Exploring Subduction Zone Earthquake Rupture

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Subduction zone earthquakes generate significant amounts of moment in great earthquakes, such as the 2004 Mw 9.0 Sumatra-Andaman event. In addition, events such as these can have tragic results, as ground shaking and tsunami can result in large numbers of casualties. We need to increase our understanding of subduction zone earthquake processes and the important tectonic conditions that can lead to the devastating events. Some of our research has explored the rupture characteristics of subduction zone earthquakes, both large and small magnitude, to understand variable rupture and tsunami earthquake occurrence. For example, tsunami earthquakes such as the 1992 Nicaragua event can be very devastating, and models suggest shallow rupture (up to the trench in some cases) though low-rigidity materials can produce the observed tsunami data. Using seismic waveforms obtained through IRIS, we have examined rupture processes of hundreds of earthquakes in 14 global subduction zones to find a depth-dependent behavior of rupture characteristics. These results, summarized below, suggest a depth dependence of frictional properties along the megathrust, which may impact tsunami earthquake generation. Indeed, these results suggest heterogeneous conditions along the megathrust, but that shallow portions of the fault may contain patches of conditionally stable material, as suggested by tsunami models.