A comparison between the great 1964 Alaska and 2004 Sumatra earthquake rupture models from the inversion of seismic, tsunami, and geodetic data

Gene Ichinose, Hong Kie Thio, and Paul Somerville, URS Pasadena, CA
Dan O'Connell, US Bureau of Reclamation, Denver, CO

Before the 2004 (M_w 9.3) Sumatra-Andaman Island earthquake there was little known about the range of source parameters from mega-thrust earthquakes. A detailed reexamination of the 1964 (M_w 9.2) Prince William Sound, Alaska earthquake improves our understanding of the rupture process and is more useful for realistic tsunami and ground motion simulations than completely stochastic methods. For the 1964 earthquake we develop a kinematic rupture model from the combined least squares inversion of WWSSN seismic body waves, CGS-NOAA tsunami tide gauge records, and regional geodetic leveling survey observations. We estimate a seismic moment of 4.3-6.2×10^{22} Nm (M_w 9.0-9.1), smaller than the previous long-period surface wave estimate of M_w 9.2. This is likely due to band-limiting circumstances like those that affected initial estimates of the true size of the 2004 Sumatra earthquake. The earthquake ruptured about 800 km from Valdez and Anchorage to Kodiak Island, Alaska along the Aleutian Trench dipping 6-12°. All slip occurred above 50 km depth and mostly < 15 km depth along the trench. The rupture duration was at least 300 sec. We identify 3 areas of significant moment release, near Montague Island, along the bend of the fault near the so-called "Kodiak Island asperity," about 300 km from the hypocenter and 100 sec after the origin time, and west of Kodiak Island about 800 km and 240 sec in separation. For the 2004 Sumatra earthquake we used satellite altimetry data of the open ocean tsunami to invert for a kinematic rupture model together with previous seismic inversion results. We compare the 1964 and 2004 earthquake rupture characteristics. The rupture models of the earthquakes appear similar up to 300 sec when the using comparable rise times (< 5 sec). Longer period solutions (from Tsunami and multiple CMT solutions) indicate that the 2004 Sumatra event is two to three times larger in area but not in slip.