Berrien Moore to Chair SC-IGBP

Berrien Moore has been appointed as the new chair of the SC-IGBP, beginning January, 1998. As such he will no longer be chairing GAIM. While we are sorry to see him leave GAIM, we are pleased and proud to have him at the helm of the IGBP. We are looking forward to great things in the future. Berrien is the Director of the Institute for the Study of Earth Oceans, and Space at the University of New Hampshire. He is also a professor of Mathematics at UNH, and was one of the two first “University Distinguished Professors.” His mathematical modelling of the global carbon cycle has received widespread attention. He has authored over 100 papers on mathematics, biogeochemistry, remote sensing, global change, and science policy. He was the 1993 recipient of the UNH Excellence in Research Award. Berrien has served on the committee of NASA’s Space and Earth Science Advisory Committee and Committee on Earth System Science, the U.S. National Academy of Sciences’ Board on Global Change, the Space Science Board’s Committee on Earth Science, and the Expert Advisory Group to the IPCC. In 1987 Berrien was appointed chairman of NASA’s Senior Science Advisory Panel, and the Space Science and Applications Advisory Committee. In 1992, he was presented with NASA’s

New GAIM Program Assistant

Karin Tierney joined the GAIM Task Force Office, at the University of New Hampshire, in September 1997 as the new Program Assistant to the Executive Director, Dork Sahagian. Karin has a BA in Political Science from UNH and is currently completing a graduate program in Public Administration. Karin will be assisting Dork with the organization and coordination of GAIM events and publications. With her experience in policy and socio-political modelling, Karin also brings a Human Dimensions aspect to the GAIM Office.
Notes From the GAIM Office

The GAIM Office has gotten into full swing with the funding of its operating grant by the US National Science Foundation. We now have funds for office staff, communications and travel, as well as partial support of GAIM workshops. We now have a GAIM Program Assistant, Karin Tierney, who will help run the office and the various GAIM activities. We are also hiring a Science Officer (stay tuned for developments). In addition, we now have student part-time helpers to assist with local errands and various office tasks. This fall GAIM has been provided with a fine new office at UNH, in the Institute for the Study of Earth, Oceans, and Space. From the new office we are looking forward to greatly increasing our support of GAIM and the IGBP research community in the coming years. We have now begun a GAIM Report series, the first volume of which is a report of the African-GAIM Modelling Workshop (described in this issue). Additional reports in the pipeline include the Ocean Carbon-Cycle Intercomparison Project (OCMIP), terrestrial Net Primary Productivity (NPP), Atmospheric Tracer Transport Codes, and Climate-Ecosystem Interactions, among others. If you would like a report which you have not received, contact the GAIM Office (gaim@unh.edu). New reports will be listed in “Research GAIM” as they are published. The full report from the IGBP Wetlands Workshop (summarized in the Winter, 1997 issue of Research GAIM) is being distributed through the IGBP Secretariat in Stockholm.

New GAIM PLAN Being Developed

In its initial stages, GAIM concentrated on certain key issues concerning the Carbon Cycle and aspects of the coupling between terrestrial ecosystems and climate. This start-up phase aimed to develop and test programmatic techniques and model development for tractable cross-cutting problems which could then be used as smaller-scale examples of the larger Earth System issues which GAIM must ultimately face. The theme of the carbon cycle was selected because of the relative maturity of research in the relevant individual disciplines. With the success of several model development projects and model intercomparison activities, GAIM is now poised, as the basis of a new GAIM PLAN, to extend its analysis to broader issues which will be encountered in global biogeochemical models. The GAIM PLAN is being written by the GAIM Task Force and the GAIM Office in conjunction with the SC-IGBP and the Core Projects. In moving toward its role as integrator of IGBP science, GAIM will focus on Tasks which cut across the realms of the Core Projects. This will involve the establishment of techniques for coupling and integration of biogeochemical subsystem models in preparation for the construction of integrated prognostic biogeochemical models. Such integration will involve coordination with each of the IGBP Core Projects. In addition, GAIM will examine theoretical and practical modelling techniques which will enable the effective coupling of subsystem models and the development and evaluation of Earth System Models. A few examples of these foci were articulated at a meeting of the GAIM Task Force in Barcelona in April, 1997. The scientific plan for the next phase of GAIM represents the next step toward its ultimate goal, yet it is recognized that all the necessary theoretical, technological and data resources are not yet available. The broadly cross-cutting issues and projects described in the GAIM PLAN are aimed at providing some of the necessary insights, and are part of a continuous re-evaluation of GAIM science.

The new GAIM PLAN is based on 2 levels of questions. (These questions encompass the scope of the original “6 key research questions” indicated in 1994 IGBP Report 28.) “Fundamental Questions” are the most general, and thus difficult to answer directly. They are based on a set of fundamental observations for which we seek coherent explanations. In order to explain the various observations it will be necessary to develop a broad understanding of the processes which drive interactions and changes within the Earth System. The process of seeking answers to the Fundamental Questions should fill the gaps in our understanding of the connections in the “Brenchet Diagram” as well as provide the framework for constructing reliable global prognostic biogeochemical models, GAIM’s ultimate goal. As such, the Fundamental Questions address the outstanding gaps in our understanding of the linkages between the various parts of the Earth System as represented by the Core Projects. In order to address these questions, it will be necessary to answer a number of more focused “Supporting Questions.” The questions are being formulated in a “top-down” approach because by formulating the Fundamental Questions, aim can be taken directly at GAIM’s ultimate goals. However, the answers must be obtained “bottom-up” because only focused research projects can provide the foundation of knowledge necessary to address the broader questions. The new GAIM PLAN is now under construction. Details will be available for the next issue of Research GAIM.
In Africa, changes are occurring in climate, rainfall patterns, soil fertility, and land cover. These changes play an important role; they impact the effectiveness of water management, agriculture and livestock production, and the regrowth of forests and woodlands. All are important for the support and development of our growing population.

The African-GAIM Modelling Workshop, was held March 3-12, 1997 in Mombasa, Kenya was found to be a great success. Scientists came from twenty African countries as well as Europe and America, who have come to attend a computer modelling workshop focused upon analyzing the issues of changes in the environment of Africa. This workshop is being convened by the Global Analysis, Interpretation, and Modelling Task Force (GAIM) of the International Geosphere Biosphere Programme (IGBP) in collaboration with the Kenya National Academy of Sciences and the University of Nairobi. The purpose of the workshop, which began on Monday, 3 March 1997, is to provide the opportunity for African scientists to work together to develop a stronger international global change research community. Developing this community in Africa is increasingly important in view of the fact that the African environment, particularly its agricultural and water resources, is especially vulnerable to global environmental changes.

The workshop was officially opened by Mr. James Lieta, the Deputy Provincial Commissioner, on behalf of the Provincial Commissioner, Mr. Timothy Sirma. The workshop was directed toward:

- Analyzing key models and data with particular relevance to Africa,
- Interpreting the capability of these models to describe system processes within the region, and validation with field data,
- Building the international modelling and data infrastructures needed to support fully the IPCC process,
- Expanding the capability within Africa to use models focused upon key topics within the overall theme of global change, including
  - the effect of land use change on carbon and nutrient cycling in terrestrial ecosystems, and
  - water cycling and water management,
- Developing model applications to problems associated with land use changes and sustainability of African agricultural and other land use.

The Workshop focused on models applicable to Africa in the global context, including terrestrial ecosystem and hydrologic models. Hydrological and ecological models were presented, run by participants in hands-on “laboratory” sessions, and interpreted in terms of African and global applications. Participants developed their own modelling projects during the workshop, to be subsequently expanded at their home institutions as part of broader African global change modelling community. The intent was to include as many younger scientists as possible.

Participants divided into two parallel sessions with one focusing on hydrologic models while and the other on ecological models. These models were presented by their developers and workshop participants were given hands-on experience in running and manipulating the models and their results. Subsequently, a simple box-modelling program was introduced to give the participants the opportunity to recreate certain aspects of the hydro- and eco-models as well as to create their own models in real time at the workshop. The final phase of the workshop was a team effort by participant groups to develop a project or pose a tractable problem for collaborative research in the months following the workshop. These included some which represented extension of existing African IGBP programs as well as new projects which were formulated at the workshop. The participant presentations highlighted the fact that there is a great deal of research expertise throughout Africa. There are also numerous international research programs being conducted throughout Africa, some within the auspices of IGBP.

A special session was held for discussion of issues impacting the African global change research community. Of these, two issues emerged as primary resources, and human impacts. It was clear from the start of the workshop that in many institutions throughout Africa, there are insufficient resources to conduct the research needed to support an
African modelling community. In particular, even the most basic computing facilities are often lacking. It was determined that this problem could best be solved in the context of active research projects. In the course of collaborative funded research, the necessary resources for modelling projects would become available. The workshop participants are formulating research projects in the months following the workshop. The second issue was the importance of human impacts of global change to the African research community. In most regions in Africa, there is considerable concern regarding the ability of current and projected food production systems to provide sufficiently for the growing population in the face of changing and variable climate conditions. A significant aspect of the workshop was to prepare the participants to return to their home institutions with the modelling exposure that will enable them to help build a stronger, more integrated African modelling community. In addition, the participants will act as a knowledge base for further education and capacity building within the African universities and research community in the coming years.

The African-GAIM Modelling Workshop was a first step in augmenting the African global change modelling community. In considering future workshops, it was agreed by the participants that while the format for this first activity was an appropriate beginning, the next gathering should be based on the presentation of concrete results from modelling projects which emerged from the workshop. The participants will keep in contact with each other and with GAIM in the meantime throughout the development, funding and implementation of their projects. A major set of presentations is planned for the SAC-V meeting in Nairobi in September, 1998.
The African-GAIM Modelling Workshop was made possible by generous financial support from: NSF, NASA, EPA, NOAA, WMO, START, and AAU.

Computers for the workshop were donated by the Hewlett Packard Corporation (HP). Thanks go to those resource people who developed and presented models, and who helped participants in their modelling work: Bill Parton, Robin Kelly, Charles Vorosmarty, Laurent Kergoat, Paul Desanker, Roland Schulze and Andrew Pike. Special thanks go to Alex Proussevitch for his hard work in configuring all donated computers for the workshop models.

IGBP/GAIM wishes to express the deepest gratitude to Professor Wandera Ogana, who helped throughout the planning stages, acted as host in Kenya, and made all the local arrangements to make the African-GAIM Modelling Workshop possible. The success of the workshop was a result of his tireless efforts.

Berrien Moore III, Chair
Dork Sahagian, Executive Director
BIOME 6000 is conducted by IGBP/GAIM in collaboration with IGBP-DIS, GCTE and PAGES. The primary aim of BIOME 6000 is to generate a properly constructed and documented data set of paleoecological records for the period around 6000 14C-years BP (6ka), indicating biome distributions in a globally uniform manner for direct comparison with the output of coupled atmosphere-biosphere models. A secondary aim is to generate a similar dataset for the period around the last glacial maximum (18ka), where there are fewer data but the signal is very large. An inaugural workshop in 1994 instituted a now well-functioning regional structure, with contact persons who liaise with the co-ordinating group (Lund) and the data central (Providence). The aim is to include all of the available, good-quality data for 6ka, relying on individual contacts and bilateral agreements as well as on existing data sets and literature.

The key interpretative method used by BIOME 6000, known as “biomization”, translates assemblages of pollen and plant macrofossils into an assignment of biome by (a) first assigning all taxa to plant functional types (PFTs) based on their known biology and bioclimatic limits, and (b) calculating the “affinities” of the assemblage for all biomes based on a priori definitions of biomes in terms of PFTs. The method does not rely on the existence of a reference data set of surface (modern) assemblages for calibration. Nevertheless, if such data are available, they can be used to test the performance of the method in reconstructing present biome distributions. This article is intended as a status report on the current state of the project, including both regional tests of the biomization procedure and development of the 6ka map.

Europe (including North Africa and the Middle East). The biomization method was developed initially for this region. It was successfully tested against a large surface sample data set, and applied to a digitized pollen data set to construct a 6ka biome map. This map is published (Prentice et al. 1996). It shows starkly the northward and upward expansion of forests at 6ka relative to present, the near-absence of “Mediterranean” type vegetation around the Mediterranean at 6ka, and the great extension of temperate deciduous forests to the north, east and south. New versions are being produced now (J. Guiot, Marseille) based on original pollen counts archived in the European Pollen Data Base (EPD), including improved coverage of North Africa and the Middle East.

Africa (including the Arabian peninsula). The method has been tested against surface samples separately in West Africa (Jolly et al. in press), East Africa, and southern Africa. It has now been applied to a comprehensive 6ka pollen data set for the whole continent, based on original pollen counts obtained either directly (from a large number of scientists) or via the new African Pollen Data Base, which was inaugurated with DIS support in September 1996. A paper by D. Jolly and others describing the 6ka results is in preparation for a “Special Feature” in Journal of Biogeography, which will spotlight BIOME 6000 and also include articles describing results from the Former Soviet Union and Mongolia, and preliminary results from China (see below). In Africa, much interest has focused on the large early/mid-Holocene northward shift of the monsoon belt into what is now the Sahara desert; the data document this precisely, in terms of vegetation changes at specific locations.

Former Soviet Union and Mongolia (excluding western Beringia). Great progress has been made following a highly successful DIS-sponsored workshop in 1996, which included paleoecologists from many different laboratories in several of the FSU countries. Since the 1996 workshop, a visit of Pavel Tarasov (Moscow) to Lund has led to the biomization method being successfully tested against a very large data set of surface samples, and applied to a now probably almost exhaustive 6ka data set of pollen records (mainly original counts, some digitized), supplemented by tree megafossil records in N. Siberia. The maps document the northward shift of the forest-tundra boundary at 6ka. They also contrast the substantial northward shifts of forest belts in the western part of the region with relatively little change in the eastern part. The map also makes it clear that (in contrast with eastern North America) there was no large extension of steppe vegetation at the expense of forest in Central Asia; the boundary remained more-or-less stable, and in the western part steppe vegetation was actually reduced.

Pacific Asia. A workshop held in Beijing in 1995 started efforts to synthesize pollen data from China. There is a great deal of high-quality data and many active Chinese scientists in this field. Through a visit of De. Ge Yu (Nanjing) to Lund and a collaboration with Prof. Sun Xiangjun (Beijing) we have been able to make a preliminary test and a preliminary 6ka synthesis map for China. The map shows clear expansion of forests at 6ka into what is now steppe vegetation in the interior of China, a large upward shift of the treeline around the Tibetan plateau and northward shifts of the forests belts in eastern (especially northeastern) China. These are the broad conclusions based on a limited data set of digitized pollen counts.

North America. The biomization method has been tested against a large data set of surface samples for eastern North America, and applied to 6ka and LGM pollen data sets (Williams et al., in press) producing results consistent with earlier interpretations, including the expansion of prairie at the expense of forest in the continental interior and the greater latitudinal extension of temperate deciduous forests at 6ka. A small workshop in Eugene in 1996 established a planning framework for the completion of the 6ka paleodata set for the region as a whole (USA, Canada, Greenland, Alaska and western Beringia) and biomization. Macrofossil analyses from packrat middens will be a major data source for the arid western USA. Tree megafossil records will
be included in the synthesis for Canada, drawing on extensive 6ka synthesis work already carried out in Canada.

**Australasia and Southern Asia.** A comprehensive pollen data base for the “Asia/Pacific” region, including SE Asia, Australia, New Zealand and the Pacific islands, is led by Dr. Geoff Hope (Canberra) and is well advanced. A visit by Dr. Habiba Gitay to Lund in 1995 allowed an initial test of the biomization method for this region. In addition, Dr. Raymonde Bonnefille (Pondicherry) is now assembling the available 6ka paleoecological records from the Indian subcontinent.

**Central and South America.** The new Latin American Pollen Data Base (led by Vera Markgraf, Boulder) will facilitate data synthesis. A biomization plan will be developed in the next year with Prof. Henry Hooghiemstra (Amsterdam).

In summary, we are on track to shortly produce a first global 6ka data product. Some regions are well advanced. Other regions require further efforts but there is a momentum in every region, particularly in the current development of comprehensive pollen data bases. This development not only helps the (short-term) task of BIOME 6000, but is also an extremely desirable trend for the future since it will make it possible (a) to extract data for any specified time slice, and (b) to access full time-series for the analysis of a wider variety of paleoclimatic phenomena including Holocene variability and the dynamics of abrupt changes.

**Broad Scientific Context.** BIOME 6000 was initially spawned by the GAIM focus known as the “6000 yr. BP experiment”. Part of the background to this is provided by the Paleoclimate Modeling Intercomparison Project (PMIP), jointly sponsored by IGBP and WCRP. Under the PMIP banner, at least 20 atmospheric general circulation models (AGCM) are performing a limited number of standard runs with paleoclimate boundary conditions. The standard run for 6ka involves changing the orbital forcing, reducing CO₂ to pre-industrial levels, and leaving everything else (including land and sea surface conditions) constant. Results can be coupled (unidirectionally) to a biome model to predict biome distributions that can be compared precisely with BIOME 6000 results.

However, numerous sensitivity experiments have shown that climate-induced changes in the land surface (for example, northward shifts of the forest-tundra boundary in North America and Eurasia, and expansion of monsoon vegetation in northern Africa) can have large positive feedback effects not included in the standard PMIP run (e.g. TEMPO 1996, Kutzbach et al. 1996). Bidirectional atmosphere-biosphere coupling experiments have now been performed for 6ka using asynchronous coupling (Texier et al. submitted; Claussen and Gayler 1995) and fully interactive coupling methods are under development (Foley et al. 1996; in prep.). The data from BIOME 6000 can show that the standard PMIP runs fall short of simulating the full extent of high-latitude forest expansion and northern African monsoon expansion at 6ka, while the bidirectionally coupled models more closely approach the data. This result indicates the importance of feedback effects from vegetation changes on future climate simulations (Melillo et al. 1996).

The 6ka data set enables us to now target the LGM and its implications for simulations of future climate. Perhaps the most important is in quantifying the direct effects of changing atmospheric CO₂ concentration on the distribution of vegetation types. Some ecosystem models suggest that these effects may be large (e.g., Foley et al. 1995, Haxeltine and Jolly, in press). In all of these applications, the approach taken by BIOME 6000 provides for the first time a properly documented “benchmark” data set that can be used for rigorous evaluation of climate and earth system models.

**References**


Identifying weaknesses of 3-D global ocean carbon-cycle models has been the focus of the IGBP/GAIM project OCMIP (Ocean Carbon-Cycle Model Intercomparison Project, Phase 1: 1995–1997); improving these models is the long-term objective of OCMIP. Four modelling groups have participated (see Research GAIM, Newsletter 1). OCMIP has standardized related model simulations and analysis, as necessary for rigorous comparison, and has pinpointed certain critical regions where models disagree considerably.

Differences between the four OCMIP models are most prominent in the Southern Ocean for both natural and anthropogenic CO₂. For example, all OCMIP models absorb between one third to one half of their global uptake of anthropogenic CO₂ south of 30°S, but the total quantity absorbed there differs by nearly a factor of two (Figure 1); most of the differences in predicted global uptake (±20%) are attributable to model differences in the Southern Ocean. The majority of the remaining anthropogenic CO₂ flux is taken up in the tropics; the northern latitudes (>30°N) absorb relatively little due to their small areal extent.

Model comparison is informative, but how do OCMIP models actually compare with the real ocean? In the Southern Ocean predictions from the four OCMIP models appear to roughly bracket real ocean distributions of anthropogenic CO₂, based on direct comparison of model results to new data-based estimates of anthropogenic CO₂ in the Southern Atlantic [Gruber et al., 1997] and Southern Indian Oceans [Sabine et al., 1997]. Uncertainties associated with such data-based estimates for oceanic anthropogenic CO₂ are not negligible and need closer attention [Wanninkhof et al., 1997]; however, differences between models are much larger, especially in the Southern Ocean.

The classical albeit indirect means of evaluating global ocean carbon-cycle model performance is through comparison of simulated vs. measured radiocarbon. OCMIP has studied both natural and bomb ¹⁴C (Orr, 1996). Uncertainties are associated with observational-based methods used to distinguish the bomb ¹⁴C component from the natural ¹⁴C background. These uncertainties are particularly large in the Southern Ocean. One simple way to reduce uncertainties involves comparing models to the measured WOCE (1990’s) minus GEOSECS (1970’s) ¹⁴C difference [Key, 1997]. Such observational ¹⁴C differences are beginning to be compared to simulated results from the OCMIP models.

But what has ¹⁴C to do with CO₂? The signals of transient ¹⁴C and anthropogenic CO₂ are nearly linearly related in some regions of the ocean as suggested by OCMIP model results. Because this relationship differs between models, the observed trend may provide a constraint with which to better evaluate ocean carbon-cycle models, if data-based uncertainties for both components can be reduced.

To study changes in future ocean uptake due to CO₂-induced shifts in ocean chemistry, all OCMIP models made simulations with IPCC scenario S450 (where atmospheric CO₂ is stabilized at 450 ppm) to year 2300. For this scenario, all models predict that the Southern Ocean air-sea flux grows in importance relative to other regions of the world ocean (Figure 2); however, model predictions diverge. Particularly, the model which absorbs the least anthropogenic CO₂ at present, absorbs the most from year 2200 onwards. Such changes must in part be due to differences in deep-ocean mixing between models, which become more apparent with time as anthropogenic CO₂ penetrates more deeply.
While results from the original four OCMIP models have been undergoing analysis and the first attempts have been made to determine causes of model-data and model-model discrepancies, numerous other groups have been busy developing their own global ocean carbon-cycle models. These models will be welcomed in the second phase of OCMIP: 1998–2000. OCMIP-2 is a joint effort led by IGBP/GAIM and IGBP/JGOFS and will take advantage of insights gained from OCMIP-1. Furthermore, OCMIP-2 will benefit from greater model diversity, which offers better insurance that a range of model predictions brackets real ocean behavior.

OCMIP-2 will include 13 models: 4 from the U.S., 7 from Europe, 1 from Australia, and 1 from Japan. The U.S. effort, being funded by NASA as a part of the U.S. JGOFS Synthesis and Modeling Project (SMP), will add number and strengthen OCMIP’s link with JGOFS and WOCE data synthesis communities. The European group of models is funded through the EC Environment and Climate Programme via the GOSAC (Global Ocean Storage of Anthropogenic Carbon). GOSAC will also lead a related model comparison effort, jointly funded by the IEA Greenhouse Gas R&D Programme, to assess global aspects of the proposal which offers to artificially accelerate ocean storage of CO₂ by diverting CO₂ emissions from fossil-fuel fired power plants directly into the abyss, thereby short-circuiting the slow process of air-sea CO₂ exchange.
OCMIP-2 will look in more detail at both natural and anthropogenic components of CO₂ and ¹⁴C. New model-data comparison will help to further diagnose problems and improve participating ocean carbon-cycle models. Additionally, circulation fields will be diagnosed through new simulations for CFC’s and ³He. Simulations for O₂ will help pinpoint deficiencies in different formulations for ocean biogeochemistry. Models will be run with identical ocean biogeochemistry in order that differences due to ocean circulation fields can be isolated. At first, a simple diagnostic phosphate restoring model will be used by all OCMIP models. Subsequently, OCMIP groups will employ a more sophisticated prognostic model developed by JGOFS 1-D modelers. A third phase of OCMIP will begin in 2001. Currently on the OCMIP3 agenda are model comparisons focused on (1) interannual variability of the air-sea CO₂ flux and (2) changing climate in the 21st century and beyond, through coupled atmosphere-ocean simulations which attempt to model how air-sea CO₂ fluxes will be affected by changing ocean circulation and circulation-induced changes in ocean biogeochemistry.

References:

Workshop on Inverse Methods in Global Biogeochemical Cycles
March 16-20, 1998
Heraklion, Crete, Greece
Sponsored by GIM/IGAC, GAIM, and EU

Overview:
Inverse methods are crucial in determining the location and magnitude of sources and sinks of chemically and radiatively important atmospheric trace gases from atmospheric concentration measurements (such as carbon dioxide, methane, nitrous oxide, carbon monoxide and ozone). The use of these methods is still relatively new in the field of global biogeochemical cycles and atmospheric chemistry modelling. The methods will become increasingly more important in the near future as denser observational networks and more data from satellite and aircraft platforms become available.

The planned five day workshop will consist of two parts. The first part (the first three days) is designed to teach young scientists (advanced Ph.D. or early postdoctoral level) about the theory and application of inverse methods. This part of the workshop will consist of a series of invited expert lectures combined with practical problem-solving exercises. The second part of the workshop (the last two days) will be in the format of a scientific meeting consisting of presentations from researchers active in the field of inverse modelling of global biogeochemical cycles. It is anticipated that the expert lectures, exercises, and research presentations will be compiled for publication as a peer-reviewed book.

Applications for Participating:
Individuals interested in attending are requested to submit an application indicating whether they are interested in attending one or both parts of the workshop.

Researchers interested in presenting a paper during the second part of the workshop should include an abstract with their application.

Financial support is available for a limited number of young researchers (advanced Ph.D. or early postdoctoral level) who will be expected to attend both parts of the workshop. Individuals applying for financial support should include a CV, brief description of research interests, and one letter of recommendation.

Applications are due by December 31, 1997. Depending on the number of applications, attendance may be restricted to parts of the workshop.

U.S. applicants should send their applications to Dana Hartley
European and non-U.S. applicants should send their application to Martin Heimann.

Organizers:
Martin Heimann (martin.heimann@dkrz.de)
Dana Hartley (hartley@eas.gatech.edu)

GIM
Prasad Kasibhatla (Duke University)

GAIM
Berrien Moore (University of New Hampshire)

Advisors:
Ian Enting (CSIRO)
Ron Prinn (MIT)
In many respects the global carbon cycle constitutes a paradigm for GAIM studies: (a) it is an interdisciplinary field crosscutting several IGBP core project activities, (b) it is strongly coupled to the physical climate system, and (c) the main processes controlling the storage and cycling of carbon are sufficiently well known to make it amenable to global scale modeling. A comprehensive model of the carbon cycle requires components of the carbon systems in the atmosphere, the ocean and on land. A fundamental question concerns the accurate quantification of the fate of the anthropogenic CO2 in the global carbon cycle - where is it being stored and for how long? The global carbon cycle is also strongly coupled to the physical climate system, however, the different feedback mechanisms between the two systems are still only poorly understood.

The Carbon Cycle Model Linkage Project (CCMLP), which has been initiated and funded in part by the Electric Power Research Institute (EPRI), is an attempt to investigate this complex interplay by means of global modeling studies involving various combinations of different comprehensive model components of the various carbon cycle subsystems. In part, CCMLP also represents a pilot study of the GAIM task force activity “The Coupled Atmosphere-Land-Ocean Carbon System 1980-2000”.

The main emphasis during the first phase of CCMLP lies on the terrestrial carbon cycle. Various global simulation experiments are being conducted within CCMLP, which explore the different global and regional responses to a series of external forcing factors, such as the historical increase in the atmospheric CO2 concentration since 1800 (Kicklighter et al., 1998), changes in land-use and impacts induced by the climate variations. As an additional feature also the behavior of the carbon isotopes (13C, 14C) is being investigated in various model simulations. In order to facilitate the model intercomparison, each of the experiments is being conducted with a strict simulation protocol, specifying in detail the model settings (e.g. grid resolution, simulation period, etc.), the input forcing data (e.g. atmospheric CO2 concentration, climate data) and the output data for the subsequent analysis.

One of the fundamental objectives of the CCMLP concerns the quantification of the climatic feedback effects on the carbon cycle. For this an investigation is being conducted, which explores the response of the carbon cycle models on the ENSO and decadal time scales by forcing them with the observed historical climate. The results can then be intercompared with variations in the atmospheric CO2 concentration and isotope ratios as recorded at the global monitoring station networks. The observed growth rate of atmospheric CO2 shows significant variations on interannual time scales which are correlated to climate fluctuations (Figure 1, Heimann, 1997). Presumably a substantial fraction of these fluctuations is caused by variations of the CO2 exchange fluxes between the atmosphere and the terrestrial biosphere.

This hypothesis is explored by means of simulations with 4 comprehensive, global prognostic terrestrial biogeochemical models (TBMs) driven by observed monthly climate datasets (temperature [Jones, 1994] and precipitation [Hume and Jones, 1993, updated]) over the time period 1900-1994. The TBMs include the HRBM model of the University of Giessen, the FBM model of the University of Frankfurt, the TEM model of the University of New Hampshire and the Marine Biological Laboratory, Woods Hole and the SILVAN model of the Max-Planck-Institute for Meteorology in Hamburg (see Heimann et al., 1997, for a descriptions of the models).

Each of the models was subjected to the following experiment protocol:

1. Initialization with a base climatology of temperature and precipitation determined from the climate data over the time period 1900-1930.

2. Simulations with monthly climate forcing over 1900-1994:
   - D1: Temperature
   - D2: Precipitation
   - D4: Temperature and precipitation in combination.

In these experiments the atmospheric CO2 concentration was held fixed, and the models employed potential vegetation only.

The TBM simulations are able to explain a substantial fraction of the observed anomalous CO2 source flux, even though the latter presumably also includes variations caused by the oceans. This is illustrated in Figure 2 which shows the globally integrated net terrestrial CO2 source flux from the combined experiment (D4), together with the anomalous source flux derived from the atmospheric CO2 record (from Figure 1). In particular the variations associated with strong El Niño-Southern Oscillation (ENSO) events (e.g. 1972-3, 1982-3 and 1987), during which the land biota acts as a net CO2 source, are reproduced in the simulations, although with an absolute magnitude varying by a factor of two among the models. The dominant process (photosynthesis, autotrophic or heterotrophic respiration, feedback effects due to changes in soil water, a.o.) that induces the fluctuations of the net CO2 flux, however, is found to be different from model to model. As an example Figure 3 shows the anomalous net surface-air CO2 flux predicted by the four models in the ENSO year 1987, which demonstrates that also the predicted regional patterns are quite different among the models.

None of the models exhibits sufficient magnitude the anomalous net CO2 uptake that was observed after the Pinatubo volcanic eruption in 1992 and 1993. Hence, while the models short term sensitivity to climate variations in tropical regions appears realistic, this might not be the case in midlatitudes where the climate anomaly in 1992-93 was most predominant.

A series of additional, short term simulations are currently being per-
formed over the 1979-1994 period, using as climate drivers the newly available meteorological reanalyses from the ECMWF weather forecast model. These simulations allow an assessment of the sensitivity of the results with respect to the different climate driver data. Further experiments are also scheduled to explore the concurrent effects of land-use changes and of the rising CO2 concentration. It is also expected, that additional models will participate in the simulations in a future phase of the project.

References:


Figure 1. Observed interannual variations in the global carbon cycle. Upper panel: Fluctuations of the atmospheric growth rate of CO2 determined from the average of the seasonally adjusted records of the Mauna Loa and South Pole stations. The dashed line is the growth rate that would result from an atmospheric balance taking into account the documented CO2 inputs from fossil fuel and changes in land use together with the uptake rates computed by an ocean and a terrestrial model. Lower panel: Anomalous, presumably climate driven, CO2 source implied by the difference between the solid and the dashed line shown in the upper panel.
Figure 2. Globally integrated CO2 source flux simulated by four TBM of the CCMLP (red line), together with the anomalous source flux shown in Figure 1 (blue dashed line).
Figure 3. Net CO2 source flux predicted by the four TBM s for the ENSO year 1987. The uppermost panels show the annual average of the anomalous climate fields that were used as forcing fields in the model simulations.
As IGBP and the international global change research community matures, “Global Change” is becoming increasingly accepted as a serious field of scientific endeavor. This can be seen in the growing number of journals dedicated to the various aspects of global change as well as in the papers presented over the last couple of years at major international scientific conferences such as EGS and AGU.

AGU Special Session
“Incorporating Human Dimensions in Earth System Models”
American Geophysical Union 1998 Spring Meeting
Boston, Massachusetts, USA; May 26-29, 1998

From the perspective of Global Change, the Earth System can be divided into physical climate, biogeochemical, and human components. While there are strong and growing links between physical climate and biogeochemical research, the links to the human dimension have largely been ignored. The reasons for this are partly because the social, economic, and political sciences comprise a different scholarly community than the physical and biogeochemical sciences, and partly because modeling the complexities of modern human society is an exceedingly difficult task, particularly when future projections are involved. However, anthropogenic activity is a major (and perhaps dominant) driver for global change. In order to develop prognostic biogeochemical models, it is critical to accurately account for changes in the driving forces stemming from human activity. While this is not yet possible, some socio-economic models exist now, and others are currently being developed. Their development in a way which can be coupled to physical climate and biogeochemical models will ultimately enable the modeling community to make reliable estimates of future impact of global change on the basis of evolving drivers to the system. This special session represents an preliminary attempt to bring together researchers from the physical, biogeochemical, and human dimensions arenas to explore the way ahead.

Abstract Deadline- February 19, 1998. For abstract information see the AGU website (http://earth.agu.org/meetings/sm98top.html) or contact the GAIM Office (gaim@unh.edu; 1 603 862 1524; 1 603 862 3875) or the IHDP secretariat (kohler.ihdp@uni-bonn.de; 49 228 739 050).

Other Special Sessions relevant to IGBP at the AGU Spring Meeting include, among others:
Integrated Spatial Information for Earth System Science
Catastrophic Glacier Outburst Floods and Environmental Change
Geographic Information Systems in Earth Sciences
The Role of Vegetation in Biosphere-Atmosphere Interactions
Water Vapor in the Upper Troposphere and the Stratosphere
Biogeochemical Cycles and Air-sea Exchange
Hydrological and Biogeochemical Controls on Atmosphere-Biosphere Exchange with Boreal Soils
Remotely Sensed Observations of the Surface Energy and Carbon Balance
Water and Watersheds
Sources of Variation of Soil Moisture
Regionalisation in Hydrology : The Role of Vegetation, Soils and Climate in Driving Catchment-Scale Hydrologic Response
Anthropogenic Impacts on Desert Hydrology
Geomorphic Responses to Environmental Change
Low Frequency Climate Variability Signatures on Regional Hydroclimatologic Variables: Implications to Hydrologic Forecasting and Planning
Responses of Coastal Wetlands to Hydrologic Alteration and Restoration
Remote Sensing of Coastal Phenomena

Notable Special Sessions at the 1997 AGU Fall Meeting (Dec 8-12, 1997) include, among others:
Transfer Processes Within the Soil-Vegetation-Atmosphere Continuum
Climate System History and Dynamics
Integrated Study of Regional Climate and Hydrology in Basin-Scale Field Experiments
Land Surface Processes and Climate: Theory, Observations, and Modeling
BOREAS: Results From Remote Sensing
Calibration and Validation of Climate Change Measurements
Tropospheric Chemistry From Space
Watershed Investigations and Modeling Issues
Impacts of Land Use on the Hydrologic–Geomorphic Responses of Watersheds
Aerosols and Climate
Climate Change Detection, Attribution, and Optimal Parameter Estimation
Consequences of the 1997-1998 El Nino for Human Health
Modeling Regional-Scale Components of the Climate System
Scientific Uncertainty in the Assessment of Global Change
Five Centuries of Climate Change: What Do Proxies Tell Us?
Late Quaternary Paleoclimatology of the Tropics
Nearshore Processes
Recent Advances in Understanding the Active Coastal Zone
Paleoceanography and Paleoclimatology: Observations and Models
Climate-Ocean Dynamics During the Holocene and Last Interglacial
Ocean Carbon Paleocycle and Climate Changes During the Quaternary
Frontiers of Isotope Applications in Paleoceanography and Paleoclimatology
Water Quality/Land Use Interactions in Forested Landscapes of the Pacific Northwest
If you are not on our mailing list but would like to receive this and subsequent issues of *Research GAIM*, or if your address has changed, please fill in this form and mail to:

GAIM Task Force Office  
Rm. 164, Morse Hall  
39 College Road  
University of New Hampshire  
Durham, NH. 03824

Check one:  
New address [ ]  
Change of Address [ ]

Name:  
[ ]

Address:  
[ ]

[ ]

You can also fax this information to: (603) 862-3874  
Or send email to the GAIM office at: gaim@unh.edu