Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SSS35-P01 Room:Convention Hall Time:May 23 18:15-19:30

Tsunami heights distributions of the 1498 Meio, the 1707 Hoei, and the 1854 Ansei-Tokai earthquakes in Aichi prefecture

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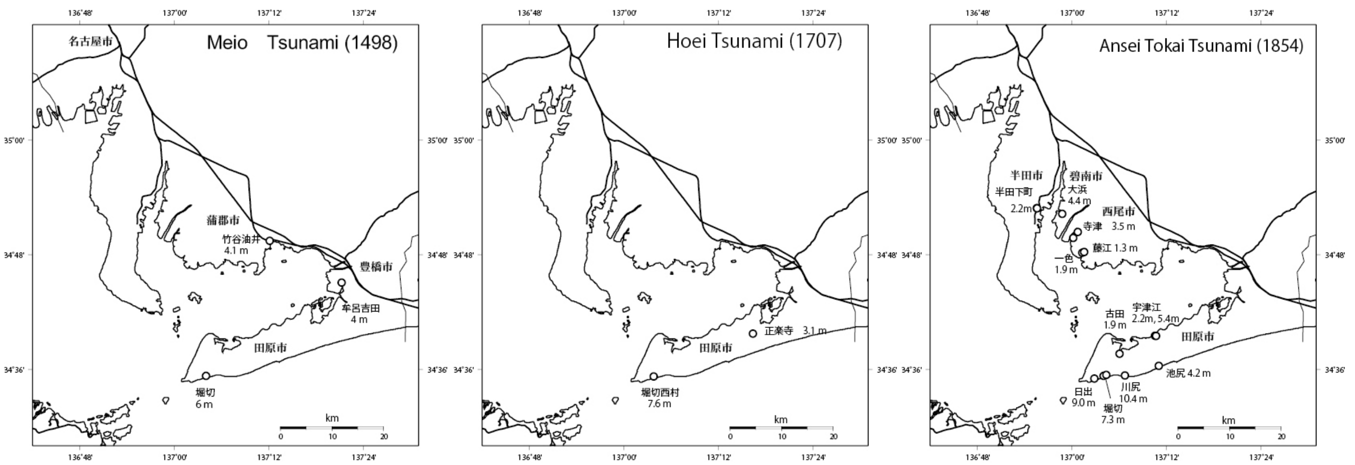
Aichi prefecture is situated in the central part of Tokai District, Central Japan, and was hit by the tsunamis accompanied with the series of the gigantic Tokai earthquakes, the 1498 Meio, the 1707 Hoei, and the 1854 Ansei Tokai earthquakes. But the tsunami heights of those gigantic Tokai earthquakes had not been discussed in past while that they had been discussed in detail by Hatori(1977, 1978) and Namegaya and Tsuji(2005). In the present study, we gathered the descriptions of those tsunamis in old documents data books published as ”Revised volumes of Collected Materials of Historical Earthquakes in Japan, vols.1, 3 additional, 5 additional vol.5-1, ERI, 1981, 1983,1987). We made field surveys at the points where there are descriptions on those tsunamis. Before the survey we checked the features of those villages on the map in the scale of 50,000 to one published in the end of 19-th centuries. We also checked historical chronologies of villages by ”Encyclopedia of place names in Aichi prefecture” published by Heibonsha Press. We visited the places of recorded points, and conducted survey of the heights and position by VRS-GPS. In the present study we did not estimate tsunami height only by descriptions on the damage. We assumed that the height of floor in a house is 70 centimeters above than ground level. Ws also assumed the thickness of water covering on the ground as 2 meters for the case that a group of houses were washed away in a village. Of course, actual tsunami heights was possible to exceeded two meters. Figure shows the distribution of the tsunami heights for the 1498 Meio, the 1707 Hoei, and the 1854 Ansei Tokai earthquakes in Aichi prefecture. The present authors wish to express their thanks to JNES for its financial support.

Keywords: the 1498 Meio Earthquake, the 1707 Hoei Earthquake, the 1854 Ansei Tokai Earthquake, Tsunami, Historical earth-quakes



SSS35-P02 Room:Convention Hall Time:May 23 18:15-19:30

H/V spectral analysis based on high density micro-tremor observations in Kochi Plain

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Kochi Plain is located around source region of the great Nankai Earthquake. Strong ground motion is expected in this area, because soft subsoil is widely deposited in Kochi Plain. In this study, we investigate H/V spectra of micro-tremor in the Kochi Plain. Micro-tremor study with single station is cheaper, quick and easier way than sampling boring core. It is convenient to reveal horizontal variation of soil/basement structure. We append 320 measurements in addition to previous reported 380 measurements (JpGU 2012, SSS26-P12). In total 700 measurements are used to H/V spectral analysis. In perspective, dominant periods of H/V spectra around Urado-Bay region are longer than other regions. According to soil/basement model using boring data, the bedrock depth at this region is especially deep but boring which reaches the bedrock is limited. In contrast, H/V spectral analysis is useful to grasp the extent of region with deep soil/basement boundary. Dominant periods of H/V spectra around western part of Kochi Plain are relatively shorter than Urado regions. High density observations in this region show clear local variations. These are not reflected on current hazard maps or seismic intensity estimation maps. Using H/V spectral analysis based on high density micro-tremor observation, we are detecting patterns of soil/basement structure which has not be grasped using only boring core data.

We planned micro-tremor observation with 200m interval and also array observation to construct soil/basement structure model to improve estimation of strong ground motion.

Acknowledgement
We thank to Prof Tadashi Hara, Nobuaki Kitamura and NEWJEC Inc for providing their data.

Keywords: Soil/Basement Structure, H/V spectra, Strong Motion, Kochi Plain, Dominant period

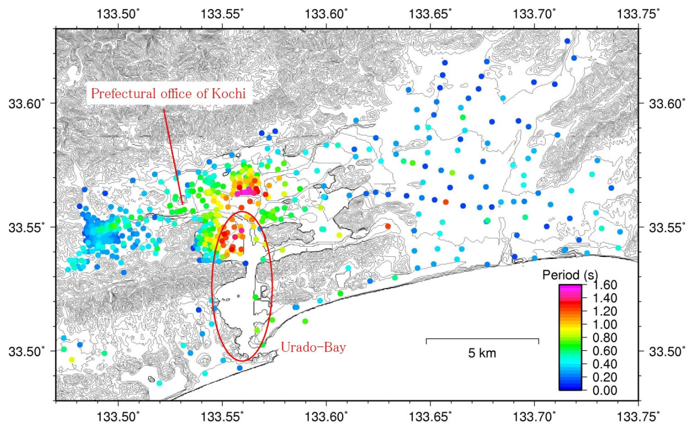

Figure 1 distribution map of H/V spectral analysis based on micro-tremor observations in Kochi Plain

SSS35-P03 Room:Convention Hall Time:May 23 18:15-19:30

Characterized source model for the 2011 Tohoku earthquake based on peak moment rate distribution

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We proposed a characterized source model based on peak moment rate distribution of the 2011 Tohoku earthquake. The asperities estimated from the total slip distribution inverted from the long-period ground motion (e.g., Yoshida et al., 2011, EPS) do not coincide with the strong motion generation areas (SMGAs) estimated using the empirical Green's function method (e.g., Kurahashi and Irikura, 2011, EPS) for the M9 Tohoku earthquake. Yoshida et al. (2011, SSJ) proposed a characterizing procedure of the source model using peak moment rate distribution. We developed a characterized source model for the M9 Tohoku earthquake for simulating the long-period (a period of 10-100 s) strong-ground motion records.

We, firstly, characterized the source model from the total slip distribution following the procedure of Somerville et al. (1999). One asperity area is extracted on the shallow margin of the fault. We used a smoothed ramp function as a slip rate function. Pulse width of the smoothed ramp function is determined with 2 Mo/M, where Mo and M are an average moment and average maximum moment rate on the asperity and background, respectively. We determined the pulse width of 57.2 s and 39.8 s for the asperity and the background. The shot-period (about 20 seconds) components of the calculated velocity waveforms do not agree with the observed ones.

Secondly, we characterized the source model based on the peak moment rate distribution. The characterized procedure bases the peak moment rate distribution, instead of the total slip distribution. The other part of the procedure is same as the one of the slip-distribution based model. The 4 areas extracted based on the peak moment distribution (High moment/slip Rate Area, hereafter HRA) are identified. The largest HRA is similar to the asperity which is identified based on the total slip, but the other 3 HRAs are located on the deeper part of the fault. Slip rate functions of HRAs and background are determined by the same procedure for the slip distribution based model.

Assuming the circular rupture propagation (Vr=2.5km/s), we calculated velocity waveforms using the peak moment rate based source model (HRA model). However, the arrival times of the largest waves of the calculated waveforms do not agree with the ones of the observed records.

We made a complex rupture pattern for the HRA model. The rupture velocity inside each HRA is given to be 0.8Vs and the rupture velocity on the background is 2.5 km/s. The calculated waveforms using the HRA model with the complex rupture pattern agree with the observed ones. The short-period components of the calculated waves are emerged from the deeper and small HRAs.

Acknowledgements: We thank NIED and Hokkaido university for providing the data. This work is supported by JNES (Japan Nuclear Energy Safety Organization).

Keywords: characterized source model, peak moment rate, strong ground motion, megathrust earthquake

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Constraining the extent of an earthquake source fault with seismic intensity distribution

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The 2011 Tohoku-Oki earthquake has provided us with important lessons. One of them is that we should pay more attention to knowledge in the fields of paleoseismology in considering giant earthquakes. Concerning prediction of strong ground motion, finite fault models are usually considered. However, such finite fault models have been estimated mainly for recent earthquakes for which seismic, geodetic, and tsunami data are available. Studies to estimate finite fault models for historical earthquakes began recently [e.g. Kanda et al. (2003), Tokumitsu et al. (2006), and Sugawara and Uetake (2009)]. In this study, we try to image finite fault models from spatial distribution of seismic intensity using a backprojection-like method. Our final target is historical earthquakes. But in this study, we try to validate a method using two modern earthquakes: The 1944 Tonankai earthquake (M7.9) and the 1946 Nankai earthquake (M8.0).

An attenuation relation of seismic intensity on the Japan Meteorological Agency scale used in this study is the same as one used in 'the national seismic hazard maps for Japan'. Given the magnitude, depth, and fault type of an earthquake, the nearest distance to a finite source fault is estimated at a site from intensity there using the attenuation relation. The crossing points between the plate boundary and spheres with the nearest distances to the fault from the sites are candidate points of the fault edges. The intensity distributions for the two earthquakes estimated by Kanda et al. (2003) are used. Concerning the fault geometry, we follow the source models estimated by Ando (1975) mainly using geodetic data. Node points are set on the fault planes with a spacing of 1km x 1km. In using the attenuation relation, we set depths of the two earthquakes to be 20km. So far, Vs30 is assumed to be 600m/s without making correction of site conditions. For the two earthquakes, the number of data for intensity 6 is too small to image the extent of source faults. Data of intensity 4 cannot constrain the fault extent. Using data of intensity 5, the extent of source faults can be estimated. However, the shallow end and horizontal ends of the faults are not imaged, because data are limited on land. Only the deep end of the faults can be estimated, which are roughly consistent with the fault models of Ando (1975). However, estimation error in this study is probably at least 10km. This may suggest that we need to incorporate the site correction and more realistic shape of the plate boundary in the analysis.

In conclusion, we have tried to image the extent of finite source faults for the 1944 Tonankai and the 1946 Nankai earthquakes from the spatial distributions of seismic intensity data using a backprojection-like method. Data of intensity 5 can constrain the deep end of the source faults. But the shallow end and horizontal ends are not well constrained because data are limited on land. The deep end of a source fault is important for seismic hazard estimates. We plan to apply the method to historical earthquakes.

Keywords: Seismic intensity distribution, finite fault, historical earthquakes

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Evaluation of difference in tsunami response , among tsunami source models

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After the 2011 Tohoku-Oki earthquake (hereafter 3.11 earthquake) evaluating based on tsunami simulation approach becomes very important role for promoting tsunami disaster prevention measures against mega-thrust earthquakes. In considering tsunami disaster prevention measures based on the knowledge from tsunami simulation, it is important for us to carefully examine what kind of tsunami source model we use. In the current scheme of tsunami simulation, there exist several ways to set the tsunamigenic source model, such as (1) rather simplified model assuming an average slip for an entire fault zone, (2) static model assuming inhomogeneous slip distribution over finite fault zone, (3) another inhomogeneous slip model further assuming the effect of rupture propagation, and so on. Since each tsunami source model has each own feature, a fair amount of difference in tsunami behavior can be possibly expected.

Thus, in this report, we do tsunami simulation analysis using several tsunami source models and evaluate how different tsunami response could be in the tsunami runup process, among tsunami source models. Specifically in the present analysis, we do tsunami simulation of 3.11 earthquake around Soma Port in Fukushima Prefecture in Japan by using several tsunami source models ([1],[2], etc), and evaluate relative differences in things such as tsunami wave height, wave pressure, and so on. For evaluating tsunami wave pressure, we assume the method of Tanimoto et al.(1984)[4], which has been used in the past research of tsunami simulation of 3.11 earthquake around Soma Port [3]. As the result, we observed a fair amount of relative differences in maximum wave height and wave pressure for incoming tsunami onto inland region.

Basically, phenomena of tsunami runup are very complex and in this study we ended up evaluating the relative differences of things like wave pressure, based on the shallow water theory. For more details of tsunami runup, evaluation has to be done by three-dimensional method of tsunami simulation.

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Keywords: Tsunami simulation, The 2011 Tohoku-Oki earthquake, Tsunami wave force

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The uncertainties in the probabilistic tsunami hazard evaluation

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In this study, we discuss the approach to several types of uncertainties in the probabilistic tsunami hazard for the whole of Japan.

We estimate peak of coastal tsunami heights by numerical simulations, and integrate for probabilistic model considering many kinds of uncertainties. In the numerical calculations for coastal tsunami heights, the initial sea surface displacements are set to be the same as vertical crustal deformations associated with earthquakes, and then a series of numerical simulations of tsunami propagation are carried out. The calculated peak tsunami height allows for a certain margin of uncertainties, in the value of the applied tsunami source model setting parameters, seafloor topography data, discrete topography of the grid-map and two-dimensional methodology of tsunami simulation scheme. Our goal is to treat these uncertainties during calculating hazard curve, so we quantitatively examine the probabilistic variability.

It is also essential to consider the variability associated with the uncertainty depend on an observation point and on tsunami source. In order to examine the uncertainty quantification, we need records of historical tsunami heights observed at same points by equivalent repeating earthquakes, but amount of high reliability observations is not enough.

In this study, we attempt to adopt the difference between the residual error from the numerical model and the observed data in the historical tsunamis, with concerning the ergodic hypothesis, as an acceptable spatial variability for analysis. Because of amount of observation data and its quality, we select 2011 off the pacific coast of Tohoku earthquake event, and decide the variability in ratio of historical data to computational value from estimated source model by previous study.

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Keywords: Tsunami, Probability, Uncertainty