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Discussions

Interactive comment on "Randomly distributed unit sources to enhance optimization in tsunami waveform inversion" *by* I. E. Mulia and T. Asano

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We would like to thank to the review for the questions and suggestions on our paper. The following are our responses to those questions and suggestions:

Question 1. How long the observed data are used for t in Eq. (3) for inversion?

The time ranges of the waveforms used for the inversion on each gauge are depicted by the gray bar above the time axis in Fig. 5 (Fig. 6 in the revised manuscript). Further explanations is described in the answer to question 7.

Question 2. What kind of Green's function is?

It is a tsunami Green's function derived from 2D linear shallow water equation Eq. (1)

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solved using numerical method with specified bathymetry resolutions. To clarify the descriptions on this, we have added the above sentence in page 3 line 19.

Question 3. What is the relation between wi in Eq.(3) and ai in Eq.(13)?

In Eq. (3), wi indicates the multiplying factor or weight for the synthetic waveforms or the Green's function to be adjusted in order to fit the observations. This adjustment is achieved by the inversion. While ai In Eq. (13), represents the water height of unit sources, which is initially set to ai = 1 m. Once wi has been obtained, it is then used to multiply the initial water height ai to reconstruct the sea surface deformation.

Questions 4 What is the initial Green's function and the final one?

The initial Green's function is the waveforms recorded at all gauges at specific time ranges originated from equidistance unit sources (Fig. 1) with 1 m amplitude Eq. (13). The final Green's function is obtained after GA's optimization, prior to the final inversion, where the position of the unit sources is no longer uniform (non-equidistance) shown by gray dots in Fig. 4d. While the amplitude and time ranges are remain the same as the initial Green's function.

Questions 5 Are all eight wave observation stations data used simultaneously in Fig.1?

Yes. Some papers on tsunami waveform inversion performed a sensitivity study by changing the number of observation stations used for the inversion. However, we don't conduct such a study as discussion on the effects of the number or location of observation stations is not our primary concern.

Question 6 In Fig.4, the artificial source was made from 28 points, and the GAPSr model estimated different points although the sea surface deformation is well represented by GAPSr model. The objective is to estimate the initial tsunami source.

The artificial tsunami source shown in Fig. 4a (Fig. 5a in the revised manuscript) was constructed from superposition of many small unit sources (not 28) with random locations and amplitudes. The GAPSr model approximates that artificial tsunami source by

using 28 unit sources. We would like to highlight that using 28 unit sources is sufficient to capture the target source profile. This is very unlikely to achieve using the regular Green's function with equidistance unit sources as in Fig. 4b and 4c (Fig. 5b and 5c in the revised manuscript), without increasing the number of unit source.

Questions 7 In Fig. 5, the time and interval at 8 wave observation stations are different? Are these data used simultaneously? Or how to use the data?

In tsunami waveform inversion, mostly only the first leading waves that are considered for the inversion. This is because the subsequent waveforms might be generated by many factors other than the initial tsunami source itself, i.e., geometric responses of the coastal. The length of the leading wave varies in each location, thus the time range for the inversion are different. For more details on the tsunami waveform inversion, please refer to Wu and Ho, 2011 in the reference list. We don't include the details on least squares inversion in our paper as we want to elaborate more on our new approach using GA.

Suggestion 1 Flowchart of estimation using GA and PS helps how to determine sources.

A flowchart is added in the revised manuscript (Fig. 4).

Suggestion 2 If there are several observation stations and data exist, all the data for same time and interval had better be used without choosing the data for systematic procedure.

The response to this suggestion is related to the answer to question 7. Using all the recorded tsunami waveforms without a proper time range selection will lead to an unrealistic inverted sea surface deformation, even though in overall it might yield a good fit of waveforms. As explained in the answer to question 7 that not all recorded waveforms possess the signature of the initial profile of the tsunami.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C1844/2014/nhessd-2-C1844-2014-supplement.pdf

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