## The Great Sumatra-Andaman Earthquake of 26 December 2004

On-Line Supplemental Materials

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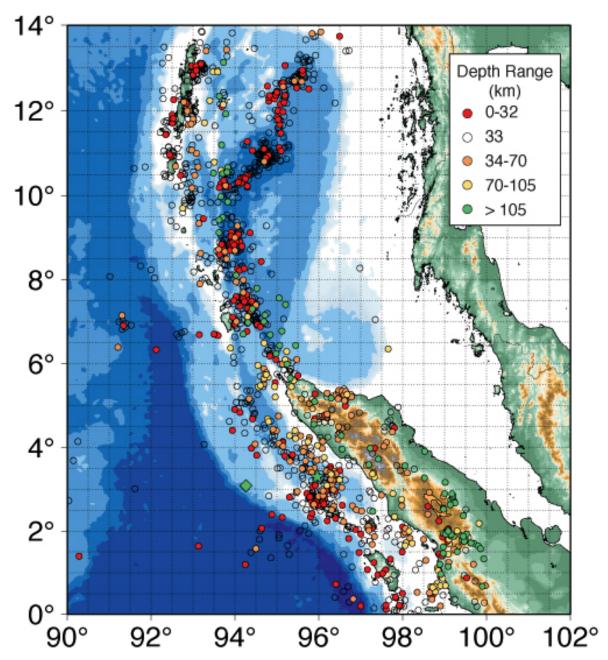


Fig. S1. Seismicity in the Preliminary Determination of Epicenters (PDE) catalog of the U.S. Geological Survey National Earthquake Information Center (NEIC) from 1965 to 25 December 2004 in the vicinity of the 2004 and 2005 mainshock rupture zones. Note the intense level of activity in the vicinity of the 2004 epicenter (green star) and in the back-arc rift/transform region of the Andaman Sea, and the comparatively low level of seismicity in the future rupture zone of the 2004 mainshock. The centroid location of the Harvard CMT solution for the 2004 event is shown by the green diamond.

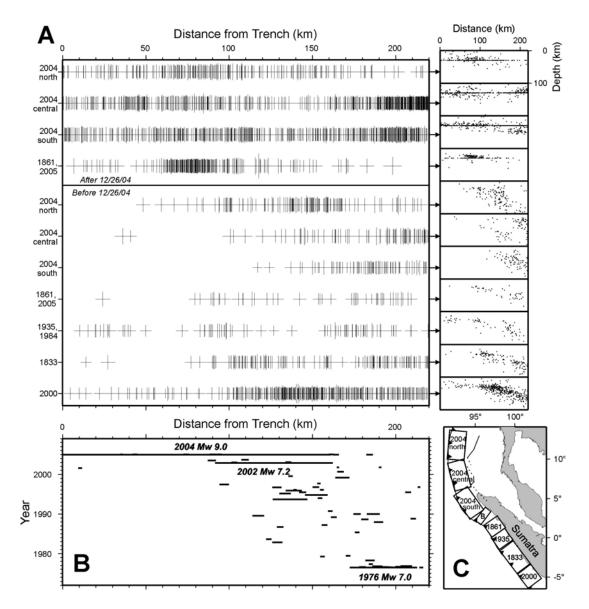


Fig. S2. Comparison of seismicity in three segments of the 2004 rupture zone with patterns in seismicity over the past 40 years. (A) Distribution of background seismicity (m<sub>b</sub>≥4) relative to the trench. Seismicity is divided into regions surrounding significant thrusting events (see map in C), separating patterns before and after the 2004 event. The lack of seismicity within 50–100 km of the trench preceding the 2004 event is similar to the lack of seismicity preceding the 2005 event in thre region of the 1861 great earthquake and ongoing reduced seismicity in the 1833 rupture zone. Relocated hypocenters [E. R. Engdahl, R. van der Hilst, R. Buland, *Bull. Seism. Soc. Am.* 88, 722 (1998), and subsequent updates] are used for the period preceding the 2004 event and preliminary NEIC locations are used for the period following the 2004 event. Right panel shows corresponding cross-sections of earthquake hypocenters for each region, taken perpendicular to the trench. (B) Progression of seismicity towards the trench over time in the region immediately surrounding the 2004 epicenter. Events are shown with size approximately equal to rupture size, assuming a circular rupture and stress drop of 10 MPa. Rupture of the 2004 megathrust is only plotted trenchward from the epicenter, an inference based on aftershock distribution and initial rupture modeling. (C) Map showing regions analyzed in A and B.

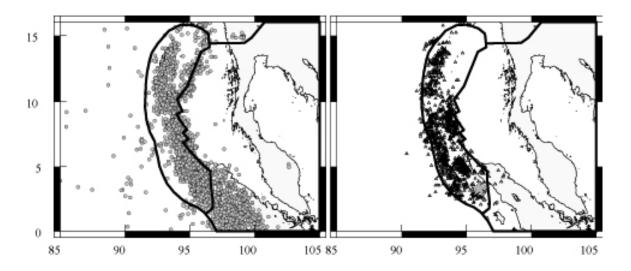


Fig. S3. Seismicity before the 26 December 2004 event from the USGS Preliminary Determination of Epicenters (PDE) listing and PDE seismicity between 26 December 2004 and 26 January 2005 (right panel). Heavy black line outlines the Andaman microplate. Note the lack of shallow seismicity along the trench before the 26 December 2004 event, which is largely filled in during the month after the event. Waveform analysis of some of the larger aftershocks confirms that they occur at shallow depth.

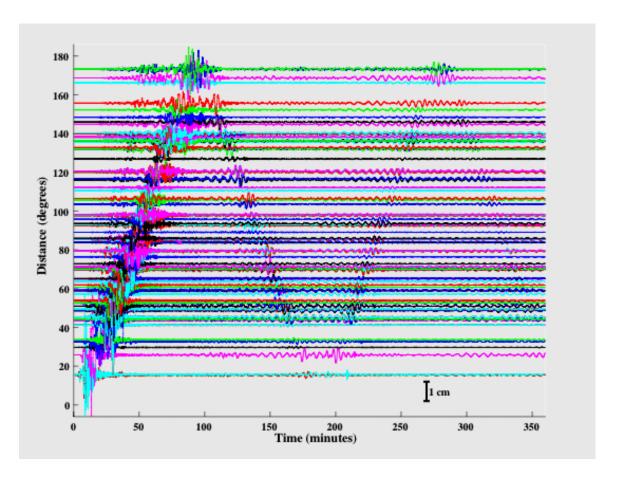


Fig. S4. Global vertical-component displacement records for the Sumatra-Andaman earthquake high-pass filtered at 120 s. The seismograms shown are from 109 Global Seismic Network (GSN) stations and were retrieved from the IRIS DMC. The time interval of 6 hours shows two global circuits of the Rayleigh waves. Note that displacements exceeded 1 cm worldwide.

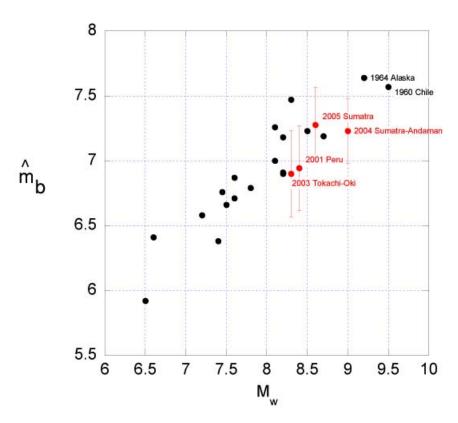


Fig. S5. Short-period magnitude measurements  $m_b^*$  versus  $M_w$  for large earthquakes. The estimates for several recent large events are shown in red. Note that the value of  $m_b^*$  for the 2004 Sumatra-Andaman event is comparable to that for events with lower  $M_w$ , and significantly lower than for the 1964 Alaska earthquake.

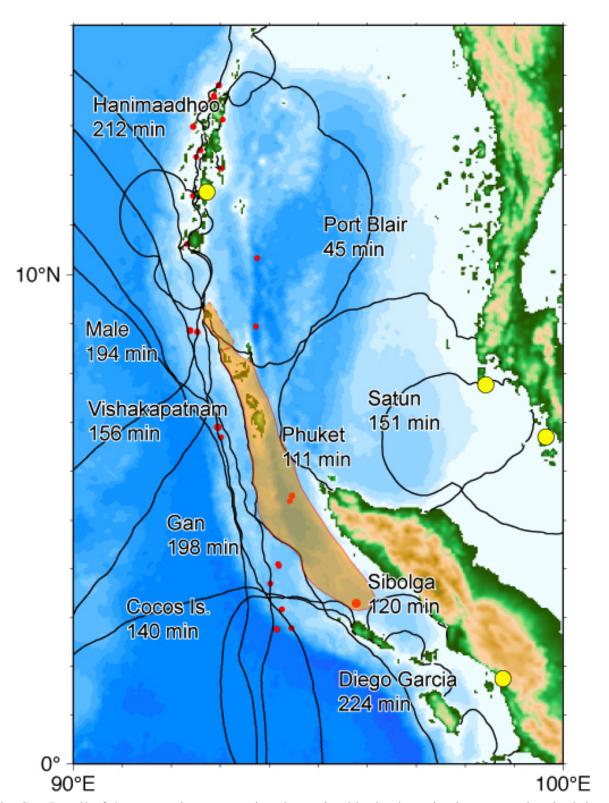


Fig. S6. Detail of the tsunami source region determined by back-projecting tsunami arrival times from positions around the Indian Ocean. The brown zone is the conservative (minimum) tsunami source region compatible with instantaneous excitation of the tsunami at the earthquake origin time.

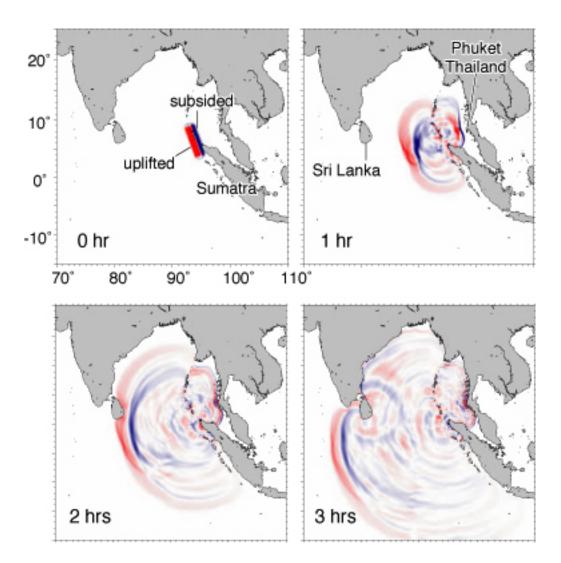


Fig. S7. Snapshots of modeled tsunami water surface motions as a function of time after the earthquake rupture initiated. Red regions show amplitude highs, blues amplitude lows. From the animation available on-line at <a href="http://staff.aist.go.jp/kenji.satake/animation.gif">http://staff.aist.go.jp/kenji.satake/animation.gif</a>.

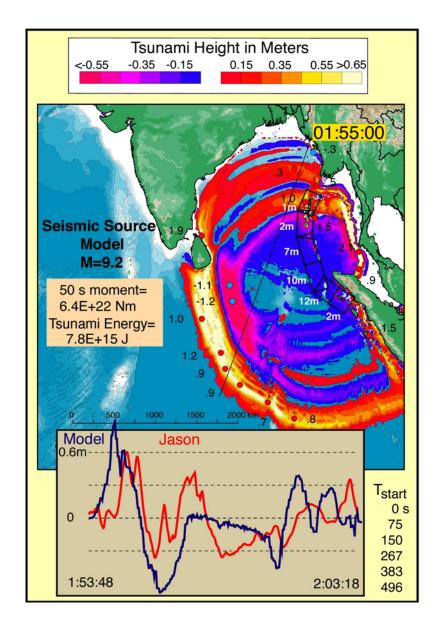


Fig. S8. Tsunami at a time of 1 hour 55 minutes after the rupture initiated, computed for the fast-slip component of the composite model, with fast slip in the southern portion of the rupture zone. A rise time of 50 s is assumed for the dislocation in the south, which propagates north along the fault at 2.5 km/s, with variable total slip on the four fault segments along Sumatra and the Nicobar Islands. Red colors in the map indicate positive ocean wave heights, while blue colors indicate negative wave heights. The numbers give open ocean wave amplitudes in m. *Et* is the tsunami wave energy in J. The straight line is the track of the Jason satellite over the source region at about this time (it spans about 10 minutes of actual transit time along the profile), and the predicted (blue) and observed (red) tsunami wave along the satellite track are shown in the inset at the bottom. Comparison with Fig. 7 in the text isolates the contribution from the slow-slip component along the northern portion of the rupture zone, which is needed to fit the broad ocean trough in the central Bay of Bengal two hours after the earthquake.

| 1       | 2.10 | 94.66 | 210      | 240       | 324      | 10        | 110  | 0                     |
|---------|------|-------|----------|-----------|----------|-----------|------|-----------------------|
| 2       | 3.63 | 93.55 | 210      | 240       | 330      | 10        | 110  | 105                   |
| 3       | 5.26 | 92.60 | 163      | 170       | 340      | 15        | 120  | 189                   |
| 4       | 6.64 | 92.10 | 163      | 170       | 340      | 15        | 120  | 270                   |
| 5       | 8.01 | 91.59 | 285      | 160       | 356      | 15        | 150  | 473                   |
| 6       | 10.6 | 91.41 | 285      | 160       | 5        | 15        | 150  | 853                   |
| Segment | lat  | lon   | Length   | Width     | strike   | dip       | rake | $T_{\text{start}}(s)$ |
|         |      |       | (km)     | (km)      |          |           |      |                       |
|         |      |       |          |           |          |           |      |                       |
|         |      | 1     | 2        | 50        | -        | -         |      |                       |
|         |      | 2     | 14       | 50        | -        | -         |      |                       |
|         |      | 3     | 10       | 50        | 10       | 3500      |      |                       |
|         |      | 4     | 10       | 50        | 10       | 3500      |      |                       |
|         |      | 5     | 0        | 50        | 17       | 3500      |      |                       |
|         |      | 6     | 0        | 50        | 5        | 3500      |      |                       |
|         |      |       | $S_1(m)$ | $Tr_1(s)$ | $S_2(m)$ | $Tr_2(s)$ |      |                       |

Table S1. Parameters of the six faults used in the composite tsunami model in Fig. 7. Latitude and Longitude refer to the southern up-dip corner of each fault at 2 km depth.  $S_1$  and  $S_2$  are the fast and slow slip components (meters) with rise times  $Tr_1$  and  $Tr_2$  respectively.  $T_{\text{start}}$  is the start time of rupture on each segment.

Quicktime (mpeg) Movies in separate files

Movie S1: Tsunami simulation for composite fast and slow slip model given below.

Movie S2: Tsunami simulation for 28 March 2005 event.