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Galileo Conference: Solid Earth and Geohazards in the Exascale Era

Preparing Seismic Applications for Exascale Using Scientific Workflows

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Scientific workflows are key to supporting the execution of large-scale simulations in many scientific domains, including solid earth geophysics. Although many different workflow tools exist, they share common features, enabling application developers to express their simulations as a series of linked software elements with data dependencies and then execute the workflow efficiently on distributed resources.

To illustrate the use and benefits of scientific workflows in seismic applications, this talk will describe CyberShake, a probabilistic seismic hazard analysis (PSHA) platform developed by the Southern California Earthquake Center (SCEC). CyberShake uses 3D physics-based wave propagation simulations with reciprocity to calculate ground motions for events from an earthquake rupture forecast (ERF). Typically, CyberShake considers over 500,000 events per site of interest, and then combines the individual ground motions with probabilities from the ERF to produce site-specific PSHA curves. CyberShake has integrated modules from another SCEC workflow application, the Broadband Platform (BBP), enabling CyberShake simulations to include both low-frequency deterministic and high-frequency stochastic content. This talk will discuss the workflow framework that CyberShake utilizes to support campaigns requiring hundreds of thousands of node-hours over months of wall clock time, and the lessons learned through 15 years of CyberShake simulations.

This talk will also reflect on the growth and development of workflow-based simulations and explore the challenges faced by applications in the exascale era, such as managing massive volumes of data, taking full advantage of exascale systems, and the emergence of AI-informed simulations. The talk will discuss ways in which workflow technologies may help mitigate these challenges as we move our science forward.