GLOBAL CHANGE

IGBP

REPORT No. 2 1987

A Document Prepared by the First Meeting of the Special Committee ICSU Secretariat, Paris 16–19 July, 1987

The International Geosphere-Biosphere Programme: A Study of Global Change (IGBP)

GLOBAL CHANGE

IGBP

REPORT No.2 1987

A Document Prepared by the First
Meeting of the Special Committee
ICSU Secretariat, Paris
16–19 July, 1987

The International Geosphere-Biosphere Programme: A Study of Global Change (IGBP)

During 1987, the planning of the IGBP has been financially supported by generous grants from ICSU, the Government of Sweden and the Andrew W. Mellon Foundation. This support is gratefully acknowledged.

ISSN 0284-8015

INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME: A STUDY OF GLOBAL CHANGE (IGBP)

A document prepared by the first meeting of the Special Committee
ICSU Secretariat, Paris
16 - 19 July, 1987

PREAMBLE

In September 1986, ICSU General Assembly decided to start the planning of a new major transdisciplinary research programme, the "International Geosphere-Biosphere Programme - A Study of Global Change" (IGBP). In January 1987, the ICSU Executive Board appointed a Special Committee for IGBP.

The decision by the ICSU General Assembly was based on a report of an ad hoc planning group, first chaired by Sir John Kendrew, President of ICSU, and later by Professor Bert Bolin. The decision to set up this planning group followed a resolution of the 20th General Assembly of ICSU (Ottawa, 1984), at which time a symposium on "Global Change" was arranged, the proceedings of which were edited by T.F. Malone and J.G. Roederer (Cambridge University Press, 1986).

The work of the Planning Group was aided by four Ad Hoc Working Groups appointed in October 1983. The following groups prepared reports, which were crucial in the development of the Kendrew/Bolin study:

- Terrestrial Ecosystems and Atmospheric Interactions
- Marine Ecosystems and Atmospheric Interactions
- Geological Processes - Past and Present
- Upper Atmosphere and Near Space Environment.

In addition, COSPAR appointed a Working Group on Remote Sensing, the report from which was also a major input to the deliberations of the Ad Hoc Planning Group.

This report constitutes the first step towards the formulation of a Global Change research programme following the decision of the ICSU General Assembly. It contains a brief account of the discussions and decisions taken at the first meeting of the Special Committee for IGBP. As such it is hoped that it will be an inspiration for individual scientists, ICSU Unions and Committees as well as relevant UN organizations and other bodies to join force in the development the most crucial international transdisciplinary research effort ever to be undertaken.

OBJECTIVES

The meeting confirmed the overall objectives of IGBP as set out in the report to the ICSU General Assembly in Bern:

"To describe and understand the interactive physical, chemical, and biological processes that regulate the total Earth system, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human actions.

In concentrating on interactive biological, chemical, and physical processes the IGBP will of necessity put less emphasis on studies that, though they have great strengths and momentum of their own, are already being addressed in existing initiatives, or that will less clearly contribute to our understanding of the changing nature of the environment of life on timescales of decades to centuries. Priority in the IGBP will therefore fall on those areas of each of the fields involved that deal with key interactions and significant change on time scales of decades to centuries, that most affect the biosphere, that are most susceptive to human perturbation, and that will most likely lead to practical, predictive capability."

GOAL

Thus, with an improved understanding of the system, a primary goal of the Programme is to advance our ability to predict change in the global environment. The development of this capability will require cooperative and complementary efforts with climate modellers in order to incorporate

the appropriate level of understanding for relevant global biological, geological, and chemical processes into physical models of the earth system.

Accordingly, initial emphasis in the Programme will be to obtain the information that is necessary to understand more completely the cycling of key elements among the terrestrial ecosystems, the oceans and the atmosphere, taking into consideration the natural and anthropogenic factors affecting these cycles, and the interactive effects of climate-induced feedbacks within and between biosphere and atmosphere.

UNDERLYING THEMES

To ensure that the research efforts central to the IGBP are consistent with the objectives of the Programme, certain underlying themes require special emphasis:

A. Documenting and predicting global change by:

   i) Collecting and analysing data to enable the identification of natural processes that lead to global change and the effects of such changes;
   ii) including, in predictive models, the knowledge of past changes, understanding of couplings between biogeochemical processes and the physical climate system; and information about current plus anticipated anthropogenic impacts on the Earth system.

B. Observing and improving our understanding of dominant forcing functions by assessing:

   i) The magnitude and significance of external forcing by solar and orbital variations and earth crust-mantle phenomena;
   ii) indeterminate natural forcing due to inherent short-term instabilities in the Earth system;
   iii) anthropogenic forcing attributable to changes in atmospheric chemical composition as well as changes in land and water use.

C. Improving our understanding of transient phenomena in the total Earth system by:

i) Developing descriptions of non-linear interactions among physical, chemical and biological components of this system, which have global consequences; and
ii) quantifying their potential to generate rapid changes from slow forcing and sharp spatial gradients from large-scale forcing.

D. Assessing the effects of global change that would cause large scale and important modifications affecting the availability of renewable and non-renewable resources by:

i) Studying sensitive regions in which rapid changes are taking place because of man's exploitation of earth resources;
ii) Using our improved knowledge of global change to understand and predict effects at the regional scale.

INTERACTION WITH OTHER ONGOING AND PLANNED RESEARCH PROGRAMMES

It is obvious that success in developing the Programme will require that we take into consideration other research programmes and plans being developed by several other international groups of scientists engaged in research on underlying themes of the future Programme. The Special Committee recognizes the need for the establishment of effective working relations with several of these groups, within and outside of ICSU, engaged in problems of solar terrestrial physics, atmospheric chemistry, terrestrial and marine ecosystems, soil processes, Quaternary geology, etc.

The first steps in this direction have been taken at the first meeting of the Special Committee and several specific groups will be asked for collaborative assistance. Other groups will become closely involved as the plans develop. It is envisaged that apart from the core Programme, to be planned and implemented by the Special Committee, supporting Global Change activities will be carried out under the authority of other organizations. In order to facilitate broad discussion relating to opportunities for the

Programme, a Scientific Advisory Council meeting will be called by the Special Committee on 24-28 October, 1988. Invitations to this meeting will be sent to National Committees for the Programme, ICSU National Members and Scientific bodies. In addition, representatives of other international scientific organizations will be invited to attend.

INTERACTION WITH NATIONAL IGBP COMMITTEES

National Committees for IGBP have to date been established in eleven countries and several others are in the process of being formed. These will be essential focal points for the development of the IGBP and close links between national and international efforts must be ensured. It is expected that an international core research programme will be developed by the Special Committee and the national committees will be invited to take an active part in the core programme during the implementation phase but also to contribute to the development of the programme. In addition, it is expected that supporting activities will be initiated at the national level without direct formal coordination through the Special Committee. This two tier structure will ensure the initiation of a wide variety of relevant research activities while still focusing at the international level on a tightly coordinated research programme.

In particular, the national committees are invited to:

- consider the underlying themes as presented in this report and put them into a national and regional perspective in order to identify appropriate national intiatives and programme components. They should ensure to keep the Executive Director informed of any such plans and are invited to comment on the themes from a national perspective.

- consider the topics for initial Coordinating Panels and Work Groups as established during the first meeting of the Special Committee (see below). They are invited to get in contact with the respective chairmen, with a copy to the Executive Director, with comments on the topics as described in this report. National initiatives are encouraged to strengthen the international efforts.

- comments on priorities for additional Coordinating Panels and Work Groups for possible action at future meetings of the Special Committee.

IGBP INITIAL ACTIVITIES

The Special Committee decided on a number of initial priority areas, which need further study to help develop the future research programme. These are neither all inclusive nor exclusive, but the Committee felt that the problem areas mentioned below merit immediate attention. In order to chart the course for further action, Coordinating Panels and Working Groups were established. Preliminary reports on the deliberations of these groups will be received by the Special Committee at its next meeting on 8-12 February, 1988, when decisions will be taken on how to proceed on these topics. At that time, developments may be initiated in other areas as well. Progress reports on the work will be delivered to the first Scientific Advisory Council meeting.

Coordinating Panels are set up in areas where the Special Committee has identified the need for development of research objectives and proposed contents of IGBP research projects. Special Committee members have been appointed to the Panels and other experts will be invited to take part in the work.

Working Groups are set up to assess current status of knowledge and future prospects for Programme activities (through, e.g., Study Conferences) in areas of interest to the IGBP. Special Committee members have been appointed to the Working Groups and others will be invited to serve.

The following Panels and Working Groups have been set up:

Coordinating Panels on:
- Terrestrial Biosphere - Atmospheric Chemistry Interactions
- Marine Biosphere - Atmosphere Interactions
- Biospheric Aspects of the Hydrological Cycle
- Effects of Climate Change on Terristrial Ecosystems

Working Groups on:
- Global Geosphere-Biosphere Modelling
- Data and Information Systems
- Techniques for Extracting Environmental Data of the Past
- Geo-Biosphere Observatories

The rationale for the topics for these groups are given below:

Coordinating Panels

Coordinating Panel on Terrestrial Biosphere - Atmospheric Chemistry Interactions

Identification of the significant biospheric sources and sinks of chemical trace gases in the atmosphere are important for understanding regional and global atmospheric chemistry and its impact on climate. There is a need to study the fundamental processes underlying the emissions in relevant ecosystems including parameterisation of these for use in global models and, ultimately, global predictions. Field experimental protocols and intercomparison between observational techniques need to be developed. Important gases that can now be clearly identified are: CH_4, CO, non-methane hydrocarbons, NO_x and N_2O.

For a proper understanding if geosphere-biosphere interactions, the Special Committee has identified the essential need for research on chemical meteorology. The plans by the Commission on Atmospheric Chemistry and Global Pollution (CACGP) for an international global tropospheric chemistry programme is welcomed with enthusiasm. Likewise, a strong link should be established with the middle atmospheric research community to insure a strong international programme in this area.

The following Special Committee members were appointed to the Coordinating Panel:
- P.J. Crutzen (Chairman)
- M.-L. Chanin
- R. Herrera
- T. Nemoto
- S.I. Rasool

Coordinating Panel on Marine Biosphere - Atmosphere Interactions

The global aspects of marine ecosystems of primary concern to the IGBP are the interplay between physical, chemical and biological processes in the euphotic zone, the photosynthetically active upper layer of the ocean.

Important questions relate to anticipated changes in the radiation budget of the Earth's surface, brought about by the changing atmospheric concentrations of anthropogenic trace gases and their effect on the seasonal cycle of convection and ventilation in the upper ocean. It is important to know the consequences of these changes in euphotic zone physics and their effect on global biogeochemical cycles, including feedback to atmospheric concentrations of radiatively active trace gases of biogenic origin. These feedback loops between climate, ocean primary production and ocean CO_2 storage depend on global as well as regional characteristics of the biogeochemical cycles of carbon, nutrients and key trace elements and on the climate control of the physical environment in the euphotic zone. A much better knowledge of the basic processes that couple physics, chemistry and biology in the sea, based upon in situ and remote sensing methods of observation, is needed to make it possible to understand and to model this component of the global system.

The development of a research plan will take into account the plans of SCOR to develop a Joint Global Ocean Flux Study (JGOFS).

The following Special Committee members were appointed to the Coordinating panel:

- B. Bolin
- T. Nemoto
- S.I. Rasool
- J.D. Woods

Coordinating Panel on Biospheric Aspects of the Hydrological Cycle

To identify changes in the reservoirs and fluxes of the hydrological cycle, and hence in the distribution of water on the earth, we need improvement in the formulation of GCM's, particularly with regard to the role of vegetation in the parameterisation of the subgrid-scale hydrologic processes.

Vegetation plays a major role in transporting water from the soil to the atmosphere. In view of the essential role of water vapour in GCM's, changes in vegetation cover will have an impact on the climate. Soil characteristics and root geometry will determine rates of water loss from the soil to the atmosphere. In order to improve GCM's and to assess possible climatic impacts of major vegetation changes, induced naturally or through land management activities, there is a need for interactive models of water transport, linking soil-vegetation with the atmosphere. In developing a possible research role for IGBP on this topic, it is essential to have close links to other relevant programmes, such as GEWEX (WCRP) and ISLSCP (COSPAR-IAMAP). To understand large changes in regional hydrology, palaeoclimatic information on past climatic and hydrologic regimes is also needed.

The following Special Committee members were appointed to the Panel:

- S. Dyck (Chairman)
- V.M. Kotlyakov
- B.H. Walker

Coordinating Panel on Effects of Climate Change on Terrestrial Ecosystems

There is a need to understand the effects of climate change on the soil, vegetation structure and species composition of terrestrial ecosystems, both directly and through changes in ecosystem processes (e.g., nutrient cycling, primary productivity) and demographic processes. The rates of ecosystem change will differ between different regions of the world. It will become necessary to understand the mechanisms that determine

the lag times in the responses of ecosystems to various types of climate change. Furthermore, it is likely that changes in vegetation will be brought about more by a change in variation and extreme weather events than by average changes.

Such studies of change in ecosystems should focus on the properties of vegetation and soil which will feedback to the global environment (for example through changes in the fluxes of water and biogenic trace gases). It is necessary to consider both natural ecosystems and those affected by man.

The following Special Committee members were appointed to the Panel:

- B.H. Walker (Chairman)
- R. Herrera
- V.M. Kotlyakov
- J.S. Singh
- D.Z. Ye

Working Groups

Working Group on Global Geosphere-Biosphere Modelling

Models of the present characteristics of the essential linkages between the geosphere and the biosphere and those changes in transfer rates of energy and matter resulting from natural and anthropogenically induced global change will be essential in the process of developing the IGBP. They will in a long-term perspective be fundamental for the synthesis of research achievements of the Programme. Furthermore, they will be of importance both with regard to scientific understanding and for increasing knowledge of how to assess possible future environmental changes both on global and regional scales.

It is essential in the early phase of the development of the IGBP to bring together scientists who are engaged in developing global geosphere-biosphere models (GBM's), with due regard to internal processes in the geosphere-biosphere system and to boundary conditions set by solar radiation

penetrating through the upper atmosphere and by the solid earth. Also, the knowledge and experience gained in the process of developing Global Climate Models (GCM's) should obviously be brought in when attempting to broaden the modelling of the earth system.

A Study Conference on Global Geosphere-Biosphere Modelling will be arranged in 1988 or in the beginning of 1989. The Conference will review global models (e.g., of major biogeochemical cycles) as well as submodels for major components (atmosphere, oceans, vegetation). Emphasis will be placed on the problem of how to deal with the interaction of physical, chemical and biological processes in the framework of analyses of the quasi-steady state aspects of the system and its variations over about the last 100,000 years.

The following Special Committee members were appointed to the Working Group:

- B. Bolin (Chairman)
- E.S. Diop
- J.A. Eddy
- J.D. Woods

Working Group on Data and Information Systems

An important theme of the IGBP is that of documenting global change, both in real time and through the reconstruction of past changes in the global environment. One measure of the success of the Programme will be whether scientists in 20 or 30 years time will have available to them the essential records (such as that of the global changes in atmospheric CO_2, in ozone, the solar constant, etc.) that will be necessary to document significant global changes in the geosphere-biosphere that have occurred and are occurring. This task will consider aspects of planning, data collection (for space and on the ground and on the sea, as well as historical records), quality control, and data storage and dissemination. To this end a Study Conference on observing systems and methods for data and information extraction and dissimination will be organized to consider:

i. Current remote sensing and surface observing networks

ii. The selection of key parameters that need to be documented;

iii. Assessment of data sets already available;

iv. Specifications of requirements for calibration and inter-comparison;

v. The preparation of appropriate data sets;

vi. Development of methods to obtain remote-sensing data (collected through, e.g., satellites) and to make these data accessible to the international scientific community;

vii. Avenues of rapid data dissemination;

Note was taken of the interest expressed by the World Data Centres (and the ICSU Panel on WDC) and other organizations, such as CODATA.

The following Special Committee members were appointed to a Working Group for the planning of a Study Conference tentatively scheduled for the USSR in August 1988:

- S.I. Rasool (Chairman)
- S. Dyck
- W.S. Fyfe
- V.A. Troitskaya

Working Group on Techniques for Extracting Environmental Data of the Past

Abiotic and biotic processes contribute to the formation and preservation of information in ice cores, tree rings, sediments, etc. that can reveal past change in the Earth environment on time scales of days to thousands of years. These natural records include information on solar variations, volcanism, global ice volume, etc., from which inference can be drawn relating to physical climate dynamics and biogeochemical processes.

There is a need to assess the present state of the art and anticipated technological developments, which will extend and refine these reconstructions, to assist in the implementation of new technologies, and to assist in the interpretation of the history of the geosphere-biosphere.

The following Special Committee members were appointed to the Working Group:

- H. Oeschger (Chairman)
- M.-L. Chanin
- E.S. Diop
- J.A. Eddy
- W.S. Fyfe

Working Group on Geo-Biosphere Observatories

There is a need for coordinated land-based measurements of geosphere-biosphere processes. It is necessary to assess how this can most efficiently be carried out. A network of geo-biosphere observatories across ecosystem-biome types is one possibility for generation of long-term data sets, ecosystem experimentation, validation of models, and ground truth for remote sensing. They could also serve as regional research and study centres. If there is validity in the network concept then a candidate list of parameters to be measured as well as the general principles for observatory siting and duration need to be determined. Two kinds of sites may be desirable: biosphere reserves such as the ones recommended by SCOPE/MAB (Jan. 1987), and others in regions where rapid change is expected to occur. Such a future network could be based on existing sites as well as new ones identified on the basis of the research needs of the IGBP.

Observatories, and exchange of scientists between observatories, could play a vital role in technique development, control of data quality and data management, and perhaps most importantly in the catalysis of inter-disciplinary and international science.

The following Special Committee members were appointed to the Working Group:

- R. Herrera (Chaiman)
- E.S. Diop
- W.S. Fyfe
- V.M. Kotlyakov

THE SPECIAL COMMITTEE

The members of the Special Committee have been appointed by the ICSU Executive Board. At its first meeting, the Special Committee elected an Executive Committee. The composition of the Special and Executive Committees and brief Curricula Vitarum of their members are as follows:

Executive Committee

Chairman:

James J. MCCARTHY, Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138, USA. Tel: (617)495 2330, Telex 258127 MCZL UR, Electronic mail: OMNET, Telemail: J.McCarthy.

Born 1944; Professor of Biological Oceanography, Director of the Museum of Comparative Zoology, and Associate Dean for Natural Sciences, Harvard University. Served on the Ad Hoc U.S. Committee for the International Geosphere-Biosphere Programme and the NASA Earth System Science Committee. Member of the NRC Ocean Studies Board. Research interests include processes that regulate marine production.

Vice-Chairman:

Rafael HERRERA, Centre for Ecology and Environmental Sciences, IVIC Apartado 21827, Caracas 1020A, Venezuela. Tel: (1)69 19 49 or 681 1188 ext. 280, Telex: 21657 IVICB VC or 21338 VC.

Born 1942; Member of the research staff at Instituto Venezolano de Investigaciones Cientificas (IVIC) since 1968. Vice-president of IVIC (1983-1986), currently Professor at the Centre for Ecology and Environmental Sciences, coordinator of Graduate Studies in Ecology. Member of Technical Commission in Biology, National Academy of Sciences (Venezuela). Research interest in the fields of biogeochemical cycles with direct experience in tropical forests, agroecosystems and large rivers.

Treasurer:

William S. FYFE, Department of Geology, The University of Western Ontario, London, Ontario N6A 5B7, Canada. Tel: (519)661 3041, Telex: 0647134 UWO LIB LDN.

Born 1927; Dean of Science, University of Western Ontario. Former Professor of Chemistry, Otago, New Zealand, Professor of Geology, University of California, Berkeley; Royal Society Research Professor, Manchester - Imperial College, U.K, Fulbright Scholar, Guggenheim Fellow (twice). Logan Medal, Geological Association of Canada. Miller Medal, Royal Society of Canada. Fellow of the Royal Society, London and Royal Society, Canada. Research interests include geochemistry, global resources and the global environment.

Executive Director:

Thomas ROSSWALL, Royal Swedish Academy of Sciences, P.O.B. 50005, S-104 05 Stockholm, Sweden. Tel: (8)15 04 30 (exch.) or 16 64 48 (direct), Telex: 17509 IGBP S, Telefax: (8)16 64 05, Electronic mail: OMNET, Telemail: T.Rosswall or USDA (Telemail) TRosswall.

Born 1941; Professor at the Department of Water in Environment and Society, University of Linköping, Sweden, and previously Associate Research Professor, Swedish University of Agricultural Sciences. Past Chairman of ICOME (International Committee on Microbial Ecology of IUMS/IUBS), Secretary-General of SCOPE (Scientific Committee on Problems of the Environment of ICSU) and Secretary of the UNEP/Unesco/ICRO Panel of Microbiology. Research in the fields of microbial ecology and biogeochemical cycles, especially nitrogen.

Other members of the Executive Committee

Paul J. CRUTZEN, Max Planck Institute for Chemistry, P.O. Box 3060, D-6500 Mainz, Federal Republic of Germany. Tel (6131)30 54 58/9, Telex: 4187674 MPCH D, Telefax (6131)30 53 88.

Born 1933; Member of the Max-Planck-Society and Director, Atmospheric Chemistry Division, Max-Planck-Institute for Chemistry, Mainz, F.R.G.;

Professor at the Department of Geophysical Sciences of the University of Chicago. Former Director of Atmospheric Quality Division at NCAR, Boulder, Colorado (1977-1980). Member, Commission on Atmospheric Chemistry and Global Air Pollution (CACGAP) of IAMAP; member, Executive Committee of SCOPE (Scientific Committee on Problems of the Environment) of ICSU. Foreign Honorary Member of the American Academy of Arts and Sciences. Research in the fields of global atmosphere chemistry/troposphere and middle atmosphere.

Vladimir M. KOTLYAKOV, Institute of Geography of the USSR Academy of Sciences, Staromonetny per. 29, Moscow, 109017 USSR. Tel: 238 8610, Telex: 411478 SJC SU.

Born 1931; Director of the Institute of Geography of the USSR Academy of Sciences, Chairman of the National Committee of Soviet Geographers. Corresponding Member of the Academy of Sciences of the USSR. Member of the Board of the International Commission of Snow and Ice. Vice-President of the International Association of Hydrological Sciences. Research on problems of theory and methodology of glaciological research.

Other Members of the Special Committee:

Bert BOLIN, Department of Meteorology, University of Stockholm, S-106 91 Stockholm, Sweden. Tel: (8)15 77 31, Telex: 15959 MISU S, Telefax: (8)15 71 85, Electronic mail ONMET, Telemail: MISU.IMI.

Born 1925; Professor of Meteorology at the University of Stockholm, Sweden, Director of the International Meteorological Institute in Stockholm. Former Scientific Director of the European Space Research Organization (1965-1967) and Vice-President of the Natural Science Research Council of Sweden (1974-1980). Member of the Royal Swedish Academy of Sciences, the Swedish Academy of Engineering, Norwegian Academy of Science. Received the OMI Prize 1982 (World Meteorological Organization). Research in the fields of dynamical meteorology and numerical weather forecasting, atmospheric chemistry, biogeochemistry.

Marie-Lise CHANIN, Service d'Aeronomie du CNRS, B.P. 3, F-91371 Verriers le Buisson Cedex, France. Tel: (1)6920 0794 or (1)6920 1060 ext. 275, Telex: 692400 AERONO, Telefax: (1)6920 2999.

Born 1934; Director of Research at the French National Centre of Scientific Research. Director of the Department "Middle Atmosphere" at the Service d'Aéronomie du CNRS, France. President of the French Committee of Geodesy and Geophysics. Member of the Interdisciplinary Commission on Meteorology of the Upper Atmosphere (ICMUA) of IAMAP. Research fields include aeronomy of the upper atmosphere, physics and dynamics of the middle atmosphere and solar induced atmospheric variability.

El Hadji Salif DIOP, Department of Geography, University of Dakar, Dakar, Fann, Senegal. Tel: 216 370 or 225 073 ext. 136, Telex: 262 UNIV DAK SG.

Born 1950; Associate Professor at the Department of Geography, University of Dakar, Senegal. President of EPEEC (Pluridisciplinary Team of Coastal Ecosystems Study). President of ICQUA/INQUA (Intercongress Committee for the Quaternary of Africa of the International Union for Quaternary Study). Member of the Scientific Committee of the I.G.C.P./I.U.G.S. (International Geological Correlation Programme/International Union for Geological Sciences, Unesco, Earth Science Division). Research especially in the field of coastal research, estuaries, paleoecology and the Quaternary development of mangroves.

Siegfried DYCK, Division of Hydrology and Meteorology, Dresden Technical University, Mommsenstraße 13, Dresden 8027, German Democratic Republic. Tel: (51)463 39 31, Telex: 02278.

Born 1926; Professor of Hydrology, Dresden University of Technology, Director Department of Water Sciences. Member of the Meteorological and Geographical Society of the GDR. Member of the Scientific Council of Fundamentals of the Environmental Protection. Corresponding Member of the Academy of Sciences of the GDR. Delegate of the GDR for the Science Commission of the General Conference of Unesco since 1974.

John A. EDDY, Office for Interdisciplinary Earth Studies, UCAR, P.O.B. 3000, Boulder, CO 80307, USA. Tel: (303)497 1680, Telex: 989764 NCAR BDR UD, Telefax: (303)497 1137, Electronic mail OMNET, Telemail: J.Eddy.

Born 1931; Director of the Office for Interdisciplinary Research at the University Corporation for Atmospheric Research in Boulder, Colorado; an office founded in 1986 "to facilitate research between the atmospheric sciences and adjacent disciplines". President of the Commission on the History of Astronomy of the IAU and the recipient, in 1987, of the Arctowski Medal of the US National Academy of Sciences. Research interests include solar physics, the history of solar behaviour and of climate and the history of astronomy and archaeoastronomy.

Takahisa NEMOTO, Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164, Japan. Tel: (3)376 1251, Telex: 25607 ORIUT J, Telefax: (3)375 6718, Electronic mail OMNET, Telemail ORI.Tokyo.

Born 1930; Director of the Ocean Research Institute, University of Tokyo. Chairman of the Japanese National Committee for IOC. Member of the Japanese National Commission for Unesco. Executive Secretary of the BIOMASS Programme, and member of SCAR/SCOR/IABO/ACMRR specialist group of Antarctic ecosystem and its living resources. Member of Commission of Ecology in IUCN. Awarded a gold medal of "La Societé Franco-Japonaise d'Oceanographie (1987)". Research in the areas of biological oceanography and plankton dynamics.

Hans OESCHGER, Institute of Physics, University of Bern, Sidlerstraße 5, CH-3012 Bern, Switzerland. Tel: (31)65 85 11, Telex: 912 643 PIBE CH, Telefax: (31)65 44 05.

Born 1927; Professor of Physics, University of Bern, Switzerland. Director of Department of Nuclear Geophysics. Past Vice-President of the Swiss National Academy of Sciences (1975-1981) and President of its Commission on Climate and Atmospheric Research (1981-1987). Member of Advisory Committee on a Polar Network of ESF. Received H.C. Grey Medal of the European Association of Geochemistry (1987). Principal Investigator of research projects in Greenland and Antarctica. Research on earth system studies: radioisotope analyses, natural system modelling.

S. Ichtiaque RASOOL, Office of Space Science and Applications, Code e, NASA, Washington, DC 20546, USA. Tel (202) 453 1000.

Born 1933; Chief scientist for Global Sciences, NASA. Editor-in-chief of "Ocean-Air Interaction". Co-Chairman of ISLSCP Steering Committee and served as Chairman of COSPAR Ad-Hoc Group on Remote Sensing for Global Change (1986). Elected member of the International Academy of Astronautics. Research on thermal structures of planetary atmospheres, Jupiter, Mars, Venus and recently the planet Earth.

Jai S. SINGH, Department of Botany, Banaras Hindu University, Varanasi 221005, India. Tel: 54291 ext. 352, Telex: 0545 208 TECH IN.

Born 1941; Professor of Botany at Banaras Hindu University, Varanasi. Fellow of the Indian National Science Academy, the Indian Academy of Sciences and the International Society for Tropical Ecology. Chief Editor of Tropical Ecology. Served on the Indian National Committee for SCOPE and MAB. Research in the field of primary productivity and nutrient cycling in grassland and Himalayan forest ecosystems.

Valeria A. TROITSKAYA, Institute of Physics of the Earth, USSR Academy of Sciences, Bolshaya Gruzinskaya 20, Moscow 123242, USSR. Telex: 411478 SJC SU.

Born 1917; Chairman of the Department of Electromagnetic Field of the Earth, Institute of the Physics of the Earth. Vice-President of the Soviet Geophysical Committee, Chairman of the Scientific Council for Geomagnetism of the Academy of Sciences of the USSR. Member of the Academy Leopoldina (DDR and FRG), elected associate of the Royal Astronomical Society, U.K., honorary member of the International Association of Geomagnetism and Aeronomy. Research interests in solar terrestrial physics.

Brian H. WALKER, CSIRO, Division of Wildlife and Rangelands Research, P.O.B. 84, Lyneham, A.C.T. 2602, Australia. Tel: (62)42 16 00, Telex: 62284 WLR AA, Telefax: (62)413 342.

Born 1940; Chief of the Division of Wildlife and Rangelands Research of the Commonwealth Scientific and Industrial Research Organization (CSIRO). Former Professor at the Department of Botany and Director. Centre for Resources Ecology at the University of the Witwatersrand, Johannesburg from 1975 until 1985. Research on management of semi-arid ecosystems and the ecology of tropical savannas.

John D. WOODS, Natural Environment Research Council, Marine Sciences, Polaris House, North Star Avenue, Swindon, Wiltshire, SN3 3EH, UK. Tel: (793)40 101 ext. 420, Telex: 444293 ENVRE G, Telefax: (793)511 117, Electronic mail OMNET, Telemail: J.Woods/Science.

Born 1939; Director of Marine Sciences at the Natural Environment Research Council, UK. Former Professor of Oceanography at the University of Kiel, FRG, and Director of Regional Oceanography at the Institut für Meereskunde. Co-Chairman of the Scientific Steering Group for the World Ocean Circulation Experiment. Research in marine and atmospheric sciences.

Duzheng YE, Academia Sinica, Beijing, China. Tel: 868361-843, Telex: 22474 ASCHI CN.

Born 1919; Research Fellow (Professor) of Meteorology, Institute of Atmospheric Physics, The Chinese Academy of Science. Past Vice-President of the Chinese Academy of Sciences (1981-1984). President of the Chinese Meteorological Society (1978-1986). Special Adviser of the Chinese Academy of Sciences. Honorary President of the Chinese Meteorological Society. Honorary Director of Institute of Atmospheric Physics, Chinese Academy of Sciences. Member of Chinese Academy of Sciences. Foreign Member of the Finnish Academy of Sciences and Letters. Research in the fields of dynamic meteorology, land-surface processes and air-sea interactions.

NATIONAL COMMITTEES FOR IGBP

Australia	**Chairman**	Professor K.D. Cole Department of Physics La Trobe University Bundoora, Victoria 3083, AUSTRALIA Tel: (3)478 3083 Telex: 33143 LATROBE AA Telefax: (3)478 5814
Chile	**Chairman**	Professor H.A. Fuenzalida Departmento de Geofisica Universidad de Chile Casilla 2777 Santiago, CHILE Tel: (2)696 8790
France	**Chairman**	Dr. J-C. Duplessy CNRS Centre des Faibles Radioactivité Avenue de la Terrasse F-91190 Gif-sur-Yvette, FRANCE Tel: (1)6907 7828
Hungary	**Chairman**	Professor J. Tigy H-1361 Pf. 6 Budapest, HUNGARY
Israel	**Chairman**	Professor M. Sela Weizmann Institute of Science Rehovot, ISRAEL
Netherlands	**Chairman**	Professor H. Postma Institut voor Onderzoek der Zee Postbus 59 NL-1790 AD Den Burg, NETHERLANDS
South Africa	**Chairman**	Professor P.D. Tyson Department of Geography and Environmental Science University of Witwatersrand Wits. 2050, SOUTH AFRICA Tel: (11)716 2980 Telex: 427 125
Sweden	**Chairman**	Professor B. Bolin Department of Meteorology University of Stockholm S-106 91 Stockholm, SWEDEN Tel: (8)15 77 31 Telex: 15959 MISU S
Switzerland	Chairman not yet appointed	

UK	**Chairman**	Professor W.G. Chaloner, FRS Department of Botany Holloway and Bedford New College Huntersdale, Callow Hill Virginia Water, Surrey GU 25 4LN UNITED KINGOM
USA	**Chairman**	Professor H.A. Mooney Department of Biological Sciences Stanford University Stanford, CA 94305, USA Tel: (415)723 1179