climate changes and their context within large-scale circulation patterns during that time appears warranted.

Innovative new research is being carried out to utilize tree-ring proxy records together with historical information to infer the occurrence of a major drought episode in the late 1500s, that affected areas stretching from northern Mexico to the eastern United States. Early indications are that this drought equals or exceeds any drought episode in the 20th century, but its spatial extent and duration – twenty years or more in some areas – appears to be unprecendented in the context of the last half-millennium.

Finally, more information is becoming available relating the outbreak of vector-borne diseases, such as malaria and yellow fever, and outbreaks of cholera in past centuries to the occurrence of major climatic events, such as major El Niño episodes. It was the goal of this conference to explore connections among information extracted from historical documentary records and proxy climate records of various sorts. The goal was also to try to use the inferred climatic events in order to provide some degree of context to understand and to develop hypotheses about the impacts of these salient climatic events on human society. We will have succeeded in our goals to the extent that new ideas, scientific partnerships, and renewed interest in pursuing these endeavors come to fruition as a result of this conference.

Acknowledgments

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Modelling Extreme Climates of the Past : What we have learned from PMIP and related Experiments

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The Paleoclimate Modeling Intercomparison Project (PMIP), endorsed by both CLIVAR and PAGES, was established in 1991 for the purpose of improving our understanding of past climatic changes and assessing how well models can simulate such changes. If climate models can demonstrate skill in simulating conditions much different from today, this will build confidence in their predictions of future climate changes.

The initial PMIP experiments focused on two periods of the relatively recent past: the last glacial maximum, 21,000 years before present (BP), and the mid-Holocene climate, 6000 year BP (Joussaume and Taylor, 1995). These periods were selected in part because of the relatively plentiful data available for comparison with model output. In addition, the last glacial maximum was a period of relatively extreme cold, and this provides a challenge to climate models, forcing them to simulate a state much different from the present one, which they are to some extent "tuned" to reproduce. The mid-Holocene, on the other hand, provides an opportunity to test whether models can realistically respond to a significant change in the seasonal insolation pattern forced by well-known small perturbations in Earth's orbital configuration (i.e., Milankovitch forcing).

The third PMIP Workshop was held in Québec (Canada), 4–8 October 1999, hosted by the Canadian Climate System History and Dynamics (CSHD) Research Network and funded by CSHD, UQAM, and PAGES. The purpose of the workshop was to report on PMIP results and PMIP related work and to reach some agreement about the future of PMIP, based on a synthesis of the results. Here we summarize results of PMIP and its future direction as discussed at the workshop. A full report on the PMIP Workshop will be published soon by the WCRP.

Simulations for the mid-Holocene with eighteen different climate models all simulate an increase in the summer monsoon over Africa and Asia as a result of increased summer insolation, but, when compared quantitatively to biome reconstructions over Africa (Jolly *et al.*, 1998), all the models underestimate the northward displacement of the desert-steppe transition (Joussaume *et al.*, 1999; Harrison *et al.*, 1998]. Comparisons with proxy data over Europe (Masson *et al.*, 1999; Guiot *et al.*, 2000) and high northern latitudes (Harrison *et al.*, 1998) also show an underestimation of the model response. It should be noted, however, that the PMIP simulations were purposefully simplified in order to isolate differences in the atmospheric component of climate models. In particular, both ocean and land surface feedbacks were suppressed in these experiments, which obviously strongly constrains the models and hampers evaluation against paleodata. The quantitative discrepancy between PMIP model results and paleodata has led to several sensitivity experiments and new experiments with more comprehensive models designed to evaluate the importance of positive feedbacks by vegetation and land surface changes (Kutzbach *et al.*, 1996; Brostrom *et al.*, 1998; Claussen and Gayler, 1997; de Noblet *et al.*, 2000; Texier *et al.*, 1997 and 1999; Coe and Bonan, 1997) as well as by ocean processes (Kutzbach and Liu, 1997; Hewitt and Mitchell, 1998; Braconnot *et al.*, 2000a). Land surface or ocean feedbacks individually, however, do not seem sufficiently strong to explain the observed biome shifts over the Sahara. Recent experiments with a coupled atmosphere-ocean-vegetation model exhibit a synergy between the two feedbacks that produces a stronger northward migration of monsoon rains (Braconnot *et al.*, 2000b). Overall, results from PMIP and related Holocene experiments suggest that vegetation feedbacks and atmosphere-ocean interactions, which are not commonly included in state of the art simulations of future climate change, can substantially alter climate response to small perturbations.

In the other PMIP experiment, designed to further understanding of the last glacial maximum, one focus has been the apparent inconsistencies between the magnitude of tropical cooling over land and oceans inferred from paleodata and simulated by models. Thanks to a new terrestrial data synthesis (Farrera *et al.*, 1999), PMIP confirms earlier studies that model simulations with SST's prescribed according to CLIMAP, with relatively warm oceans, produce cooling over land that is generally weaker than that inferred from paleodata. Models that include a slab ocean to calculate sea surface temperatures show a range of terrestrial cooling that is closely tied to the magnitude of tropical ocean cooling (Pinot *et al.*, 1999). Some models produce a strong terrestrial cooling, but this is associated with maritime cooling that is too large to be consistent with recent alkenone data. One model, however, gives reasonable results over both land and oceans, which suggests that both types of data may in fact be reconcilable after all.

Over Eurasia, models reproduce the reconstructed LGM temperature and precipitation changes reasonably well except over western Europe in winter (Kageyama *et al.*, 2000). This apparent discrepancy may arise in part because of the simplifications inherent in the PMIP experiments. In the prescribed SST experiment, there are uncertainties in the SSTs reconstructed from proxy-data, and in the computed SST experiment, a simplifying assumption has been made that the ocean heat transport remains fixed. In the coming years, better SST estimates should become available from the EPILOG project, and coupled atmosphere-ocean models will begin to be developed for the LGM. Vegetation feedbacks may have also played an important role (Crowley and Baum, 1997; Kubatzki and Claussen, 1998; Levis *et al.*, 2000). Until then, modeling groups participating in PMIP plan to share results from exploratory studies that may cast some light on the limitations of the initial PMIP simulations.

At the workshop, various options for the future of PMIP were discussed, including the possibility of terminating the project. The strong interest expressed in extending PMIP activities, notably with respect to coupled model simulations and to new time intervals, suggested that PMIP could continue to serve the community through coordinating some of this research. It was decided that as a first step, working groups would be established to focus on a few priority themes briefly outlined below. The mid-Holocene and Last Glacial Maximum periods will remain central to a portion of both the modeling and data synthesis components of PMIP. Based on recent exploratory work by several groups, the following decisions were reached:

- The model-model and model-data comparisons for the mid-Holocene will be extended to coupled atmosphere-ocean model simulations, which are now available. The design of a common coupled ocean-atmosphere-vegetation experiment will be defined for future investigation.
- For the LGM, it is premature to consider carrying out a common coupled model experiment, but work will continue less formally through the sharing of results from individual experiments. PMIP remains strongly interested in the EPILOG project and strongly encourages the effort of the paleooceanographic community to revise estimates of SSTs at the LGM. Reliable estimates of sea-surface conditions (along with error bars or other indications of accuracy) will be essential for future simulations and for validation of the ocean models being used in coupled model simulations of the LGM.
- Two other periods (the early Holocene and the end of the last interglacial) appear to be of interest to many PMIP participants. Working groups have therefore been formed to analyze the possibility of defining new common experiments and to foster further discussion of these time periods.
- Of particular interest to the groups involved in PMIP is the early Holocene, when insolation forcing was stronger, but (unlike the mid-Holocene) ice sheets were still present. An effort will be initiated to design a new PMIP experiment for this time period.
- An experiment focusing on inception of ice growth at the end of the last interglacial (~115 ka BP) was considered premature. Several groups, however, have already begun exploratory work on this period, so it was agreed that a special session would be dedicated to this subject during the next PMIP workshop, in two years from now.

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Addenda to PAGES Newsletter 99–3

Two articles in the last issue of PAGES News appeared without full authorship and reference information.

The article entitled "A 300,000 Year Record from the Lac du Bouchet, France" (p. 8) failed to include a list of co-workers whose results were used (Andrieu V., Beaulieu J.L., Coulon C., Creer K.M., Féraud G., Reille M., Roger S., Williams T.) and made no reference to the publications from which the pollen analytical data were taken: Reille *et al.*: Quaternary Science Reviews 17, 1107–1123 (1998); Reille & de Beaulieu: Review of Palaeobotany and Palynology, 54, 233–248 (1988), Palaeogeography, Palaeoclimatology, Palaeoecology, 80, 35 – 48 (1990) and Quaternary Research, 44, 205–215 (1995), and de Beaulieu & Reille: Mededelingen Rijks Geologische Dienst, 52, 59–70 (1995). Full references are available on the PAGES website.

The article entitled "Southern Ocean Core MD 94–101" (p. 9) was co-authored by Monique Labracherie and Jean-Louis Turon, Département de Géologie et Océanographie (DGO), CNRS URA 197, Université de Bordeaux I, France (labracherie@geocean.u-bordeaux.fr and turon@ geocean.u-bordeaux.fr) and Laurent Labeyrie CNRS-CEA, France (labeyrie@cfn.cnrs-gif.fr)

Announcement – call for contributions

In the next issue of PAGES News, due to appear in May 2000 we plan to highlight the PAGES-PANASH (Paleoclimates of the Northern and Southern Hemispheres) program, the associated PEP (Pole-Equator-Pole) transects, and inter-PEP connections. We encourage scientists with material relevant to the PEP transects to submit short research highlights (max 2 pages, 2 figures), program news (max 500 words), or workshop reports electronically by March 31 to: alverson@pages.unibe.ch. Detailed guidelines for publication in the PAGES Newsletter are available from our website *www.pages.unibe.ch/publications/newsletters.html.*

Past Global Changes and their Significance for the Future

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The most recent issue of Quaternary Science Reviews (Vol. 19, No. 1–5, pp. 1–480) is a special issue arising from the PAGES Open Science Meeting, held in 1998. This collection of papers is on the one hand, a comprehensive review of the state of the art in paleoenvironmental reconstruction. Moving beyond review and reconstruction however, the volume seeks to bring a wealth of paleoclimate information to the forefront of deliberations about modern environmental change and, indeed, future climate predictions.

The volume, which is also available as a hardbound book from Elsevier press, is guest edited by K. Alverson, F. Oldfield and R. Bradley and consists of 27 papers divided into five sections. The first section highlights a range of examples, given quantitative calibration and robust chronology, for local, regional and global paleoenvironmental reconstruction from individual proxy archives. The fact that climate change has shown both global coherence as well as highly differentiated regional expression, implies that individual proxy records must be placed within a robust spatial framework. Thus, the second section of the volume presents recent results from the coordinated PAGES Pole-Equator-Pole (PEP) transects based on multiple sites and multiple proxies. In the third section of the volume, the spatial mosaic provided by the PEP transects is complemented by a detailed look at the temporal evolution of the climate system associated with stadial/interstadial transitions which, together with the glacial cycle itself, comprise some of the most dramatic events to have occurred in the last half a million years. The fourth section of the volume concentrates on paleoclimate modeling, and comparison of models with paleoclimate data syntheses, an important test for models currently being used for climate prediction purposes.

Finally, in light of the fact that recent past climatic and environmental change, and indeed future change, are intricately interwoven with human society, the volume closes with a set of papers which give an overview of the late Holocene. The papers in this final section demonstrate that the climate of the last few millennia has fluctuated far beyond the range of variability captured by recent instrumental records. The potential human consequences of such natural variability are staggering. Indeed, the final paper hints at a concept of 'vulnerability trajectories', specific to given regions and societies, but each reflecting the interplay between climate variability and human development. Creating a deeper understanding of this interplay on the basis of evidence from the past comprises a further challenge for PAGES.

For more information on this publication, including the full table of contents and ordering information, see http://www.pages.unibe.ch/publications/reports00.html.