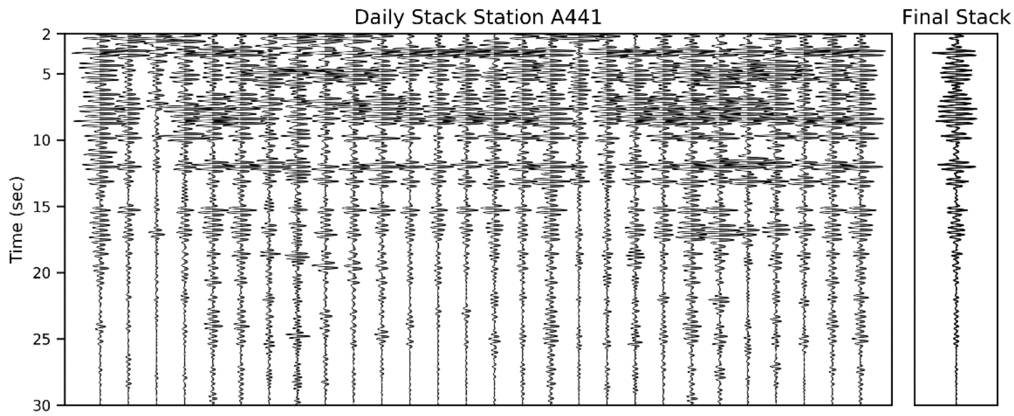
This manuscript investigates the reflectivity of the Iberian crust along a dense transect crossing the Iberian Central System (ICS) and adjacent foreland basins. Interestingly, the authors utilize autocorrelation functions (ACFs) of ambient seismis noise recorded at a number of short-period (f > 2 Hz) stations. The ACFs are obtained after stacking a number of daily phase autocorrelograms in the 1.5-4 Hz frequency range with phase weight for each station. A reflectivity cross-section is then built from the juxtaposition of single-station ACFs and interpreted in terms of past and present tectonic processes.

Overall, I found the manuscript to be correctly structured, well written and appropriate for the broad readership of Solid Earth. I have, nonetheless, two main concerns about methodology and interpretation:

(i) Given the large variability in the number of days utilized to construct the final ACFs at different stations (28-60 days), and the relatively small number of days in all of them, shouldn't the stability of the ACFs have been investigated before attempting any interpretations? One way of doing that would be to compute ACFs with an increasingly larger amount of (random) days to see whether the stacked autocorrelograms converge to a stable time series or not.

Indeed, it is important to assess the number of autocorrelograms (AC) needed for a stable response in order to be sure that what is retrieved is an actual reflection and not a spurious event or an artefact. We did this by taking daily stack and compare the signal retrieved by each of them. As we sliced every day in pieces of 1 hour we ended up with 24 autocorrelations for each day. Visual inspection in Figure 3 shows that the main reflections retrieved are consistent each day with 24 AC stacked, although minor variability is found, thus assuring that the signal is stable. Stacking more days would yield the same result as we are adding the same signal to the stack. For clarity porpoises, we have added the final stack of the same station used in Figure 3 to compare between the daily stack and the final stack.



(ii) The interpretation of the final cross-section (Fig 4b) seems to be strongly guided by a coincident cross-section published by the same lead author, which was obtained from the autocorrelation of telesseismic waveforms. I think it would help to add that cross-section to Fig 4 (as Fig 4c) to better illustrate the choices made by the authors in Fig 4b. In addition, that would also help highlight what 'seismic noise can really tell us about the Alpine reactivation'; without that additional piece of information, it is sometimes unclear whether a specific feature is a new finding from ambient seismic noise or just confirmation of something that was reported elsewhere. Finally, I have a number of minor concerns/suggestions:

We agree that it is a good way to compare previous results with those presented in this manuscript and we have added the GloPSI profile as figure 4c.

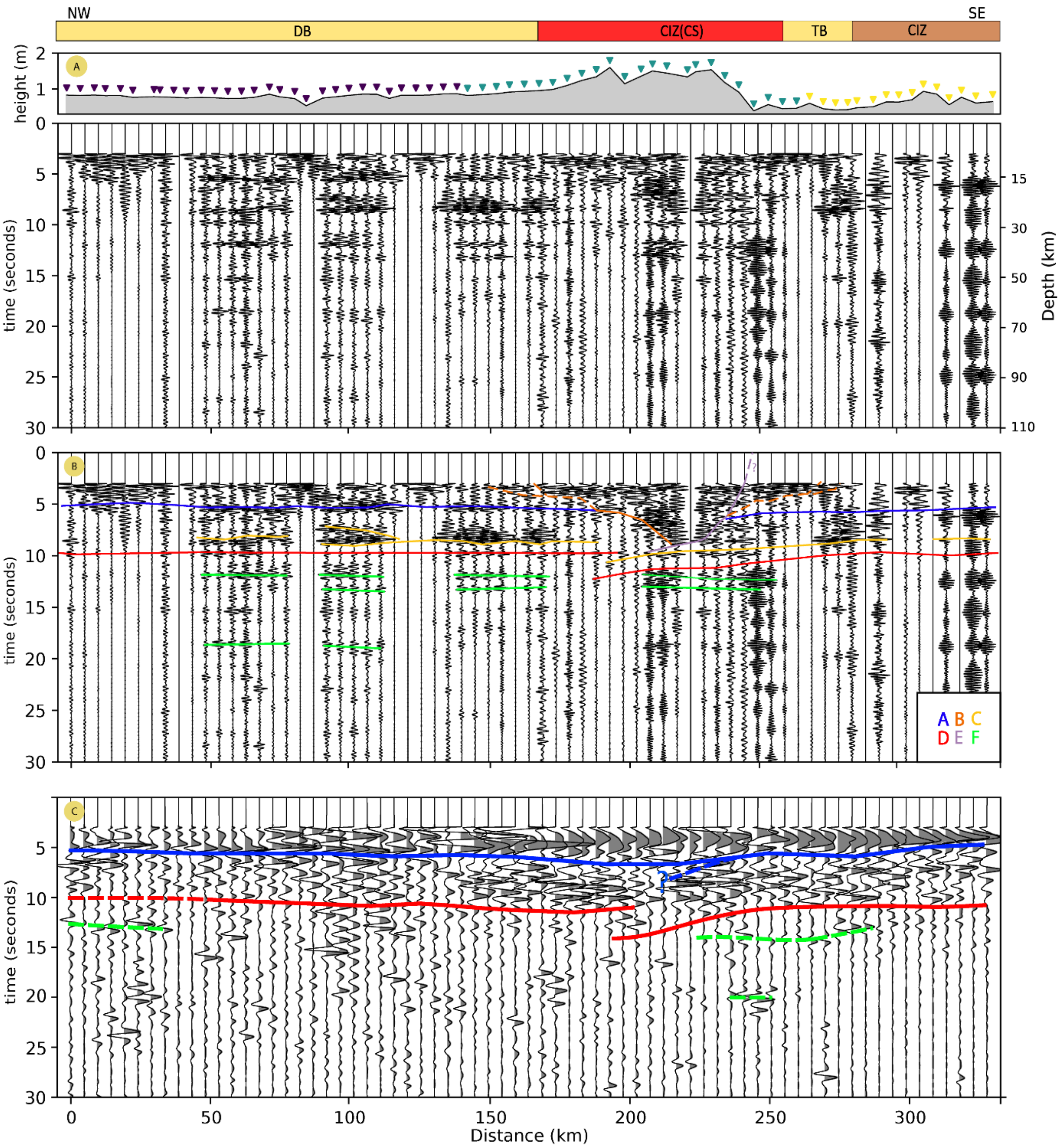


Figure 4. A) Reflectivity profile retrieved by autocorrelation of ambient seismic noise. In the wiggle plots, the grey lobes indicate negative polarity. Coloured triangles placed over a topographic section represent the different acquisition stages (from N to S: third, first, and second deployments). B) Interpretation of different reflectors, which are labelled between A-F. A marks the boundary between the upper crust and the lower crust. B represents the interpreted depth extension of granites below the ICS. C marks a intracrustal reflector within the lower crust. D is the crust–mantle boundary. E represents a key S verging thrust affecting southern end of the ICS. F marks the scattered reflectivity within the upper mantle. C) Reflectivity profile extracted from autocorrelations of teleseismic events over the same deployment array (modified from Andrés et al., 2019).

P2L35 - For completeness, I think the following manuscript should be added to the list of lithospheric studies:

Julià, J. & Mejía J. (2004). Thickness and Vp/Vs ratio variation of the Iberian crust, Geophys. J. Int. 156, 59-72.

Added.

P6L156-157 - Could the authors be a bit more specific about how the final frequency range (1.5-4 Hz) was selected? Just saying that 'it provides good reflectivity ... with consistent daily stacks' is not very informative.

The frequency band (FB) was selected after trying different ones, from very low frequencies to higher than 4 Hz (Fig. 2, although only shows until 4 Hz). For each of these FB we tested the consistency of the stacks as explained above. The selection of the best FB was a compromise between resolution and consistency of the produced stacks. As we can see in Figure 2, as we increase the frequency more features are retrieved in the autocorrelation and also appear more defined. As an example, the red box in Figure 2 shows how a single high amplitude reflection, at low frequencies, actually contains part of the signal of another feature that can be resolved increasing the frequency. For instance, we found that above 4 Hz the daily stacks were not converging and we needed more days to begin to find coherence. Accordingly, we decided to select a FB below that top limit and the one preferred was the one explained in the manuscript. Nonetheless we have extended the explanation for clarity.

"Therefore, it can be argued that the best frequency range depends on the data, structural complexities and the objective of the study. We have tested frequencies ranging from 0.3-0.5 Hz to 1.5-4 Hz to assess the best suited band to retrieve body-waves for lithospheric imaging in the study area (Fig. 2). As seen in Figure 2, at higher frequencies the vertical resolution increases. The red box marks a reflection that at lower FB range only resolves a big amplitude event, whereas at higher FB it is clear that it also contains signal from another feature. Therefore, the selection of the best frequencies was based on the recovered reflectivity and the consistency of the daily stacks of the stations. For each frequency band we computed daily stacks of the data and check the convergence of the autocorrelations. For frequencies above 4 Hz the daily stacks did not converge as expected. Due to the limited amount of recorded days, we set the top frequency to 4 Hz. The bottom limit of the filter was set so it avoids the microseismic noise peaks that strongly influences the lower frequencies."

Figure 3 - Why are the reflections at 2.5 s, 13.5 s and 17 s not selected? To me, they seem as good as the ones with an arrow.

We agree that those reflections can be marked as some kind of structural reflectivity response. The aim in Figure 3 was to illustrate the consistency of the daily autocorrelations and mark some of the most relevant ones, without bloating the image too much. Moreover, the reflector located at 13.5 s TWT is marked in Figure 5.

P8L185 - Why is the crust-mantle boundary interpreted at 10-12.5 TWT? I see a stronger reflection at 8-9 TWT along most of the profile; moreover, this feature is not interpreted under the Duero Basin (Fig 4b). Is it for consistency with the telesseismic ACF cross-section?

As we stated at the beginning of the discussion section, we support our interpretation in previous published results, such as the one mentioned by the reviewer (Andrés et al., 2019), but also by previous wide-angle seismic studies that sample the parts of the same area of interest (Ehsan, et al., 2015) and represent the base upon we build our interpretation. The reflection proposed as the crust-mantle boundary matches with that of Andrés et al, 2019, which provides consistency to the idea of it being the actual Moho interface. Furthermore, the reflection at 8-9 s TWT, would mean a Moho interface at 24-28 km depth (with an average velocity of the crust of 6.2 km/s) which is way shallower than what is proposed in other studies (Ehsan, et al., 2015; Diaz et al., 2016; Palomeras et al., 2017).

Figure 4 - I do not see any depth scale in this figure; however, the authors claim the conversion to depth was done (P8L175-177). Could a depth scale be added to Fig 4?

Thanks for pointing out this mistake. The depth scale has been added to Figure 4.

P9L206-P10L218 - This text is duplicated. Please, remove.

Removed, thanks for noting it.

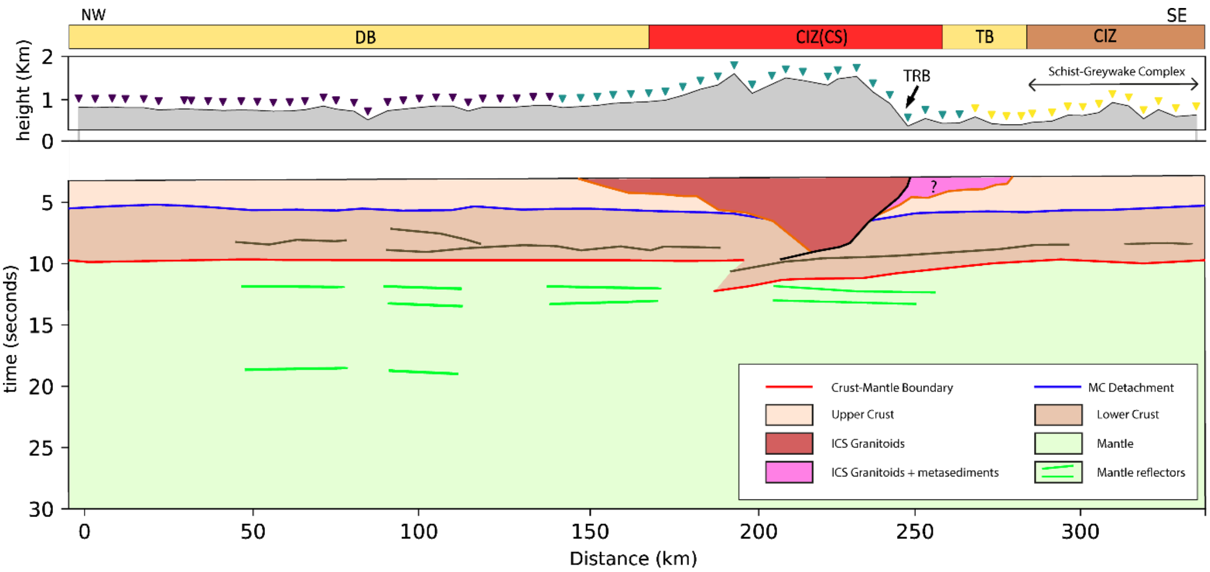
P10L237-240 - Could that ’opposite polarity’ be some sort of cycle skipping? That region seems to be structuraly complex (Fig 5) and I wonder if a migration to depth would somehow shift the traces enough to place them ’in phase’.

Indeed, some problems derived from the structural complexity of the region could arise during the processing. Unfortunately, we don’t have a way to assess it as we lack a reliable seismic velocity model to perform a depth migration to the seismic profile.

P13L325-326 - Could the location of the ’Schist-Graywake Complex’ be indicated in Fig 5?

We have added the extension of the Schist-Graywake Complex as suggested.

Please note that we have added a modified Figure 5 in the revised manuscript as the figure in the submitted manuscript was an early version and not the final one. We spotted this error by a question raised by reviewer #1.



P15L364 - Perhaps the text after line 365 could be under a new subsection (i.e. 6.1.3. Moho).

We have adopted this suggestion and named the subsection as “6.1.3. Crust-mantel boundary”

P16L420 - What ’other possibilities exist? As they ’cannot be ruled out’, I think those should be explained here.

Other possibilities exist as there is not a seismic profile with enough resolution (i.e. seismic reflection data), to assess the amount of shortening that the lower crust has accommodated, although we strongly believe that some of the shortening has been absorbed by the lower crust below the Iberian Central System. For completeness we have extended this sentence as follows:

"These values suggest that the amount of shortening observed at upper crustal level is similar to that imaged at the lower crust in Figs. 4 and 5, thus supporting our model. However, other possibilities exist and cannot be ruled out. Further deep normal seismic studies with higher lateral resolution are needed in order to assess the amount of shortening accommodated at lower crust levels"