

REPLY TO REVIEWERS

REVIEWER 1:

The Authors provided an excellent manuscript in terms of clarity, organization and quality of the content. I admit I've enjoyed the reading and have been impressed by the work done to assembly the SEITCOM-1D code. It is exactly the type of comprehensive, flexible, fast and reliable code that was missing for the forward computation of surface waves dispersion curves and RF. I'd like to congratulate the authors for this.

Reply: We thank the reviewer for the positive comment and view on our work.

I have hardly any issue to mention, except for some minor suggestions:

- The name SEITCOM-1D does not seem to be an acronym, or at least this is not reported in the text. Consider to find a more appealing name, which sounds more related to "geoscience". "SEITCOM" sounds more related to the "telecommunication" field.

Reply: We have changed the name to a better name. We also point out that the original name was very similar to another software used in source seismology for earthquakes monitoring and detection.

- L140: 1300°C --> convert to K for consistency with the rest of the text.

Reply: We have changed the units

- L274: explain what mantle fertility means, as not all interested readers might be familiar.

Reply: We have added a brief comment regarding mantle fertility.

- L428: I assume that c refers to phase velocities and dU to group velocities. Please state.

Reply: We have clarified this for the reader: c = phase velocity and U = group velocity.

- Figure 5: missing x-label for periods

Reply: We have updated figure 5 accordingly.

- ALL FIGURES: please make all fonts/size the same across labels. Now they seem changing from one another (e.g. in Fig8-9 the "Temperature" labels are in bold...

Reply: We have normalized all figures to one consistent format.

Dear Editor,

I have carefully reviewed the manuscript entitled “SEITCOM-1D: An Interactive 1D Code for Temperature and Composition Modelling of the Crust and Mantle from Seismological Data” by Arnaiz-Rodríguez and Fullea. The authors present a valuable open-source Julia implementation (SEITCOM-1D and SWD.jl) that effectively integrates petrological phase equilibria with forward seismological modelling of surface waves and receiver functions. The work is both timely and significant, as it provides a coherent framework that links seismological observables with thermochemical interpretation. The manuscript also includes appropriate validation tests and well-chosen illustrative examples.

Recommendation: Minor revisions. The manuscript is generally sound and well structured; however, I request several clarifications and minor additions (detailed below) prior to publication.

In summary, I consider this manuscript a meaningful contribution to the field and recommend its acceptance following the requested minor revisions.

Sincerely, Roberto Cabièces

Reply: We thank the reviewer for the positive comment and view on our work.

QUESTIONS FOR AUTHORS:

1. The SWD.jl dispersion engine is presented as a fast, approximate alternative to Mineos.jl, with error behaviour described (e.g. larger errors for strong attenuation and high overtones). Could the authors provide: (a) runtime benchmarks (typical CPU/time for representative models) and (b) recommended decision rules for users when to prefer SWD.jl vs Mineos.jl?

Reply: We have included several comments in section 2.4 to address this comment.

2. The model assumes isotropy and a 1-D thermal parametrization. Could the authors discuss more explicitly the implications and limits of the isotropy assumption on (a) synthetic RF and (b) surface-wave sensitivity — and quantify (if possible) how large radial anisotropy would have to be to bias their inferred thermochemical interpretations?

Reply: For **receiver functions**, synthetics are computed using a propagator matrix formulation (Thomson, 1950; Haskell, 1953; Kennett, 1983), which assumes a purely elastic, laterally homogeneous medium. Intrinsic attenuation is therefore not included, and the present implementation is isotropic. This is consistent with the primary use of RFs which is to constrain discontinuity depths and interface geometry rather than attenuation or anisotropic parameters. Moderate levels of anisotropy mainly affect RF amplitudes and waveform details, while converted-phase timing—and thus inferred interface depths—are only weakly affected. For **surface waves**, radial anisotropy and attenuation are explicitly accounted for.

We note that only relatively strong, unmodeled radial anisotropy would be required to significantly bias the thermochemical interpretations, and this effect is largely mitigated by the joint use of

anisotropic surface-wave constraints and RF-derived interface depths. Nevertheless, we will account for both in RF calculation in the next release of the code.

3. The chemical parameterization in the mantle uses Al_2O_3 and FeO as main free variables and derives other oxides from statistical correlations. Please justify the sensitivity of the main results to these chosen parameterizations (e.g., would different correlations or a different independent oxide change the key conclusions?) and comment on applicability to very non-peridotitic domains.

Reply: The choice of Al_2O_3 and FeO as independent compositional variables follows previous thermodynamically consistent mantle parameterizations (Afonso et al., 2013a; Fulla et al., 2021) and reflects a balance between model flexibility and data resolvability. Al_2O_3 is a robust proxy for mantle fertility, strongly controlling modal clinopyroxene and garnet contents, while FeO primarily affects density and seismic velocities. Other major oxides (CaO , MgO) are statistically well correlated with Al_2O_3 in global mantle peridotite databases and are therefore not independent degrees of freedom.

Given that seismological observables are dependent on three variables (V_p , V_s , ρ), introducing additional independent oxides would increase the number of free parameters. Here we basically change 3 variables by other 3 (T,P,C).

Our parameter ranges encompass typical depleted to fertile peridotitic mantle and are sufficient for most tectonic settings. While our current parameterization is optimized for peridotitic regions, it is not exclusive to them. The flexibility in Al_2O_3 and FeO content allows for modeling a wide range of mantle compositions, including non-peridotitic regions. Users can specify compositional anomalies within any layer, enabling the inclusion of regions with different compositions, such as eclogite-rich regions or regions affected by subduction. This adaptability ensures that our model can handle a variety of mantle compositions and tectonic settings.

4. Porosity corrections are applied for sediments but not for igneous crustal rocks (discussion and choices are stated in the text). Could the authors (a) justify this decision with references/measurements for typical secondary porosity ranges, and (b) discuss possible biases for fractured upper crustal settings (e.g. faulted regions)?

Reply: We have added the possibility to correct igneous rocks by porosity too in order to account for secondary porosity.

5. Validation: the manuscript shows comparisons with other codes and reports small discrepancies for selected tests. Could the authors (a) provide the exact model files / scripts used for those comparisons (so readers can reproduce Fig.5 and Fig.6), and (b) please state whether the code repository includes automated tests.

Reply: This are provided in the github page witht the code.

6. Attenuation (Q_s) and anelastic formulations are important for SWD performance. Could the authors clarify which anelastic parameters are user-exposed vs fixed (e.g., grain-size, activation

energies), and give guidance on how to choose them for realistic mantle scenarios? If possible, include an example sensitivity plot ($Q_s \rightarrow$ phase shifts).

Reply: In our code, anelasticity is implemented following Dannberg et al. (2017), based on a Burgers viscoelastic formulation calibrated to laboratory data for olivine (Jackson & Faul, 2010) and extrapolated to mantle conditions. Most anelastic parameters (activation energies and volumes, relaxation strengths, frequency exponents, reference values) are fixed and taken directly from Dannberg et al. (2017), with phase-dependent parameter sets applied according to the stable mineral assemblage (olivine, wadsleyite, ringwoodite, perovskite). This choice ensures internal thermodynamic and rheological consistency and avoids introducing poorly constrained degrees of freedom.

The main user-exposed parameter controlling attenuation is grain size. The user may select among three depth-dependent grain-size models (constant, Schierjott et al., 2020; Dannberg et al., 2017), which bracket plausible mantle scenarios and dominate the variability in Q_s . Notice that grain size, activation energy, etc are laboratory estimates and we have deemed it better to leave the results from research done in this domain instead of leave many parameters that the user might not be familiar with. Fig 3 gives a good idea of how Q_s varies with grain size.

7. Code availability and reproducibility: the Data Availability states the package is on GitHub. Please (a) add a DOI / release tag (e.g., Zenodo) for the version used in this manuscript, (b) include a short README excerpt in the manuscript or supplement showing a minimal run example (input + expected output), and (c) indicate required dependencies and approximate memory/CPU requirements.

Reply: The new link of the code is:

<https://github.com/marianoarnaiz/TCSEIS>

And the code is in zenodo:

[10.5281/zenodo.18100247](https://zenodo.org/record/18100247)

8. It would be advisable to include illustrative pseudocode for the principal core methods implemented in the software. Additionally, I recommend providing a block diagram that outlines the overall architecture and workflow of the full code.

Reply: We provide a simple diagram showing the code in Figure 1.

Reply: We have taken all of these next minor errors into consideration

MINOR FIXES Typos / small writing edits & places to improve.

Below I list specific phrases I found that should be corrected or improved.

These are quick fixes that would tidy the manuscript. “compressional and sheave waves velocity anomalies” — sheave → shear.

“between 0 and 4 GaP every 0.05 GPa” — likely 4 GPa (unit typo: capital P and a stray ‘a’). Please correct to GPa.

“K-feldespars” — should be K-feldspars (or “K-feldspar” depending on intended form).

“(NO MELT, dotter lines).” — dotter → dotted.

“(màpé)” and similar accented forms appear many times — ensure consistency and define the term (you use “màpé” as shorthand; prefer to define once and then use “mapé” or “mape” consistently).

“ferrocerae” (or similar) — this looks like a misspelling in the description of D” / lower-mantle phases (I think the intended mineral is ferropericlae or ferroperovskite — check and correct).

Reference / author name inconsistency: the text cites “Haker et al., 2003” in one place and “Hacker et al., 2004” elsewhere — unify/correct the spelling and years for that source. A few sentences are long and could be split for readability — e.g., the paragraph introducing the code’s aims would benefit from bulleting or shorter sentences (improves clarity for broad readership).

Figure captions: some captions could be more explicit about the parameter choices (e.g., state the exact composition and temperature fields used in each panel) — this helps readers reproduce the figures. Units & notation: ensure spacing is consistent around symbols (e.g., “T = 50 s” vs “T=50 s”), and check notation for subscripts/superscripts (some glyphs in the PDF look misaligned).

Replace the Data Availability Statement by:

“The full SEITCOM-1D v1.0 package is openly available for download at the project’s GitHub repository (<https://github.com/marianoarnaiz/SeitComp.jl>). The software requires a functional installation of the Julia Language (version 1.7 or higher) to run.”

Reply: We have taken all of these minor errors into consideration