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Computational Earthquake Physics
PART II: Introduction

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Large earthquakes are catastrophic natural disasters which can potentially cause massive casualties and huge property loss. In the beginning of the new century, large earthquakes violently struck the world, especially in the Asia-Pacific region. Nearly 300,000 people were killed by the magnitude 9.0 Northern Sumatra Earthquake and tsunami, and the magnitude 7.8 Pakistan earthquake of October 8th, 2005, which resulted in 90,000 deaths. In the meantime, there has been great progress in computational earthquake physics. New understanding of earthquake processes, numerous ideas on earthquake dynamics and complexity, next-generation numerical models and methods, higher performance supercomputers, and new data and analysis methods are emerging. These include the SERVO grid and iSERVO, LSM (Lattice Solid particle simulation Model); Australian Computational Earth Systems Simulator (ACcESS); Japan's Earth Simulator; GeoFEM; GeoFEST; QuakeSim; LURR (Load-Unload Response Ratio); earthquake Critical Point Hypothesis, PI (Pattern Informatics), Critical Sensitivity, friction laws and seismicity, episodic tremor, the Virtual California model, interaction between faults and the interactions between earthquakes, ROC (Receiver Operating Characteristic), SMDM (Statistical Mesoscopic Damage Mechanics) and MFEM (Multi-scale Finite-Element Model), among others.

In 2005, the world lost a seminal figure in the study of earthquakes, Professor Keiiti Aki. One of the world's leading seismologists and an important contributor to ACES, Professor Aki had planned to deliver an important lecture at the 2005

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European Geophysical Union meeting titled ''Opening of a New Era for Earthquake Prediction Research'' shortly before his death. In the abstract to his lecture Professor Aki states: ''The Hagiwara symposium ... held at the Sapporo IUGG in 2003...opened a new era for the earthquake prediction research. We now find, however, a growing recognition among earthquake scientists…that modeling is as important as monitoring for a healthy development of earthquake prediction research as a branch of Physical Science.'' Many of the results to which Professor Aki refers represent the outcome of ACES-related research and activities, and these ideas will be presented in this volume.

The APEC Cooperation for Earthquake Simulation (**ACES**) [1], was endorsed by APEC (Asia-Pacific Economic Cooperation) in 1997. The inaugural workshop, the second and third workshops of ACES were held in 1999, 2000 and 2002, respectively [2–5]. During the week of July 9–14, 2004, China hosted the 4th ACES workshop [6,7] in Beijing. The 4th ACES Workshop was a milestone for ACES as unanimous agreement was reached for the follow-on to ACES, the ACES-iSERVO [8] International Institute (International Solid Earth Research Virtual Observatory Institute). A colloquium on iSERVO was held at the 4th ACES Workshop leading to broad endorsement for establishment of the ACES-iSERVO institute by the international group of over 100 scientists in attendance. The subsequent signing of a formal agreement to establish the institute will initiate a frontier international research institute on simulating the solid earth. The institute's focus will be development of predictive capabilities for solid earth phenomena via simulation and breakthrough science using the computational simulation capabilities aimed at understanding solid earth system complexity.

This special issue is divided into two parts. The first part (Part I) was issued in Pure and Applied Geophysics, Vol. 163, No. 9, 2006, which incorporates Micro-scale Simulation, Macro-scale Simulation and Scaling Physics. The second part (Part II, this issue) incorporates Computational Environment and Algorithms, Data Assimilation and Understanding, Model Applications and iSERVO. Topics covered range from iSERVO and QuakeSim; implementing the international solid earth research virtual observatory by integrating computational grid and geographical information web services; LURR (Load-Unload Response Ratio) described in six papers involving this promising earthquake forecasting model; Pattern Informatics and Phase Dynamics and their applications, which was also a highlighted in the Workshop; computational algorithms, including continuum damage models and visualization and analysis of geophysical data sets; evolution of mantle material; the state vector approach; and assimilation of data such as geodetic data, GPS data, and seismicity and laboratory experimental data.

The 4th ACES workshop (2004) was planned by the ISB (International Science Board) of ACES. Consisting of Peter Mora, Xiang-chu Yin, Mitsuhiro Matsuura, Andrea Donnellan and Jean-Bernard Minster, and was hosted by the Institute of Earthquake Science, China Earthquake Administration and LNM (State Key

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