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Special Issue: APEC Cooperation for Earthquake Simulation

ACES is a multi-lateral grand challenge science research cooperation of APEC (the Asia Pacific Economic Cooperation). The project is sponsored by Australia, China, Japan and USA and involves leading international earthquake simulation and prediction research groups. ACES aims to develop realistic supercomputer simulation models for the complete earthquake generation process, thus providing a "virtual laboratory" to probe earthquake behavior. This capability will provide a powerful means to study the earthquake cycle, and hence, offers a new opportunity to gain an understanding of the earthquake nucleation process and precursory phenomena. The project represents a grand scientific challenge because of the complexity of phenomena and range of scales from microscopic to global involved in the earthquake generation process. It is a coordinated international effort linking complementary nationally based programs, centers and research teams. Further detail about ACES can be found at http://www.quakes.uq.edu.au/ACES/.

This special issue grew out of several ACES workshops—especially one held October 15–20 2000 at Hakone and Tokyo, Japan. The issue describes the role of emerging distributed system technology in Earthquake Science with the paper "Grid Services for Earthquake Science". The majority of the papers come from the Japanese team from the GeoFEM project. This is a major initiative to advance this field—partly motivated by the enormous damage created by the January 16, 1995 Kobe, Japan earthquake, which although only a magnitude 6.9 event, produced an estimated $200 billion loss. GeoFEM is the software infrastructure for the earth science component of a project started in 1997 by the Science and Technology Agency of Japan. The flagship of this effort is a 40 teraflop parallel supercomputer—the Earth Simulator. The performance of GeoFEM on several architectures including those related to the Earth Simulator is studied in "Optimization of GeoFEM for High Performance Sequential Computer Architectures". Most of the papers describe the software, mesh generation, and sparse matrix parallel algorithms used in GeoFEM which is designed to support general finite element simulations. This work is elaborated in "Parallel Iterative Solvers for Unstructured Grids using Directive/MPI Hybrid Programming Model for GeoFEM Platform on SMP Cluster Architectures", "Finite Element Modeling of Multibody Contact and Its Application to Active Faults", "Effective Adaptation Technique for Hexahedral Mesh", "Thermal Convection Analysis in a Rotating Shell by a Parallel FEM—Development of a Thermal–Hydraulic Subsystem of GeoFEM" and "Parallel Multilevel Iterative Linear Solvers with Unstructured Adaptive Grids for Simulations in Earth Science". One paper co-authored by the GeoFEM and Australian groups, "Parallel Simulation System for Earthquake Generation: Fault Analysis Modules and Parallel Coupling Analysis", studies not only a variety of finite element simulations but also the coupling of codes. GeoFEM represented the coarse scale model providing the background for a fine scale particle simulation code LSMearth.

The final GeoFEM paper “Parallel visualization of gigabyte datasets in GeoFEM” describes the visualization system built for the Earth Simulator project.

Unfortunately the US effort has not benefited from the large scale (Japanese) government initiative in Earthquake simulation. The only US Earth Science paper, “Parallelization of a Large-Scale Computational Earthquake Simulation Program” describes the successful parallelization of two codes used by a group led by John Rundle. The Virtual California code studied here is a particularly interesting Green’s function approach.

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