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EARTHQUAKES ON COMPLEX FAULTS: DYNAMIC MODELS OF RECORDED GROUND MOTION

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TECHNICAL ABSTRACT

The September 20, 1999 M7.6 Chi-Chi (Taiwan) earthquake produced enough near-source seismic data to verify many theoretical predictions of the effects of fault geometry on the physics of the earthquake process. These effects include increased motion on the hanging wall (peaked at the fault trace), a transition from thrust to significant left-lateral slip as one proceeds northward on the fault, and a mismatch between the near-field and far-field estimates of faulting style, energy, and apparent stress. Through rigorous 3-D dynamic models of this earthquake, all of these features can be seen to be robust consequences of the three-dimensional, asymmetric fault geometry and its angle with the free surface of the earth. Through further analysis, the strike-slip component of motion near the fault trace is seen to be a combination of dynamic and static effects. Finally, the simulations reveal that dynamic overshoot is a much larger effect for dip-slip faults than for otherwise identical vertical faults. The results emphasize the necessity of rigorous models that correctly account for both the effects of fault geometry and dynamic waves in the rupture and slip processes. The results of this study imply that for dipping faults that intersect the earth's surface, many important features of the ground motion distribution are controlled by the fault geometry, and in principle might be predicted ahead of time.