Tsunami analysis of the 2004 Off Kii-Peninsula earthquake

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On 5 September 2004, the 2004 Off Kii-Peninsula earthquakes (Main shock: Mw=7.5, Foreshock: Mw=7.3 (JMA)) occurred and generated tsunami observed at the tide gauge and ocean bottom pressure gauge along the pacific coast of Japan. The mechanism of the main shock and slip distribution was estimated by the analysis of seismic waves and it was showed at web page (Yamanaka[2004]:http://www.eri.u-tokyo.ac.jp/sanchu/Seismo_Note/2004/EIC153.html,Yagi [2004]:http://iisee.kenken.go.jp/staff/yagi/eq/Japan20040905/new.html). In this study, we first carried out the tsunami forward numerical computation with the above fault parameter as an initial condition, and compared it with observed waveforms. Second, we estimated the slip distribution by tsunami inversion assumed various fault parameters.

Yamanaka [2004] estimated a fault model (135,40,123) by the analysis of teleseismic waves and showed that the rupture propagated to the direction of northwest. On the other hand, Yagi [2004] estimated two fault models ((85,40,90), (315,90,150)), and showed that the rupture began with the strike slip fault, and the rupture of reverse fault followed that. As follows, we call these models Yamanaka model and Yagi model.

We used the observational data recorded at the eight tide gauge stations (Tosa-shimizu, Kushimoto, Uragami, Owase, Toba, Uchiura, Kozusima, Titisima), at the eight ocean bottom pressure gauge stations (PG-1,2 (JAMSTEC), TOKAI, BOSO-2,3 (JMA), VCM-1,2,3 (NIED) and GPS tsunami gauge (ERI)). These data are the same as Satake et al., 2005.

On the tsunami numerical computation, the governing equation was based on the linear long-wave theory. The computed region was 130E-145E, 25N-36N. We gridded the bathymetric data into 20 sec at the deep ocean, into 4 sec near the tide gauge station.

We performed the tsunami forward numerical computation with the slip distributions of Yamanaka and Yagi model. For comparison between the computed and observed waveforms, we used two quantitative parameters (E: normalized residual error, K: sum of the squared residuals). As a result of comparisons, the value of E were 0.97 (Yamanaka) and 0.82 (Yagi), which indicates Yagi model can explain the observed waveforms better than Yamanaka model. The comparison of K parameter shows that Yamanaka model could explain the observed waveforms at east of the epicenter better than Yagi model but Yagi model could explain the observed waveforms at west of the epicenter better than Yamanaka model. When comparing the computed and observed waveforms, we weighted computed waveforms with W to fit the observed; W= (Omax-Omin)/(Cmax-Cmin)/(number of the observational stations), where Omax(Cmax) and Omin(Cmin) are the maximum and minimum amplitude of the observed (computed) waveforms between first and second waves. The value of W was 0.49 (Yamanaka) and 0.79 (Yagi).

Next, we performed the tsunami inversion assumed three fault models P, Q, Q' : P is the fault model of Yamanaka, Q is Yagi's and Q' is Yagi's reverse fault model rotated 22(deg) counterclockwise around the epicenter and strike slip fault. Consequently, we found the case of Q' was the best model explaining the observed waveforms. However, we have not got the fault model explaining observed waveforms sufficiently, so we will try to improve the fault model.

Reference: Satake, K., T. Baba, K. Hirata, S. Iwasaki, T. Kato, S. Koshimura, J. Takenaka and Y. Terada, 2005. Tsunami source of the 2004 Off Kii-Peninsula earthquakes inferred from offshore tsunami and coastal tide gauge, Earth Planets Space, submitted