SESSION 42- Regional Physics-Based Ground Motion Simulations: A Tool for Seismic Hazard and Risk Assessment

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Session Description

Recent progress in understanding earthquake physics, together with advances in highperformance computing, has opened up new opportunities for physics-based, fault-tosite earthquake ground-motion simulations. These simulations, now capable of handling frequencies of direct engineering relevance, enable the representation of region-specific source, path, and site effects beyond the limitations of traditional empirical models. Realistic regional-scale simulations that explore different earthquake rupture scenarios provide critical insights into the regional distribution and site-specific intensity of shaking, as well as the associated uncertainties for future large earthquakes. They are increasingly being used to enhance seismic hazard estimates, deepen our understanding of earthquake processes, and inform risk assessments of the built environment.

This session will highlight state-of-the-art methodologies and applications of physicsbased simulations, including their integration into ergodic and non-ergodic groundmotion models, the development of hybrid models that combine empirical and simulated datasets, and the incorporation of new predictive variables such as nearsource metrics. We invite contributions on kinematic and dynamic rupture modeling, wave propagation through multi-scale 3D velocity structures with linear and non-linear properties, and case studies demonstrating how simulations provide insight into the interaction of source, path, and site effects.

We also welcome work on the validation of simulated ground motions against recorded data, strategies for quantifying uncertainties in 3D velocity models, and the

characterization of inter- and intra-event variabilities. Presentations on the use of simulations in fragility and vulnerability modeling, urban seismic risk assessment, and the development of non-ergodic hazard models are strongly encouraged. Finally, we seek contributions advancing computational methods, including approaches based on Artificial Intelligence and Machine Learning, strategies for large-scale and near-realtime simulations, and efforts on the creation of accessible datasets of validated simulated ground motions.

By bringing together diverse perspectives from seismology and earthquake engineering, this session aims to demonstrate the transformative role of physics-based ground-motion simulations in bridging fundamental science with applied seismic hazard and risk assessment.