Preface

Determining safe levels of greenhouse gases constitutes one of the grand challenge problems in climate change studies. Over the past decade or so, coupled climate models have become increasingly sophisticated in terms of modeling various non-linear feedbacks of the coupled ocean-land-atmosphere-sea ice climate system. The response of climate due to natural and human-induced factors is now being explored using carefully designed sensitivity studies under various emission scenarios. The task of performing century-long runs using several ensembles requires considerable attention to code optimization and related computational science issues. The open software aspect of these community climate models has been important for a broad range of researchers who can employ state-of-the-art modeling capabilities for their investigations.

The United States Climate Change Science Program (CCSP) calls for continued research to improve the science of climate prediction as well as enhancing climate modeling systems. Access to high-end climate simulation capabilities and supercomputers is imperative. DOE continues to be a frontrunner in the field through its sponsorship of the Community Climate System Model(CCSM) activity. The contributions of ocean sea-ice model development activity at Los Alamos National Laboratory, the climate change simulation and analysis activity of Dr. Warren Washington and his group at NCAR and at the Program for Coupled Model Diagnosis and Intercomparison (PCMDI) at Lawrence Livermore National Lab, along with efforts at Oak Ridge National Lab, Argonne National Lab, and Lawrence Berkeley Lab are testimony to the fruitful DOE-NSF CCSM partnership. The large number of scientists incorporating the CCSM in their research compounds the investment of DOE and other federal agencies in climate model development.

This special issue focuses on the parallel algorithms and software practices required to support climate models on a variety of high performance parallel computers. Several of the papers reported here are a result of the Scientific Discovery through Advanced Computing (SciDAC) partnership within DOE between Office of Advanced Scientific Computing Research (ASCR) and BER. SciDAC has advanced the field of climate science by harvesting the expertise in interdisciplinary fields of climate science, software engineering, computer and computational sciences. The CCSM code incorporates many of the developments reported here. For example, the software that provides the "glue" to couple the ocean and atmosphere model components of CCSM is described. Also presented are special adaptations of the algorithms and parallel decompositions that take advantage of the performance of modern distributed memory supercomputers while maintaining a portable, single source code.

In the future it will be necessary to expand the scientific scope of climate models by adding new physical, chemical and biological processes. The next generation climate models will simulate interactions with the carbon cycle, aerosols, atmospheric chemistry, biogeochemistry, and dynamic vegetation. The software engineering approaches described in this special issue report impressive performance results of current climate models on the most advanced parallel computing platforms and thus help prepare the research community as it enters the next phase of model development towards high fidelity, high performance earth system models.

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