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Non linear inversion of the December 2004 tsunami source.

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The Sunday, December 26, 2004 giant earthquake, initiated at 00:58:53 (UTC) off the west coast of Northern Sumatra, has been one of the largest events in the human history and the largest in the era of modern digital recording. On the other side, the accompanying tsunami has been one of the worst events in human history as it caused more than 250,000 fatalities and unprecedented damages along the coasts of the whole Indian Ocean. The exceptional rupture extent and duration of the earthquake made difficult to retrieve the details of the whole source mechanism using classical inversion methods. Actually, several proposed source models differ in length, width, slip and rupture velocity. It has been shown in the literature that tsunami data, such as tide-gage records and run-up heights, can be useful to constrain some parameters of the causative earthquake source.

The aim of this work is to infer the slip distribution along the causative seismic fault. Moreover, we test the possibility of constraining the rupture velocity, as the sampling interval of the available tide-gage records are likely to be smaller than the total rupture time. We use a dataset constituted by 1) some selected tide-gage records distributed along the coast of the Indian Ocean and 2) satellite measured sea level anomalies collected on passing of the tsunami wave at the open sea, as well as 3) GPS measurements of the coseismic static displacement. We divide the fault into 8 parts along strike direction and into 2 parts along dip. For each of the resulting 16 subfaults, we calculate the corresponding numerical Green's functions, by integrating the shallow water equations through a finite difference method. We search for the slip distribution and rupture velocity simultaneously, by means of a simulated annealing technique, comparing the recorded and synthetic waveforms in the time domain. We perform preliminary synthetic tests to validate the method and to estimate the resolution.

Our results show that the slip distribution is strongly inhomogeneous with maximum values concentrated in two patches along the fault and centered at latitudes of about 4°N and 10°N respectively.