

## The Pivotal Role of Paleosciences in the New IGBP

J.M.F. MORAIS

IGBP Secretariat, Royal Swedish Academy of Sciences, Stockholm, Sweden; morais@igbp.kva.se

GLOBAL  
I G B P  
CHANGE

The EPICA, Vostok and Dome Concordia ice core data from Antarctica have dramatically reinforced a global perspective on the behavior of the Earth's environment. Crucial to this perspective is the increasing awareness of two aspects of Earth System functioning.

Firstly, the Earth itself is a single system within which the biosphere is an active, essential component. This system operates with a regular periodicity, with strong connections between climate and biogeochemical cycling, and within tightly constrained maxima and minima of key environmental parameters.

Secondly, human activities are now so pervasive and profound in their consequences that they affect the Earth at a global scale in complex, interactive and apparently accelerating ways. The effects of human activities are now discernable beyond the limits of natural variability; humans have become a planetary-scale force that has pushed the Earth System beyond its normal "operating range".

The structure of the new, Phase II IGBP research effort mirrors the enhanced scientific emphasis that is being placed on Earth System-level processes and phenomena and on the more detailed dynamics within the Earth System. The Programme is thus built around eight projects: three oriented towards the three major Earth System compartments—land, ocean and atmosphere; three concentrating on the interfaces that transport and transform matter and energy between the three compartments; and two focusing on the changing environment of the planet as a whole, from past through present to the future (Fig. 1).

Understanding global change requires knowledge of the past in order to assess ongoing processes and feedbacks and the sensitivity of various parts of the ocean-atmosphere-land components, and

to correctly estimate human impact on this system. This temporal component, especially high-resolution studies of past abrupt change, climate dynamics and regional responses, provides us with the information necessary to better predict our future through modeling.

In essence, past natural experiments in the Earth System, like "messages in a bottle" of climate and hydrologic change preserved in ice cores, tree rings, lake and marine sediments, etc., allow scientists to test the reproducibility of various models to reconstruct past events. For example, greenhouse gas concentrations are rising rapidly and are influencing our climate but are the recent changes observed in the Earth System unprecedented in the past? In this regard, the dynamic perspective and timing of recorded events is critical to unraveling the functioning of the Earth System. How fast did the diverse components change in the past? Where and when did this happen?

These issues are of major importance and interest to all the IGBP projects because they permit an assessment of recent anthropogenically influenced processes

with respect to naturally occurring past variations. Sea level, biodiversity, land systems, the cryosphere and atmosphere—all Earth System components provide records of their past behavior. PAGES deals with these past records, integrating all the IGBP projects alongside the project on Analysis, Integration and Modelling of the Earth System (AIMES), and is therefore pivotal to each component of the Programme.

Last but not least, PAGES provides paleo-perspectives on the future sustainability of a habitable planet. As a central IGBP project, it directs its efforts towards providing the IGBP community with regionally significant and globally relevant information on the past behavior of the Earth System, to enable an assessment of the conditions leading to its future sustainability. This requires the integration of records of past changes, as well as systemic analysis and modeling of paleodata, in order to better understand human-climate and ecosystem interactions through time. Of particular focus is the value-added use of biogeochemical proxies in modeling, while exploring ways of assessing

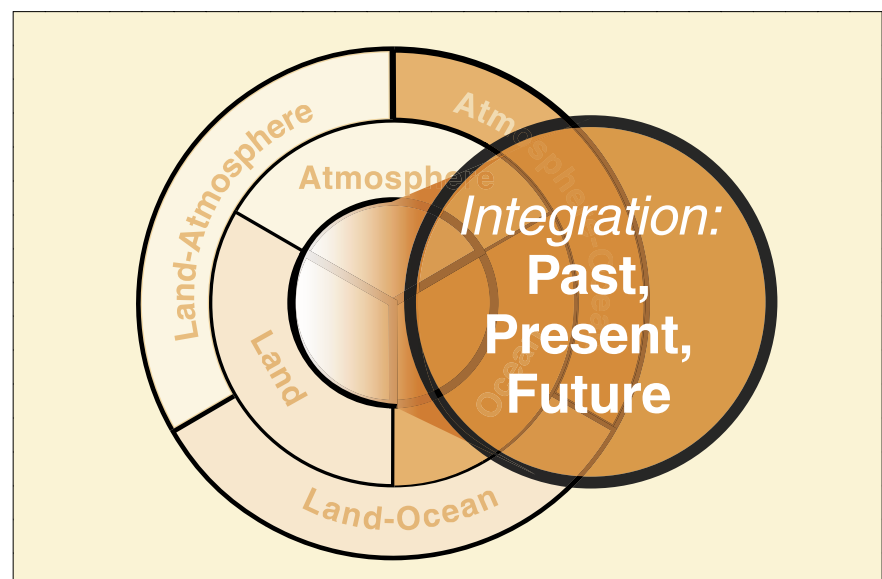


Fig. 1: The new IGBP structure showing PAGES role as the integrating tool.

contemporaneous change on land and in the oceans.

At a macro decision-making level, it is gratifying to see a sign of the further recognition of the role of paleosciences: The 4th Intergovernmental Panel on Cli-

mate Change (IPCC) Assessment Report will include a full chapter on paleoclimate. What cannot be overlooked is the transmission of these data products and their implications for policy, educational and societal action through educa-

tion, networking and outreach at all levels. Here the PAGES website has taken up the challenge of carrying the "message in the bottle" further afield and translating it into more popular knowledge.



## The Future of PAGES/CLIVAR Intersection Activities

C. KULL<sup>1</sup>, Z. YAN<sup>2</sup>, E. JANSEN<sup>3</sup> AND A. WEAVER<sup>4</sup>

<sup>1</sup>PAGES IPO, Sulgeneckstrasse 38, 3007 Bern, Switzerland; kull@pages.unibe.ch

<sup>2</sup>CLIVAR CPO, Empress Dock, Southampton, SO14 3ZH, UK; yxy@soc.soton.ac.uk

<sup>3</sup>Bjerknes Centre for Climate Research, Allegaten 55, 5007 Bergen, Norway; eystein.jansen@bjerknes.uib.no

<sup>4</sup>School of Earth & Ocean Sciences, University of Victoria, Victoria, BC V8W 3P6, Canada; weaver@uvic.ca



The CLIVAR/PAGES Intersection Working Group is jointly sponsored by the PAGES project of the International Geosphere-Biosphere Programme (IGBP) and the Climate Variability and Predictability Programme (CLIVAR) of the World Climate Research Programme (WCRP). It plays an important role in developing and implementing the research agendas of both CLIVAR and PAGES. The group was established in the mid 1990s. Details of its history are recorded in meeting reports and relevant publications archived at: [www.clivar.org/organization/pages/index.htm](http://www.clivar.org/organization/pages/index.htm).

A major issue in the past has been communication between the modeling and data communities. The PMIP (Paleoclimate Modeling Intercomparison Project) activities were especially successful, producing a lot of scientific output. Conferences and workshops showed a clear need for such collaborative work in order for modelers to benefit from paleodata to test, calibrate and assess state-of-the-art climate models, and for paleoscientists to be informed about what kind of data is needed to assess the results of climate models.

After successful conference activities in the past, PAGES/CLIVAR seeks to address burning issues in the scientific intersection of the two projects. In November 2004, the newly constituted PAGES/CLIVAR Working Group held its inaugural meeting in Victoria, Canada. The group is lead by Eystein Jansen from PAGES and Andrew Weaver from CLIVAR.

In the future, PAGES/CLIVAR seeks to strengthen its collaboration, while addressing new PAGES- and CLIVAR-related topics with joint IGBP-WCRP activities and revised Terms of References, as follows:

- To promote improved high-resolution, well-dated, quantitative paleoclimate records with seasonal-to-interannual resolution in regions that are of direct relevance to IGBP and WCRP.
- To formulate and promote, in collaboration with PAGES and CLIVAR, a program for analyzing and synthesizing paleoclimate data, in order to reveal evidence of patterns of variability within the climate system over seasonal-to-millennial time scales.
- To promote improved quantitative methods of model-data comparison and evaluation in order to understand the variability present in both the paleoclimate record and the models.
- To promote the use of paleoclimate data to examine issues of climate predictability.
- To coordinate with other modeling activities of relevance to IGBP and WCRP.

### Topics for Future Activities will Include:

#### 1. Climate Variability over the Last Few Millennia

Well-dated, high-resolution proxy reconstructions and model simulations incorporating estimates of natural and anthropogenic forcings suggest that late 20th century warming is anomalous in the context of the past 1,000-2,000 years. Significant differences exist, however, between various competing estimates (Fig. 1). Despite progress in recent years, important uncertainties and caveats exist with regard to both empirical reconstructions and model estimates. One important issue relates to the varying seasonality and spatial representativeness of different estimates. PAGES/CLIVAR advocates a paleoclimate reconstruction methodology and data intercomparison project ("PRMDIP") in which various paleoclimate reconstruction methods will be applied to common data sets to elucidate the differences between methods and regions, and where further needs related to the understanding of the past regional variability will be discussed. See also the related Science Highlight by H. Wanner, pages 19-21).

#### 2. Abrupt Climate Change

Topics considered include ocean dynamics, ice-sheet stability and related modeling studies. PAGES/CLIVAR especially seeks to support and initiate modeling studies of past abrupt climate change events.