Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SSS39-P17 会場:コンベンションホール 時間:5 月 25 日 13:45-15:15

2011 年東北地方太平洋沖地震のマルチタイムウィンドウ津波波形インバージョン
Multiple time-window tsunami waveform inversion of the 2011 off the Pacific coast of Tohoku, Japan earthquake

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We performed a multiple time-window analysis of tsunami waveform inversion for the 11 March 2011 off Pacific coast of Tohoku earthquake (M 9.0), and estimated the slip distribution. The 2011 tsunami was recorded instrumentally on coastal tide or wave gauges and offshore gauges such as ocean bottom pressure (OBP) and GPS wave gauges. The offshore gauge records within the source area showed two-stage tsunami waveforms which have a gradual increase of water level followed by an impulsive wave. The coastal run-up and inundation heights were also measured by many researchers, and the large peak appeared around Miyako in Iwate prefecture. Our previous result of tsunami waveform inversion (Fujii et al., 2011, Earth Planets and Space) assuming a simultaneous rupture of subfaults indicated that the largest slip of about 48 m occurred near the trench axis off Miyagi. However, the computed coastal tsunami heights from this model show a peak on northern Miyagi coast and did not reproduce the distribution of the measured tsunami heights.

In this study, we adopted multiple time windows on each subfault for the tsunami waveform inversion analysis assuming a constant rupture velocity in order to estimate the slip distribution both in space and time. This inversion scheme allows us to estimate a time delay of slip on each subfault after the rupture front arrived at an edge with the assumed velocity. The number of time windows is five for each subfault. Each time window has a duration of 30 s as a rise time of slip. We added four more subfaults at the northern end of the subfault model introduced by Fujii et al. (2011), and also used tsunami waveform records at more gauges than the previous study. In total, we used 11 OBP gauges, 10 GPS wave gauges and 32 coastal tide or wave gauges. The observed tsunami waveform data were resampled at an interval of 12 s to be used for the inversion. The new result indicates that the fault slip propagated from the epicenter and took about 3 minutes to reach the northern and southern ends of the source area. The large slip along the Japan trench axis is more extended than the previous result, with the maximum slip of 36 m. The slips along northern trench are about 10 m and more. The computed coastal tsunami heights from the updated model with delayed slips show another peak on central Iwate coast, where the largest tsunami heights were measured. We also computed tsunami inundation areas in Sendai and Ishinomaki plains and found that they explain the distribution of the 869 Jogan tsunami deposits. While we previously proposed the fault models of the Jogan earthquake (Satake et al., 2008; Namegaya et al., 2010, An. Rep. Active Fault and Paleoearthq. Res.), the 869 source could have been the same as the 2011 source.

キーワード: 2011 年東北地震, 津波波形インバージョン, マルチタイムウィンドウ, 沿岸津波波高, 浸水計算
Keywords: 2011 Tohoku earthquake, Tsunami waveform inversion, Multiple time windows, Coastal tsunami height, Inundation modeling