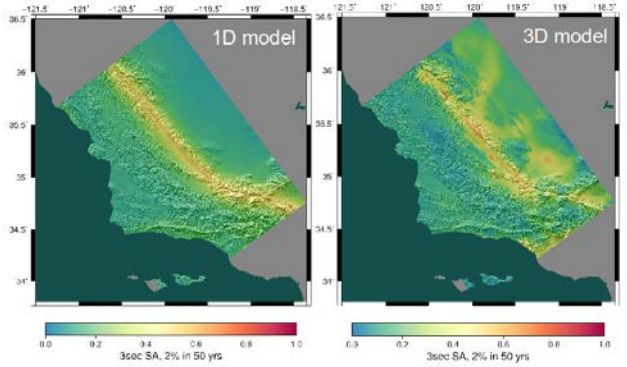
BLUE WATERS
SUSTAINED PETASCALE COMPUTING

Allocation: NSF PRAC/6,600 Knh
PI: John Vidale (current PI)
Thomas Jordan (former PI)
University of Southern California
Geoscience

PHYSICS-BASED MODELING OF HIGH-FREQUENCY GROUND MOTIONS AND PROBABILISTIC SEISMIC HAZARD ANALYSIS

Research Challenge

The U.S. Geological Survey (USGS) currently uses empirical Probabilistic Seismic Hazard Analysis (PSHA) to promote seismic safety engineering and disaster preparedness across the United States, including California. SCEC's research goal is to develop physics-based seismic hazard models for California and elsewhere that are more accurate than the empirical USGS National Seismic Hazard Map Project standard models. The long-term goal is to extend physics-based PSHA across the full bandwidth needed for seismic building codes and other purposes.



Seismic hazard maps for Central California from CyberShake Study 17.3 (left) a simple 1D seismic velocity model and (right) a 3D seismic velocity model were used by the CyberShake deterministic wave propagation simulations.

Methods & Codes

SCEC researchers added improved physics into their high-performance earthquake wave propagation software and improved the software performance on both CPUs and GPUs. They performed the first 4-Hz nonlinear magnitude 7.7 earthquake simulation using 4,200 GPUs, as well as CyberShake Study 17.3 that applied the CyberShake PSHA computational method to Central California for the first time. They Increased their use of third-party libraries including ADIOS, HDF5, and PnetCDF to scale up the I/O performance.

Results & Impact

CyberShake simulations are under review for use in new Los Angeles urban seismic hazard maps under development by the USGS. These new maps are being considered for the National Earthquake Hazards Reduction Program, the American Society of Civil Engineers 7–10 Seismic Provisions, and for the Los Angeles City building codes. SCEC's sustained work on Blue Waters is transforming and modernizing earthquake science and engineering, and thus represents a major contribution to Strategic Goal 1 of the NSF 2014–2018 Strategic Plan which is "Transform the Frontiers of Science and Engineering."

Why Blue Waters

New earthquake simulations that model advanced physics at high resolution require increasing amounts of computational, memory, and storage resources. Computational demands continue to grow because the calculations are not yet at full-resolution, because not all important physics have yet been included, and because individual earthquake simulations do not "solve" a problem when run just once or twice. Great uncertainty remains in the ground motions expected in future earthquakes, and urban society will be safer when better seismic hazard information is available about these critical scientific and public safety challenges.