Relaxing segmentation on the Wasatch fault zone: impact on seismic hazard

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The Wasatch fault zone (WFZ) is one of the most studied normal fault systems in the world and one of the most hazardous in the United States as it has paleoseismic evidence of repeated Holocene surface-faulting earthquakes and occurs within the densely urbanized Wasatch Front region. Here, we develop an earthquake rupture forecast for the WFZ that quantifies the 50-year probability of all potentially damaging earthquakes above M<sub>w</sub> 6.2. Our goal is to evaluate the impact that models of fault segmentation (i.e., hard limits on rupture extent) have on seismic hazard. We evaluate the long-term rate of ruptures on the WFZ, adapt standard inverse theory used in the Uniform California Earthquake Rupture Forecast 3, and implement a segmentation constraint where ruptures that cross primary structural complexities are penalized. Penalized ruptures have low rates or are removed from the inversion. We develop and test three segmentation models, including (1) a segmented model in which ruptures are confined to individual segments, (2) a penalized model where some multi-segment ruptures are allowed, and (3) an unsegmented model in which all ruptures are allowed, and none are penalized. Our results show that mean seismic hazard is highest in the segmented model because of more frequent moderate-magnitude (M<sub>w</sub> 6.2–6.8) ruptures and lowest in the unsegmented models. We evaluate the change in hazard curves and maps from these segmentation models, test how other parameters such as slip rate and magnitude-scaling relations affect our results and conclude that segmentation exerts a primary control on seismic hazard. Our study demonstrates the need for additional geologic observations of prehistoric rupture extent as well as methods to include this information in hazard assessments.