Assessing Seismic Hazard by Simulating Scenario Earthquakes and Ground Motion: A Case Study in North China

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Abstract: Seismic shaking is one of major hazards caused by large, damaging earthquakes. Because of limited instrumental recordings, numerical simulations of ground motions from scenario earthquakes on active faults within realistic geologic structure can provide critical estimates of seismic shaking amplitude and duration from potential earthquakes, in particular near earthquake faults.Traditionally, ground motion simulations have been mainly using kinematic source models, in which rupture propagation and slip distribution on earthquake faults are prescribed, which make it very difficult for kinematic models to capture rupture complexities observed in large earthquakes that can impact near-field ground motion significantly. Recent efforts are made to use dynamic rupture models in ground motion simulations to incorporate more physics and to capture realistic complexities in earthquake sources [Andrews and Barall, 2011]. In this study, we use a dynamic finite element method [Duan and Oglesby, 2006; Duan, 2010, 2012] to simulate dynamic ruptures of scenario earthquakes on a recently identified 160-km-long seismic gap along the Tianjin-Hejing-Cixian (THC) fault [Yin et al., 2014] and seismic wave propagation in the North China basin, to assess ground shaking hazards in the area from potential earthquakes on the seismic gap. We find that earthquake source processes and 3-D basin structure play important roles in ground motion amplitude and duration [Duan et al., 2017; Liu and Duan, 2018]. Combination of rupture directivity and 3-D basin structure can result in large-amplitude (>1 m/s) ground shaking near the fault. Sedimentary basins can amplify and elongate seismic shaking. In particular, a deep and closed Quaternary basin between Beijing and Tianjin can lead to ground shaking of tens of cm/s for more than 1 min.Ground shaking at the newly built Beijng Daxing International Airport is relatively weak (< 0.1 m/s)from scenario earthquakes on this seismic gap.

Key words: scenario earthquakes, ground motion simulation, dynamic rupture model, seismic hazard, North China basin

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