A comparison study of 2006 Java earthquake and other Tsunami earthquakes

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Abstract

We have revised our preliminary slip model of July 17 2006 Java earthquakes by combined inverting teleseismic body wave and long period surface waves. Our preferred solution has a smaller dip angle (6 deg.) and larger moment magnitude (7.9) than the solution of Global CMT. The earthquake initiated at a depth around 12 km and ruptured southeast for 160 sec with a speed of 1.0-1.2 km/sec, consistent with our preliminary estimation. After applying the same methodology to study the rupture processes of two previous "Tsunami" earthquakes, 1992 Nicaragua and 1994 Java earthquakes, we compare their slip distributions, relationship with sea floor heterogeneity, and relationship with seismicity (white dots, Engdahl et al, 1998).

Legend:

Red lines show synthetic seismograms; Black lines show data; Red contours show the fault slip in meter. Black contours show the thickness of water layer in km; Red dots: PDE aftershocks.

Motivation

Can we get a better estimation to the fault rupture in downdip direction?

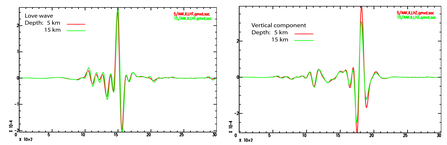
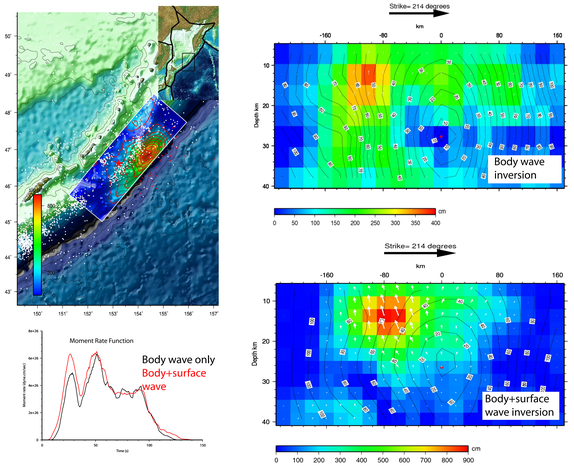
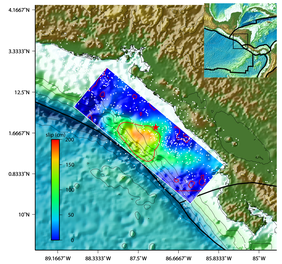


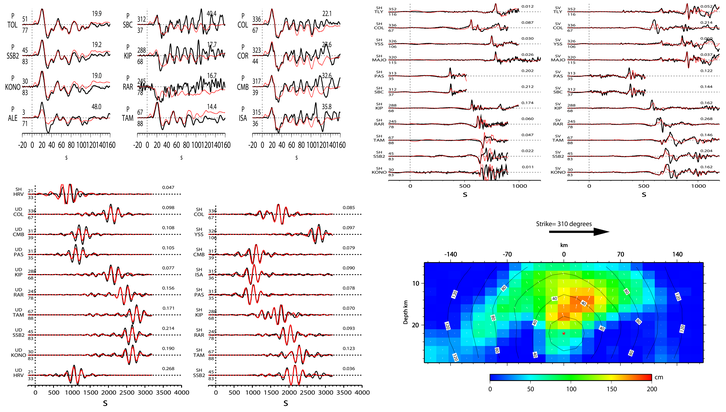
Figure 1. Comparison of normal modes synthetic seismograms at station AAK for point sources at depth of 5 km (red) and 15 km (green). The CMT solution of the 2006 JAVA earthquake was used. Note the obvious difference between long period Love and Rayleigh waves.

Example: 2006 Kuril island Earthquake



1992 Nicaragua Earthquake

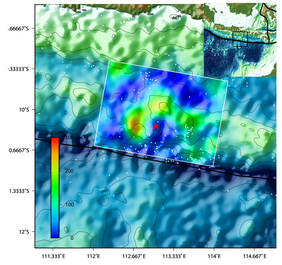




Basic information

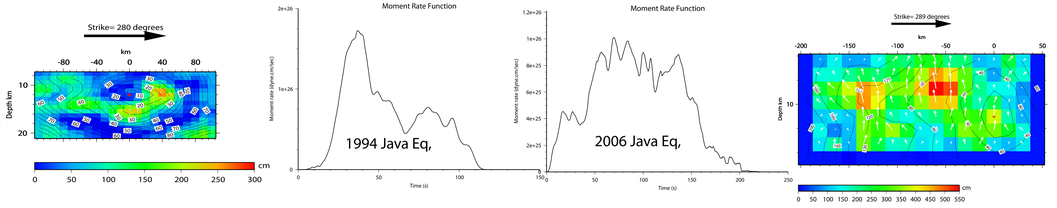
Strike	310.0 deg.
dip	11.5 deg.
Rake (ave.)	97.9 deg.
Rupture velocity (ave.)	1.1 km/sec
Seismic moment	6.1x10^{20} Nm
Mw	7.8
Rise time (ave)	14 sec

1994 Java Earthquake

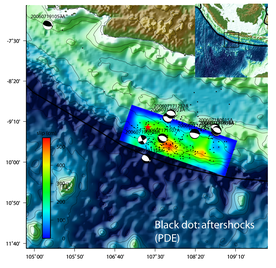


Basic information

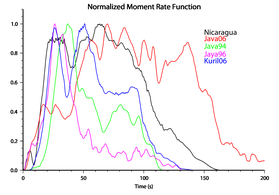
	1994 Java Eq.	2006 Java Eq.
Strike	280.0 deg.	289.0 deg
dip	5.0 deg.	6.0 deg.
Rake (ave.)	89.5 deg.	95.7 deg.
Rupture velocity (ave.)	1.8 km/sec	1.1 km/s
Seismic moment	7.4x10^{20} Nm	11.0x10^{20} Nm
Mw	7.84	7.95
Duration	114 sec	163-200 sec
Rise time (ave.)	13 sec	14 sec
Tsunami Height	4-13 m (Tshji et al., 1995)	5-21 m (*)



2006 Java Earthquake

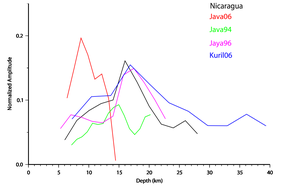


Moment rate functions



Comparison of normalized moment rate functions of 1992 Nicaragua (Nicaragua), 1994 Java (Java94), 1996 Jaya (Jaya96), 2006 Java (Java06), and 2006 Kuril island earthquake (Kuril06). The centroid depths of all of them are about 15 km, Harvard CMT (Dziewonski &Woodhouse,1983)

Moment rate versus depth



Comparison of moment release rate per km. Note that the centroid of 2006 Java earthquake is much shallower than other events.

Conclusions

We have analyzed the rupture processes of 2006 Java earthquake as well as 1992 Nicaragua, 1994 Java, and recent 2006 Kuril Island earthquakes. We find:

1. Inverted scalar moments of all these earthquakes are larger than corresponding solutions of Harvard CMT, probably due to the difference in dip angle, centroid depth, and half-duration. The slip distributions are generally consistent with previous results, e.g., (Kikuchi & Kanamori, 1995; Abercrombie et al, 2001)
2. In many aspects, the 2006 Java and 1992 Nicaragua earthquakes are belong to the same category though their centroid depths are quite different. In contrast, the 1994 Java earthquake, which had excited large local Tsunami, is closer to the category of the 2006 Kuril Island and 1996 Jaya (Biak) earthquakes.
3. All earthquakes, particularly 2006 Kuril Island earthquake, are apparently bounded in along strike directions by sea floor heterogeneities. The rupture of 1994 Java and 1992 Nicaragua earthquakes may associate with subducted sea mountain (Abercrombie et al, 2001) or high land (Figure in left) but there is no obvious evidence for 2006 Java earthquake.
4. Similar to other subduction zone earthquakes, few earthquakes occurred near high slip patches during interseismic or post-seismic periods. Three of four earthquakes showed here initiated at the seismicity zone at the downdip side of high slip patches. 1994 Java event is the only exception.

References

Abercrombie, R. E., et al. (2001), The 1994 Java tsunami earthquake: Slip over a subducting seamount, J. Geophys. Res.-Solid Earth, 106, 6595-6607.

Bird, P. (2003), An updated digital model of plate boundaries, Geochemistry Geophysics Geosystems, 4.

Dziewonski, A. M., and J. H. Woodhouse (1983), An Experiment In Systematic Study Of Global Seismicity - Centroid-Moment Tensor Solutions For 201 Moderate And Large Earthquakes Of 1981, Journal Of Geophysical Research, 88, 3247-3271.

Engdahl, E. R., et al. (1998), Global teleseismic earthquake relocation with improved travel times and procedures for depth determination, Bull. Seismol. Soc. Amer., 88, 722-743.

Kikuchi, M., and H. Kanamori (1995), Source Characteristics of the 1992 Nicaragua Tsunami Earthquake Inferred from Teleseismic Body Waves, Pure Appl. Geophys., 144, 441-453.

Tsuji, Y., et al. (1995), Field Survey Of The East Java Earthquake And Tsunami Of June 3, 1994, Pure Appl. Geophys., 144, 839-854.

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