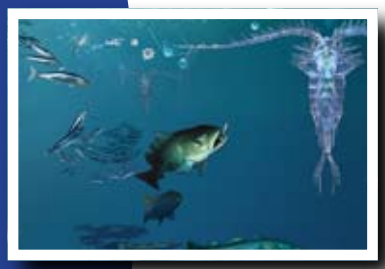
IGBP
Annual Report






2007

GLOBAL CHANGE
IGBP

Global Environmental Change Research
20 Years
IGBP

Earth System Illustration

The Earth system illustration appearing on the first page and elsewhere in this Annual Report was commissioned by IGBP from the English artist Glynn Gorick. The structure of the illustration mirrors the programme structure of IGBP, which is built around the Earth system compartments of land, atmosphere and ocean, the interfaces between these compartments, and system-wide integration.

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International Geosphere-Biosphere Programme

IGBP is an international scientific research programme of the International Council of Science (ICSU) that networks scientists around the world to conduct interdisciplinary Earth system science and global change research.

Vision

To provide scientific knowledge to improve the sustainability of the living Earth.

Objective

IGBP studies the interactions between biological, chemical and physical processes, and human systems. IGBP collaborates with other programmes to develop and impart the understanding necessary to respond to global change.

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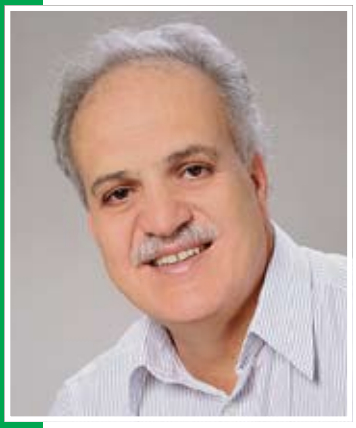

Carlos Nobre
IGBP Chair
São José dos Campos, Brazil

Foreword

During 2007, IGBP as a whole continued the successful implementation of its Phase II Science Plan. Additionally, I want to highlight a few activities that point to new directions.

Applied Earth System Science (ESS): Under the leadership of IGBP's AIMES project, the concept of 'Applied ESS' continued to be developed and was highlighted during the IGBP Congress. Along the same lines, it is recognised that IGBP needs to become more relevant for Impact, Adaptation, and Vulnerability (IAV) research, as there is widespread recognition of the inevitability of climate change. In that context, IGBP was successful during the past year in highlighting, through Congress sessions and media releases, that global environmental change (GEC) is more than climate change, a message gaining wider acceptance among policy makers and the public.

Communication with the IPCC Assessment process: It may be a bit of an overstatement, but some analysts have said that the 21st Century in fact started in 2007 as a consequence of the tremendous impact brought about by the publication of the IPCC Fourth Assessment Report. The former and present UN Secretaries General, Kofi Annan and Ban Ki-moon, have both stated that global climate change is the greatest challenge to be faced by humankind in this century. Therefore, it is critically important for IGBP to be more relevant to the GEC assessments, especially for the IPCC Fifth Assessment (IPCC AR5) process.

In fact, IGBP is moving to be well positioned in terms of participating with leadership in preparatory meetings for the establishment of scenarios for IPCC AR5 and new protocols for the Global Climate Model scenario generations. These protocols demand new Global Climate Models that incorporate atmospheric chemistry and full land and ocean carbon cycles. IGBP has contributed a great deal to such modelling developments. Additionally, IGBP has been assisting the ESSP in its interactions with the UNFCCC SBSTA to establish a fruitful dialogue between GEC Programmes and the UNFCCC.

IGBP Congress and AfricanNESS: A great deal of effort in 2007 was devoted to preparations for the IGBP Congress, held in May 2008 in Cape Town, with its focus on Africa and the relationship between GEC and regional development. IGBP was also instrumental in helping to advance the science plan for the African Network for Earth System Science (AfricanNESS).

IGBP Fundraising: The IGBP Secretariat worked hard to address the critical issue of diminishing contributions to its core budget. It prepared reports to key countries whose (renewed) contributions could help bring stabilisation to IGBP finances. IGBP is now cautiously optimistic about the 2008 budget and its general financial outlook. There is a recognition that IGBP is vulnerable in its dependence on few major donors, and that it needs to broaden its membership by recruiting new member countries.

Last but not least, a successful search was made for a new executive director, Sybil Seitzinger, who was appointed in 2008.

Kevin Noone
IGBP Executive Director
Stockholm, Sweden

A Year in Review

IGBP's Executive Director Reflects on Changes, Challenges in 2007

The last year has been marked by a number of challenges, milestones and transitions. The major challenges revolved around maintaining our facilitation of cutting-edge, international global environmental change research while adjusting to financial constraints. A major milestone was IGBP's 20th anniversary, and by the time this annual report is published, a new executive director will have transitioned into position.

IGBP undertook major efforts in the last year to solidify its national contributions, and to begin establishing contacts with private sector organisations that could eventually broaden its financial base. National and regional reports were developed that illustrate the added value of IGBP for national research initiatives. IGBP representatives presented the added value of IGBP to a number of national funding agencies. The currency for national contributions to IGBP was switched from US dollars to Euros, and a yearly adjustment for inflation was put into place. These initiatives are beginning to bear fruit, and although the financial climate is not as good as it once was, we appear to have made it through a "little ice age" without freezing solid. IGBP is grateful to its financial sponsors for their continuing support through a tough financial climate.

The concept of *applied* Earth system science requires that stakeholders are involved in designing and carrying out research initiatives. To this end, IGBP organised its 20th Anniversary Symposium by gathering together representatives from the scientific, private and policy sectors to look at past and future issues where collaboration between the sectors was (and will be) necessary. Of the roughly 80 participants, about 40% were from the science sector, with the remaining split evenly between the private and policy sectors. The symposium was a great opportunity to establish contact with people outside the scientific community, and IGBP will actively be maintaining these contacts in the future.

Finally, I will take this opportunity for a short farewell (just to warn you — a longer one is coming in the IGBP NewsLetter!). By the time this annual report is printed, Professor Sybil Seitzinger will have started as the new IGBP executive director (welcome, Sybil!). It has been a great honour and pleasure to collaborate with all of you in the IGBP network for the last four years — especially with Chairs Carlos Nobre and Guy Brasseur, with whom I've had the good fortune to work. In particular, I want to end by saying what a privilege it has been to work together with the folks at the IGBP Secretariat. IGBP is extremely fortunate to have such a professional, committed and conscientious group of people in the head office. IGBP will be in excellent hands, and I can't wait to see what happens next year!

IGBP Science Highlights

IGBP research studies the Earth as a coupled human-environmental system, with an emphasis on system-level processes and the detailed feedbacks and dynamics between and within Earth system components (land, sea and air). The research highlighted in this section of the IGBP Annual Report represents a small portion of the cutting-edge science and policy interactions supported by our network.

IPCC Interactions

The impact of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) has been tremendous, to the extent that the IPCC (together with Albert Gore) was awarded the 2007 Nobel Peace Prize. Scientists in IGBP's network not only conduct the research on which the IPCC bases its reports, but they also have been directly involved in drafting the assessment reports. During the past year, IGBP had additional, important interactions with the IPCC.

Climate Models: The Next Generation

One of the fixtures of the first four IPCC assessment reports has been the consistent method through which climate modelling for climate change projections has been carried out. Traditionally, climate change projections were derived from a number of scenarios for socio-economic development, from which various emissions patterns were estimated (Figure 1, a). These emissions were then fed into climate models to determine future concentrations of greenhouse gases, as well as climate parameters like surface temperature and precipitation.

A new approach to this type of modelling, proposed by the international scientific community including WCRP, IGBP and the IPCC Working Groups I and II, starts with greenhouse gas concentration and emissions to generate climate system responses and

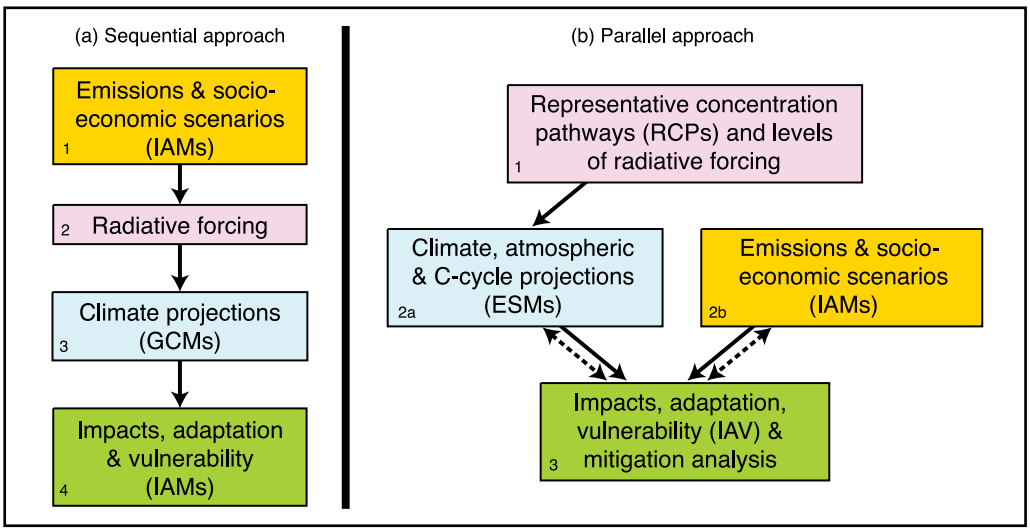

Figure 1. Approaches to the development of global scenarios: (a) previous sequential approach; (b) proposed parallel approach. Numbers indicate analytical steps (2a and 2b proceed concurrently). Solid arrows indicate transfers of information. Dotted arrows indicate integration of information. [1]

ultimately new scenarios for future assessment and scientific activities (Figure 1, b). [1] The process would begin with representative concentration pathways (RCPs) that are based on radiative forcings that span published ranges of emissions and climate space [1]. From this initial preparatory phase, a parallel process has been proposed (see Moss et al., 2008 for details). Briefly, new story lines will be jointly developed between the WGII and WGIII communities from the initial RCPs. When climate model output is available, cross checks with compatible emissions and climate models will contribute to the generation of new scenarios through a collaboration between the new climate model results and WGII and III research for future assessment activities beyond the IPCC Fifth Assessment Report.

This new scenarios approach was proposed to the IPCC in a report submitted to the 28th IPCC plenary meeting in Budapest, Hungary in April 2008 (IPCC-XXVIII/Doc.8, 19.III.2008; www.ipcc.ch or www.aimes.ucar.edu). The IPCC has approved the proposal for the scientific community to jointly and collaboratively develop a new set of scenarios.

This approach, initially suggested through an interdisciplinary and cross-community workshop, provides an excellent example of how the international research community (particularly IGBP's AIMES project and WCRP's WGCM project) has contributed to the development of Earth system science and the IPCC process, a notion that was clearly advocated by Solomon and Manning: [2]

> "The IPCC does not plan or carry out research, and this separation between research and assessment is essential if the IPCC is to be an objective assessor. The mandate of the IPCC is to evaluate information that must be independently documented, primarily as peer-reviewed literature. The planning and coordination of international research are best carried out by organisations such as the World Climate Research Programme, the International Geosphere-Biosphere Programme, and the International Human Dimensions Programme. These bodies often consider IPCC assessments and help provide the means for the scientific community to produce related research."

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2. Solomon S and Manning M (2008) The IPCC Must Maintain its Rigor. *Science* 31 9,14 57.

GEC Programmes Setting Research Priorities to Meet Policy Needs

Researchers and those responsible for climate observations recognise that there is an increasing demand by decision makers for climate change information required for adaptation and the assessment of impacts and vulnerability. Improving climate models and observations continues to be of great importance, and at the same time there is a requirement to underpin an increasing range of user/stakeholder needs. Guidance about decisions on adaptation is often being demanded faster, and with greater detail than research can deliver and than the observing system can support. It was in this context that the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP) and IGBP set the goals for the "Future Climate Change Research

and Observations: GCOS, WCRP and IGBP Learning from the IPCC Fourth Assessment Report" workshop in Sydney, Australia, 4-6 October 2007.[1]

Some 66 IPCC authors and other experts associated with the three international programmes discussed fundamental climate change observation and research needs and challenges, based on gaps and uncertainties identified by IPCC Working Group I (The Physical Science Basis), and Working Group II (Impacts, Adaptation and Vulnerability) in their latest assessments.

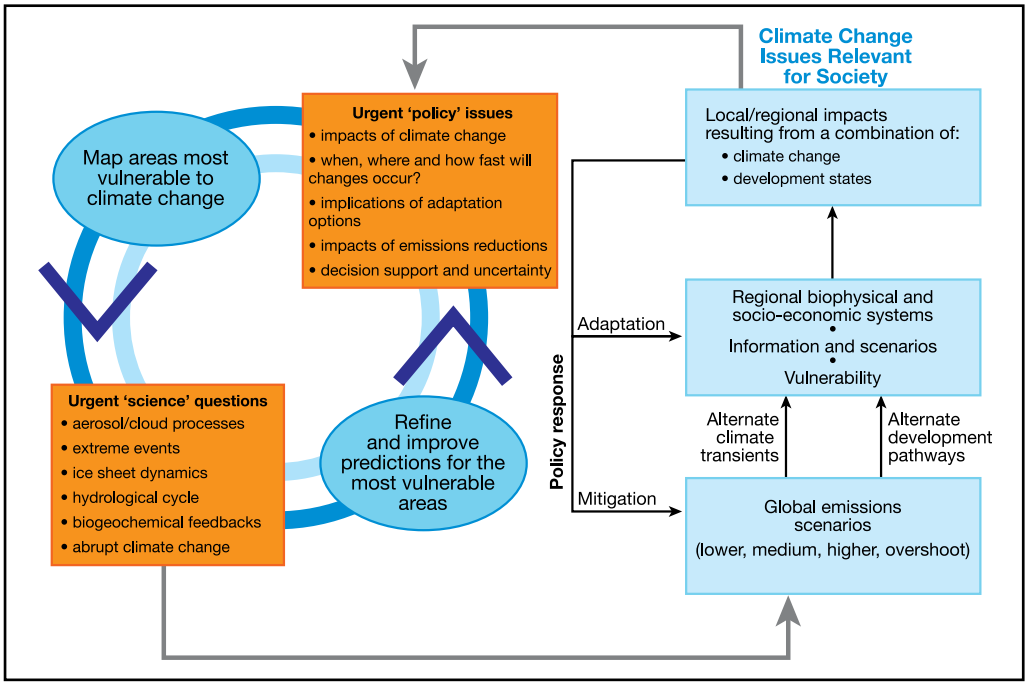
A profound recommendation developed during the workshop was that the framework for climate research and observations should be redesigned with the specific goal of producing the information needed for decisions about impacts, adaptation and mitigation. First, vulnerability to climate change must be defined and mapped out for the globe. This vulnerability "map" would then be used to focus research strategies for and prioritise among the scientific issues in climate research. At the intersection of vulnerability and science issues are research and observational strategies specifically aimed at improving the predictability and understanding of impacts, adaptive capacity, and societal and ecosystem vulnerabilities. This new approach is shown schematically in Figure 2.

Using vulnerability to frame climate research will connect the integrated assessment, impacts, adaptation and vulnerability, and climate modelling communities in a much more fundamental way. Ideally, it will also lead to research results that are more directly aligned with societal needs, a good example of doing *applied* Earth system science.

The GCOS/WCRP/IGBP 2008 Future Climate Change Research and Observations report is available online at: www.igbp.kva.se/page.php?pid=222

Figure 2.

Using vulnerability to frame climate change research. Source: GCOS/WCRP/IGBP report.[2]



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2. GCOS/WCRP/IGBP (2008) Future Climate Change Research and Observations: GCOS, WCRP and IGBP Learning from the *IPCC Fourth Assessment Report*, 68 pp.

Intercontinental Transport of Air Pollutants

One of the mainstays of research in IGBP's International Global Atmospheric Chemistry (IGAC) project is to investigate the process behind intercontinental transport and transformation of air pollutants. A case in point is the Arctic, because most of the pollution in this region originates from more southerly continental locations, according to a review of Arctic air pollution by IGAC Chair Kathy Law and Andreas Stohl (Senior Scientist, Norwegian Institute for Air Research) that appeared in *Science*.[3]

Absorbing carbon (or black carbon)—often found in soot emissions—is of particular interest in the Arctic, due to its potential influence in changing the energy balance of snow surfaces in the region.[1,2]

In one of many papers cited in Law and Stohl's *Science* article, Stohl, et al.[4] investigated a severe pollution event involving smoke from European agricultural fires being transported into the Arctic. This pollution event corresponded to the highest ozone, carbon monoxide (CO) and aerosol optical depth measurements ever observed at the Zeppelin station in Ny Ålesund, Svalbard, located far north of the Arctic Circle. Clear

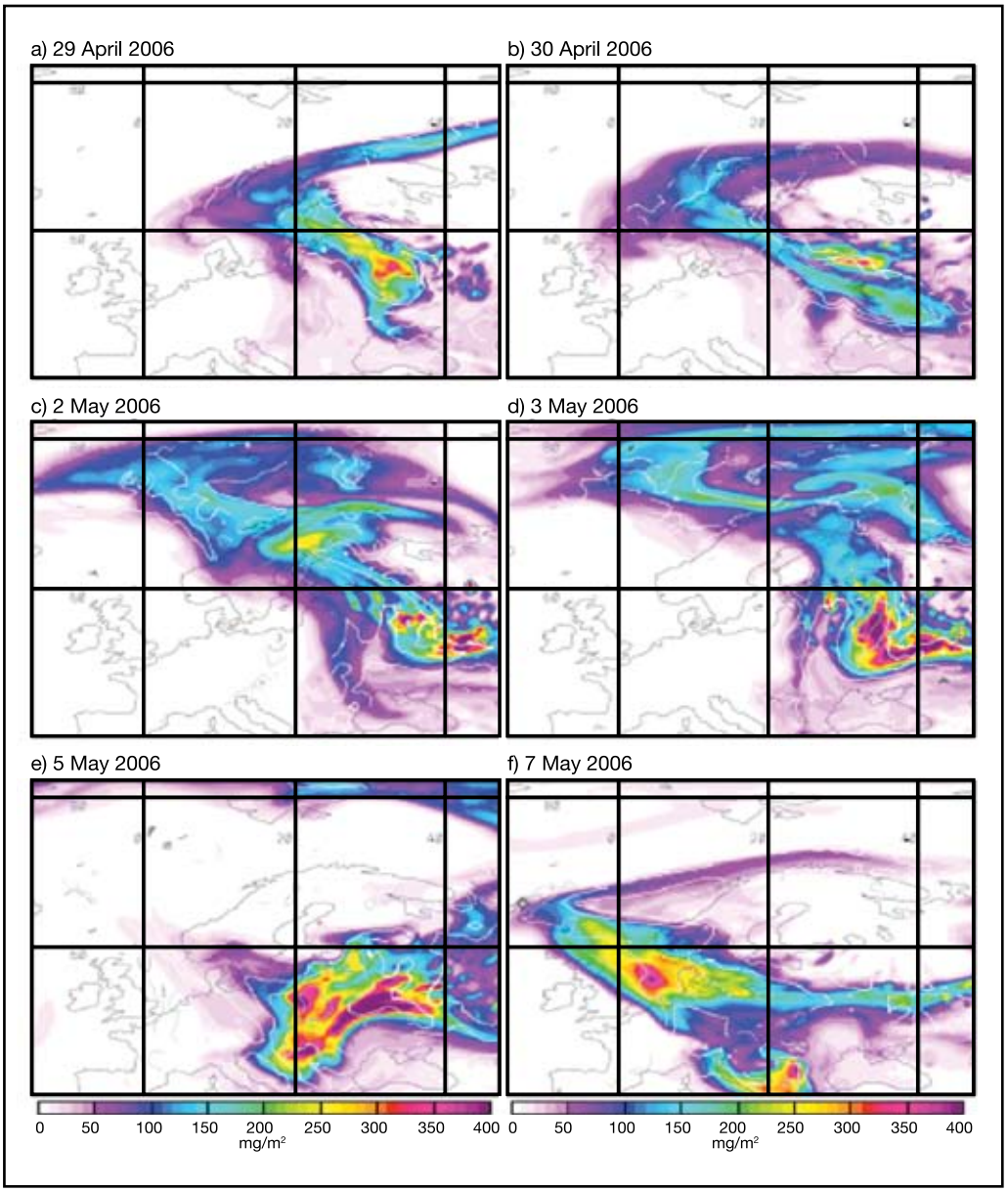

Figure 3.

Calculated CO concentrations showing the transport of pollution from biomass burning in eastern Europe into the Arctic. Reprinted with permission from *Atmospheric Chemistry and Physics*.

effects were observed on snow chemistry and albedo as a result of this pollution event. The researchers performed simulations of CO concentrations in the smoke plumes (Figure 3). CO is a good, stable tracer of anthropogenic pollution, and is relatively easy to model. Their results corresponded well to satellite-derived CO concentrations, and ground-based measurements of trace gases and particles, making the model suitable for interpreting the transport/transformation pathways in this and other cases.

The researchers concluded that biomass burning has been underestimated as a source of aerosol and air pollution in the Arctic region, and recommended regulations on agricultural waste burning to reduce pollution transport into the Arctic.

References:

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Impacts of Atmospheric Nitrogen on the Open Ocean

Land-based anthropogenic nitrogen has severely altered many coastal ecosystems, resulting in increasing eutrophication. Human activities have also added large quantities of atmospheric nitrogen to the open ocean (Figure 4). Research by several IGBP scientists that appeared in the journal *Science* [1] looked at the potential importance of the growing quantity of atmospheric reactive nitrogen that enters the open ocean as a result of human activities and its impact on the present marine nitrogen cycle. They found that anthropogenic atmospheric nitrogen (AAN) could account for around one third of the ocean's external (non-recycled) nitrogen supply and up to three percent of the annual new marine biological production.

The researchers estimate that from 1860 to the present, the increase in AAN has led to nearly an order of magnitude increase in anthropogenic nitrous oxide (N_2O) emission from the oceans.

While oceanic AAN deposition may result in increased N_2O emissions, increasing radiative forcing, it also increases primary production and export production to the deep ocean, removing CO_2 from the atmosphere and therefore decreasing radiative forcing. The net balance suggests that up to about two-thirds of the decrease in radiative forcing from CO_2 uptake could be offset by the increase due to N_2O emissions. In other words, there would still be a net reduction in global warming, but not as much as would be calculated if only the CO_2 uptake were considered.

The findings suggest that more knowledge is needed about the extent and time scale of the impacts of AAN deposition on the oceans and the feedbacks to the climate system. These issues are complex and interactive, and must be considered in climate scenarios, according to the researchers.

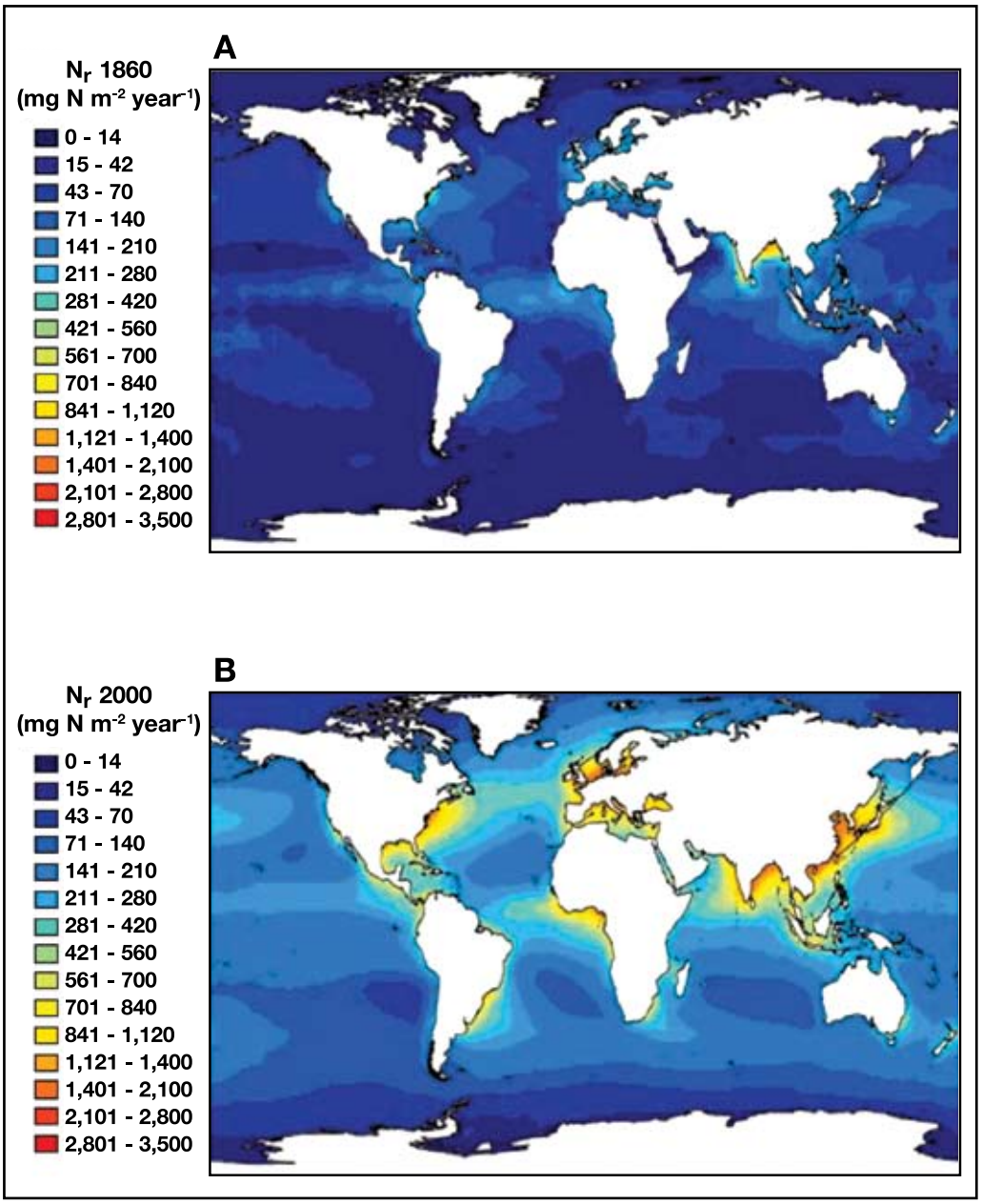

Figure 4.
Reactive nitrogen deposition to the oceans.[1] Reprinted with permission from AAAS.

References:

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Global Environmental Change and Ecosystem Services

Ecosystem services are the benefits that humans reap from natural areas where living and non-living life-support systems function in concert with each other. These services include a range of human essentials, such as food production, clean water and clean air. Global environmental change, including land changes, affects the sustained provision of a wide set of ecosystem services. Predicting how these changes will affect ecosystem services can now be done with more certainty, thanks to a new model developed by scientists affiliated with IGBP and IHDP's Global Land Project (GLP). Details of the model

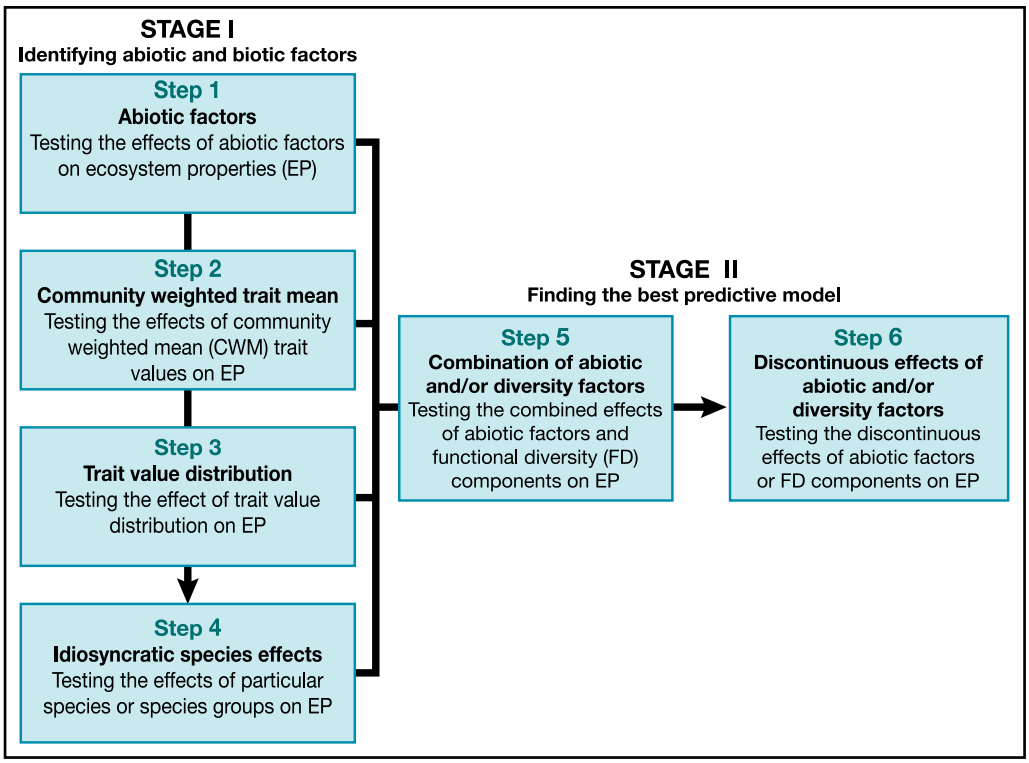
were published in the December 26, 2007 issue of the *Proceedings of the National Academy of Sciences* (PNAS) [1], in a special land change science feature that included articles by several GLP-affiliated scientists.

Adequate societal response to global change requires quantitative assessments of different land change impacts on ecosystem services. In this context, the approach offers an innovative way to develop quantitative predictive models of land cover change impacts on ecosystem services. The scientists proposed a formal, six-step procedure for identifying abiotic and biotic factors that affect ecosystem properties and for constructing useful predictive models of these ecosystem properties (Figure 5). The model reduces uncertainty in the prediction of ecosystem properties and derived ecosystem services within the context of land cover change.

Reducing this uncertainty has important theoretical and applied implications. First, although there is increasing consensus that plant functional traits strongly affect ecosystem properties and resulting ecosystem services, very little is known about the relative role of different components of functional diversity, such as the mean and frequency distribution of plant trait values. The method developed by the IGBP-affiliated scientists allows identification of cases in which ecosystem properties can be satisfactorily predicted from different functional diversity components and to quantify their relative importance. Second, the reduction of uncertainty will help identify the ecosystem service most vulnerable to biodiversity changes.

The editors of *PNAS* awarded the paper the 2007 Cozzarelli Prize, an award for papers that reflect the highest standards of scientific excellence and originality.

Figure 5.
A conceptual framework for linking GEC and ecosystem services. Reprinted from *PNAS*.



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IGBP Outreach and Networking Activities

IGBP Celebrates 20th Anniversary

IGBP was created two decades ago at a time when little understanding existed of how the Earth worked as a system, how the parts were connected, or even about the importance of the various components of the Earth system. Feedback mechanisms were not always clearly understood, nor were the dynamics controlling the Earth system as a whole. Herbert Friedman, in the introduction to the report "Toward an International Geosphere-Biosphere Program: A Study of Global Change" (NRC, 1986) called for a "*bold, 'holistic' venture in organised research – the study of whole systems of interdisciplinary science in an effort to understand global changes in the terrestrial environment and its living systems.*"

In the following two decades, the focus of IGBP evolved into what is now expressed in the current IGBP vision statement: "*The vision of IGBP is to provide scientific knowledge to improve the sustainability of the living Earth.*" IGBP continues to evolve, and we are realising that in addition to the process-level discovery science that IGBP has facilitated, we also are increasingly called upon to develop a kind of *applied* Earth system science: science that takes fundamental understanding about how the Earth system functions, and applies this knowledge to support decisions about issues of societal relevance. Engaging stakeholders is a necessary component of this new enterprise for IGBP.

A major activity during 2007 was the IGBP 20th Anniversary Symposium, "Earth System Science and Society", held at the Royal Swedish Academy of Sciences in Stockholm on 17-18 September. One of the main aims of the two-day symposium was to weave

Nobel Laureate Paul Crutzen, European Commission representative Claus Brüning, and Pauline Midgley of IER, Germany were panel speakers for a session on "The ozone hole and the Montreal Protocol".

together contributions, presentations and discussions between representatives from the scientific, political, and private sectors. The purpose of the discussions was to analyse the relationship between the different communities in regards to global environmental change issues, and to determine the reasons why some issues were successfully resolved and others remain on the scientific and political agenda.

Sessions, presenters and moderators for the IGBP 20th Anniversary Symposium.

Day 1 (17 September) The past 20 years	Day 2 (18 September) The next decades
Introduction by Kevin Noone, IGBP, Sweden **Global climate change and the IPCC** **Science** - Bert Bolin, 1st IPCC Chair, Sweden **Policy** - Svante Bodin, Swedish Ministry for the Environment **Private** - Mathis Wackernagel, Global Footprint Network, US **Moderator:** Johan Kuylenstierna, SIWI, Sweden	**Air quality and climate** **Science** - Robert Charlson, University of Washington, US **Policy** - Anders Wijkman, European Parliament **Private** - Paola Kistler, Alcan Inc., Canada **Moderator**: Johan Rockström, SEI, Sweden
The ozone hole and the Montreal Protocol **Science** - Paul Crutzen, Nobel Laureate, Germany **Policy** - Claus Brüning, European Commission **Private** - Pauline Midgley, IER, Germany **Moderator:** Margaret Leinen, Climos, US	**Ocean acidification** **Science** - Victoria Fabry, California State University San Marcos, US **Policy** - Carol Turley, Plymouth Marine Laboratory, UK **Private** - Tore Torp, Statoil, Norway **Moderator:** Margaret Leinen, Climos, US
Land use change in the tropics **Science** - Carlos Nobre, IGBP Chair, Brazil **Policy** - Syaiful Anwar, Ministry of Forestry, Indonesia **Private** - Ildo Sauer, Petrobras, Brazil **Moderator:** Johan Rockström, SEI, Sweden	**Consequences of renewable energy** **Science** - Kevin Noone, IGBP **Policy** - Michael Wood, US Ambassador **Private** - Arne Mogren, Vattenfall AB, Sweden **Moderator:** Johan Kuylenstierna, SIWI, Sweden
Iron fertilisation of the oceans **Science** - Peter Liss, University of East Anglia, UK **Policy** - John Cullen, Dalhousie University, Canada **Private** - Margaret Leinen, Climos, US **Moderator:** Berrien Moore III, University of New Hampshire, US	**Adaptation and sustainable development** **Science** - Johan Rockström, SEI, Sweden **Policy** - Göran Holmqvist, Sida **Private** - Sara Farley, World Bank, US **Moderator:** Berrien Moore III, University of New Hampshire, US

The first day of the symposium was mainly a retrospective one, looking at: global climate change and the IPCC; the ozone hole and the Montreal Protocol; land-use change in the tropics; and iron fertilisation of the oceans. The second day was a more forward-looking one, concentrating on present and horizon issues such as: air quality and climate; ocean acidification; consequences of renewable energy; and adaptation and sustainable development.

Close to 80 participants from more than 15 countries were invited to the symposium, roughly 40% from the scientific, 30% from the political, and 30% from the private sectors. A major aim of the symposium was to start to build a long-lasting forum for a dialogue between these three sectors on issues of global environmental change. For more information, see the Symposium webpage at: www.igbp.kva.se/page.php?pid=389.

GEC Programmes to Formally Advise UNFCCC

Climate change science (and global environmental change science more broadly) is changing extremely rapidly. The assessment reports produced by the IPCC are the primary source of credible, salient and legitimate information for the negotiations that go on within the UN Framework Convention on Climate Change (UNFCCC). Because of the rapidity with which our understanding of the climate is progressing, and the rapidity with which new negotiating challenges arise, the UNFCCC has expressed the desire for a mechanism through which a dialogue could be established to keep the negotiators abreast of new scientific findings and the research community updated on what challenges the parties to the convention are facing.

To facilitate this dialogue, the Subsidiary Body for Scientific and Technological Advice (SBSTA), which provides advice on scientific, technological and methodological matters to parties of the UNFCCC, organised a meeting during their 26th session at which the Earth System Science Partnership (ESSP), the Inter-American Institute for Global Change Research (IAI) and the Asia-Pacific Network for Global Change Research (APN) were asked to give short presentations and engage in discussions with representatives from a number of parties to the UNFCCC. This initial meeting was very successful, and led to the decision by SBSTA to invite the global environmental change programmes and organisations to "*regularly inform SBSTA of developments in research activities relevant to the needs of the Convention, such as on emerging scientific findings, research priorities and research planning, including in response to key uncertainties identified by the IPCC.*"

This invitation was gladly accepted and the first such meeting was organised by SBSTA on 5 June 2008 during their 28th session. All four of the ESSP partner programmes (IGBP, IHDP, WCRP, DIVERSITAS) were represented at this meeting, along with representatives from APN, IAI and IPCC. SBSTA was very pleased with the presentations and discussions, and agreed that these meetings should continue at the 30th and subsequent (even-numbered) sessions.

These regular meetings are a key mechanism through which a true dialogue between the research community and the parties to the UNFCCC can be fostered. IGBP and the other global environmental change programmes contribute to the convention via the IPCC (please see the related quote from Solomon and Manning on page 4), but this new forum provides the programmes with an extremely valuable direct communications channel to the parties.

AfricanNESS Science Plan and Implementation Strategy Completed

The AfricanNESS science plan and implementation strategy was completed and officially launched at the Fourth IGBP Congress in Cape Town, South Africa in May 2008. The science plan is available for download from the IGBP and ESSP web sites.

The plan serves as a road map for global environmental change research in Africa; its purpose is:

> "to describe the areas of global environmental change research that are of particular importance and interest for Africa, to describe the basic research needed to support cogent decisions about adaptation and mitigation, and to provide reasonable options for the support structure needed to facilitate and implement the research."

The science plan was prepared in wide consultation with African global environmental change (GEC) researchers, and also with the international research community outside Africa. It reflects the collective views of this research community as to the needs and special interest areas for African GEC research. The plan is stratified into three levels of increasing detail; the intention is to clearly describe the large-scale issues of particular importance for Africa, outline the kinds of international, multidisciplinary research approaches necessary to approach these issues, give examples of specific questions and projects that could be part of an African GEC research initiative, and finally to propose a mechanism through which these initiatives could be realised. This mechanism is called ***AfricanNESS***: the African Network for Earth System Science.

AfricanNESS concentrates on four top-level issues that are the focus of concern with respect to global environmental change and its impacts in Africa:

- Food and nutritional security, including crops, wild-gathered resources, livestock resources and fisheries;
- Water resources, particularly in the water-limited, sub-humid, semi-arid and arid regions;
- Health, especially in relation to the biodiversity-linked, environmentally mediated and vector-born diseases that are responsible for the high disease burden in Africa; and
- Ecosystem integrity, on which the persistence of biodiversity and the delivery of ecosystem services depends.

These focal issues find expression, for instance, in the Millennium Development Goals.

The researchable topics in such broad themes are unavoidably many and interconnected. To achieve a degree of focus and clarity, they have been arranged in the AfricanNESS science plan into eight **thematic clusters**. The elements of such clusters typically interact strongly among themselves, and so are best treated in a coordinated fashion. There are also connections between clusters, so one element may have relevance in sev-

Thematic clusters (blue text) and research elements			
Rainfall	**Land Cover**	**Livelihoods**	**Cities**
Variability	Degradation	Fisheries	Flooding
Distribution	Fragmentation	Pastoralism	Sea level rise
Processes	Fires	Crop farming	Pollution
Land surface feedbacks	Biodiversity loss	Vulnerable people and places	Water resources
Rainfall in global climate models	Water resources		Infrastructure
	Wetlands		
Diseases & Pests	**Africa & the Earth System**	**Integrated Development**	**Marine**
Environmental and emergent	Carbon cycle	Energy	Ecosystems and coral reefs
Advanced bioclimatic modelling	Dust aerosols	Transportation	Biodiversity and food resources
	Water cycle	Air quality	Large-scale circulations
	Ocean-land interaction	Scenarios	
	Palaeoclimate	Governance	
	Biogeochemistry		
	Regional climate modelling		

The AfricanNESS science plan's eight thematic clusters.

eral themes, although for conciseness it is described only in one. The thematic clusters are deliberately not aligned with traditional disciplinary boundaries.

To further organise and prioritise the research topics in this African global change research strategy, the science plan applies the following seven principles:

1. Favour a limited number of multi-year coordinated research programmes over a large number of short-term, independent projects;
2. Promote inter-disciplinary, multi-institutional and regional research;
3. Develop science-policy-practice interfaces;
4. Build lasting human and institutional capacity;
5. Ensure that the products of scientific research are credible, salient and legitimate;
6. Contribute to the global research agenda from an African perspective;
7. Recognise and develop indigenous knowledge and capacity.

The resulting themes represent the intersection of the information needed to support development of favourable research opportunities, and the research capabilities desired in Africa. The objective is to develop the capacity, within Africa, to anticipate and adapt to global change and to adopt a development path that is locally and globally sustainable.

Finally, the science plan proposes a structure and mechanism by which these themes and elements can be approached, and gives an estimate of the level of support needed to make AfricanNESS into a functional research network for Africa.

A working group was established during a scoping meeting held at the IGBP Congress in Cape Town. It is chaired by Professor Isabelle Niang, Cheikh Anta Diop University, Senegal, and has been charged to come up with concrete suggestions for establishing a support structure for AfricanNESS.

IGBP Regional Support Office–Brazil

The IGBP Regional Support Office–Brazil began operating in May 2006. Located within the Brazilian Federal Institute for Space Research (INPE) and funded by the Brazilian government, the Regional Office is staffed by two science officers. The Regional Office supports the IGBP Chair and develops and supports regional IGBP and ESSP activities throughout South America and other developing regions of the world, serving as a link between global programmes and regional scientists. Staff represent IGBP at regional global change-related events, and attended more than 20 such events in 2007. The science officers are also active scientists who publish in scientific journals and lead research projects investigating such things as the role of social networks in climate decision-making in Latin America, and carbon dynamics in tropical hydropower reservoirs and ecosystems.

In March 2007, the Office organised the First Brazilian Symposium on Global Environmental Change in Rio de Janeiro. The Symposium was designed to bring climate change to the forefront of the Brazilian national agenda. More than 400 people attended the event, representing a broad spectrum of Brazilian society (public sector, academia, and the media), and making a significant national impact. International scientists from IGBP and IHDP also participated.

The IGBP Regional Office also helped IGBP and IHDP organise the 22nd IGBP Scientific Committee and the 14th IHDP Scientific Committee meetings in March in Angra dos Reis, Brazil.

In 2007, the Regional Office successfully established a scientific and financial agreement between INPE and the Brazilian Academy of Science, thus securing financial support for its activities in the region and within the Programme.

Other activities include:

Collaboration with the IGBP Secretariat:

- Assisted with the planning and implementation of the Fourth IGBP Congress, including fundraising;
- Coordinated and edited issue 70 of the IGBP *Global Change NewsLetter*, and secured support from INPE to print and mail the IGBP newsletter to more than 2,500 institutions in less-developed countries around the world.

Facilitating regional collaboration and research:

- Enhanced links to South America by serving as liaison for IGBP's Global Land Project as well as for the ESSP Global Carbon Project and Global Water System Project;
- Conceptualised, funded, and organised the 2008 Brazil-held ESSP Biofuels Workshop, identifying research opportunities and policy needs related to sustainable bio-energy options;
- Provided support for South American students to attend the 2007 SOLAS Summer School in Corsica, France;
- Organised teaching modules, sessions, and synthesis materials related to IGBP science, e.g. the "The Science of Global Change" session at the *Third Regional Conference on Climate Change* in São Paulo, November 2007.
- Maintained a productive working relationship with the Inter-American Institute for Global Change Research (IAI), which led to a working group session on "Regional knowledge systems for sustainable development" at the Fourth IGBP Congress.

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IGBP: A Valuable, International Earth System Research Network

IGBP adds value to national and regional research programmes by bringing together researchers to address scientific questions where an international, integrated approach is the best or the only way to provide answers to the issues concerned. National science communities participate in IGBP's complex, multi-national field campaigns and experiments, model and data intercomparisons, regional and global upscaling activities, data exchange, and the synthesis of research results. Through the IGBP network scientists have an opportunity to shape international research strategies. IGBP's integrative and interdisciplinary work provides the scientific infrastructure to enable and support a truly international Earth system science research agenda.

To facilitate dialogue between national and international global change research, IGBP has 74 National Committees that play an essential role in IGBP's scientific planning and implementation.

An overview of IGBP's regional activities, as well as brief summaries about a number of National Committees, are presented on the following pages.

Africa:

- IGBP was crucial in helping with seed funding and support for the emerging Earth system science research network in Africa, AfricanNESS (see details on page 13);
- The Global Ocean Ecosystem Dynamics (GLOBEC) project is working with researchers in Namibia, Angola, South Africa, Morocco and Senegal on issues related to fisheries, the marine resources of the Benguela Current ecosystem, and the influence of the natural variability of the Northwest African upwelling system;
- The International Global Atmospheric Chemistry (IGAC) project, together with the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS), are collaborating in an international, integrated, multidisciplinary project called the African Monsoon Multidisciplinary Analysis (AMMA);
- The Land-Ocean Interactions in the Coastal Zone project (LOICZ) is working with researchers in Morocco on coastal zone management issues;
- IGBP held its Fourth Congress in Cape Town, South Africa in May 2008, focussing on "Sustainable Livelihoods in a Changing Earth System".

Africa
Cameroon

On 6-8 June 2007, the national committee organised an international colloquium in Yaoundé. The theme of the colloquium was "Central Africa, Cameroon and Global Change", and it brought together more than 60 participants from Africa and Europe. Main sponsors were the Institut de recherche pour le développement (IRD) and the Agence universitaire pour la Francophonie.

Africa
Mozambique

Mozambique has established a Global Change National Committee, under the auspices of the Scientific Research Association of Mozambique (AICIMO), a full national scientific member of ICSU. The Committee has representation from all four ESSP programmes (IGBP, IHDP, WCRP and DIVERSITAS) as well as GECAFS. The interdisciplinary nature of the Committee will help Mozambique handle its priorities through multi-disciplinary projects with national and international coverage, based on the present team of 25 scientists. The Committee is chaired by Boaventura Chongo Cuamba (from Eduardo Mondlane University) and the vice-chair is Ernesto Lenathy Muheca (from Pedagogical University). The Committee will be officially launched during the 29th ICSU General Assembly in Maputo, Mozambique, in October 2008.

Asia

Mongolia

Mongolia has recently established a Global Change National Committee, under the auspices of the Ministry of Nature and the Environment. The goals of the committee are to organise global environmental change related activities in the country, and to coordinate their activities with other ministries, research organisations, donor countries and organisations, projects and programmes. The 14-member committee is chaired by B. Enhmandah (Vice-Minister of Nature and Environment), and has T. Chuluun as its vice chair.

Asia

Japan

The Joint Committee for IGBP and WCRP has launched two large projects that will run over a five-year period. One is on the integrated Earth system simulation (supported by MEXT), the other is on the fine-scale coupling of climate change prediction and socio-economic adaptation (supported by the Ministry of Environment).

One priority of the new Japanese government is climate change mitigation and adaptation, and currently several proposals regarding global change science and technology developments are being discussed. The Joint Committee of IGBP and WCRP is committed to ensuring that these proposals recognise the importance of integrated Earth system science.

Europe

Slovakia

BIOHYDROLOGY 2009: A changing climate for biology and soil hydrology interactions, Bratislava, Slovakia, 21-24 September 2009, co-organised by the Slovak national committee for IGBP, is the second international conference to discuss exclusively the interactions between hydrological and biological processes in soil under conditions of changing climate. URL: www.ih.savba.sk/biohydrology2009/.

Asia:

- GLOBEC is working with researchers in Korea, China (in collaboration with our Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project) and Japan on issues related to fisheries and climate, in particular in the North Pacific and Arctic;
- IMBER has active research on biogeochemistry and ocean ecosystems in China, Korea, Taiwan, Japan and India;
- The Surface Ocean-Lower Atmosphere Study (SOLAS) has active research on air-sea exchanges of climatically important gases in China, Taiwan, India, Japan and Korea;
- IGAC sponsors the Megacities: Asia project to facilitate better coordination between groups making measurements of aerosols and oxidants in and around large cities in Asia, in order to accurately make the link between source emissions and regional-scale air quality and climate impacts;
- LOICZ is studying the Yellow River Delta and Bo-Hai Sea to evaluate groundwater and river water discharges and their dissolved material transports into the Bo-Hai Sea, and the effect of recent Yellow River cut-off due to changes in land utilisation and water management on groundwater and the Bo-Hai Sea;
- IMBER and LOICZ co-sponsored a conference on Continental Margins in Shanghai, China.

Europe:

- GLOBEC's project on Cod and Climate Change studies how climate variability affects the productivity and distribution of cod stocks, which have shown to be sensitive to environmental variability. Cod is a major component of most North Atlantic ecosystems;
- IMBER has active research on biogeochemistry and ocean ecosystems in Finland, France, Italy, UK, Germany, The Netherlands, Russia and Spain;
- SOLAS has held a very popular summer school every two years in Corsica to introduce integrated ocean-atmosphere research to PhD students. SOLAS has active research on air-sea exchanges of climatically important gases in Belgium, Denmark, France, Germany, Ireland, Italy, The Netherlands, Norway, Russia, Spain, Sweden and the UK;
- LOICZ sponsors several projects in Europe, including research on bio-geomorphological interactions within floodplains and their role in sediment transport and ecological transformation processes in the lower Rhine delta; marine research on eutrophication in the Baltic Sea, and an investigation of recent morphodynamics of Arctic coastal estuarine-deltaic systems of Russia; research on water quality in coastal areas of Portugal; and monitoring coastal morphodynamics in Ireland;
- The project on Past Global Changes (PAGES) coordinates research activities in the Czech Republic, Finland, Germany, Lithuania, Russia, Switzerland, and Turkey;

- IGBP promotes active Earth system science networking through its European International Project Offices located in Germany (GLP, LOICZ), France (IMBER), UK (GLOBEC, SOLAS), Switzerland (PAGES), and Finland (iLEAPS);
- Active IGBP National Committees in many European countries work to conduct integrative science that contributes to IGBP projects and the programme as a whole.

North America:

- GLOBEC's project on Cod and Climate Change studies how climate variability affects the productivity and distribution of cod stocks, which have shown to be sensitive to environmental variability. Cod was chosen as the principal target species because its biology is well known and it is a major component of most North Atlantic ecosystems;
- GLOBEC also lends support to Mexican research titled "Investigaciones Mexicanas de la Corriente de California (IMECOCAL)" that aims to improve our capability to predict the response of the pelagic ecosystem to regional and global climate change, as well as to the combined effects of harvesting practices by Mexico and the United States;
- SOLAS has completed a very active programme of activities in Canada and is undertaking active research on air-sea exchange of climatically important gases in the United States;
- IMBER and PAGES coordinate research activities in Canada and the United States;
- iLEAPS is comparing remotely sensed estimates of gross primary productivity with in situ measurements from several flux network (e.g., FLUXNET, Ameriflux, Agriflux) sites in North America;
- The AIMES and IGAC International Project Offices are located in Colorado and Washington, respectively.

Oceania:

The role of the Southern Ocean is critical for understanding Earth system dynamics and IGBP's research in Oceania plays an important role in the Programme's overall syntheses of global environmental change. To this end, SOLAS, IMBER and GLOBEC have active research in the Southern Ocean, including Integrated Analyses of Circumpolar Climate Interactions and Ecosystem Dynamics in the Southern Ocean (ICED) and gas exchange and iron fertilisation experiments. IMBER, SOLAS and LOICZ have active research activities in Australia and New Zealand.

IGBP's PAGES project coordinates research activities in Australia and New Zealand, and the Global Land Project (GLP) has been working on integrating and developing research from the highly successful Global Change and Terrestrial Ecosystems (GCTE) and the Land Use and Land-Cover Change (LUCC) initiatives, with activities aimed at dryland processes in Australia.

Europe
Portugal

On 27 September 2007, the Portuguese National Committee for IGBP held a symposium in Lisbon on "Stability of the Atlantic, Mediterranean and Sahara Systems" in preparation for an Integrated Regional Study (IRS) being proposed for implementation, as well as to discuss efforts to restructure NC activities and the creation of a "National Community for Global Change Research" Association. The latest IGBP–Portugal NewsLetter (nr 6, July 2007) highlights the plans and rationale for the IRS and lists 11 major publications related to NC activities. (http://igbp-portugal.org)

Europe
Germany

Over the last few years, the members of the German National Committee, representing DIVERSITAS, WCRP, IGBP, IHDP and ESSP, together with German scientists from the natural and social sciences and the national research funding agencies (BMBF, DFG), have developed a national research programme on climate change. The programme is entitled: "Coping with climate change: Land use in the area of conflict of resource conservation, food and energy". This broad research programme gives perspectives for new interdisciplinary research projects for regions that are strongly influenced by the impacts of global climate change (those areas which have permafrost, highly dynamic growth regions, etc.).

This national research programme was discussed by around 200 scientists at a national conference held in Bad Honeff, Germany in April 2008. In May 2008, the national research programme was finalised and presented to the German research funding agencies.

Please visit our website at www.nkgcf.org for more details or to download the national research programme.

Europe

United Kingdom

On 27 June 2007, the UK National Committee held a meeting on "Palaeo and Modern Perspectives on Global Change", which aimed to examine the key challenges posed by the palaeo-record from the perspective of each of the IGBP projects and to build a dialogue between these projects and the PAGES community. URL: www.bridge.bris.ac.uk/palmope

Europe

Russia

In November 2007 the Russian National Committee of IGBP organised a global change science poster competition with the goal of popularising global change science. The competition was open to Russian students and young scientists, and participants were asked to write for a general audience and to utilise online resources such as the IGBP and IPCC websites in preparing their contributions. The winning posters can be downloaded from the IGBP website (www.igbp.net/page.php?pid=402). First prize went to Anastasiya Revokatova whose poster focussed on the role of anthropogenic and natural factors in climate changes.

South America

Colombia

On 10-15 October 2007, the Colombian National Committee for IGBP organised – together with the University of Antioquia at Medellin – an international conference titled "Expo Universidad 2007 – Climate Change, Science and Conscience". Keynote speakers included Carlos Nobre, Chair of IGBP, Peter Bunyard (UK), and Ulisses Confalonieri (Brazil). More information: www.udea.edu.co/consulta/publico

South America:

IGBP's regional research in South America plays an important role in the Programme's overall syntheses of global environmental change. Some examples of current IGBP research in South America are:

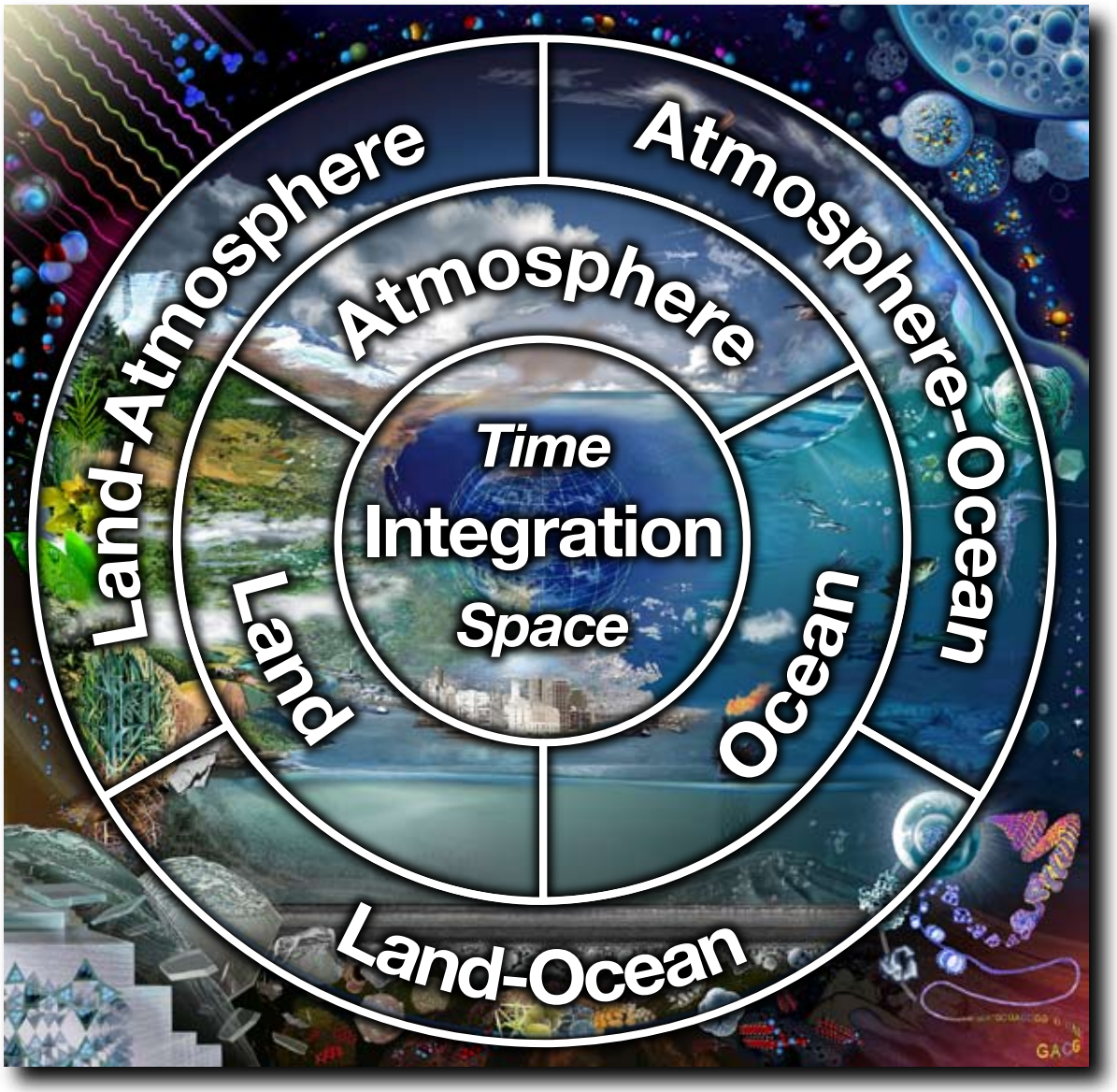
- GLOBEC, SOLAS and IMBER have active research in Chile, particularly with researchers at the Center of Oceanographic Research in the Southeastern Pacific (FONDAP-COPAS);
- In Peru, GLOBEC researchers participate in the project on Dynamics of the Peruvian Upwelling Ecosystem, consisting of detailed monitoring of the abiotic environment, planktonic and benthic communities, and pelagic and demersal populations;
- LOICZ studies nutrients and heavy metal transfer through the land-ocean interface at the coastal zone in five coastal basins along the northeast and southeast coast of Brazil;
- PAGES sponsors research on the Long-Term climate Reconstruction and Dynamics of (southern) South America (LOTRED-SA), and also supports research activities in Chile and Colombia;
- IGBP has recently opened a regional support office in Brazil to focus on issues of environmental sustainability in developing countries. (See page 15 for details)

Countries with IGBP National Committees

Argentina
Australia
Austria
Bangladesh
Belgium
Benin
Bolivia
Botswana
Brazil
Bulgaria
Cameroon
Canada
Chile
China
Colombia
Comoros
Congo, Democratic Republic of
Cuba
Czech Republic
Denmark
Egypt
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Ivory Coast
Jamaica
Japan
Kenya
Korea, Republic of
Lebanon
Malaysia
Mexico
Mongolia
Morocco
Mozambique
Netherlands
New Zealand
Norway
Pakistan
Peru
Philippines
Poland
Portugal
Romania
Russian Federation
Senegal
Sierra Leone
Singapore
Slovakia
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Syrian Arab Republic
Taiwan
Thailand
Togo
Tunisia
United Kingdom
United States
Venezuela
Vietnam
Zambia
Zimbabwe

IGBP Science

IGBP research comprises a suite of nine research projects focussed on the major Earth system components (land, ocean and atmosphere), the interfaces between them (land-ocean, land-atmosphere and ocean-atmosphere) and system-wide integration (Earth system modelling and palaeo-environmental studies).



Atmosphere

Earth's atmosphere is both a part of, and a product of, the biosphere. Its natural composition is chemically unstable: if plants had not evolved, there would be at least a thousand times less oxygen, and a hundred times more carbon dioxide in the air. Conditions would then be unsuitable for nearly all other present-day forms of life. Earth's biological processes are also responsible for other greenhouse gases, such as methane, nitrous oxide and ammonia, which play an important role in global climate control and also affect the thickness of the Earth's protective ozone layer.

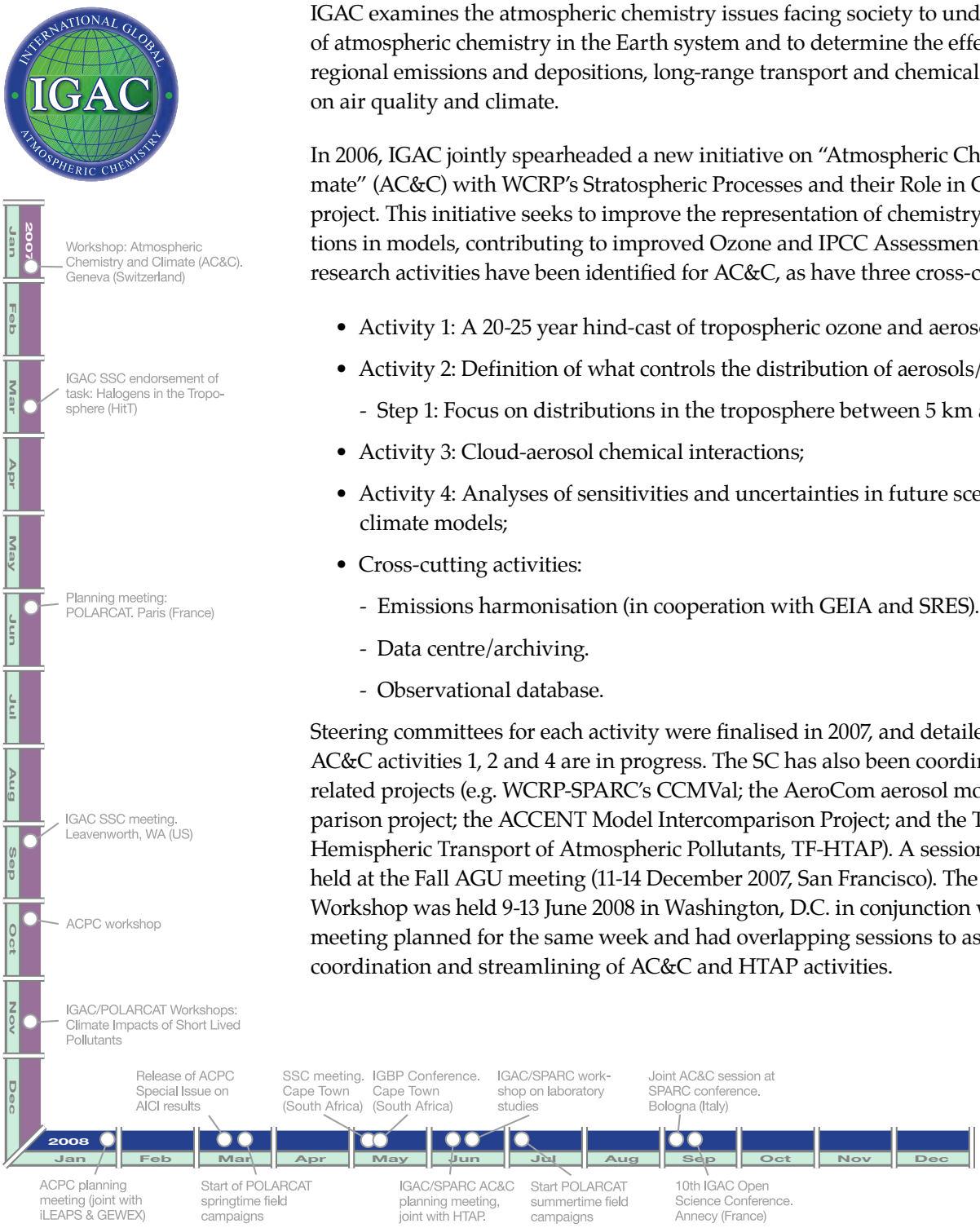
International Global Atmospheric Chemistry (IGAC)

IGAC examines the atmospheric chemistry issues facing society to understand the role of atmospheric chemistry in the Earth system and to determine the effects of changing regional emissions and depositions, long-range transport and chemical transformations on air quality and climate.

In 2006, IGAC jointly spearheaded a new initiative on "Atmospheric Chemistry and Climate" (AC&C) with WCRP's Stratospheric Processes and their Role in Climate (SPARC) project. This initiative seeks to improve the representation of chemistry/climate interactions in models, contributing to improved Ozone and IPCC Assessments. Four main research activities have been identified for AC&C, as have three cross-cutting activities:

- Activity 1: A 20-25 year hind-cast of tropospheric ozone and aerosols;
- Activity 2: Definition of what controls the distribution of aerosols/gases;
  - Step 1: Focus on distributions in the troposphere between 5 km and tropopause.
- Activity 3: Cloud-aerosol chemical interactions;
- Activity 4: Analyses of sensitivities and uncertainties in future scenarios for climate models;
- Cross-cutting activities:
  - Emissions harmonisation (in cooperation with GEIA and SRES).
  - Data centre/archiving.
  - Observational database.

Steering committees for each activity were finalised in 2007, and detailed plans for AC&C activities 1, 2 and 4 are in progress. The SC has also been coordinating with related projects (e.g. WCRP-SPARC's CCMVal; the AeroCom aerosol model intercomparison project; the ACCENT Model Intercomparison Project; and the Task Force on Hemispheric Transport of Atmospheric Pollutants, TF-HTAP). A session on AC&C was held at the Fall AGU meeting (11-14 December 2007, San Francisco). The 2nd AC&C Workshop was held 9-13 June 2008 in Washington, D.C. in conjunction with an HTAP meeting planned for the same week and had overlapping sessions to assure optimum coordination and streamlining of AC&C and HTAP activities.



A study of Hong Kong's air quality is one of the many IGAC activities.

Photo credit:
Sanjay Pindiyath

Air-Ice Chemical Interactions (AICI) Task

The AICI Task concluded its first phase in 2007, with the publication of a special journal issue summarising the latest findings (please see the publications list), and including synthesis papers combining data from different regions and from different activities (laboratory, field and modelling). These papers were the outcome of a series of AICI workshops supported by IGAC.

Mega-Cities Asia Task

In its first phase, this task aimed to make a comparable set of studies of atmospheric chemistry within mega-cities in the Asian region, with an interest both in air quality and radiative/climate impacts. This was accomplished through parallel measurements in mega-cities in Japan, mainland China, China-Taipei, Korea, and (as of 2007) Thailand. Progress was made in 2007 on data accessibility, which has been a persistent issue within this task.

There are a large number of mega-cities-related field activities ongoing throughout the Asian region. Some of these activities are:

- The IMPACT study in Japan measuring aerosols (including black and organic carbon), reactive gases and other air pollutants;
- China, Pearl River Delta (Hong Kong-Guangzhou-Macau cluster);
- China, CAREBEIJING (Campaigns of Air Quality Research in Beijing);
- China, Four-City Study (Hong Kong, Beijing, Shanghai, Lanzhou);
- China-Taipei (aerosols, ozone and long-distance transport);
- Korea (visibility, building comparability with other studies);
- Thailand (elemental and organic carbon, carbon monoxide measurements).

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Land

The development of civilisation during the past 10,000 years has been accompanied by radical changes in the terrestrial environment. Mankind now harvests plant-derived materials from over 35 percent of the total land surface, at considerable environmental cost. Additional impacts are likely in the future, arising from global changes in atmospheric composition (with CO_2 and ozone of particular importance) and their likely consequences (increasing temperatures, changes in precipitation, and other climate changes), and increased UV radiation.

Global Land Project (GLP)

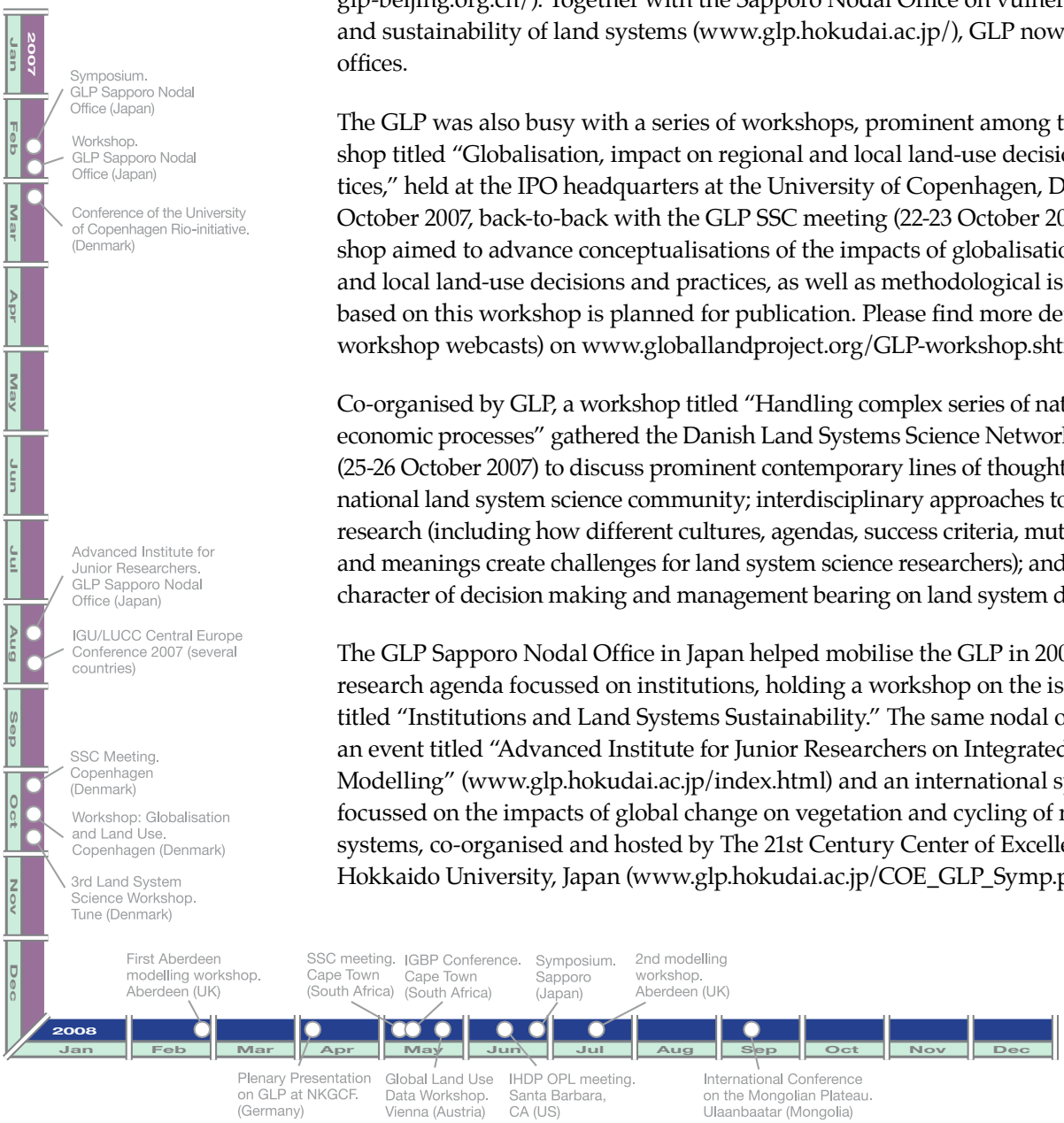
This joint project of IGBP and IHDP studies the human transformation of ecosystems and landscapes, including the links between decision making and practices impacting land-use, ecosystem services and global environmental change.

Started in 2006, the GLP continued to consolidate into a fully functioning research programme in 2007, during which time two more nodal offices became fully functional: the Aberdeen Nodal Office on integration and modelling (webpage: glp.macaulay.ac.uk/index.php) and the Beijing Nodal Office on land use and ecosystem interactions (www.glp-beijing.org.cn/). Together with the Sapporo Nodal Office on vulnerability, resilience and sustainability of land systems (www.glp.hokudai.ac.jp/), GLP now has three nodal offices.

The GLP was also busy with a series of workshops, prominent among them the workshop titled "Globalisation, impact on regional and local land-use decisions and practices," held at the IPO headquarters at the University of Copenhagen, Denmark, 24 October 2007, back-to-back with the GLP SSC meeting (22-23 October 2007). The workshop aimed to advance conceptualisations of the impacts of globalisation on regional and local land-use decisions and practices, as well as methodological issues. A synthesis based on this workshop is planned for publication. Please find more details (including workshop webcasts) on www.globallandproject.org/GLP-workshop.shtml.

Co-organised by GLP, a workshop titled "Handling complex series of natural and socio-economic processes" gathered the Danish Land Systems Science Network in Copenhagen (25-26 October 2007) to discuss prominent contemporary lines of thought from the international land system science community; interdisciplinary approaches to land systems research (including how different cultures, agendas, success criteria, mutual interactions and meanings create challenges for land system science researchers); and the role and character of decision making and management bearing on land system dynamics.

The GLP Sapporo Nodal Office in Japan helped mobilise the GLP in 2007 to define a research agenda focussed on institutions, holding a workshop on the issue in February titled "Institutions and Land Systems Sustainability." The same nodal office also held an event titled "Advanced Institute for Junior Researchers on Integrated Land Systems Modelling" (www.glp.hokudai.ac.jp/index.html) and an international symposium focussed on the impacts of global change on vegetation and cycling of materials in ecosystems, co-organised and hosted by The 21st Century Center of Excellence Program of Hokkaido University, Japan (www.glp.hokudai.ac.jp/COE_GLP_Symp.pdf).



Human transformation of ecosystems including farming and land development are key research areas for GLP.

Photo credit: morgueFile

Finally, the GLP held the Second Conference of the University of Copenhagen Rio-initiative, titled "Climate Change and Sustainable Development in LDCs" (see www.geogr.ku.dk/projects/rio/index.shtml). It took place in the Department of Geography and Geology of the University of Copenhagen, Denmark.

Other GLP products in 2007 were a series of high-profile publications, including — but far from limited to — a special issue in the *Proceedings of the National Academy of Sciences* on land change science (*PNAS*, December 2007, Vol. 104, No. 52) to which a number of GLP members and GLP-network members contributed. The lead paper is: "The Emergence of Land Change Science for Global Environmental Change and Sustainability", by B. L. Turner II, Eric Lambin, Anette Reenberg. Other papers in this special issue with authorship from GLP SSC members are: Sandra Díaz, Sandra Lavorel, Francesco de Bello, Fabien Quétier, Karl Grigulis, and T. Matthew Robson. Sandra Diaz's paper was awarded a Cozzarelli Prize as an exceptional paper published in 2007 (see Science Highlights item on page 8).

Project output in 2007 was mainly scientific and in the form of workshops and scientific publications. GLP's outreach and capacity-building activities include, among others, the creation and maintenance of four websites variously at the IPO, Aberdeen, Beijing and Sapporo Nodal Offices and a newsletter last published in January 2008 (with a printed and digital version) (www.globallandproject.org/newsletter.shtml). In addition to that, GLP leaders and SC members have made numerous presentations about the GLP and its projects, to enhance its connectivity with other research efforts and related communities, including the NASA-funded LCLUC; the IARU (International Alliance of Research Universities) Energy and Environment; the Centre for Geoinformatics (ZGIS) and the iSpace Research Centre, both in Salzburg, Austria; the Northern Eurasia Earth Science Partnership Initiative (NEESPI); iLEAPS; AIMES young scholars network; Advanced Institute for Junior Researchers on Integrated Land Systems Modelling; "The Land Use Study Center" at Beijing University and IGSNRR/CAS, also in Beijing. Many of these presentations also served to increase and maintain interactions with other IGBP and ESSP projects, national committees and international programmes.

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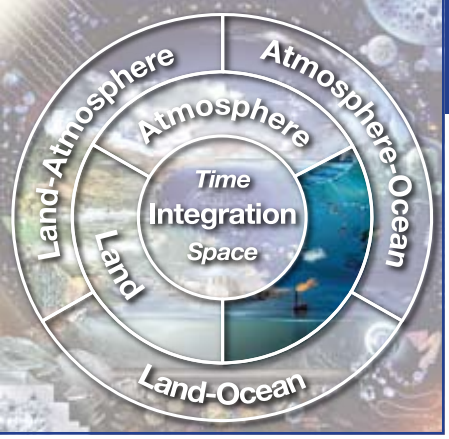


Ocean

The ocean is a vital component of the Earth's metabolism and plays a key role in global change. Marine ecosystems are inextricably involved in the physical, chemical, biological and societal processes of global change. It is impossible to describe and understand the Earth system without understanding the ocean, the special characteristics of the environment that it provides for life, the changes that it is undergoing and the manner in which these changes interact with the total Earth system. Understanding the functioning of marine ecosystems and how they respond to global change is also essential to effective management of marine living resources, such as fisheries.

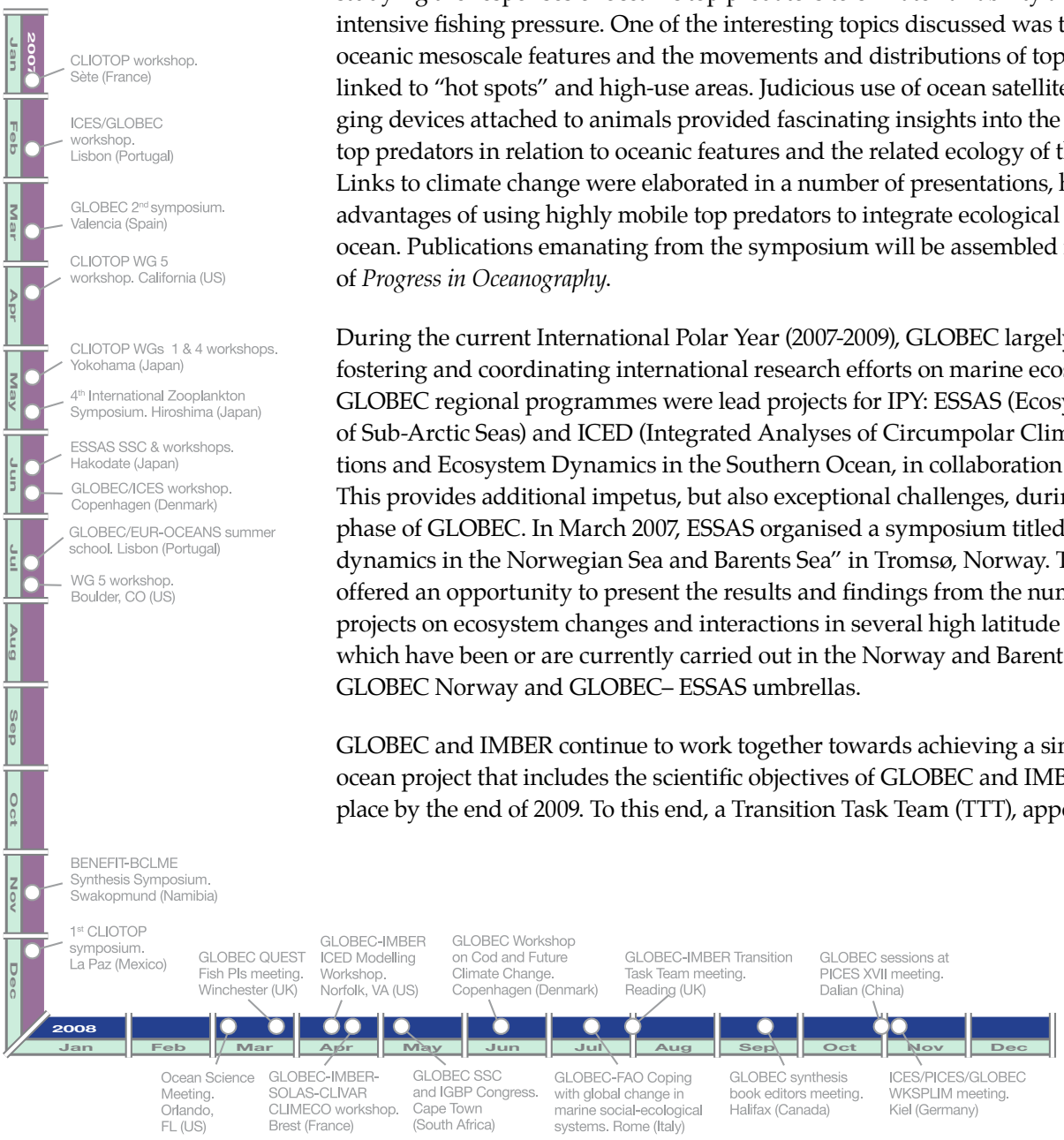
Global Ocean Ecosystem Dynamics (GLOBEC)

GLOBEC studies how global change affects the abundance, distribution, diversity and productivity of marine populations.

In December 2007, CLIOTOP, one of GLOBEC's six regional programmes, organised its first symposium on "Climate Impacts on Oceanic Top Predators" in La Paz, Mexico. The symposium aimed to stimulate international scientific collaboration among researchers studying the responses of oceanic top predators to climate variability and change and to intensive fishing pressure. One of the interesting topics discussed was the link between oceanic mesoscale features and the movements and distributions of top predators, often linked to "hot spots" and high-use areas. Judicious use of ocean satellite data and logging devices attached to animals provided fascinating insights into the behaviour of top predators in relation to oceanic features and the related ecology of these systems. Links to climate change were elaborated in a number of presentations, highlighting the advantages of using highly mobile top predators to integrate ecological signals in the ocean. Publications emanating from the symposium will be assembled in a special issue of *Progress in Oceanography*.

During the current International Polar Year (2007-2009), GLOBEC largely contributes to fostering and coordinating international research efforts on marine ecosystems. Two GLOBEC regional programmes were lead projects for IPY: ESSAS (Ecosystem Studies of Sub-Arctic Seas) and ICED (Integrated Analyses of Circumpolar Climate Interactions and Ecosystem Dynamics in the Southern Ocean, in collaboration with IMBER). This provides additional impetus, but also exceptional challenges, during the synthesis phase of GLOBEC. In March 2007, ESSAS organised a symposium titled "Ecosystem dynamics in the Norwegian Sea and Barents Sea" in Tromsø, Norway. This symposium offered an opportunity to present the results and findings from the numerous existing projects on ecosystem changes and interactions in several high latitude environments which have been or are currently carried out in the Norway and Barents Seas under the GLOBEC Norway and GLOBEC– ESSAS umbrellas.

GLOBEC and IMBER continue to work together towards achieving a single integrated ocean project that includes the scientific objectives of GLOBEC and IMBER to be in place by the end of 2009. To this end, a Transition Task Team (TTT), appointed under the



A Minke whale, photographed near the northwest end of Adelaide Island in the Western Antarctic Peninsula, during a Winter Southern Ocean GLOBEC cruise, from aboard the ARSV L.M. Gould.

Photo credit:
Dan Costa

chairmanship of Professor John Field, has been formed to develop the scientific content of the addendum to the IMBER science plan, to reflect the science of the second phase of IMBER. The first meeting of the TTT, which was organised by the GLOBEC IPO, took place in Reading, UK, 30 July to 1 August 2008. The second meeting of the TTT is scheduled for December 2008 and the public posting on websites of the addendum draft is planned for early in 2009 for feedback from the scientific community.

The following are some common activities between IMBER and GLOBEC:

- GLOBEC-IMBER End-to-End task team;
- Integrated Analyses of Circumpolar Climate Interactions and Ecosystem Dynamics in the Southern Ocean (ICED), a follow-up to the GLOBEC Southern Ocean Programme;
- Chinese GLOBEC/IMBER programme;
- EUR-OCEANS (European Network of Excellence for Ocean Ecosystems Analysis, www.eur-oceans.eu), which is now entering its last year of operation.

Two GLOBEC books are underway. The *GLOBEC-SPACC Synthesis – Climate Change and Small Pelagic Fish,* to be published in the first quarter of 2009, synthesises one of GLOBEC's most successful regional programmes, "Small Pelagics and Climate Change" (SPACC). This book will be launched at the third GLOBEC Open Science Meeting in Victoria, Canada in June 2009. The *GLOBEC Synthesis – Global Change and Marine Ecosystems* is currently under review, and is expected to be published in the autumn of 2009. GLOBEC has produced a total of 3,058 (2,612 refereed) research papers since its implementation.

Co-sponsors:

International Council for Science
SCOR ICSU
Scientific Committee on Oceanic Research

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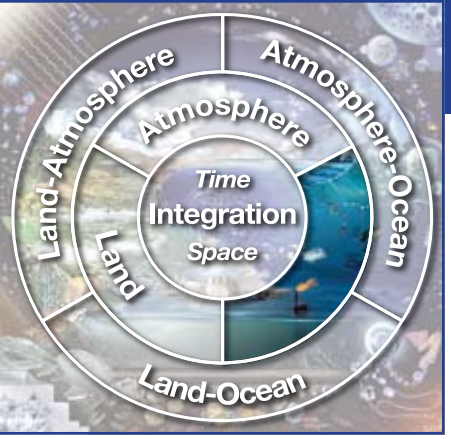


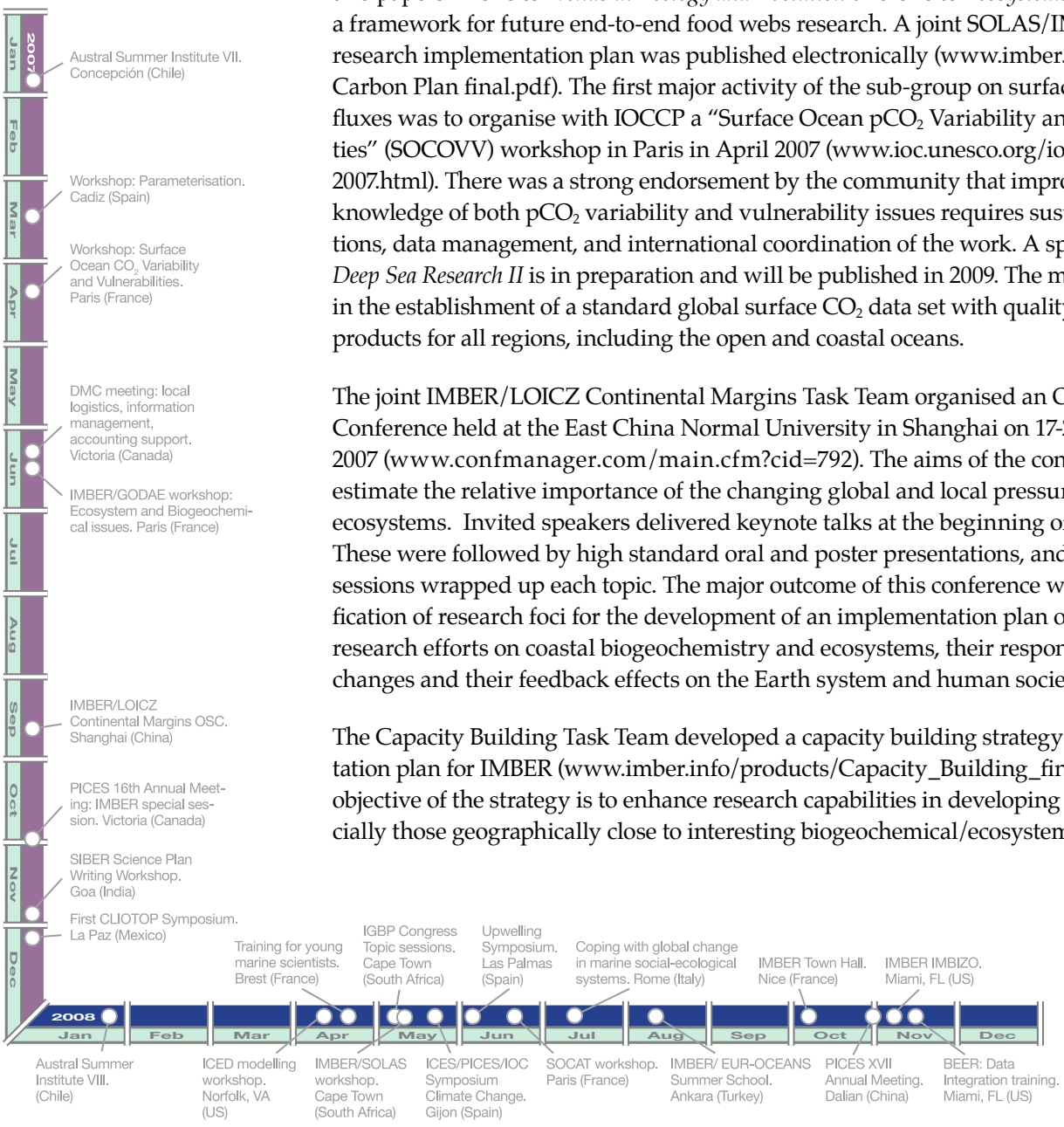
Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

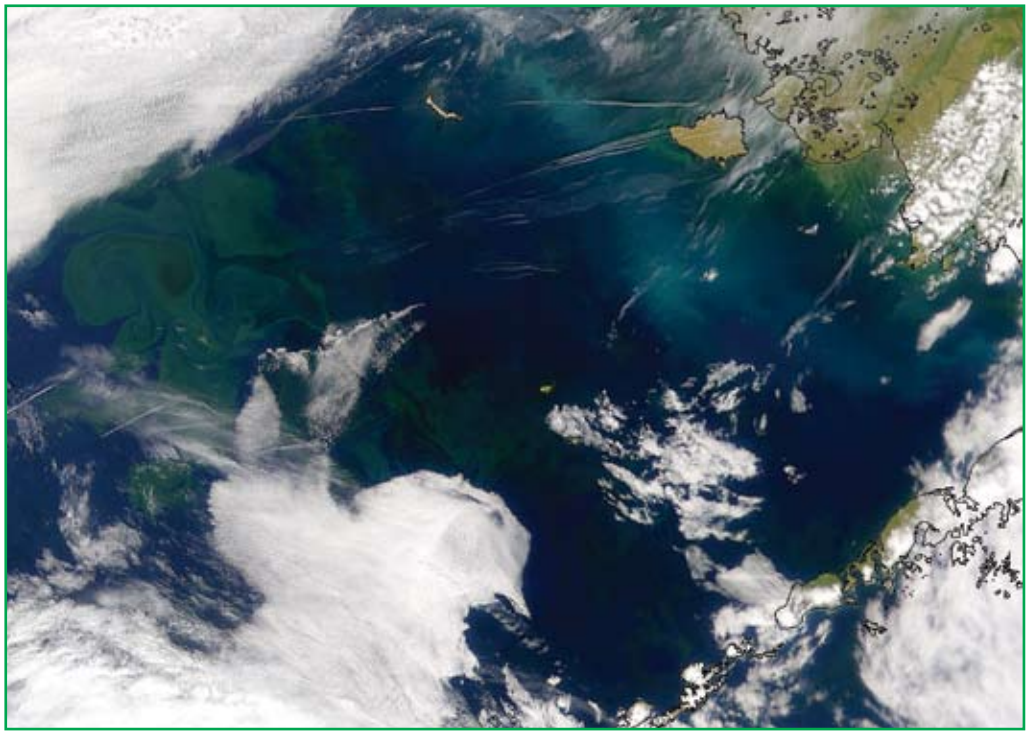
IMBER studies the sensitivity of marine biogeochemical cycles and ecosystems to global change, on time scales ranging from years to decades.

In 2007, IMBER activities increased notably. Five working groups and task teams are active in the development and implementation of the project. The End-to-End Food Webs Task Team reviewed the concept of end-to-end food webs research and submitted two papers — one to *Trends in Ecology and Evolution* and one to *Ecosystems* — providing a framework for future end-to-end food webs research. A joint SOLAS/IMBER carbon research implementation plan was published electronically (www.imber.info/products/Carbon Plan final.pdf). The first major activity of the sub-group on surface ocean CO_2 fluxes was to organise with IOCCP a "Surface Ocean pCO_2 Variability and Vulnerabilities" (SOCOVV) workshop in Paris in April 2007 (www.ioc.unesco.org/ioccp/pCO2_2007.html). There was a strong endorsement by the community that improving our knowledge of both pCO_2 variability and vulnerability issues requires sustained observations, data management, and international coordination of the work. A special issue of *Deep Sea Research II* is in preparation and will be published in 2009. The meeting resulted in the establishment of a standard global surface CO_2 data set with quality controlled products for all regions, including the open and coastal oceans.

The joint IMBER/LOICZ Continental Margins Task Team organised an Open Science Conference held at the East China Normal University in Shanghai on 17-21 September 2007 (www.confmanager.com/main.cfm?cid=792). The aims of the conference were to estimate the relative importance of the changing global and local pressures on coastal ecosystems. Invited speakers delivered keynote talks at the beginning of each session. These were followed by high standard oral and poster presentations, and discussion sessions wrapped up each topic. The major outcome of this conference was the identification of research foci for the development of an implementation plan of collaborative research efforts on coastal biogeochemistry and ecosystems, their responses to global changes and their feedback effects on the Earth system and human society.

The Capacity Building Task Team developed a capacity building strategy and implementation plan for IMBER (www.imber.info/products/Capacity_Building_final.pdf). One objective of the strategy is to enhance research capabilities in developing countries, especially those geographically close to interesting biogeochemical/ecosystem provinces.





Phytoplankton and Coccolithophores in the Bering Sea. The green water on the left features a high concentration of phytoplankton. On the right, off the west coast of Alaska, a bloom of a specific type of phytoplankton, coccolithophores, appears bright blue-green.

Photo credit:
SeaWiFS Project, NASA/ Goddard Space Flight Center, and ORBIMAGE

Finally, the IMBER Data Management Committee (DMC) held their first meeting in Victoria, Canada on 10-11 June 2007. The Data Management Committee recommended promoting a cooperative data management approach. This includes:

- Involving data specialists right from the start;
- Appointing, delegating or hiring a person with data management experience to serve as the project data specialist;
- Training young scientists to conduct data management (useful on their CVs); and
- Promoting incentives rather than penalties.

To integrate the activities and outcomes of the various IMBER working groups and task teams, IMBER will conduct a series of coordinated, co-located workshops called IMBIZOs over the next decade (IMBIZO means "gathering" in Zulu). The first IMBIZO will be held in Miami, Florida in November 2008, on the theme "Integrating biogeochemistry and ecosystems in a changing ocean". There will be three concurrent and interacting workshops and joint plenary and poster sessions. The workshop topics include end-to-end food webs and biogeochemical cycles, and studies of the Mesopelagic layer and the Bathypelagic zone of the ocean. Each of the workshops will prepare a special journal issue containing syntheses and primary research papers. The IMBER data management committee is also organising a half-day interactive workshop entitled "Being Efficient and Environmentally Responsible". This workshop will provide an opportunity for junior and senior scientists to participate in a presentation on the benefits of various data integration and handling techniques illustrated in the IMBER Data Integration Manual.

The IMBER objectives are also implemented through contributing projects (EUR-OCEANS, ICED, SIBER), and seven endorsed projects to date (www.imber.info/endorsed_projects.html). In addition to its website, IMBER produces a quarterly electronic newsletter and a monthly eNews bulletin, circulated to the IMBER community.

Co-sponsor:

International Council for Science
ICSU
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Land–Atmosphere Interface

Earth System Interfaces

Earth system interfaces—those interactions between land-atmosphere, land-ocean and ocean-atmosphere—play an equally important role in the study of global environmental change as the main Earth components do. These interactions reinforce the notion that the Earth behaves as a system in which the oceans, atmosphere and land, and their living and non-living components, are all connected. IGBP broadens its study of the Earth system with its three interface projects.

Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS)

The iLEAPS project looks at the physical, chemical and biological processes that transport and transform energy and matter at the land-atmosphere interface and that are tightly coupled and highly sensitive to climate change.

The interactions between the biosphere and the atmosphere mediated by the production and emission of reactive trace gases are crucial and central components of the study of Earth system and life science. Their importance to the structure and functioning of terrestrial ecosystems and to the chemical weather of Earth is only now beginning to be appreciated, and there is wide acknowledgement that these are areas needing concerted scientific effort on a large scale. A five-year scientific programme was initiated in 2004 on "Volatile Organic Compounds in the Biosphere-Atmosphere System" (VOCBAS). VOCBAS has acted as a catalyst of biological research on VOCs, and as the biological interface with programmes specifically addressing VOC impact on the chemistry and physics of the atmosphere. Scientific contributions made possible by VOCBAS support during 2007, mainly through exchange visits between young scientists of European laboratories, have been collected in a VOCBAS dedicated special issue of the international journal *Plant Biology* (please see the publications list).

iLEAPS, along with IGAC and WCRP's GEWEX project, are collaborating on a new initiative called Aerosols, Clouds, Precipitation, Climate (ACPC). The ACPC Planning Group wrote a joint white paper that formed the starting point for the ACPC Specialist Workshop held in Boulder, Colorado, in October 2007, where some 60 participants from the fields of aerosol physics and chemistry, cloud dynamics and microphysics, atmospheric radiation, and climate dynamics gathered to design the scientific scope of the project. The joint white paper and Boulder workshop report are available in the iLEAPS Newsletter 4 (2007) and 5 (2008). The ACPC Steering Committee will initiate the writing of a Science Plan and Implementation Strategy in October 2008.

In October 2007, iLEAPS organised an expert workshop at Wageningen University and Research Centre, Netherlands, focussing on surface and boundary layer exchanges of reactive and greenhouse gases. The aim was to review the current knowledge of the relation between physical and chemical processes and their impact on the larger spatial and temporal scale distribution of atmospheric compounds. Participants discussed three main themes: 1) Atmosphere-land interaction: sources and sinks of atmospheric compounds; 2) Boundary layer processes: mixing, dispersion and exchange with free

Smoke from agricultural fires suppresses rainfall from a cloud over the Amazon (right). In pristine air some distance away, a similar size cloud rains heavily on the same day.

Photo credits:
Danny Rosenfeld,
Meinrat O. Andreae

troposphere; 3) Implementation of surface and boundary layer models in air quality and atmospheric chemistry-transport models. The workshop outcome will be used as a roadmap for topics that require further investigation: current status and deployment of measurement technology to conduct trace gas flux measurements; uncertainties in fluxes inferred from observed tracer concentrations in the boundary layer; reactive trace gas exchanges under nocturnal conditions; the impact of turbulence and non-uniform emissions on the reactivity; the dependence of modelled tracer concentration on the representation of the planetary boundary layer (day-time and night-time conditions).

Another major iLEAPS activity in the past year was the project's presence at the European Geosciences Union General Assembly 2008 in Vienna, Austria, in April. iLEAPS organised/co-organised several sessions at the meeting, including a special session on "Interactions of land cover and climate" with several review presentations. For updates, see www.ileaps.org/.

Outreach and capacity building activities

In December 2007 iLEAPS launched a new web site at www.ileaps.org. The website is based on Joomla, an open source content management system, and includes multisites for all iLEAPS projects/events. It also features the new ESSP visual profile and an enhanced navigation structure.

iLEAPS continues to publish and distribute its newsletter. The fourth issue in July 2007 was dedicated to biomass burning and fire-land-atmosphere interactions including 14 scientific articles as well as new project descriptions and workshop reports. The fifth issue, published in March 2008, focussed on the outcome from the ACPC Experts Workshop in 2007.

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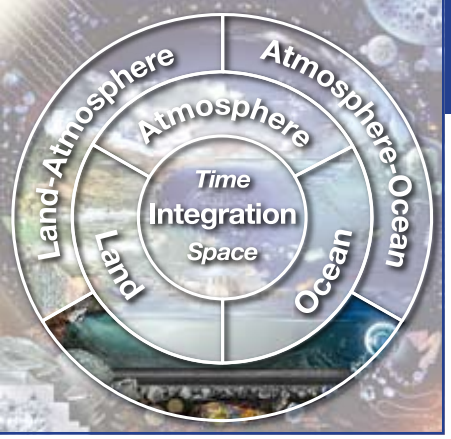

Land–Ocean Interface

Land-Ocean Interactions in the Coastal Zone (LOICZ)

LOICZ studies the key role that the coastal zone plays in the Earth system functioning, being the interface where land, ocean and atmosphere meet and interact.

During 2007, LOICZ intensified the implementation of its three Priority Topics dealing with [i] socio-ecological systems, [ii] assessing and predicting impacts of environmental change, and [iii] linking governance and science (Figure 1). A number of workshops focussed on methodologies and synthesis and promoted strategic partnerships.

A scientific highlight on Priority Topic 1 ("Linking Social and Ecological Systems in the Coastal Zone") was the publication of results from the LOICZ-affiliated EU project European Lifestyles and Marine Ecosystems (ELME, http://www.elme-eu.org). It provided valuable approaches to coupled ecosystem and social system assessment and modelling, including scenarios of likely futures for European regional seas from the Black Sea to the Baltic. ELME touched new grounds in exploring the effects of lifestyles on coastal system functions and providing simulations of ecosystem health and goods and services under different principles of governance and globalisation. Further extensive publishing of this innovative work is expected, which will likely influence subsequent work within and beyond the EU. Additionally, during 2007/08, a series of symposia and workshops on "Social-Ecological Systems Analysis" are being held in China, Brazil, South Africa, Germany and likely India, to continually assess and compare past and future transformations of different coastal social-ecological systems and drivers.

Priority Topic 2 ("Assessing and Predicting Impact of Environmental Change on Coastal Ecosystems") continued developing its inventory of coastal nutrient budgets around the world, including a review of methodologies and applications for estimating nutrient fluxes from coastal watersheds. Multiple approaches have meanwhile joined the original approach, and a major accomplishment is reflected in the wide national use of the ASSETS model plus LOICZ Typology approaches and science dissemination tools in the recent US National Estuarine Eutrophication Assessment (NOAA). An important decision in 2007 was to cooperate with SCOR and launch a working group addressing the quantification of links between eutrophication and harmful algal blooms (in contribution to GEOHAB). A series of publications, featuring LOICZ-supported workshops on material fluxes, will come out in 2008. Additionally, the LOICZ biogeochemical budget website with its ongoing web presence since the mid 1990s, aimed at multiple audiences

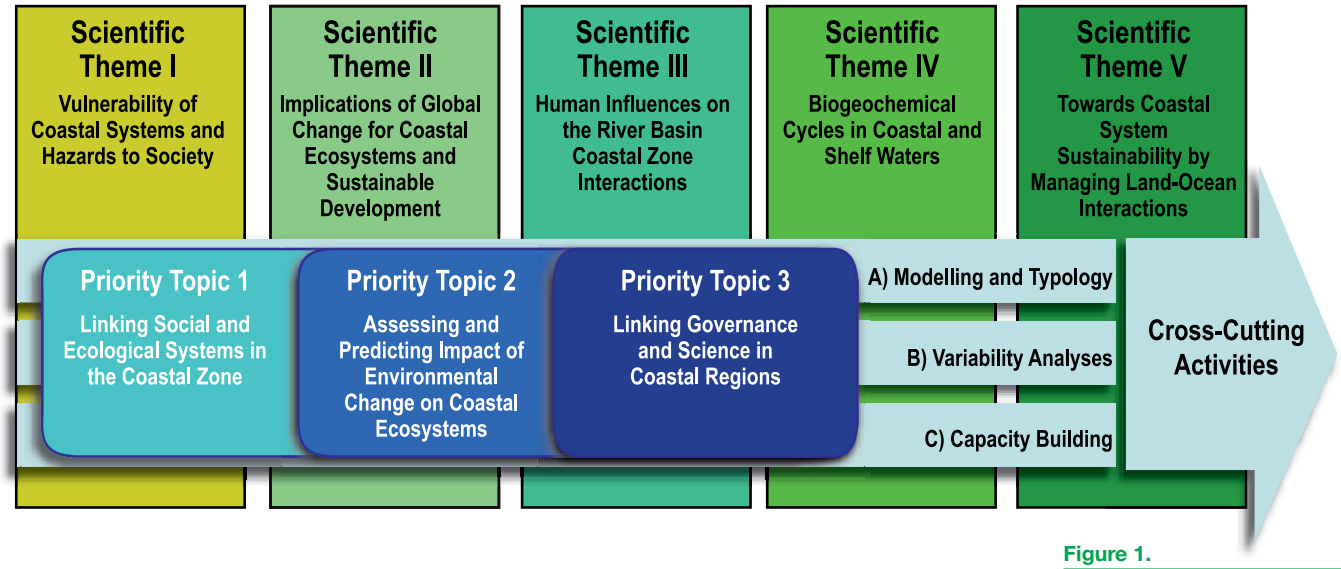

Figure 1.
LOICZ Scientific Themes, Priority Topics, and Cross-Cutting Activities.

and biogeochemistry students, receives continuous additions from researchers and LOICZ-affiliated projects (webpage: nest.su.se/mnode).

Governance baseline assessment and the development of a harmonised approach for global application is the focus of Priority Topic 3 (Linking Governance and Science in Coastal Regions). This topic includes two parallel activities: a) development of the methodology (in progress) and b) the proof of concept in a joint science-practitioners approach in Latin America. A concept working group met three times in the last year to detail the process and methods to address this topic. The inaugural meeting generated a concept paper linking coastal governance to the *LOICZ Science and Implementation Plan* and sets forth the objectives and anticipated products over a five-year period. The second meeting reviewed and amplified a draft of the research methods to be applied in selected world regions. The third meeting sharpened the research methods and developed the outline of the case studies that will form the basis of regional assessments for Latin America and elsewhere. LOICZ's work with NGO partner *EcoCostas* in Latin America, a regional network of coastal management practitioners, is co-supported by the IAI and IHDP. It is a bottom-up, issue-driven approach in direct interaction with relevant stakeholders. Methods will likely be published in 2008 and governance baseline workshops are anticipated also to take place in the Arctic and later (2009) in Asia.

On the regional scale two workshops provided excellent scientific outputs, both generating and relying on collaboration and interdisciplinary networking, which will soon be reflected in a sequence of publications. Those are the LOICZ-GWSP-CSDMS group on deltas and vulnerability and the IASC-LOICZ-AMAP-IPA group on coastal change in the Arctic. Publications (in *Science*, AGU's newspaper *EOS*, and basic White Papers) should be available soon. Finally, LOICZ IPO staff have become involved in academic teaching at various universities and have engaged in public science dissemination and training in schools and with teachers.

Co-sponsor:

IHDP

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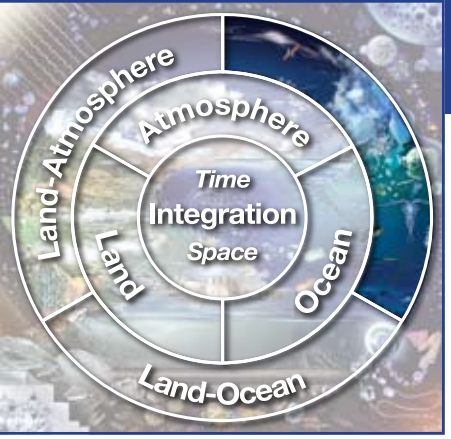


Surface Ocean–Lower Atmosphere Study (SOLAS)

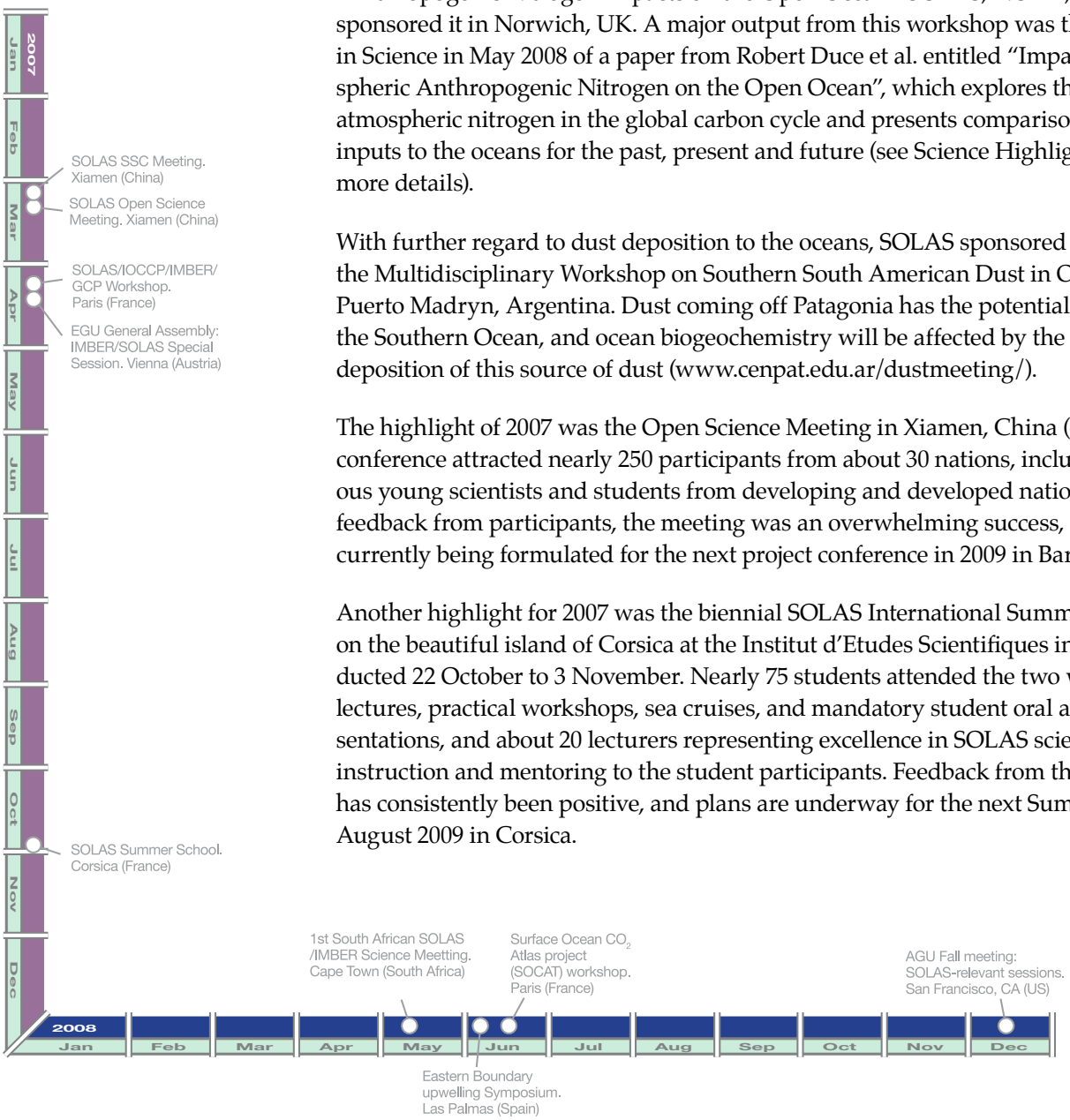
SOLAS's primary objective is to achieve quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere, and of how this coupled system affects and is affected by climate and environmental change.

In November 2006, 30 scientists from a dozen nations met for a workshop on the "Anthropogenic Nitrogen Impacts on the Open Ocean". SOLAS, NOAA, INI and ESF sponsored it in Norwich, UK. A major output from this workshop was the publication in Science in May 2008 of a paper from Robert Duce et al. entitled "Impacts of Atmospheric Anthropogenic Nitrogen on the Open Ocean", which explores the influence of atmospheric nitrogen in the global carbon cycle and presents comparisons of nitrogen inputs to the oceans for the past, present and future (see Science Highlights, page 7, for more details).

With further regard to dust deposition to the oceans, SOLAS sponsored participation in the Multidisciplinary Workshop on Southern South American Dust in October 2007 in Puerto Madryn, Argentina. Dust coming off Patagonia has the potential to iron-fertilise the Southern Ocean, and ocean biogeochemistry will be affected by the transport and deposition of this source of dust (www.cenpat.edu.ar/dustmeeting/).

The highlight of 2007 was the Open Science Meeting in Xiamen, China (6-9 March). The conference attracted nearly 250 participants from about 30 nations, including numerous young scientists and students from developing and developed nations. Based on feedback from participants, the meeting was an overwhelming success, and plans are currently being formulated for the next project conference in 2009 in Barcelona, Spain.

Another highlight for 2007 was the biennial SOLAS International Summer School, held on the beautiful island of Corsica at the Institut d'Etudes Scientifiques in Cargese, conducted 22 October to 3 November. Nearly 75 students attended the two weeks of course lectures, practical workshops, sea cruises, and mandatory student oral and poster presentations, and about 20 lecturers representing excellence in SOLAS science provided instruction and mentoring to the student participants. Feedback from the students has consistently been positive, and plans are underway for the next Summer School in August 2009 in Corsica.



SOLAS investigates the roles that ocean-atmosphere interactions play in the climate system.

Photo credit:
Emlyn Addison

The SOLAS programmes in Germany (SOPRAN) and in the UK have teamed up to develop atmospheric (UK) and oceanic (Germany) observatories in the Cape Verde islands (Tropical Eastern North Atlantic Time-Series Observatory; TENATSO, www.tenatso.com/). TENATSO is located downwind of the Mauritanian upwelling area and is within a region of frequent dust deposition from Africa, providing an ideal site for investigation of surface biogeochemical response and air-sea interaction. The sites also have attracted collaboration with US colleagues, and much of the infrastructure has been developed to accelerate the local scientific capacity.

During the 2006 IGAC/CACGP conference in Cape Town, SOLAS initiated the development of a network of scientists throughout Africa, the Southern Africa SOLAS network. This effort has led to the successful First Southern African SOLAS/IMBER Science Meeting, which took place in Cape Town 9 May 2008, immediately after the IGBP Congress. SOLAS and IMBER SSC members met participants of the Southern Africa network seeking to expand the scope of this African network, with the intention to more deeply engage that continent's researchers into the science of SOLAS.

SOLAS has secured leadership in the EU funded networking scheme European Cooperation in the Field of Scientific and Technical Research (COST) with the theme of "Tools for Assessing Global Air-Sea Fluxes of Climate and Air Pollution Relevant Gases; COST-Action-735". This Action seeks to develop climatologies of air-sea flux of gas and particles. In parallel, the SOLAS IPO secured funding for the position of a Project Integrator to more deeply engage the SOLAS-wide community toward the goals of the COST Action. Over the next few years, the COST-735 Action will have a significant impact on the project's progress.

In addition to publishing monthly e-mail bulletins and a twice-yearly newsletter, the SOLAS IPO has re-developed the architecture and content of its website.

Co-sponsors:

International Council for Science
ICSU
SCOR
Scientific Committee on Oceanic Research

iCACGP

WCRP
World Climate Research Programme

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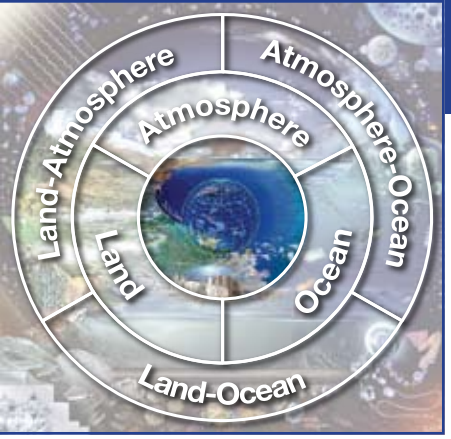


System-wide Integration

Models, observations and measurements contribute to understanding and quantifying Earth system dynamics. Their scientific integration and synthesis are fundamentally important activities for IGBP. The ultimate goal of these activities is to provide policy and resource-management communities with useful global change and Earth system information.

Analysis, Integration and Modelling of the Earth System (AIMES)

AIMES activities translate region- or process-specific changes into global understanding of assessment, mitigation and management.

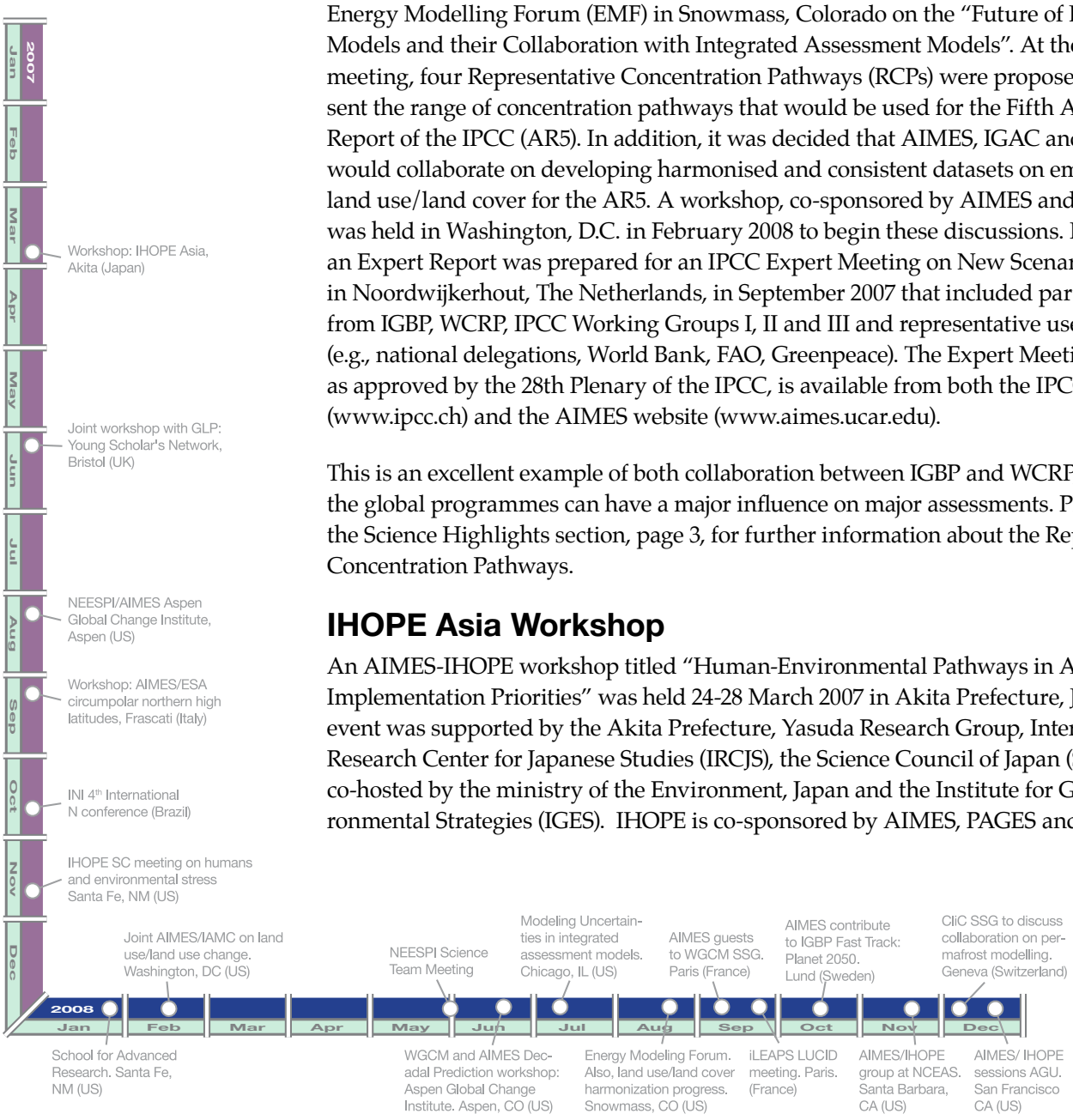
IPCC Representative Concentration Pathways

AIMES contributed and collaborated with the WCRP Working Group on Coupled Models (WGCM) and the Integrated Assessment Modelling Consortium (IAMC) at an Energy Modelling Forum (EMF) in Snowmass, Colorado on the "Future of Earth System Models and their Collaboration with Integrated Assessment Models". At the Snowmass meeting, four Representative Concentration Pathways (RCPs) were proposed to represent the range of concentration pathways that would be used for the Fifth Assessment Report of the IPCC (AR5). In addition, it was decided that AIMES, IGAC and the IAMC would collaborate on developing harmonised and consistent datasets on emissions and land use/land cover for the AR5. A workshop, co-sponsored by AIMES and the IAMC was held in Washington, D.C. in February 2008 to begin these discussions. In addition, an Expert Report was prepared for an IPCC Expert Meeting on New Scenarios held in Noordwijkerhout, The Netherlands, in September 2007 that included participants from IGBP, WCRP, IPCC Working Groups I, II and III and representative user groups (e.g., national delegations, World Bank, FAO, Greenpeace). The Expert Meeting Report, as approved by the 28th Plenary of the IPCC, is available from both the IPCC website (www.ipcc.ch) and the AIMES website (www.aimes.ucar.edu).

This is an excellent example of both collaboration between IGBP and WCRP, and of how the global programmes can have a major influence on major assessments. Please see the Science Highlights section, page 3, for further information about the Representative Concentration Pathways.

IHOPE Asia Workshop

An AIMES-IHOPE workshop titled "Human-Environmental Pathways in Asia: IHOPE Implementation Priorities" was held 24-28 March 2007 in Akita Prefecture, Japan. The event was supported by the Akita Prefecture, Yasuda Research Group, International Research Center for Japanese Studies (IRCJS), the Science Council of Japan (SCJ) and co-hosted by the ministry of the Environment, Japan and the Institute for Global Environmental Strategies (IGES). IHOPE is co-sponsored by AIMES, PAGES and the IHDP.



The challenge for AIMES is to achieve a deeper and more quantitative understanding of the role of human perturbations to the Earth's biogeochemical cycles and their interactions with the coupled physical climate system.

Photo credit:
Kenn W. Kiser

About 120 participants from 15 countries participated, and discussions focussed on how to establish an 'e-corridor' or ecological and cultural gradient of research sites in Japan. URL: www.aimes.ucar.edu/activities/ihope.shtml/

The 3rd AIMES Young Scholars Network Workshop

AIMES, in collaboration with NCAR and other institutions, hosted the third Young Scholars Network (YSN) workshop on Earth system science in June 2007 in Bristol, UK with the topic "Modelling Land-Use Decision Making". The goal of this workshop was to begin a dialogue between land-use planners and Earth system modelling communities. The 2007 YSN workshop engaged 3 senior scientists along with 20 participants from 13 different countries for three and a half days of workshop and meeting time. The meeting was structured as a 'working' workshop, where participants developed a white paper prior to the workshop. A workshop report (Verbeeten et al. 2007) describes workshop findings and future ideas. The YSN spent an additional day in conjunction with the AIMES Scientific Steering Committee meeting in nearby Totnes, UK. The participants were highly engaged during that day. The 2007 YSN was held in collaboration with the Global Land Project (GLP). Contributions for the workshop were received from NCAR's Advanced Study Program (ASP), Societal-Environmental Research and Education Laboratory (SERE), NSF GEO/ATM, AIMES, Quantification and Understanding the Earth System (QUEST) and the Natural Environment Research Council (NERC).

Global Emissions Inventory Activity (GEIA)

The GEIA project continues to develop anthropogenic emissions datasets that include results from emission models, factors and their associated feedbacks that can be extracted and inserted into a carbon-chemistry-climate coupled modelling framework and history of human activities for both science and policy assessment communities. GEIA works in close collaboration with AIMES and the European project ACCENT (www.accent-network.org/). AIMES and GEIA, along with IGAC, are working closely to develop a harmonised and consistent anthropogenic and non-anthropogenic emissions dataset for both the climate modelling and integrated assessment modelling communities for the upcoming AR5.

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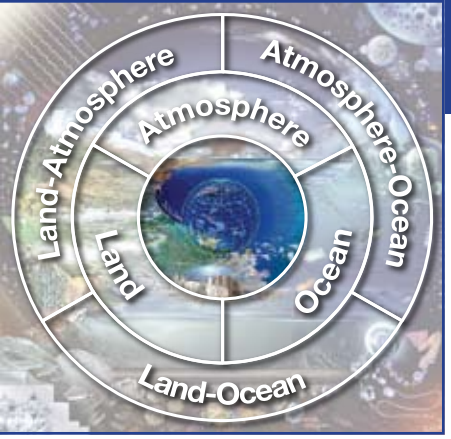


System-wide Integration

Past Global Changes (PAGES)

PAGES supports research aimed at understanding the Earth's past environment in order to make predictions for the future.

In 2007, the primary objective of PAGES remained the facilitation of international collaboration and interdisciplinary science. PAGES' main emphasis continued to be on high-resolution studies of past climatic and environmental changes that assess natural variability and anthropogenic impact, and that can be used with model simulations to make sound estimates of future global change and its consequences.

The results generated by PAGES activities immediately serve the research communities that address present and future aspects of global change, complementing observational and modelling research. Palaeoscience results are regularly used to provide a context for observed changes (a prominent example is the ice core atmospheric greenhouse gas record in Al Gore's film, and many more examples in most reports on aspects of global change). In a more quantitative approach, palaeodata are used by the prediction and modelling communities as benchmarks for testing the validity of concepts and models.

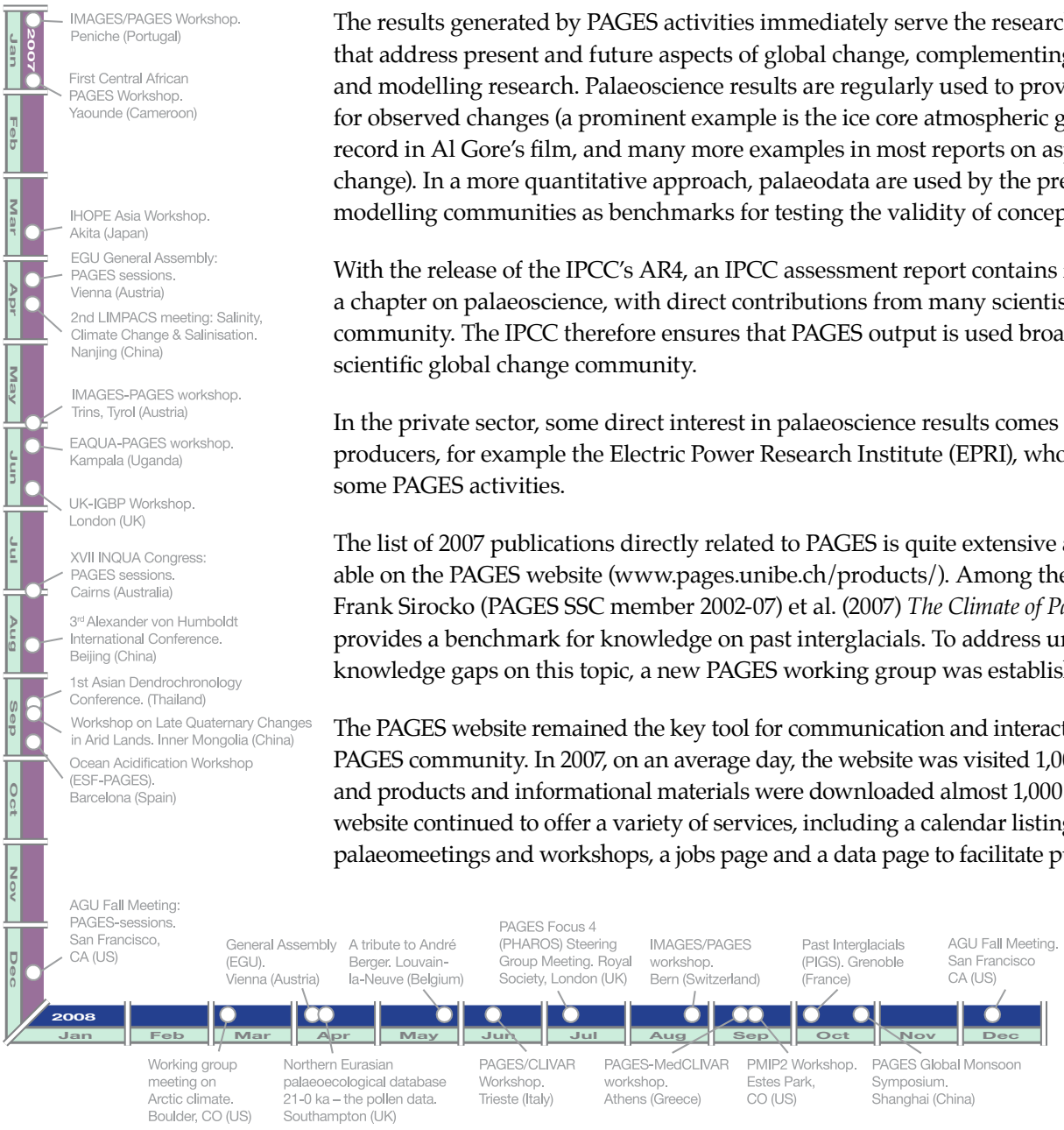
With the release of the IPCC's AR4, an IPCC assessment report contains for the first time a chapter on palaeoscience, with direct contributions from many scientists in the PAGES community. The IPCC therefore ensures that PAGES output is used broadly, beyond the scientific global change community.

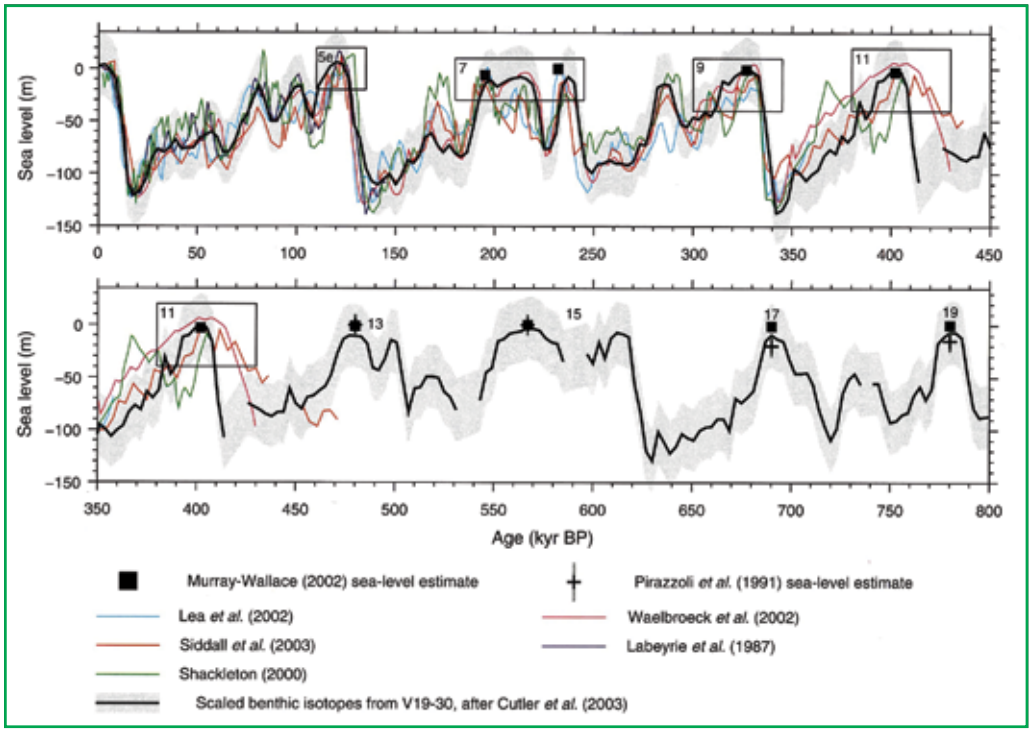
In the private sector, some direct interest in palaeoscience results comes from energy producers, for example the Electric Power Research Institute (EPRI), who co-sponsor some PAGES activities.

The list of 2007 publications directly related to PAGES is quite extensive and made available on the PAGES website (www.pages.unibe.ch/products/). Among these, the book by Frank Sirocko (PAGES SSC member 2002-07) et al. (2007) *The Climate of Past Interglacials*, provides a benchmark for knowledge on past interglacials. To address uncertainties and knowledge gaps on this topic, a new PAGES working group was established.

The PAGES website remained the key tool for communication and interaction within the PAGES community. In 2007, on an average day, the website was visited 1,000-1,500 times, and products and informational materials were downloaded almost 1,000 times. The website continued to offer a variety of services, including a calendar listing upcoming palaeomeetings and workshops, a jobs page and a data page to facilitate public access to

PAGES
PAST GLOBAL CHANGES





Compilation of continuous sea level estimates for the last 800,000 years. During past interglacials recurring every approximately 100,000 years, sea level was similar to today within a range of some meters. This series of similar, but not identical, scenarios can be used to quantify how sensitive sea level (and other Earth system variables) responds to climate change. (Figure from Siddall et al., (2007) in Sirocko et al., (Eds), The Climate of Past Interglacials)

palaeodata. Two new "National PAGES", for the UK and Morocco, were also added. These web pages provide contacts and links to palaeoresearch within individual countries.

Two issues of the PAGES newsletter were published in 2007, with special topical sections on southern hemisphere past climate dynamics and past human-climate-ecosystem interactions.

At the end of 2007, the PAGES People Database contained the details of 4,300 scientists and institutions worldwide.

Through the support of its funders, PAGES continued to provide workshop funding for PAGES initiatives and palaeoscience meetings. As a result of open calls for workshop support, PAGES co-sponsored 14 workshops that took place in 2007, thereby connecting workshops with PAGES scientific objectives. The funding supported the attendance of numerous scientists, with more than half coming from developing countries.

PAGES held or co-sponsored six workshops in developing countries, bringing together international experts and the regional scientific community. Two workshops were held in Africa (Cameroon and Uganda), with a follow-up planned for 2009 hosted by the PAGES SSC member M. Umer in Ethiopia. Three workshops, on chemical and ecological changes of lakes, the Asian monsoon, and aridity, were held in China. A community and capacity building workshop for the southeastern tree-ring community was held in Thailand. In addition, PAGES supported an international course held in Chile on methods in palaeo-ecology. For one week, established international scientists from the PAGES realm taught courses to an international class of 25 predominantly South American students.

Other PAGES interactions with IGBP include: (i) co-sponsoring and co-organising the IGBP Fire initiative; (ii) pursuing the Ocean Acidification topic by co-sponsoring, with ESF, a workshop on the planktonic response to this phenomenon, with broad participation across marine IGBP communities; (iii) participating in the IHOPE initiative led by AIMES and co-sponsored by PAGES; (iv) contributing to the AIMES-led Young Scientists Fire Network.

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Fast Track Initiatives

IGBP's Fast Track Initiatives (FTIs) are short-term research projects that address cross-cutting topics of current interest in Earth system science. They involve scientists from across the IGBP community and beyond, and culminate in review articles, books, new research activities or databases. Current FTIs are:

Refining Plant Functional Classification for Earth System Modelling

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This FTI aims to design a new basis for plant functional classifications. Its main activity in 2007-2008 has been the building of a unique plant functional traits database that will support the development of improved plant functional type (PFT) representation in large-scale dynamic vegetation models. To make substantial advances towards the compilation of this collective, worldwide database, a workshop titled "Improving the representation of biodiversity in large-scale vegetation modelling: A global plant trait database" was organised in Paris, France on 19-21 March 2008. About 30 scientists participated, representing a large proportion of the major databases and large-scale dynamic vegetation models in the world. Outputs of this workshop are of three types:

- A fast-growing collective database, now containing observations for approximately 10% of plant vascular species worldwide;
- A shortlist of modelling efforts to be carried out within the context of the FTI, involving carbon assimilation and growth, fire response, and community assembly, among others;
- A set of intellectual property guidelines that will rule the exchange of information and the allocation of authorship in the FTI, and will be offered as a basis to regulate intellectual property issues in other collective databases.

The FTI is a joint initiative with DIVERSITAS.

The State of the Earth 2030-2050

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This FTI will analyse and describe what the Earth might be like in the 2030–2050 period based on expert knowledge from a wide range of disciplines.

In order to achieve the overall objective of this initiative, an exploratory workshop focussing on the evolution of the planet and its human inhabitants in the decades ahead is scheduled for October 2008 in Lund, Sweden. The purpose of the workshop is to:

- Describe a number of desirable futures for Earth in 2050;
- Explore pathways to move from the present situation toward those futures; and
- Identify more immediate constraints to, and opportunities for, moving human-environment systems onto the more desirable pathways.

About 50 participants are invited; 40-45 are experts in a particular aspect of the Earth system, either socio-economic or biophysical, and the remainder are generalists with an interest and expertise in the integration of knowledge and approaches and/or in transition management. The broadly ranging themes to be covered by the experts include climate, biodiversity, water resources, genetics and marine resources in the biophysical sciences; demographics, economics, geopolitics, history and technology assessment in the social sciences; and philosophy, religion, history, and anthropology in the humanities.

Regional aspects of desirable futures will also be explicitly considered at the workshop, focussing strongly on the equity issues between developed and developing countries, as well as important aspects of human well-being (material assets, security, health and social cohesion). A book that synthesises the discussion of the working groups is expected to be published following the meeting in Lund, and in addition, several other types of output are envisioned.

Ocean Acidification Over Time

This IGBP-SCOR Fast Track Initiative investigates past changes in ocean biogeochemistry to better understand the consequences of ongoing ocean acidification (OA).

The biggest unknowns in OA research all relate to the biotic response to changing water chemistry. Consequently, ESF and PAGES, with participation from other IGBP projects, focussed on this issue with a workshop in Barcelona in September 2007 titled "Atmospheric CO_2, ocean acidification, and ecological changes in planktonic calcifying organisms". Data from present and past strongly suggest that projected levels of OA are likely to have a major effect on planktonic calcification and hence on marine ecosystems and that it will impact on the marine organic carbon pump via reduced ballasting of marine snow.

A major need for research is the identification of the tipping point at which the detrimental effects of OA can no longer be forestalled. Three reports were published (in *EOS*, the PAGES newsletter and *The Eggs*).

The results of this FTI were incorporated in a Strategic Workshop on Ocean Acidification in Las Palmas, Spain, 28-30 January 2008, organised by ESF. A Policy Briefing and a Science Programme Proposal will be published from this meeting to work toward larger-scale recognition, coordination and funding of ocean acidification research.

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Science Partnership

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Earth System Science Partnership (ESSP)

The ESSP is a science partnership of the four international global environmental change research programmes (DIVERSITAS - an international programme of biodiversity science, IGBP - International Geosphere-Biosphere Programme, IHDP - International Human Dimensions Programme on Global Environmental Change, and the WCRP - World Climate Research Programme) to initialize and catalyze highly integrative studies of the Earth System.

In 2007, the ESSP Scientific Committee met for the first time, chaired by Professor Rik Leemans of Wageningen University, The Netherlands. The ESSP is also under review (report out in 2008) and is developing a strategic plan. Community-wide activities include a new bioenergy activity; a CGIAR-ESSP challenge programme proposal on climate change, agriculture and food security; interactions with the conventions and assessments, including the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC. All of these activities have had input from IGBP. The ESSP is also working in partnership with its parent programmes in developing a communications strategy and has published a report on carbon reductions and offsets.

The ESSP is extremely grateful of financial support from the International Group of Funding Agencies for Global Change Research (IGFA) members to the ESSP Coordination Office in 2007. Special thanks go to Austria (Ministry for Education, Science and Culture), Taiwan (National Science Council), France (INSU-CNRS), Norway (Research Council), The Netherlands (Netherlands Organization for Scientific Research), United Kingdom (Natural Environment Research Council) and the United States (National Science Foundation).

The ESSP Joint Projects include:

- GWSP: Global Water System Project;
- GECAFS: Global Environmental Change and Food Systems;
- GCP: Global Carbon Project;
- GECHH: Global Environmental Change and Human Health.

Global Carbon Project (GCP)

The scientific goal of the Global Carbon Project is to develop a complete picture of the global carbon cycle, including both its biophysical and human dimensions together with the interactions and feedbacks between them.

In 2007, GCP released the first annual trend analyses of the global carbon budget. The analyses integrate anthropogenic emission trends (fossil fuel and land use change), their global and regional drivers (population, GDP, carbon intensity of the economy, and others), the dynamics of the natural carbon sources and sinks (oceans and land), and key measurements of the magnitude of the carbon-climate feedback (e.g., airborne fraction). The analyses were published in two papers in *PNAS* (Canadell et al. 2007a; Raupach et al. 2007) as well as on the GCP web site. This effort contributed substantially to the IPCC Fourth Assessment, providing basic carbon-budget information cited in both the WG1 Summary for Policymakers (IPCC 2007) and in Chapter 7 of the WG1 report.

Two major scientific findings resulted from the new analyses:

- The efficiency of the natural sinks to remove carbon dioxide is declining.
- The current fossil fuel emission trajectory is tracking, if not surpassing, the most carbon intense IPCC scenarios, and this is due in part to a historical increase in the carbon intensity of the global economy.

The Global Carbon Project is taking the lead in the ESSP-wide bioenergy activity.

The Urban and Regional Carbon Management initiative of GCP has been very successful in developing a dedicated network of scientists, five publications, eight workshops, the Urban Energy and Climate Modelling Forum, and conducting science-policy dialogues in the form of symposium and UNFCCC-COP events. Further high-level publications and activities are being planned.

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Global Environmental Change and Food Systems (GECAFS)

GECAFS achievements in 2007 include: 1) follow-up food systems research in Indo-Gangetic Plain (APN funding); 2) "Food Systems" concept established (Ericksen, 2007); 3) GECAFS Southern African, Caribbean, and Indo-Gangetic Science Plans published; 4) Web-based GECAFS Forum designed and launched (ca. 150 subscribers). GECAFS helped design the ESF/COST Forward Look on European Food Systems in a Changing World. A major publication on the Conceptual Framework describing Food Systems-GEC Interactions by Polly Ericksen was published in 2007. GECAFS is leading, on behalf of ESSP, a major proposal with the 15 Centres supported by the Consultative Group on International Agriculture Research (CGIAR) entitled "Climate Change, Agriculture and Food Security". GECAFS also made preparations for a major international conference in Oxford on Food Security and Environmental Change, held in April 2008.

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Global Environmental Change and Human Health (GECHH)

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to be established

The main research objectives of GECHH are to:

1. identify and quantify health risks posed by global environmental change, now and in the reasonably foreseeable future;
2. describe spatial (geographic, intra/inter-population) and temporal differences in health risks to better understand vulnerabilities and intervention priorities;
3. develop adaptation strategies to reduce health risks, assess their cost effectiveness, and communicate results; and
4. foster research training, and boost networked international research capacity in global environmental change and human health.

The scientific steering committee has been established, led by Co-Chairs Mark Rosenberg (Canada) and Ulisses Confalonieri (Brazil). Main priorities for the coming year will be the establishment of an international project office (IPO), strengthening links with other international projects and networks, and defining long-term strategic objectives.

The science plan was revised in 2007, with major input from the IHDP. The GECHH project is now co-sponsored by all four ESSP programmes.

Global Water System Project (GWSP)

Global Water System Project

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GWSP highlights in 2007 include: 1) the launch of the Digital Water Atlas, which maps the historical, present and possible future states of the global water system; 2) the creation of a Global Water System Lexicon (glossary) with an overall aim to provide a coherent description of the elements of the Global Water System and a platform for interdisciplinary communication; 3) improved understanding of Global Water Governance; and 4) greater GWSP-LOICZ collaboration.

Science highlights include work on a community approach to assess the world water balance. In 2007 the GWSP organized a collective effort of the global water modelling community to better understand the world water balance and the availability of freshwater on the planet.

At its meeting in Amsterdam in February 2007, the Executive Committee agreed on the establishment of global initiatives as integrative study areas and associated expert groups as a new strategic approach for the implementation of GWSP activities. Three global initiatives were introduced, within which the implementation of the tasks of the Scientific Framework will be coordinated and by which the delivery of truly integrated and interdisciplinary research results will be achieved. The initiatives are targeted toward the production of scientifically cutting-edge and highly policy-relevant results. For the delivery of these results, an integration of activities across themes and subthemes of the Scientific Framework as well as across disciplines is a prerequisite. In this way, the initiatives are a strategic tool for the overall integration and synthesis of project results. More details about the initiatives can be found on the GWSP website: www.gwsp.org/downloads/GWSP_Global_Initiatives_overview.pdf

Monsoon Asia Integrated Regional Study (MAIRS)

An ESSP Integrated Regional Study

A major achievement for MAIRS was the development of the project's initial Science Plan. This included the MAIRS vision, "to significantly advance the understanding of the interactions between the human-natural components of the overall environment in the monsoon Asia region and implications for the global Earth system in order to support the strategies for sustainable development".

MAIRS brings individual scientists from the region together in workshops and in joint projects. It also brings a framework for the integration of environmental science to the region and intends to encourage its use directly and through donors. MAIRS intends to lead the integration of research disciplines and approaches to produce actionable insights for sustainable development in the monsoon Asia region. The project identified its main themes for research: rapid transformation of land and marine resources in the coastal zones; multiple stresses on high mountain ecosystems and biophysical resources; degradation of land resources in semi-arid zones due to climate change and use; and changes in resource use and emissions as a result of rapid urbanisation. Recent publications include: MAIRS Initial Science Plan released in English (WP1) and Chinese (WP2), MAIRS mountain group report (WP3), MAIRS Urban group report (WP4), MAIRS AAS special issue on regional environmental change (in press), a book series on climate change: rapid assessment for East Asia and South Asia (in press), and a book on the Cryosphere and hazards of Hindu-Kush, Himalaya and the Tibetan Plateau (in progress).

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Global change SysTem for Analysis, Research and Training (START)

An ESSP Capacity Building programme

The added value of START is that it: 1) stimulates, promotes and supports collaborative regional research in Africa, Asia and Oceania; 2) enhances capacity building through fellowships, advanced training institutes, and special opportunities for young scientists; 3) provides improved linkages among scientists, policy makers and practitioner communities; and 4) mobilises substantial additional resources for the above activities from science and development agencies and private foundations. The end-users of START products include: 1) scientific communities in developing regions; 2) international global environmental change science programs and scientists; 3) national (including the US) and regional policy makers and practitioners; 4) the development community, 5) IPCC and other global change convention-linked programs; 6) sponsors and funders. A major START success has been the Assessments and Integrations to Adaptation and Climate Change (AIACC) with TWAS, UNEP and the IPCC. This (now completed) project incorporated 24 regional studies (45 countries) and engaged many researchers (300 from developing countries and 100 graduate and undergraduate scientists) and institutions with major outputs including research papers in peer-reviewed literature, contributions to the IPCC AR4 and inputs to national communications and adaptation plans, as well as two major books. START also collaborates closely with the Asia-Pacific Network for Global Change Research (APN) and has various activities in Africa. START has embarked on a follow-up project to AIACC on Advancing Capacity in Support of Climate Change Adaptation.

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Other Collaborations

The Observing Community

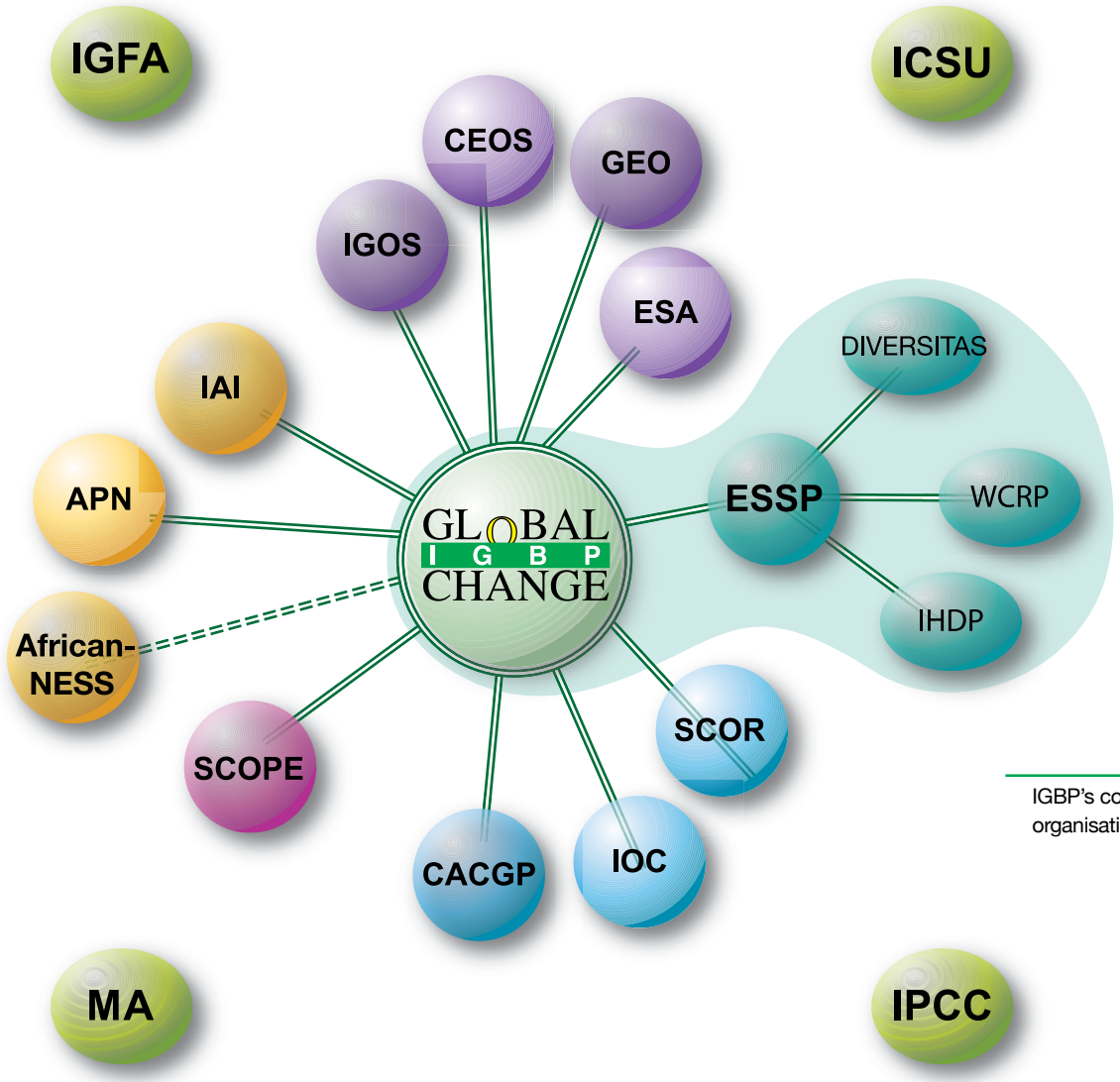
As parts of the network within IGBP expand towards global observation systems through in situ and satellite measurements, it has become crucial to collaborate to finance and develop new and existing observation programmes. IGBP is a *participating organisation* in the remote sensing **Group on Earth Observations** (GEO), and participated in the GEO-IV Ministerial summit in Cape Town, South Africa. In addition, IGBP participated in meetings of the GEO Science and Technology working group. Collaboration continued with the **European Space Agency** (ESA), with increasing connectivity across the different IGBP projects. Stephen Plummer continues to act as the IGBP liaison at the ESA Centre for Earth Observation (ESRIN) at Frascati, Italy, and provides a direct structural link for channeling research initiatives between the two organisations. IGBP (and the iLEAPS project office) are also beginning a new collaboration with WCRP, NEESPI and NASA directed at the polar regions of the northern hemisphere. In addition to involvement with GEO and ESA, IGBP (through the efforts of Berrien Moore and Philippe Ciais) also participates in the activities of the **Integrated Global Observing Strategy** (IGOS) and the **Committee on Earth Observation Satellite**s (CEOS).

Research and Capacity Building Partners

IGBP continues to have strong collaboration with the **Scientific Committee on Oceanic Research** (SCOR), which co-sponsors IGBP's marine projects and the Fast Track Initiative on ocean acidification over time. The *Second Symposium on the Ocean in a High CO_2 World* is being planned in collaboration with SCOR, the **Intergovernmental Oceanographic Commission** (IOC) and the **International Atomic Energy Agency** (IAEA) for October 2008 to assess the status of ocean acidification and its consequences for marine ecosystems. SCOR sponsors GEOTRACES, which is an international study of the marine biogeochemical cycles of trace elements and their isotopes, and interacts closely with IMBER and SOLAS. IGBP and SCOR are also members of the reference user group of the new EC-sponsored **European Project in Ocean Acidification** (EPOCA). The group had its first meeting in June 2008 in Nice, France.

The **Commission on Atmospheric Chemistry and Global Pollution** (CACGP) is co-sponsor of both SOLAS and IGAC. CACGP supports atmospheric chemistry research that contributes to solving the basic societal issues of water supply, food production and human/ecosystem health.

IGBP works closely with the **Asia-Pacific Network for Global Change Research** (APN) and the **Inter-American Institute for Global Change Research** (IAI), which support IGBP-related research and training activities. Collaboration with APN and IAI is very important in terms of helping to develop the scientific agenda for research within IGBP in Asia and the Americas, especially through the new IGBP regional support office in Brazil. We are very actively involved in trying to facilitate the implementation of a similar network for Africa called AfricanNESS (please see page 13 for more details).



IGBP's connections with other organisations.

Communications

Communicating Earth system science and global change research is an important component of IGBP activities. The IGBP communications strategy is guided by a series of long-term goals based on the IGBP vision:

1. To establish IGBP as a credible source of Earth system science (shifting emphasis from a disciplinary to an integrated approach).
2. To promote Earth system science as an important field of science, and to provide an example of a scientific structure designed to support this field.
3. To position IGBP within the scientific community as a primary organisation that adds value to national and international projects by providing the global context and an integrative framework for national and regional research efforts.
4. To provide policy-relevant (but not policy-prescriptive) information about global change for policy makers and the public.

The IGBP Secretariat performed the following communications activities in 2007:

Global Change NewsLetter

IGBP's *Global Change NewsLetter* continues to be an important communications tool for the programme. The Secretariat produced four issues in 2007/2008, including one focussed on biofuels that was coordinated and edited by Myanna Lahsen and Jean Ometto of the IGBP Regional Support Office in Brazil.

In early 2008 IGBP produced a newsletter in support of its Congress theme, "Sustainable Livelihoods in a Changing Earth System", with a particular focus on global environmental change and the developing world. As a further outreach tool for the general public and policy makers, a factsheet on global environmental change in Africa was produced and included in the newsletter.

For environmental and budgetary reasons, the newsletter is now produced only electronically and is available as a PDF download on the IGBP website. Efforts are underway with the Brazil office to print and distribute the newsletter to developing countries only.

20th Anniversary Symposium

The year 2007 marked IGBP's 20th anniversary (see more details in the Outreach section). In support of the event, the Secretariat produced and updated a number of IGBP marketing tools, including:

- IGBP's poster with the Earth system science illustration, which was displayed at the anniversary symposium and will be used at future outreach events;
- magnetic bookmarks and stickers bearing the Earth system science illustration;

- anniversary brochure, outlining the history of IGBP;
- special pages on the IGBP website highlighting speakers and events related to the anniversary symposium.

IGBP Website

IGBP launched its redesigned website two years ago, and the number of visitors to the site continues to grow. During 2007/2008, the site had nearly 93,000 unique visitors, for an average of nearly 7,800 visitors per month (up from 6,000 visitors a month in 2006). During that period, the site had almost 1.8 million hits.

Email Bulletin

IGBP's bi-monthly email bulletin keeps network scientists informed of IGBP and global environmental change research activities. The Secretariat emailed eight bulletins in 2007/2008 and redesigned the format as an html document to improve its look and readability.

IGBP Media Coverage

IGBP and several of its scientists appeared in major science journals during 2007. An IGBP press release on climate modelling, distributed in parallel with the IPCC fourth Assessment Report, generated international media coverage. A *Science* article on CO_2 in the Southern Ocean by IGBP network scientist Corinne Le Quéré also generated international media coverage. IGBP Chair Carlos Nobre featured prominently in an issue of *Nature* that focussed on deforestation in the Amazon. The First Brazilian Symposium on Global Environmental Change, organised by IGBP's Regional Support Office in Brazil, attracted many representatives from the local media.

Publications List

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Scholze M (2007) Earth Network. *Nature* Vol. 447; No. 228; doi: 10.1038/nj7141-228b

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Ladd C, Mordy CW, Kachel NB and Stabeno PJ (2007) Northern Gulf of Alaska eddies and associated anomalies. *Deep-Sea Research I* Vol. 54; 487-509

Ottersen G, Hjermann DØ and Stenseth NC (2007) Changes in spawning stock structure strengthen the link between climate and recruitment in a heavily fished cod (Gadus morhua) stock. *Fisheries Oceanography* Vol. 15, 230-243

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GLP Publications

Braimoh AK and Vlek PLG (Eds.) (2007) *Land Use and Soil Resources* Springer. 254 pp.

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Financial Report

IGBP activities are predominantly funded by contributions from member countries. Central funds support the operation of the IGBP Secretariat, the meetings of the Scientific Committee of IGBP and the Scientific Steering Committees of IGBP projects, IGBP contributions to the activities of the ESSP and other partner organisations, and communications and outreach activities.

Table 1 summarizes the IGBP central budget for 2007. Income for 2007 was 1.79M USD, of which 218k USD are grants administered by IGBP or grants for specific purposes (e.g., the IGBP 20th Anniversary symposium), but from which we derive no direct financial support for network activities. National contributions for 2007 were 1.5M USD. Effectively, national contributions support all of the IGBP core activities.

Expenditures for 2007 are summarized in the lower part of Table 1. The major expenditures are to support the governance meetings for IGBP and its projects, salaries and travel costs for Secretariat personnel, and communications activities. A proportional breakdown of major expenditures is shown in Figure 1.

IGBP is required to have a reserve fund of 1.5MSEK and a separate personnel fund of 157,560 SEK. These funds do not affect cash flow, and are not shown in our balance report.

The desired level for Operating Assets transferred to each subsequent year is approximately 200,000 USD (equiv. 140,000 EURO). These funds are needed to ensure a positive cash flow in the first part of each year. The amount transferred at the end of 2007 was just over 152,000 USD (equiv. 100,808 EURO), somewhat below the desired level.

Cost cutting in 2007

Because it was evident at the beginning of 2007 that our projected income from national contributions would not equal our normal level of expenditures, a number of cost-cutting efforts were put into place, including:

- An across-the-board 20% reduction in expenditures, including reductions in the project block grants (used to support the project Scientific Steering Committee meetings), reductions in travel for Secretariat staff, reductions/elimination of upgrading computers and equipment at the IGBP Secretariat;
- Reducing the IGBP Secretariat staff by 1.2 positions, and postponing re-hiring our Science Editor (effectively meaning a reduction of 2.2 positions at the Secretariat);
- Moving to electronic-only publication of the IGBP Newsletter.

2007		
Income	**USD**	**EURO**
Total national contributions received in 2007	1,500,197	1,029,135
Other IGBP network income	61,682	42,314
Operating IGBP network assets from 2006	11,626	7,975
Subtotal IGBP network income	**1,573,505**	**1,079,424**
Administered grants incl. assets from 2005	218,494	149,887
TOTAL INCOME	**1,791,999**	**1,229,311**
Expenditures	**USD**	**EURO**
Total scientific and communication activities	679,142	465,892
IGBP network budget assets	455,651	312,577
Administered grants incl. assets to 2008	223,491	153,315
Publications and website	20,875	14,321
Secretariat salaries and related costs	798,160	547,538
Scientist salaries	546,147	374,657
Administration salaries	252,013	172,881
Secretariat operating expenses	139,792	95,897
Loss due to exchange rate	7,079	4,856
TOTAL EXPENDITURES	**1,645,048**	**1,128,503**
OPERATING ASSETS TO 2008	**146,950**	**100,808**

Table 1.
Income and expenditures for 2007.

Exchange Rate:
USD-EURO: 0.686

To stabilise its central budget, IGBP has implemented the following changes for the 2008 budget:

- Switched national contributions to Euros. The Euro and the Swedish *krona* are linked currencies, so that obtaining national contributions in Euros would eliminate the uncertainty in our budget due to currency fluctuations. This would not apply to the United States, only to Euro countries and others that are able to easily transfer funds in Euros.
- Adjusted the invoices for national contributions for 2008 upward by 10% to account for part of the inflation increase since 1999. Thereafter, the requests for national contributions will be adjusted yearly for inflation.

These changes are reflected in the budget summary for 2008 (Table 2). The projected income for 2008 is 1.66M Euros, of which 336K Euros are grants administered by IGBP or grants for specific purposes (e.g., the IGBP Congress). National contributions for 2008 were budgeted at 1.34M Euros, and expected contributions are 1.21M Euros. Estimated expenditures for 2008 are summarized in the lower part of Table 2; a proportional breakdown of major expenditures is shown in Figure 2.

IGBP is drafting a fundraising strategy to identify short- and long-term activities aimed at improving IGBP's financial base. This includes pursuing funding opportunities with foundations and the private sector; however, it is unlikely that these will provide significant income for central activities in the immediate future.

Table 2.
Income and expenditures for 2008 (estimated).

2008 (Estimated)

Income	**Euro**
Total national contributions expected to be received in 2008	1,214,910
Other IGBP network income	13,490
Operating IGBP network assets from 2007	100,808
Subtotal IGBP network income	**1,329,208**
Administered grants incl. assets from 2007	339,605
TOTAL INCOME	**1,668,813**

Expenditures	**Euro**
Total scientific and communication activities	838,260
IGBP network budget assets	498,655
Administered grants incl. assets to 2009	339,605
Publications and website	27,216
Secretariat salaries and related costs	615,198
Scientist salaries	407,904
Administration salaries	207,295
Secretariat operating expenses	82,614
Loss due to exchange rate	20,000
TOTAL EXPENDITURES	**1,583,288**
OPERATING ASSETS TO 2009	**85,525**

Figure 1.

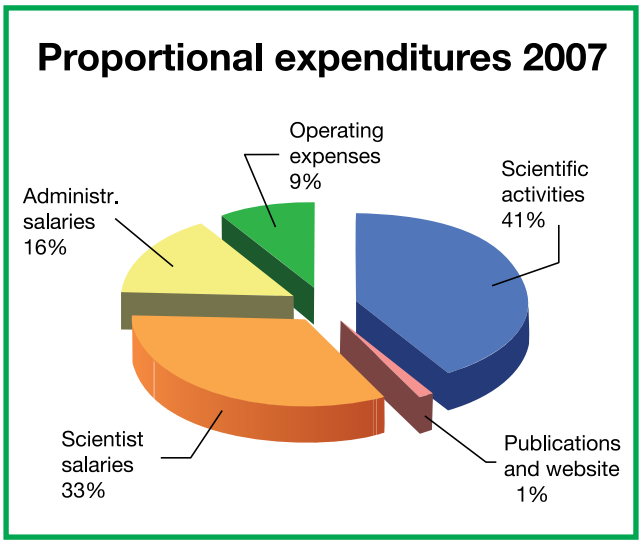
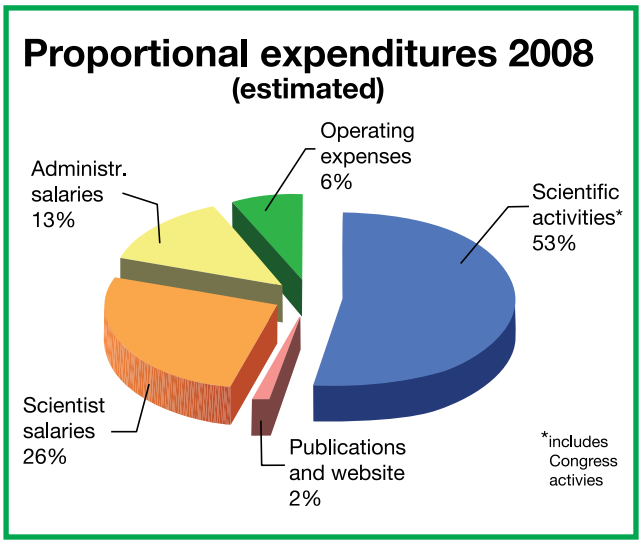


Figure 2.



National Contributions, 2007 (received from 37 countries) arranged by level of contribution

1	USA	20	South Africa
2	Sweden	21	Czech Rep.
3	Germany	22	Greece
4	Japan	23	India
5	UK	24	Poland
6	Italy	25	New Zealand
7	Russia	26	Israel
8	Spain	27	Ireland
9	Netherlands	28	Portugal
10	Australia	29	Hungary
11	Switzerland		Indonesia
12	Taiwan	30	Malaysia
13	Belgium	31	Thailand
14	Norway	32	Sri Lanka
15	China	33	Colombia
16	Austria	34	Iceland
17	Denmark		Kenya
18	Korea	35	Romania
19	Finland		

National Contributions received for previous years:

Belgium (2006)

Spain (2006)

Expected National Contributions, 2008 (to be received from 40 countries) arranged by level of contribution

1	USA	21	Finland
2	Sweden	22	South Africa
3	Germany	23	Czech Rep.
4	France	24	Greece
5	Japan		India
6	UK	25	Poland
7	Italy	26	Israel
8	Russia		New Zealand
9	Spain	27	Ireland
10	Netherlands		Portugal
11	Australia	28	Hungary
12	Brazil		Indonesia
13	Switzerland	29	Malaysia
14	Taiwan		Singapore
15	Belgium	30	Thailand
16	Norway	31	Colombia
17	China		Iceland
18	Austria		Kenya
19	Denmark		Romania
20	Korea		Sri Lanka

National Contribution expected to be received for previous years:

France (2007)

Breakdown of funding for IGBP core projects, 2007

Project	Country/Organisation	USD	EUROS
AIMES	US NSF	250,000	171,500
	NCAR (in kind)	20,000	13,720
	IGBP	32,000	21,952
	AIMES TOTAL INCOME	**302,000**	**207,172**
GLOBEC	NSF-SCOR	85,000	58,310
	IOC UNESCO	10,000	6,860
	PML (in kind)	198,000	135,828
	NERC	250,000	171,500
	Other	5,000	3,430
	IGBP	16,000	10,976
	GLOBEC TOTAL INCOME	**564,000**	**386,904**
IGAC	NASA	66,666	45,733
	NOAA	66,666	45,733
	US NSF	66,666	45,733
	European ACCENT	43,000	29,498
	Academia Sinica,Taipei	10,000	6,860
	IGBP	32,000	21,952
	IGAC TOTAL INCOME	**284,998**	**195,509**
iLEAPS	Univ. of Helsinki, Faculty of Sciences	233,236	160,000
	Ministry of Education	29,155	20,000
	Finnish Met. Inst.	43,732	30,000
	IGBP	32,000	21,952
	iLEAPS TOTAL INCOME	**338,122**	**231,952**
IMBER	SCOR - NSF	50,000	34,300
	SCOR Carry-over from Previous Year	39,725	27,251
	IGBP	16,000	10,976
	CNRS/IRD/Brittany region	180,540	123,850
	CNRS funds	31,701	21,747
	University of Western Brittany / IUEM	15,192	10,422
	IMBER TOTAL INCOME	**333,158**	**228,546**
GLP	Univ. Of Copenhagen	266,342	182,711
	IGBP	16,000	10,976
	IHDP	20,000	13,720
	GLP TOTAL INCOME	**302,342**	**207,407**
LOICZ	Inst. for Coastal Research	611,245	419,314
	IGBP	32,000	21,952
	LOICZ TOTAL INCOME	**643,245**	**441,266**
PAGES	Swiss NSF	250,000	171,500
	US NSF	250,000	171,500
	IGBP	32,000	21,952
	PAGES TOTAL INCOME	**532,000**	**364,952**
SOLAS	NERC	329,466	226,014
	IGBP	20,000	13,720
	SCOR	25,000	17,150
	SOLAS TOTAL INCOME	**374,466**	**256,884**

Breakdown of funding for IGBP core projects, 2008

Project	Country/Organisation	EUROS
AIMES	US NSF	171,500
	NCAR (in kind)	13,720
	IGBP	21,952
	AIMES TOTAL INCOME	**207,172**
GLOBEC	NSF-SCOR	58,310
	IOC UNESCO	6,860
	PML (in kind)	167,384
	NERC	193,194
	Other	20,237
	IGBP	10,976
	GLOBEC TOTAL INCOME	**457,671**
IGAC	NASA	47,814
	NOAA	47,814
	US NSF	47,814
	European ACCENT	29,498
	Academia Sinica,Taipei	6,860
	IGBP	21,952
	IGAC TOTAL INCOME	**201,753**
iLEAPS	Univ. of Helsinki, Faculty of Sciences	160,000
	Ministry of Education	20,000
	Finnish Met. Inst.	30,000
	IGBP	21,952
	iLEAPS TOTAL INCOME	**231,952**
IMBER	SCOR - NSF	34,300
	SCOR Carry-over from Previous Year	9,134
	IGBP	11,755
	CNRS/IRD/Brittany region	163,638
	CNRS funds	26,608
	University of Western Brittany / IUEM	16,169
	IMBER TOTAL INCOME	**261,604**
GLP	Univ. Of Copenhagen	188,098
	IGBP	10,976
	IHDP	13,720
	GLP TOTAL INCOME	**212,794**
LOICZ	Inst. for Coastal Research	419,314
	IGBP	21,952
	LOICZ TOTAL INCOME	**441,266**
PAGES	Swiss NSF	181,790
	US NSF	181,790
	IGBP	21,952
	PAGES TOTAL INCOME	**385,532**
SOLAS	NERC	234,265
	IGBP	10,976
	SCOR	17,150
	SOLAS TOTAL INCOME	**262,391**

Acronyms

AAN	Anthropogenic Atmospheric Nitrogen
AC&C	Atmospheric Chemistry and Climate
ACCENT	Atmospheric Composition Change: European Network of Excellence
ACPC	Aerosols, Clouds, Precipitation, Climate
AfricanNESS	African Network of Earth System Science
AGU	American Geophysical Union
AIACC	Assessment of Impacts and Adaptations to Climate Change
AICI	Air-Ice Chemical Interactions
AICIMO	Scientific Research Association of Mozambique
AIMES	Analysis, Integration and Modelling of the Earth System
AMAP	Arctic Monitoring and Assessment Programme
AMMA	African Monsoon Multidisciplinary Analysis
APN	Asia-Pacific Network for Global Change Research
BALTEX	Baltic Sea Experiment
BCLME	Benguela Current Large Marine Ecosystem
BENEFIT	Benguela Environment Fisheries Interactions and Training Programme
BMBF	Federal Ministry of Education and Research, Germany
CACGP	Commission on Atmospheric Chemistry and Global Pollution
CAREBEIJING	Campaigns of Air Quality Research in Beijing
CEOS	Committee on Earth Observing Satellites
CGIAR	Consultative Group on International Agriculture Research
CliC	Climate and Cryosphere
CLIOTOP	Climate Impacts on Oceanic Top Predators
CLIVAR	Climate Variability and Predictability Study
CNRS	Centre national de la recherche scientifique
COST	European Cooperation in the Field of Scientific and Technical Research
CSDMS	Community Surface Dynamics Modelling System
DFG	Deutsche Forschungsgemeinschaft
DIVERSITAS	an international programme of biodiversity science
EGU	European Geophysical Union
ELME	European Lifestyles and Marine Ecosystems
EMF	Energy Modelling Forum
EPRI	Electric Power Research Institute
ESA	European Space Agency
ESF	European Science Foundation
ESRIN	ESA Centre for Earth Observation
ESSAS	Ecosystem Studies of Sub-Arctic Systems
ESSP	Earth System Science Partnership
EU	European Union
EUR-OCEANS	EURopean network of excellence for OCean Ecosystems Analysis
FLUXNET	a “network of regional networks” of observations from micrometeorological tower sites
FONDAP-COPAS	Center of Oceanographic Research in the Southeastern Pacific
FTI	Fast Track Initiative
GCM	Global Climate Model

GCOS	Global Climate Observing System
GCP	Global Carbon Project
GCTE	Global Change and Terrestrial Ecosystems
GEC	Global Environmental Change
GECAFS	Global Environmental Change and Food Systems
GECHH	Global Environmental Change and Human Health
GEIA	Global Emissions Inventory Activity
GEO	Group on Earth Observations
GEOHAB	Global Ecology and Oceanography of Harmful Algal Blooms
GEOTRACES	an international study of the global marine biogeochemical cycles of trace elements and their isotopes
GEWEX	Global Energy and Water Cycle Experiment
GLOBEC	Global Ocean Ecosystem Dynamics
GLP	Global Land Project
GWSP	Global Water System Project
IAEA	International Atomic Energy Agency
IAI	Inter-American Institute for Global Change Research
IAMC	Integrated Assessment Modelling Consortium
IARU	International Alliance of Research Universities
IASC	International Arctic Science Committee
ICED	Integrating Climate and Ecosystem Dynamics
ICSU	International Council for Science
IER	Institut für Energiewirtschaft und Rationelle Energieanwendung
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme
IGFA	International Group of Funding Agencies for Global Change Research
IGOS	Integrated Global Observing Strategy
IGSNRR	Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences
IHDP	International Human Dimensions Programme on Global Environmental Change
IHOPE	Integrated History and Future of People on Earth
iLEAPS	Integrated Land Ecosystem–Atmospheric Processes Study
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research
IMECOCAL	Investigaciones Mexicanas de la Corriente de California
INI	International Nitrogen Initiative
INPE	Brazilian Federal Institute for Space Research
INQUA	International Union for Quaternary Research
IOC	Inter-governmental Oceanographic Commission (of UNESCO)
IOCCP	International Ocean Carbon Coordination Project
IPA	International Permafrost Association
IPCC	Intergovernmental Panel on Climate Change
IPO	international project office
IPY	International Polar Year
IRD	Institut de recherche pour le développement
IRS	Integrated Regional Study
LCLUC	Land-Cover and Land-Use Change (LCLUC) Program
LOICZ	Land-Ocean Interactions in the Coastal Zone
LOTRED-SA	Long-Term climate Reconstruction and Dynamics of (southern) South America

LUCC	Land Use and Cover Change
MA	Millennium Ecosystem Assessment
MAIRS	Monsoon Asia Integrated Regional Study
MEXT	Ministry of Education, Culture, Sports, Science and Technology-Japan
NASA	US National Aeronautics and Space Administration
NCAR	US National Center for Atmospheric Research
NEESPI	Northern Eurasia Earth Science Partnership Initiative
NERC	Natural Environment Research Council, UK
NOAA	US National Oceanic and Atmospheric Administration
NRC	National Research Council
NSF	National Science Foundation (United States)
PAGES	Past Global Changes
PFT	Plant Functional type
PML	Plymouth Marine Laboratory, UK
PNAS	Proceedings of the National Academy of Sciences
QUEST	Quantification and Understanding the Earth System
RCP	Representative Concentration Pathways
SBSTA (UNFCCC)	Subsidiary Body for Scientific and Technological Advice
SCOR	Scientific Committee on Oceanic Research
SEI	Stockholm Environment Institute
SERE	Societal-Environmental Research and Education Laboratory
SIBER	Sustained Indian Ocean Biogeochemical and Ecological Research
Sida	Swedish International Development Cooperation Agency
SIWI	Stockholm International Water Institute
SOCOVV	Surface Ocean pCO_2 Variability and Vulnerabilities
SOLAS	Surface Ocean–Lower Atmosphere Study
SOPRAN	Surface Ocean Processes in the Anthropocene
SPACC	Small Pelagics and Climate Change
SPARC	Stratospheric Processes and their Role in Climate
SRES	Special Report on Emissions Scenarios (IPCC)
SSC	scientific steering committee
START	Global Change System for Analysis, Research and Training
TENATSO	Tropical Eastern North Atlantic Time-Series Observatory
TF-HTAP	Task Force on Hemispheric Transport of Atmospheric Pollutants
TWAS	The Academy of Sciences for the Developing World
UK	United Kingdom
UN	United Nations
UNEP	UN Environment Programme
UNESCO	UN Educational, Scientific and Cultural Organisation
UNFCCC	UN Framework Convention on Climate Change
US	United States
VOCBAS	Volatile Organic Compounds in the Biosphere-Atmosphere System
WAM	Western African Monsoon
WCRP	World Climate Research Programme
WGCM	Working Group On Coupled Models
WMO	World Meteorological Organisation
YSN	Young Scholars Network
ZGIS	Centre for Geoinformatics




International Geosphere-Biosphere Programme

ICSU
International Council for Science