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

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At the Third Meeting of the Scientific Committee for the IGBP, The Royal Swedish Academy of Sciences in Stockholm, from left to right: Trevor Platt, Shizuo Tsunogai, Genady N. Golubev, Vladimir M. Kotlyakov, Marie-Lise Chanin, W. Richard Peltier, Peter S. Liss, James J. McCarthy, Jerry M. Melillo, Bert Bolin

Strategy for Global Modelling Developed at Stockholm

"IGBP needs are best served by a suite of global biogeochemical models: the Earth system is too complex, and our understanding of its interactions insufficiently advanced, to aim for a single synthesis". That was one of the key points in Dr Berrien Moore's scene setting review of the Global Analysis, Interpretation and Modelling (GAIM) proposed core project, discussed by the 3rd meeting of the IGBP Scientific Committee.

Four of the world's leading scientists involved in various aspects of global modelling were guests at the meeting, held at Stockholm 28-31 August. Professor Lennart Bengtsson (Hamburg) presented some of the latest results from coupled ocean-atmosphere General Circulation

Models; Professor Paul Crutzen (Mainz) reviewed the status and future outlook of atmospheric chemistry models; Dr Colin Prentice (Uppsala) addressed the aims and recent progress in obtaining a functional, global description of terrestrial vegetation; and Professor Ulrich Siegenthaler (Berne) provided an overview of our understanding of the ocean carbon cycle.

The outcome of those discussions was firm guidance from the IGBP Scientific Committee on the role and direction of the GAIM project. Whilst it must work closely with and provide input to the other IGBP projects (for example, by identifying effects and geographic regions likely to be most important in global change), it should also be closely linked to modelling activities in the World Climate Research Programme (WCRP). A Planning Committee for GAIM is now being established, with early action urged on the preparation of a Science and Implementation Plan and the initiation of GAIM activities.

Core Project Structure Consolidated: Decisions Made on STIB and GCEC

The future development of the Stratosphere-Troposphere Interactions and the Biosphere (STIB) proposed core project and the Global Change and Ecological Complexity (GCEC) potential core project were reviewed by the IGBP Scientific Committee at its Stockholm meeting.

The Committee decided not to establish a STIB Core Project at the present time. Instead it will encourage the inclusion of studies on the biological impact of UV radiation within the Global Change and Terrestrial Ecosystems (GCTE) project and the Joint Global Ocean Flux Study (JGOFS), and of relevant atmospheric processes within the International Global Atmospheric Chemistry (IGAC) project. In addition, collaborations with other organizations, especially WCRP, will be pursued, to ensure that changes in ozone concentration and UV radiation in the stratosphere, and their climatic implications, are adequately investigated.

The IGBP Chairman, Professor Jim McCarthy, stressed that this decision did not mean that IGBP regarded stratospheric processes, and their potential impact on the biosphere, as unimportant. However, there were already a number of international programmes addressing the 'ozone hole' and associated phenomena, and it was not considered appropriate that IGBP should take on responsibility for their global coordination. The biological aspects are of great interest, but in the IGBP context will best be investigated in conjunction with research on other factors affecting biological processes in marine and terrestrial ecosystems.

Dr Marie-Lise Chanin was thanked for her considerable work in developing a clear statement of the research needs in this area, and the contributions of the STIB Planning Committee and many others who had assisted with that task were also acknowledged.

The second major decision on IGBP project structure was that studies of ecological complexity (the GCEC proposed project) should be considered for possible inclusion within Global Change and Terrestrial Ecosystems, since they closely complement GCTE Focus 2 'Change in

Ecosystem Structure'. This decision follows the recommendations of the GCTE Open Meeting, held in Brighton in February (IGBP Newsletter No 6), and of the Focus 2 meeting, held in Trondheim in June.

The Scientific Committee noted that SCOPE reviews are in progress that are closely relevant to both these subject areas, on Biodiversity (jointly with IUBS) and on Effects of Increased UV Radiation on Biological Systems. The outcome of those reviews was awaited with great interest, and would be taken into account in the further development of the IGBP research plan.

Core Project Levels of Research Identified

The Scientific Committee for the IGBP, at its 3rd meeting, discussed different levels of recognition of individual research projects. The following levels of research contribution have been recognized by the Global Change and Terrestrial Ecosystems (GCTE) Project, and a similar approach has also been endorsed by the Joint Global Ocean Flux Study (JGOFS). It is

hoped that this, after a more thorough discussion at the 4th SC-IGBP meeting, can be accepted as standard for all IGBP Core Projects.

1. Core Research
This research consists of large-scale, integrative projects that are international in scale and global in scope. These projects have been designed specifically by the Core Project Scientific Steering Committee to meet Core Project objectives.
2. Regional/National Research
This research arises from national IGBP committees or from other national or regional groups of scientists. On the whole the work will be designed specifically for the Core Project, but will often be national and/or regional rather than global in scope.
3. Relevant Research
There will be many smaller research projects initiated by individual investigators/institutions that are proposed as Core Project contributions. The SSCs cannot review all of these proposals themselves, but instead will refer them back to the appropriate national IGBP committee for consideration and subsequent action.

News from the IGBP Secretariat

Dr. Richard Moss has joined the IGBP Secretariat in Stockholm as Programme Officer. Richard is also Deputy Director and Research Associate of the Human Dimensions of Global Environmental Change Programme (HDGEC). The establishment of a post at the IGBP is one of the results of the agreement of collaboration between the International Social Science Council (ISSC) and the IGBP. The ISSC is sponsoring this post to promote the integration of social science studies with the natural science research on the Earth system of the IGBP. Dr. Moss, a political scientist, was previously with the Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, NJ, USA.

The Human Dimensions of Global Environmental Change Programme of the ISSC now has opened headquarters in Barcelona, with Dr. Manuel Ludevid, Executive Director, HDGEC Programme Secretariat, Pomaret 21, E-08034 Barcelona, Spain, Tel: (+34-3) 417 9340; Fax: (+34-3) 417 9309.



*Richard Moss
at the IGBP Secretariat*

Ocean Biogeochemistry and Air-Sea CO₂ Exchange

P. WILLIAMSON AND T. PLATT

Multidisciplinary JGOFS studies in the North Atlantic have illustrated the influence of phytoplankton on the exchange of carbon dioxide between atmosphere and ocean. Models that simulate the response of the ocean carbon cycle to climate change need to take account of the complexity of such biological effects.

The Joint Global Ocean Flux Study (JGOFS, a SCOR/IGBP Project) addresses the role of ocean processes in global biogeochemical cycles, with emphasis on carbon and possible responses to climate change. Whilst special attention is given to air-sea exchanges of CO₂, JGOFS recognises that the ocean system operates as a whole: events occurring at the sea surface and in the upper ocean are intimately linked to processes in deeper water and ocean sediments. Furthermore, carbon transfers and transformations show scant regard for boundaries between scientific disciplines; their investigation therefore requires closely coordinated teamwork by chemists, biologists, physical oceanographers, earth scientists and modellers.

That approach is a novel one. Despite far-sighted work nearly 60 years ago (Cooper 1933, *J. mar. biol. Ass. UK*, 18, 729-53), measurements of biotic parameters had previously been excluded from large-scale surveys of the partial pressure of carbon dioxide at the sea surface (the driving force for ocean-atmosphere exchanges), and models of the ocean carbon cycle often take account of only physico-chemical processes.

JGOFS' adoption of a multidisciplinary, biogeochemical outlook has been vindicated by the wealth of important findings and new insights arising from the 1989 North Atlantic Bloom Experiment and subsequent follow-on work. These studies have to date involved over 20 research cruises by six participating nations (Canada, France, Germany, Netherlands,

UK and USA). Preliminary results were presented at an international symposium, held in Washington DC (JGOFS Report No 7, SCOR 1991), when impressive progress was reported by researchers working on a wide variety of topics. These included the interpretation of ocean colour data, obtained from satellites and aircraft overflights; synoptic surveys of CO₂ parameters and related variables, using semi-automated underway analyses; the development of radiochemical and biomarker techniques, to track the transport and transformation of carbon compounds; the trophic significance of bacteria, microzooplankton and zooplankton in respiratory, recycling and removal pathways; the quantification of dissolved organic carbon (DOC) in the upper ocean; and the successful, multinational deployment of fixed and drifting sediment traps and other *in situ* sampling devices.

The tasks of synthesis and integration are being achieved through JGOFS modelling studies, with initial effort including an analysis of the annual cycle of CO₂ fluxes in seasonally-stratified waters. Since mixing regimes are likely to change if global warming trends persist, biological responses to seasonal stratification (the 'spring bloom'), and related effects on CO₂ chemistry, are of particular interest. Primary production in the sunlit upper ocean can have the following effects on the air-sea exchange of CO₂:

1. By changing dissolved, inorganic carbon into organic cell constituents (through photosynthesis), the partial pres-

sure of carbon dioxide, pCO₂, in the surrounding water is reduced. This will promote the drawdown of CO₂ from the atmosphere, with the rate of uptake being a function of the air-sea pCO₂ difference and the strength of wind-driven mixing at the surface.

2. By taking up dissolved nitrate for 'new production', the alkalinity of surface water is increased - that has the effect of further reducing pCO₂.

3. If inorganic carbon is precipitated as calcium carbonate (calcite) as part of the phytoplankton cell structure, the alkalinity of surface waters is reduced - and pCO₂ increased, counteracting the effects of (1) and (2). Although relatively few phytoplankton species produce calcite, those that do can in certain regions be extremely abundant (eg the bloom-forming coccolithophorid *Emiliania huxleyi*), with around a 50:50 ratio in the biogenic production of organic and inorganic carbon compounds.

Respiration is the process whereby organic compounds are remineralised by the metabolic processes of both autotrophic and heterotrophic organisms, releasing CO₂ to the water. That raises its partial pressure and, when such water is next in contact with the atmosphere, promotes the return of CO₂ to the air. Respiration takes place throughout the water column, although mostly in the upper ocean. The quantity and quality of particulate 'export' from the upper ocean affect the depth distribution of respiratory activity in the water column, in turn determining the time constant for CO₂ return to the atmos-

phere. Variability in the nature and amount of DOC export may also be important, but this has yet to be investigated.

Simple models that relate $p\text{CO}_2$ changes to the changing biology and chemistry of seasonally stratified waters have been developed by JGOFS researchers and applied to the North Atlantic data sets (Taylor *et al.* 1991, *Global Biogeochem. Cycles* 5, 151-71; Watson, Robertson & Ling 1991, *NATO ARW, Melreux* in prep). They provide a good fit to the field observations; for example, successfully simulating the rapid, biologically-induced decrease in surface $p\text{CO}_2$ (from $340\mu\text{atm}$ to $260\mu\text{atm}$) that occurred in April-May, and its partial recovery (to c $300\mu\text{atm}$) during the summer. The initial fall in $p\text{CO}_2$ values, observed in both 1989 and 1990, had not been previously documented for the open ocean; its timing matched the onset of stratification, bloom development and nutrient depletion. Confirmation of a strong biological influence on $p\text{CO}_2$ was provided by transect and mapping studies, showing that spatial heterogeneity in $p\text{CO}_2$ measurements was closely correlated with phytoplankton patchiness (Watson *et al.* 1991, *Nature* 350, 50-3). In addition, recent investigations of an extensive *E. huxleyi* bloom have demonstrated that phytoplankton species composition can have a major effect on alkalinity and other CO_2 parameters (P. M. Holligan & J. Robertson, pers. comm.) - as predicted from the biogeochemical models, but not previously observed *in situ*.

These studies are far from complete. Nevertheless, they show that biological processes can have an important influence on air-sea CO_2 exchange, and en-

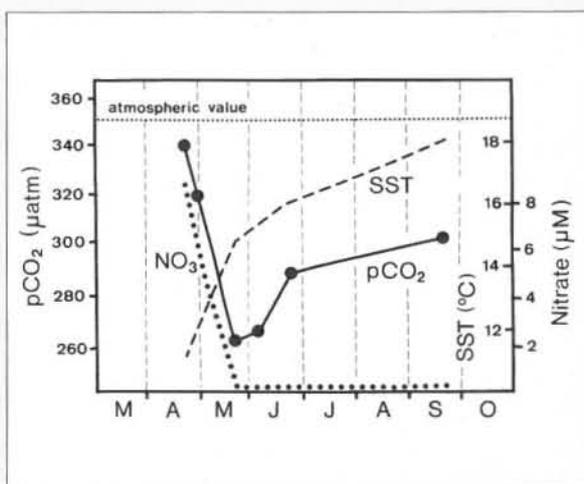
courage the view that the interacting system can be quantitatively described. With additional seasonal coverage, and a more extensive database of $p\text{CO}_2$ measurements for other ocean areas, it should therefore be possible to greatly improve estimates of the net oceanic uptake of carbon under present-day conditions. That value is currently in dispute, with estimates ranging between 1-3 Gt C per year (Tans *et al.* 1990, *Science* 247, 1431-8). More importantly, well-constructed models of seasonal carbon exchanges at the sea surface are an essential first step to the development of realistic models of the whole ocean carbon cycle, taking into account mid- and deep-water processes and longer time scales. When coupled to ocean-atmosphere general circulation models, it should then be possible to provide scientifically-credible prognoses of long-term responses of the ocean system to global change scenarios, linking temperature-induced changes in ocean mixing not only to the physical factors affecting CO_2 transport and exchange, but also to the changes in plankton communities and their biogeochemical role.

One data set of particular interest in this context is the 40 year time series of the Continuous Plankton Recorder survey in the North Atlantic, showing that the abundance of different plankton groups is sensitive to relatively subtle hydrodynamic and climatic changes (Dickson *et al.* 1988, *J. Plankton Res.* 10, 151-69; Taylor 1991, *New Scientist* no 1760, 52). Total phytoplankton abundance in the CPR survey areas has broadly followed temperature trends, with a marked increase since 1980 (and with some evi-

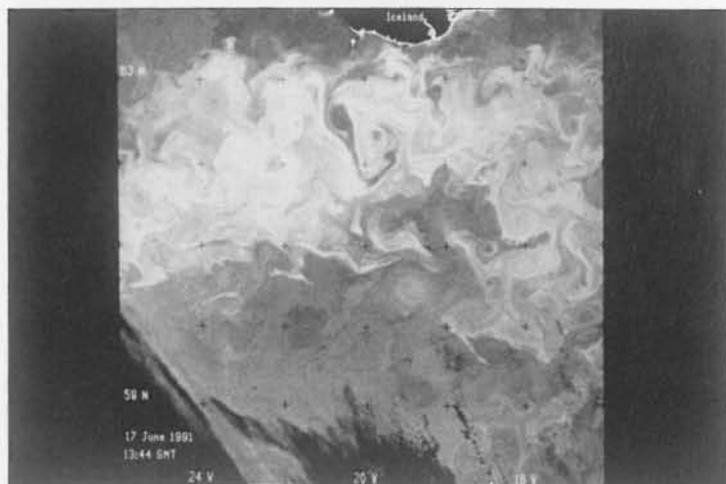
dence for similar trends in other ocean basins; M. Colebrook, pers. comm.). Over very much longer time-scales, analyses of marine sediments and ice-core data indicate that biological feedback effects, operating through changes in circulation patterns, were probably of great importance during previous periods of global climate change.

Contrary to some assertions (Broecker 1991, quoted in *Science* 253, 845; *Global Biogeochem. Cycles*, in press), no claims are made by JGOFS that a worldwide change in marine primary production is already underway as a result of human activities, nor is there any expectation of a direct biological response to additional anthropogenic emissions of CO_2 (since phytoplankton are not considered to be carbon limited). Nevertheless, the future stability of the ocean carbon cycle should not be assumed on the basis of our incomplete understanding of its complexities. Since even very simple dynamic systems can show chaotic or unpredictable behaviour, it would be unwise to dismiss ocean biology as irrelevant to potential global warming - or to pin too much faith on simplistic models that ignore such factors as changes in nutrient regimes, biological interactions in the upper ocean, and changes in the quality and quantity of export production. If models do not include biological processes, it is hardly surprising that they fail to show biological responses ■

Trevor Platt is the Chairman of the JGOFS Scientific Steering Committee and Phillip Williamson, Deputy Executive Director of IGBP, was formerly Project Manager of the UK JGOFS programme.



Changes in surface water $p\text{CO}_2$, sea surface temperature (SST, $^{\circ}\text{C}$) and nutrients (nitrate, NO_3) in the North East Atlantic around 48°N 20°W , April - September 1990; courtesy of Andrew Watson, Jane Robertson and colleagues, UK JGOFS (BOFS).



JGOFS field measurements of coccolithophorid CO_2 exchanges in the North Atlantic were aided in 1991 by an excellent series of satellite images of the phytoplankton bloom.

NOAA/AVHRR IMAGE, PROCESSED BY P. BAYLISS & S. GROOM (UK JGOFS)

Past Global Changes Defining Research Activities

FIRST MEETING OF THE PAGES SCIENTIFIC STEERING COMMITTEE,
MAINZ, 11-13 MARCH 1991.

REPORT BY PROF. J. EDDY, CO-CHAIR, IGBP-PAGES CORE PROJECT

The philosophy expressed at Mainz, and reflected in the report of the implementation plan, is that the PAGES project now stands as the first linked cars of a train in a station, ready to move forward, but still able to change or add elements as required to do its task.

The Past Global Changes (PAGES) Core Project is directed at securing a better understanding of the natural and human-induced variations of the Earth system in the past, through the organization of coordinated national and international endeavours to obtain and interpret a variety of natural and written records. It is one of five core projects that have been established to date by the IGBP.

Until recent years, the study of historical records and of natural archives such as those found in tree-rings, lake and ocean sediments, corals and ice-cores has been

carried out on a largely individual basis, by single investigators or laboratories, directed at the interpretation of a single historical proxy record, and most often for a limited region of the globe. Examples are dendroclimatological studies of regional aridity and river flow, the reading of deep-sea cores to determine ocean temperature, or the interpretation of polar and mid-latitude ice cores.

These classical methods of inquiry, driven by advances in technology and the application of modern methods of physical and chemical analysis, have developed

a set of powerful analytical techniques. From these have come the ability to recover changes in surface temperature, air and ocean chemistry, volcanic events, and the distribution of vegetation from the distant past - with temporal resolution that is sometimes adequate to distinguish seasonal changes in the local or regional environment. New information gleaned from the reading of these natural diaries in the past few years has been largely responsible for our present awareness of the coupled nature of the global system. It has also provided the only data which can be



Work during the summit operation in Greenland, 1990. Pictures courtesy of Professor Hans Oeschger, Berne, Switzerland.

Table 1: Characteristics of Proxy Records

Archive	Resolution	Extent	Information
Historical records	day/hr	2,000 year	T H B V M L S
Tree-rings	year/season	10,000 year	T H Ca B V M L S
Lake sediments	year	1,000,000 year	T B M
Polar ice cores	year	100,000 year	T H Ca B V M S
Mid-latitude glaciers	year	10,000 year	T H B V M S
Coral deposits	year	100,000 year	T C w L
Sedimentary rock	year	10,000,000 year	H C s V M L
Loess	10 years	1,000,000 year	H C s B M
Paleosoils	100 years	100,000 year	T H C s V
Ocean cores	100 years	10,000,000 year	T C w B M
Pollen	1000 years	100,000 year	T H B

T temperature
H humidity and precipitation
C chemical composition of air (a),
water (w), soils (s)
B information on biomass

V volcanic eruptions
M geomagnetic field
L sea level
S solar activity

used for the validation of models of climatic and environmental change on time scales of decades to centuries.

It is obvious to any who work in the field of palaeo-records that we have only begun to exploit what is possible. It is also clear that through the coordination of such efforts - particularly through the combination of data secured through a variety of methods - the power of any of these techniques could be vastly increased. This has already been demonstrated through organized activities such as CLIMAP and international activities organized by INQUA (International Union for Quaternary Research) to coordinate the use of multiple techniques with a focus on specific areas or periods of time.

The opportunity to coordinate data collecting while focusing on specific areas or periods through the PAGES project, comes at a time when the recovery and interpretation of past data has taken on a sense of urgency. Environmental changes of 10,000 or 100,000 years ago, and the processes through which they were brought about, are of more than academic interest to a world that may face dramatic changes of climate in the near future. It would greatly improve our understanding of impending changes were we able to answer questions such as the following:

- In what sequence, in the course of glaciations and deglaciations, do changes in



Work during the summit operation in Greenland, 1990.

greenhouse gases and surface temperature occur?

- How has surface temperature changed, regionally and globally, through the last 100 years? the last 1,000 years? the last 10,000 years?
- Through what limits do natural feedbacks in the Earth system respond to changes in atmospheric greenhouse gases?
- To what extent have the activities of man modified climate and the global environment in the past?

Project Definition

The span of historical and natural records that are now available to answer these and other questions are summarized in Table 1, including the span over which they can be read, their temporal resolution, and some of the information that they provide.

To understand global changes of the past, or to predict the changes expected in the future, one would like to know a detailed history of environmental changes throughout the full reach of the past, and for every region of the globe. Practical considerations regarding human and financial resources, the limits of what data are potentially available where, and the press for answers to specific questions regarding impending changes, require instead that a project aimed at illuminating the past should focus initially on those periods and places where the most needed information will likely be found. Thus, the PAGES project will focus on agreed-upon "slices of time", and on the coordinated recovery of information in selected regions of the globe that are most likely to yield insights into the operation of the Earth system. Following the guidelines of the IGBP, emphasis in choosing these times and places will be guided by the need to understand global changes of decade-to-century scale that most effect the biosphere and climate.

Table 2: Schematic Organization of the PAGES Project

Research Themes	Research objective: STREAM I	Research objective: STREAM II
<p>A. Solar and orbital forcing and response</p> <p>B. Fundamental Earth System Processes</p> <ol style="list-style-type: none"> 1. Trace-gas composition and climate 2. Global impacts of volcanic activity 3. Ice-sheet mass balance and global sea-level change 4. Biosphere dynamics and environmental change <p>C. Rapid and Abrupt Global Changes</p> <p>D. Multi-Proxy Mapping</p>	<p>The objective of Stream I is to reconstruct the detailed history of climatic and environmental change for the entire globe for the period since 2,000 BP, with temporal resolution that is at least decadal, and ideally, annual or seasonal.</p>	<p>The objective of Stream II is to reconstruct a history of climatic and environmental change through a full glacial cycle, in order to improve our understanding of the natural processes that invoke global climatic changes.</p>

Cross Project Needs:

- Palaeo-climatic and palaeo-environmental modelling
- Advances in the technology of recovery and interpretation of proxy data
- Management of palaeo-data.

Project Organization and Goals

The initial efforts of the PAGES project will focus on two temporal streams, each of which addresses four underlying themes and three cross-project needs, to define a multi-element matrix organization shown schematically in Table 2. Within each element of the matrix, specific research tasks will address key scientific questions that are defined by the overarching needs of the IGBP, through other Core Projects and key activities of the programme.

Stream I

Stream I will concentrate on the past 2000 years of Earth history: a period chosen as that of man's greatest impacts on the planet and the era of significant overlap between written records and the environmental information stored in natural archives. A better understanding of the climatic fluctuations that occurred during this period (including the Little Ice Age

and the preceding Medieval Warm Interval) can be expected to provide important insights into the rates of regional-to-global-scale changes that are expected to occur within the Earth system in the next 50-100 years.

A clearer illumination of the global and regional changes that have occurred in the last 2000 years has many potential pay-offs. The period of most reliable climate history, now limited to at most a few centuries, will be extended at least five-fold; a more extensive global record of land-use changes will allow us to begin to assess the effects of past human impacts on the Earth system; it may be possible to distinguish human-induced changes in this period from natural responses to external forcing mechanisms and internal system dynamics, allowing calibration and estimation of anticipated anthropogenic impacts; and, by focusing on the period of overlap between written history and natural records, Stream I research will provide

a Rosetta stone which can be used to validate and interpret data from the much more distant past.

Stream II

Stream II will focus on glacial-interglacial cycles of the last several hundred thousand years of the late Quaternary, concentrating on understanding the dynamics that cause glacial-interglacial variations, including the roles of atmospheric chemistry and ocean circulation, and that of biota, to illuminate the interactive feedbacks among various components of the Earth system that control the response of the system to climatic forcing. The purposes are to understand both the causes of change and the way the Earth system functions during times of glacial maximum and minimum conditions; to document the onset and nature of the transitions from warm to cold and cold to warm periods; and to define the causes and characteristics of the more abrupt changes that

punctuate these periods and the transitions between them.

Although the two streams concentrate on periods of Earth history that are very recent in geological terms, data and insights from the more remote past are needed to define the background on which more recent changes are imposed, and to illuminate the more fundamental processes that link elements of the Earth system. Research elements of the PAGES project will thus specifically include the study of earlier Earth system history, as an additional source of information relevant to the study of more recent and more rapid changes.

Underlying Themes

The four underlying themes that will be included in initial studies within each of the two streams are given in Table 2.

The last of these underlying themes (D. on Table 2) is aimed at the systematic collection and intercomparison of a variety of data from the spectrum of historical and proxy sources that are available. The ability to integrate information extracted from different natural and historical archives is a prerequisite for constructing a composite picture of climatic anomalies and trends in all of the activities of the project. It defines the needed contribution of PAGES to modelling activities of the IGBP. It will also transcend the immediate goals of the IGBP in making available to future generations of Earth scientists a fuller and more organized record of the recent history of the Earth system. The PAGES project will also address three cross-project needs on modelling, technology, and the management of palaeo-data.

Specific Activities

Activities and products that can be anticipated from the PAGES project include:

- Assessing and compiling what is now known of past environmental changes, to identify temporal and spatial gaps where information is particularly needed or deemed to provide the greatest insight into the operation of the Earth system.
- Organizing coordinated activities and campaigns, focused upon selected time slices and sensitive regions of the globe, involving many sources of historical and proxy data.
- Enlisting scientists and technicians to strengthen the cadre of researchers who now work in the acquisition and interpretation of palaeo-data and in palaeo-modelling, and the national support needed for their activities.

- Synthesizing data that now exists and that will be acquired in the course of project activities, with the aim of addressing particular questions and evolving needs for these data.

- Providing synthesized information to validate climatic and Earth system models.

- Establishing archives of palaeo-data for various types of information and for ready worldwide access.

The initial scientific strategy for the PAGES project was developed during 1987-1990 by a Scientific Steering Committee appointed by the Special Committee of the IGBP. The scientific plan for the PAGES project was reviewed and recommended for project implementation at the Second Meeting of the Scientific Advisory Council (SAC II) of the IGBP in Paris in September 1990. A Core Project Office for PAGES, co-sponsored by Switzerland and the USA, will be established in Bern in the autumn of 1991.

A fuller and more current description of about 80 pp, *The PAGES Project: Proposed Implementation Plans for Research Activities* is now in preparation, to be distributed in the late autumn of 1991. The report elaborates upon two earlier project planning documents, IGBP Report 6 (1989) *Global Changes of the Past*, 39 pp, and Chapter 7 (The PAGES Project, 30 pp) of IGBP Report 12: *The International Geosphere-Biosphere Programme: A Study of Global Change. The Initial Core Projects* (1990). Copies of the full report can be obtained from H. Oeschger at the Institute of Physics, University of Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland: Tel: (+41-31) 65 44 62, Fax: (+42-31) 65 44 05, or from J. A. Eddy, Office for Interdisciplinary Earth Studies, Boulder, Colorado, USA (Tel: (+1-303) 497 1680, Fax: (+1-303) 497 1679, E-mail: J.Eddy@Omnet). A list of the members of the PAGES Core Project Scientific Steering Committee was published in *Global Change Newsletter* No. 5, March, 1991.

Global Change and Terrestrial Ecosystems (GCTE)

The Global Change and Terrestrial Ecosystems Core Project Office in Canberra, Australia, has just issued the first number of GCTE News. The first edition marks the transition of GCTE from its three-

year gestation, or planning phase, to its operational phase. It has been distributed to some 500 individuals and agencies who have indicated interest. It is edited by Will Steffen, GCTE Core Project Officer, at CSIRO Division of Wildlife and Ecology, PO Box 84, Lyneham ACT 2602, Australia, Fax: +61-6-241 2362.

NEW GCTE CONTACT POINTS: OXFORD ASSOCIATE OFFICE OPENS

Dr. John Ingram has been appointed as Associate Project Coordinator for GCTE Focus 3 on Global Change Impact on Agriculture and Forestry, starting 2 September 1991. The address is: GCTE Core Project Associate Office, Department of Plant Sciences, University of Oxford, South Parks Road, Oxford OX1 3RB, United Kingdom, Tel: (44-865) 275 079, Fax (44-865) 275 074. Dr. Ingram was previously with the Tropical Soil Biology and Fertility Programme, a programme jointly run by the International Union of Biological Sciences and the Unesco Man and the Biosphere Programme, with headquarters at Nairobi.

There is also a GCTE Core Project Associate Office in Stanford (CA, USA) for Focus 1 on Ecosystem Physiology, at the Department of Biological Sciences, Stanford University, Stanford, CA 94305-5020, USA, Tel: (+1-415) 723 1179, Fax: (+1-415) 723 9253. An Associate Project Officer will be appointed shortly. The GCTE Office in Canberra and the Associate Core Project Offices, in addition to implementing research plans on their respective foci, will also serve as information links between GCTE and the outside science community ■

Biospheric Aspects of the Hydrological Cycle (BAHC)

SAN VINCENZO, ITALY,
10-12 SEPTEMBER 1991

A draft implementation plan for BAHC was discussed at the first meeting of the Scientific Steering Committee for the project that met in Italy under the chairmanship of Professor Hans-Jürgen Bolle. The committee decided to structure the work for BAHC into four Foci, subdivided into Activities and Tasks, in accordance

FOCI OF THE CORE PROJECT ON BIOLOGICAL ASPECTS OF THE HYDROLOGICAL CYCLE

Focus 1 Microscale to mesoscale hydrology.

Chairman S. Running

Activity 1	Physical canopy models (SVATs)
Activity 2	Canopy conductance (biology) model project
Activity 3	Effects of orography on water and energy fluxes
	Task 1 Advection at patch scale
	Task 2 Effects of hills on surface fluxes
	Task 3 Subsurface water movement
Activity 4	Surface and subsurface water flow
	Task 1 Discharge data-bases
	Task 2 Water routing
	Task 3 Integration and interaction of water and biogeochemistry

Focus 2 Large-scale experiments

(Joint IGBP/WCRP Working Group on Land-Surface Experiments)

Chairman J.-C. André

Activity 1	Experimental design
Activity 2	Experiment coordination
Activity 3	Data dissemination, remote sensing
Activity 4	Comparative evaluation and transferability

Focus 3 Continental integration

Chairman C. Field

Activity 1	Remote sensing
Activity 2	Soil, vegetation data and their spatial integration
Activity 3	Surface and river basin hydrology

Focus 4 Weather Generator

Chairman to be appointed

Activities to be defined

with the structure of the other Core Projects. Members of the BAHC-SSC were also asked to take responsibility for the development of detailed science and implementation plans for the foci.

The Chairs of the first three Foci Working Groups will convene meetings to develop the science and implementation plans. Thus, Focus 1 will meet in Canberra, Australia on 2-6 December 1991, Focus 2 in Paris on 13-14 February 1992, Focus 3 in New York in December 1991 and Focus 4 is planned to meet in Berlin in December or January. The plans will be available for the 2nd meeting of the BAHC SSC to be held in Berlin on 27-30 April

1992. The revised science and implementation plans will be presented to the first BAHC Open Meeting to be arranged in Tallinn from 27 to 31 July 1992.

The BAHC Core Project Office has just been established in September of this year at the Institute for Meteorology, Free University of Berlin, with financial support from the German Federal Ministry of Research and Technology (BMFT). The Office is headed by Dr. Alfred Becker, a hydrologist, previously with the Institute for Water Economy and a former lecturer at the Institute for Hydrology of the Technical University of Dresden, who has recently been appointed consultant to

Unesco. Other staff include Dr. Werner Kratz, a biologist, who joins the team from the Institute for Ecology of Free University of Berlin, and Dr. Ephrat Lahmer-Naim, a physicist, formerly working at the Hahn-Meitner Institute in Berlin. Ms. Annette Schulte-Doeinghaus is responsible for secretarial matters and Ms. Herta Geb is responsible for finance and administration.

The address is: BAHC Core Project Office, Institut für Meteorologie, Freie Universität Berlin, Dietrich-Schäfer-Weg 6-10, D-1000 Berlin 41, Germany. Tel: (+49-30) 838 71184, Fax: (+49-30) 838 711 60.

News from IGBP

National Committees

Germany

After the initial national IGBP Committee meeting in March 1989, the planning of the contribution of the Federal Republic of Germany to the different core projects was further developed by coordination groups. After the 2nd meeting of the Scientific Advisory Council for the IGBP (Paris, 3-7 September 1990) three national IGBP Workshops took place to define the potential contributions from German scientists to the core projects International Global Atmospheric Chemistry (IGAC), Joint Global Ocean Flux Study (JGOFS) and Biospheric Aspects of the Hydrological Cycle (BAHC) as described in Global Change Report No. 12. In addition, the Ecosystem Research Centres in Germany (Bayreuth, Göttingen, Kiel and München) got together to draw up their potential contributions to GCTE.

The IGAC committee developed a programme that focuses on air chemistry above the North Atlantic, the effects of biomass burning in the tropics and subtropics, and trace gas emissions from agricultural areas. The JGOFS workshop summarized the ongoing and possible future marine research projects relating to JGOFS, Land-Ocean Interactions in the Coastal Zone (LOICZ) and Past Global Changes (PAGES). The priority within JGOFS targets the particle flux in the North Atlantic. PAGES will focus on the sedimentary history in the same area taking advantage of the research sites of JGOFS. LOICZ-related research is already under way on the estuary of the river Elbe.

The group on land-surface processes proposed an experimental and modelling programme for the North-East European plains and one major German river system.

Ecosystem research relevant to Global Change and Terrestrial Ecosystems will be enhanced at the Ecosystem Research Centres according to their respective research priorities, such as forests, agricultural areas and lakes. The rain forest in Brazil is the main target in the tropics.

The integration of the scientists in East Germany caused a new situation and makes it necessary to iterate the concept,

to streamline the programme and to set new priorities. It is expected that this process will be finished at the second German IGBP Symposium, which will take place in Berlin, 14-15 October, 1991. The results of the symposium, in which about 80 scientists are expected to participate, will be published and become available from the IGBP Secretariat in Berlin, which is organizing the symposium. The sponsor of the symposium is the German Research Foundation (DFG) while the IGBP Secretariat is funded by the German Federal Ministry of Research and Technology (BMFT).

Sabine Lütke-meier, German National Committee for the IGBP

Israel

The Ministry of the Environment and the Academy of Sciences jointly arranged an international workshop on "Regional Implications of Future Climate Change" in Rehovot on 28 April-2 May 1991, to which several scientists from abroad were invited, in addition to over 50 participants from Israel. Some 30 half-hour lectures discussed various aspects of past and expected climatic changes in the Mediterranean region and their environmental implications. The executive summary calls on the government and the scientific community to increase efforts in research in all of these areas, with highest priority to interdisciplinary research focusing on the water balance, which is of special significance to Israel.

Dan H. Yaalon, Chairman, Israeli National Committee for the IGBP

Japan

The Japanese National Committee for the IGBP is a body within the Science Council of Japan. It started a new term in April 1991, with new members appointed and the election of a new Chairman. Subcommittees have also been established relating to core projects and key activities. In addition to the IGBP National Committee, a technical committee for the IGBP

composed of 28 members has been established in the Council in order to discuss, plan and carry out the international and national tasks related to the IGBP. In April 1990 the Science Council recommended supporting IGBP activities to the Japanese Government. Eleven ministries and agencies have answered officially giving support, and some of them have made a budget on IGBP related research.

The National Committee has published "IGBP News No. 1" in July 1991, (in Japanese) for exchanging information among Japanese researchers. The Committee will publish a pamphlet in English presenting the seven fields of activity of the Japanese IGBP, and listing the members.

International symposia on global change topics are organized by the National Committee, and symposia related to IGBP research are being organized by the respective National IGBP Committees for each research field, covering such topics as the palaeoenvironment of Monsoon Asia, urban climate change and its control, the Milankovich cycle and environmental change, among others.

Masatoshi Yoshino, Chairman, Japanese National Committee for the IGBP



Explosion of the Sakura-jima Volcano, southern Kyushu, Japan. January 1975.

Regional Information Centres : Scientific Libraries with IGBP Reports

The IGBP has to-date produced 18 Reports, with more still in print. The distribution, however, has not been as broad as we would wish. It has been limited to members of IGBP Committees (both National and Scientific), and to scientific institutions who have specifically requested them. In addition, readers may write to us to obtain reports relating to their field of research. In order to make our reports available to as many scientists and researchers as possible, the IGBP is now sending them to major scientific and technical libraries throughout the world.

The decision to establish a world network of Regional Information Centres (RICs) was made by the ICSU Executive Committee following discussion of the IGBP at the 23rd ICSU General Assembly in Sofia, Bulgaria, in October 1990. The selection of fifty libraries and scientific/technical information centres, to form the network of RICs, was made in consultation with IATUL and IFLA, both being Scientific Associate Members of ICSU.

With regard to this programme, the functions of these centres are as follows:

(i) to accept, as donations, copies of all IGBP reports, bulletins and newsletters and retain them in their collection of scientific literature;

(ii) to make catalogue entries for the items accepted;

(iii) to select and prepare a list of institutions within the territory to be covered and ensure that regular information on the available literature is made available to each institution. In many cases this will be achieved by means of a public or private access catalogue distributed as a normal library procedure. It is expected that this information will increasingly become available in electronic digital format and distributed on an information network;

(iv) to supply on request copies of papers, or extracts from these reports under the normal conditions as regards delivery appropriate for the regional territory, charging the recipient as appropriate for

the cost of this service. IGBP grants unrestricted rights of copying to these centres in order that they fulfil this function;

(v) to advise the IGBP Secretariat in Stockholm about the progress of the programme.

Dr. Dennis F. Shaw, Chairman of the IFLA Science and Technology Libraries Section, and President of IAUTL (1986-1990) sent us the list of recommended libraries. To date 41 libraries have accepted, and we hope to complete the list of Regional Information Centres in those areas that are now under-represented.

Libraries participating in the IGBP Regional Information Centre Project and Contact Persons

Australia

Mr. Warren Horton, National Library of Australia, Canberra ACT 2600, Tel: (+61-6) 262 1111, Telex: 62100, Telefax: (+61-6) 257 1703.

Dr. Will Steffen, CSIRO, Wildlife and Ecology, PO Box 84, Lyneham, ACT 2602, Tel: (61-6) 242 1755, Telex: 62003, Telefax: (61-6) 241 1742,

E-mail: WLS@CBR.DWE.CSIRO.AU.

Botswana

D.M. Mbaakanye, Secretary, Botswana Library Association, PO Box 1310, Gaborone, Tel: (267) 351 151, x 2297, Telex: 2429.

Bulgaria

Ms. Ann Todorova, Director, Library, Central Library of the Higher Technical Institutes, Boul. Dragan Tzankov 2, Sofia 1000, Tel: (359-2) 665 274, Telex: 66321/423.

Canada

Mr. B. Dumouchel, Canada Institute for Scientific & Technical Information, National Research Council, Ottawa, Ontario KIA 0S2, Tel: (1-613) 993 1600, Telex: 533115 Telefax: (1-613) 952 9112.

China

Mr. Shi Jian, Director, Library of Academia Sinica, International Exchange Section, 27 Wangfujing Dajie, Beijing.

Dr. Qian Zhishen, Director, ISTIS Library, Institute of Scientific and Technical Information of Shanghai, 1634 Huai Hai Zhong Lu, Shanghai 200031, Tel: (86-21) 374 599, Telex: 30306 istis cn, Telefax: (86-21) 433 53 11.

Colombia

Beatriz Céspedes de B., President, Grupo de unidades de información especializada (GUIE), Aptdo. Aereo 12990, Medellín.

Denmark

Dr. Vibeke Manthey, Danmarks Tekniske Bibliotek, Anker Engelunds Vej 1, DK-2800 Lyngby, Tel: (45) 42 88 30 88, Telex: 37148, Telefax: (45) 42 88 30 40.

Finland

Prof. Elin Törnudd, Library, Helsinki University of Technology, Otaniementie 9, SF-02150 Espoo, Tel: (358-0) 45 14 112, Telex: 121591, Telefax: (358-0) 45 14 132.

France

Mme. Francine Masson, Conservateur en Chef, Bibliothèque de l'École Polytechnique, F-91128 Palaiseau Cedex, Tel: (33-1) 60 19 40 42, Telex: 601596, Telefax: (33-1) 69 41 33 92.

Germany

Mr. Jobst Tehnzen, Deputy Librarian, Universitätsbibliothek, Hannover und Technische Info. Bibliothek, Welfengarten 1B, D-3000 Hannover 1, Tel: (49-511) 77 62 22 68, Telex: 922168 Telefax: (49-511) 71 59 36.

Ghana

S.A. Afre, Librarian, University Library, University of Science and Technology, University Post Office, Kumasi, Tel: (233-21) 5351, x 235, Telex: 2555 ust gh.

Hungary

Mr. Peter Szanto, Director of the Library, National Technical Information Centre & Library, P.O.B. 12, H-1428 Budapest, Tel: (36-1) 138 4837, Telex: 22 4944 omikk, Telefax: (36-1) 118 0109.

India

Dr. S.R. Ganpule, Librarian, Indian Institute of Technology Central Library, Powai, Bombay 400 076, Tel: (91-22) 514 1421, Telex: 011 71385 iitb in, Telefax: (91-22) 514 1880.

Dr. Mohinder Singh, Librarian, Indian Institute of Technology, Central Library, Hauz Khas, New Delhi 110016, Tel: (91-22) 663 716, Telex: 31-73087 iit in.

Ireland

S. Phillips, Librarian, Main Library, University College Dublin, Belfield, Dublin 4, Tel: (353-1) 693 244, ext 7694, Telex: 93207.

Israel

Ms. Nurit Roitberg, Director, Elyachar Central Library, Israel Institute of Technology, Technion City, Haifa 32 000, Tel: (972-4) 292 507, Telex: 46650 tecli il, Telefax: (972-4) 233 501.

Japan

Dr. Kakugyo Chiku, Kanazawa Institute of Technology Library Center, 7-1 Ohgigaoka, Nonoichi Ishikawa 921, Tel: (81-762) 462 112, Telex: 5122456, Telefax: (81-762) 486 189.

Mr. Toshihide Katsurauma, Librarian, The Kansai University Library, Chief of Administration, P.O. Box 50 Suita, Osaka 564, Tel: (81-6) 388 1121, ext. 4310, Telefax: (81-6) 330 1464.

Korea, Republic of

Dr. Keon Tack Oh, Secretary, KORDE-LA, Korean Research & Development Library, Room 0411, KIST Library, P.O.B. 131, Cheong-Ryang, Seoul, Tel: (82-2) 962 8801, Telex: 27380, Telefax: (82-2) 963 4013.

Malaysia

Mr. Syed Salim Agha, Chief Librarian, University Pertanian Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Tel: (60-3) 356 101, Telex: 37454 uniper ma, Telefax: (60-3) 948 3745.

Netherlands

Dr. Gerard A.J.S. van Marle, Librarian, University of Twente, Central Library, P.O.B. 217, 7500 AE Enschede, Tel: (31-53) 892 057, Telex: 44200 thtes nl, Telefax: (31-53) 351 805.

New Zealand

Mr. Neil Heinz, Serials Librarian, Serials Unit, University of Auckland Library, Private Bag, Auckland, Tel: (64-9) 737 999, Telex: 21480 unilib, Telefax: (64-9) 334 29.

Nigeria

Mrs. A.O. Ike, Librarian, University Library, Abubakar Tafawa Balewa University, P.M.B. 0248, Bauchi, Bauchi State, Tel: (234-77) 43500/43501/42095.

Norway

Mrs. Randi Gjersvik, Director, Library, The Technical University Library of Norway, Høgskoleringen 1, N-7034 Trondheim-North, Tel: (47-7) 595 110, Telex: 55186 nthhb n, Telefax: (47-7) 595 103.

Poland

Dr. Henryk Szarski, Main Library & Scientific Information Center, Technical University of Wrocław, Wybrzeże S. Wyspińskiego 27, 50-370 Wrocław, Tel: (48-71) 21 27 07 or 20 23 05, Telex: 0715371 bgpw pl, Telefax: (48-71) 22 36 64.

South Africa

Prof. E. D. Gerrits, Universiteit van Pretoria, Merensky Library, Academic Information Service, 0002 Pretoria, Tel: (27-12) 420 2241, Telex: 322723 sa, Telefax: (27-12) 342 2453.

Spain

Ms. Anna M. Planet, Head Science Libraries, Biblioteca de la Universitat de Barcelona, Facultat de Geologia, Biblioteca, C/Marti Franques s/n, Zona Universitària (Pedralbes) E-08028 Barcelona, Tel: (34-3) 318 4266, ext. 2207, Telex: 98871 unb e, Telefax: (34-3) 317 0689.

Sweden

Mr. Jan Rohlin, Director, The Library, Chalmers University of Technology, Chalmers Tvärgata 1, S-412 96 Göteborg, Tel: (46-31) 72 10 00 ex 3744, Telex: 2369 chalbib s, Telefax: (46-31) 16 84 94.

Switzerland

Dr. Karl Böhler, Librarian, ETH-Bibliothek, Gifts Section, Rämistrasse 101, CH-8092 Zürich, Tel: (41-1) 256 2125, Telex: 53178 ethbi ch, Telefax: (41-1) 695 396.

Turkey

Mr. Filiz Cermen, Library Director, Middle East Technical University Library, İnönü Bulvarı 05631, Ankara, Tel: (90-4) 237 100, ext. 2780, Telex: 42761 odtk tr, Telefax: (90-4) 236 941.

United Kingdom

Mrs. Anne Bell, Science Librarian, University of Wales, College of Cardiff, PO Box 430, Cardiff CF1 3XT, Wales, Tel: (44-222) 874 000 ext 4795, Telex: 498635, Telefax: (44-222) 371 921.

Mr. Michael Breaks, Librarian, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, Tel: (44-31) 449 5111.

Dr. Dennis Shaw, Radcliffe Science Library, University of Oxford, Parks Road, Oxford OX1 3QP, Tel: (44-865) 272 839, Telefax: (44-865) 272 705, E-mail: DFSHWA@VAX.OX.AC.UK.

United States

Mr. Glenn Brudvig, California Institute of Technology, Robert A. Millikan Memorial Library, Mail Code I-32, Pasadena, California 91125, Tel: (1-818) 356 6416.

Ms. Miriam A. Drake, Director of Libraries, Georgia Institute of Technology, Price Gilbert Memorial Library, Atlanta, Georgia 30332-0900, Tel: (1-404) 894 4500, Telefax: (1-404) 894 8190.

Dr. Lois M. Pausch, Acting Geology Librarian, University Library, University of Illinois at Urbana-Champaign - Geology Library, 223 Natural History Building, 1301 West Green St., Urbana, Illinois 61801, Tel: (1-217) 333 2676, Telex: 9102450780, Telefax: (1-217) 244 0398 / 6649,

E-mail: PAUSCH@UIUCVMD

Mr. Jay K. Lucker, Director, The Libraries, Massachusetts Institute of Technology, Room 14S-216, Cambridge, Massachusetts 02139, Tel: (1-617) 253 5651, Telex: 174194 mit cam, Telefax: (1-617) 253 8894.

USSR

Dr. Vladimir Viskov, Academy of Sciences of the USSR, Soviet Geophysical Committee, Molodyozhnaya 3, Moscow 117296, Tel: (+7-095) 930 05 46, Telex: 411478 sgc su.

Yugoslavia

Dr. Cveta Perc, Director, Centralna Tehniška Knjižnica, Univerza Edvarda Karjelja v Ljubljani, Tomsicova 7, 61000 Ljubljana, Slovenia, Tel: (38-61) 223 133; 216 795, Telex: 32240 fakstr, Telefax: (38-61) 218 567.

IGBP Report Series

List of IGBP Reports. Those marked with an * are no longer in print and cannot be ordered from the IGBP Secretariat, but they can be consulted through the above libraries.

- * The International Geosphere-Biosphere Programme: A Study of Global Change. Final Report of the ICSU ad hoc Planning Group (1986)
- * Document Prepared by the First Meeting of the IGBP Special Committee (1987)
- * Report from the Second Meeting of the IGBP Special Committee (1988)
- * The International Geosphere-Biosphere Programme: A Study of Global Change (IGBP). A Plan for Action (1988)
- * Effects of Atmospheric and Climate Change on Terrestrial Ecosystems. Compiled by B. H. Walker and R. D. Graetz (1989)
- * Global Changes of the Past. Compiled by H. Oeschger and J. A. Eddy (1989)
- * Report from the First Meeting of the IGBP Scientific Advisory Council. Volumes I and II (1989)
- * Pilot Studies for Remote Sensing and Data Management. Edited by S. I. Rasool and D. S. Ojima (1989)
- * Southern Hemisphere Perspectives of Global Change. Scientific Issues, Re-

search Needs and Proposed Activities. Edited by B. H. Walker and R. G. Dickson (1989)

10.* The Land-Atmosphere Interface. Edited by S. J. Turner and B. H. Walker (1990)

11.* Proceedings of the Workshops of the Coordinating Panel on Effects of Global Change on Terrestrial Ecosystems. Edited by H. A. Nix, R. T. Prinsley, D. M. Stafford Smith, S. J. Turner and B. H. Walker (1990)

12. The International Geosphere-Biosphere Programme: A Study of Global Change. The Initial Core Projects (1990)

13. Terrestrial Biosphere Exchange with Global Atmospheric Chemistry. Edited by P. A. Matson and D. S. Ojima (1990)

14. Coastal Ocean Fluxes and Resources. Edited by P. M. Holligan (1990)

15. Global Change System for Analysis, Research and Training (START). Edited by J. A. Eddy, T. F. Malone, J. J. McCarthy and T. Rosswall (1991)

16. Report from the IGBP Regional Meeting for South America (1991)

17. Plant-Water Interactions in Large-Scale Hydrological Modelling (1991)

18:1 Report of the Recommendations of a Workshop. New Delhi, India. Edited by R. R. Daniel (1991)

Other New IGBP Publications

Colombia

Efectos del Cambio Global en Colombia. Contribucion al IGBP. Bogotá, Academia Colombiana de Ciencias Exactas, Fisicas y Naturales, 1991. 115 pp.

Netherlands

Het systeem van de uitdaging van het International Geosphere Biosphere Programme, door drs. W. Bakker en drs. H. M. van Emden. Den Haag, 1991. 28 pp.

Sweden

Swedish Contributions to IGBP and WCRP. A Report issued by the Swedish National Committee for the IGBP, July 1991. 56 pp. Stockholm, The Royal Swedish Academy of Sciences, Documenta, 54.

JGOFS

Report of Second Session of the Joint JGOFS-CCCOPanel on Carbon Dioxide. 22-26 April 1991, Paris, France. SCOR/ICSU/Unesco, 1991. 39 pp.

Publications received:

Global Energy and Water Cycle Experiment (GEWEX). Report of the Third Session of the JSC Scientific Steering Group for GEWEX (Hamilton, Bermuda, 21-25 January 1991). World Climate Research Programme, 1991. (WCRP-57)

Hydrological Interactions Between Atmosphere, Soil and Vegetation. G. Kienitz, P.C.C. Millty, M. Th. van Genuchten, D. Rosbjerg & W. J. Shuttleworth (Eds). Wallingford: International Association of Hydrological Sciences, 1991. 494 pp. (IAHS Publication, 204). *Papers presented at the Symposium of the same name held during the XXth General Assembly of the International Union of Geodesy and Geophysics at Vienna, August 1991.*

Climate Change: Science, Impacts and Policy. Proceedings of the Second World Climate Conference. J. Jäger & H. L. Ferguson (Eds). Cambridge: Cambridge University Press, 1991. 567 pp.

The Earth as Transformed by Human Action. Global and Regional Changes in the Biosphere over the Past 300 Years. B.L. Turner II, William C. Clark, Robert W. Kates, John F. Richards, Jessica T. Mathews, & William B. Meyer (Eds). Cambridge: Cambridge University Press with Clark University, 1990. 713 pp.

New Global Environmental Change Periodicals:

Global Environmental Change. Human and Policy Dimensions. Volume 1, Number 1, December 1990. Edited by Professor J. K. Mitchell, Rutgers University, USA. Published quarterly by Butterworth-Heinemann, Westbury House, Bury Street Guildford, Surrey, UK.

Global Environmental Change is an international journal that addresses the human ecological and public policy dimensions of the environmental processes which are threatening the sustainability of life of Earth. The topics of the papers include, but are not limited to, deforestation, desertification, soil degradation, species extinction, sea level rise, acid precipitation, destruction of the ozone layer, atmospheric warming/cooling, nuclear winter, the emergence of new technological hazards, and the worsening effects of natural disasters. A back-up section includes reports on news of the United Nations University in the area of global environmental change, book reviews, conference reports, announcements of new scientific publications, a meetings calendar.

Global Environmental Change Report. Volume 1, Number 1, December 1989. Edited by Bradford J. Hurley. Published twice a month by the Cutter Information Corporation, 37 Broadway, Arlington, Massachusetts, USA.

The Global Environmental Change Report is an 8-page newsletter that provides concise coverage of policy trends, industry developments, and scientific findings related to climate change, strat-

ospheric ozone depletion, deforestation, and acid rain. It is intended for scientists, engineers, industry executives and policy makers. Subscribers to the newsletter also receive Regional Reports on critical areas of the world, a document service describing new documents and how to order them, a calendar of important meetings and conferences around the world, and a hotline to provide answers to specific questions.

IGBP and Related Meetings

IGBP Meetings

1991

16-19 October, Cambridge, UK

Joint Global Ocean Flux Study (JGOFS) Southern Ocean Modelling Workshop

17 October, Château de Bonas (Toulouse), France

Land-Ocean Interactions in the Coastal Zone (LOICZ) Core Project Planning Committee

11-15 November, Canberra, Australia

Global Change and Terrestrial Ecosystems (GCTE) Scientific Steering Committee

30 November-1 December, Vienna

3rd Meeting of the Standing Committee for Global Change System for Analysis, Research and Training (START)

2-4 December, Canberra, Australia

Working Group on Microscale to Mesoscale Hydrology: Biological Aspects of the Hydrological Cycle (BAHC) Focus 1

9-10 December, San Francisco, USA

International Global Atmospheric Chemistry (IGAC) Scientific Steering Committee

12-14 December, Singapore

Asian IGBP National Committees. Dr. A. N. Rao, Department of Botany, National University of Singapore, Lower Kent Ridge Road, Singapore 0511, Singapore, Fax: (65) 779 5671

December, New York City, NY, USA

Working Group on Continental Integration BAHC Focus 3

1992

8-10 January, Tokyo, Japan

3rd Meeting of the Officers of the Scientific Committee for the IGBP

13-17 January, Thailand

IGBP Regional Global Change Meeting for South East Asia

13-14 February, Paris, France

IGBP-BAHC/WCRP-GEWEX Joint Working Group on Land-Surface Experiments/BAHC Focus 2 on large Scale Experiments

4-6 April, Munich, Germany

4th Meeting of the Scientific Committee for the IGBP

27-30 April, Berlin, Germany

Second Meeting of the Scientific Steering Committee for BAHC

1-5 June, Uppsala, Sweden

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

21-24 July, Saskatoon, Canada

GCTE Workshop "Global Change and Agriculture: Modelling the Wheat Ecosystem"

27-31 July, Tallinn, Estonia

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

Niamey, Niger (date to be announced)

IGBP Regional Conference for Africa

1993**January/February**

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

November, Seattle, WA, USA

GCTE Workshop on Global Change and Forestry

IGBP-Related Meetings 1991**6-11 October, Beaverton, OR, USA**

NATO Advanced Research Workshop: Global Cycle of Methane - Sources, Sinks, Distributions and Role in Global Change. Prof. M. Khalil, Oregon Graduate Center, Institute of Atmospheric Sciences, 19600 NW Von Neumann Drive, Beaverton, OR 97006-1999, USA

13-15 October, Kona, Hawaii, USA

Second Pacific International Space Year Conference

14-15 October, Berlin, Germany

2nd German National IGBP Symposium

14-17 October, Château de Bonas (Toulouse), France

NATO Advanced Research Workshop: The Impacts of Global Change on Coastal Oceans. Dr. Patrick Holligan, Plymouth Marine Laboratory, Prospect Place, Plymouth PL1 3DH, UK

15-19 October, Clemson, SC, USA

NATO Advanced Research Workshop: Climate Change - The Biological Implica-

tions. Prof. K. Peterson, Clemson University, Dept. of Biological Sciences, Clemson, SC 29634, USA.

22-23 October, Washington, D.C., USA

Earth Observations & Global Change Decision Making: A National Partnership. NASA/NOAA/ERIM Conference. Dr. Robert H. Rogers, P.O. Box 134001, Ann Arbor, MI 48113-4001, USA, Fax: (313) 994 5123.

28 October-1 November, Cuzco City, Peru

Society of Latin American Specialists in Remote Sensing (SELPER) Fifth Symposium on Remote Sensing. Dr. W. Danoy Arias, SELPER, Capitulo peruano, Apartado Postal 4992, Lima, Peru, Tel: (51-14) 410 425.

6-8 November, Kyoto, Japan

International Energy Agency Conference on Technology Responses to Global Environmental Challenges: Energy Collaboration for the 21st Century. Research Institute of Innovative Technology for the Earth, Shin-kyoto Center Bldg, Karasumanishi-iru, Shiokouji-dori, Shimogyô-ku, Kyoto 600, Japan

11-17 November, Lake Arrowhead, CA, USA

NATO Advanced Research Workshop: Modelling Sustainable Development and Global Environmental Change. Prof. R. Berk, UCLA Center for the Study of the Environment & Society, Dept. of Sociology, UCLA, 405 Hilgard Ave, Los Angeles, CA 90024-1551

16-18 November, Washington, DC, USA

Global Change and the Human Prospect. issues in Population, Science, Technology, and Equity. Nancy Berry, Sigma Xi, P. O. Box 13975, Research Triangle Park, North Carolina, 27709, USA, Fax: (1-919) 549 0090

24-29 November, Vienna, Austria

Agenda of Science for Environment and Development into the 21st Century (ASCEND 21). ICSU, in cooperation with the Third World Academy of Sciences

2-4 December, The Hague, Netherlands

4th Meeting of the International Group of Funding Agencies (IGFA)

2-4 December, Kyoto, Japan

International Symposium on Diversity and Flexibility of Biotic Communities in Fluctuating Environments, Kyoto University, Kyoto.

2-6 December, Baltimore, Maryland, USA

The Chemistry of the Atmosphere: Its Impact on Global Change. International Union of Pure and Applied Chemistry World Conference. CHEMRAWN VII Secretariat, c/o Amer-

ican Chemical Society, Room 205, 1155-16th Street, NW, Washington, D.C. 20036, USA

6-9 December, New Delhi, India

IGU Seminar on Monitoring Geosystems: Perspectives for the 21st Century. Dr. R. B. Singh, Department of Geography, Delhi School of Economics, University of Delhi, New Delhi 110 007, India. Fax: (91-11) 672 427

8-14 December, New Delhi, India

International Conference on Land-Water Interactions. Dr. Brij Gopal, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110 067, India, Fax: (91-11) 686 5886.

8-13 December, Berlin, Germany

66th Dahlem Workshop, Global Changes in the Perspective of the Past

9-10 December, Herdon, VA, USA

Committee on Earth Observation Satellites Plenary Meeting

1992**5-10 January, Irvine, CA, USA**

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

14-16 January, Cambridge, MA, USA

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

20-26 January, Sevilla, Spain

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

27-31 January, Bermuda Biological Station, Bermuda

NATO Advanced Research Workshop: Biogeochemical Ocean Atmosphere Transfers. Prof. R. Prinn, Massachusetts Institute of Technology, 54-1312, Center for Global Change Science, Cambridge, MA 02139, USA

27 January-1 February, Fortaleza, Brazil

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

4-5 February, Tokyo, Japan

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

2-5 March, Chambéry, France

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

3-6 March, Amsterdam, Netherlands

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

4-6 March, Havana, Cuba

International Scientific Colloquium on Space Observations. Prof. Dr. Ramón Pomés Hernández, Comision Cubana para el Espacio, Academia de Ciencias de Cuba, La Habana 10200, Cuba, Fax: (537) 22 83 82

4-7 March, Lima, Peru

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

22-27 March, Garmisch-Partenkirchen, Germany

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

23-27 March, Hilo, Hawaii, USA

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

24-27 March, Palaiseau, France

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

27-29 March, Waseda University, Tokyo, Japan

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

30 March-4 April, Munich, Germany

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

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

NATO Advanced Research Workshop: Biogeochemical Modelling in the Ocean. Dr.

Geoff Evans, Institut für Meereskunde, JGOFS CPO, Universität Kiel, Düsternbrooker Weg 20, 2300 Kiel 1, Germany

26-29 May, Houston, TX, USA

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

1-12 June Rio de Janeiro, Brazil

United Nations Conference on Environment and Development

22-26 June, Genoa, Italy

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

28 August-9 September, Washington, D.C., USA

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

14-18 September, Bristol, UK

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

21-25 September Kiel, Germany

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

1-5 November, Reno, Nevada, USA

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

2-6 November, Accra, Ghana

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

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

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

11-13 July 1993, Yokohama, Japan

International Association of Hydrological Sciences (IAHS) and the International Association of Meteorology and Atmospheric Physics (IAMAP)

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