Tsunami model of the 2011 Tohoku Earthquake reproducing the wave gauge record offshore the Fukushima Daiichi NPP

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1. Objectives of research
During the 2011 off the Pacific coast of Tohoku Earthquake, severe core damage accidents occurred in unit one, two and three in Fukushima Daiichi nuclear power plant due to the failure of core cooling after the reactor shutdown. For understanding the process of tsunami caused by the earthquake and for utilizing tsunami evaluation at the nuclear power plants, tsunami source model, L67, of the 2011 Tohoku Earthquake was determined based on the data of the tsunami waves, crustal deformation and run-up height.
Although the model L67 can simulate the first tsunami and the first crest of the secondary tsunami of wave gauge record offshore the Fukushima Daiichi NPP, it cannot reproduce the second crest of the secondary tsunami. Imamura et al. (2016) proposed the revised model of Sugino et al. (2013) which reproduce the second crest of the secondary tsunami. In this research we improve the reproducibility of the wave gauge record based on the following approach.

2. Contents of research
(1) Joint inversion of tsunami wave and 1-second sampling GPS data
For developing the model L67, we took the consideration of the problem that the slip process of the previous tsunami source models such as Cabinet office (2012), Sugino et al. (2013) and Satake et al. (2013), has long duration compared with those of models based on earthquake ground motion data and that of 1-second sampling GPS data by Geospatial Information Authority, Japan. In order to resolve this problem we used the short time window for inversion as 30 sec times 3. Consequently the slip process of the model L67 has shorter duration compared with the above tsunami source models.
In this research we conducted the joint inversion using tsunami wave and 1-second sampling GPS data. It seems that the duration of slip process will become naturally shorter by using the 1-second sampling GPS data.

(2) Inversion using “hypothetical tsunami records”
Non-linear effect is strong in the wave gauge record offshore the Fukushima Daiichi NPP. So we can use only initial portion of the record for the linear inversion. In order to improve the reproducibility of the wave gauge record, “a hypothetical tsunami record” at the depth of 50 m offshore the Fukushima Daiichi NPP was simulated using the initial fault model and the green functions and the adjusted hypothetical tsunami record was added to the inversion as observed record. The calculated tsunami wave became similar to the wave gauge record through a trial and error process.
The same approach was used for improving the K and kappa for the run-up height data.

3. Conclusions
The tsunami source model of the 2011 Tohoku Earthquake reproducing the wave gauge record offshore the Fukushima Daiichi NPP was determined based on the above inversion approach. The duration of slip process became naturally shorter by using the 1-second sampling GPS data. The reproducibility of the wave gauge record was much improved compared with the model L67 by using the “hypothetical tsunami record”. Goodness of fit for tsunami wave and run-up height is same as that for model L67.

References
Imamura et al. (2016) The re-examination of the tsunami affected on the Fukushima Daiichi nuclear power plant by revising the tsunami model for the 2011 Tohoku Pacific Ocean earthquake tsunami, Journal of JSCE (Coastal Engineering), Vol.72, No.2,I-361-I-366

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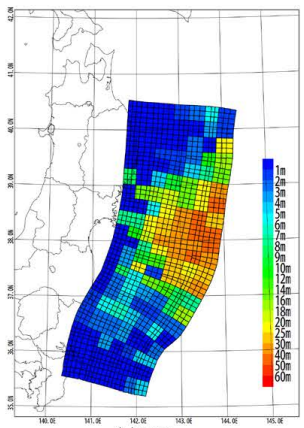
Keywords: tsunami source model, the 2011 off the Pacific coast of Tohoku Earthquake, Fukushima Daiichi nuclear power plant, 1-second sampling GPS data


(a)L67

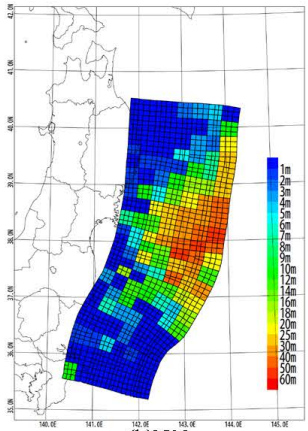

(b)N03

図1　波源の比較

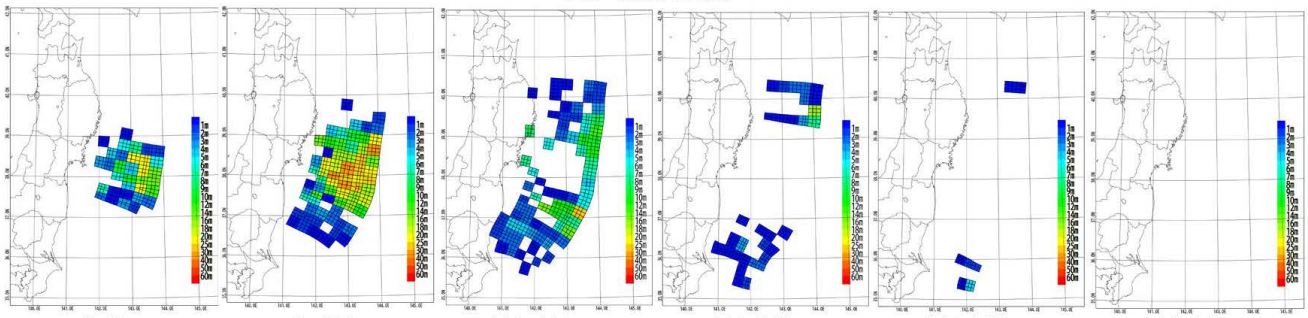


図2　破壊進展図(L67)

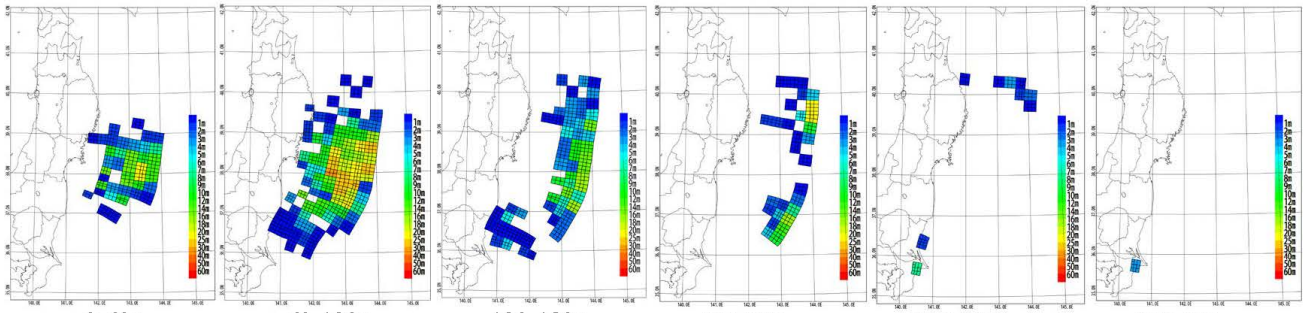


図3　破壊進展図(N03)

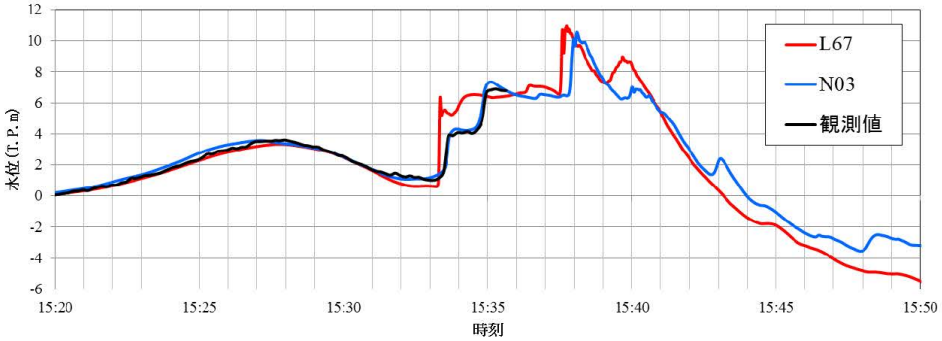


図4　波高計での観測値と計算値の水位時刻歴

表1　適合度表 (K, κ)

	L67		N03	
	K	κ	K	κ
北海道～千葉 (3882 点)	1.00	1.34	1.00	1.34
福島第一 (19 点)	1.00	1.10	0.99	1.11
福島第二 (71 点)	0.99	1.18	1.00	1.13