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Pre-Shock Deformation and Source Process: The Case of the 2004 Great Sumatra Earthquake

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Theoretically, pre-shock deformation should have relation to the source process, but this needs the verification/falsification by real observational data. The occurrence of the December 26, 2004 great earthquake off the west coast of northern Sumatra, Indonesia, provides an unprecedented opportunity to test such a theory. We examined the pre-shock cumulative moment release in different segments of the earthquake fault of the great Indonesia earthquake using the earthquake catalogue of NEIC for the past 30 years. Earthquake fault zone is defined by the aftershock zone and is subdivided into three segments according to slip distribution: the Sumatra Segment, the Nicobar Segment, and the Andaman Segment. Scaling coefficients and curvature parameters are calculated to characterize the property of pre-shock moment release. Distribution of scaling coefficient is further obtained using a sliding window. It is observed that the Sumatra Segment which accommodates the nucleation point of the earthquake faulting is accompanied by significant AMR behavior, and the nucleation point of the great earthquake is close to the magnitude 7.6 earthquake occurred 2 years before. The Andaman Segment which accommodates the termination point of the earthquake rupture is accompanied by an intense pre-shock AMR segment, in connection to the segment with marginally significant pre-shock deceleration property. The Nicobar Segment with weaker slip is accompanied by weaker accelerating property or simply linear increase of moment release. The strong aftershock to the south of the great earthquake locates in the segment with significant AMR property. Should the AMR behavior be considered as one of the precursory changes before large earthquakes, this result provides an important hint to the analysis of seismic activity for the estimation of earthquake hazard.