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

The Joint Global Ocean Flux Study Report from the JGOFS Scientific Steering Committee to the Executive Committee of SCOR



The past year saw a large amount of scientific activity in JGOFS as Phase I of the Southern Ocean Process Study neared completion, the Equatorial Pacific Process Study entered its third field season, and the results of the pilot phase of the Arabian Sea Process Study were being assessed. In addition, the JGOFS-WOCE Global CO₂ Survey moved into full implementation with 10 cruises, and activities continued at the Bermuda and Hawaii Time Series Stations. New time-series operations were begun by France-JGOFS at Kerguelen in the Southern Ocean and by Germany in the Canary Islands in the eastern subtropical north Atlantic. Thus JGOFS is actively implementing all field operations described in its Science and Implementation Plans. Over 40 process study and survey cruises and approximately 36 time series cruises have been completed in the past 12-18 months.

The scientific highlights of the year for

JGOFS were in the Equatorial Pacific, where the intensive phase of the Process Study was nearing completion, and the Southern Ocean, where major new insights were gained in a series of cruises. During mid to late 1992, the El Niño conditions which had prevailed during the earlier phases of the EQPAC process study waned, allowing comparison of El Niño and non-El Niño conditions in the open central Pacific. The USA survey cruise on the RV THOMAS THOMPSON encountered a massive accumulation of phytoplankton in a convergence zone near 2°N. Subsequent observations on a benthic cruise in November-December revealed that diatom-dominated phytodetritus covered the bottom from 5°S to 5°N, echoing similar findings in the NABE study.

In the first major field season for the JGOFS Southern Ocean study, several key achievements and advances have already emerged:

1. The mapping of spatial and temporal variability of air-sea CO₂ exchange has been enhanced considerably in areas of the Southern Ocean which were data-sparse. Areas between the southern continents and Antarctica, parts of which are implicated by ocean colour imagery in major CO₂ flux, are now particularly well covered.

2. Significant advances have been made in our understanding of the role of the seasonal sea-ice zone in determining the magnitude and spatio-temporal variability of carbon sequestration in the Southern Ocean (approximately 50% of the area south of the Polar Frontal Zone). In particular, two intensive process studies have yielded a much greater understanding of the sequence of biogeochemical events associated with the spring ice melt, and have underscored the complex interactions between hydrographic and ice-edge structure.

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3. Factors likely to control primary production in the Southern Ocean have been addressed in several process cruises. Iron limitation has been investigated, along with more critical examination of the impact of vertical mixing and of grazing. Understanding of the impact of UV-B is beginning to emerge.

4. Through frequent collaboration with World Ocean Circulation Experiment investigations, the biogeochemical role of fronts within the Southern Ocean is being unravelled.

5. Despite formidable logistic difficulties, time-series and other long-term sites are being established.

A number of international JGOFS Task Teams and Planning Groups have met in 1993. The North Atlantic Planning Group met in Warnemünde in April and began to develop a scientific plan for a process study in the North Atlantic, the objective of which will be to reduce the uncertainties in the estimates of the size of the carbon sink in the North Atlantic. This is to be achieved by improving our understanding of biogeochemical and physical processes regulating the uptake of atmospheric CO₂. It is intended that this will be the last process study in the JGOFS programme, taking place in 1998, and that it will take advantage of the understanding and results gained from the 1989-1990 North Atlantic Bloom Experiment (NABE) as well as other regional studies. A detailed report of this meeting is available from the JGOFS Core Project Office.

The JGOFS Data Management Task Team met at the British Oceanographic Data Centre in May under its new Chairman, Dr. Roy Lowry. The group reviewed the status of the international NABE data set and considered that a number of useful data products could be assembled within the coming year for distribution to the science community. The international JGOFS SSC has placed a very high priority on finding the resources required to assist with truly international data management in addition

to the various ongoing national activities. A report from the Data Management Task Team is available from the JGOFS CPO.

The JGOFS SSC places a great emphasis on issues of Global Synthesis, recognizing that the truly global estimates of oceanic carbon fluxes and other parameters important to JGOFS can only be obtained through internationally coordinated effort; nations can at best only participate in two or three of the regional process studies. The most important function of the international programme is to provide the means for integration of the results of these national activities towards the international objectives.

The level of interaction with other IGBP Core Projects has increased during the past year. The JGOFS/LOICZ (IGBP Core Project on Land-Ocean Interactions in the Coastal Zone) Task Team on Continental Margins, established in 1991 held its second formal meeting immediately after the recent JGOFS SSC meeting. It is in the process of completing a science plan for JGOFS/LOICZ work in the coastal and shelf seas. This interaction results from the needs of both projects to understand horizontal boundary fluxes of carbon and sediment transport across the continental shelf.

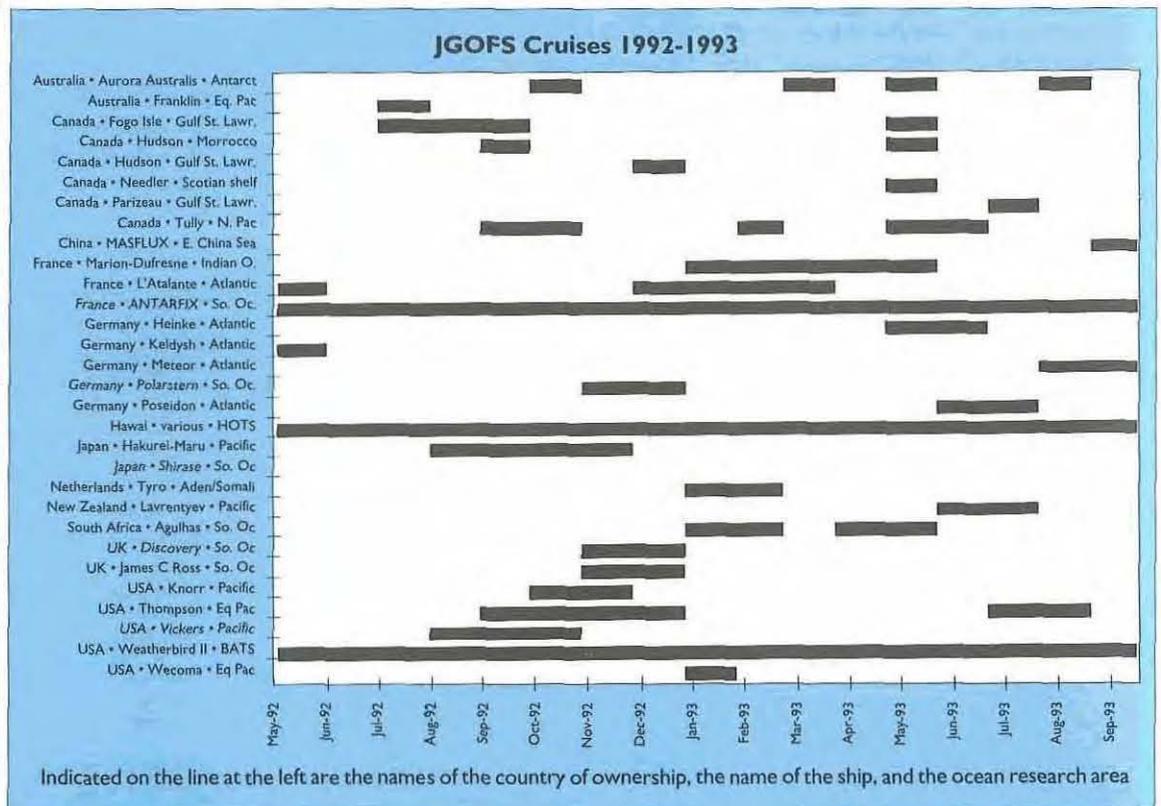
The JGOFS/IGAC (International Global Atmospheric Chemistry Project) Task Team on Biogeochemical Air-Sea Transfers, established this year, will hold its first meeting in December. This arises from the joint JGOFS/IGAC NATO Advanced

Research Workshop on the topic. Some IGAC field work has been done on JGOFS cruises in the Equatorial Pacific. The interaction results from the need for better understanding of exchanges at the air-sea interface.

The JGOFS Indian Ocean Planning Group which is responsible for the scientific planning of the Arabian Sea Process Study, met in Mombasa, Kenya in November. A two week training course in the methods for the most important JGOFS Core Measurements was organized with support and assistance from the Intergovernmental Oceanographic Commission. Members of the Planning Group served as instructors in the course which had about 25 participating scientists from the region. An urgent need for an international coordinator for the Arabian Sea Process Study has been identified and an effort is underway to find the necessary resources for this.

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Global Change and Terrestrial Ecosystems

Scientific Steering Committee Meeting

Operational issues were highlighted at the recent meeting of the GCTE SSC held in Tokyo on 6-8 September. As GCTE moves more strongly into the implementation phase of its research programme, the SSC is giving increasing attention to strengthening the integration within the GCTE project and to establishing effective links with other groups.

Integration within GCTE

A number of GCTE activities, such as the consortium of elevated CO₂ research projects and the wheat research network, are moving ahead strongly. As other such coordinated GCTE networks are established, GCTE is instituting a number of activities to ensure efficient integration within the programme. These include shared Tasks and joint workshops and meetings.

LEMA

GCTE's Long-term Ecological Modelling Activity (LEMA) network is taking shape with the acceptance of the initial group of centres into the network. An interim set of objectives for LEMA has been determined, and the proposal to establish the LEMA Secretariat has been forwarded to appropriate agencies. The first meeting of the LEMA Coordinating Committee will be held in the first half of 1994.

LEMA will promote GCTE's research effort by linking together ecological modelling groups around the world to share models and data, to undertake model inter-comparisons, to provide feedback to experimental projects, and to initiate and develop new modelling tools required in global change research.

The first set of LEMA centres represents a broad geographical spread (five continents are represented), every major biome type, and a wide range of specialist skills.

Ecological complexity

The draft operational plan for GCTE's **Focus 4 - Global Change and Ecological Complexity** - was accepted by the SSC, and Professor Osvaldo Sala of the University of Buenos Aires was invited to lead the research effort. His acceptance was condi-

tional on finding support to run the Focus 4 office. A meeting to refine further the Focus 4 operational plan, to establish links with other groups interested in the global change/biodiversity issue, and to officially launch the research programme will be held in the first quarter of 1994.

GCTE's research on ecological complexity is distinguished from other research programmes on biodiversity and global change in that it focuses on global change impacts on complexity (which includes connectivity and spatial diversity- patchiness- as well as species diversity) and its relationship to ecosystem function. The Focus 4 research effort will draw heavily on the current SCOPE project on the functional significance of biodiversity.

Freshwater Ecology

The lack of an identifiable role for freshwater ecology within IGBP was raised at the Third Meeting of the Scientific Advisory Council for the IGBP at Ensenada, Mexico, in January, and at previous GCTE SSC meetings. At the Tokyo GCTE SSC meeting a discussion paper on the issue was considered, and a number of important aspects - greenhouse gas emissions from freshwater systems, freshwaters as integrators and concentrators of global change signals, and the impacts of global change on freshwater ecosystems and on water supply - were discussed.

The GCTE Scientific Steering Committee forwarded to the Scientific Committee for the IGBP options for a possible additional focus on freshwater ecology within the IGBP.

GCTE Science Conference

A state-of-the-science assessment of research into terrestrial ecosystem interactions with global change will be made at the Woods Hole Oceanographic Institution (Massachusetts, USA) during the conference from 23 to 27 May, 1994. The meeting promises to present exciting new results as well as stimulate new areas of research where our current understanding is poor.

GCTE's early achievements will be the primary focus of the conference, with overview papers presented by each of the Focus Leaders and highlights of individual research projects given by GCTE Activity and Task Leaders. In addition, there will be invited papers by scientists not currently affiliated with GCTE.

A major feature of the conference is a number of sessions on cross-cutting themes which involve more than one GCTE Focus and which involve GCTE in collaborative work with other IGBP Core Projects/Framework Activities and with other groups. These cross-cutting themes include:

- Linking ecosystem physiology with ecosystem dynamics
- The terrestrial biosphere in the Earth system
- Interactive effects of global change on complex agro-ecosystems
- How much is the Earth's vegetation changing?

The meeting will be held at the Ma-



The GCTE Scientific Steering Committee Meeting, Tokyo, September 1993

IGBP Transects

GCTE's plans to establish an international system of transect studies for global change research have become a reality with the identification of the first set of transects.

Each IGBP transect has been chosen to reflect the effect of variation in a major environmental factor as it influences terrestrial ecosystem structure/function/composition, biosphere/atmosphere trace gas exchange, and hydrologic cycling.

These transects can most easily be visualized as a series of research sites along a simple gradient of a single controlling factor or global change driving force (e.g., temperature, precipitation).

The presence of a strong underlying gradient shapes the ecosystems along a transect and their interactions with other environmental factors, thereby helping us to understand how these systems function, and how they are likely to change.

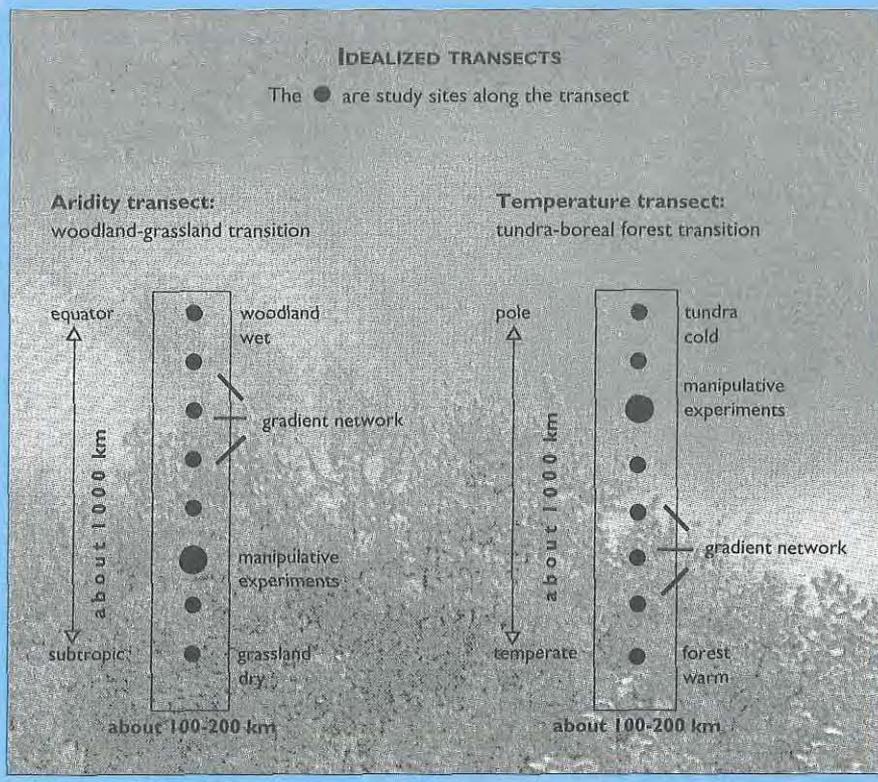
The initial set of IGBP transects will be chosen according to a rather stringent set of criteria:

- (i) a coherent set of sites that differ more or less straightforwardly and continuously in a major environmental factor that is subject of change (or has already changed) as a consequence of anthropogenic global environmental change
- (ii) located in a region that is likely to be altered by forcing from global change, where the alteration is itself likely to be globally significant, or where the alteration is likely to lead to significant feedbacks
- (iii) is sufficiently broad that: a) understanding gained from the transect can be applied more broadly; b) crosses transition between systems dominated by major life forms (e.g. forest/prairie or savanna; tundra/taiga); and c) requires resources beyond the scope of individual research groups. On the other hand, transects should not be so broad as to lose focus (e.g., pole-to-pole transects).
- (iv) is already established or actively developing, with sites selected, and much of the research team in place.

Although originally planned to contribute primarily to GCTE's Focus I work on ecosystem physiology, it is now clear that the transects will also contribute to other GCTE activities and to other Core Projects within the IGBP:

- GCTE: biogeochemical studies, change in ecosystem structure and composition; production forestry and rangelands; ecological complexity and ecosystem function.
- IGAC: trace gas emissions from terrestrial systems, including biomass burning
- BAHC: biotic control of water and energy exchange between the land surface and the atmosphere
- DIS: application of remote sensing data to terrestrial global change studies
- LUC: land-use and land-cover change
- LOICZ: impact of land-use change on sediment loading of streams and rivers

Initially four major regions, each crossing a transition between a major life form, have been identified for transect studies. These are: tundra-boreal; semi-arid tropical savanna; temperate forest-prairie; and humid and dry tropical forest (where the gradient is in intensity of land-use).



rine Biological Laboratory, Woods Hole, Massachusetts, USA, from 23 to 27 May 1994. Nearly 400 scientists are planning to attend the conference, based on responses to the first circular.

Abstracts of papers for the Conference should be submitted to Dr. Brian H. Walker, GCTE Core Project Office, CSIRO Division of Wildlife and Ecology, PO Box 84, Lyncham ACT 2602, Australia. Fax: (+61-2) 241 2362, e-mail: bhw@cbr.dwe.csiro.au, before 15 January.

Registration should be sent, by 15 April 1994, to Lou Ann King, Manager of Conferences, Marine Biological Laboratory, Woods Hole, MA, 02543, USA. Fax: (+1-508) 540 7187.

TEMA:

Terrestrial Ecosystems in Monsoon Asia

A large, developing research project in East Asia promises to greatly enhance our understanding of the responses of forest ecosystems to global change.

The objectives of the Terrestrial Ecosystems in Monsoon Asia (TEMA) project, which has been accepted into the GCTE Core Research Programme, are to predict the effects of elevated CO₂ and climate change on the distribution and structure of forests in Monsoon Asia, and to determine the associated feedback effects to the global carbon cycle.

TEMA's research strategy is based on a series of experimental sites in Monsoon Asia from the boreal forests of Siberia and Hokkaido (Japan) through cool and warm temperate forests in mainland Japan and eastern China, to tropical rainforests in Southeast Asia. TEMA includes two GCTE high priority biomes: boreal forests, which are expected to change significantly because of increasing temperature, and tropical rainforests, which are undergoing rapid change in land use.

Humid climate prevails over Monsoon Asia: high precipitation with more or less conspicuous rainy seasons. In this climate, the predominate vegetation is forests, which are distributed continuously from boreal to tropical without intervening arid zones - a characteristic unique to this region.

Another characteristic of the region is a range of high mountains. Air temperature, which is one of the most important factors that determine vegetations structure, changes altitudinally as well as latitudinal-

ly and forest types change zonally with the temperature gradient. The pattern of forest types along both altitudinal and latitudinal temperature gradients under current climatic conditions will form the basis for the study of global change impacts on Monsoon Asia.

TEMA's experimental sites stretch over 6,000 km from Siberia to Sumatra, including Japan, eastern China, Malaysia and Thailand. The following study sites have been or will soon be established: Mt Kluchevskoy, Furano, Mt Hakkoda, Ogawa, Chichibu, Kiyosymi, Shigayama, Mt Fuji, Odaighara, Yoshiwa, Aya, Yakushima, Mt Minya Konka, Mt Kinabalu, Mt Kerinci.

TEMA consists of four components:

- *Screening of Key Species with Respect to the Response to Global Change. Identification and classification of functional types*

Physiological and morphological responses of key species to three important components of global change - increasing CO₂ concentration, increasing temperature, and change in humidity - will be used to classify these species into plant functional types. Plant characteristics to be

screened include photosynthesis, respiration, allocation and growth, as well as reproduction, phenology, propagule dispersal, and resistance to freezing.

- *Modelling of Forest Structure as an Integration of Functional Types, Prediction of the Effect of Global Change on Forest Structure*

Interactions between different functional types and different sizes of plants determine the structure of forests. Models based on the diffusion equation will be used to describe forest dynamics. The effects of episodic events, such as natural and artificial disturbance and extremes in temperature on forest dynamics, will be included in the model. The response of each functional type to global change, and their interaction, will form the basis for predicting the overall change in forest structure.

- *Biogeographical Analysis of the Distribution and Structure of Forest Ecosystems in Monsoon Asia. Extension of the model from the patch to the regional scale*

Distribution and structure of forest vegetation in eastern Asia are closely correlated to climatic conditions. Physiological and ecological mechanisms that under-

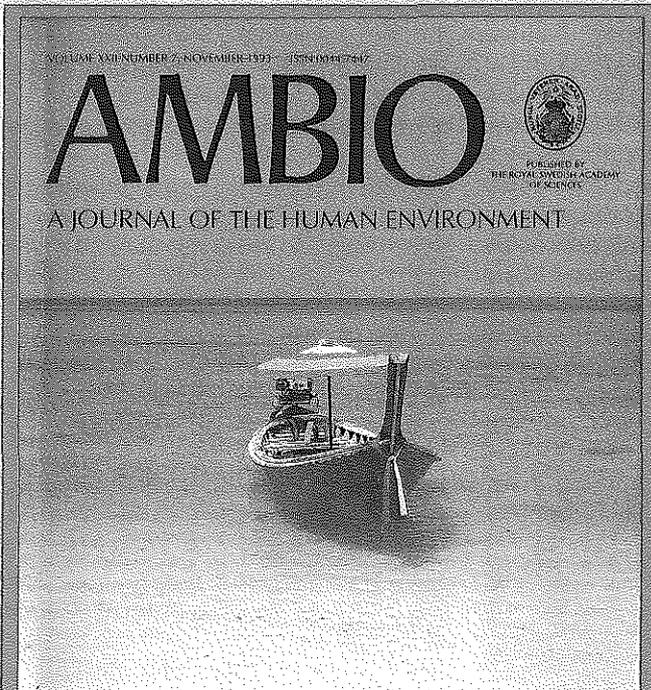
lie these correlations will be exploited by such models as production process models, heat balance models, and cost-benefit models, to simulate the impact of global change on landscape and regional scales.

- *Modelling of the Carbon Cycle of Forest Ecosystems in Monsoon Asia. Feedbacks to the atmosphere and the physical climate system.*

A model of the carbon cycle of Monsoon Asian forest ecosystems will be constructed and the effect of global change on the carbon cycle simulated, for input to global carbon models. The models will be supported by experimental studies of the CO₂ exchange of Monsoon Asian forests, and potential of these forests to be a "missing sink" of CO₂ will be evaluated.

The research plan for TEMA was further refined at a workshop, held in September 1993 in conjunction with a meeting of the GCTE Scientific Steering Committee.

TEMA is coordinated by *Professor Tadaki Hirose*, Biological Institute, Faculty of Science, Tohoku University, Aoba-yama, Sendai 980, Japan; Fax: (+81-22) 263 9206



Integrating Earth System Science

A special IGBP issue of AMBIO Vol. XXIII, No. 1, February 1994

A SELECTION OF PAPERS INCLUDES:

- | | |
|---|--|
| Integrating Earth system science <i>B. Bolin, J.J. McCarthy & P. Williamson</i> | Landscape to regional scale responses of terrestrial ecosystems to global change <i>B. Walker</i> |
| Planetary metabolism <i>B. Moore & B.H. Braswell</i> | The impact of rising CO ₂ on the terrestrial biosphere <i>H. A. Mooney & G. Koch</i> |
| Global change models - a physical perspective <i>G. McBean</i> | A remote sensing based vegetation classification logic for use in global biogeochemical models <i>S. W. Running, T.R. Loveland & L.L. Pierce</i> |
| Interactions and collaborations across the social and natural sciences <i>R. Balstad Miller</i> | Large-scale experimental and modelling studies of hydrological processes <i>W. J. Shuttleworth</i> |
| Science and policy making <i>B. Bolin</i> | Global land-use/land-cover change, toward an integrated programme of study <i>B. Turner & W.B. Meyer</i> |
| Palaeo-perspectives: overview and the ice-core record <i>C. Lorius & H. Oeschger</i> | Perspectives on Policy <i>F. Bretherton</i> |
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| Response of a coupled ocean-atmosphere model to increasing atmospheric carbon dioxide <i>S. Manabe, R.J. Stouffer & M.J. Spelman</i> | Changes in general circulation and its influence on precipitation trends in Central America: Costa Rica <i>A. Brenes Vargas & V.F. Saborio Trejos</i> |
| The interactive atmosphere: global atmospheric-biospheric chemistry <i>R. Prinn</i> | |
| Biogeochemical interactions in the equatorial Pacific <i>R.T. Barber, J.W. Murray, J. J. McCarthy</i> | |

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People with the IGBP

Changes in the Scientific Committee for the IGBP

The Scientific Committee is the leading body of the IGBP. The Officers and the Members are appointed by ICSU, and the Chairs of the Scientific Steering Committees for the individual core projects and framework activities are appointed by the SC-IGBP, or jointly with other sponsoring scientific bodies. The Scientific Committee, selected among outstanding scientists in global change research for their personal accomplishments, has the responsibility for planning the programme and for its implementation. It represents both a wide range of expertise in all fields of Earth system research, and a regional diversity.

Seven new members will join in January 1994. We wish to thank here those members who are leaving, both as Chairs of Scientific Steering Committees and as ICSU-appointed Members of the Scientific Committee, for the generous gift of their energy and time to help IGBP reach its goals.

New Members appointed by ICSU

Inder Pal Abrol is Deputy Director General (Resource Management) of the Indian Council of Agricultural Research, New Delhi. His national scientific responsibilities cover guiding research in resource management: cropping systems, soil and water management, agrometeorology, agroforestry, and salinity management in different agroclimatic regions of India. He is a member of many national and international professional organizations, among them founding member of the Society for Promotion of Wastelands Development, India. Dr. Abrol has been Vice-Chair and Chair of the Commission on Soil Technology of the International Society of Soil Science.



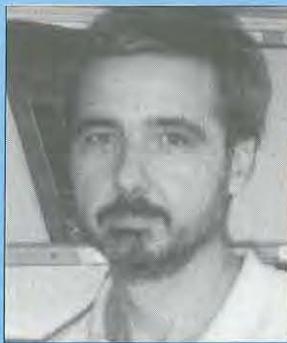
Inder Pal Abrol



Ann Henderson-Sellers

Ann Henderson-Sellers is Director of Climatic Impacts Centre and Professor of Physical Geography, School of Earth Sciences, at Macquarie University in Sydney. Outstanding among her multiple interests is climate modelling, which led to her appointment as the Leader of the Analysis Team of the Model Evaluation Consortium for Climate Assessment (MECCA). Her research interests are climatology, numerical modelling and monitoring at a global scale of the atmosphere, hydrosphere, cryosphere, land surfaces and the biosphere.

Oswaldo Sala is Professor in the Department of Ecology Faculty of Agronomy at the University of Buenos Aires. Dr. Sala's international scientific responsibilities include membership on the GCTE Scientific Steering Committee since 1990, where he will continue to serve as leader of Focus 4 on biological diversity. His research in-



Oswaldo Sala

terests are: (1) vegetation dynamics in arid and semi-arid regions, including primary production estimates, resource partitioning, water relations, and grazing effects; (2) carbon budgets of temperate grasslands and their responses to global change.

George Zavarzin, is Corresponding Member of the Academician of the Russian Academy of Sciences, and Academician and Professor at the Institute of Microbiology, Moscow. Dr. Zavarzin is the leader of the Global Change Impact on the Bio-

sphere component of the Russian National Research Programme on Global Change in the Environment and Climate. He is a microbiologist, specializing in microbial production of methane. His research interests include ecology and geochemistry.

Two members are leaving, now that their term of appointment has come to an end. Both have helped in guiding the implementation phase of the IGBP, from the time that the science plan was adopted in 1990.

José Sarukhán, Rector of the National Autonomous University of Mexico, a renowned ecologist, brought to the Scientific Committee his expertise in tropical deciduous forests and the impact of land-use patterns. Particular thanks are given for the invitation to hold the highly successful Third Scientific Advisory Council for the IGBP in Mexico, in January 1993.

Suresh K. Sinha, Professor of Eminence at the Water Technology Centre, Indian Agricultural Research Institute, New Delhi, is an expert on the impact of climate change on agriculture, and particularly drought situations. He now returns to the pressing demands of academic duties.

New Chairs of Scientific Committees



John Field

John Field is the new Chair of the Joint Global Ocean Flux Study Scientific Steering Committee. He is Professor of Zoology at the University of Cape Town, Rondebosch, South Africa. His research interests have focused on the functioning of marine ecosystems, the roles of physical factors in marine ecosystems, and modelling. He has been Vice-Chair of JGOFS since 1991.

The Past Chair, **Trevor Platt** (Canada), Chief of Biological Oceanography, Biological Sciences Branch, at the Bedford Institute of Oceanography, is a specialist in marine production processes. He has been a member of the JGOFS SSC since 1988, and continues to contribute his expertise to the JGOFS SSC during 1994.



Pavel
Kabat

Pavel Kabat is the new Chair of the Scientific Steering Committee for the Biospheric Aspects of the Hydrological Cycle (BAHC) Core Project. He is at The Winand Staring Centre for Integrated Land, Soil and Water Research, Wageningen, Netherlands where he is head of the Department of Agrohydrology. Dr. Kabat is well known for his work on soil-vegetation-atmosphere relation from patch to regional scales, and for contributions to simulation modelling in soil hydrology. He is involved in several large scale land surface - atmosphere interaction experiments, and was one of the integrating coordinators of the Hydrologic-Atmospheric Pilot Experiment (HAPEX) Sahel field campaign in 1992.

The previous Chair, **Hans-Jürgen Bolle**, Professor of Meteorology at the Meteorological Institute, Free University of Berlin, was vital in the development of BAHC from the time of his appointment to the initial BAHC Coordinating Panel in 1987. He will continue to devote his expertise to the IGBP as Chair of the German National IGBP Committee.



John
Townshend

John R. Townshend, the new Chair of the Standing Committee for the IGBP Data and Information System, is Professor and Chair at the Department of Geography, University of Maryland at College Park, USA. His experience is in advanced research in remote sensing data applications for Earth science, and he has



IGBP publications were displayed, among the vast collection of scientific works created by ICSU members, at the ICSU General Assembly in Santiago. The exhibition was organized by ICSU Press, under the guidance of Dr. Dennis Shaw, Chairman of the Section on Scientific Serials of the International Association of Technological University Libraries (IATUL), Past President of IATUL, and initiator of the IGBP Regional Information Centres plan.

worked with DIS for the past three years.

As Chair of the IGBP-DIS Land Cover Working Group, Professor Townshend was instrumental in developing the Global Land 1-km Advanced Very High Resolution Radiometer Data Set, described in IGBP Report No. 20 Improved Global Data for Land Applications.

Professor Townshend is also Chair of the NASA/NOAA AVHRR Land Pathfinder Science Working Group responsible for planning the development of a long-term retrospective global data set. He is a member of the US National Academy of Sciences Committee on Geophysical Environmental Data, and a one of the ICSU representatives on the Joint Scientific and Technical Committee of the Global Climate Observing System.

Stepping down as Chair is **S. Ichtiague Rasool**, who will continue as the Director of the DIS Office in Paris, and will continue to serve on the Global Analysis, Information and Modelling Task Force. Dr. Rasool led the building of the data programme for the IGBP, from the initial

establishment of the IGBP when he chaired the first DIS Working Group and was a member of the Special Committee of ICSU for the IGBP.



Hal Mooney, Vice Chair of the Global Change and Terrestrial Ecosystems Core Project, and leading specialist in biodiversity, was elected Vice President of the International Council of Scientific Unions at the ICSU General Assembly in Santiago de Chile, October 1993. The scientific topics discussed at the ICSU meeting included biodiversity, ozone and UV-B effects, and El Niño and related phenomena.

Honours

This autumn the careers of two outstanding scientists were celebrated as they reached the same milestone in their lives.

A scientific symposium entitled 'Explorations of the Earth and Other Planets' marked the 60th birthday of **Ichtiague Rasool** at the University of Maryland, College Park, on 29 September. Dr. Rasool, now in Paris at the University Pierre and Marie Curie, is Director of the IGBP DIS Office and Chief Scientist for Global Studies with the U.S. National Aeronautics and Space Administration. His expertise is in studies of long-term atmospheric evolution of earth and the planets. He has made crucial contributions to research on thermal structures of planetary atmospheres, and the development of data interpretation techniques for satellite sensors.

A scientific symposium on 'Challenges in Atmospheric Chemistry and Global Change: Yesterday, Today and Tomorrow' was held at the National Centre for Atmospheric Research on 2-4 December in honour of the 60th birthday of **Paul J. Crutzen**, Director of the Max Planck Institute for Chemistry, in Mainz, Germany. Professor Crutzen is an internationally recognized expert in atmospheric chemistry and its role in biogeochemical cycles and climate, especially his work on the role of nitrogen oxides in chemistry of the stratosphere, and on the modelling of atmospheric photochemical processes. He is a member of the Scientific and Technical Advisory Panel Roster of Experts of the United Nations Environment Programme, and has received numerous prizes and awards.

Both scientists, in addition to their distinguished careers, have contributed substantially to the development of the IGBP, and were members of the first Scientific Committee nominated by ICSU in 1987.

PAST GLOBAL CHANGES

The PAGES Core Project held its Scientific Steering Committee (SSC) Meeting in Washington DC in October 1993.

Great were the expectations: PAGES has been very active in the past year with approximately a dozen workshops, either in connection with other palaeo-science conferences or special PAGES project-planning meetings. These meetings provided the basis for the implementation of PAGES core research.

PAGES Pilot Project

One of the central science objectives of the PAGES Core Project concerns the intercomparison of Palaeoclimates of the Northern and Southern Hemispheres (the PANASH Project):

Focus I of the PANASH Project addresses the question: "How anomalous are the last 100 years in the time-frame of the last 1000 years?" Several meetings and workshops have dealt with studies of climate forcing and the record of variability during this period. The greatest interest centered on the history of the palaeo-monsoon and ENSO phenomena.

Focus II considers the question: "How are environmental changes in the Northern and Southern Hemisphere related (in timing and phase) over the last 150,000 years?" PANASH II has evolved to consist of a marine element, the International Marine Global Changes Study (IMAGES), and three continental elements which form the three Pole-Equator-Pole (PEP) project-transects: the Americas (PEP I), Australia-Eastern Asia-Siberia (PEP II), and Africa-Mediterranean-Eastern Europe (PEP III). These projects are currently in the planning stage and will be integrated into a global framework for palaeoclimate research.

Core Research

During the past year, up to 20 studies were presented as potential core research projects for the Past Global Changes science programme, and were discussed at the meetings of the PAGES Executive Committee. They included elements of PANASH, but also address cross-project needs, such as: the development of new analytical methods, data management, palaeoclimate modelling, and specific PAGES research themes, such as volcanic climate forcing.

At the Washington meeting the SSC

members discussed the endorsement of these as PAGES core research (some of which are still in the conceptual stage). After a spirited discussion, the SSC decided that it would be too rapid a step to move directly into implementation; it was decided to reconsider the overall project strategy. The PAGES Executive Committee, at its meeting in January 1994, will reevaluate the project structure and implementation strategy, and present a more integrated concept to the SSC at its next meeting in Australia in June 1994.

Scientific Assessment of Climate Change

A further topic of discussion was the PAGES input to the Intergovernmental Panel on Climate Change (IPCC), now preparing its next full scientific assessment for publication in 1995. Palaeo-information is of relevance for all the chapters of the IPCC Scientific Assessment. PAGES asked groups of palaeo-scientists to prepare brief documents relating to the nine chapters of the IPCC Scientific Assessment. These will be published independently by PAGES and will help to update the scientific priorities.

PAGES Research Results

Great interest was shown in the results of studies of the new ice cores from Summit, Greenland. The ice cores reveal the existence of rapid climatic changes both during the last glaciation and the Eemian interglacial. They also indicate that in a warm interglacial, climate may switch between different states as in the last glacial. These results have stimulated the search for other marine and continental Eemian interglacial records. The attempt to understand the underlying mechanisms of rapid changes is considered a critical future task for PAGES.

A recently proposed pilot study, concerning the climate variability of the North Atlantic region and Europe (and America), was proposed as a PAGES initiative. Intended to synthesize and integrate existing data, the study comprises high resolution historic information, tree-ring, ice core and coral proxy records and climate modelling experiments.

A strong interest in PAGES themes and key questions was expressed by representatives of national programmes. These national activities form an important con-

tribution to the PAGES global effort, but they are also important for the assessment of environmental change impact at the local and regional levels.

Concerns

The SSC discussions were very open and engaged. The full spectrum of the interests of PAGES scientists was evident, but concerns were also voiced:

- The modelling requirement for very high resolution records (at the annual, or even seasonal, level) of parameters which can be transferred into physical climate system parameters will be a difficult challenge.
- Disappointment that, because of a lack of absolute chronology, palaeo-environmental information (palaeo-maps) sometimes cannot be considered for comparisons with modelling experiments.

These vivid discussions are an expression of the strong commitment of the SSC members to making PAGES a success. Such discussions are inherent to global change science. Through them, scientists from fields with very different traditions are beginning to find common ground for the advancement of the objectives of the PAGES Project.

Reported by *Hans Oeschger, Chair, Past Global Changes Scientific Steering Committee*

PAGES Data Activities

Both the discussions at PAGES meetings and the text of the PAGES implementation plan (IGBP Report 19) have called for PAGES to build a strong international consensus for the handling of data management issues. In October, 1992, the establishment of the ICSU World Data Center (WDC-A) for Paleoclimatology in Boulder, Colorado, was formally announced. From its beginning the World Data Center was designed to help coordinate the data activities of the IGBP Past Global Change Core Project, and to make sure that palaeo-environmental data activities were on the agenda of IGBP-Data and Information System. It was the beginning of major PAGES/WDC accomplishments during the past year.

All the data are now available on INTERNET. Over 1 GB data has been accessed from more than 20 countries in the first year. However, data is still available for

MEMBERS OF IGBP COMMITTEES

*Short characteristics***Scientific Committee for the IGBP****Officers**

Peter S. Liss (Chair), University of East Anglia, Norwich, UK. Professor at the School of Environmental Sciences. Specialisation in environmental chemistry, with research in ocean/atmosphere chemistry, in particular air-sea gas exchange.

James J. McCarthy (Past-Chair), Harvard University, Cambridge, Massachusetts, USA. Professor of Biological Oceanography, Director of the Museum of Comparative Zoology, Harvard University. Research interests include nutrient cycles in the sea, and processes that regulate marine production.

Jerry M. Melillo (Vice-Chair), Marine Biological Laboratory, Woods Hole, MA, USA. Co-director of The Ecosystems Center; investigator of research projects in boreal, temperate and tropical ecosystems. Research fields include biogeochemistry and ecological modelling.

Robert W. Stewart (Vice-Chair), Victoria, BC, Canada. Professor of Physics and Oceanography. Research interests include physical oceanography, underwater acoustics, turbulence (ocean and atmospheric), boundary layer meteorology, air-sea interaction, and sea-level variation.

Shizuo Tsunogai (Vice-Chair), Hokkaido University, Hakodate, Japan. Professor of Analytical Chemistry, Department of Chemistry, Faculty of Fisheries. Research interests include cycles of chemical substances in the atmosphere, the sea and the sea floor, and biogeochemical studies on the atmosphere-marine system.

Patrick Buat-Ménard (Treasurer), University of Bordeaux, France. Head of the Department of Geology and Oceanography. Research expertise covers the atmospheric cycling of trace metals and particulate carbon; and the marine biogeochemistry of trace metals, natural radionuclides and sulphur compounds.

Members

Inder Pal Abrol, Indian Council of Agricultural Research, New Delhi, India. Deputy Director General (Resource Management). Research interests in soil science, specialist in basic and applied aspects of management of salt affected soils; cropping systems research, soil and water management, agrometeorology, and agroforestry.

John Field (Chair, Scientific Steering Committee, Joint Global Ocean Flux Study) University of Cape Town, Rondebosch, South Africa. Professor at the Zoology Department. Research interests in the functioning of marine ecosystems, roles of physical factors, modelling.

Fu Congbin, Academia Sinica, Beijing, China. Professor of Meteorology, Director of the Climate Research Laboratory at the Institute of Atmospheric Physics. Research in the fields of physical and dynamic climatology, climate change, air-sea interaction and climate-vegetation interaction.

Genady Golubev (Chair, Standing Committee, Global Change System for Analysis, Research and Training), International START Secretariat, Washington DC, USA. Professor of Environmental Sciences, Geography and Hydrology. Research on global environmental problems and water resources assessment and management.

Ann Henderson-Sellers, Macquarie University, Sydney, Australia. Director, Climatic Impacts Centre and Professor of Physical Geography, School of Earth Sciences. Research interests: climatology, numerical modelling and monitoring at a global scale of the atmosphere, hydrosphere, cryosphere, land surfaces and the biosphere.

Patrick Holligan (Chair, Scientific Steering Committee, Land-Ocean Interactions in the Coastal Zone), Plymouth Marine Laboratory, UK. Senior Research Scientist, Natural Environmental Research Council. Research interests in phytoplankton ecology and biogeochemistry, remote sensing of the oceans and biological feedback systems.

Harold K. Jacobson (Chair, Human Dimensions of Global Environmental Change Programme), University of Michigan, USA. Professor of Political Science and Director, Centre for Political Studies, Institute for Social Research. Research on international institutions, especially the national implementation of international environmental accords.

Pavel Kabat (Chair, Scientific Steering Committee, Biospheric Aspects of the Hydrological Cycle), Winand Staring Centre, Wageningen, The Netherlands. Expertise in soil-vegetation-atmosphere relation from patch to regional scales, and soil and ground water hydrology.

Stephan Kempe, Institute for Biogeochemistry and Chemistry of the Oceans, University of Hamburg, Germany. Research interests include the carbonate system of the ocean, carbon cycle in coastal seas, biogeochemistry of rivers, evolution of ocean chemistry and formation of microbialites.

J.W. Maurits la Rivière (Chairman, ICSU Advisory Committee on the Environment), Professor Emeritus of Environmental Microbiology at the University of Delft, Netherlands, and specialist in environmental engineering, biogeochemical cycles, microbial metabolism and ecology, and biological waste treatment and utilization.

Margaret Leinen, Graduate School of Oceanography, University of Rhode Island, USA. Vice-Provost for Marine Programmes; specialist in palaeoceanography, with research in ocean sedimentary records, especially the North Pacific.

Gordon A. McBean (Chair, Joint Scientific Committee for the WCRP), University of British Columbia, Vancouver, BC, Canada. Professor of Atmospheric Science and Head, Department of Oceanography. Research on atmosphere-ocean interaction, role of storms in climate, and oceanic heat and water balances.

Berrien Moore III (Chair, Task Force, Global Analysis, Interpretation and Modelling), University of New Hampshire, USA. Professor of Systems Research at the Institute for the Study of Earth Oceans and Space. Mathematician; with interest in modelling the global carbon cycle and the role of the ocean as a sink for CO₂.

Eric O. Odada, University of Nairobi, Kenya. Senior Lecturer at the College of Biological and Physical Sciences. Department of Geology; leader of the International Decade of East African Lakes (IDEAL) project. Geologist/limnologist, with special interest in African rift lake sediments as palaeorecords.

Hans Oeschger (Chair, Scientific Steering Committee, Past Global Changes), University of Bern, Switzerland. Professor Emeritus, and formerly Head of the Department of Physics of the Climate and Environmental Physics. Earth system science, earth system processes based on studies of isotopes and tracers; studies include radioisotope analyses, and natural system modelling.

W. Richard Peltier, University of Toronto, Ontario, Canada. Professor at the Department of Physics; research in geophysical fluid dynamics on problems involving nonlinear hydrodynamic waves and wave/mean-flow interaction in the atmosphere and oceans, and the dynamics and evolution of the planetary interior and surface, especially mantle convection and palaeoclimatic change.

Ronald G. Prinn (Chair, Scientific Steering Committee, International Global Atmospheric Chemistry Project), Massachusetts Institute of Technology, USA. Professor of Meteorology and Director, MIT Center for Global Change Science. Research interests include the chemistry, dynamics, and physics of the atmospheres of the Earth and other planets, and the chemical evolution of atmospheres.

Osvaldo E. Sala, University of Buenos Aires, Argentina. Professor at the Department of Ecology, Expertise on the links between ecosystem structure/composition and system function, especially vegetation dynamics in arid and semi-arid regions; and carbon budgets of temperate grasslands and their responses to global change.

P. Bernard Tinker, Department of Plant Sciences, University of Oxford, UK. Expertise in soil science, agriculture, and ecology; research on plant nutrition and root function, particularly for tropical crops and trees, with special emphasis on responses of agricultural systems to global change.

John R. Townshend (Chair, Standing Committee, IGBP Data and Information System), University of Maryland, USA. Professor and Chair, Department of Geography, Research in remote sensing data application to Earth science; has pioneered in land cover classification using satellite data.

Brian H. Walker (Chair, Scientific Steering Committee, Global Change and Terrestrial Ecosystems), Chief of the Division of Wildlife and Ecology, Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra, Australia. Ecologist, with wide knowledge in ecosystem dynamics, ecosystem function and biodiversity, with particular expertise in the dynamics of tropical savannas.

George A. Zavarzin, Institute of Microbiology, Academy of Natural Sciences (Academician), Moscow, Russia. Corresponding member of the Russian Academy of Sciences. Microbiologist, specializing in the study of microbial production of methane. His research interests include microbial ecology and geochemistry, land use and microbial biodiversity.

**Scientific Steering Committee
Biospheric Aspects of the
Hydrological Cycle (BAHC)**

Pavel Kabat (Chair) (see SC-IGBP)

Alfred Becker (Vice-Chair), Potsdam Institute for Climate Impact Research, Germany. Interests in hydrological research and modelling at different scales with special emphasis on the drainage basin approach; biospheric aspects of modelling and investigations of the impacts of climate change on hydrology and water resources.

Brad Bass, Climate Adaptation Branch, Atmospheric Environment Service, Toronto, Canada. Experienced in agroclimatic modelling and human geography. Currently supervising the development of risk assessment framework for incorporating climate change scenarios into water resources planning.

Moustafa T. Chahine, Jet Propulsion Laboratory, Pasadena, USA. *Ex-officio* member, representing the Global Energy and Water Cycle Experiment (GEWEX), of the World Climate Research Programme (GEWEX). Chairman of the GEWEX Scientific Steering Group; expertise in all fields related to water and energy cycles around the Earth.

Reinder A. Feddes, Agricultural University Wageningen, The Netherlands. Professor and Chair of Soil Physics, Agrohydrology and Groundwater Management. Experimental and modelling studies on heat and moisture fluxes at the land-surface, and hydrology of the unsaturated and saturated zone from patch to regional scale; remote sensing approaches to modelling of soil-water-vegetation-atmosphere processes.

Christopher Field, Carnegie Institution of Washington, Stanford, CA, USA. Ecologist, with experience in small-scale ecological studies and experiments, large-scale ecological and ecophysiological issues, and development of global ecology.

Paul G. Jarvis, Edinburgh University, UK. Professor at the Institute of Ecology and Resource Management. Ecologist; with experience in soil-vegetation-atmosphere-transfer experimental and modelling studies; whole-plant or ecosystem physiologist. Expertise in the role of forests in regional water balance, and canopy flux studies.

Isamu Kayane, University of Tsukuba, Japan. Professor, Institute of Geoscience. Expertise in hydrological processes, soil and ground water hydrology, and global water balance; research and modelling of land-surface-atmosphere interface processes.

Alexander N. Krenke, Russian Academy of Sciences, Moscow, Russia. Professor at the Institute of Geography. Experienced in land-surface climatology and hydrology research; involvement in the preparation and implementation of large-scale experiments in central Russia.

Carlos A. Nobre, Brazilian Space Research Institute, São José dos Campos, Brazil. Professor, Center for Weather Forecasting and Climate Research. Expertise in field and modelling studies of land-surface climate interactions at larger scales (meso- to macro-scale), especially in tropical regions; climate impact studies with GCMs in particular on the role of tropical deforestation.

Lekan Oyebande, University of Lagos, Nigeria. Professor at the Department of Geography and Planning, Faculty of Environmental Science, Expertise in hydrology and water resources, with special emphasis on its interaction with climate and the biosphere.

Michael R. Raupach, Centre for Environmental Mechanics, CSIRO, Canberra, Australia. Research on modelling planetary boundary layer processes and their interaction with land-surfaces of different type and structure.

Cynthia Rosenzweig, Goddard Institute for Space Studies, NASA, New York, NY, USA. Expertise in modelling land-surface processes at larger scales and application of such models in GCMs; the representation of agricultural crop systems in large scale models, and modelling of the human dimension of global change.

Steven W. Running, University of Montana, Missoula, MT, USA. Professor, School of Forestry. Ecologist, with expertise in large-scale integrated hydroecological models, and modelling of ecological processes in large area models (landscape, river basin, regional and continental scales).

Bernard Saugier, University of Paris, Orsay, France. Professor at the Department of Ecologie Végétale. Plant ecologist, integrating ecology and whole-plant physiology; control of crop water use in relation to growth. Research interests range from the plant to the global scale, addressing water and carbon balances.

E.-Detlef Schulze, University of Bayreuth, Germany. Professor at the Department of Plant Physiology. Ecologist, with a broad understanding of ecophysiology, and contributions to the improved understanding and modelling of ecosystem control of fluxes from vegetation cover to the atmosphere; expertise in water, carbon and nitrogen cycling through ecosystems.

Piers Sellers, National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland, USA. Ex-officio member, representing International Satellite Land Surface Climatology Project (ISLSCP). Chair of ISLSCP Scientific Steering Group. Expertise in modelling energy and water fluxes at the land-surface atmosphere interface, in particular in global circulation models, and the application of satellite data to characterize and quantify land-surface features and exchange processes.

W. James Shuttleworth, University of Arizona, Tucson, USA. Professor at the Department of Hydrology and Water Resources. Expertise in land-surface processes experimentation and modelling on different scales; initiator of experimental campaigns in the tropics, and other large-scale experiments on land-surface atmosphere interaction.

Riccardo Valentini, University of Tuscia, Viterbo, Italy. Professor at the Department of Forest Science and Environment. Specialist in the area of eddy correlation in natural ecosystems and in modelling radiation penetration through forest canopies. Experienced in forest ecological research, in particular in CO₂ flux investigation and modelling terrestrial ecosystems.

Reynaldo Luiz Victoria, University of São Paulo, Piracicaba, São Paulo, Brazil. Professor at the Centro de Energia Nuclear na Agricultura. Experienced in the investigation of water borne material fluxes and of their dependence on land-surface characteristics in hydrological systems, in particular in river systems in humid tropical regions.

Charles J. Vorosmarty, University of New Hampshire, Durham, USA. Research Faculty, Complex Systems Research Center, Institute for the Study of Earth, Oceans and Space. Expertise in large-scale modelling of land-surface processes, with particular reference to biogeochemical cycles; research in the drainage basin approach towards the investigation and solution of global change processes and problems on different scales.

Scientific Steering Committee Global Change and Terrestrial Ecosystems (GCTE)

Brian H. Walker (Chair) (see SC-IGBP)

Harold A. Mooney (Vice-Chair), Department of Biological Sciences, Stanford University, California, USA. Expertise in ecophysiology, with broad knowledge in many other aspects of ecology, particularly biodiversity and its functional significance.

F. Stewart Chapin II, University of California at Berkeley, USA. Professor at the Department of Integrative Biology. Expertise in ecosystem function, experimental work on biological diversity and ecosystem function.

Jan Goudriaan, Wageningen, Netherlands. Professor at the Agricultural University, expertise in crop system modelling, and in the terrestrial carbon cycle.

Yoh Iwasa, Kyushu University, Fukuoka, Japan. Professor at the Department of Biology, Faculty of Science. Theoretical ecologist in modelling the impact of environmental factors on biodiversity.

Sune Linder, Swedish University of Agricultural Sciences, Uppsala, Sweden. Professor of Forest Ecology. Experience in experimental and modelling studies of tree physiology and forest productivity.

Jean-Claude Menaut, Ecole Normale Supérieure, Laboratoire d'Ecologie, Paris, France. Ecologist, with expertise in biogeochemistry and dynamics of savannas, and interest in monitoring change.

Ian Noble, Research School of Biological Sciences, Australian National University, Canberra, Australia. Expertise in ecosystem dynamics modelling, with an interest in landscape processes and in human-driven change to ecosystem structure.

William J. Parton, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, USA. Ecophysiological modelling, particularly in the development of a model for nutrient dynamics; global ecosystem models.

P. S. Ramakrishnan, School of Environmental Sciences, Jawaharlal Nehru University, India. Multidisciplinary interests linking ecology with social sciences. Research on the relationship between human-driven change to ecosystem composition and the resulting impacts on ecosystem function.

Oswaldo E. Sala (see SC-IGBP)

Robert J. Scholes, Council for Scientific and Industrial Research, Division of Forest Science and Technology, Pretoria, South Africa. Research experience in experimental and modelling aspects of biogeochemistry, especially in tropical savannas, forests and grasslands.

E.-Detlef Schulze, University of Bayreuth, Germany. Professor at the Department of Plant Physiology. Ecologist, with a broad understanding of ecophysiology, and contributions to understanding and modelling of ecosystem control of fluxes from vegetation cover to the atmosphere; expertise in water, carbon and nitrogen cycling through ecosystems.

Herman H. Shugart, Department of Environmental Sciences, University of Virginia, Charlottesville, USA. Expertise in ecosystem dynamics modelling, from patch to global scales; development of forest gap-phase succession models.

Mike J. Swift, Tropical Soil Biology and Fertility Programme, UNESCO Regional Office for Science and Technology for Africa, Nairobi, Kenya. Research in soil biology, tropical agriculture and multi-species agroecosystems.

Paul S. Teng, International Rice Research Institute, Manila, Philippines. Expertise in insect and pest distribution and dynamics, with an emphasis on linkage of pest and crop models.

P. Bernard Tinker (see SC-IGBP)

Ian Woodward, University of Sheffield, UK. Professor at the Department of Animal & Plant Sciences. Expertise in both ecophysiology and global ecosystems modelling; mechanistically based global vegetation redistribution models; and linkages of vegetation models to GCMs.

Zhang Xin-shi, Chinese Academy of Sciences, Beijing, China. Director of the Laboratory of Quantitative Vegetation Ecology, Institute of Botany. Plant and ecosystem ecologist, with broad knowledge of east Asian vegetation distribution and dynamics.

Scientific Steering Committee International Global Atmospheric Chemistry Project (IGAC)

Ronald G. Prinn (Chair) (see SC-IGBP)

Paul J. Crutzen (Vice-Chair), Max Planck Institute for Chemistry, Mainz, Germany. Main research interest is atmospheric chemistry and its role in biogeochemical cycles and climate, especially work on the role of NO_x in chemistry of the stratosphere, and on modelling of atmospheric photochemical processes.

Hajime Akimoto, Research Center for Advanced Science and Technology, University of Tokyo, Japan. Research interests include atmospheric chemistry of reactive species, particularly photochemical reaction mechanism in the troposphere and related atmospheric measurements.

Guy P. Brasseur, National Center for Atmospheric Research, Atmospheric Chemistry Division, Boulder, Colorado, USA. Expertise in modelling of atmospheric photochemical processes, with emphasis on application of General Circulation Models to prediction of future atmospheric composition.

Ralf Conrad, Max-Planck Institute for Terrestrial Microbiology, Marburg, Germany. Director, Department of Biogeochemistry Research interests focus on the microbiology and biogeochemistry of atmospheric trace gases, and on the microbial ecology of paddy soil.

Robert J. Delmas, Laboratory of Glaciology and Geophysics of the Environment, St Martin d'Hères, France. Expertise in the chemistry of glacial ice and polar sheets; with emphasis on the atmospheric chemistry of polar regions.

Dieter H. Ehhalt, Institute for Atmospheric Chemistry, Jülich, Germany. Theoretical and experimental research in atmospheric chemistry: stratospheric distributions of long-lived trace gases and their consequence on stratospheric ozone; isotope geochemistry.

Ian E. Galbally, Division of Atmospheric Research, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Mordialloc, Victoria, Australia. Expertise in the measurement of trace gas fluxes between the atmosphere and terrestrial ecosystems, especially N gases.

Barry J. Huebert, University of Hawaii, Honolulu, USA. Professor at the Department of Oceanography. Research interests focus on the development of methods for measuring fluxes of materials between regions of the atmosphere, including air-sea exchange processes and marine atmospheric chemistry.

Valerii A. Isidorov, University of Saint Petersburg, Russia. Professor at the Department of Chemistry. Expertise in organic atmospheric chemistry, and ecological chemistry.

Patricia A. Matrai, Division of Marine and Atmospheric Chemistry, Rosentiel School of Marine and Atmospheric Science, University of Miami, Florida, USA. Biological oceanographer, specialised in marine phytoplankton biology and biochemistry, and their role in key global biogeochemical cycles.

Pamela A. Matson, Department of Environmental Science, Policy and Management, University of California, Berkeley, USA. Research on the effects of natural and anthropogenic disturbances on biogeochemical cycling and trace gas exchange in tropical ecosystems.

Heinz-Ulrich Neue, Division of Soil and Water Sciences, International Rice Research Institute, Manila, Philippines. Research has focused on biogeochemistry of wetland soils, plant nutrition, soil stress tolerance of rice, organic matter dynamics in tropical wetlands, and trace gas emissions from rice fields.

Nicholas J. P. Owens, University of Newcastle, UK. Professor at the Department of Marine Sciences. Expertise in nitrogen cycling processes in diverse marine ecosystems. Research is focused on production and consumption of bio-gases (methane and nitrous oxide) in the sea.

Stuart A. Penkett, School of Environmental Sciences, University of East Anglia, Norwich, UK. Researcher into chemical processes in the atmosphere; present research with the quantification of processes leading to ozone production and destruction in the background troposphere, and chemical phenomena in the real atmosphere.

Henning Rodhe, Department of Meteorology, Stockholm University, Stockholm, Sweden. Main research interests are the atmospheric parts of the biogeochemical cycles of sulphur, nitrogen and carbon, including the environmental effects of the anthropogenic perturbations of these cycles: acidification, eutrophication and climate change.

Eugenio Sanhueza, Venezuelan Institute of Scientific Research (IVIC), Caracas, Venezuela. Present main interest is the study of the atmospheric chemistry and biogeochemical cycles in tropical ecosystems.

Wang Ming-xing, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China. Research results in atmospheric aerosols, acid rain, and climate changes due to the increase of atmospheric trace gases.

Scientific Steering Committee Joint Global Ocean Flux Study (JGOFS)

John G. Field (Chair) (see SC-IGBP)

Otis Brown, University of Miami, Florida, USA. Professor and Associate Dean for Research, Rosentiel School of Marine Science. Research interests in radiative transfer in the ocean-atmosphere system for visible light; particle scattering of light in seawater; satellite infrared observations of sea surface temperature in the Atlantic and Indian Oceans.

Peter Burkill, Research Scientist, Plymouth Marine Laboratory, Plymouth, UK. Expertise in upper ocean microbial biogeochemistry of polar, temperate and tropical systems; flow cytometry and molecular ecology.

Chen-Tung Arthur Chen, National Sun Yat-Sen University, Kaohsiung, Taiwan, China. Professor, Institute of Marine Geology. Research fields include chemical oceanography, chemical limnology and sediment geochemistry.

Steven Emerson, University of Washington, Seattle, USA. Professor of Oceanography. Specialization in marine chemistry with emphases on: oxygen mass balance in the surface ocean, carbon respiration and calcium carbonate dissolution in deep sea sediments, and palaeoceanographic tracers of the extent of ocean oxia.

Julie Hall, National Institute for Water Research, Hamilton, New Zealand. Co-programme coordinator, West Coast Ecosystems Programme. Specialization in microbial foodweb dynamics and grazing relationships.

Nobuhiko Handa, Water Research Institute, Nagoya University, Japan. Professor, Institute for Hydropheric-Atmospheric Sciences, specialization in organic geochemistry, research in ocean chemistry, particulate fluxes of organic matter.

S. Krishnaswami, Physical Research Laboratory, Ahmedabad, India. Professor, Earth Sciences Division. Specialization in geochemistry with research in the fields of weathering and transport; scavenging processes in the ocean, and sedimentary records.

Alexander P. Lisitzin, Academician at the Academy of Sciences, Moscow, Russia. Professor of Geology, P.P. Shirsov Institute of Oceanology. Background in geology, with specialization in marine suspended matter, marine geology, sedimentary flux, hydrothermal processes, biogeochemistry.

Liliane Merlivat, Université Pierre et Marie Curie, Paris, France. Director, Laboratory of Dynamic Oceanography and Climatology. Research fields include air-sea gas exchange with emphasis on the distribution of carbon dioxide exchanges at the ocean surface.

Robert M. Moore, Dalhousie University, Halifax, Nova Scotia, Canada. Professor of Chemical Oceanography, Acting Chairman, Department of Oceanography. Research interests include marine production of volatile organohalogenes and their ocean-atmosphere fluxes; Arctic oceanography, air-sea interaction.

John Parslow, Division of Fisheries, Commonwealth Scientific and Industrial Research Organization (CSIRO), Hobart, Tasmania, Australia. Research interests include remote sensing of ocean colour, marine ecosystem models, and phytoplankton ecophysiology.

Trevor Platt (Past Chair), Biological Oceanography, Biological Sciences Branch, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada. Research on marine production processes, especially the factors controlling photosynthesis and its synoptic measurement by remote sensing.

Egil Sakshaug, University of Trondheim and Trondheim Biological Station, Norway. Professor of Marine Botany. Specialization in marine phytoplankton ecology and ocean carbon flux, experimentation and modelling of photobiological aspects.

Victor Smetacek, University of Bremen, Germany. Professor of Biological Oceanography, and Head, Biology II Section, Alfred Wegener Institute. Specialization in plankton ecology and biogeochemical cycles in relation to the physical environment.

Jürgen Willebrand, University of Kiel, Germany. Professor of Physical Oceanography, Institute for Oceanography. Research interests in ocean circulation dynamics and ocean climate interactions.

Scientific Steering Committee Land-Ocean Interactions in the Coastal Zone (LOICZ)

Patrick Hoffigan (Chair) (see SC-IGBP)

Edgardo D. Gomez, Marine Science Institute, University of the Philippines, Quezon City. Professor of Marine Biology and Director of the Marine Science Institute. Research interests include coral reef ecology, coastal zone management, and invertebrate mariculture.

Viatcheslav V. Gordeev, Institute of Oceanology, Russian Academy of Sciences, Moscow. Senior research scientist, specialisation in estuarine and marine geochemistry, including chemistry of hydrothermal fluids and plumes.

Donald C. Gordon Jr., Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada. Research interests include: cycling of organic matter in marine and coastal ecosystems, ecosystem modelling and environmental impact assessment.

Stephan Kempe (see SC-IGBP)

Liu Ruiyu, Institute of Oceanology, Qingdao, China. Research Professor in Marine Biology. Research interests are on benthic ecology, structure and function of coastal ecosystems, responses of biodiversity to environmental changes, and anthropogenic influence on the ecosystem and living resources in coastal zones and estuaries.

John D. Milliman, College of William and Mary, Gloucester Point, Virginia, USA. Dean of Graduate Studies and Professor, School of Marine Sciences. Research areas include river sediment flux and fate to the sea, calcium carbonate deposition in neritic environments, and the causes and effects of sea-level change.

Henrik Postma, Netherlands Institute for Sea Research, Texel, The Netherlands. Research interests include chemical oceanography and integrated coastal science (biogeochemistry and ecology).

Jeffrey E. Richey, University of Washington, School of Oceanography, Seattle, USA. Specialisation in river basin biogeochemistry, hydrology and geochemical tracers and modelling of river systems, including particular application to the Amazon river basin.

Andrew Solow, Marine Policy Center, Woods Hole Oceanographic Institute, Woods Hole, Massachusetts, USA. Specialisation in environmental statistics, including time series analysis, spatial statistics, Bayesian methods, statistical biology and ecology.

Colin Woodroffe, University of Wollongong, Australia. Senior Lecturer in the Department of Geography, with research interests in the geomorphology and ecology of tropical coasts, sea-level change and island ecosystems.

Tetsuo Yanagi, Ehime University, Matsuyama, Japan. Professor of Coastal Oceanography, at the Department of Civil and Ocean Engineering, Faculty of Engineering. Research fields are material transport in the coastal sea and numerical modelling of ecological systems.

Scientific Steering Committee Past Global Changes (PAGES)

Hans Oeschger (Chair) (see SC-IGBP)

Björn Berglund, Lund University, Sweden. Professor at the Department of Quaternary Geology. Expertise in palaeoecology, especially vegetation history since the last glaciation in Scandinavia.

Raymond S. Bradley, University of Massachusetts, Amherst, USA. Professor at the Department of Geology and Geography. Expertise in climate variability and palaeoclimatology, especially of the last two thousand years.

Jean-Claude Duplessy, National Centre for Scientific Research, Gif-sur-Yvette, France. Director of the Centre des Faibles Radioactivités and Director of Research. Scientific expertise in paleo research, and ocean processes.

Burkhard Frenzel, Hohenheim University, Stuttgart, Germany. Professor at the Institute of Botany. Specialised in palaeoecology, palaeoclimatology and quaternary stratigraphy.

Jean Jouzel, Centre for Nuclear Studies, Gif-sur-Yvette, France. Associate Director of the Laboratory for Climate Modelling, and Associate Director of the Laboratory for Glaciology and Geophysics of the Environment, St Martin d'Hères, France. Research emphasis on various aspects of the water isotope atmospheric cycles, and palaeoclimate reconstruction from the analysis of water isotopes in ice cores.

Liu Tungsheng, Academia Sinica, Beijing, China. Professor at the Institute of Geology, with expertise in quaternary geology, environmental geology. Research on the past palaeoenvironmental changes in Northern China, Qinghai-Xizang Plateau, and Antarctica.

Claude Lorius, Saint Martin d'Hères, France. Associate Director, Laboratory for Glaciology and Geophysics of the Environment, and President of the French Institute for Polar Research and Technology. Past global changes from polar ice cores; climate and atmospheric environment on long term and century time scales, and mass balance of the Antarctic ice sheet.

Willem G. Mook, Netherlands Institute for Sea Research, Texel, The Netherlands, and Professor at the University of Groningen. Research interests include natural isotope abundances, radiometric dating, isotopes in the global water cycle.

Eric O. Odada (see SC-IGBP)

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Robert Wasson, Division of Water Resources, Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra, Australia. Geomorphologist; Quaternary environmental history with particular emphasis on deserts; impact of land use on fluvial systems since the beginning of agriculture.

Task Force on Global Analysis, Interpretation and Modelling (GAIM)

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Ian Woodward, University of Sheffield, UK. Professor at the Department of Animal & Plant Sciences. Expertise in both ecophysiology and global ecosystems modelling; has developed mechanistically based global vegetation redistribution models; work on linkages of vegetation models to GCMs.

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Standing Committee

Data and Information Systems (DIS)

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John S. MacDonald, MacDonald Dettwiler and Associates (President), Richmond, British Columbia, Canada. Expertise in large data systems development, supervised installations of several satellite receive stations spread around the world.

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Standing Committee

System for Analysis, Research and Training (START)

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M. Filomena F. Campos, National Research Council of the Philippines, Manila, The Philippines. Chairperson, SARCS. Areas of research expertise: biodiversity, women in science and technology, indigenous science in agriculture.

Jean-Pierre Contzen, Commission of European Communities, Brussels, Belgium. Director General of the Joint Research Centre. Responsible for the EC programmes in the field of environment; and for the coordination of EC space activities. Scientific interests in global change research and Earth observation.

Robert W. Corell, Assistant Director of the National Science Foundation, Washington, DC, USA. Directorate Geosciences, with responsibility for U.S. research programmes in the atmospheric and ocean sciences. Background in ocean engineering.

Workneh Degefu, Regional Director of the World Meteorological Organization Office for Africa, Bujumbura, Burundi. Field of expertise includes the organization and management of meteorological and hydrological services. Research interests cover cloud physics, and meteorological drought.

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Zhao Shidong, Commission for Integrated Survey of Natural Resources, Chinese Academy of Sciences, Shenyang, China. Research Professor of Applied Ecology. Research fields include structure, function and dynamics of forest ecosystems, responses of forest ecosystems to climate change and biodiversity.

Core Project Planning Committee Land-Use/Land Cover Change (LUCC)

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David L. Skole (Co-Chair), University of New Hampshire, Durham, USA. Professor of Natural Resources, Institute for the Study of Earth, Oceans & Space. Expertise in computer sciences, with research interest in applying satellite data to questions regarding carbon cycle; using GIS technology to monitor large scale deforestation.

Günther Fischer, International Institute for Applied System Analysis, Laxenburg, Austria. Expertise in modelling of world food systems; research to develop a GIS-based dynamic modelling framework, combining general equilibrium theory, welfare economics and stochastic optimization.

Louise O. Fresco, Wageningen Agricultural University, The Netherlands. Professor, Department of Agronomy. Research interests in the development of ecological models at the plot and landscape level, integrating crop growth, water and nutrient flows and cultivation practices, and the classification and analysis of land-use systems.

Dean Graetz, Commonwealth Scientific and Industrial and Research Organization, Lyneham, Australia; Leader of the Global Climate Change Project of the Division of Wildlife and Ecology, Landscape ecologist, focusing on the assessment and monitoring of arid ecosystems using ground and satellite measurements, as applied to long-term changes in rangeland soils and vegetation and in drought monitoring at regional and continental scales.

Teitaro Kitamura, Kyoto University, Japan. Professor of Regional Planning, Division of Tropical Agriculture. Research interests in land-use classification and planning; regional planning in tropical areas, particularly Southeast Asia; links between global environmental issues and rural and regional planning.

Rik Leemans, Global Change Department, National Institute Public Health and Environment, Bilthoven, The Netherlands. Research interests in modelling of vegetation and land cover dynamics, broad-scale vegetation patterns and their interactions with environmental variables, especially climate; large-scale ecological databases and geographical information systems.

Liu Yanhua, Chinese Academy of Sciences, Beijing, China. Professor of Geography and Head of the Physical Science Division, Institute of Geography. Research on rural policy and programme formation, regional planning at a national level; development of remote sensing and GIS to monitor land cover and environmental assessment.

Luiz Martinelli, University of São Paulo, Piracicaba, Brazil. Professor at the Centre for Nuclear Energy and Agriculture. Research in environmental studies, particularly water and carbon cycles and how land use changes in the Amazon basin have affected these cycles.

Elena Milanova, Moscow State University, Moscow, Russia. Professor, Faculty of Geography. Research focus on the use of the landscape approach to land suitability assessment, land-use planning, and scale-dependent landscape mapping.

H.W.O. Okoth-Ogendo, University of Nairobi, Kenya. Professor of Public Law, Faculty of Law. Research interests cover agrarian law and institutions, environmental law and policy, population and reproductive rights, and land use and water management.

Martin Parry, University of Oxford, Oxford, UK. Professor and Director of the Environmental Change Unit. Research interests in global change and agriculture, climate change and its environmental implications. (New position as of March 94: Professor, Department of Geography, University College, London)

Steven Sanderson, University of Florida, Gainesville, USA. Professor of Political Science and Director of the Tropical Conservation and Development Programme for Latin American Studies. Research interests include the impact of international trade on agricultural land use, rural incomes policies, domestic food policies, and conversion of natural cover to human use.

installation on computers: PCs, Macs and machines on magnetic media. The data holdings have been doubled with the addition of several major new data sets. A new development is PaleoVu, a data browse and visualization software tool, which is now running in test form on PCs.

The WDC-Assembled boundary condition data for use by the Palaeoclimate Modelling Intercomparison Project. It has begun palaeo-vegetation model-data comparison effort with the IGBP Projects on Global Change and Terrestrial Ecosystems, the IGBP-Data and Information System, and the Global Analysis, Interpretation and Modelling Task Force. To further advance data strategies and management, PAGES has sponsored or arranged data workshops aimed at organizing specific types of palaeo-environmental data.

Global Palaeo-environmental Data

An international PAGES workshop on Global Palaeo-environmental Data was convened by Jonathan Overpeck and Jonathan Pilcher in Bern, Switzerland, from 23 to 25 August.

More than 35 palaeo-environmental data experts, from 10 different countries, represented many of the major data producing and managing efforts around the world. Results of the workshop were:

- a draft "PAGES Data Management Guide" that includes 1) protocols for PAGES data management and sharing (what should be shared, how should it be shared, etc.) and 2) specific guidelines for the submission of various types of data,
- updating of the international palaeo-environmental community on PAGES' data management progress (e.g., what efforts are taking place, what are planned, and how these efforts might be coordinated),
- improving the technical goals of the PAGES data management strategy (how do we best manage both raw data and information derived from the raw data - especially reconstructions? better coordination, designing more useful data products, etc.),
- identifying key data sets that must be included in the PAGES data base
- identifying data sets that need to be accessible to PAGES scientists, but that may reside in other IGBP or global change databases (e.g., instrumental meteorological data for proxy calibration efforts), and
- devising strategies and incentives for maximizing the participation of scientists in the PAGES data sharing endeavour.

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Ice Core Data Bank

Ice core research has made important contributions to our understanding of global climatic changes. A recent result from the PAGES Greenland Ice Core Project shows dramatic and very rapid temperature changes occurring during the previous (Eemian) interglacial period, findings which have far-reaching implications for global change research.

The PAGES ice core scientific community met in Bern, immediately following the palaeo-environmental data workshop on the 26th and 27th August, to discuss the formation of a data bank for ice core research. The group recommended the establishment of the Ice Core Data Bank (ICDB), at the World Data Center-A for Paleoclimatology, and encourages all scientists working in the field to contribute their data to it. The group drafted a set of guidelines for data submission, and made recommendations as guiding principles for the ICDB. Recommendations are:

- i) A single data centre, the World Data Center-A for Palaeoclimatology, is identified as the initial contact point for palaeoclimate data from ice-cores. Glaciological data from surface collections and shallow cores, as well as possibly some deep cores, should also be submitted to the World Data Center-A Glaciology. A hierarchy of data types is suggested: published, ancillary, and unpublished.
- ii) Ice core researchers should submit all published data to the Ice Core Data Bank. Researchers are also encouraged to submit unpublished and ancillary data if such is of good quality, and would not otherwise be available.

Researchers should make every effort in the scientific community to ensure that data is contributed to the bank, and that it is consulted. The Data Advisory Panel of PAGES should be used to help solve any problems with the data centres.

Ice core researchers are encouraged to update archived data (e.g. new age models, additions to existing records).

iii) Data centres should also interact with journals to encourage submission of data. The data centre should actively advertise for and recruit data, and ensure its consultation.

The group felt that easy access to the data was the most crucial factor. To encourage easy access, file access and release should be via the Internet Anonymous FTP access.

The data centres should inform data submitters of the existence of appropriate, alternative data centres for parallel submission of data (e.g., WDC-A Glaciology).

Comments submitted with the data are essential and should be incorporated into the presentation seen by those consulting the data. How to cite the data, comments on quality and potential pitfalls, and contact person in the event of questions should be included.

Data already published in tables should be incorporated in the data base.

iv) PAGES should help spread the word to all institutions collecting data about the existence of an Ice Core Data Bank. Where necessary, PAGES should help to persuade administrators that data should be released.

PAGES should actively support and encourage inter-laboratory calibrations to ensure high data quality and inter-compatibility.

PAGES is requested to act as an impartial clearing house for questions concerning the ICDB. These can be passed along to the world data centres or to appropriate funding and scientific organizations.

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New PAGES Associate Director in Bern

Suzanne A. G. Leroy became Associate Director of the PAGES Core Project Office (PAGES CPO) in Bern, Switzerland, on 1 November, 1993.

Dr. Leroy was research scientist at the Department of Palaeotology and Palaeogeography, Catholic University of Louvain in Belgium, where she received her doctorate in 1990, specializing in palynology. She has worked on both lacustrine and marine sediments. Her recent professional interests focus on the non-astronomical forcing of abrupt climate change, and the human dimensions of our changing environment.



Suzanne
Leroy

The Weather Generator Project

Data Requirements for Ecological and Hydrological Studies

The working group on the Weather Generator Project [Focus 4 of the Biospheric Aspects of the Hydrological Cycle (BAHC) project] met in September in Bratislava, Slovakia. The working group is concerned with identifying and evaluating the techniques that could be used to downscale current global and synoptic scale climate and weather data to temporal and spatial resolutions that are suitable for the user communities in hydrology, ecology and the related management disciplines of agriculture, forestry and water resources. The workshop addressed the following five questions:

1. What are the current sources of large-scale climate and weather data that could be downscaled?
2. What downscaling techniques are currently available?
3. What are the data requirements of hydrological and ecological models?
4. In what form can the uncertainties associated with downscaled climate information be presented for modellers and other user groups?
5. Can a standard set of weather data be developed for selected spatial and temporal resolutions to serve as inputs for evaluating ecological and hydrological models?

The working group standardized the data requirements of the ecological, hydrological and related user communities, including the specification of desired spatial resolution, temporal resolution, and uncertainty. In addition, the sensitivity of ecological, agricultural and hydrological models to each input have been identified. The assembled tables provide a reference set of variables for research groups working on downscaling methods. Finally, the participants in the workshop agreed on definition of uncertainty as well as a format for presenting data to users.

The full report is available from the BAHC Core Project Office. (In addition to the results of the discussions, it includes tables, appendices and definitions.)

Report Summary

There are several data sources available at a variety of scales that could be further downscaled to the spatial and temporal

scales required for hydrology, ecology and related management decisions in water resources and agriculture. For studies concerned with climate change, the most popular sources are the general circulation models (GCMs). These provide information for a range of variables for an equilibrium climate on a grid, typically on the order of 300 km linear resolution. In addition there are a limited number of transient (an atmospheric GCM coupled to an ocean GCM) and time-dependent (gradual increase in the levels of greenhouse gases) simulations available.

Although GCMs are run with short time steps, commonly thirty minutes, the most reliable spatial scales are continental to global and the most reliable temporal scale is seasonal. These spatial and temporal resolutions are far too crude for most applications, which typically use information within the range of mesoscale events (kilometres to tens of kilometres). Therefore, for applications in ecology, hydrology and related disciplines, the GCM output must be spatially disaggregated (downscaled) and interpolated to an appropriate resolution. In addition it is necessary to include a temporal component along with the spatial disaggregation in order to better match the space-time behaviour of weather.

Other large scale information for climate change can be derived from palaeoclimatic sources and analogues. Palaeoclimatic information is derived from proxy variables such as tree rings, ice cores and pollen sediments. These data are useful in providing qualitative guidelines for historical scenarios. However, palaeoclimatic methods alone cannot provide global, let alone regional, information suitable for ecological and hydrological modelling at a specified space-time resolution.

Historical climate data can be used to derive analogues by creating ensembles of variables for anomalously warm years. These analogues are used to derive site specific or regional values. They are primarily used for temperature and precipitation at the surface, as well as circulation patterns at a height of 500 or 700 mb. Spatial analogues use monthly means to identify one region's current climate with the perturbed GCM climate for another selected region. For example, under a cli-

mate change the scenario, the monthly temperatures in the southwestern region of the Canadian province of Ontario may be similar to those for the state of Kansas in the United States under current climatic conditions. The daily temperature record for Kansas would be used to construct a climate scenario for southwestern Ontario. This approach is most suitable for temperature, but may be of limited value for discontinuous fields such as precipitation.

It is also possible to assemble climate data sets from different sources such as radar, conventional observations, satellite data and numerical weather models. For example, the Global Precipitation Climatology Project (GPCP) of the World Climate Research Programme provides gridded monthly precipitation covering the entire globe at a spatial resolution of 2.5° latitude and longitude or approximately 265 km linear resolution. This data set is derived from rain gauge measurements, satellite data and numerical weather forecasts. The GPCP is developing a future data base at a spatial resolution of 1.0° latitude and longitude. Operational synoptic forecast models provide information at a temporal resolution of less than one day and a spatial resolution between 100 - 200 km. Mesoscale forecast models, using the same atmospheric physics but including land-surface information, can further reduce this resolution to 50 km.

There are three main approaches available for downscaling global, synoptic and other coarse-scale data to specific areas or sites. These approaches, referred to in the BAHC Operational Plan (IGBP Report 27, 1993), can be classified as either (i) empirical, (ii) semi-empirical, or (iii) dynamic. Empirical approaches are based on linear relationships between surface observations at different scales. Semi-empirical approaches link surface observations to variables in the free atmosphere. Dynamic approaches integrate larger-scale models (such as GCMs) or observations with mesoscale processes and surface parameterization schemes.

Future Workshops and Research Activities

The major objective of the Weather Generator Project is to meet the data requirements of the ecological, hydrological and

related user communities. The Weather Generator working group has standardized these data requirements, including the specification of the desired spatial resolution, temporal resolution, and uncertainty. In addition, the sensitivity of ecological, agricultural and hydrological models to each input has been identified providing an indication as to the importance of uncertainty for each input in different applications. Assembled tables provide a reference set of variables for research groups working on downscaling methods to produce inputs for ecological or hydrological studies. Finally, the participants in the workshop agreed upon definition of uncertainty as well as a format for presenting data to the users.

A workshop on the evaluation of downscaling methods will be held in 1994. The evaluation of different methods will be based on how they will meet the data requirement identified at the Bratislava meeting. A broad range of participants, representing different approaches to downscaling, will be invited to give presentations. This workshop is planned in conjunction with the UNESCO International Symposium on Water Resources Planning in a Changing World, to be held in Karlsruhe, Germany, 28-30 June, 1994.

The third Task of the weather generator component is also concerned with physical relationship between precipitation, latent heat and sensible heat fluxes at a resolution of the GCM grid cell and the observed fluxes at the subgrid scale. A diagnostic model has been developed to recover the subgrid scale, nonaveraged fluxes from the averaged quantities at the synoptic scale. The diagnostic model has been used to examine precipitation events of long duration over Europe. The next aspect of this task will involve an analysis of dry events over the same area. It is believed that this physical description of downscaling can be used together with other data sources to improve the weather generator in sparsely monitored regions. Some of these data sources could include satellite and radar imagery. Representatives of these communities will be invited to meet with representatives of BAHC to begin discussions on how to better use these data sources in the development of the Weather Generator Project, as part of 1994 workshop.

There are two parallel programmes that have been proposed in conjunction with the 1994 BAHC workshop. The Water Resources section of the Canadian Atmospheric Environment Service (AES) is conducting a two-year evaluation programme of several downscaling methods for incor-



The Weather Generator Working Group in Bratislava, Slovakia, in September 1993

porating climate change scenarios into water resources planning. The first workshop is scheduled to be held in Waterloo, Ontario, February 20-22, 1994 in conjunction with the Institute for Risk Research and BAHC. In addition, case studies for sites in Canada, central Europe and possibly elsewhere will be developed to compare the semi-empirical approach to down-

scaling and the dynamic approach. The semi-empirical approach will use GCM output to describe changes in the frequency of circulation patterns that will be linked to surface precipitation. The dynamic approach will use the GCM output for several heights (s-levels) of the atmosphere and a land-surface scheme to drive a mesoscale model.

Ecology, Agriculture and Forestry

Requirements for the Weather Generator Project

The research needs for ecology, hydrology and other related user groups can be subsumed under the two categories: (i) the interaction of the terrestrial biosphere with the hydrologic cycle and the climate and (ii) the effect of climatic variation and change on the various systems of concern.

There are many research questions in ecology, agriculture and forestry that require improved climatic data. Within BAHC, simulation models are used to examine the soil-vegetation-atmosphere interface. In agriculture several types of models are used to simulate the response of crop yield to climate and different management strategies. Simulation models in forestry are used to investigate questions related to distribution, watershed characteristics and physiology. Although some degree of overlap is inevitable, there are questions that are unique to each user group.

In ecology some of the important questions include the extrapolation of patch-scale models to larger spatial and temporal scales, and assessing the impact of higher levels of atmospheric CO₂ and climate change on ecosystem processes. In agriculture the important questions include the direct and indirect effects of higher levels of atmospheric CO₂ and climate change on crop yield. In addition it is important to incorporate laboratory research on the direct effects of CO₂ on crop physiology, individual organs, and individual plants into crop models. In forestry the major research questions include the impacts of climate change on the areal distribution of natural forests, the impacts of climate change at the local scale, changes in the probability of forest fires, and the impacts of climate change on the hydrological characteristics of a watershed.

Agricultural, forest and other ecological systems have to cope with variability in environmental conditions. A considerable proportion, perhaps 70%, of the spatial and temporal variability in crop production is directly related to meteorological variability. The likelihood is that climatic change will exacerbate the risks to ecosystems by increasing the variability of the global climate system. In addition, ecological systems generally exhibit non-linear responses to environmental driving variables. Consequently, the impacts of climate change cannot be assessed solely on the basis of mean changes in climate; estimates of the spatial and temporal variability of climatic parameters, and the magnitude and frequency of extreme events may be of greater consequence for impact studies. Clearly, the degree of non-linearity of any response may differ between ecosystems and needs to be accounted for in determining meteorological data requirements.

Extracted from the Weather Generator Report

The complete Weather Generator Project Report is available from: Ephrat Lahmer-Naim, BAHC Core Project Office, Institut für Meteorologie, Freie Universität Berlin, Carl-Heinrich-Becker Weg 6-10, D-12165 Berlin, Germany. Tel: (+49-30) 838 711 84, Fax: (+49-30) 838 711 85, Internet: bahc@fub46.zedat.fu-berlin.de

START in Temperate East Asia

The development of a network of Regional Research Centres for global change research is advancing rapidly, and the areas participating in the Global Change System for Analysis, Research and Training (START) initiative now spread around the globe. The first region to found its Secretariat and Scientific Advisory Panel was Southeast Asia; Regional Secretariats have also been established for Northern Africa (Accra, Ghana), Southern, Central and Eastern Africa (Lilongwe, Malawi), Mediterranean (Toulouse, France) and Temperate East Asia (Beijing, China).

Other activities collaborating closely with START forge ahead - the Inter-American Institute for Global Change Research (IAI), initiated by the US, now has its Secretariat in Washington. The Commission of European Communities has launched the European Network for Research on Global Change (ENRICH); and in Japan in January 1994 a second regional meeting will be held to discuss an Asia-Pacific Network (APN).

To further spread the START initiative to the vast areas of Asia, the first planning meeting for a START Regional Research Network in Temperate East Asia (TEA) was convened in Beijing, China, in August 25-27, 1993, under the sponsorship of the Chinese Academy of Sciences. Delegates from each country of the region, China, Japan, Korea (RO and DPR), Mongolia and the Russian Federation attended the meeting. Representatives of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the Commission of European Communities attended as observers.

The importance of Temperate East Asia in the study of global change

Temperate East Asia, due to its unique geographical and socio-economic conditions, constitutes one of the most sensitive regions in relation to the global climate and environmental changes, with a high rate of change and strong signals. Enhancing the study of global change in this region is crucial for global understanding.

This region, one of the most densely populated areas of the Earth, has to feed nearly one third of the world's population. The impact of global change on the sustainable development of this region is crucial for a stable world.



Delegates in Beijing in August to plan the START Committee for Temperate East Asia. Ye Dusheng, Shikon Takei and Fu Congbin

Scientific Themes

The initial scientific themes for a regional research network for the region should address:

- (1) Impact of global change on the sustainable development of the region, focusing on the water resources, agriculture and coastal zone
- (2) Regional issues of global significance
 - Role of monsoon-driven ecosystems and other major ecosystems of the region in the global biogeochemical and hydrological cycles and their effects on climate
 - Sources and sinks of biogenic greenhouse gases, with emphasis on methane from rice paddy areas and cattle
 - Changing land use/land cover patterns due to human activities, such as deforestation and desertification
 - Land-ocean interactions in the coastal area
 - Past global environmental change, with particular reference to relations of climate and land-cover change.

The meeting recommended:

- (1) To establish a RRN for TEA as soon as possible;
- (2) To set up a Temperate East Asian Planning Committee for START (TEACOM) to guide the implementation, consisting of representatives from China (Beijing), Japan, Korea (DPR and RO), Mongolia and Russia (the Siberian and Far-Eastern Branch of the Russian Academy of Sciences), with a representative from the Academy of Sciences in Taipei (China). An Interim Secretariat for TEACOM

will be established by the Chinese Academy of Sciences in Beijing.

(3) The first meeting of TEACOM would be in January 1994 in Tokyo, with a second meeting in August 1994 in Ulaanbaator, Mongolia.

(4) The immediate tasks of TEACOM would include development of a work plan, an inventory of key institutions and scientists in the region involved in global change research, and organization of initial training activities. The work plan will be ready by the summer of 1994.

(5) The meeting resolved to request UNESCO's cooperation in education and training in the various fields of global research study and that relate to UNESCO's goals, such as the establishment and maintenance of data management information systems, modelling, exchange programmes among researchers and professional staff of relevant national institutions, data sharing and exchange, etc.

China expressed its willingness to host the Regional Research Centre for Temperate East Asia in Beijing, and Mongolia wishes to establish a sub-centre for semi-arid and arid research. China also expressed interest to participate in the START South-East Asia Network.

The START Committee for Temperate East Asia was formally established at the September meeting in Goa, India, of the Standing Committee for START.

Professor Congbin Fu, Member of the Scientific Committee for the IGBP, Laboratory of Climate Research, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing.

International Global Atmospheric Chemistry Project

International Tropospheric Ozone Year

Scientists within the International Global Atmospheric Chemistry Project (IGAC) are discussing an initiative for an International Tropospheric Ozone Year (ITOY), approximately 5 years from now, during which intensive global measurements of tropospheric ozone would be carried out through cooperation among scientists from many nations. The aim of the effort would be to greatly enhance the data base for this key compound, especially in remote regions from which there are no or very few data, such as major parts of tropical Asia, South America, Africa, and the oceans, primarily the Pacific and the Indian Ocean. The idea is to extend the project over one year (maybe two years) and to conduct regular vertical ozone soundings in the troposphere and lower stratosphere at a relatively large number of selected sites. Aircraft campaigns which are being planned within several IGAC activities would also be an important component of ITOY.

To obtain such global data is of critical importance for a proper understanding of the ozone budget and the overall photochemistry of the troposphere, including its oxidizing efficiency. This need is well recognized in the IGAC Global Tropospheric Ozone Network and Global Atmospheric Chemistry Survey Activities, among others. The collection of these data is also important in order to establish a definitive baseline for judging the future global atmospheric impact of the major economic expansion, which is undoubtedly going to take place in the developing nations of the world. The remote sensing community could make a very important contribution to, as well as profit from ITOY, since, by 1998, satellite instruments will have been developed to obtain information on tropospheric ozone, albeit with substantially less vertical resolution than for lidar or balloon ozone soundings. ITOY could play a large role for some of the major field projects that are being conducted and planned as part of IGAC and other international projects. At some stations the ozone measurements will certainly be supplemented by those of other photochemically important compounds, such as CO, NO_x, and NMHC.

In order to pursue these ideas further, it has been decided at this early stage to

sound the interest and seek the advice of a broad spectrum of scientists regarding the ITOY concept, by asking the following questions:

- Do you agree that such a project is worthwhile?
- Which regions should and can be covered by ITOY?
- For how long should ITOY be conducted?
- What should be the methods (balloons, lidars, satellites) and frequency of ozone soundings?
- What financial resources and mechanisms do you think might be tapped into, especially regarding funding of the balloon soundings in the developing world?
- Any other thoughts.

The members of the ITOY Working Group are:

Paul J. Crutzen, Max Plank Institute for Chemistry, Mainz (Germany)

Dieter H. Ehhalt, Jülich Research Center (Germany)

A. P. Mitra, National Physical Laboratory, New Delhi (India)

Ronald G. Prinn, Massachusetts Institute of Technology (USA)

Henning Rodhe, Stockholm University (Sweden)

If ITOY is to proceed for 1998, the details of the project need to be defined in 1994. Therefore, please send your comments, by the end of February, to Dr. Alex Pszenny, the IGAC Core Project Officer, at the IGAC Core Project Office, Massachusetts Institute of Technology, Building 24-409, Cambridge, MA 02129-4307, USA. Fax: (+1-617) 253 9886, E-mail: pszenny@mit.edu (Internet).

Mid-Latitude Ecosystems and Photochemical Oxidants (MILOX)

A first meeting was held in Atlanta, Georgia (USA), on 15-17 September, to identify the primary scientific themes, issues and tasks for the MILOX initiative of the International Global Atmospheric Chemistry Project. The meeting was organized and chaired by Professor William L. Chameides of the Georgia Institute of Technology, Convener of the MILOX Coordinating Committee. Twelve scientists from six countries participated. Based on the discussions, Prof. Chameides has produced a draft outline for a MILOX re-

search plan that is currently being reviewed by the meeting participants. It describes the proposed focus of MILOX as follows:

"The MILOX mission will encompass the assessment and study of the long-term effects of increasing urbanisation, industrialisation and high input agriculture, and the concomitant degradation of regional and global-scale air quality that accompanies these trends, on ecosystems of economic and environmental import using the northern mid-latitudes as a field laboratory. Of particular concern will be the problem of increasing concentrations of tropospheric ozone and related oxidants and their impact on the environment. The MILOX scientific focus is strategically designed to bridge the gap between regional/national research programmes aimed at assessing short-term air quality effects on local agriculture and forestry and the longer-term, larger-scale implications of expanding anthropogenic activities on terrestrial ecosystems, especially regarding the ability of these ecosystems to sustain a growing and increasingly urban human population. In order to maintain close relevance with contemporary policy issues, a significant fraction of the MILOX effort will be devoted to assessment. The MILOX programme will also aim to be highly interactive with related efforts within the IGBP Global Change and Terrestrial Ecosystems (GCTE) Core Project and within the emerging Human Dimensions of Global Change (HDP) programme."

A follow-up meeting is tentatively planned for the February/March, 1994, time frame, most likely at a European venue. The purposes of this second meeting will be to finalize and flesh out the broadly defined tasks formulated at the Atlanta meeting and to establish a timeline for implementing them. It was also agreed in Atlanta that a European Co-Convener for MILOX would be chosen in the coming months: Drs. B. Versino (Italy), J. Colls (UK), J. Merino (Spain), and D. Kley (Germany) will serve on an ad hoc committee to nominate a suitable individual for ratification at the early 1994 meeting.

Prof. William L. Chameides, School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA 30332-0340, USA. Tel:

(+1-404) 894 3893; Fax: (+1-404) 853 0232, E-mail: wcham@eas.gatech.edu (Internet)

Report from Asia on global monitoring of methane emissions from rice paddies

At the Asian Planning Meeting on IGBP, held in Singapore in December 1991, activities discussed for the Asian Region by IGAC included a recommendation for coordinated monitoring of methane emission in rice paddy fields in Asian countries. Several monitoring programmes were under way in selected countries at that time. To promote companion measurement activities in other Asian countries, India offered to organize a Workshop-Training Course and serve as the centre for coordinating paddy field methane measurements from all of Asia.

The workshop was held on 20-24 September this year at the National Physical Laboratory in New Delhi. The meeting was organized by the National Physical Laboratory, the Committee on Science & Technology in Developing Countries (COSTED), and the Indian National Committee for IGBP under the direction of an International Advisory Committee headed by Dr. A. P. Mitra, CSIR Bhatnagar Fellow and Chair of the Indian National IGBP Committee. It was sponsored by the Council of Scientific and Industrial Research (India), Commonwealth Science Council (UK), Inter-Ministerial Group on IGBP (India), and IGBP-START. Forty-nine participants were in attendance for training. They represented several countries, including India, China (Beijing and Taipei), Thailand, Sri Lanka, Bangladesh, Malaysia, Mauritius, Trinidad & Tobago, Vietnam, and Nepal.

The programme began with key-note addresses by Dr. A. P. Mitra (an overview of sources, sinks and interaction of methane in the atmosphere) and Professor R. L. Sass (Methane emissions from rice paddies, an IGAC focus), followed by two days of theoretical and practical lectures given by members of the IGAC Rice Cultivation and Trace Gas Exchange (RICE) Activity and other scientists from India.

During the following week from September 27 to October 1, 1993, the National Physical Laboratory hosted a Federation of Asian Scientific Academies and Societies Seminar on Global Environmental Chemistry. The IGAC-RICE resource persons for the workshop also participated in this Seminar and were joined by Professor Paul Crutzen, Vice-Chair of the IGAC Scientific Steering Committee, who gave the key-note address "An Overview of Global Environmental Chemistry". The

fifty-nine scientists in attendance at this seminar included many who stayed over from the Workshop-Training course.

A follow-up meeting to the Workshop-Training Course is tentatively planned for February, 1995. At that time the participating countries are scheduled to have completed the first phase of their monitoring measurements on paddy field methane from their respective countries. The purpose of the meeting will be to evaluate and compare those data. It is planned that the IGAC-RICE activity will participate in that process.

Ronald L. Sass, IGAC-RICE Co-Convener, at: Department of Ecology and Evolutionary Biology, Rice University, Houston, Texas 77251, USA. Fax: (+1-713) 285 5232, E-mail: sass@pop.rice.edu

Planning meeting held for IGAC's Aerosol Characterization Experiments

An open meeting was held in Seattle, WA (USA), on 14-16 September, 1993, to continue planning for the first two in the series of aerosol characterization experiments: ACE-1 and ACE-2. The goal of these experiments is to quantify the combined chemical and physical processes controlling the evolution and properties of those atmospheric aerosols which are relevant to radiative forcing and climate change. More than 50 scientists attended the meeting, which was organized by Dr. Timothy S. Bates of the NOAA Pacific Marine Environmental Laboratory (USA), Co-Convener of the IGAC Multiphase Atmospheric (MAC) Activity.

ACE-1 will be conducted in January-February 1995, over the southwest Pacific Ocean, south of New Zealand and Australia, and will involve the joint efforts of MAC and MAGE. The goal of ACE-1 is to determine and understand the processes outlined above in an unpolluted, remote marine boundary layer. Building on the initial programme drawn up in a previous open meeting in February 1993, in Hobart, Tasmania, the participants developed a detailed measurement plan. This included a list of the necessary measurements, the investigators who plan to make these measurements, platform requirements (ships, aircraft, and land sites), and the optimal disposition of these assets. Two CSIRO-sponsored field programmes, the Cape Grim Photochemical Intensive (GCPI) and the Southern Ocean Cloud Experiment (SOCEX) have been scheduled to run simultaneously with ACE-1, thus broadening the range of capabilities. The possibility also exists that the third Iron-as-a-Limiting-Nutrient Experiment

(FeLINE-III) cruise may occur in conjunction with ACE-1. This would enhance greatly the biological and chemical oceanographic aspect of ACE-1 that is required for proper investigation of mechanisms that control the exchange of trace gases and particulate materials across the air-sea interface. An ACE-1 Implementation Plan based on the discussions is currently being drafted and should be available by December 1993. Another ACE-1 planning meeting will be held in Tasmania in early February 1994.

A draft science plan for ACE-2, developed during an initial meeting held in July 1993 at the CEC Joint Research Centre in Italy, was considered and endorsed by the Seattle meeting participants. ACE-2 is tentatively planned for boreal summer 1997, in the Madeira-Azores-Canaries region of the North Atlantic Ocean. ACE-2 will focus on the anthropogenically-influenced marine atmosphere of the North Atlantic in order to contrast aerosol characteristics, processes and effects with those observed during ACE-1. It was agreed that Dr. Frank Raes should chair a planning committee for ACE-2. That committee is being formed during autumn 1993 and will prepare a revised science plan that will be the basis for an open planning meeting in 1994, somewhere in Europe.

The meeting closed with a brief discussion of where an ACE-3 should be. Consensus was that a polluted, continental region such as eastern Asia should be considered.

Further information on ACE-1 planning can be obtained from the Co-Convener, of the IGAC Multiphase Atmospheric Chemistry Activity:

Dr. Timothy S. Bates, NOAA/PMEL/OCRD, Building 3, 7600 Sand Point Way, NE, Seattle, WA 98115, USA, Fax: (+1-206) 526 6744, Internet: bates@pmel.noaa.gov

Dr. John L. Gras, CSIRO Division of Atmospheric Research, Private Bag No. 1, Mordialloc, Victoria 3195, Australia. Fax: (+61-3) 586 7600, Internet: jlg@dar.csiro.au or from the Convener of the IGAC Marine Aerosol and Gas Emissions, Atmospheric Chemistry and Climate Activity:

Prof. Barry J. Huebert, Department of Oceanography, University of Hawaii, 1000 Pope Road, Honolulu, HI 96822, USA. Fax: (+1-808)956 9225, Internet: huebert@okika.soest.hawaii.edu For further information on ACE-2 planning, contact:

Dr. Frank Raes, Environment INE, CEC Joint Research Centre, I-21020 Ispra (Varese), Italy. Fax: (+39-332) 78 94 53, Internet: frank.raes@jrc.it

Global Tropospheric Chemistry

A call for papers has been issued for the Scientific Symposium to be held at Fuji-Yoshida, Japan, on 5-9 September 1994. The meeting is the 8th Symposium of the Commission of Atmospheric Chemistry and Global Pollution, and the 2nd Scientific Conference of the International Global Atmospheric Chemistry Project.

The scientific programme should address field and laboratory measurements and modelling studies related to global tropospheric chemistry. There are four main scientific themes:

- 1) Distribution and fluxes of greenhouse gases, including carbon dioxide
- 2) Tropospheric ozone
- 3) Sulphur and nitrogen cycles: their roles in acidification, with emphasis on the situation in Asia
- 4) Aerosol and cloud chemistry and their roles in climate regulation.

The deadline for abstracts is 1 February 1994. Approximately 75 papers will be selected for oral presentation, with the remainder presented as posters. Oral presentations will be integrated into the four themes, with each theme introduced by an invited paper. Authors will be notified of acceptance of their papers for either oral or poster presentation by 15 May 1994. The papers will be published in two special issues of *Atmospheric Environment*.

Abstracts submission guidelines and general information can be obtained from Professor T. Ogasawa, CACGP/IGAC Symposium, Department of Earth and Planetary Physics, Graduate School of Science, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan. Fax: (+81-3) 3818 0745

IGBP Meetings

1994

5-6 January, San Francisco, CA, USA
PAGES Executive Committee Meeting

9-12 January, Cambridge, MA, USA
First meeting of the BAHC-IGAC-GCTE Science Task Team

16-17 January, Tokyo, Japan
2nd TEACOM (START Temperate Eastern Asia Committee) Meeting

17-21 January, Lilongwe, Malawi
First Regional South African Workshop for START, with 2nd meeting of the START Regional Committee for Northern Africa, and 3rd meeting of the START Regional Committee for Southern Africa. Z. M. Kasomekera, University of Malawi, Bunda College of Agriculture, PO Box 219, Lilongwe, Malawi. Tel: (+265) 277 222, Fax: (+265) 277 251, or 277 364

25 January, Taipei, Taiwan, China
Meeting of IGBP Donors

26-27 January, Taipei, Taiwan, China
International Group of Funding Agencies for Global Change Research (IGFA). Ho Lin, Dept. of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan. Tel: ((+886-2) 363 6775, Fax: (+886-2) 363 3642

27-29 January, Brunei
Fourth Meeting of the Southeast Asia Regional Committee for START

2-4 February, Durham, NH, USA
IGBP-Data and Information System (DIS) Standing Committee Meeting

4-5 February, Boulder, CO, USA
PAGES/PALE Principal Investigators. John Andrews, Boulder, CO, USA. Tel: (+1-303) 492-8347; Fax: (+1-303) 492 6388

7-8 February, Bern, Switzerland
PAGES Workshop on Fluvial Systems. Bob Wasson, Australia (Tel: (+61-6) 246 4911; Fax: (+61-6) 246 5800).

7-11 February, Nairobi, Kenya
GCTE/ISSS/TSBF/UNDP/ICRAF/US-SMS Workshop on the management of carbon in tropical soils under global change. John Ingram, GCTE Focus 3 Project Officer, Department of Plant Sciences, University of Oxford, South Parks Road, Oxford, OX1 3RB, UK. Tel: (+44-865) 275 079; Fax: (+44-865) 275 060

14-16 February, Colombo, Sri Lanka
1st Meeting of South Asia Planning Committee for START (SASCOM)

20-22 February, Waterloo, Ontario, Canada
BAHC Risk Estimation/Downscaling Workshop. Ephrat Lahmer-Naim, BAHC Core Project Office, Institute for Meteorology, Freie Universität Berlin, Carl-Heinrich-Becker-Weg 6-10, D-12165 Berlin, Germany. Fax: (+49-30) 838-711 85; Internet: bahe@fub46.zdat.fu-berlin.de, or Brad Bass, Atmospheric Environment Service, Canadian Climate Centre, 4905 Dufferin Street, Downsview, Ontario M3H 5T4, Canada. Fax: (+1-416) 739 4297, Internet: bbass@cid.aes.doc.ca

23-25 February, Las Vegas, NV, USA
IGBP-DIS Land Cover Change Working Group

10-13 March, Bonn, Germany
8th Meeting of the Scientific Committee for the IGBP

13-16 March, Bonn, Germany
Fourth Meeting of the IGBP National Committees. Sabine Lütkekeier, IGBP-Sekretariat, Institut für Meteorologie, Freie Universität Berlin, Dietrich

Schäfer-Weg 6-10, D-12165 Berlin, Germany. Tel: (+49-30) 838 71117, Fax: (+49-30) 838 71160, E mail: H.Bolle.IGBP (Omnet)

21-22 March, Manila, Philippines
GCTE Rice Network Planning Workshop, with the International Rice Research Institute. John Ingram, GCTE Focus 3 Project Officer, Department of Plant Sciences, University of Oxford, South Parks Road, Oxford, OX1 3RB, UK. Tel: (+44-865) 275 079; Fax: (+44-865) 275 060

21-26 March, Tucson, Arizona, USA
Scientific Steering Committees for Biospheric Aspects of the Hydrological Cycle (BAHC) and the International Satellite Land Surface Climatology Project (ISLSCP), in conjunction with the Workshop on Aggregate Descriptions of Heterogeneous Land-Covers. 21-22 March: ISLSCP-SSC; 23-24 March, Land-Cover Workshop, 25-26 March: BAHC-SSC. Dr. Ephrat Lahmer-Naim, BAHC CPO, Institut für Meteorologie, Freie Universität Berlin, Carl-Heinrich-Becker-Weg 6-10, D-12165 Berlin, Germany. Fax: (+49-30) 838 711 85, Internet: BAHC@fub46.zdat.fu-berlin.de

28 March-1 April, Bilthoven, Netherlands
Application of Forest Stand Models to Evaluate Global Change Issues. Dr. Thomas M. Smith, GCTE Focus 2 Office, Department of Environmental Sciences, University of Virginia, Clark Hall, Charlottesville, VA 22903, USA. Tel: (+1-804) 924 7642; Fax: (+1-804) 982 2137

7-8 April, Beijing, China
PEP II Meeting: Changes in palaeoclimate and palaeoenvironment in the last 200,000 years along pole-equator-pole: Arctic, Asia, Australia and Antarctica. Bob Wasson, Division of Water Resources, CSIRO, GPO Box 1666, Canberra, ACT 2601, Australia. Tel: (+61-6) 246 4911, Fax: (+61-6) 246 5800, or Liu Tungsheng, Institute of Geology, Academia Sinica, PO Box 634, Beijing 100011, China. Tel: (+86-1) 202 77 66, Fax: (+86-1) 491 91 40

11-12 April, (to be decided)
PAGES Executive Committee Meeting. Dr. Herman Zimmerman, Division of Atmospheric Sciences, Rm. 775, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA, 22230, USA. Tel: (+1-703) 306 1527; (Fax: (+1-703) 306 0377.

25-26 April, Washington, DC
IGBP-DIS Soils Working Group

2-6 May, Rio de Janeiro, Brazil
Scientific Symposium on Global Change, in conjunction with the World Climate Research Programme, the Human Dimensions of Global Environmental Change Programme, and the Inter-American Institute for Global Change. First and last day START Bureau meeting. Haroldo Mattos de Lem-

Meeting of National Committees for the IGBP, 13-16 March 1994

The German National Committee for the IGBP has invited all the National IGBP Committees to meet in Bonn, Germany, on 13-16 March, 1994. The meeting will provide a forum for new information on the status of the IGBP, with special emphasis on the state of the art in modelling (a presentation of GAIM, the Global Analysis, Interpretation and Modelling framework activity), and for the exchange of views and experience on the multinational coordination of global change research.

On the agenda are presentations of the progress in Core Project scientific research, and of Core Projects under development. National Committees will discuss their role in advancing Core Project research, in developing the IGBP, and in establishing regional research networks.

Contact: Dr. Sabine Lütkekeier, IGBP Sekretariat of the Federal Republic of Germany, Institut für Meteorologie, Freie Universität Berlin, Carl-Heinrich-Becker-Weg 6-10, D-12165 Berlin, Germany. Fax: (+49-30) 8387 1217; E-mail: H.Bolle (Omnet)

os, Brazilian Academy of Sciences, Cx. Postal 229, Rua Alfilópio de Carvalho 29. 3^o, Rio de Janeiro 20.001-970. Tel: (+55-21) 220 4794; Telex: 2123087 daac br, Fax: (+55-21) 240 4695.

May 1994, Lund, Sweden

PAGES/GCTE Workshop on Palaeovegetation Mapping: the Last Glacial Maximum to Present. Dr. I. Colin Prentice, Sweden, Tel: (+46-46) 10 41 76; Fax: (+46-46) 10 44 23, or Dr. Thompson Webb, USA, Tel: (+1-401) 863 3128; Fax: (+1-401) 863-2058)

23-27 May, Woods Hole, Massachusetts, USA
First GCTE Science Conference, and GCTE SSC meeting. Will Steffen, GCTE Core Project Officer, CSIRO, Division of Wildlife & Ecology, PO Box 84, Lyneham ACT 2602, Australia. Tel: (+61-6) 242 1748; Fax: (+61-6) 241 2362; E-Mail: wls@csr.dwe.csiro.au (Internet)

May 1994, Alexandria, Egypt

2nd START Planning Committee for the Mediterranean (MEDCOM) Meeting

May/June, Nantes, France

JGOFs North Atlantic Planning Group. Hugh W. Ducklow, JGOFs Core Project Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA. Tel: (+1-508) 457 2000, ext. 3357, Fax: (+1-508) 457 2193, E-mail: H.Ducklow (Omnet), hducklow@cliff.whoi.edu

1-3 June, Nantes, France

International Colloquium: Subpolar Oceans, World Ocean and Climate, in connection with Futuroceans '94. Laurent Labeyrie, Laboratoire Mixte CNRS-CEA, Centre de Faibles Radioactivités, Parc du CNRS, Gif-sur-Yvette, F-91198, France. Tel: (+33-1) 6982 3536, Fax: (+33-1) 6982 3568, E-mail: labeyrie@cole.cfr.cnrs-gif.fr

8-10 June, Canberra, Australia

PAGES Scientific Steering Committee

June (late), Tokyo, Japan

JGOFs Data Management Task Team. Dr. Roy Lowry, British Oceanographic Data Centre, Proudman Oceanographic Laboratory, Bidston Observatory, Birkenhead, Merseyside L43 7RA, UK. Tel: (+44-516) 538 633; Fax: (+44-516) 536 269; Dr. Toshiro Saino, Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164, Japan. E-mail: T.Saino (Omnet)

25-27 June, Karlsruhe, Germany

BAHC Workshop on Evaluation of Downscaling Methods, in conjunction with the UNESCO International Symposium on Water Resources Planning in a Changing World. Ephrat Lahmer-Naim, BAHC Core Project Office, Institute for Meteorology, Freie Universität Berlin, Carl-Heinrich-Becker-Weg 6-10, D-12165 Berlin, Germany. Fax: (+49-30) 838-711 85

8-11 August, Beijing, China

International Symposium on Global Change in Asia and the Pacific Regions. c/o LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, PO Box 2718, Beijing 100 080, China. Tel: (+86-1) 256 0172, 257 1939; Fax: (+86-1) 256 2347.

14 August, Glasgow, UK

PAGES Workshop on dating techniques and comparability of chronologies, in connection with the 15th International Radiocarbon Conference. Willem Mook, Netherlands Institute for Sea Research, P. O. Box 59, Landsdiep 4, 1797-SZ 't Horntje, NL-1790 AB Den Burg - Texel, The Netherlands. Tel: (+31-2220) 693 66, Fax: (+31-2220) 19 674, E-mail: NIOZ.TEXEL (Omnet)

August, Singapore

5th Meeting of the Southeast Asian Regional Committee for START (SARCS)

5-9 September, Fuji-Yoshida, Japan

International Symposium on Global Atmospheric Chemistry: Human impact on the global troposphere. 2nd Scientific Conference of the International Global Atmospheric Chemistry Project (IGAC) and 8th Symposium of the IAMAP Commission on Atmospheric Chemistry and Global Pollution; preceded by the IGAC SSC meeting. Toshihiro Ogawa, CACGP/IGAC Symposium, Dept. of Earth and Planetary Physics, Faculty of Science, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan.

7-10 September, Brussels, Belgium

START Standing Committee

Publications

IGBP Publications

IGBP Report No. 27

Biospheric Aspects of the Hydrological Cycle. The Operational Plan (1993). Edited by BAHC Core Project Office, Berlin. Stockholm: IGBP. 103 p.

The IGBP booklet *Global Change: Reducing Uncertainties* has just been re-printed. Individual copies may be sent free upon request. For bulk shipment, a charge is made for the mailing cost

Core Project Publication

High Resolution Record of Past Climate from Monsoon Asia: The Last 2000 Years and Beyond (1993). Recommendations for Research, PAGES Workshop Report, Series 93-1. Edited by Raymond Bradley. [54] pp. *PAGES Core Project Office, Bärenplatz 2, CH-3011, Bern, Switzerland*

ICSU Publication

Understanding Our Own Planet. An Overview of Major International Scientific Activities (1993). Prepared by John S. Perry, with assistance from J. W. M. la Rivière, J. Marton-Lefèvre & D. Jarmul. Paris: International Council of Scientific Unions. 36 pp. *ICSU Secretariat, 51 bd. de Montmorency, F-75016, Paris, France*

Global Change Research

Trace gas exchange in a global perspective (1993). Edited by Dennis S. Ojima & Bo H. Svensson. Copenhagen: Munksgaard International. 206 pp. (Ecological Bulletins, 42)

Changing Trends in Antarctic Research. Edited by Aant Elzinga (1993). Dordrecht, Kluwer, 161 pp. (Environment and Assessment, 3). Kluwer Academic Publishers Group, PO Box 322, 3300 AH Dordrecht, The Netherlands. In the USA and Canada: Kluwer Academic Publishers, 101 Philip Drive, Norwell, MA 02601, USA.

The Role of the Antarctic in Global Change. An International Plan for a Regional Research Programme (1993). Prepared by the SCAR Steering Committee for the IGBP. Cambridge (UK): Scientific Committee on Antarctic Research, Scot Polar Research Institute, Lensfield Road, Cambridge CB2 1ER, UK.

Towards a Model of Ocean Biogeochemical Processes, (1993) Edited by Geoffrey T. Evans & Michael J. R. Fasham. Berlin: Springer-Verlag, 350 pp. (NATO Advanced Science Institutes Series, Subseries I: Global Environmental Change, vol. 10).

National Activities

Australia

Climate Activities in Australia, 1993. A Report on Australian Participation in International Scientific Climate Programs (1993). Melbourne: Commonwealth Bureau of Meteorology. 105 pp.

IGBP START Inventory of Global Change in Australia (1993). Graeme Pearman, Chair START Subcommittee. Request from Paul Holper, CSIRO Division of Atmospheric Research, PB 1, Mordialloc, Victoria 3195, Australia, fax: (+61-3) 586 7600

India

Book of Abstracts: National Symposium on International Geosphere-Biosphere Programme, Madras (1993). Madras: Indian National Committee for IGBP; Anna University; COSTED; Central Leather Research Institute. 217 pp.

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Israel

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