

## Responses to Reviewer's Comments

We would like to express our sincere gratitude for the reviewer's review and comments on our manuscript. We have revised the manuscript accordingly. Below are our point-by-point responses.

1. Line 30: excitation efficiency. What is that?

Thanks for the reviewer's suggestions.

We have replaced "excitation efficiency" with a clearer phrase: "the overall efficiency of exciting these effects". Please see Line 22.

2. Lines 195 and 196: it is not fully correct that when changing the waveform, one does not change the travel time... This means that the maximum of the envelope is a good indicator of waveform travel times. Please rephrase the sentence of lines 195-196 considering these notes.

Thanks for the reviewer's suggestions.

We have rewritten the corresponding sentences in the manuscript. We now explicitly state that the primary effect of nonlinearity is to modulate the wave's envelope shape, rather than perturbing its fundamental propagation phase. Please see Lines 198-199.

3. Line 279: what is rectilinearity? Please define it.

Thanks for the reviewer's suggestions.

We have added a clear definition for rectilinearity in the revised manuscript (Lines 285-287).

4. Line 285: Same here, what is the Spearman's rank correlation coefficient. Please explain with clarity what it is and the reason of this choice.

Thanks for the reviewer's suggestions.

We have expanded the explanation for Spearman's rank correlation coefficient in Lines 295-298.

5. Line 326: What do you mean by mixed sources? What is that?

Thanks for the reviewer's suggestions.

We have revised this term to describe the source mechanisms as composite, as they contain both double-couple and significant non-double-couple components. Please see Line 339.

6. Line 331: What is this time-frequency energy? Hilbert transform frequency, i.e., instantaneous frequency or Fourier frequency? Please clarify. In addition, please define inside

the text that time-frequency-energy difference plots are the non-linear minus the linear. It is only defined in the figure caption.

Thanks for the reviewer's suggestions.

We have changed "time-frequency energy" to the more accurate term "time-frequency spectrum" and clarified that these spectra are calculated by applying the Generalized S-Transform (GST) to the waveforms. Additionally, we have now defined in the revised manuscript that the time-frequency spectral differences are the result of the nonlinear simulations minus the linear simulations. Please see Lines 344-347.

7. Line 368: Fundamental seismic sources?

Thanks for the reviewer's suggestions. We have replaced the original phrase with a more specific description of the three basic moment-tensor source types.

8. Please remove the part of specfem2d simulations. One cannot compare a 3D code with a 2D. The physics of wave propagation in 2D is different from 3D... Please remove this part completely and do not mention in the manuscript any 2D comparison. It makes no sense.

Thanks for the reviewer's suggestions. We have removed the content and mentions related to the comparison with SPECFEM2D from both the supplementary material and the manuscript.

9. I, however, can see that the code of the authors shows some high frequency components in their waveform. This is usually normal and, in my experience, can be simply removed by filtering, so please do that. It should be ok then.

Thanks for the reviewer's suggestions. We have applied an appropriate low-pass filter to the waveforms shown in Fig. 8 and Fig. 9.

## **List of relevant changes made in the revised manuscript**

In addition to the specific responses to the reviewer's comments above, we have summarized the revisions made to the manuscript as follows:

1. We have removed the comparison with SPECFEM2D simulations from both the manuscript and the supplementary material, as suggested by the reviewer, to avoid invalid comparisons.
2. We applied a low-pass filter to the synthetic waveforms of the referenced earthquake events (Figures 8 and 9) to remove high-frequency components.
3. We refined several terms for accuracy, including changing "excitation efficiency" to "efficiency of exciting these effects" and renaming "mixed sources" to "composite sources".
4. We added explicit definitions for "rectilinearity" (Lines 285-287) and "Spearman's rank correlation coefficient" (Lines 295-298) to better explain the waveform attributes used in the analysis.
5. We clarified the method used for time-frequency analysis (Generalized S-Transform) and explicitly defined the difference plots as "nonlinear minus linear" simulations.
6. We have updated the figure and table citations in the Supplementary Material to ensure consistency with the revised manuscript.