

IGBP **2** Annual Report **003**

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IGBP Annual Report 2003

Mission

To deliver scientific knowledge to help human societies develop in harmony with Earth's environment.

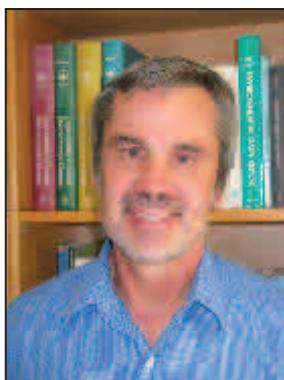
Objective

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.

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Report from the Executive Director



Will Steffen
Executive Director

IGBP officially launched its second decade of international research on global biogeochemistry at the 2003 Scientific Committee meeting in Punta Arenas, Chile, completing the transition to a new phase of research. The programme is now operating entirely within its new structure, with the emphasis turning strongly towards within-IGBP integration to meet programme-wide goals. The highlights of the year were the publication of several IGBP synthesis volumes, and the remarkable

success of the 3rd IGBP Congress held in June in Banff, Canada. Additionally, IGBP continued to enhance and extend its already strong communication effort, to further develop the role of its National Committees, and to strengthen its linkages to the observation community.

The 3rd IGBP Congress was a worthy successor to the first two congresses, held respectively in Bad Münstereifel, Germany, 1996, and Shonan Village, Japan, 1999. All three congresses have been significant in transforming IGBP from a collection of independent projects to a coherent programme of Earth System science. The Banff Congress was noteworthy for the large number of working group sessions that tackled questions across project boundaries, ranging from practical discus-

sions on joint activities, to lively debates on the current most challenging Earth System science questions, such as explaining the Vostok ice-core data. The ease with which meetings, side meetings and plenary speakers crossed disciplines and projects, is evidence that IGBP continues to be a leader in promoting a holistic approach to Earth System science.

The Banff Congress was also important for boosting the effort to revitalise IGBP National Committees. Two days were dedicated to National Committee presentations and discussions, that provided much useful advice to the IGBP leadership, and informed National Committee representatives of the status of the international IGBP effort. Throughout the Congress National Committee representatives participated freely in working group sessions and project steering committee meetings, thereby enhancing the interaction between the national and international aspects of IGBP.

Observations of the changing global environment are essential for IGBP research. During 2003 IGBP strengthened its collaboration with the observation community in several significant ways. The programme led the development of a carbon cycle monitoring strategy – the Integrated Global Carbon Observing (IGCO) theme, under the auspices of the Integrated Global Observing Strategy (IGOS) Partnership, and participated in the first Earth Observation Summit, in July, in Washington DC, USA. IGBP's longer-term efforts to improve linkages with the observation community are supported by a collaborative agreement with the European Space Agency (ESA), that provides resources for a staff position dedicated to the definition and production of data products of direct benefit to IGBP research.

The Earth System Science Partnership – a collaboration between IGBP and three international global change research programmes, continued to flourish in 2003. The fourth joint project on global sustainability – Global Environmental Change and Human Health, developed rapidly in 2003. It is expected to complete its science plan and begin implementation in 2004.

The second Integrated Regional Study (on the Monsoon Asia region) was launched in 2003 under the leadership of START. In collabora-

tion with SCOPE, a conceptual framework is being developed for the study, and a rapid assessment of the current state of understanding of regional and global change in Asia is being undertaken.

A summary of the year would not be complete without noting the successful culmination of the synthesis project, which marked the conclusion of the programme's first phase of work through the 1990s. Following the inaugural publication of the START synthesis in 2002, IGAC, JGOFS and PAGES all published their synthesis volumes in 2003. The BAHC synthesis will follow in early 2004. Additionally, the programme-wide synthesis – *Global Change and the Earth System: A Planet Under Pressure*, was completed in late 2003 and published by Springer-Verlag in January 2004.

Two of IGBP's most successful projects, GCTE and JGOFS, finally said farewell at the end of 2003, having reached their sunset dates. Both concluded in exemplary fashion. JGOFS held a final open science conference in May in Washington DC, USA, attended by more than 300 scientists. The conference demonstrated JGOFS remarkable advances in understanding of the marine carbon cycle. GCTE held a symposium in December in Morelia, Mexico, as its final event. The wealth of new insights generated by GCTE into the complex interactions of terrestrial ecosystems with global change provide a solid base on which to build the new Global Land Project.

In conclusion, 2003 was a year of celebrating the successes of the past, consolidating and completing the transition to the new phase of research, and forging ahead towards a new level of within-IGBP integration. The challenge for the coming phase of IGBP is to balance the continuing need for more focused, disciplinary-level understanding of compartments of the Earth System with the need to assemble these pieces into Earth System understanding. With a stable support base and a community of the best global change scientists around the world, the programme is in an excellent position to meet this challenge.

Will Steffen
Executive Director
IGBP Secretariat
Stockholm, Sweden
June 2004

Highlights of 2003

3rd IGBP Congress

The 3rd IGBP Congress took place in Banff, Canada, from 19-24 June 2003, with 265 participants. The Congress was open to all the members of Science Steering Committees of established IGBP Projects, as well as the members of the Transition Teams of developing projects. For the first time, the Chairs of the 78 IGBP (or Global Change) National Committees were also invited to attend an IGBP Congress. The Congress was a vital opportunity to review the directions for the second phase of IGBP, to finalise the major scientific questions that will be tackled, and to discuss strategies for research implementation. Much of this work was achieved by 26 separate working groups, all of which documented workshop discussion and conclusions.

It was concluded at the Congress that while disciplinary research will remain important, improved research integration – particularly between the natural and social sciences – is required to answer pressing Earth System questions. Indeed, the Earth System should be viewed as a single system with interactions between its natural and social sub-systems. It was also recognised that Earth System modelling must progress beyond equilibrium models to cope with the non-linear dynamics that characterise Earth System behaviour, including both abrupt and irreversible changes.

The discussions of the IGBP National Committee representatives paved the way for a revitalisation of the role of National Committees within IGBP. Discussions focussed on institutional networking and intergovernmental research support, integrated regional studies, IGBP outreach

and IGBP structural issues. These discussions have provided the mandate for an increased role for National Committees in many aspects of how IGBP operates, including in the setting of research agendas.

The Congress strongly endorsed the new IGBP structure, and advanced the development of Integrated Regional Studies (IRS) and Fast-Track Initiatives (FTI). The IRSs will provide the conceptual framework for pulling regional information together into a coherent global view. FTIs will enable specific scientific questions to be rapidly addressed in a more integrated manner than within core projects working independently.

Scientifically, programmatically and logistically the 3rd IGBP Congress was an overwhelming success.

New IGBP Synthesis Books

In 2003, three new IGBP synthesis books were published by Springer-Verlag in the IGBP Book Series, representing the culmination of a decade of research by the IGBP projects IGAC, JGOFS and PAGES:

- *Atmospheric Chemistry in a Changing World: An Integration and Synthesis of a Decade of Tropospheric Chemistry Research*. Editors: Brasseur, Prinn and Pszenny. 300pp.
- *Ocean Biogeochemistry: The Role of the Ocean Carbon Cycle in Global Change*. Editor: Fasham. 297pp.
- *Paleoclimate, Global Change and the Future*. Editors: Alverson, Bradley, Pedersen. 220pp.

These new books are a major achievement of the IGBP synthesis process, and testify to the breadth, depth and quality of IGBP science undertaken in the last ten years.

In addition, the major Earth System science synthesis – *The Earth System: A Planet Under Pressure*, was completed in 2003, and published by Springer-Verlag early in 2004. With 11 authors led by IGBP Executive Director, Will Steffen, and contributions from nearly 500 others

Science Highlights from 2003

The In and Outs of Oceanic Carbon

The ocean is the Earth's biggest active carbon reservoir, and its carbon store continues to grow particularly due to inputs from the far smaller atmospheric reservoir. Overall, the ocean is accumulating carbon and has absorbed 25-35% of the CO₂ emitted from fossil fuel burning.

However, exchanges between the atmosphere and the ocean occur in both directions in different places and at different times. Quantifying these time-varying regional CO₂ exchanges is important since improving the understanding of the carbon cycle will improve evaluations of the amplitude of future climate change, and will help reduce the uncertainties in land-atmosphere CO₂ exchanges, that are (or may be) constrained by international agreements such as the Kyoto protocol.

The southern hemisphere oceans are thought to absorb on average between 0.5 and 1.5 billion tonnes of carbon each year [1]. However, the seasonal and inter-annual variability of this exchange is poorly known. Recent research based on a combination of oceanographic measurements of pCO₂, atmospheric measurements of CO₂ and regional inver-

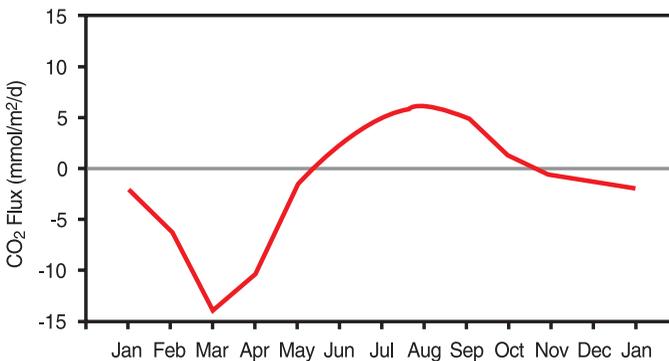


Figure 1. Monthly CO₂ ocean-atmosphere fluxes for the year 2000 at 50°56' S extrapolated from pCO₂ observations [2] and using the exchange coefficient formulation of Wanninkhof (1992) [4].

sion of atmospheric transport has revealed a strong seasonal pattern in Southern Ocean exchanges, and indicates that the region is not a permanent CO₂ source or sink (Figure 1) [2,3].

Furthermore, from regular sampling during 1998-2002, the inter-annual variability of the ocean-atmosphere CO₂ fluxes in the southern hemisphere has been determined. The data suggest that the inter-annual signal of both temperature and CO₂ could be associated with large-scale climatic events such as the strong ENSO event of 1997-98 [5].

This work is a part of SOLAS.

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Piercing the Haze of Aerosol Chemistry

Atmospheric aerosols scatter and absorb solar radiation, thus warming the atmosphere and cooling the Earth. They alter atmospheric chemistry and cause human health problems. While the magnitude and seasonal patterns of regional aerosol plumes and their radiation balance implications have been well quantified from satellite observations, these data do not provide the chemical and physical characterisation necessary to fully understand the climate, atmospheric chemistry and health impacts. A decade of field campaigns have characterised natural and anthropogenic aerosols, and allow comparison of aerosol properties between regions and sub-regions. The five regions characterised are the sub-tropical northeast Atlantic [1], the US eastern seaboard [2,3], the Indian Ocean [4], the west Pacific Ocean [5],

Absorbing-aerosols have now been shown to have complex effects on radiative forcing: aerosols that are highly light absorbing cause both atmospheric heating and surface cooling. Surface cooling may strongly affect the hydrologic cycle in ways that are not yet well understood. Conversely, heating of the atmospheric boundary layer may cause cloud evaporation allowing greater sunlight penetration and increased surface heating.

The north-eastern US plume has been found to be comparable in terms of aerosol mass, surface extinction, and optical depth to the Indian and Asian plumes, dispelling the myth that developing nations are the source of the largest plumes. Furthermore, and contrary to expect-

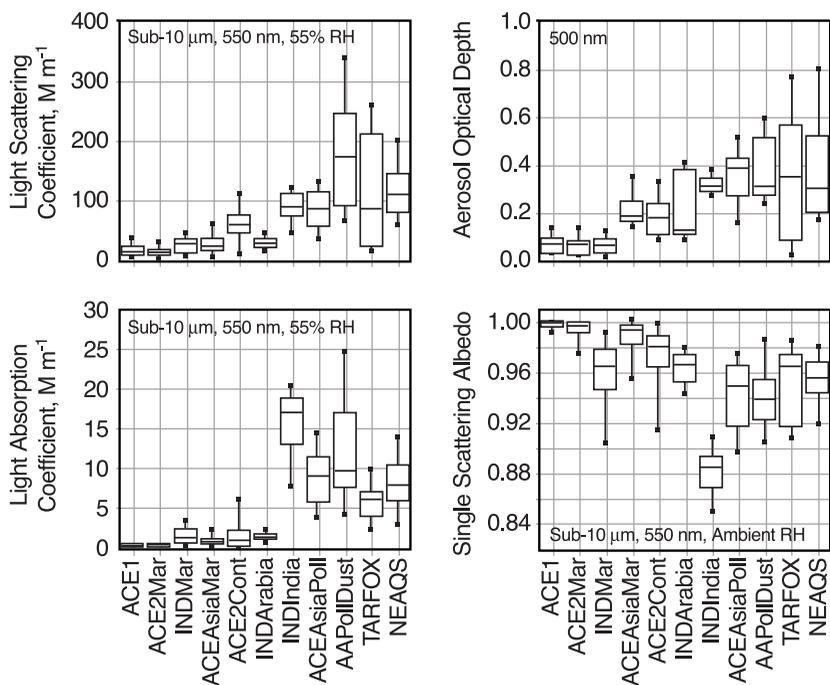


Figure 3. Box plots of aerosol optical properties. Boxes show 25th, 50th and 75th percentiles; bar ends indicate 5th and 95th percentiles.

tations, Asian dust has been found to be relatively non-absorbing. Although the data indicated soot from industrial and urban regions associated with the dust, this did not have the large effect on the single scatter albedo that was expected.

This work is a part of IGAC.

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The What, Where and Why of Vegetation at the Last Glacial Maximum

21,000 years ago ice sheets covered large expanses of North America, Scandinavia and the northern fringes of Europe, and sea levels were consequently lower. The oceans were colder, sea-ice was more extensive, greenhouse gas concentrations were lower, and atmospheric dust levels were high. This was the last glacial maximum (LGM). But how different was the vegetation mosaic and why?

Vegetation mapping based on pollen and plant-macrofossil data, compiled by the IGBP-sponsored Palaeovegetation Mapping Project (BIOME 6000) reveals many differences between the LGM and the present (Figure 4). In particular, boreal and temperate forests were reduced in extent, with grasslands and dry shrublands taking their place across most of mid-latitude Eurasia. In a recent study [1], the

outputs from several climate models were used as inputs to equilibrium vegetation model simulations to enable comparisons between simulated and reconstructed vegetation patterns. Two types of vegetation response were explored in these simulations: firstly, the response purely to the climate of the LGM, and secondly, the response to both the LGM climate and the lowered CO₂ concentrations. CO₂ levels affect various aspects of plant physiology that can lead to distributional changes along both latitudinal and altitudinal gradients. The simulations allowed the relative importance of climate change and CO₂ concentration change on vegetation patterns to be estimated.

Results indicate that the additional overall vegetation distribution response to CO₂ concentration varied between nearly one fifth of the climate-only response (in the northern extra-tropics) and nearly half of the climate-only response (in the tropics). The greater relative response to CO₂ levels in the tropics is partly because of the lesser climate change, and partly because of the greater sensitivity of photosynthetic efficiency to CO₂ levels in the tropics. The physiological response to CO₂ was particularly important for tropical forests, where areal reductions of 44-69% were simulated, compared to the simulated climate-only response of areal expansions of 3-35% – in part a consequence of increased land area with sea level lowering. In spite of variations between simulations,

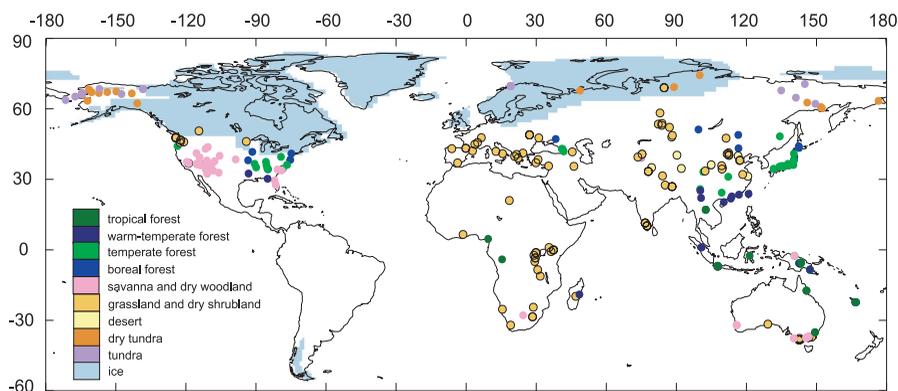
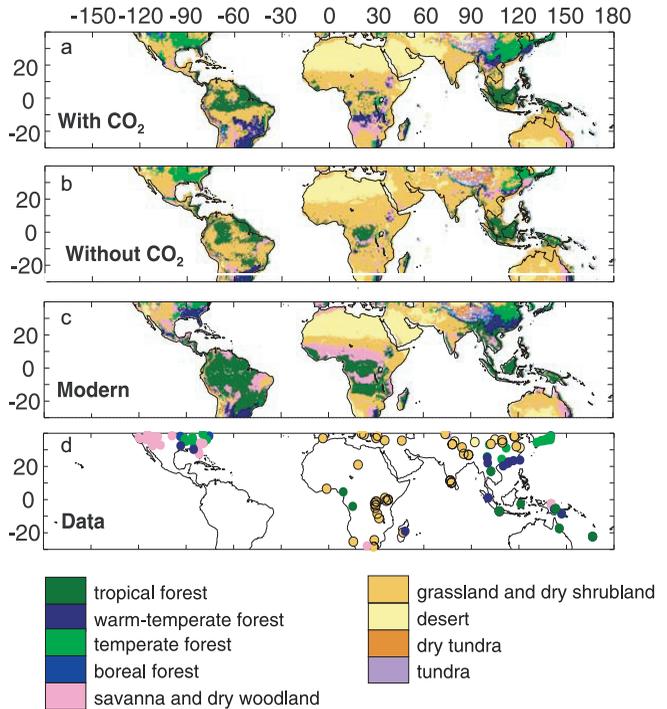


Figure 4. Reconstruction of LGM vegetation patterns from palaeo-data as analysed by the IGBP-sponsored BIOME 6000 project [2-15].

Figure 5. Simulated and observed biomes in the mid-latitudes and tropics. a): simulation including CO₂ effect; b): simulation without CO₂ effect; c): simulated modern distribution; d): palaeo-data.



the study clearly demonstrated that inclusion of the physiological CO₂ effects led to a systematically closer match with observations.

While these simulations have helped explore vegetation patterns at the LGM and their causation, there is much room for improvement. Comparisons between the simulations and the reconstructions from palaeo-data show broad agreement, but also discrepancies. The simulations overestimate the extent of temperate forest in the northern hemisphere – especially in Asia, and all simulations indicate forests in southern Europe in contrast to the grasslands and/or tundra that actually prevailed (Figure 5). Some discrepancies are known to stem from limitations in the climate modelling used in the study, which relied on atmospheric general circulation models, in some cases coupled with mixed-layer ocean models. This approach does not account for changes in ocean circulation that are known to have occurred. Furthermore, because the simulated vegetation changes (due to both climate

and CO₂) are sufficient to induce significant changes in climate due to albedo and conductance feedbacks, improved palaeo-climate simulations can also be achieved by consideration of land-surface feedbacks due to changes in vegetation type, structure and physiology [16]. The value of incorporating both land-surface

and ocean circulation feedbacks into palaeo-climate simulations is one issue that will be explored in the second phase of the Palaeo-climate Modelling Inter-comparison Project (PMIP) cosponsored by PAGES and CLIVAR.

This work contributes to GAIM and PAGES.

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National Committee Activities

IGBP is a non-governmental organisation in the “ICSU family”. It is one of several international, interdisciplinary scientific bodies supported by contributions from National Academies of Science. National Academies are invited by ICSU to form IGBP (or Global Change) National Committees, whose main function is to act as conduits between national scientific communities and the global IGBP community. In particular these committees help national scientific communities become more aware of, and more active in IGBP science, and increase the involvement of nations’ scientists in the IGBP planning process. There are currently 78 established IGBP or Global Change National Committees.

A highlight of 2003 was the National Committee sessions at the 3rd IGBP Congress, which developed many ideas for strengthening the role of National Committees. Sessions included plenary presentations, working groups (on Institutional Networking and Intergovernmental Research Support, Integrated Regional Studies, IGBP Outreach, IGBP Structural Issues), discussion panels (on Earth System Science and Integrated Regional Studies, Earth System Science and Capacity Building) and a poster session on national IGBP activities. The challenges of communication were a major topic item of discussion. The key working group findings are summarised below.

The Institutional Networking and Intergovernmental Research Support working group recognised the need for a network of stably funded scientific institutions in key regions, and the need for long-term stable intergovernmental support to build local and regional capacity in Africa. It was agreed that requirements for participation in an institutional network should be scientific quality, relevance to IGBP goals, formal engagement, personnel resources and international outreach. The working group recognised that the National Committees themselves constitute an institutional network that can engage key national institutions, collaborate with National Academies of Sciences and Inter-Academy Panels, promote the development of new national institutions relevant to IGBP goals, identify funding opportunities, convey the importance of IGBP to national funding and policy-making agencies and increase public awareness of IGBP science.

The Integrated Regional Studies working group used the Monsoon Asia template to discuss the scientific questions and implementation mechanisms for Integrated Regional Studies. It was agreed that the scientific agenda should focus on understanding socio-economic and natural processes that impact on critical sustainable development issues. National Committees can promote, introduce and liaise with Integrated Regional Studies, making them an active part of their scientific programmes and activities.

The IGBP Outreach working group recommended the establishment of an electronic IGBP mailing list with regular updates, and the development of National and Regional IGBP Newsletters. Both should focus both on the second phase of IGBP and on building the ESSP. It was also recommended that IGBP diversify funding sources and seek regional opportunities, design and distribute IGBP promotional packages, and clearly define the benefits of IGBP involvement.

The working group on IGBP Structural Issues endorsed proposed changes to the IGBP Constitution, and suggested creation of a Committee of National Committee Chairs that would meet biannually. This would facilitate information exchange, regional meeting coordination, and implementation of an open and fair procedure for nominating committee members to IGBP-SC and SSCs. Presentations and reports from the National Committee sessions at the Congress can be found on the Congress pages of the IGBP website.

In line with the Congress recommendations IGBP has begun working to increase the relevance and influence of National Committees within IGBP. Initially this is happening via Global Change Newsletter articles and National Committee web sites, and via invitations to National Committee representatives for relevant IGBP meetings. Important National Committee meetings in 2003 included the inaugural meeting of the new US National Committee at the US National Academy of Sciences in July, and a meeting of Spanish Ministry for Science officials and Spanish funding agencies hosted by the Spanish National Committee in Madrid in association with the annual IGBP Officers meeting in October.

Performance for 2003

Publications

In 2003 IGBP projects produced 50 major synthesis or review publications (see listing on page 46). Amongst these are four synthesis volumes in the IGBP Book Series (JGOFS, IGAC, PAGES and IGBP-wide) published by Springer-Verlag.

In the ongoing effort to disseminate IGBP science to a wider audience the IGBP Secretariat continues to produce the IGBP Science Series, the Global Change Newsletter, and seminar presentation material.



The IGBP Scientific Committee meeting in January, in Punta Arenas, Chile, was opened by the Chilean President, Ricardo Lagos (left). IGBP Chair, Guy Brasseur, (centre) and former Vice Chair Paul Crutzen (right) together with other SC members produced a "Punta Arenas Statement" on Global Change.

In 2003, the 5th booklet in the IGBP Science Series (*GLOBEC – Marine Ecosystems and Global Change*) was released, and the 4th booklet (*Global Change and the Earth System: A Planet Under Pressure*) was translated into Chinese by the Chinese Academy of Sciences. Four issues of the 32 page Global Change Newsletter were produced, and around 12,000 copies distributed.

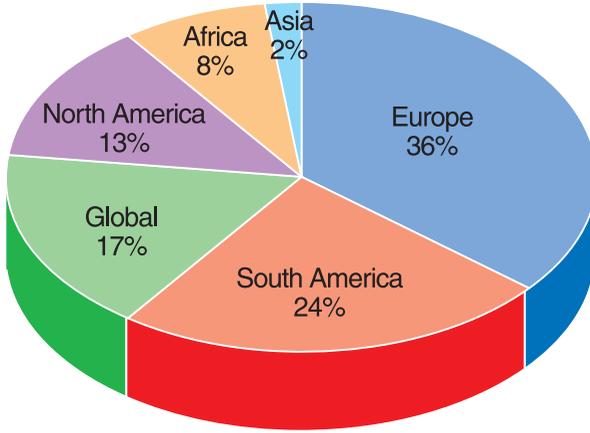
The IGBP Secretariat is reducing costs and environmental impacts by producing and distributing electronic versions of publications. The Global Change Newsletter is distributed to some by email, and the Newsletter and other free IGBP publications are available for download from the IGBP website.

Media Profile

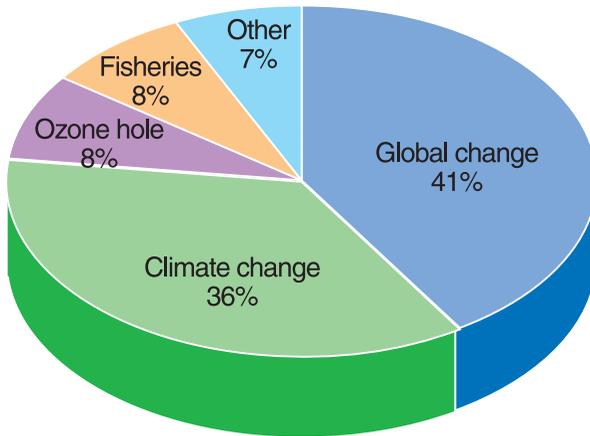
IGBP received considerable media attention during 2003 with approximately 70 items appearing in international print and electronic outlets. The IGBP Scientific Committee meeting in January, in Punta Arenas, Chile, was opened by the Chilean President, Ricardo Lagos, attracting substantial national media attention. A press conference was attended by 10 journalists and generated around 15 items in the national and local media. At President Lagos' invitation IGBP issued a "Punta Arenas Statement" on global change, which the President shared later in the year with leaders of the G8 nations.

The launch in Stockholm of the IGBP Synthesis book *Global Change and the Earth System: A Planet Under Pressure* attracted the attention of over 30 journalists, with 11 present at the book launch. Around 45 items appeared in Swedish and international media, including an article in the International Herald Tribune co-authored by European Commissioner for the Environment, Margot Wallström, and leading IGBP scientists. The article was cited by several media outlets including the BBC World Service and Reuters (the full article was also published in the IGBP Newsletter, No. 57). Media coverage for the year (including January 2004) is summarised in the charts below.

Media Coverage by Region



Media Coverage by Topic

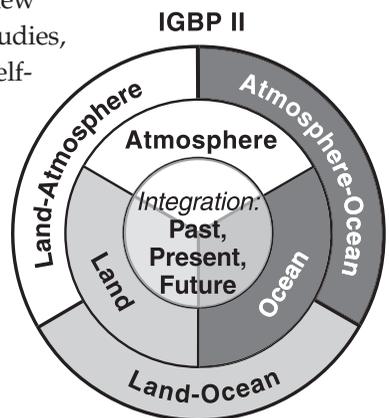


IGBP in 2003

Completing the Transition

2003 marked the completion of the transition phase of IGBP. By December the programme was operating fully within the new structure, and the last project planning activities were close to completion. Building on the successes of the now-completed GCTE and of LUCC (that will complete its work in October 2005), the new Global Land Project held an open science conference in December 2003 to complete its planning phase and to begin building a strong community. Early in 2003 a similar conference was held to advance the new Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project towards implementation. In partnership with GLOBEC, IMBER will contribute significantly to the ocean compartment of the new IGBP structure.

GAIM and PAGES evolved during 2003 towards their central integration and synthesis roles in IGBP. One of the most important developments of the past decade was the explosion of new understanding of the Earth System from palaeo-studies, and during 2003 PAGES undertook an extensive self-analysis of how to better integrate palaeo-research with the more contemporary focus of other IGBP projects. GAIM is rapidly evolving from a primarily carbon-oriented project into a project that, in collaboration with IGBP's ESSP partner programmes, will analyse and model the entire Earth System.



The developments of 2003 have settled IGBP into its new structure and set the stage for more formal, systematic, programme-wide research integration. The challenges for the coming few years are to maintain and support the focused research of the projects, whilst building innovative approaches to integration that enable understanding of the complex dynamics of the Earth System.

IGBP Projects

Ocean



Joint Global Ocean Flux Study (JGOFS)

2003 was the last of over 15 years of highly successful JGOFS international research on ocean biogeochemistry. More than 330 scientists from 32 countries attended the final conference: *A Sea of Change: JGOFS Accomplishments and the Future of Ocean Biogeochemistry* in May, in Washington DC, USA, at which the final JGOFS synthesis book – *Ocean Biogeochemistry* – was launched. The International Project Office collected and published a DVD of datasets from JGOFS national programmes, and datasets continue to be collected to enable archiving of the “integrated JGOFS dataset” in the World Data Centre System. JGOFS synthesis activities continue with a book on continental margins (in collaboration with LOICZ) and a special issue of the journal *Progress in Oceanography* on the Indian Ocean (Arabian Sea) synthesis, both in preparation. The International Project Office, hosted by the University of Bergen in Norway, closed in December 2003 after eight years of excellent work. IGBP extends its thanks to the IPO staff led by Roger Hanson, and to the Chairs and members of the SSC over the years for making JGOFS an outstanding success.

Website: www.uib.no/jgofs/jgofs.html



Global Ocean Ecosystem Dynamics (GLOBEC)

Following the 2nd Open Science Conference in China in 2002, GLOBEC has been going from strength to strength. National and regional programmes are extremely active, with two regional programmes planning synthesis books (*Small Pelagics and Climate Change* and *The Influence*

of Climate Change on Cod). Southern Ocean GLOBEC is completing its field phase and is also generating publications. Two new regional programmes are under development: Ecosystem Studies of Sub-Arctic Systems (ESSAS) and a pan-equatorial activity on Climate Impacts on Oceanic Top Predators (CLIOTOP). In May 2003, the GLOBEC-PICES-ICES 3rd International Zooplankton Symposium in Gijon, Spain, attracted 350 scientists from 53 countries. GLOBEC is already planning its overall integration and synthesis phase to ensure that outcomes are brought together in a timely fashion before project completion in 2009. GLOBEC is committed to engaging research communities from around the world, and has achieved full participation of scientists from many southern African, South American, Asian and other countries.

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Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

The evolution of a new project in the ocean domain of IGBP continued in 2003 with the completion of the draft IMBER Science Plan and Implementation Strategy. The Transition Team, under the leadership of Julie Hall (New Zealand), organised a successful Open Science Conference in January 2003. 370 participants from 36 countries attended the meeting, providing valuable contributions for project development. A notable meeting at the 3rd IGBP Congress saw interactions with other IGBP projects to plan collaborative research activities. Interactions with GLOBEC are particularly important, and planned joint activities on end-to-end foodwebs and ecosystem modelling are being developed. The draft IMBER Science Plan and Implementation Strategy can be downloaded from the IGBP website. The plan will be revised in 2004 for approval by IGBP and SCOR. The GLOBEC-IMBER collaboration will converge into a single project at the completion of GLOBEC in 2009.

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Land



Global Change in Terrestrial Ecosystems (GCTE)

GCTE, one of the pillars of IGBP's first decade of research, completed its mission in 2003. To celebrate the conclusion of this very successful project, a final symposium was held in December, in Morelia, Mexico, in association with the Open Science Conference of the Global Land Project. The symposium highlighted the rich array of GCTE science from the last three to five years, and Lou Pitelka (SSC Chair for the final 18 months) and Hal Mooney (an inaugural GCTE leader) provided a retrospective analysis of GCTE achievements and their significance. In addition to the Morelia symposium, GCTE made major contributions during the year to the development of the Global Land Project, including ensuring that active and appropriate GCTE networks are included in the planning and implementation of the Global Land Project. As its final product, GCTE will produce a volume in the IGBP Book Series (published by Springer-Verlag) based on the Morelia symposium.

Website: www.gcte.org



Land Use and Cover Change (LUCC)

During 2003 LUCC laid the ground for the coming two years of synthesis work before it concludes in October 2005. LUCC science has progressed well to fulfil the LUCC Science Plan, and projects are being rigorously evaluated by the International Project Office and the Scientific Steering Committee. LUCC research has generated six books, two special journal editions, and 11 peer-reviewed synthesis and overview papers. During 2003 workshops directly involving LUCC were held in Turkey in August, in The Netherlands in April and December, in Canada in October and in Mexico in December. LUCC was also successful in obtaining financial support until project completion for the International Project Office in Belgium from the Belgian Ministry of Science (OSTC).

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Global Land Project (GLP)

During 2003 the proposed Global Land Project – a joint IGBP and IHDP initiative – continued to take shape. The conceptual framework for the project was developed at the 3rd IGBP Congress and endorsed at the Open Science Conference (OSC) in December, in Mexico. A novel project structure was proposed at the OSC that embodies the essential elements of the preceding decade of GCTE research and ongoing Lucc science, and integrates the human and biophysical dimensions of land use change relevant to global change. A Science Plan and Implementation Strategy was drafted during 2003 with considerable progress following the Congress and the OSC. The draft plan has been reviewed and is undergoing further revision and refinement, towards anticipated approval by the IGBP and IHDP Scientific Committees in 2004.

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Atmosphere

International Global Atmospheric Chemistry (IGAC)

IGAC progressed rapidly under its new structure and science plan during 2003. The ACE-Asia campaign (Asia-Pacific Region Aerosol Characterisation Experiment), initiated during the earlier phase of IGAC, is close to completion and several high-profile papers have been published or are in press. The DEBITS network (Deposition of Biogeochemically Important Trace Species) and the ITCT-2k2 project (Intercontinental Transport and Chemical Transformation, 2002) continue under the new IGAC structure. Activities initiated in 2003 include the AICI project (Air-Ice Chemical Interactions), the new ITCT-2k4 effort as a direct follow-on to its 2k2 predecessor, and a project studying the emissions of oxidants and aerosols from Asian megacities. The latter is the first in a series studies of emissions from the large urban conglomerates around the globe. IGAC continues to sponsor, or co-sponsor, many workshops around the world, which may lead to new IGAC tasks, or new synthesis or overview papers. Sub-



stantial preparation was made in 2003 for the 8th International IGAC Conference, in New Zealand, September 2004. From early 2003 IGAC was supported by three International Project Offices, located with the three IGAC Co-Chairs:

- Seattle, Washington, USA (Co-Chair Tim Bates, EO Sarah Doherty)
- Rome, Italy (Co-Chair Sandro Fuzzi, EO Gian Paolo Gobbi).
- Taipei, Taiwan (Co-Chair Shaw Liu, EO Doris Chen).

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Ocean-Atmosphere



Surface Ocean - Lower Atmosphere Study (SOLAS)

The completion of the SOLAS Science Plan and Implementation Strategy in 2003 marked the end of the planning phase of SOLAS and a move towards implementation of the science, under the leadership of Peter Liss (UK). An International Project Office funded by NERC has been established in the UK; this will considerably strengthen SOLAS coordination and networking. Many countries already have active SOLAS communities with research either underway or being planned. A number of joint international studies are also already underway, such as the Sub-arctic Ecosystem Response to Iron Enrichment Study, involving Canadian, Mexican and Japan research vessels. The first SOLAS Summer School, designed to develop a new generation of graduate students in ocean-atmosphere science, was held successfully in France in June 2003. Further summer schools are planned for 2005 and 2007. SOLAS regional research includes the developing internationally coordinated atmospheric and oceanic field campaigns in the tropical Atlantic and West African regions.

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Land-Atmosphere

Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS)



As the newest of the IGBP interface projects, iLEAPS planning progressed rapidly during 2003 to enable implementation from early 2004. The highlight of the year was the Open Science Conference, held in September-October in Helsinki, Finland. The conference featured an impressive array of science that laid the foundation for iLEAPS, and pointed towards several networks or campaigns that could form the first phase of iLEAPS activity. The large existing network – FLUXNET, which grew from the now completed IGBP projects BAHC and GCTE, is set to become a flagship activity of iLEAPS. FLUXNET encompasses over 100 continuously operated monitoring sites around the world, measuring fluxes of water vapour, carbon dioxide and energy between the land surface and the atmosphere. iLEAPS plans to establish a network of ‘super tower sites’ to complement FLUXNET, that will measure the emissions and depositions of a large array of compounds, particularly volatile organic compounds. A major boost for iLEAPS in 2003 was the announcement by University of Helsinki that it would host the International Project Office. This announcement was rapidly followed by the appointment of Executive Officer, Anni Reissell, and other IPO staff.

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Land-Ocean

Land-Ocean Interactions in the Coastal Zone (LOICZ)



During 2003 IGBP and IHDP scientists progressed the “LOICZ futures document” into a draft Science Plan and Implementation Strategy. To facilitate the transition from a disciplinary-focused project to an integrated and interdisciplinary project, the Scientific Steering Committee proposed: (i) five scientific themes, (ii) a restructuring of the IPO – initially with regional nodes in Singapore and Germany, and

(iii) a broadening of the SSC and its collaborative network. The Committee also continued co-sponsorship discussions with IHDP. LOICZ continued to enlarge its network and widen its geographic extent with the endorsement of new activities aligned with the new draft Science Plan and Implementation Strategy. LOICZ sponsored or participated in meetings in Chile in January, in France in April, in Canada in June, in Turkey in August and in Canada in October. LOICZ produced five special journal issues and several major papers, in addition to the regular newsletters, Annual Report, meeting reports and several minor publications. Hartwig Kremer replaced Chris Crossland as Executive Director of the LOICZ International Project Office in January 2003, and Martin Le Tissier joined the IPO as Deputy Executive Officer late in the year.

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Integration



Past Global Changes (PAGES)

A highlight of 2003 for PAGES was the publication of the synthesis volume in the IGBP Book Series: *Paleoclimate, Global Change and the Future* edited by Alverson, Pedersen and Bradley. A special issue of *Quaternary Science Reviews on Environmental Response to Climate and Human Impact in Central Europe* was also published, being a German contribution to PAGES-PEPIII. During 2003 PAGES consulted widely to stimulate strategic linkages to underpin its new integrating role in IGBP. The PAGES website – a central tool in PAGES scientific networking and communications with an average of around 350 visitors per day – introduced a new look and new functions including the on-line database “PAGES people”. The new ‘National PAGES’ provides links to, and contacts for, the country-level scientific sub-network. The website featured six scientific highlights from PAGES research during the year. The openness of PAGES is reflected in the newsletter that publishes the minutes of the Scientific Steering Committee meetings, and maintains a high level of scientific and network reporting. PAGES

contributed to several meetings during 2003, and hosted a session at the AGU fall meeting in San Francisco, USA, on “Rates of Change in the Earth System”, convened by Keith Alverson, Julie Brigham-Grette and Thomas Stocker.

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Global Analysis, Integration and Modelling (GAIM)

During 2003 GAIM grew into its new role as a central integrating project of IGBP. One of its new activities, proposed at the 2003 SC-IGBP meeting, is the support of several Fast-Track Initiatives. These will assemble, in one to two years, the state-of-the-science on critical Earth System issues. The first Fast-Track Initiatives consider the *Global Nitrogen Cycle*, the *Global Iron Cycle*, and *Fire*. GAIM also continued to advance Earth System modelling through collaboration with WCRP on the C4MIP project (Coupled Carbon Cycle Climate Model Intercomparison Project) of WCRP, and through support of the EMIC (Earth System Models of Intermediate Complexity) network. GAIM also joined forces with WCRP to compile a catalogue of model inter-comparison projects (MIPs). The ‘MIPS Catalogue’ will document completed MIPs and summarise the lessons learnt on methods, protocols and results presentation. A new innovative GAIM activity (in collaboration with PAGES and IHDP) is IHOPE – the Integrated History Of People and Environment project, that will map an integrated 3,000 year record of natural and human system change, with higher temporal and spatial resolution for the last 200 years. The Earth System Atlas progressed in 2003 to an extensive demonstration version intended to secure project funding. To accommodate these new activities GAIM transferred support and co-ordination of the three carbon cycle projects (the Ocean Carbon-cycle Model Inter-comparison Project – OCMIP, the Atmospheric Tracer Transport Inter-comparison Project – TransCom, and the Ecosystem Model-Data Initiative – EMDI) to the Global Carbon Project.

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IGBP Connections



Earth System
Science Partnership

ESSP

Introduction

The Earth System Science Partnership is an alliance of four international global change research programmes (DIVERSITAS, IGBP, IHDP and WCRP) for the integrated study of the Earth System, the changes that are occurring to the System and the implications of these changes for global sustainability. The ESSP is governed by the Chairs and Directors of the four constituent programmes, acting on behalf of the Scientific Committees of DIVERSITAS, IGBP and IHDP and the Joint Scientific Committee of the WCRP. The central activities of the ESSP are projects on issues of global sustainability, designed to address the global change aspects of four critical issues for human well-being: energy and the carbon cycle, food systems, water resources and human health. The progress of these four projects is described below.

Website: www.ess-p.org

ESSP Projects



Global Carbon Project (GCP)

2003 was an exciting year for the GCP with the project formally launched by publication of its scientific framework document. More than 2,000 copies were distributed within a month of publication, attesting to the broad interest in and support for the project. Even in the first year of project implementation, the achievements have been significant. The GCP has sponsored or participated in 11 workshops,

conferences and symposia, and has produced nine major publications in the international literature. In addition, the first networks around specific activities were established, for example, carbon management aspects of development strategies for cities in the Asia-Pacific region and the Americas. Partnerships have been built with the terrestrial component of the Integrated Global Carbon Observing (IGCO) theme of IGOS-P, and with the Ocean CO₂ Panel to create the International Ocean Carbon Coordination Project. The further development during 2003 of the second GCP International Project Office, in Tsukuba, Japan, and its imminent launch in early 2004 promises to further boost GCP.

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Global Environmental Change and Food Systems (GECAFS)



GECAFS is developing and implementing an innovative research agenda that draws on both biophysical and socio-economic sciences. The development of this agenda is generating new concepts and establishing new paradigms in interdisciplinary research and in science-policy linkages. GECAFS is establishing novel collaborations between the international global change research community and research partners interested in the development agenda. To complement scientific co-sponsorship by IGBP, IHDP and WCRP, GECAFS has formalised collaboration with CGIAR, FAO and WMO.

During 2003 conceptual and methodological issues were outlined in four areas, all directly related to GECAFS objectives: food system typologies, vulnerability research, regional-scale scenario construction and decision support systems. Research in these inter-related topics will complement a set of regionally-based studies of food systems under development in the Indo-Gangetic Plain, the Caribbean and southern Africa. The 2nd GECAFS Scientific Advisory Committee Meeting was held in South Africa in April, and reported to the annual meeting of ESSP Chairs and Directors. Reviews of the project's future plans are ongoing, helping to refine criteria for GECAFS conceptual studies and identify further regional research activities. Drafting of a

Science Plan and Implementation Strategy was initiated during 2003, for approval in 2004.

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Global Water System Project (GWSP)

During 2003 much effort was put into the development and refinement of the scientific framework for the GWSP. This was initially led by a project scoping committee co-ordinated by Holger Hoff. After review of the initial document a wider committee was established to refine the framework under the leadership of Joseph Alcamo. The document was revised during and following the important Open Science Conference held in October, in New Hampshire, USA, that was attended by around 100 delegates. During 2003 funding from the German Government enabled the establishment of an International Project Office at the University of Bonn. The appointment late in the year of Eric Craswell as the Executive Officer and staff to support him was a major addition to the momentum of the GWSP. Project implementation will begin following the expected approval of the scientific framework in 2004.

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Global Environmental Change and Human Health (GECHH)

Recognising the growing need to better understand the multi-faceted and complex linkages between global change (including climate change, land and sea use changes, global biodiversity loss and changes, and global socio-economic changes) and human health, the ESSP initiated a new joint project during 2003. Two primary and closely related goals have been defined: (i) to identify, and then reduce, the risks to human health posed by global environmental change; and (ii) to systematically collect evidence of these health risks that can inform policy for risk minimisation or avoidance. An initial scoping

meeting in Paris, in March, included representatives of organisations and institutes from 15 countries, including WHO. A planning team has begun drafting a Science Plan and Implementation Strategy.

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Regional Activities

START

Global Change SYstem for Analysis, Research and Training (START)



START is sponsored by the ESSP. In late 2003 the START Strategy Plan for the coming decade was approved by the project SSC. The plan describes the intention to continue the highly successful efforts in capacity building, regional cooperation, infrastructure establishment, scientific training and dialogue with policy makers. In addition, START has the challenge of implementing the Monsoon Asia Integrated Regional Study (see below). During 2003 GEF funding established 24 regional projects to assess impacts and adaptations to climate change. These regional projects involve 45 countries and 235 developing country researchers including 60 research students, and will contribute to the next IPCC assessment. A highlight of 2003 for START was the highly successful International Young Scientists' Global Change Conference in Italy, in November. A rigorous peer-review of submitted abstracts led to a selection of 85 from over one thousand submissions. During the year over one thousand scholars from developing countries were involved in START activities, including regional workshops, collaborative networks, short-term fellowships, and visiting scientist/lecturer awards. START also conducted or participated in numerous workshop with core and joint ESSP projects. During 2003 START continued work on a major multi-authored book on Integrated Regional Assessments, and progressed plans for a synthesis volume of African global change research.

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Integrated Regional Studies

At the 3rd IGBP Congress in 2003 the proposal for a small number of Integrated Regional Studies (IRS) was presented and supported. IRS will consider a region as a holistic entity in the context of the Earth System, will contribute sound integrated scientific understanding in support of sustainable development of the region, and will contribute to a quantitative and qualitative understanding of regional-global linkages and the consequences of changes in these linkages.

A long-standing example of an IRS within IGBP is the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA). LBA comprises over 80 closely linked and coordinated research groups involving 600 scientists from South and North America, Europe and Japan. The second IRS to be established is the Monsoon Asia Integrated Regional Study (MAIRS). Under the leadership of START, several MAIRS scoping meetings have been conducted and an interim steering group established. Funding from ICSU has been secured that will support three sub-regional rapid assessment exercises. The Chinese Academy of Sciences has offered to establish and support an IPO for MAIRS.

The Observing Community

IGBP is a member of the Integrated Global Observing Strategy (IGOS) Partnership that was created in 1998. The aim of IGOS is to provide an over-arching strategy for space-based and *in-situ* observations of the Earth's atmosphere and climate, oceans and coasts, land surface and interior. IGOS Partners have built upon the strategies and achievements of other international global observing programmes, to increase the global observing capacity, and to achieve cost-effective and timely delivery of coherent and integrated observations.

The IGOS Partnership consists of five major groups: the Committee on Earth Observation Satellites; the Global Observing Systems (such as the Global Climate Observing System and the Global Terrestrial Observing System); the sponsors of the Global Observing Systems; the International Group of Funding Agencies; and the international global change research community. IGBP and WCRP represent the international global

change research community. Professor Berrien Moore III – former Chair of IGBP - is the IGBP representative on IGOS-P.

During 2003, IGBP contributed to IGOS-P activities primarily through leadership of the Integrated Global Carbon Observing (IGCO) theme. The objectives of the theme, the development of which was led by Philippe Ciais with assistance from Professor Moore, are (i) to provide the long-term observations required to improve understanding of the present state and future behaviour of the global carbon cycle, particularly the factors that control the global atmospheric CO₂ levels, and (ii) to monitor and assess the effectiveness of carbon sequestration and/or emission reduction activities on global atmospheric CO₂ levels, including attribution of sources and sinks by region and sector. The IGCO theme team completed its work in 2003, and the IGCO report is available from the IGBP Secretariat and downloadable from the IGBP website. The emphasis in coming years will be on the implementation of a global carbon observing system. In addition to the IGCO theme, IGBP contributes to the development of themes on atmospheric chemistry, the coastal zone and land systems.

The implementation of an Earth observation strategy received a significant boost mid-year with the Earth Observation Summit, in Washington, DC, USA. The objective of this inter-governmental meeting was to obtain government level commitment for the next decade for the building of an international, comprehensive, integrated Earth observation system that will be sustained into the future. IGBP and WCRP were both invited to make presentations at the Summit, indicating the importance that this inter-governmental initiative places on collaboration with the international scientific research community.

Linkages between the IGBP community and the observation community are also supported through an annual grant from the European Space Agency (ESA). The ESA grant supports consultant Stephen Plummer, to interface with the IGBP user community to elaborate, organise and deliver data products and services in support of IGBP research. In 2003, Dr Plummer constructed databases on several terrestrial aspects relevant to research on the global carbon cycle, including fires, leaf area index, fraction of absorbed radiation and vegetation growth cycle. These products are being tested as a part of the data-model fusion efforts of the Global Carbon Project (GCP).

IGBP Community

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Chairs of the currently active IGBP National Committees.

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IGBP Secretariat

Under the leadership of the Executive Director, the IGBP Secretariat implements the decisions of the Scientific Committee of the IGBP, works with IGBP Projects to provide support to the overall research effort, raises funds for IGBP activities, communicates IGBP research to a wide variety of audiences, liaises with partner organisations and administers the IGBP central budget. The Secretariat is hosted by the Royal Swedish Academy of Sciences in Stockholm.

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Susannah Elliott	<i>Science Communicator</i>
Sofia Roger	<i>Information Coordinator, (part time)</i>
Angelina Sanderson	<i>Acting Science Editor (until June)</i>
Bill Young	<i>Science Editor (from September)</i>

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Graeme Pearman
Co-chair START, AUSTRALIA

Louis Pitelka
Chair GCTE, USA

Publications

The major scientific publications – synthesis and integration papers, special journal editions and books – generated by the IGBP community during 2003 are listed below.

Alverson K and Solomina O (Eds) (2003) High latitude Eurasian paleoenvironments. *Paleogeography, Paleoclimatology, Paleoecology*, in press.

Alverson KD Bradley RS and Pedersen TF (Eds) (2003) *Paleoclimate, Global Change and the Future*. IGBP Series. Springer-Verlag, Heidelberg, Germany. 212pp.

Arneth A, Korhonen H, Kulmala M, Raivonen M, Ruuskanen T and Suni T (Eds) (2003) *Proceedings of ILEAPS: Integrated Land Ecosystem – Atmosphere Process Study*. International Open Science Conference. *Aerosol Science*, 62A&B.

Barange M (2003) Ecosystem science and the sustainable management of marine resources: from Rio to Johannesburg. *Frontiers in Ecology and the Environment*, 1(4):190-196.

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Brink KH, Limeburner R and Beardsley RC (2003) Properties of flow and pressure over Georges Bank as observed with near-surface drifters. *Journal of Geophysical Research*, 108:C11:8001.

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Financial Report

IGBP activities are predominantly funded by contributions from member countries. Central funds support the IGBP Secretariat, the Scientific Committee of IGBP, the Scientific Steering Committees of IGBP projects, and IGBP contributions to ESSP activities. The support to the IGBP Secretariat includes funding various publications, communication and outreach activities, and scientific liaison.

Income in 2003 was higher than in 2002, as required to finance the successful and important 3rd IGBP Congress. Overall, the distribution of expenditure for 2003 was similar to 2002.

Income and Expenditure

For the year ending 31 December 2003, financial contributions were received from 42 countries, listed below in order of level of contribution.

- | | | |
|--------------------|---------------------|-----------------|
| 1. USA | 15. Norway | 29. Ireland |
| 2. France | 16. Canada | 30. Indonesia |
| 3. Russia | 17. Czech Republic | 31. Singapore |
| 4. Germany | 18. China (Beijing) | 32. Malaysia |
| 5. Sweden | 19. Greece | 33. Philippines |
| 6. Japan | 20. Austria | 34. Thailand |
| 7. United Kingdom | 21. Denmark | 35. New Zealand |
| 8. Italy | 22. Korea | 36. Venezuela |
| 9. Spain | 23. Finland | 37. Bolivia |
| 10. Netherlands | 24. South Africa | 38. Iceland |
| 11. Australia | 25. India | 39. Romania |
| 12. Switzerland | 26. Poland | 40. Colombia |
| 13. China (Taipei) | 27. Israel | 41. Kenya |
| 14. Belgium | 28. Portugal | 42. Zambia |

INCOME

US Dollars US Dollars

National Contributions 1,851,826 1,851,826

Grant from ICSU Fund 116,496 116,496

Special contributions for the 3rd IGBP Congress

The Research Council of Norway 14,376

CCAF, Canada 36,784

NSERC, Canada 6,908

SNSF, Switzerland 4,965

NWO, NL 20,196

NSF, USA 32,000

SCOR, USA 18,333

133,562

NASA, USA for LBA project 57,557

NOAA, USA for IGCO project 9,990

ESA, France 11,375

Other income (including special NSF grant to IPO and private donations) 160,736

239,658

Operating Assets from 2002 271,290

TOTAL INCOME 2,612,832

EXPENDITURE

Scientific Activities

Meetings and workshops 1,309,609

Special NSF grant to IPO 150,270 1,459,879

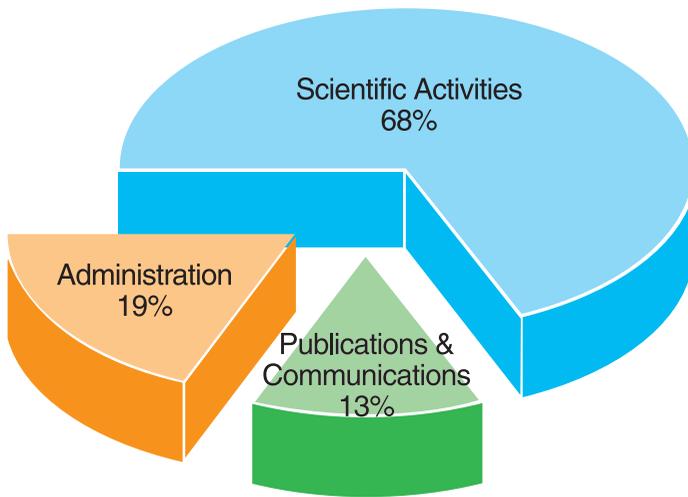
Publications, Information and Communication 250,257

Administrative Expenses 357,585

TOTAL EXPENDITURE 2,067,721

OPERATING ASSETS TO 2004 545,111

Proportional expenditure for 2003



Acronyms

APN	Asia-Pacific Network for Global Change Research
BAHC	Biospheric Aspects of the Hydrologic Cycle
CCAF	Climate Change Action Fund (Canada)
DIVERSITAS	An International Programme of Biodiversity Science
ESA	European Space Agency
ESSP	Earth System Science Partnership
GAIM	Global Analysis, Integration and Modelling
GCP	Global Carbon Project
GCTE	Global Change and Terrestrial Ecosystems
GECAFS	Global Environmental Change and Food Systems
GECHH	Global Environmental Change and Human Health
GLP	Global Land Project
GLOBEC	Global Ocean Ecosystem Dynamics
GWSP	Global Water System Project
ICES	International Council for Exploration of the Sea
ICSU	International Council for Science
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme
IGCO	Integrated Global Carbon Observing Theme
IGOS	Integrated Global Observing Strategy
IHDP	International Human Dimensions Programme on Global Environmental Change
iLEAPS	Integrated Land Ecosystem - Atmosphere Processes Study
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research Project
IOC	Inter-governmental Oceanographic Commission (of UNESCO)
JGOFS	Joint Global Ocean Flux Study

LBA	Large-Scale Biosphere-Atmosphere Experiment in Amazonia
LOICZ	Land-Ocean Interactions in the Coastal Zone
LUCC	Land-Use and Cover Change
NERC	National Environment Research Council (UK)
NSF	National Science Foundation (USA)
NWO	Netherlands Organisation for Scientific Research
PAGES	Pages Global Changes
PICES	North Pacific Marine Science Organisation
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee on Oceanic Research
SOLAS	Surface Ocean – Lower Atmosphere Study
SNSF	Swiss National Science Foundation
SSC	Scientific Steering Committee
START	Global Change System for Analysis, Research and Training
WCRP	World Climate Research Programme
WMO	World Meteorological Organisation

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