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THE INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME: A STUDY OF GLOBAL CHANGE (IGBP)
OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

IN THE PUERTO RICAN CLOUD FOREST, DURING THE PLANNING WORKSHOP
FOR THE INTER-AMERICAN INSTITUTE FOR GLOBAL CHANGE RESEARCH



From left to right: Eneas Salati, Director General, Instituto Nacional de Pesquisas da Amazonia, Brazil; Thomas Rosswall, Executive Director, IGBP; José M. Moreno, Scientific Advisor, Interministerial Commission for Science and Technology, Spain.

Picture courtesy of Giorgio Fiocco, Università degli Studi di Roma "La Sapienza". See page 4.

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Data and Information System

Requirements for Terrestrial Biospheric Data for IGBP Projects: Toulouse Workshop, 17-19 June 1991

A primary function of the IGBP Data and Information System (IGBP-DIS) is to facilitate the creation of long-term, global data sets that are essential for the IGBP Core Projects and the development of global biogeochemical models. Multi-decadal records are necessary for: i) monitoring the planet to distinguish natural change from human induced change; ii) understanding processes taking place in response to or leading towards a global change, and iii) developing and testing models with predictive capability.

As the IGBP Core Projects get ready to implement their research programmes, their needs for global and long-term data sets become better defined. Matching these requirements with what exists reveals that currently the situation is largely dismal, particularly in the case of the land biosphere. Data sets are few in number, quality is often poor and there is a clear need for improvement in all aspects of data collection, compilation, management and distribution.

To discuss these issues in depth, a workshop with representatives from the Core Projects involved in land biosphere research was organized by IGBP-DIS in Toulouse, France on 17-19 June, 1991. About 80 scientists and data specialists from 17 countries participated. Support for the meeting was provided by the US National Aeronautics and Space Administration (NASA), the French Centre National pour les Etudes Spatiales (CNES) and the Commission of European Communities (CEC).

The purpose of the workshop was to

identify: i) IGBP needs for global scale, long-term data bases for land biosphere research; ii) parameters and variables required on a global basis and the precision and accuracy necessary to detect a long-term trend and to perform process studies; iii) additional data sets required by the Core Projects and the spatial and temporal frequency requirements for these data; and iv) improved procedures to ensure access to data by IGBP scientists.

At the workshop, an analysis of data requirements for modelling studies presented by IGBP Core Project representatives revealed common needs:

1) Global land-cover distribution and its change. Depending on the readiness and maturity of the modelling activities in different Core Projects, land-cover data requirements vary in specificity. These are:

a) Global distribution of land-cover types (~ 20 biomes) with their seasonal phenology and year to year changes, if any, over the long term. Such measurements are needed for a number of reasons. Firstly, for global climate models which require these data at a rather coarse resolution (100 x 100 km), and the hydrological and landscape models which are expected to work with cell sizes of 10 x 10 km. In order to parameterize land biosphere in these models, land-cover data at a much finer resolution are needed, as was emphasized by the members of the Scientific Steering Committee for Biospheric Aspects of the Hydrological Cycle (BAHC). Secondly, global assessments of land-cover change are needed at high resolution (preferably weekly at approximately 1 km spatial scale) for monitoring the extent of wetlands both in the tropics and in the boreal region, for improving the estimates of the rates of biomass burning, and for assessing the net primary productivity (NPP) over land and its variability.

b) Global vegetation model (GVM). The Global Change and Terrestrial Ecosystems (GCTE) Core Project has a special requirement of monitoring land-cover change at specific sites around the world (>100) at the highest possible resolution (tens of meters). These data can also be

used to validate the global data sets at these same sites.

2) Data on soils appear to be the most elusive and at the same time very desirable for all the terrestrial Core Projects. Soil attributes such as water holding capacity, effective rooting depth and chemical attributes, including carbon content, are needed at the best possible resolution.

3) Regarding a global topography data base, the relevant IGBP requirements are for consistent global coverage and the finest possible resolution in the vertical, in the order of 10 m, and hence improvement in the existing (10 x 10 km) digital elevation models which have gaps over large areas in the tropics and poor vertical resolution. Making the topographic data more consistent and accessible to the science community is a high priority need identified by both GCTE and BAHC.

4) Finally, most global and continental scale modelling in the Core Projects needs climate data such as simultaneous measurements of temperature, humidity, wind fields and precipitation (comprising the "weather generator") with additional data on ice and snow cover, run off, basin extent and net radiation. Much of these data are being compiled under projects sponsored by the World Climate Research Programme (WCRP), the World Meteorological Organization (WMO) and in the United States by the National Oceanic and Atmospheric Administration (NOAA). It was proposed that IGBP-DIS could facilitate the availability of these data sets to the IGBP Core Projects.

Conclusions

The Toulouse workshop gave a clear mandate to IGBP-DIS, in collaboration with scientists from the Core Projects, to proceed with the following:

- Initiate the development of first an 8 km resolution global data base of Advanced Very High Resolution Radiometer (AVHRR) products, and subsequently a 1 km data base (see "Vegetation data from weather satellites", below).
- Develop, in collaboration with the International Satellite Land Surface Climatolo-

gy Project (ISLSCP), improved algorithms for retrieving "added value" data sets on land cover from satellite observations, particularly from AVHRR 8 km and 1 km products. This can be achieved by applying the knowledge acquired from the ISLSCP field experiments in which, for example, values of fluxes are obtained by acquiring simultaneous measurements of several parameters near and on the land surface.

- Define a two-phase soil data project. The first phase will focus on compiling the existing data on soil profiles, including information on physical and chemical properties, which in conjunction with existing soil maps will be used to produce a global geo-referenced soil data base in digital format. The second phase, a long-term project, will address whatever inadequacies are revealed during the first phase, and focus on improving the information content of the digital data base and make it more compatible with IGBP needs.

- Develop a strategy to improve the existing 10 x 10 km Digital Elevation Model using national data sets. Eventually higher resolution products could be made available through the release of existing data at the US Defence Mapping Agency. In this regard, several initiatives are currently underway. IGBP-DIS should take the lead in getting these efforts coordinated.

- Initiate a Primary Productivity Measures project which will develop a methodology to compute the net primary productivity (NPP) by a combination of satellite measurements of the normalized difference vegetation index (NDVI) and the absorbed photosynthetically active radia-

tion (APAR), and models or regressions based on climatological data. The coordination will be provided by the IGBP Core Project on Global Analysis, Interpretation and Modelling (GAIM).

- Proceed with a Wetland Extent Methodology project which will focus upon devising a strategy for better estimating the areal extent of global wetlands. This project, to be launched by a workshop, will focus first on boreal wetlands. Coordination will be provided by the International Global Atmospheric Chemistry Project (IGAC). Later efforts will consider tropical wetlands.

- Develop a Fire Biomass project, in collaboration with the IGAC, with several short term objectives: i) evaluate land-cover measurement requirements for biomass burning data; ii) establish test regions in the boreal zones in collaboration with the production of the 1 km global AVHRR data base to produce a 1 km test fire data; and iii) establish a small working group to develop consensus algorithms for fire-biomass burning data.

- Facilitate access to existing data bases of climatic variables, that are not readily available to IGBP Core Project scientists. A close interaction with the WMO and the WCRP is imperative. Such collaboration may also lead to the development of "weather generators", which are necessary inputs to the formulation of landscape dynamics models.

These are the first order requirements of the IGBP scientists gathered to discuss data on land biosphere for global change studies. Programme managers need to be

continuously reminded of what J.-L. Lions, President of CNES, succinctly put in his opening message to the workshop "A model without data has no predictive value, ... data without a model can only bring confusion."

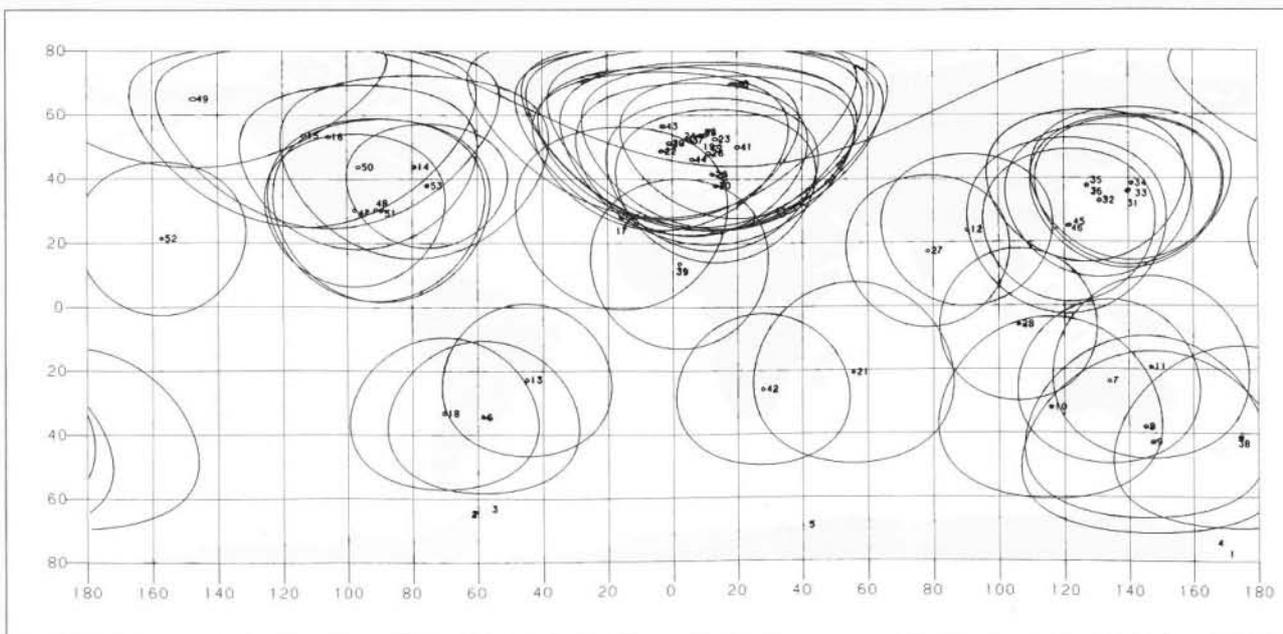
Since preparation of this report, funds have been obtained from US sources to begin implementing several of the recommendations of the Toulouse workshop.

Ichtiague Rasool, Chair, Standing Committee on IGBP-DIS

Vegetation data from weather satellites: Scope for 1 km global coverage

Instruments that observe the Earth from space make it possible to carry out truly global studies. Plans for a full suite of satellite-borne sensors in the late 1990s, specifically designed for environmental mapping and monitoring, are crucial to the success of IGBP. Yet there is also the potential for wider application of remote sensing systems that are already in operation, particularly the meteorological satellites operated by the US National Oceanic and Atmospheric Administration (NOAA).

Although not originally intended for studies of global vegetation, the Advanced Very High Resolution Radiometer (AVHRR) sensor carried on the NOAA satellites detects radiation separately in the



AVHRR reception range for 48 ground stations with known digital archives

red and near infrared parts of the spectrum. The red spectral measurements are sensitive to the chlorophyll content of vegetation, and the near infrared to the mesophyll structure of leaves; taken together they provide information on a wide variety of important attributes of vegetation cover, including leaf area index, leaf biomass, net primary productivity and photosynthetic capacity. Methods are also being developed to use AVHRR data to determine land surface temperature, the extent and frequency of biomass burning (forest and grassland fires), and evapo-transpiration rates.

Specific advantages of the AVHRR observation system are that it provides full global coverage every few days, greatly increasing the likelihood of obtaining a seasonal sequence of cloud-free images. In addition, there is a well-established system of ground receiving stations for data capture and initial processing, with data archives that provide a record back to the early 1980s. The spatial resolution of AVHRR is around 1 km. This is relatively poor in comparison to Landsat and other satellite sensors; however, any finer resolution would produce an unmanageably large volume of data for global land cover studies (at least for current computing capabilities).

Whilst AVHRR data have been suc-

cessfully used at the 1 km scale for sub-continental studies of vegetation properties and their temporal changes, the global data set is at present limited to 15 - 20 km resolution. Thus there is considerable potential for greater utilization at scales of ecological relevance. Ways to achieve that potential have recently been reviewed by the Land Cover Working Group of the IGBP Data and Information System, chaired by Dr John Townshend of the University of Maryland, USA. Topics covered by the Working Group Report (IGBP Report Series, 1992; in press) include: the scientific requirements for a 1 km data set; pre-processing procedures; availability of current AVHRR data; the feasibility of coordinating global coverage; and the management of the 1 km data set.

The Working Group's main conclusions and recommendations are that:

- A global data set of the land surface should be created from the AVHRR data at around 1 km resolution, with full global coverage at least once every 10 days for at least a year.
- Such a data set would be of very great benefit to several IGBP Core Projects, notably Global Change and Terrestrial Ecosystems (GCTE), the International Global Atmospheric Chemistry project (IGAC),

Biospheric Aspects of the Hydrological Cycle (BAHC), and Global Analysis, Interpretation and Modelling (GAIM).

- Substantial effort is required in the pre-processing of the data set (radiometric calibration, atmospheric correction, geometric correction and temporal compositing), with several aspects requiring additional research before standard procedures can be established. It can then be determined how best to proceed with continuous monitoring of the Earth, year after year, at this resolution.
- A global facility will be required to ensure coordination between ground stations, and the creation of a uniform data set. Such a data set when converted into information related to the attributes of the vegetation cover would be of great benefit.

Rapid action on these recommendations is urged so that the 1 km land cover data set can be available in time for the main implementation phase of IGBP activities. The activities of the Working Group show how IGBP-DIS can mobilise and focus effort to obtain global data sets to meet IGBP's scientific requirements.

Pre-publication copies of the report, edited by John Townshend, are available at: IGBP-DIS Office, Tour 26, 3ème étage, 4 Place Jussieu, F-75005 Paris, France ■

The Inter-American Institute for Global Change Research

It is essential to the understanding of global change that important aspects of change are studied on a regional as well as global basis. To this end, the United States proposed establishment of several global change research institutes to bring together the critical mass of resources and capabilities to undertake global change research in three important regions of the world: The Americas, Europe/Africa, and the Far East/South-west Pacific. This proposal was presented by President Bush during the White House Conference on Science and Economics Research Related to Global Change in April 1990.

A Planning Workshop for the Inter-American Institute for Global Change Research was hosted by Dr. Dallas L. Peck, Chairman of the U S Interagency Committee on Earth and Environmental Sciences on 15-19 July, 1991,

in San Juan, Puerto Rico. Twenty-two countries from North, Central and South America and the Caribbean were represented. Observers included representatives of the International Council of Scientific Unions (ICSU), the IGBP, the International Social Science Council - Human Dimensions of Global Environmental Change Programme (ISSC-HDGEC), and the World Climate Research Programme (WCRP).

The goal of the workshop was to design an institute to conduct and facilitate scientific, social and economics research on global change issues that are both unique to the region and important to the world. Specific objectives of the workshop were: i) to develop a regional consensus for a scientific and management agenda for such an institute; ii) to decide on the overall role such an

institute should play in global change research and develop an organizational plan; iii) to identify criteria for the siting of such an institute; and iv) to discuss funding requirements and mechanisms. The workshop participants decided that the Institute should be called the "Inter-American Institute for Global Change Research".

Workshop participants expressed strong interest in creating an Institute capable of pursuing a highly interdisciplinary programme designed to integrate the social, economic, and natural science aspects of global change research. A network-based organizational structure, including a central facility and affiliated research sites, was promoted as a means of supporting the multidisciplinary research agenda. This proposed initiative is consistent with the objectives

and structure of the IGBP System for Analysis, Research and Training (START), and the workshop report recommends that discussions should begin immediately with the START Standing Committee.

The Working Group on the science agenda, in addition to compiling a broad list of scientific topics, identified unique and significant characteristics and requirements of the region, such as the need to greatly improve the resolution of Global Climate Models as applied to the region and to the Andean Cordillera in particular, the hydrological cycle, stratospheric ozone and UV radiation as it affects high altitudes, large continental-scale fluxes,

coastal/oceanic phenomena such as ENSO, the role of large biomass of tropical and boreal forests, the interplay of coral reefs with the carbon cycle, population studies, biodiversity as a sensitive early warning signal of global change, and the impact of global change processes on very diverse ecosystems, among other topics. It also identified four research areas and connected each one to existing international global change and climate programmes: 1) Identification, detection, background and monitoring: WCRP, IGBP, WCDP (WMO); 2) Understanding mechanisms: IGBP, WCRP, HDGEC; 3) Impact estimation: IGBP, HDGEC; 4) Mitigation, adaptation: HDGEC.

The workshop created an Interim Working Group to continue to develop the concepts outlined in San Juan and to refine the scientific research agenda and focus it on issues of regional priority and global interest. The Interim Working Group will compile the options they have identified, and their recommendations on the development of the Institute, in a report to the second session of the workshop scheduled for March/April 1992. A high-level meeting, where appropriate government representatives will come together to formally establish the Institute, is scheduled for April/May 1992 ■

Land Ocean Interactions in the Coastal Zone (LOICZ)

NATO Advanced Research Workshop on the Impacts of Global Change on Coastal Oceans

The second meeting of the Planning Committee for the proposed IGBP Core Project on Land-Ocean Interactions in the Coastal Zone (LOICZ) was held in conjunction with a NATO Advanced Research Workshop on "The Impacts of Global Change on Coastal Oceans", at the Château de Bonas, Toulouse, France on 14-17 October, 1991. The workshop was organised by Dr. Patrick Holligan (Plymouth, UK; Chair of the LOICZ Planning Committee), Prof. Bill Reiners (University of Wyoming, USA), and Prof. Henk Postma (Texel, Holland) and attended by 45 scientists from 13 countries.

The interface between land and ocean can be considered as that part of the global system which, for the range of climatic conditions over geological time scales, experiences alternating marine and non-marine conditions. It comprises the present day coastal plains and continental shelves, that together make up about 8% of the world's surface area and include many of the world's most productive and diverse ecosystems – coastal forests and wetlands, mangrove and salt marsh communities, seagrass and coral reefs, kelp beds, and coastal upwelling regions. These ecosystems play a crucial role in the retention, biogeochemical transformation and recycling of mineral and organic matter that is transported from land to sea as a result of weathering processes,

especially in the tropics, and represent a significant component of the natural biological variability of the Earth system that results from global variations in sea level and climate.

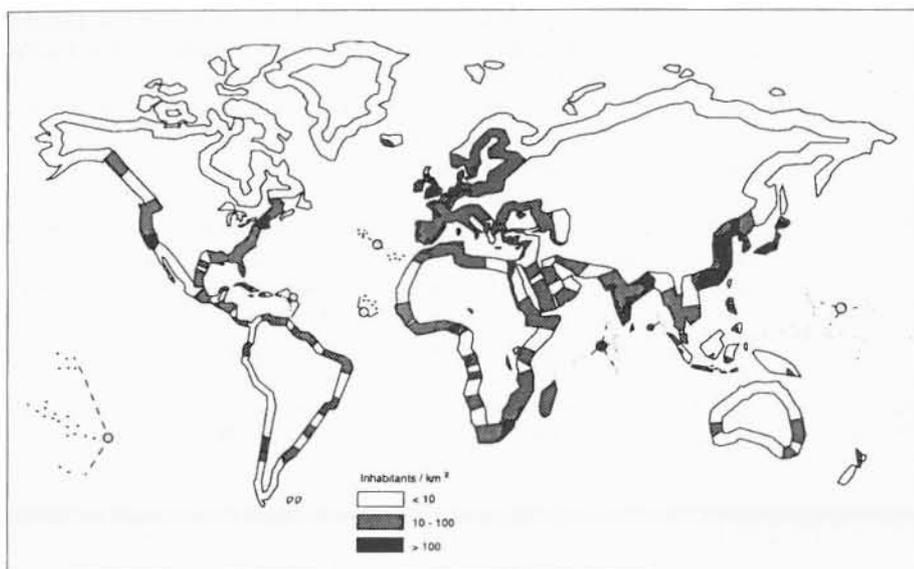
The coastal plains and shelf seas are also of immense value to man as regions of habitation and recreation. Today over 50% of the world's population lives within 50 km of the coast, which in number is more than the total world population 40 years ago.

The demands for space and for natural resources on land and at sea are continually increasing. More than 90% of the global marine fish catch comes from the coastal waters. Mariculture is a rapidly expanding industry and is expected to supply as much as 25% of living marine resources early in the next century. The exploration and exploitation of mineral reserves continues unabated. Despite being dependent on the coastal zone for many needs, we remain very ignorant of the processes that determine the nature and behaviour of coastal ecosystems and of the various ways in which we are affecting them. Predicting the responses of the coastal zone to global change, and the feedback effects on the global environment of modifying coastal ecosystems must be major goals for any new international initiative for research on the Earth system.

The primary objectives of the NATO

workshop, through a series of invited talks and group discussions, were to assess the impacts of global change on the coastal oceans, to develop the conceptual basis of a global research programme for predicting future impacts, and to evaluate the scientific aims of the proposed IGBP-LOICZ project. The programme of the meeting was designed to advance a stage further the results of a Dahlem Workshop held in Berlin in 1990, towards planning an international project on the nature, prediction and socio-economic implications of global change at the interface between land and ocean (reported in: *Ocean Margin Processes in Global Change*. Eds. R.F.C. Mantoura, J.-M. Martin & R. Wollast; John Wiley & Sons, 1991, 469pp.) Any new initiative in coastal oceanography must also complement the range of activities of the International Oceanographic Commission (IOC) of Unesco, which were summarised for the workshop participants by Dr. Tom Osborn from the IOC.

Lectures and group discussions at the Advanced Research Workshop focused initially on the form and scales of external forcing (climate, ocean circulation, the hydrological cycle) that determine exchanges of matter between land and ocean, and on the importance of coastal ecosystems as sources or sinks of biogeochemical constituents, such as methane and nitrous oxide,



Schematic world map of population densities in coastal areas (*Times World Atlas*)

that may affect the climate. The dynamics of boundary conditions (e.g., river/estuary, estuarine plumes, fronts between mixed and stratified water and at the shelf edge), which largely control the flushing times of shelf seas, remain poorly understood. Small rivers are the source of a greater proportion of the sediments reaching the coastal oceans than previously thought. The oceans largely determine the inputs of energy and nutrients to the shelf seas but how conditions at the shelf edge affect inshore waters and the coastal zone has received relatively little attention. Although shallow marine waters are presently major global sites for sediment accumulation and the burial of organic matter, the fluxes and their control by hydrodynamic and biotic properties are not well known, particularly for tropical regions. Furthermore, in relation to the global carbon cycle, the coastal zone is probably a significant site of CO_2 emission to the atmosphere, as a result of the oxidation of organic matter exported from land.

A general problem for coastal prediction is recognizing the scales at which land processes and ocean processes interact within the coastal zone, and how changes to particular elements of coastal ecosystems immediately affect others. Episodic events, such as floods, storms, tsunamis, periods of rapid sea level rise, and ocean upwelling, are thought to be of particular importance, but their overall impacts on ecosystem structure and function are difficult to measure.

Attention was then given to the changes occurring in coastal oceans due to the activities of man on land and at sea, and due to variability in climate and sea level. The precise nature of change is often difficult to define on account of a lack of appropriate observational data, and the causes of change are complex and generally attributable to a combination of both anthropogenic and

natural factors. For example, sea level is affected by global eustatic and regional isostatic factors as well as local coastal subsidence due to ground water extraction and reductions in the delivery of riverine sediments by man.

The effects of man are considered the most serious for the global sustainability and survival of coastal ecosystems in the immediate future. Urbanisation, deforestation, intensive agriculture, and manipulation of river systems alter the inputs of fresh water, suspended matter, nutrients and organic matter to deltas and estuaries. Waste disposal on land and at sea introduce a wide range of harmful contaminants. Coastline development and protection, and the over-exploitation of marine living resources cause loss of habitat and reduce biodiversity. Removal of mangrove forests, draining of coastal wetlands and salt marshes, and the ecological changes due to eutrophication affect the structure of food chains and recruitment processes.

Furthermore, the longer term impacts of changes in climate and sea level are not well understood, due to uncertainties about the regional accuracy of climate models,

and about future rates of sea level rise. It is possible that secondary climatic factors (wind, precipitation, frequency of extreme conditions) will be more important than temperature changes *per se*. Also areas strongly modified by man, such as deltas and other highly populated coastal environments, will be most susceptible to the effects of climate change.

The main actions now needed are to assess objectively the time/space scales and modes of interaction of human and climate forcing on coastal ecosystems, to study and predict on a global basis the ecosystem responses to such forcing, to provide reliable scientific information for the formulation of social and economic policies for coastal management, and to promote educational and training activities (especially in less developed countries) relevant to understanding and responding to the impacts of global change on coastal oceans.

It is envisaged at this early stage of planning that the LOICZ project will have components dealing with extensive and intensive studies of the land-ocean interface, the prediction of impacts of environmental change, and investigations of the socio-economic implications of such predictions. Extensive studies are likely to include participation in establishing a global database and classification system for the coastal zone, and in assessing budgets for the exchanges of matter (especially carbon and other major elements) between the land and oceans. Intensive studies will focus on processes that control the rates of transport and transformation of matter within catchment basins, the shelf seas, and at the shelf edge, that affect the structure and functioning of coastal ecosystems, and that determine the nature of biological feedback on geomorphological and geochemical processes in the coastal zone.

A science plan for the LOICZ project is now being prepared by the Planning Committee and will be presented to the Scientific Committee for the IGBP in 1992 ■

Patrick Holligan, Chair, LOICZ Core Project Planning Committee



Estuaries and islands along the south China coast. Hong Kong is at the right, Macau in the center, and Quanzhou (Canton) lies inland at the upper right.

News from IGBP

National Committees

Belgium

The official installation of the Belgian National Committee of the IGBP took place on October 23, 1991, in the Academy House in Brussels. The meeting was attended by his Royal Highness Prince Filip, leading scientists and public policy makers. Within the framework of the IGBP, the committee will serve as a tool to stimulate international and interdisciplinary cooperation at various levels. The meeting was chaired by Prof. Oscar Vanderborcht, Chair of the Belgian IGBP Committee, who underlined the necessity of mutual exchange of information for scientific progress and development.

Prof. J. Van Bladel, Belgian representative for the International Council of Scientific Unions (ICSU), highlighted the evolution of international programmes and clarified the existing links between the Belgian national committees and ICSU.

The key position of the IGBP as a multidisciplinary coordination body for assessment of the impact of mankind on our planet was made clear by Prof. T. Rosswall, Executive Director of the IGBP.

Both Secretaries of the Royal Academies of Science described the tasks of the Academies and the national committees and their possible future directions. Prof. G. Verbeke stressed the increasing importance of collaboration within and between countries in the perspective of a European unification. He pointed out that important efforts to establish a European Academy have been made and suggested that it may be more realistic to work out cooperation agreements between existing academies. For national committees in different fields of research such agreements would be the most useful.

Prof. P. Roberts-Jones praised the activities of different Belgian national committees for the sciences, and expressed the wish that similar working initiatives be set up in the fields of the letters and fine arts.

According to Mrs. Boeykens, President of the International Council of Women, the role of women in environmental concerns is crucial, but often neglected.

For this reason a framework that actively promotes participation of women in development planning and decision-making should be established. Mr. E. De Rycke, State Secretary of Science Policy, gave an overview of the research programmes that have been planned by his services.

One of the main objectives of the European Communities is to preserve, protect and improve the quality of the environment, said Prof. P. Bourdeau, Director for Environment and Non-Nuclear Energy Research of Directorate General XII of the European Community. The EC cannot but benefit from the existence of active National IGBP Committees, both for the implementation of research options and for defining future work.

An interesting part of the inauguration was a poster session, where more than 25 laboratories displayed their work. A research survey listing 57 projects under the headings of both established and proposed Core Projects, with the names of the team members of each project, was distributed. At the same occasion a compendium was handed out that will be sent to IGBP National Committees and Core Project members, giving a full description of relevant Belgian research efforts: IGBP-Related Research in Belgium. A compendium. O. Vanderborcht (ed.) Brussels, Royal Belgian Academies of Sciences, National Committee for the International Geosphere-Biosphere Programme, 1991. 135 pp. Inquiries and requests for copies can be addressed to the Belgian IGBP Secretariat.

Mrs. Elly Janssens, IGBP Secretariat Belgium, Royal Belgian Academy of Sciences, Palais des Académies, 1, rue Ducale, B-1000 Bruxelles.

China

(China Association for Science & Technology)

A committee of nine experts, chaired by Professor Ye Duzheng, Chairman of the CAST-IGBP Committee, was formed in May 1991 to coordinate the scientific pro-

grammes of global change study in the eighth national five-year plan (1991-1995). The committee will organise five scientific workshops designed to define the of study global change in China. These are:

Past Global Changes in China

Topics cover: techniques and methods for extracting data and information of the past and the reconstruction of the climate of China in the past 2000 years; definition of possible global and regional events in the palaeoclimate and the environment; studies of dominant factors and key interactive processes in past changes.

Climate Change Effects on Terrestrial Ecosystems

Research will concentrate on: analysis of data, especially satellite, to detect possible effects of climate on terrestrial ecosystems; and theoretical analysis and numerical modelling of climate effects on terrestrial ecosystems.

Impact of Human Activities on Biological Sources of Trace Gases, the Water Cycle, and Energy Exchange

Studies cover: comparative study on exchange processes of water, heat, and trace gases in natural and man-made ecosystems; estimation of biomass and identification of key ecosystem processes and variables; identification of trace gases produced by human activities; and water cycle processes in the soil-vegetation-atmosphere systems under different land uses.

Sensitive Areas of Environmental Change and Detection of Early Signals of Significant Global Change

Study topics include: detection techniques and methods; intensive observation in areas particularly sensitive to climate change; calibration of remote sensing data; and analysis of land-surface features by airborne remote sensing techniques and satellite images.

Characteristics and Trends of Changes in the Life-Supporting Environment in China

Research will address the issues: predictability of global change; development of regional models to describe and interpret the changes in climate and ecosystems; and development of dynamic models of environmental change.

Ongoing research projects in China relating to global change study

Among scientific research projects carried out in the period 1981-1990, at least 26 can be identified as closely related to the IGBP Core Projects.

A large part of the research addresses specific regions with regard to land cover change and land restoration. Two research projects - one on atmosphere/land-surface processes, and the other on the Kuroshio ocean current - are part of a Sino-Japanese cooperative programme. Other oceanographic studies cover: air-sea interactions, the Quaternary coastline, sea-level changes, the marine environment, and aerosols over the Antarctic ocean. Development and application of remote sensing techniques are also included in the overall programme.



Intensification of land use across the Ordos Plateau, Inner Mongolia, China. Attempts have been made to slow wind erosion by tree planting.

The Global Change Pilot Study

The pilot study of the CAST-IGBP Committee, begun in 1988, focuses on the present state and historical evolution of the climate, freshwater bodies, vegetation, soil, and atmospheric trace gases in China. A series of reports of the pilot study are to be published (in Chinese). The problems reflected in the reports will form the basis for the design of future scientific research programmes on global change in China. The issues addressed in the pilot study are the following:

What are the present conditions of the life-supporting environment in China?

The serious environmental situation in China is the essential reason why scientists are concentrating on global change issues that provide a background to regional environmental degradation in China (Table 1). How the Chinese environment will devel-

Table 1. Chinese environment compared with global conditions

Element	Amount	Global	China	Contribution of China as % of Global
Trace gas emissions	CO ₂ (Tg)	5800	620	11
	CH ₄ (Tg)	553	26	5
	CGC-11 (Tg)	0.29	0.010	3
	CFC-12 (Tg)	0.37	0.016	4
Forest	area (km ²)	41,834,200	1,700,000	4
	deforestation (km ² /yr)	70,460	13,420	19
Soil	cultivated dry land area (10 ⁴ km ²)	3,257	315	10
	desertification (km ² /yr)	60,000	1,560	3
Water sources	annual runoff (km ³)	46,800	2,712	6
	m ³ per person	10,800	2,600	24
Soil erosion	(10 ⁸ ton/yr)	600	50	8
	soil into sea (10 ⁸ ton/yr)	240	20	8

Table 2: Climate conditions during different time scales in China

Time	Climate
18,000 - 15,000 BP	extreme conditions of the Dali glacial period
9,000 - 3,000 BP	mid-Holocene optimum
3,000 - 1,400 BP	neo-glacial fluctuations
6 - 8th Century	Sui-Tang warm period: 1 - 2°C warmer compared with today
14 - 19th Century	Little Ice Age: 2°C colder compared with today
19 - 20th Century	warming in East China, especially warmer winter in the north
1950s - 1980s	warming in North China, while cooling in South China

op in the next century under regional forces such as deforestation and soil erosion, and global factors such as the enhanced atmospheric greenhouse effect, requires urgent understanding.

Where does the present Chinese environment fit in historical evolution?

On time scales longer than 1,000 years, the present climate is far from the glacial yet below previous interglacial peaks, although on the scale of 10-100 years a warming trend has been observed in North China (Table 2). What relation is there between climate changes at different periods, and what conclusions can we draw for the future?

How large are the differences between environmental changes in different regions?

The medieval warm period in Europe reached its peak around the 10th century, at the same time as the Sui-Tang warm period in China came to an end. The out-of-phase relationship between these warm periods on the same land mass raises questions that must be solved in order to develop our ability to forecast regional climate changes.

Identification and significance of abrupt climate changes

Abrupt changes are a strong signal in environmental evolution. We cannot exclude

the possibility that our environment will change catastrophically in the near future. In North China, a notable shift from wet to dry climate occurred around 3,200 BP, and another significant shift from wet to dry occurred, over an even shorter period of time, around the end of the 3rd century; both of them took place during a cooling period. On the other hand, a shift from dry to moist happened in some regions of North China when the Little Ice Age reached its extreme, and a notable change from moist to dry occurred around the 1910s, when warming began in China.

What happens in transitional zones?

Different transitional zones may be defined as falling between wet monsoon area and dry inland desert, between forest and grassland, between agricultural and pastoral area. In China, many kinds of different transitional zones can be identified on rainfall charts, providing excellent sites for the study of environmental changes.

How much do we know about biogeochemistry?

Though it is widely accepted that atmospheric greenhouse gases are increasing, we understand little about their sources and sinks, and even less about the mechanisms regulating emissions. Particular attention will be given to atmospheric methane, and to the biogeochemical cycles of carbon and nitrogen.

How and to what extent do regional surface conditions interact with climate change?

There is historical evidence that climate changes have previously had major effects on the hydrological cycle, vegetation, soil conditions, and human activities in some regions. Analyses of modern data also show interactions between climate and soil moisture and other surface conditions in China.

Data sets

Various data sets of climatology, hydrology and geology already exist in China. Specifically designed observation systems, such as the Chinese Ecological Research Network (CERN), are or will be producing important ecological data sets. Extensive international scientific cooperation in data processing is necessary in order to produce a homogenous data bank for IGBP research activities.

The first issue in English of the bulletin of the Chinese IGBP Committee, from which the above report has been abstracted, was published in May 1991.

Chen Panqin, Deputy Secretary-General, IGBP Committee, Chinese Academy of Sciences, 52, Sanlihe Road, Beijing

Collaboration between China (Taipei) and the USSR on Ocean Studies

The research vessel *Akademik Aleksandr Vinogradov* carrying 48 Soviet scientists and 60 crew docked in the southern port city of Kaohsiung, Taiwan, on 16 June 1991 for a five day visit at the invitation of Dr. Chen-Tung Arthur Chen, Chairman of the IGBP Committee of the Academia Sinica in Taipei.

The Soviet vessel left the port of Vladivostok on 16 April 1991 for studies in the Western Pacific Ocean relevant to the Joint Global Ocean Flux Study (JGOFS), World Ocean Circulation Experiment (WOCE) and Past Global Changes (PAGES) projects. The vessel left Hilo, Hawaii, on 30 May and occupied the western portion of the WOCE P3 hydrography section and the eastern part of P26. Sea water samples were collected by the chief Soviet scientist for intercalibration studies of the carbonate parameters. In addition, the Taiwanese R/V *Ocean Researcher 1* reoccupied P26 (also the Repeat 20 section) ten days after *Vinogradov*. Intensive intercomparison of the data will be made.

The visit of the *Vinogradov* signals the willingness of both governments to engage in scientific collaboration as a result of liberalization on both sides. The Soviet scientists and crew were warmly welcomed. They toured the facilities of the College of Marine Sciences, and other laboratories of the national Sun Yat-Sen University. The ship also held an open house for approximately 250 local scientists.

The *Vinogradov* plans to revisit Kaohsiung in July 1992, when approximately 15 Taiwanese oceanographers and atmospheric scientists are to board the ship to study the East China Sea and the Sea of Japan on the ship's return to Vladivostok.

Chen-Tung Arthur Chen, Chairman, IGBP Committee, National Sun Yat-Sen University, Kaohsiung, Taiwan 80424

Czechoslovakia

A symposium on "Geophysical Aspects of the IGBP - Global Change" was organized by the Czechoslovak National Committee for the IGBP during a geophysics scientific assembly held in Prague, 9-12 April 1991, with broad participation from Central Europe.

IGBP Projects were presented by Prof. Paul Crutzen, who reviewed the state-of-the-art of tropospheric chemistry research

within the IGBP, Prof. Sigfried Dyck, who presented an overview of biospheric aspects of the hydrological cycle, and Prof. Volodya Viskov, who presented a strategy for data exchange for the IGBP, in particular in the USSR. Papers presented by other scientists from Czechoslovakia, the USSR and Germany covered the results from meteorological, hydrological and solar physics research.

Because of the similarity of the basic goals, and the complementarity of the IGBP and the WCRP programmes, the Czechoslovak Committees for the IGBP and for the WCRP collaborate closely together, and members of both committees attend each others' meetings. A report on the IGBP in general, and activities in Czechoslovakia in particular, was prepared by the Czechoslovak Committee for the WCRP.

Past Global Changes in Czechoslovakia

Both streams of the PAGES programme (Stream I for the period since 2,000 BP, and Stream II through a full glacial cycle) are represented, including studies of holocene sediments in the valley of Labe river, and solar-terrestrial (climate) relationships, among other topics.

Global Change and Terrestrial Ecosystems in Czechoslovakia

Six different ecosystems in seven regions were selected as suitable for monitoring and research. Czechoslovak scientists are participating in the preparation of a vegetation map of Europe. Studies proposed for inclusion in the GCTE Core Project represent an extension of Czechoslovak activity in the Man and the Biosphere Programme of the United Nations Organization for Science, Education and Culture (Unesco), and the International Union of Biological Sciences (IUBS).

Biospheric Aspects of the Hydrological Cycle in Czechoslovakia

Projects include studies of the Labe River, Žitny Island (in relation to the Gabčíkovo dam on the Danube river); and the influences of anthropogenic activity and climatic change on water resources. There is close coordination among Czechoslovak scientists on BAHC-related activities and those related to the Global Energy and Water Cycle Experiment (WCRP).

The Czechoslovak research projects are at different stages of development: final planning, first research activities, continuation of previous research activities, and the necessary search for financial support from very limited domestic sources.

Dr. Jan Laštovička, Secretary, Czechoslovak Committee for the IGBP, CSAV, Bocni II, Box 1401, CS-141 31 Praha 4

Germany

The second German IGBP symposium, sponsored by the German Research Foundation (DFG) and attended by 70 scientists, took place at the Japanese-German Centre in Berlin on October 14-15, 1991. The Chairman of the German IGBP Committee, Hans-Jürgen Bolle, gave an overview of the plans for German contributions to the IGBP since the first IGBP symposium in 1989. Thomas Rosswall, Executive Director of the IGBP, presented an overview of the status of current IGBP planning and research. The national core project coordinators summarized activities, and presented the views of their groups on possible future contributions to the IGBP.

International Global Atmospheric Chemistry

M. O. Andreae presented the proposals on the North Atlantic Regional Experiment (NARE), on biomass burning and changes in land use in the tropics, and on trace gas emissions from agricultural areas.

Joint Global Ocean Flux Study

Bernt Zeitzschel, Past Chair of JGOFS, presented the latest developments in the research plans. The Core Project Office for JGOFS is located at the Institut für Meereskunde in Kiel, where Prof. Zeitzschel founded the office. He also presented the marine perspective of a study of past global changes.

Past Global Changes

The terrestrial perspective of past global changes was presented by Burkhard Frenzel, who hosted the PAGES meeting in Mainz in March. The projects are strongly integrated into either national climate programmes or European research programmes. A Dahlem workshop will be organized on Global Changes in the Perspective of the Past in December this year.

Biospheric Aspects of the Hydrological Cycle

R. Roth gave an account of the BAHC Core Project, whose Chair is Hans-Jürgen Bolle, with its Core Project Office at the Freie Universität Berlin. The German contribution to BAHC will concentrate on participation in international field experiments and the REKLIP (Regio-Klima-Programme) in the upper Rhine valley, in cooperation with France and Switzerland.

Global Change and Terrestrial Ecosystems

E.-D. Schulze and F. Beese spoke about the five German ecosystem research centres in Bayreuth, Göttingen, Halle, Kiel and München who have founded the German Terrestrial Ecosystem Research Net-

work (TERN) that will deal with research into GCTE goals, and offers the possibility of experimental studies at their research sites.

Other research activities

Regarding the proposed Core Project on Land-Ocean Interactions in the Coastal Zone (LOICZ), Stephan Kempe gave an overview of the international planning, and the ongoing national activities. A German national workshop will be held in the spring of 1992.

Karin Labitzke gave a brief presentation on the status of Stratosphere-Troposphere Interactions and the Biosphere (STIB), which the Scientific Committee for the IGBP has decided not to establish as a Core Project at the present time (see NewsLetter No. 7, p. 2). The German scientific community very much regretted this decision, and encouraged initiatives to be taken to include STIB activities in other programmes.

The effects of volcanic activities on the atmosphere and biosphere are a component of the planned German research for the IGBP, which H.-U. Schmincke pointed out represents the "geosphere" part of the IGBP in the strictest sense. The latest volcano eruptions, particularly Pinatubo, have demonstrated the severe effects volcanos can have on the atmosphere and biosphere. The possibility of closer links between STIB and volcanologic studies was discussed.

The Senate Committee of Environmen-

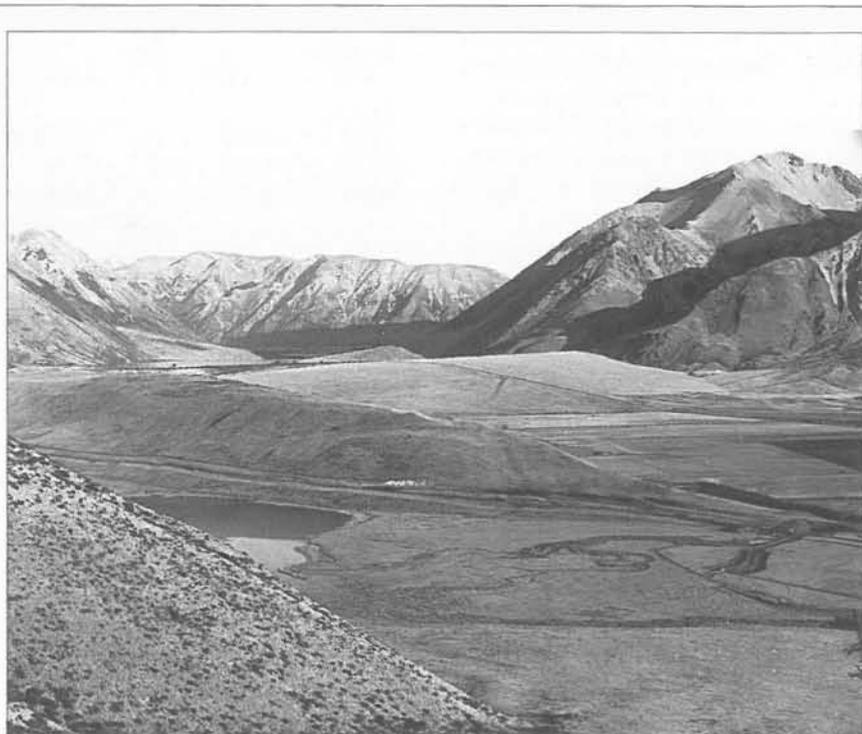
tal Research of the German Research Foundation endorsed the conclusions of the meeting at its assembly on November 12, 1991.

Sabine Lütkeemper, Secretary, German National Committee for the IGBP, Freie Universität Berlin, Dietrich-Schäfer-Weg 6-10, D-Berlin 41

New Zealand

Three different levels of research contribute to IGBP Core Projects: global studies that are internationally planned, regional/national studies, and the works of individual research groups (see Global Change NewsLetter No. 7, p. 2). A good match between the national and international plans is particularly important. That situation has been achieved by New Zealand's terrestrial ecosystem programme, developed in close liaison with the GCTE Core Project. In correspondence to the GCTE Chair, the New Zealand Minister of Science, Denis Marshall, replied favourably to incorporation of three national studies into the larger IGBP effort, giving their present status.

1. The grasslands and CO₂ project is a joint Department of Scientific and Industrial Research (DSIR)/Ministry of Agriculture and Fisheries "flagship" project, and is being funded for the current fiscal year.
2. The OASIS (Observation of Atmosphere-Surface Interaction in the Southern Hemi-



New Zealand. Cass Basin, showing post glacial fan development.

sphere) multiscale experiment on water and energy fluxes between the land surface and the atmosphere has been funded for 1991 with participation by scientists from DSIR, the New Zealand Meteorological Service, the Forest Research Institute, and the Ministry of Agriculture and Fisheries.

3. The project on gas and energy exchange between the atmosphere and the land surface by the Forest Research Institute has received substantial funding for the present year. It follows a three-year project on carbon dioxide exchange between the atmosphere and a forest ecosystem.

The New Zealand Government has decided that the general topic of climate change should be the subject of a National Science Strategy. This will assist in ensuring that this multifaceted subject is considered for support in a coordinated way across not only the government sector but also including the universities and other research groups.

Jane Soons, Convener, New Zealand IGBP Committee, Royal Society of New Zealand, PO Box 598, Wellington

Romania

The Romanian National Committee for the IGBP was established in April 1991 by the Romanian Academy of Sciences. The committee is composed of specialists in geology, geophysics, geography, biology, meteorology, astronomy, agriculture, and forestry, a reflection of the committee's intention to develop highly multi-disciplinary research.

Planned activities relate to a national science plan for the IGBP and to the implementation of IGBP Core Projects, especially cross-project initiatives in different research institutes. Only the principal global change initiatives which are part of ongoing research projects have been identified at the present stage. They are aimed at developing regional programme linkages in order to integrate Romanian research into the international IGBP effort.

The first two IGBP Romanian National Committee meetings dealt with organizational problems, assessed the significance of research themes carried out or completed in different institutions, and examined their relation to IGBP core projects. The first issue of the Romanian IGBP Newsletter, presenting different plans and national programmes for the IGBP, has been prepared for publication.

Studies of previous climate changes

Climate changes in Romania over the last 200 years are being studied, with analysis

of temperature and precipitation changes in the context of global and regional trends. The relationship of these changes with the modification of the environment and its gradual transformation by human activities will be examined.

Quaternary climate changes, especially those of the Upper Pleistocene, are identified on the basis of palynological analyses in peat deposits of the Eastern Carpathians, the Apuseni Mountains and the Transylvanian Basin, and in the sediments of river terraces and caves.

Terrestrial Studies

The impact of climate changes on agriculture and forestry is analyzed by ecological models of natural and agrarian ecosystems, with emphasis on the upper limit of forest in the Carpathians and its dependence on temperature, rainfall, and human impact.

Other IGBP-related research addresses the complex relations between the geomorphology of slopes and river beds, and vegetation in the Sub-Carpathians. Assessment made on small catchments show that this region is one of the most affected in Europe by land-cover denudation. Studies are mostly based at the Patrlagele Geographical Research Station of the Bucharest Institute of Geography, that would wish to be included within the START network of IGBP Regional Research Sites.

Coastal Studies

Several research projects are also being carried out on the Romanian coast of the Black Sea and the Danube Delta. The sea/land interaction is analyzed by repeated survey mapping and measurements at different points on the coast. The morphological modification of the shore and of the sea depth are compared with the alluvial deposits of the Danube, with the sea level rise, and with human activities. Research priorities are focused on the Danube Delta the ecological importance of which is internationally recognized. Studies include the recent evolution of the deltaic ecosystem, sedimentation processes, and pollution level. A programme of measuring the physical, chemical and biological properties of the marine environment is under way, to evaluate the present state and the trends of ecosystems in the Romanian coastal zone.

Prof. Liviu Constantinescu, Chairman, and Dr. Dan Balteanu, Secretary, Romanian National Committee for the IGBP, Romanian Academy of Sciences, Department of Geomorphological Sciences, Calea Victoriei 125, sector 1, 71 102 Bucharest 22

South Africa

With coordination funding provided by the South African Foundation for Research Development, an active Global Change Programme has been established in South Africa. Our approach has been to integrate present relevant research into the South African IGBP effort, providing funds for workshops, communication and inter-institutional travel. Research funding is obtained through the normal channels, but, by generally stimulating awareness of the importance of climate change-related research, it is hoped to direct a greater share of research funding into IGBP-related work.

A statement of the Goals and Objectives of the South African Global Change Programme has been drawn up, printed in pamphlet form, and widely circulated as part of a strong drive by the Committee to increase awareness of possible global climate change in southern Africa. A special effort has been made to target industrialists, and a highly successful presentation on "the realities of global climate change for South Africa" was made to top businessmen in Johannesburg. It is hoped to repeat this presentation in other centres. A great stride forward was made earlier this year when the Minister of Environment Affairs announced the formation of an Interdepartmental Coordinating Committee for Global Environmental Change. It will be this committee's function to coordinate the action required for formulating broad national policy and strategy on global environmental change. The Interdepartmental Committee is chaired by a member of the IGBP National Committee, Dr. Vere Shannon.

At the scientific level, the Committee is in the process of compiling a register of all South African research projects relevant to global change. A number of workshops have been held during the last year, and we have a particularly active interdisciplinary community of scientists working in palaeoenvironments who have organized three stimulating workshops to explore their potential contribution to the IGBP. The marine scientists have also had a number of workshops integrating our World Ocean Circulation Experiment and Joint Global Ocean Flux Study research with investigations into the local implications of global change for the rich fisheries off the west and south coasts. The Sea Level Research Unit at the University of Cape Town has been involved in measuring sea level rise and determining its potential impacts; the unit also took

part in an international experiment to test the feasibility of using marine acoustics to measure global warming. The first of two planned workshops aimed at increasing modelling skills recently took place at the University of the Witwatersrand.

The South African Committee has recognized the tremendous importance of coordination and communication in a programme as broad as the IGBP. The main means of communication is the South African Global Change Newsletter which is produced every three months and circulated to approximately 600 people worldwide. Communication with scientists in the rest of the world receives a high priority and contact visits are funded for as many of South African researchers as possible with our limited budget. We also extend a warm welcome to any scientists from other countries in Africa and the rest of the world who are able to visit us.

Lesley Shackleton, Coordinator, South African Global Change Programme, PO Box 6, Observatory 7935, South Africa

Thailand

The IGBP National Committee of Thailand was officially established in July 1989 by the Ministry of Science, Technology and Energy. The Committee consists of 8 members from universities and government agencies. Each member is specialized in a field that is related to the IGBP established core projects. The Secretariat of this committee is provided by the Office of the National Research Council of Thailand.

One of the real impacts to the Thai scientific community was the First National Workshop on IGBP in Bangkok, held in September 1990 following the Second Meeting of the Scientific Advisory Council for the IGBP in Paris (SAC II). The objectives of the Workshop were: i) to inform the Thai scientific community about the IGBP Global Change Programme; ii) to compile information from Thai researchers on global change; iii) to exchange ideas and experience for future development of research projects; iv) to establish priorities on research projects proposed by the Workshop.

Conclusions and recommendations

The Workshop identified gaps in global change research in Thailand, such as the absence of studies on sea-level rise particularly relevant to Thailand; on methane emissions from paddy fields; on the impacts of El Niño on rainfall; and the insufficient use of Thai laboratories.

The working group on ocean and atmospheric sciences identified the following subjects as relevant to the IGBP Core

Projects and to Thai concerns: coastal erosion and coastal water circulation, past global changes, atmospheric chemistry, sediment inputs and sedimentation rates, seawater and atmospheric temperature, urban climatology, and causative factors for the formation of typhoons in the Gulf of Thailand. The group on terrestrial and hydrospheric sciences concentrated more specifically on Thai problems: effects of atmospheric temperature change and greenhouse gases on economically important plant species, depletion of water supply as related to urban/industrial development, waste-water treatment and re-use of sludge, mineral resources and energy development, distribution of soil properties, deforestation and global change. The Workshop recommended monitoring changes on a regular basis, and the establishment of an information centre to utilize available data more effectively.

Although the subject of global change and its effects are frequently mentioned by many types of mass media in Thailand, systematic studies in this field are still lacking due to insufficient support by funding agencies. It will take time to bring together researchers interested in this field to work towards common goals. Collaboration with international scientific communities is also needed; the leading roles of IGBP and of ICSU should be encouraged and fully supported.

Dr. Twesukdi Piyakanchana, Chair, Thai IGBP Committee, Department of Marine Science, Faculty of Sciences, Chulalongkorn University, Bangkok 10330

United States

The Committee on Global Change Research (CGCR), the US National Committee for the IGBP, operates as an element of the US National Research Council (NRC), a private, non-governmental body that advises the federal government on science and technology. Active since 1987, the Committee has developed a series of reports recommending scientific goals, interdisciplinary research topics, and implementation priorities for the US Global Change Research Programme, the primary US contribution to the IGBP. The CGCR also works to coordinate the activities of the many sister units of the NRC whose work relates to global change issues. The Committee communicates with the federal government through the latter's Committee on Earth and Environmental Sciences, an interagency group that coordinates planning and implementation of the global change programme,

including US participation in the IGBP, WCRP, and HDGEC.

The Committee met on October 28-30, 1991, at Airlie, Virginia, with excellent participation from the federal agencies. The meeting marked a transition in Committee leadership, with Professor Ralph J. Cicerone, University of California, Irvine, replacing Professor Harold A. Mooney, Stanford University. Professor Cicerone, a distinguished atmospheric chemist and Member of the National Academy of Sciences, previously led the atmospheric chemistry programmes of the National Center for Atmospheric Research.

The meeting's agenda fell into four divisions – international programmes, the US programme, committee initiatives, and NRC coordination. Several members of the IGBP Scientific Committee and the WCRP Joint Scientific Committee participated in the discussions, which focused on relationships with US activities and coordination issues. In the US programme, it was evident that budget constraints and restructuring of key satellite programmes had somewhat narrowed the scope of implementation. The Committee's initiatives to develop research concepts in the areas of solar influences, solid earth processes, terrestrial ecosystems, and integrated data systems were all bearing fruit: *ad hoc* groups reported good progress toward useful reports. Reports from allied NRC groups dealing with climate research, human dimensions, data, and ocean science indicated that a productive family of activities was evolving in these areas.

The Committee decided to pursue a number of courses of action:

- Continue frequent meetings between its Executive Committee and representatives of the federal CEES for the purpose of early detection of strategic issues.
- Development of a brief report summarizing the intellectual achievements of the US programme
- Development of an assessment of US programmes in terms of the emerging international framework of IGBP, WCRP, and HDGEC.
- Organization of a forum to provide an objective discussion of selected currently controversial scientific issues relating to global change.
- Continue to work with the US federal agencies to develop a broad and balanced programme of research that will build a base of understanding of the changing Earth system.

The Committee's next meeting is planned for February 1992 in Irvine, California.

Dr. John S. Perry, Staff Director, Atmospheric Sciences & Climate, National Research Council, 2101 Constitution Avenue NW, Washington, DC 20418

Publications

IGBP National Committees

Belgium

IGBP-Related Research in Belgium. A compendium. O. Vanderborght (ed.) Brussels, Royal Belgian Academies of Sciences, National Committee International Geosphere-Biosphere Programme, 1991. 135 pp.

Japan

National Plan of IGBP-Japan. Japan National Committee for IGBP. Japan Global Change IGBP Report No. 1, August 1991, 42 pp.

IGBP-Related Publications

Arid Ecosystems Interactions. Recommendations for Drylands Research in the Global Change Research Program, based on a workshop organized by the Office for Interdisciplinary Earth Studies, UCAR, Boulder, Colorado, October 25-27, 1989 (1991), 81 pp.

Climate Change: Science, Impacts and Policy. Proceedings of the Second World Climate Conference (1991). J. Jäger and H. L. Ferguson (eds), Cambridge, Cambridge University Press, 578 pp. *May be ordered from the Customer Services Department, Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, UK.*

Savanna Modelling for Global Change. Report of a Workshop held at Harvard Forest, Petersham, Mass, USA, 15-20 October 1990. Biology International, 24, 1991, 47 pp.

Soil Fertility and Global Change. The Role of Tropical Soil Biology and Fertility Studies in the IGBP. M. J. Swift (ed). Biology International, 25, 1991. 24 pp.

IGBP Meetings

1992

8-10 January, Tokyo, Japan

Second Meeting of the Officers of the Scientific Committee for the IGBP

13-17 January, Thailand

IGBP Global Change System for Analysis, Research and Training (START) Regional Meeting for Asia

13-14 February, Paris, France

Working Group on Land Surface Experiments, Biospheric Aspects of the Hydrological Cycle (BAHC) Focus 2

3-6 April, Munich, Germany

4th Meeting of the Scientific Committee for the IGBP

27-30 April, Berlin, Germany

Second Meeting of the Scientific Steering Committee for Biospheric Aspects of the Hydrological Cycle (BAHC)

1-5 June, Uppsala, Sweden

Scientific Committee on Problems of the Environment (SCOPE)/IGBP-GCTE Workshop on Modelling Organic Matter Dynamics in Forests and Grasslands

21-24 July, Saskatoon, Canada

Global Change and Terrestrial Ecosystems (GCTE) Workshop "Global Change and Agriculture: Modelling the Wheat Ecosystem"

27-31 July, Tallinn, Estonia

Open Meeting on Biospheric Aspects of the Hydrological Cycle. Dr. Alfred Becker, BAHC Core Project Office, Institut für Meteorologie, Freie Universität Berlin, Dietrich-Schäfer-Weg 6-10, D-1000 Berlin 41, Germany, Fax: (49-30) 838 71160

23-27 November, Niamey, Niger

IGBP Regional Conference for Africa

1993

February, Mexico

SAC III: Third Meeting of the Scientific Advisory Council for the IGBP

November, Seattle, Washington, USA

GCTE Workshop on Global Change and Forestry

IGBP-Related Meetings

1992

5-10 January, Irvine, California, USA

Atmospheric Methane: 1st Annual Conference of the National Institute for Global Environmental Change. Prof. F. S. Rowland, Dept. of Chemistry, University of California Irvine, Irvine CA 92717, USA, Fax: (1-714) 725 2905.

14-16 January, Cambridge, MA, USA

The World at Risk: Natural Hazards and Climate Change. Anne Slinn, Centre for Global Change Science, MIT, Room 54-1312, Cambridge, MA 02139, USA, Fax: (1-617) 253 0354

20-26 January, Sevilla, Spain

SCOPE VIII General Assembly: Principles, Patterns and Processes of Land-Use Change

27-31 January, Bermuda Biological Station, Bermuda

Biogeochemical Ocean Atmosphere Transfers (NATO Advanced Research Workshop). Prof. R. Prinn, Massachusetts Institute of Technology, Room 54-1312, Center for Global Change Science, Cambridge, MA 02139, USA, Fax: (1-617) 253 0354

27 January-1 February, Fortaleza, Brazil

International Conference on the Impacts of Climatic Variations and Sustainable Development (ICID). Antonio Rocha Magalhães, c/o Fundação Esquel Brazil, Edif. ASCB-SAS Conj. 06, Bloco L-s/801-A, 70070 Brasília, DF, Brazil

4-5 February, Tokyo, Japan

Japanese National Committee IGBP Symposium for Countries in Monsoon Asia and the West Pacific. Organizing Committee, Science Council of Japan, 22-34, 7-chome, Ropongi, Minatiku, Tokyo, 106 Japan, Fax: (81-3) 3403 6224

10-13 February, Pasadena, California, USA

International Space Year Conference on Earth and Space Science Information Systems. Arthur I. Zygielbaum, Jet Propulsion Laboratory, 4800 Oak Grove Dr., MS 180-701, Pasadena, CA 91109, USA, Fax: (1-818) 354 8333.

17-20 February, Toulouse, France

Workshop on the Regional Climate Research Centre for the Mediterranean Basin and Subtropical Africa. Dr. Jean Claude André, Météo-France, Centre National de Recherches Météorologiques, F-31057 Toulouse Cedex, France, Tel: (33) 61 07 93 70, Fax: (33) 61 07 96 00.

17-28 February, Les Houches, France

Modelling Oceanic Climate Interactions (NATO Advanced Study Institute). J. Willebrand, Institut für Meereskunde, Universität Kiel, Düsternbrooker Weg 20, D-2300 Kiel 1, Germany, E-mail: J.Willebrand (Omninet).

2-5 March, Chambéry, France

Integration, Dissemination and Use of Environmental Data for Research on Crop Modelling. Committee on Data for Science and Technology (CODATA) Commission on Global Change Data

2-6 March, Windhoek, Namibia

Southern African Development Coordination Conference (SADCC) "Conference on Climate Change". Jan E Larsson, SADCC Soil Water Conservation, PO Box 24, Maseru, Lesotho, Fax: (266) 310 049, 310 190

3-6 March, Amsterdam, Netherlands

First International Conference on Carbon Dioxide Removal. Chris Hendriks, ICCDR, c/o KIVI, PO Box 30424, NL-2500 GK The Hague, The Netherlands

4-6 March, Havana, Cuba

International Scientific Colloquium on Space Observations. Prof. Dr. Ramón Pomés Hernández, Comisión Cubana para el Espacio, Academia de Ciencias de Cuba, La Habana 10200, Cuba, Fax: (53-7) 22 83 82

4-7 March, Lima, Peru

International Symposium on Former ENSO Phenomena in Western South America: Records of El Niño Events. Dr. José Macharé, Instituto Geofísico del Perú, Apartado 3747, Lima 100, Peru, Fax: (51-14) 37 02 58

22-27 March, Garmisch-Partenkirchen, Germany

EUROTRAC Symposium 1992: European Experiment on the Transport and Transformation of Environmentally Relevant Trace Constituents in the Atmosphere. Dr. Peter Borrell, Fraunhofer Institute, Kreuzteckbahnstrasse 19, D-8100 Garmisch-Partenkirchen, Germany

23-27 March, Hilo, Hawaii, USA

American Geophysical Union Chapman Conference on Climate, Volcanism, and Global Change. Dr. Stephen Self, Dept. of Geology and Geophysics, University of Hawaii Manoa, Honolulu, Hawaii 96822, USA

24-27 March, Palaiseau, France

High Spectral Resolution Infrared Remote Sensing for Earth's Weather and Climate Studies, (NATO Advanced Research Workshop). Dr. A. Chedin, Ecole Polytechnique, Lab. Météorologie Dynamique, F-91128 Palaiseau Cedex, France

27-29 March, Waseda University, Tokyo, Japan

Japan National Committee for the IGBP: International Symposium on Global Change. Waseda Symposium, c/o M & J International, 2210-2 Imajuku-cho, Asahi-ku, Yokohama, 241, Japan

30 March-4 April, Munich, Germany

European International Space Year Conference: Space in the Service of the Changing Earth. Dr. B. Pfeiffer, ESA/ESTEC-ISY Office, Keplerlaan 1/PO Box 299, NL-2200 AG Noordwijk, Netherlands, Fax: (31) 1719 14642

21-24 April, La Rochelle, France

Measurement of Primary Production from the Molecular to the Global Scale: International Council for the Exploration of the Sea (ICES) Symposium. Trevor Platt, Biological Oceanography Division, Bedford Institute of Oceanography, PO Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada, Fax: (1-902) 426 9388

3-9 May, Château de Bonas (Toulouse), France

Towards a Model of Ocean Biogeochemical Processes (NATO Advanced Research Workshop) Dr. Geoff Evans, JGOFS CPO, Institut für Meereskunde, Universität Kiel, Düsternbrooker Weg 20, 2300 Kiel 1, Germany, Fax: (49-431) 565 876

26-29 May, Houston, Texas, USA

International Geoscience and Remote Sensing Symposium (IGARSS '92). Dr. Andrew J. Blanchard, Director, Space Technology and Research Center, Houston Advanced Research Center, 4800 Research Forest Drive, The Woodlands, TX 77381, USA, Fax: (1-713) 363 7923

26-29 May, Athens, Greece

6th International Symposium on Acoustic Remote Sensing and Associated Techniques of the Atmosphere and Oceans. Athens ISARS '92, IMPAE/National Observatory of Athens, PO Box 20048, GR-118 10 Athens, Greece

1-12 June Rio de Janeiro, Brazil

United Nations Conference on Environment and Development. Scientific Secretariat: PO Box 80, CH-1231 Conches, Switzerland, Fax: (41-22) 466 815

15-17 June, New Orleans, Louisiana, USA

Remote Sensing for Marine and Coastal Environments. Marine Environment Conference, Environmental Research Institute of Michigan, PO Box 134001, Ann Arbor, MI 48113-4001, Fax: (1-313) 994 5123

14-18 June, Bad Dürkheim, Germany

Global Climate Change - Impacts on Terrestrial Ecosystems. Kay Russell, Elsevier Science Publishers, Conference Department, Mayfield House, 256 Banbury Road, Oxford OX2 7DH, UK, Fax: (44-865) 320 981

22-26 June, Genoa, Italy

Ocean Management in Global Change: Ente Colombo '92. Prof. Adalberto Vallega, University of Genoa, Via Sottoripa 5, I-16123 Genoa

10-14 August, Stockholm, Sweden

Stockholm Water Symposium 1992. c/o Stockholm Convention Bureau, Box 6911, S-102 39 Stockholm, Sweden

23-28 August, Halifax, Nova Scotia, Canada

Tropospheric Chemistry of Ozone in the Polar Regions (NATO Advanced Research Workshop). Prof. H. Niki, York University, Dept. of Chemistry, 4700 Keele St, Ontario, Canada M3J 1P3, Canada

24-29 August, France

Ice in the Climate System (NATO Advanced Research Workshop) Prof. William Peltier, University of Toronto, Dept. of Physics, Toronto, Canada

28 August-5 September, Washington, D.C., USA

World Space Congress, 29th COSPAR Meeting. American Institute of Aeronautics and Astronautics, 370 L'Enfant Promenade S.W., Washington, D.C. 2004-2518

9-21 September, Grasse, France

The Role of the Stratosphere in Global Change (NATO Advanced Study Institute). Dr. M.-L. Chanin, CNRS, Service d'Aéronomie, BP 3, 91371 Verrières le Buisson Cédex, France

14-18 September, Ashford, UK

Interacting Stresses on Plants in a Changing Climate (NATO Advanced Research Workshop). Dr. M. Jackson, University of Bristol, Dept. of Agricultural Sciences, Long Ashton Research Station, Bristol, UK

15-18 September, Fellhorst, Germany

Carbon Cycling in the Glacial Ocean: Constraints on the Ocean's Role in Global Change (NATO Advanced Research Workshop). Prof. R. Zahn, GEOMAR, Research Centre for Marine Geosciences, Dept. of Palaeoceanography, Wischhofstrasse 1-3, D-2300 Kiel 14, Germany

21-25 September, Kiel, Germany

4th International Conference on Paleoclimatology: Short and Long Term Global Changes. Dr. John Thiede, GEOMAR, Wischhofstrasse 1-3, Bldg. 4, D-2300 Kiel 14, Germany, Fax: (49-4) 3172 5391

27 September-11 October, Siena, Italy

Long-term Climatic Variations - Data and Modelling (NATO Advanced Study Institute). Prof. J.-C. Duplessy, Centre des Faibles Radioactivités, CNRS, Avenue de la Terrasse, F-91198 Gif-sur-Yvette, France

October, France

The Role of Regional Organizations in the Context of Climate Change (NATO Advanced Research Workshop). Dr. M. Glantz, National Centre for Atmospheric Research, Environmental & Societal Impacts Group, PO Box 3000, Boulder, CO 80307, USA

1-5 November, Reno, Nevada, USA

Managing Water Resources During Global Change. 28th Annual Conference and Symposium of the American Water Resources Association. Raymond Herrmann, WR-CPSU, Colorado State University, Fort Collins, CO 80523, USA, Fax: (1-303) 491 2255

2-6 November, Accra, Ghana

Toward Sustainable Environmental and Resource Management Futures for Sub-Saharan Africa. Prof. Walther Manshard, Schwarzwaldstr. 24, D-7812 Bad Krozingen, Germany, Tel: (49) 7633 3488

November/December, Paris, France

Scientific Symposium on the Human Dimensions of Global Environmental Change. Evelyne Blamont, International Social Science Council, Maison de l'Unesco, 1 rue Miollis, 75015 Paris, France, Fax: (33-4) 43 06 87 98

1993**15-16 February, Palmerston North, New Zealand**

Climate Change Symposium, XVII International Grassland Congress. c/o Agronomy Department, Massey University, Palmerston North, New Zealand, Fax: (64-6) 350 5614

11-23 July, Yokohama, Japan

International Association of Hydrological Sciences (IAHS) and the International Association of Meteorology and Atmospheric Physics (IAMAP). Dr Takeo Kinoshita, National Research Institute for Earth Science, Tennodai-3, Tsukuba, Ibaraki, 305 Japan

July, Oxford, UK

Climate Change and World Food Security (NATO Advanced Research Workshop). Dr. M. Parry, University of Oxford, School of Geography, Environmental Change Unit, Oxford, OX1 3TB, UK

28 July-5 August, Mexico City

The Cultural and Biological Dimensions of Global Change. XII International Congress of Anthropological and Ethnological Sciences. Dr Linda Manzanilla, UNAM, Ciudad Universitaria, 04510 Mexico DF.

Announcements

Saint Francis Prize for the Environment "Canticle of All Creatures"

Dr. Thomas F. Malone was awarded the International Saint Francis Prize for the Environment on 26 October 1991. Following an audience with the Pope in Rome the day before, the prize was given in Assisi by the President of the Jury, Giovanni Battista Marini-Bettòlo Marconi, President of the Pontifical Academy of Sciences. The prize is promoted by the Franciscan Centre of Environmental Stud-



Dr. Thomas F. Malone

ies, who also organized a seminar on Environment and Poverty for the occasion.

The prize was awarded to Dr. Malone for scientific research, one of the three areas covered by the Saint Francis Prize. The others are education and communications, awarded to Salvatore Furia, and realized projects and effective action, awarded to the Republic of Costa Rica.

Dr. Malone was one of the pioneers to advocate the development of the International Geosphere-Biosphere Programme: A Study of Global Change, established in 1986, and considered by the jury to be indispensable to the planning efforts to protect tomorrow's Earth.

Formerly professor of geology at the Holcomb Research Institute of Butler University, Indianapolis, USA, and presently professor at the Department of Marine, Earth and Atmospheric Sciences at North Carolina State University, Raleigh, USA, Dr. Malone has been at the worldwide level one of the principal promoters of

interdisciplinary environmental research. He has studied geochemical aspects of the environment and greatly furthered the idea of global management of the environment through national and international organizations

From as early as 1967, Dr. Malone was a decisive force behind the development of the Global Atmospheric Research Programme (GARP) and, from 1980, of the World Climate Research Programme (WCRP). Dr. Malone has also served as Secretary General of the Scientific Committee on Problems of the Environment (SCOPE), whose intense, constant and successful research projects within the context of the International Council of Scientific Unions have already made important scientific contributions.

Recruitment of a Core Project Officer for IGAC

There is an immediate opening for the position of Core Project Officer for the International Global Atmospheric Chemistry (IGAC) Project, stationed at the Massachusetts Institute of Technology. The project, created in response to growing international concern about several observed changes in atmospheric chemistry and their impact on humanity, involves global atmospheric and biospheric research activities, both ongoing and planned, that are organized and carried out by international teams of scientists. It is a Core Project of the IGBP.

The Core Project Officer supports, facilitates and coordinates the work of the IGAC Activity Leaders and IGAC Steering Committee. This includes development of scientific and funding documents for the various activities and interfacing with various funding organizations and

related scientific projects around the world. The successful applicant should possess a Ph.D. or equivalent, and have significant experience in atmospheric or atmospheric-biospheric chemistry research. Proficiency in communications (written and verbal, English working language), organizational skills, and the ability to work effectively and productively alone and with others are a necessity.

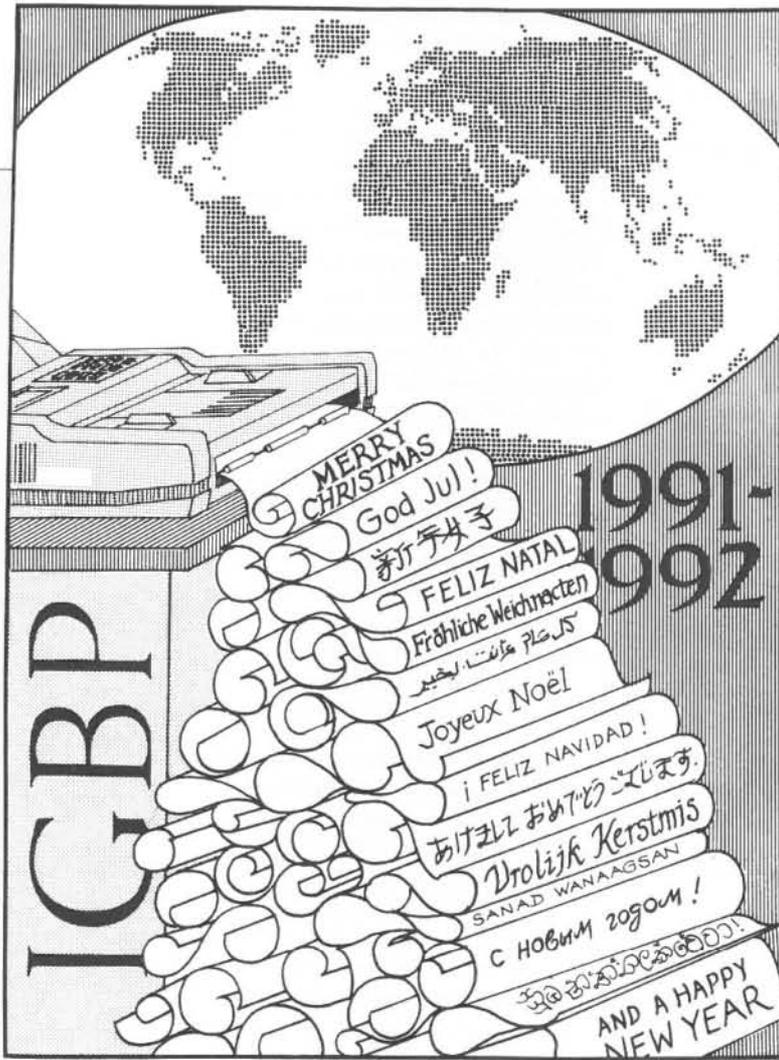
Interested candidates should send a copy of their curriculum vitae and names of 3 references to the Chair of the IGAC Steering Committee: Prof. Ronald G. Prinn, Director, Centre for Global Change Science, MIT, Rm. 54-1312, Cambridge, MA 02139, USA. The deadline for application is 1 February 1992. Further information may be obtained by calling the Centre for Global Change Science: Tel: (+1-617) 253 4902, Fax: (+1-617) 253 0354. The position is funded for three years, and salary is commensurate with experience. MIT is an equal-opportunity employer.

Secondment Opportunity at IGBP Secretariat, Stockholm

There is the opportunity for a US scientist to work as Programme Officer at the IGBP Office in Stockholm for a two year period starting June 1992, sponsored by the Committee on Earth and Environmental Sciences in Washington and other possible funding sources. The Programme Officer would assist in the planning and coordination of IGBP activities, in liaison with IGBP Core Projects. The required qualifications are a Ph.D. or equivalent, preferably with previous administrative experience. Interested candidates should send a copy of their CV and three references to Prof. Thomas Rosswall, Executive Director IGBP by 31 January 1992.



Stockholm in winter, photo: Bernt Jansson



Seasons greetings from the Staff at the IGBP Secretariat

Thomas Rosswall
THOMAS ROSSWALL

Richard Moss
RICHARD MOSS

Phillip Williamson
PHILLIP WILLIAMSON

June Barwick
JUNE BARWICK

Suzanne Nash
SUZANNE NASH

Elise Wannman
ELISE WÄNNMAN

Cecilia Edlund
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