Referee Report

Monitoring induced distributed double-couple sources using Marchenko-based virtual receivers

Joeri Brackenhoff, Jan Thorbecke, and Kees Wapenaar

Joeri, Jan, Kees, & the Editor:

The paper "Monitoring induced distributed double-couple sources using Marchenko-based virtual receivers" demonstrates a methodology for reconstructing the response to both monopole and dipole sources in the subsurface at virtual receiver locations throughout the medium using a Marchenko method, which is proposed to be used for forecasting the response throughout the medium to future induced seismic events, or for monitoring the response throughout the medium of actual seismic events that have already occurred.

I greatly enjoyed reading and reviewing this paper, and believe this work will be of great interest to the geophysics community. My recommendation to the editor is that this work be accepted subject to minor revisions, and I will separate my comments into the minor revisions necessary for this work to be published, and additional thoughts that I feel would make the paper easier to read. The following are all with respect to the main paper, as opposed to the supplementary materials.

Minor Revisions:

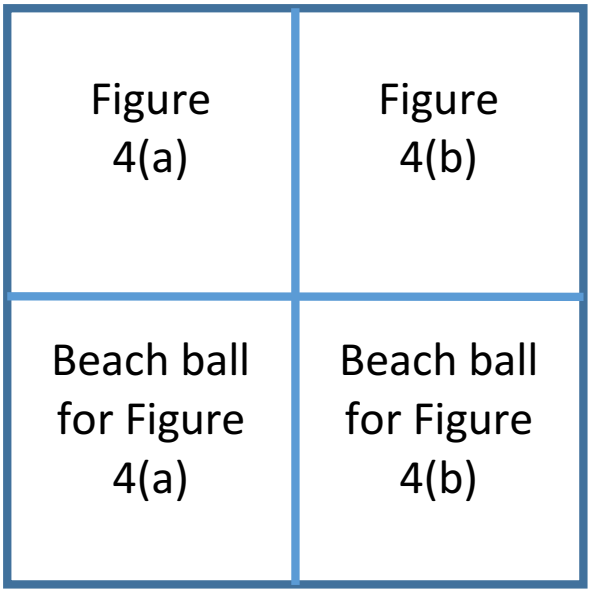
1. The choice of colour scheme in Figure 1, and as a consequence Figures 2 and 3, raises a number of issues. In Figure 1(a), the choice to overlay dark green arrows over a green background makes said arrows difficult to view on what is conceptually an excellent figure. A greater issue arises due to the overlaying of green arrows on a red background, which may be problematic for those with red-green colour-blindness. Given that the motif of red and green arrows to represent ray paths is a continued theme through Figures 2 and 3, I would suggest changing the colour map used to plot the underlying velocity model so as to highlight the arrows.
2. Page 19, line 11: *"The evanescent problem does not occur when the sources along the fault have random amplitudes"*. It is not obvious to me why this should be the case**.** Is this an axiom or a previously found result? If it is somebody's result then it needs an appropriate reference, if it is axiomatic then it would benefit from an explanation as to why this should be the case. You acknowledge 2 sentences after this statement that *"faults are extremely heterogeneous"*, if this forms part of the basis on which the previous statement was made then I believe this paragraph would benefit from minor restructuring of the opening 3 sentences to reduce any feeling of a circular logic being applied.

Additional thoughts:

1. Page 1, line 22: *"When the source is not active, but rather passive, such as when caused by an induced earthquake, the resulting signal can be measured as well"*. This sentence feels wordy and unconcise compared to the rest of the paper. Given that a source can be considered as either active or passive, and the previous description is explicitly about active source seismics, it doesn't seem necessary to state passive sources are not active. I would suggest something like

"For passive sources, such as induced earthquakes, the resulting signal can be measured as well".

2. Page 4, line 15: *"For moderately inhomogeneous media".* Recognising that this type of statement is reasonably common in papers, this statement feels somewhat vague and imprecise compared to the majority of the paper. I'm not sure if there is a better way to express this however.
3. Figure 2: I believe that Figures 2(a) and 2(b) would benefit from each being slightly larger, as the current figures feel somewhat overcrowded with text labels and arrows, for example the "+" symbol in Figure 2(b) that is almost touching the arrow from $\mathbf{x}_B$ to $\mathbf{x}_A$. With a slightly larger figure there may also be space to use a heavier line width on the arrows, which I feel would also significantly improve the readability of the figure for the same reason as for Figure 1.
4. Figure 4: Whilst this figure serves its purpose of distinguishing the wavefield due to a monopole source from the wavefield due to a dipole source in the same medium, I immediately felt looking at this figure that placing the well-recognised "beach-ball" diagrams of such sources next to their respective wavefields might aid the reader in rapidly recognising the differences in the wavefields without needing to double-check for the changes in polarity around the wavefront. For example:



5. Figure 9: The green line does not show up clearly when printed on paper. I know that reading papers on a screen is increasingly popular, but there are some who will read it on paper and may miss this detail. A better contrasting shade of green or a wider line may help it stand out more.
6. Page 21, line 11: *"… we repeat the retrieval of the virtual source and the real source where we replace the retrieval of the wavefield by the classical back propagation".* As I understand it, you are saying that you repeat the virtual source methodology (dealing with each virtual source one by one), and the "real" source method (in this example it is a real synthetic source rather than a recording from an actual seismic survey as demonstrated in the following section) whereby the individual point sources are assumed to be inseparable and

thus processed as the summation of the sources, and apply the back-propagation method shown previously in Figures 6(e)-(h) for the monopole source case. I had to read over the preceding results a number of times before I decided what was going on. It would be unfair of the reader to ask the author to write everything in a manner that required no thinking at all, but if this were able to be expressed more clearly then it would be worthwhile to do so before publication.

7. Page 23, lines 18 & 19: *"More information about imaging using the Marchenko can be found …".* I presume that this is a typo and should say *"Marchenko method"*, in any case I would suggest changing this to something like *"More information about imaging of a field data example using Marchenko methods can be found*…" to emphasise the different approach used when processing field data as opposed to solely synthetic data examples.