
Reviewer F:

This is a nicely written paper that combines methodology development, synthetic test and field application of moment tensor inversion. I only have some minor comments.

1. Step 3, I am not quite clear about how the expansion coefficients were obtained. Based on equations 6, 7, 8, you first create the matrix W based on waveforms, then perform SVD, then the expansion coefficients are calculated based on V and λ from the SVD, is this correct? For the " W ", is this constructed based on filtered or unfiltered? Equation 8 used unfiltered waveform, right? Please clarify this process.
2. In Equation 14, only relative magnitude between events 2, 3, 4 and event 1 is used, but not between events 3, 4 and event 2, even though event 2 has catalog magnitude estimate, is there a reason for this?
3. Figure 4 - I don't see the "true solution is blue", maybe use other color that distinguish more clearly from gray.
4. It is interesting to note the strong bias for overestimating moment in Figure 5, is there an explanation?
5. I don't quite understand Figure 9. So there are 353 events, and a subset of 19 solutions are selected. Do you generate 1000 solutions (each contains the 353 events) and select the 19 solutions based on agreement with polarity and amplitude constraint? I am a bit confused with the word "solutions" here, as I thought event event would have a solutions, but it appears that each "solution" contains multiple events. Also, Figure 9 shows the relative residual and stable, likely and bad events - please explain the criteria for defining those event groups. Also, does the histogram in Figure 9 based on the "best solution" or the average from the 19 solutions?

Recommendation: Revisions Required

Reviewer G:

"Relative Moment Tensor Inversion for Microseismicity: Application to Clustered Earthquakes in the Cascadia Forearc."

Doriane Drolet¹, Michael G. Bostock¹, Simon M. Peacock¹, Alexandre Plourde²

¹Department of Earth, Ocean, and Atmospheric Sciences, The University of British Columbia, Vancouver, Canada

²Geological Survey of Canada (Atlantic), Halifax, Canada

Dear Authors and Editor:

I am grateful for the opportunity to review the Manuscript, "Relative Moment Tensor Inversion for Microseismicity: Application to Clustered Earthquakes in the Cascadia Forearc." The relative moment tensor inversion methodology presented in your manuscript is a practical approach that I found particularly intriguing. I was not familiar with this methodology before reading the manuscript, and I appreciate the detail in its description. Your work is of great relevance, especially in the context of the Pacific Northwest, where I have worked for a long time and am very familiar with the seismicity patterns in the region. You did excellent and careful work in relocating an intermittent seismicity cluster at 10-28 km depth beneath the San Juan Islands and obtaining moment magnitude estimates. Studying these types of enigmatic clusters of events in detail is crucial when trying to understand the processes that generate them and how those relate to the active tectonics of the region and their associated hazards. Your interpretation that the presence of earthquakes in that location is likely related to slab-derived fluids being able to permeate and rise to shallower levels makes a lot of sense. Despite the careful stress analysis using the moment tensors and relocations, it is difficult to pinpoint any specific fault structures on which the slip may be occurring. These earthquakes and therefore slip, are quite deep, far from the surface expression of the known faults. They exhibit a variety of moment tensors (aka faulting mechanisms) and the various sub-clusters in the swarm region are not easily geometrically related to each other. From my experience and other studies, this is also true for other deeper seismicity in the Puget Sound region. These types of careful and detailed analyses are very useful, and I wholeheartedly support publishing this manuscript after a few minor revisions, listed below.

Sincerely,
Renate Hartog

Comments:

1. I was not able to find the Data and Code releases on Zenodo (tried to access <https://doi.org/10.5281/zenodo.10850729> without success)
2. At the beginning of section 4, the real data application, note that you only inverted for double-couple moment tensors.

3. On p.10 you mention the trace of the moment tensor has to be 0. required for an isotropic source. Did you mean to write a non-isotropic source?
4. On p. 14 line 355. Step 7.4 should probably be step 8.4.
5. On p. 14, you reference the USGS-hosted ANSS ComCat website, b., I suggest a different citation. The reference on lines 653 and 654 reads:

653 U.S. Geological Survey. Earthquake Lists, Maps, and Statistics,
 2023b. <https://earthquake.usgs.gov/earthquakes/eventpage/uw10427908/>
 654 executive. accessed October 16, 2023.

I suggest using:

U.S. Geological Survey, Earthquake Hazards Program, 2017, Advanced National Seismic System (ANSS)
 Comprehensive Catalog of Earthquake Events and Products:

Various, <https://doi.org/10.5066/F7MS3QZH>. <https://earthquake.usgs.gov/earthquakes/eventpage/uw10427908/executive>. accessed October 16, 2023.

1. 14 line 372, use San Juan Islands Archipelago instead of the singular form.
2. The Alvarez reference cited in Figure 11's caption should move to the top of the References list instead of the bottom.
3. Figure 12: the slab moho depth contours are not labeled in this Figure. Per Figure 6 they are at 40 and 50 km depth (but, see next comment). It would be helpful to the reader to change "Purple lines are the oceanic Moho contours from Bloch et al. (2023)." To "Purple lines are the 40 and 50 km oceanic Moho contours from Bloch et al. (2023)."
4. Figure 13. Oceanic moho depths are labeled 50 and 60 km, whereas in Figure 6 the corresponding contours are labeled 40 and 50 km. Please correct the wrong one, or if one is on top of the slab and the other is moho depth, please correct the appropriate captions and text.
5. In Figure 13, the DMFZ is labeled as BMFZ. Please correct this typo.
6. Supplement: In the caption of Figure S5 there is a typo, tenor $\diamond$ tensor
7. Supplement: In the caption of Figure S14, it says "other refer," but it should be "others refer."
8. Supplement: Figure S14. The UPGMA method could use a reference or more details on the distance metric between source mechanisms that was used.
9. The references and citations were complete, and there were no extra ones! I don't often see that when reviewing manuscripts. Thank you.

Recommendation: Revisions Required
