Modeling and Data Syntheses of Past Climates

Paleoclimate Modelling Intercomparison Project Phase II Workshop; Estes Park, Colorado, 15–19 September 2008

PAGE 93

The Paleoclimate Modelling Intercomparison Project (PMIP) is a long-standing initiative that provides coordinated paleoclimate modeling and data activities to facilitate valuable discoveries on the mechanisms of climate change. At its recent workshop in Colorado, sponsored by the U.S. National Science Foundation, the U.S. National Oceanic and Atmospheric Administration, and International Geosphere-Biosphere Program Past Global Changes, more than 70 scientists met to review past successes and discuss future efforts. Participants included atmospheric scientists, oceanographers, and paleoclimatologists from the data and modeling communities.

The climate from the mid-Holocene (~6000 years before present) and the Last Glacial Maximum (LGM; ~21,000 years before present) have been the focus of PMIP and are recognized as benchmark periods for climate models. For the past 5 years, 12 modeling groups have participated in simulations of these time periods with ocean-atmosphere or ocean-atmosphere-vegetation models (PMIP 2). Several hundred scientists were involved in running and analyzing the simulations, in producing paleo data sets for model evaluation, and in model-model and model-data comparisons. The LGM simulation was conceived as an experiment to examine the climate response to the presence of large ice sheets and low greenhouse gas concentrations, and the mid-Holocene simulation was designed to examine the climate response to a change in the distribution of incoming solar radiation caused by known changes in orbital forcing.

PMIP results presented at the workshop demonstrated that models that are capable of adequately reproducing modern and historical climates nevertheless can fail to reproduce observed changes in the past. For example, PMIP 2 models give similar and realistic simulations of modern Atlantic Ocean thermohaline circulation, but some give much different realizations for thermohaline circulation during the LGM in comparison with interpretations from paleoclimate data proxies. New results were also shown that improved on the methods of reconstructing climate parameters from paleoclimate proxies. These new strategies, which use pollen assemblages with inverse vegetation modeling that accounts for the known carbon dioxide decrease at LGM, have resulted in much better agreement between simulated and observed LGM winter cooling over western Europe and the Mediterranean area.

PMIP results have been used extensively in the last two Intergovernmental Panel on Climate Change assessments. An outcome of the workshop was the identification of key climate targets for PMIP 3 model simulations and data synthesis that can help reduce uncertainties in future climate projections. It was proposed that a very high priority for international modeling groups participating in Phase 5 of the Coupled Model Intercomparison Project (CMIP-5) of the World Climate Research Program's Working Group on Coupled Modelling (WGCM) should be to perform simulations for mid-Holocene and LGM with the same model components and at the same resolution as the projections of future climate. The workshop participants identified several additional coordinated experiments of high priority, including modeling the last millennium, the mid-Pliocene (~3 million years ago), and the last interglacial (~125,000 years ago). Working groups have also been established for studying the transient behavior of the Earth system of the past 21,000 years. PMIP 3 will continue to provide a forum for modelers and observationalists to discuss experiments for other past time periods.

For further information on the meeting, please visit http://www.cgd.ucar.edu/ccr/paleo/pmip2/workshop.html.

—Bette L. Otto-Bliesner, National Center for Atmospheric Research, Boulder, Colo.; E-mail: ottobli@ucar.edu; Sylvie Joussaume and Pascale Braconnot, Laboratoire des Sciences du Climat et l'Environnement, Gif-sur-Yvette, France; Sandy P. Harrison, University of Bristol, Bristol, UK; and Ayako Abe-Ouchi, University of Tokyo, Tokyo, Japan

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Carbon and Nutrient Cycling in the Southwestern Atlantic Ocean

State of Knowledge on the Southwestern Atlantic Ocean Margin; Montevideo, Uruguay, 16–22 November 2008

PAGE 93

The southwestern Atlantic Ocean margin (SWAOM), along the coasts of southern Brazil, Uruguay, and Argentina, is one of the most productive regions of the world ocean and is believed to be the largest carbon dioxide (CO_2) sink in the Atlantic Ocean. The region is dominated by two major boundary currents (the Brazil and the Malvinas), which impinge on a broad continental shelf along southeastern South America and converge offshore of the Rio de la Plata, the largest source of freshwater to the South Atlantic Ocean. Scientific knowledge about this region is based on past research focused generally on processes within the confines of the waters of the individual countries and from single disciplines. However, the complex interactions of physical, chemical, and biological processes that control the transport and production in time and space across this region require multidisciplinary investigation and international cooperation. This led a group of more than 40 marine scientists from these countries and the United States to convene a workshop to review what is known about this region, to suggest how future multidisciplinary research might be organized, and to foster regional and North-South scientific cooperation.

The workshop was organized around 2 days of plenary talks reviewing the state of knowledge of this region, mainly discipline focused, followed by 3 days of discussions in breakout groups focused on multidisciplinary topics. These discussions converged on the coupling of micronutrients and macronutrients, with biomass and CO_2 uptake in this region as an overarching focus for future research on this ocean margin.

Workshop participants agreed that the following seven hypotheses serve to guide future research: (1) The extensive region of high productivity exists because unique conditions combine macronutrients from the Southern Ocean with iron and other micronutrients from multiple regional sources. (2) Significant contributions of iron come from multiple sources, including entrainment from sediments as subantarctic waters pass around the Malvinas Islands; upwelling associated with shelf-break fronts; mixing on the shelf off Patagonia; the Rio de la Plata and other surface runoffs; submarine groundwater discharge; and atmospheric deposition. (3) The SWAOM is dominated by net carbon fixation. (4) Net fixed carbon on the shelf is exported to the open ocean at the Subtropical Shelf Front (STSF) and at the Brazil/Malvinas convergence zone (BMCZ), where northern and southern shelf waters, driven by the Brazil and Malvinas currents, converge. (5) In the coastal region dominated by the Rio de la Plata, submarine groundwater discharge is a more dominant source of macronutrients and micronutrients, carbon, and land-derived tracers than are riverine inputs. (6) For the northern Patagonian gulfs region, coastal inputs of micronutrients converge with macronutrient sources on the shelf to support the highly productive area of the margin. (7) The southern Patagonian region is influenced by additional nutrient inputs associated with