THE 2007 SOUTH SUMATRA SEQUENCE

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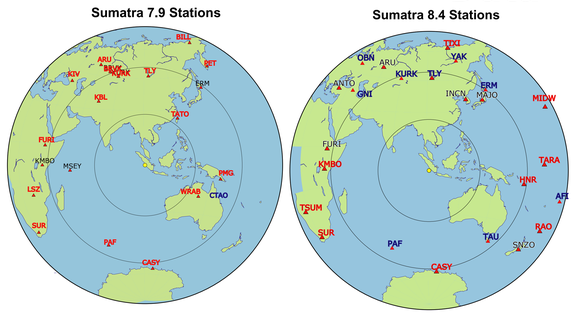
Introduction

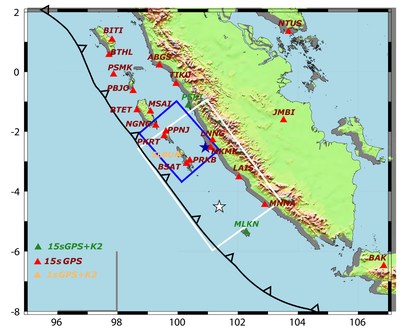
On September 12, 2007, a sequence of large earthquakes ruptured the megathrust offshore south Sumatra, starting with an Mw8.4 event and an Mw7.9 event 12 hours later. These earthquakes occurred within the area monitored by the Sumatra Geodetic Array (SuGAr), which provided exceptional records of near field ground displacements (with 15 to 1 sample per second sampling rate). These data were analyzed jointly with seismic waveforms to produce kinematic finite-source models of these ruptures.

The recent Sumatra sequence cover approximately the rupture area of the Mw~9.0 historical earthquake of 1833. Moreover this area of the subduction megathrust had been studied before for the inter-seismic strain accumulation (Chlieh et al., 2007). The existence of the former studies as well as the unique dataset availale, make the recent Sumatra earthquake sequence an excellent case study to understand more about the relation of interseismic coupling to coseismic rupture and rupture kinematics of subduction earthquakes.

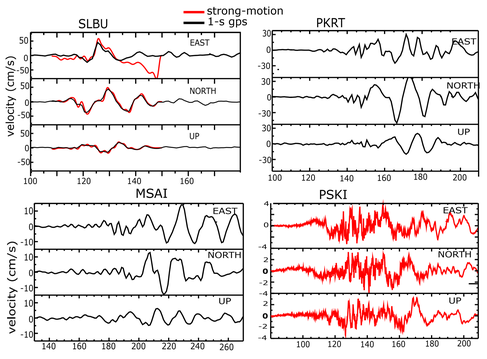
Data



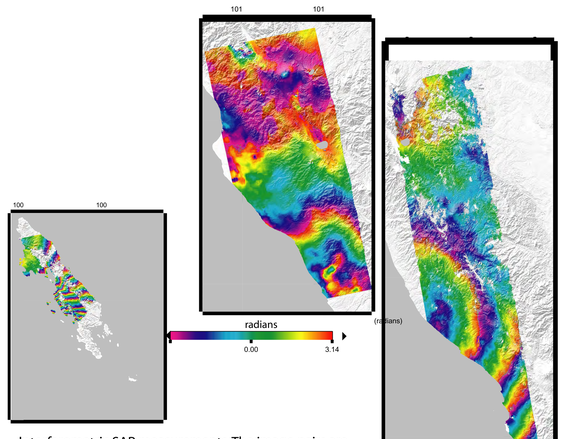
Map of teleseismic station locations used for modeling the M_w7.9 (left) and M_w8.4 (right) earthquakes. The stations of which both P and SH waveforms are used are shown in red, P only are shown in black and SH only are shown in blue.



Map of Sumatra Geodetic Array (SuGAr) stations in the vicinity of South Sumatra earthquake sequence. The hypocenter and the slip area of the M_w8.4 earthquake and M_w7.9 earthquake are shown in white and blue respectively.



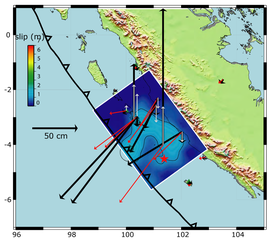
Recordings of near-field ground motions of M_w8.4 from 1-second GPS stations (black) and strong-motion instruments (red).

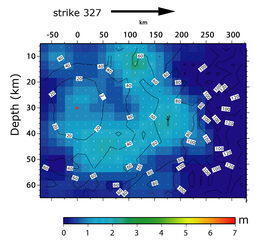


Interferometric SAR measurements. The image pairs are
Pagai Island (left): 6 Aug-21 Sept
North Bengkulu (center): 18 Aug-3 Oct
South Bengkulu (right): 29 Jan - 16 Sept
Each fringe corresponds to 11.8 cm of displacement towards the satellite (ascending , plunge 34.3)

Rupture kinematics of the 2007 South Sumatra Mw8.4 earthquake

Teleseismic Inversion



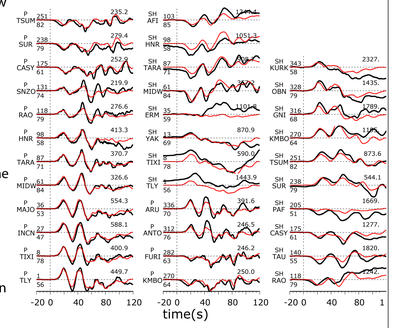


Teleseismic inversion results.

On top left figure, the map view of the slip on the fault and comparison of estimated GPS displacements (red horizontal, gray vertical) with GPS data (black) are shown.

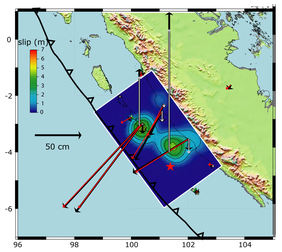
Slip on the fault plane with time contours are shown on the top right figure.

The bottom right figure shows the fits to the waveform , data in black and model fits in red

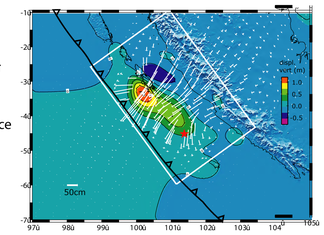


GPS Inversion

GPS modeling results. Figure on the top shows the map view of slip on the fault and fits (horizontal red, vertical gray) to the GPS data (black).

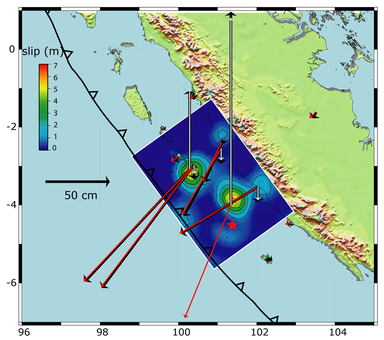


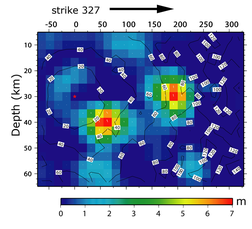
Bottom figure shows the estimated static field (color for vertical) and arrows for the horizontal) at the surface using the GPS inversion model at the top figure.



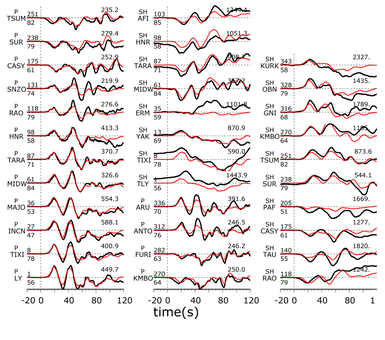
Joint (teleseismic and GPS) inversion

Map view of slip on the fault and fits (horizontal red, vertical gray) to the GPS data (black).

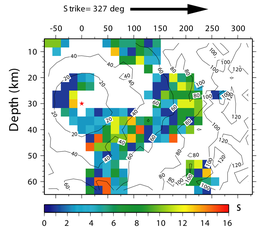




The slip on the fault plane with time contours.
Maximum slip is about 7m.



The fits to the teleseismic waveform , data in black and model fits in red



The rise times (the time it takes to reach the final slip) for the slip patches that slip more than 50 cm. Overall, the rise times seem to scale with slip with average of 1meters/second.