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The 2004 Giant Sumatra Earthquake Source Model from Satellite Altimetry

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The satellite altimetry measurements of sea surface heights for the first-time captured the Indian Ocean tsunami generated from the December 2004 Sumatra earthquake. The analysis of the sea surface height disturbance suggests that the rupture of giant earthquake propagated at extremely slow speed, 0.7 km/sec, even in the early stage, at least 1200-km-long segment to the north along the northern Sunda Trench. The extremely slow rupture produces much long source duration of approximately 30 minutes, approximately four to ten times longer than source duration estimates (180-500 sec) from short-period seismic waves. The satellite altimetry data requires total seismic moment of 9.86 x 10^{22} Nm, making Mw 9.3. This estimate is approximately 2.5 times larger than the value (4.0 x 10^{22} Nm) from long period surface wave analysis but nearly the same as that from the ultra-long period normal mode study. The maximum amount of slip (~30 m) is identified in a region closest to the northern most Peninsula of the Sumatra Island in which a huge tsunami run-up height was observed. The extremely slow rupture and too long source duration suggests that the giant earthquake may be a so-called tsunami earthquake. The average dislocation around the epicenter, the southern end of the entire aftershock zone, is estimated to be approximately 16 m. As Stein and Okal have noted, fault segments to the south of the 2004 rupture zone, in which two M~9 class earthquakes occurred in 19th century, should be paid much attention.