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Natural Hazards and Earth System Sciences
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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This article describes a methodology to estimate the sea surface deformation of tsunami source. The proposed algorithm (GAPSr) that finds optimum locations of unit sources gives sea surface pattern that can match the target sea surface very well. The advantage of this algorithm over the classical tsunami inversion method is shown in this article.

I have minor comments that require no major additional work but should be addressed in the manuscript before it can be published.

1) The abstract should more focus on the proposed methodology and results. Lines 3-11 in the abstract are better to be in the Introduction.

2) Page 3661 lines 23-24: Smoothing constraint can be introduced to tsunami waveform inversion to obtain a more stable solution as shown in previous studies (i.e., Gusman et al., 2010; Gusman et al., 2013).

3) The target sea surface deformation was generated from a same Gaussian distribution as that used to build the Green's functions. This could be the main reason why all three methods of least squares, GAPSu, and GAPSr can reproduce the target sea surface deformation very well. However, a real tsunami source of initial sea surface deformation does not always follow the Gaussian distribution that is used to generate the synthetics. This should be addressed in the manuscript.

4) The number of unit sources in GAPSr is limited to 28. The number of unit sources to generate the target sea surface deformation is not mentioned in the manuscript, I presume it is also 28. If that so, it is not surprising that the GAPSr can recover the sea surface deformation very well. The GAPSr method can give a very good result because the problem is well conditioned. What happens if the number of unit sources that was use to make the target sea surface deformation was much more than 28, while the GAPSr used 28? The GAPSr method might work better if the number of unknown parameters is not limited to 28. Because of this and my provious comment about the synthetics I argue that the current version of GAPSr could also falls into ill-posed problem when used for a real case, which is not in favor to the authors' claim in page 3661 line 29 and page 3662 lines 1-2.

5) Seems like the initial sea surface deformation is assumed to happen instantaneously (rupture velocity = infinite), please mention this in the manuscript. For great earthquake such as the 2011 Tohoku earthquake the rupture process took about 3 min, in this case a more realistic rupture velocity does matter.

6) Lines in Figure 5 are not so clear perhaps thicker lines can be used and comparison for the GAPSu and least squares results can be plotted separately from that for the GAPSr.

7) Pressure gauge moves with ocean bottom deformation during an earthquake. This kind of gauges does not record uplift or subsidence even though the deformation was actually occurred. If Gauge 1 and Gauge 2 are indeed pressure gauges then such uplift shown in Figure 5 will not be recorded.

8) Point 5 in page 3670: When the inversion is performed for the final time, is the unit source locations are searched again?

References

Gusman, A. R., Y. Tanioka, T. Kobayashi, H. Latief, and W. Pandoe (2010), Slip distribution of the 2007 Bengkulu earthquake inferred from tsunami waveforms and InSAR data, J. Geophys. Res., 115, B12316, doi:10.1029/2010JB007565.

Gusman, A. R., M. Fukuoka, Y. Tanioka, and S.'i. Sakai (2013), Effect of the largest foreshock (Mw 7.3) on triggering the 2011 Tohoku earthquake (Mw 9.0), Geophys. Res. Lett., 40, 497–500, doi:10.1002/grl.50153.

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