Geophysical Research Abstracts
Vol. 15, EGU2013-12194, 2013
EGU General Assembly 2013
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The Long Term Slip Deficit Budget and the Seismic Cycle.

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Estimates of spatially heterogeneous coupling between plates in subduction zones provide a basis for forecasting high slip in future events; strong coupling between earthquakes, producing rapid strain accumulation, should be correlated with high slip during the next earthquake. However, studies comparing coupling and slip do not show the expected correlation . We test the hypothesis that slip is governed, not only by coupling, but by the long term history of loading and slip on the fault; strongly coupled locations which have experienced large slip in recent earthquakes may have low slip-deficit, a measure of accumulated strain energy on the fault, despite their relatively high slip-deficit rate. Using reconstructions of slip in historical and recent earthquakes under the Mentawai Islands, W. Sumatra, we show that coupling is strongly correlated with slip accumulated over several events on the same segment rather than on any single earthquake. This observation is inconsistent with the idea of a characteristic earthquake and even of an earthquake cycle which together form the basis of of deterministic earthquake forecasting . Instead it suggests that slip-deficit is accumulated according to the plate convergence rate moderated by the strength of coupling and is relaxed heterogeneously during slip events which need show no repeatability either in time or in space; the slip deficit budget, at least for the Mentawai megathrust segment, needs balanced only over hundreds of years. This implies that slip-deficit estimated by reconstruction of slip and loading over long times, is necessary to understand the current state of stress on active faults.