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The role of rupture dynamics and style of faulting on regional pattern of coseismic landslides

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Earthquakes have long been recognized as one of the main triggers for landslides across the globe as well as one of the driving engines behind the creation of mountainous topography. High-magnitude earthquakes in mountains terrain can produce clusters of several hundreds to thousands landslides in a very short period of time. Despite longstanding research on landsliding associated with earthquakes, the role of different types and geometries of faults in coseismic landsliding and their control on the spatial distribution of landslides are not fully understood. Although far less enquiry has addressed the role of hanging and foot walls of faults and the significance of coseismic fault slips on landslide intensity, the widely accepted theory is that the number and areal extent of landslides decrease systematically with increasing distance from coseismic faults and epicenters. Recently, dynamic rupture simulations demonstrate, however, that, for the same initial stress magnitude, differences in fault types and geometries cause different magnitudes of fault and ground motions. Here, we compiled the documented complete event-based inventories of coseismic landslides triggered by individual earthquakes to see if, on a global scale, landslide number is a function of faulting mechanism and fault dip angle. To investigate the role of rupture dynamics on the regional distribution of coseismic landslides and to examine if change in faulting style along strike influences landslide distribution and intensity, we focused on the 2008 Wenchuan (Mw 7.9) earthquake-struck region where two types of faulting mechanisms occurred and induced extreme coseismic landsliding over a broad area. We found that, the spatial distribution of coseismic landslides is conspicuously related to the characteristics and dynamics of coseismic rupturing. That is, the intensity and aerial coverage of coseismic landsliding were higher in the southwest, where predominantly reverse faulting occurred on shallowly dipping fault segments, but they respectively significantly decreased and narrowed down toward the northwest, where fault slips changed progressively to predominantly dextral faulting on steeper fault segments. We conclude that the spatial distribution of coseismic landslides was influenced by fault geometry, whereby the coseismic landslide density varied with change in fault type, coseismic slip rate and stress rotations.