, the innovation and the solution of socio-economic problems. Attention will be paid to basic research as well.

To do this, Plan III comprises several R&D Programmes through which it tries to resolve some of the problems facing Spain at the present time: coordination of sectorial policies with national R&D policies and international programmes; the integration of the productive sectors in the R&D policies; the promotion of the innovation and dissemination of the knowledge; the support of important social issues (environment, health, etc.); and the development of human capital and its mobility.

The National Programmes included into the 3rd National R&D Plan are divided into three main areas:

I. QUALITY OF LIFE AND NATURAL RESOURCES

- Biotechnology
- Health
- Food technology
- Agricultural research
- Environmental research
- Climate research
- Water resources
- Marine sciences and technology*
- Antarctic research

II. PRODUCTION AND COMMUNICATION TECHNOLOGIES

- Advances production technologies
- Space research
- Materials
- Information and communication technologies
- Telematic services and applications
- Chemical processes technologies

III. HORIZONTAL AND SPECIAL PROGRAMMES

- Promotion and linking-up of the science-technology-industry system (PACTI)
- Training of research personnel
- High energy physics
- Social and economic studies

Within these areas the one of Quality of Live and Natural Resources is the most related to Global Change Research. Within this area, three new National Programmes related to Global Change issues have been created, beside the already existing Environmental Research National Program: Climate Research Programme (coordinated with Ministry of Environment), Water Resources Programme (in collaboration with Ministry of Environments, Ministry of Agriculture and Ministry of Industry and Energy) and Marine Sciences and Technology Programme (in collaboration with Ministry of Agriculture).

Even more, the National Plan III is including a programme to promote the linking-up of the scientific, technological and productive systems, and to encourage an effective orientation and utilization of knowledge and scientific and technical capabilities on the part of the productive sectors and of society as a whole. There are tow fundamental instruments for doing this : PETRI actions and joint projects. PETRI actions are particularly appropriate for SMEs ; joint projects constitute a key instrument in the promotion of technological development in the productive sector.

Each national programme has a Programme Committee composed by experts from different specialties, corresponding to the priorities areas identified by CICYT. These experts participate in the initial preparation of the content of each national programme, the work document, assisted by representatives of the CICYT and General Secretariat for the National Plan. These committees are also participated by international programmes representatives, mainly IGBP, through the Deputy Direction General for International Scientific Cooperation.

SWEDEN

1. General RaD Policy Trends

- Quicker turn around in terms of structural changes
- "Compacting" of financing
- Symbiotic use of the semi-new semi-private research foundations
- EU connection
- University structure issues (e.g. small and medium colleges)
- Gender issues
- Quality and relevance issues
- Compacting international research funding

2. Environmental policy (and RaD)

- The "Green Sweden" overall policy posture
- The sustainability RaD approach
- Environmental funding through the "foundation" system (Mistra) and ***not*** through the environmental protection agency (SNV)
- Continued international environmental interest

3. Global change research

- Organizational issue at national level:

IGBP/WCRP committee	}	are independent
and	}	but
Human dimensions committee	}	connected

- Common task interests to be tested ("Baltic region case")
- Funding via "normal" project funding base in the mainline
- Communication and "democratic" dialogue (not only information transfer) with the public, both with regard to scientific results but also with regard to the relevance of emphasis in broad terms.

SWITZERLAND

Summary reporting highlights of the national programmes, recent changes and trends and policy changes

1. Policy changes in Switzerland as background of GCR

Global Change Research (GCR) is not treated as a separate scientific field in Switzerland, but is included in environmental research. This discipline has changed over the past 20 years. After the limitations of the technocratic approach during the eighties and nineties were recognized, a return to a more comprehensive concept of environmental protection, with economic, social and cultural factors determines today's discussion.

Environmental research is concentrated in the following institutions:
Universities of Berne, Zurich, Geneva, Basle, Lausanne, Neuchatel, Fribourg, St. Gall;
Federal Institutes of Technology, Zurich and Lausanne;
Swiss Federal Institute for Water Research and Water Pollution Control (EAWAG Institute Paul Scherrer (PSI); Swiss Federal Institute for Forest, Snow and Landscape Research (WSL);
Swiss Federal Laboratories for Material Testing and Research (EMPA).

When confronted with environmental questions in developing legislation, certain Federal Offices also carry out public sector research or commission other research institutes.
The following offices are the most active in environmental research:
Federal Office for Environment, Forests and Landscape (BUWAL);
Swiss Meteorological Institute;
Federal Offices for the Energy Industry;
Federal Office of Agriculture (with seven agricultural research stations).

2. Organization of GCR funding and programmes and links with international programmes (WCRP, lGBP, lHDP, START), their international committees and corresponding national committees

A report of the BUWAL 1992 presents the wide and varied spectrum of activities taking place in Switzerland, with technology and the natural sciences as the major research priorities. This report shows that government-funded environmental research clearly outweighs projects financed by private industry. The 200 million Swiss francs provided by the public sector far exceeds the 150 million francs supplied by private enterprise.

The major source of funding is the Swiss National Science Foundation (SNSF), which supports physical climate research (mainly basic research) in the form of individual projects and as part of the two oriented research programmes, the National Research Programme "Climate Changes and Natural Disasters" (NRP 31) and the Swiss Priority Programme "Environment" (SPPE). In addition to these two programmes, other NRPs are related to the environment are: NRP 25 "Town and Transport"; NRP 26 "Mankind, Health and the Environment"; NRP 41 "Transport and environment".

Participation of Switzerland in the 4th RTD Framework Programme of the EU
With regard to the 4th RTD Framework Programme (FP4), Switzerland is considered as a European third country Thus, Swiss legal entities may participate in a project, if the participation is in the interest of community policies. However, no community funds are available for Swiss research teams. Despite these rules, the Swiss scientific community actively takes part in FP4. At present, funding is fully assured by a special credit adopted by the Swiss Federal Parliament for this purpose. Under FP4 more than 140 million CHF were allocated to Swiss institutions participating in over 460 EU-research projects. An additional 140 projects, including Swiss research teams have been approved in Brussels and will, therefore, also receive funding from the Swiss Government.
About 12% of the participation concerns the programme "Environment and Climate." Once the Commission has accepted a proposal for funding, the Swiss partners must formally apply for their costs to be assumed by the Federal Office for Education and Science (FOES).

3. Budget development, including recent trends on the funding of overall programmes and international project offices of specific projects and support for international infrastructure (including WCRP, IGBP or IHDP designated contribution; not FCCC, IPCC, ICSU etc).
Although various sections of the SNSF are increasingly concerned with topics relevant to the environment, additional funding for research in this field is not available.
The PAGES Core Project Office is currently located in Berne, Switzerland and supported equally by the National Science Foundations of the USA and Switzerland.

4. New research programmes/groups/plans including highlights of national and research funding
NRP 31: Climate Change and Natural Disasters began in 1992 and will be completed early next year after five years of research activities. The most important results of the programme will be summarized in five synthesis reports with the following priorities: GC and reaction of the atmosphere in the Alps; reaction of the hydrological cycle; potential of natural risks; reaction of ecosystems as well as consequences for society and economy. Reports on television, videos, CD-ROM and a book will be used to inform the public. For the first time there will be a valorization programme to provide potential private and governmental users with the scientific results of the PNR 31.

The first research period (1992-95) of the Swiss Priority Programme Environment (SPPE) included 120 projects, 250 events and approximately 1200 publications. The second phase of this programme is assured for the next four years by the allocation 45 million Swiss francs for 80 projects for the second research period.

5. National strategies on communication of scientific results and the public decision makers and private sector
Since 1996 all current projects supported by the SNSF are available from a Databank on the Homepage of the SNSF.

Through an easy to use search strategy, access to any one of the approximately 3000 registered projects is assured. It is also possible to directly contact specific researchers through their e-mail address.

ProClim is a forum for climate and global change issues initiated in 1988, and was the first organization which has assigned research projects in Switzerland to international global change programmes. As an independent organization of the Swiss Academy of Sciences, ProClim actively promotes interdisciplinary scientific collaboration, assists with the development of coordinated research projects, and facilitates the exchange of information on global change science within Switzerland. The ProClim Infosystem provides an overview of Swiss research activities in the fields of Climate and Global/Regional Change. A series of analyses provides an overview of Swiss research and monitoring activities, which were established in collaboration with the Commission on Climate and Atmosphere Research, the Swiss National IGBP respectively the Swiss National IHDP Committee.

Various efforts are being made to strengthen the dialogue between public policy makers and scientists. Some of the results of these efforts are:

The report “Research on Sustainability and Global Change: Economic and Politifisions of Swiss Researchers" was published under the auspices of ProClim. This study is aimed at decision makers in politics and industry as well as scientists and institutes supporting research.

The Swiss Commission for Strategic Environmental Research and Sustainable Development established in 1996 aims at advising the Federal Council and the Federal Department of the Interior in the field of environmental research and environmental aspects of other scientific fields, as well as promoting a policy of sustainable development.
It intends to establish a policy concerning environmental research (basic, oriented and commissioned) focussing on optimization of the existing institutions and instruments.

In 1996 seven members of the Swiss Parliament initiated the Parliamentary Group on Climate Change, whose purpose is to provide members of parliament with information about climate change issues, and to stimulate discussion on the need for political action. The Group meets once each Parliamentary Session.

At the beginning of this year the Swiss Academy of Sciences founded the "Advisory Body to the EDI on Climate Change Research and Policy COcCC)" on the request of the Federal Department of the Interior (EDI). The duties of the OcCC include, among other activities, recommendations concerning research priorities, coordination of research activities, and suggestions for the protection of the climate. This committee includes representatives from climate research and industry, as well as members of the government and the SNSF.

Reviews and other relevant documents on Global Change Research in Switzerland

Research and Monitoring of Climate and Global Change in Switzerland
Part I - Physical Climate System (1995)
Part I - Physical Climate System - an update (1997)
Part II - Biogeochemical Processes (1996)
Part III - Human Dimensions of Global Environmental Change (1996) .
Research on Sustainability and Global Change - Visions in Science Policy by Swiss Researchers 1997

UNITED KINGDOM

National Highlights for 1997

The New Government

The Labour Party was elected as the new party of Government for the UK in May 1997. The new Government regards the environment (particularly climate change) as a high priority issue and intends to play a leading role in international Conventions and negotiations. The personal appearance of the Prime Minister at the Special Session at the UN General Assembly in June, where he affirmed the UK's target of a 20% reduction in greenhouse gases by 2010, was a valuable demonstration that the new Government takes these issues very seriously.

At the request of the new administration, the Government's Chief Scientific Adviser, Professor Sir Robert May FRS, has already delivered a report on climate change which forms part of the Government's preparations for the third Conference of the Parties to the UN Framework Convention on Climate Change to be held in Kyoto in December. The paper considers the scientific uncertainty surrounding global warming, sketches out likely consequences for Britain and elsewhere, and stresses the need for immediate action.

The paper states:

The quality of the UK's contribution to research on climate change, in the broadest sense, is strong out of all proportion to our relative size or research spending. We should aim to maintain this strength, so as to have international policy underpinned by fundamental understanding, to continue our position of international policy and scientific leadership in this arena, and to help persuade the world's sceptics that climate change is a real and serious problem.

The Government announced a Comprehensive Spending Review, that aims to bring public spending programmes into line with the new Government's priorities and objectives. All departmental budgets and the Science Budget are subject to this review. A Cabinet sub-committee will appraise the results and make recommendations to Cabinet

Changes to the departmental structure of Central Government have been made which will have implications for activities of relevance to Global Environmental Change in the UK. The Departments of Environment and Transport have been merged to create the new Department of Environment, Transport and the Regions (DETR). One of the primary implications of the merger is that environmental concerns will be better integrated into policy decisions on transport planning. It is hoped that this will more readily lead to reductions in greenhouse gas emissions from, especially, road transport.

The Overseas Development Administration (ODA) has been renamed the Department for International Development (DFID). The new department is committed to working for a safer, more decent and environmentally stable world and will ensure that sustainable development and poverty elimination are at the center of Government objectives. A specific undertaking has been made to help developing countries fulfill their international environmental commitments.

After a long gap, the UK has rejoined UNESCO, regarding it as an important international organization of which the UK should be a part.

The UK scientific community has been looking afresh at the bewildering scale and complexity of the Programmes, especially “Sciences in the Service of Development”. While the UK has maintained contact with some parts of this Programme, there are other areas that are less familiar.

A government programme was launched in April to provide a stakeholder-led assessment of climate change impacts within an integrated national framework. It will bring together those from the public and private sectors with responsibilities for accommodating the effects of climate change to undertake sectoral- and regional-based impact assessments. Previous assessments have examined the impacts of climate change on specific sectors. The ability of one sector to respond to climate change impacts may be constrained by competing demands of another. Individual sectors need to work together in an integrated manner to obtain a more realistic assessment of climate change impacts. This will enable appropriate adaptation strategies to be developed which take account of impacts and interactions across sectors and regions. The assessments conducted will provide Government and private sector decision-makers with better information to inform policy decisions and adaptive strategies. A Programme Office has been established at the Environmental Change Unit, University of Oxford.

The Dearing Report

In July 1997, a vision of the UK higher education system of the future was set out in a Report from the National Committee of Inquiry into Higher Education, under the chairmanship of Sir Ron Dearing. It is the most significant and wide-ranging review of higher education in Britain for thirty years. The Report looks at the purpose of higher education, recommends continuing expansion of opportunities for all and addresses the needs to promote learning for its own sake and to train a capable, skilled workforce. The Report recommends that it should be a clear objective of national policy to be of world class in the business of learning at all levels and in a range of research of different kinds.

One specific and contentious recommendation, based on the premise that the costs of higher education should be shared between those who benefit, is that full-time students should pay roughly 25 per cent of the average cost of a course.

Another key recommendation, based on the requirement for more investment in research infrastructure, is that University research grants should include more realistic support for overheads. Funders of global change research, among others, are now considering the impact this would have on the volume of research that could be supported.

The Technology Foresight Programme

Now called just *Foresight', this programme aims to improve the international competitiveness of the UK economy, and to enhance the UK's quality of life, by bringing together business, the science base and Government, to identify and respond to emerging opportunities in markets and technologies. One of the sixteen sectoral Panels examined Natural Resources and the Environment. The Programme has been highly successful in many respects, particularly in terms of improved networking.

The current phase of the programme aims to engage the wider business community in Foresight, reaching out beyond the research and development functions in companies. A second national review within the Foresight exercise will begin in 1999. Recently the Foresight structure gave a broadly-based cross-sectoral meeting an opportunity to discuss research priorities within Global Environmental Change from the users' point of view.
Following discussions with the Foresight Finance Panel and the Department of Trade and Industry, a new programme TSUNAMI (Technology and Science from the Universities, NERC Institutes and the Meteorological Office for Insurance), has been supported through the government's Sector Challenge Fund to improve the UK insurance industry's understanding of natural catastrophe risks. Future projects supported are likely to include studies of climate variability. The frequency of extreme events and the magnitude of those events are of interest to different sectors of the Industry.

Inter-Agency Committee on Global Environmental Change Following a successful review by the Chief Scientific Advisor, the Inter-Agency Committee on Global Environmental Change (IACGEC) was re-established. The review concluded that IACGEC should be retained with much the same aims as before. However, a broader more flexible membership structure should be introduced with “Full" and “Associate" members. Associate Members receive papers but in general only attend meetings for specific items of interest. Professor Sir Richard Southwood FRS of the University of Oxford was appointed as the new Chairman. Full Members of the committee are BNSC, DETR, DTI, ESRC, Meteorological Office, NERC and OST. Associate Members are BBSRC, EPSRC, MRC, MAFF, DFID and SO. The UK's Global Environmental Research Office retains secretariat responsibility for the Committee. The first meeting of the re-established committee was held in May 1997. The main item of business was how to monitor the implementation of the UK National Strategy for Global Environmental Research, produced by an expert panel chaired by professor Brian Hoskins FRS of Reading University and published in 1996 by IACGEC. A report is currently being prepared to assess the impact of the report on the policies and research portfolios of relevant agencies.

The Royal Society's UK IGBP National Committee has been reactivated and will meet shortly to discuss UK science and policy issues of relevance to IGBP. Items for discussion at the meeting will include:

1. the role of the UK IGBP National Committee;
2. links between UK IGBP Core Project communities;
3. IGBP SAC Vmeeting in Nairobi;
4. establishment of a UK Global Environmental Change Scientific Committee to oversee UK activities of relevance to IGBP, WCRP and IHDP, and to interact with IACGEC, the Committee of “funders”.

Scientific Programmes
The NERC-funded programme Terrestrial Initiative in Global Environmental Research (TIGER) came to an end in 1997. TIGER was the largest and most complex programme ever organized in the UK in the field of terrestrial and freshwater sciences.

The initiative had three broad thrusts:

1. to investigate the physical and biological processes through which the land surface influences climate;
2. to predict the overall effects of climate change on the natural environment;
3. to understand the feedbacks from the land that may accelerate or slow climate change.

One of TIGER's most significant discoveries has been the large scale on which carbon is being accumulated by large forested areas worldwide. Internationally, the Programme has made a significant contribution to the core research activities of IGBP and WCRP. Soil Biodiversity is a new NERC thematic research programme that has been allocated 6m and will run for 5 years. The programme aims to increase the understanding of the function of soil organisms and the role of diversity in maintaining soil processes and resilience to perturbation. Many of the soil biota are undescribed, as are their metabolic activities. The programme is designed to increase the knowledge base and to give advanced training in the fields of taxonomy and molecular techniques, in cooperation with the scientific community and potential users in industry and government. The programme will concentrate on the following topics:

1. The role of soil biodiversity in carbon flux;
2. Improving techniques to describe the soil organisms with a key functional role;
3. The effects of land management practice on soil biota and fluxes of carbon and nitrogen;
4. The transformation of pollutants in soil by the activity of indigenous and novel organisms;
5. The role of biota in the passage of nutrients and pollutants through the soil;
6. The relevance of soil biodiversity indicators to land use management.

Another NERC thematic research programme, allocated and intended to run for 5 years, has been approved to Study the Composition and Structure of the Lower Stratosphere and Upper Troposphere at Middle Latitudes. The programme will combine field measurements, laboratory studies and data analysis to provide basic scientific underpinning for the understanding and prediction of present and future changes in atmospheric composition and climate. The programme will both exploit existing expertise and encourage new developments to maintain the UK's pre-eminent role in the international efforts in atmospheric chemistry and climate change. Participating scientists will investigate three main issues:

1. What effect do air traffic emissions have on the chemistry of the atmosphere?
2. How does ozone move around in the stratosphere and what is causing the decline in middle latitudes?
3. How are changes in the composition of greenhouse gases in the lower stratosphere involved in the circulation of the lower and upper atmosphere?

United States

Global Change Research Programme

In response to the development of scientific understanding and research capabilities, the United States Global Change Research Program (USGCRP) is focusing research efforts on four areas of Earth system science that are of significant scientific and practical importance:

1. Seasonal to Interannual Climate Variability, with the goal of obtaining a predictive understanding and the skills to produce forecasts of short-term climate fluctuations and to apply these predictions to problems of social and economic development in the United States and abroad.
2. Climate Change over Decades to Centuries, with the goal of understanding, predicting, and assessing changes in the climate and the global environment that will result from the influences of projected changes in population, energy use, land cover and other natural and human-induced factors, and providing the scientific information needed by society to address these changes.
3. Changes in Ozone, UV Radiation, and Atmospheric Chemistry, with the goal of understanding and characterizing the chemical changes in the global atmosphere and their consequences for human well-being.
4. Changes in Land Cover and in Terrestrial and Aquatic Ecosystems, with the goal of providing a stronger scientific basis for understanding, predicting, assessing, and responding to the causes and consequences of changes in terrestrial and aquatic ecosystems resulting from human-induced and natural influences.

- Improve skills in predicting climate fluctuation, particularly over the United States;
- Monitor the tropical Pacific Ocean in order to better determine its influence on climate, and to improve predictions;
- Map global precipitation and its relationship to climate fluctuations;
- Incorporate field data into models in order to improve forecasts of climate variability;
- Assess human vulnerability to climate variations and identify predictions; and
- Establish a network of research centers to improve forecast model development and diagnostics, and the application of predictive information to socio-economic planning processes.

Significant recent scientific achievements of USGCRP sponsored research

Improved prediction of El Niño events - A number of forecasting methods based on numerical models successfully predicted the end of the prolonged El Niño conditions of 1991-1995 and their replacement by colder-than-normal conditions in the eastern Pacific in 1996.

This change contributed to the drought in the southwestern United States, then the heavy winter precipitation in the on western coast. Predictions of year-to-year climate fluctuation are now being made.

International Research Institute (IRI) - Significantly improved computer models are becoming available to simulate the global climate and predict future change. A new high-resolution ocean model is simulating ocean currents in the Arctic.

Ecosystem Response to Increasing Atmospheric CO_2 - With continued use of fossil fuels, atmospheric CO_2 concentrations are likely to continue to rise substantially over at least the next

century. However, there are still relatively few data on how entire ecosystems respond to increases in CO_2. A network of field experiments using Free Air CO_2 Enrichment (FACE) technology has now been implemented to evaluate responses of terrestrial plants and ecosystems at elevated concentrations of atmospheric CO_2 expected in future decades. Initial data from crop and forest experiments suggest increased growth and net carbon sequestration in perennial ecosystems when plants are grown in the field at elevated CO_2 concentrations. These long-term experiments will continue to lay the scientific foundation for understanding the consequences of future emissions of CO_2 from combustion of fossil fuels.

Marine Ecosystems: Iron as a limiting nutrient? - Recent studies in the tropical Pacific Ocean indicate that iron, which is relatively abundant in waters near land, may be the limiting nutrient in determining primary production of marine life in the waters of the central ocean basins. In a series of field experiments involving controlled additions of iron salts to surface waters, scientists documented dramatic plankton blooms and concomitant draw-down of other excess nutrients. These results are encouraging studies of factors controlling primary production, carbon cycling, and ocean-climate impacts elsewhere in the world ocean.

Key research challenges fort he next decade include enhancing efforts to develop

- Regional-scale estimates of the timing and magnitude of climate change and other aspects of global change;
- Regional analyses of the environmental and socio-economic consequences of climate change and other aspects of global change, in the context of other stresses;
- Integrated assessments of the implications for society and the environment of climate change and other aspects of global change.

Funding Trends

Research supported through the US Global Change Research Program (USGCRP) is documenting environmental change and leading to a better understanding of its significance. The entire program was funded at 1.8 billion dollars for FY97, which roughly the same funding as FY96. A modest increase of 3-4% was requested for FY98. Maintenance at approximately the same levels is expected through the next few years.

FY98 Program highlights of the major USGCRP agencies

National Oceanic and Atmospheric Administration (NOAA) - In FY98, NOAA will continue to advance the scientific understanding essential for the development of sound policies through several activity streams, including 1) understanding and predicting climate variability on seasonal to interannual time scales and 2) understanding and assessing decadal and longer climate variability.

NOAA's research elements are designed to generate a predictive understanding of the integrated Earth system: 1) Climate Dynamics and Experimental prediction; 2) Global Ocean-Atmosphere-Land System (GOALS); 3) Atlantic Climate Change Program (ACCP);

4) Global continental scale International Project of the Global Energy and Water Cycle Experiment (GCIP/GEWEX); 5) Climate Observations; 6) Climate Change Data and Detection; 7) Economics

and Human Dimensions of Climate Fluctuations; 8) Atmospheric Chemistry; 9) Ocean-Atmospheric Carbon Exchange Study; 10) Paleoclimatology; and 11) Aerosols.

Department of Energy(DOE) - To support its global change research efforts, the Biological and Environmental Research program (BER) of the DOE office of Health and Environmental Research utilizes the unique multi disciplinary capabilities and facilities of the DOE National Laboratories and supports biological and environmental research projects and research infrastructure at National Laboratories, universities and other research institutions. Highlights of the BER program:

- Climate and hydrology: Key activities of the Atmospheric Radiation Measurement (ARM) program are the further development and utilization of measurement capabilities at the Tropical Western Pacific site, the initial conduct of intense observational periods on the North Slope of Alaska, and uncrewed aerial vehicle (UAV) flights over the Southern Great Plains site.
- Atmospheric Chemistry and Carbon Cycling: The Terrestrial Carbon Processes (TCP) program focuses on improvement of the understanding of the biophysical processes and will implement the Ameriflux network to measure the net exchange of CO_2 between the atmosphere and terrestrial ecosystems in North America.
- The Program of Ecosystem Research (PER), the National Institute for Global Environmental Change (NIGEC), and the TCP will support experimental and modeling studies to improve understanding of the response of terrestrial ecosystem to human-induced changes in atmospheric composition and climate.

National Aeronautics and Space Administration (NASA) - The overall goal of the Mission to Planet Earth (MTPE) is to understand the Earth system and the effects of natural and human-induced changes on the global environment. To preserve and improve the Earth's environment for future generations, policies and decisions worldwide should have the strongest possible scientific basis. To that end MTPE has two main components: (1) Scientific research costs; and (2) the costs associated with satellite, aircraft and balloon measurements, operations and data processing and distribution.

The scientific component of the MTPE is supported by an integrated science plan that relates research plans to space observations, and fully integrates the Earth Observing System (EOS) and non-EOS science. EOS is a program of multiple spacecraft and interdisciplinary science investigations designed to provide a 15-year data set of key parameters needed in order to understand global climate change. The major themes of NASA's MTPE Science Research Plan are Land-cover and Land-Use Change Research, Seasonal to Interannual Climate Variability and Prediction, Natural Hazards Research and Applications, Climate-Natural Variability and Change Research, and Atmospheric Ozone Research.

National Science Foundation (NSF) - During FY98, NSF will continue to support research and related activities across all of its global change programs. A significant share of the agency's efforts will focus on continuation of major international collaborative field programs. Of these programs, the World Ocean Circulation Experiment (WOCE) and the Joint Global Ocean Flux Study (JGOFS) and Earth System History (ESH), among other, programs. GLOBEC expansions

will support studies from the Atlantic to the Pacific Ocean with special focus on sensitivity of target species to global changes and analysis of ecosystem productivity and interactions. Growth related to ESH will allow for international collaborative between ESH scientists and the International Marine Past Global Change Study (IMAGES) on high accumulation ocean sediment from the Indo-pacific region. ESH-sponsored scientists also will collaborate with the International continental Drilling Program for recovery and analysis of long, high-resolution sediment cores and with CLIVAR scientists for recovery and analysis of paleo-environmental records on seasonal to century time scales. In FY98, continued support for CLIVAR activities will sponsor research aimed at the improvement of seasonal-, interannual-, and decadal-scale climate understanding and prediction.