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Solid Earth
Discussions
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Interactive comment on "Using Horizontal to Vertical Spectral Ratios to construct shear-wave velocity profiles" *by* Janneke van Ginkel et al.

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Dear Agostiny Marrios Lontsi,

Thank you for your positive remarks and some insightful comments on the paper. We appreciate the time and effort that you have dedicated to our manuscript. We have evaluated your comments and our response is discussed and summarized below. The technical corrections are discussed per bullet in more detail. Your textual corrections on the manuscript are updated in the final revised version.

RC = referee comment

AC = authors comment

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Discussion paper

Specific comments

RC: P10Figure5. change the presentation of Figure 5. (a) for example should contain H/V (+average) results from each teleseismic event for the seismometer at the surface only; (b) at 50m, ... Add (f) for the average at each seismometer.

***AC**: Figure 5 illustrates the averaging method over the five depth levels for each teleseismic event. This averaging is done to suppress any extra noise. In this figure we show that the H/V is not changing across the different depth levels. Subsequently, the average H/V for each teleseismic event is averaged again. This step was not included in figure 5. You have raised a good point here and accordingly, we have added panel f in Figure 5 (Figure 1 in this response) illustrating this averaging step. In our opinion, this presentation represents best our method instead of showing H/V curves separated for each depth level per panel.*

RC: P11Figue6. I think that you should edit (a) and (b) so that they have the same background topography. The main difference should be on the approach used to estimate Vs. Eventually indicate the location of outlier stations G45 and G52.

***AC**: Thanks for pointing this out, Figure 6 is updated with same background topography and the locations of G45 and G52 added.*

Technical corrections

Abstract

***AC**: in this section, the textual suggestions are implemented*

Introduction

***AC**: in this section, the textual suggestions are implemented*

Geological setting

***AC**: in this section, the textual suggestions are implemented*

Existing velocity models

***AC**: in this section, the textual suggestions are implemented*

Dataset

***AC**: in this section, the textual suggestions are implemented*

RC: P5Table1: add two columns one with approximate epicentral distance to a reference station and the second the azimuth.

***AC**: Table 1 is updated with the two extra columns. In the second column we tabulate the backazimuths*

Velocity profiles from teleseismic phases

***AC**: in this section, the textual suggestions are implemented*

RC: P6L130: The interference of multiple reverberations within the soft layer leads to a resonance pattern in which certain frequencies are amplified and others interfere destructively. Please add a reference or leave the statement out, unless you have investigated it yourself. Consider also the previous comment if the two sentences can be merged or not.

***AC**: Here we did not add a reference, since we investigated this with a simple one-layer-over-halfspace model. Here, a Delta-pulse from below is travelling upwards, the first response at the surface contains all frequencies equally, but when one takes the amplitude spectrum of the first arrival and subsequent reverberations, one sees the resonance spectrum, in which some frequencies have been amplified and other de-amplified. The amplified frequencies represent the resonance frequencies and over-tones.*

RC: P7Figure3. Please indicate on the figure your direct S phase and the coda window (and the subsequent weaker shear-wave phases). Caption ... (seismometer G300,

epicentral distance ???? km). ... (seismometer HGN, epicentral distance ???? km).

***AC**: We updated the figure and the caption. In the caption, the direct P-and S-arrivals are indicated and epicentral distances added. Based on the comment from the other reviewer we indicated in Figure 3 the 1000s window that is selected for the H/V estimations. By plotting the teleseismic signal at this scale, it is very hard to distinguish the direct S-arrival, but this arrival is around 1400s.*

RC: P13L221-222: For these regions outside Groningen, one... resonance frequency f 0 in the form => Please reformulate. (For example) Alternatively to using Equation 4 together with an average NSG shear-wave velocity as found in the previous section for the sediment thickness of NSG, we first use the large data set available for the Groningen area to establish a frequency- depth relationship. The newly established relationship is then used to estimate the sediment thickness for NSG where the geology is the same.(?). If not the relationship doesn't hold.

***AC**: You made a good point here that the relationship only holds when the NSG is of similar composition. We have added this to the text.*

Probability density functions of ambient noise H/V spectral ratio

***AC**: in this section, the textual suggestions are implemented*

RC: Different terminology for the H/V for body wave, surface waves, ellipticity

***AC**: The different H/V curves we discuss have all a different origin, resulting in a potentially different resonance frequency. Therefore, we use these three different terms for H/V:*

- *H/V body wave = HVBW*
- *H/V surface wave = we have no special H/V terminology for surface waves. The HVAN is the overall H/V from the ambient noise*

- *Ellipticity the theoretical ellipticity curves calculated in Geopsy, based on surface waves.*

RC: P14L236-237: Therefore in this section... in Section 5. Please reformulate. (for example; In this section, we estimate the H/V spectral ratios using ambient noise wavefield. The obtained results are compared with modelled H/V spectral ratio. For the H/V modelling, we use the algorithm based ???? (body waves? Surface waves?) and the velocity profiles derived in Section 5 as input models.

***AC**: Geopsy-gpell is based on the surface wave elliptical particle motion. We have added surface waves to the text to make this clearer.*

RC: P15Figure: Please add an inset or header on each subfigure to indicate the recording length. The Figures could also fit in a single column.

***AC**: Figure 10 is updated with insets with the recording length and merged into a single line figure.*

RC: P19Figure13. RayDec and HVAN seems not to be on the same scale. Please check your settings in geopsy, processing window, and use ”square average” for the calculation

***AC**: The H/V processing has not been performed in Geopsy. We used vector summation for averaging the PSDs for the two horizontal components, as described in section 5.1. In RayDec a refined procedure is used to combine the two horizontal components such that the Rayleigh-wave component is emphasized.*

Discussion

RC: Please discuss the H/V data integration through PDF HVAN

***AC**: You raised here a good point and accordingly we have added in the revised manuscript a paragraph on the H/V data integration through PDF HVAN*

RC: There is a clear correlation around 0m/s. Many stations have delta Vs of -150 m/s. Any comment? or consider these stations as outlier?

***AC**: 6 stations have a delta Vs of -150m/s, if we plot these stations spatially, or make a correlation plot with the depth of the base NSG, we do not observe a relationship between those parameters, see Figure 2 in this response. We cannot come up with a reason that the delta Vs -150 occurs this often. However, we do not see these as outliers but it is still part of the distribution.*

RC: The established frequency-depth relationship for deep structures

***AC**: The section (5.3) on the frequency-depth relationship contains at the end a few sentences of discussion. We deliberately did not shift this part to the final discussion since it would disturb the flow of the paper.*

We hope we cover your comments and are willing to respond to any further questions and suggestions you may have.

Sincerely,

Janneke van Ginkel, Elmer Ruigrok and Rien Herber

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2020-86, 2020.

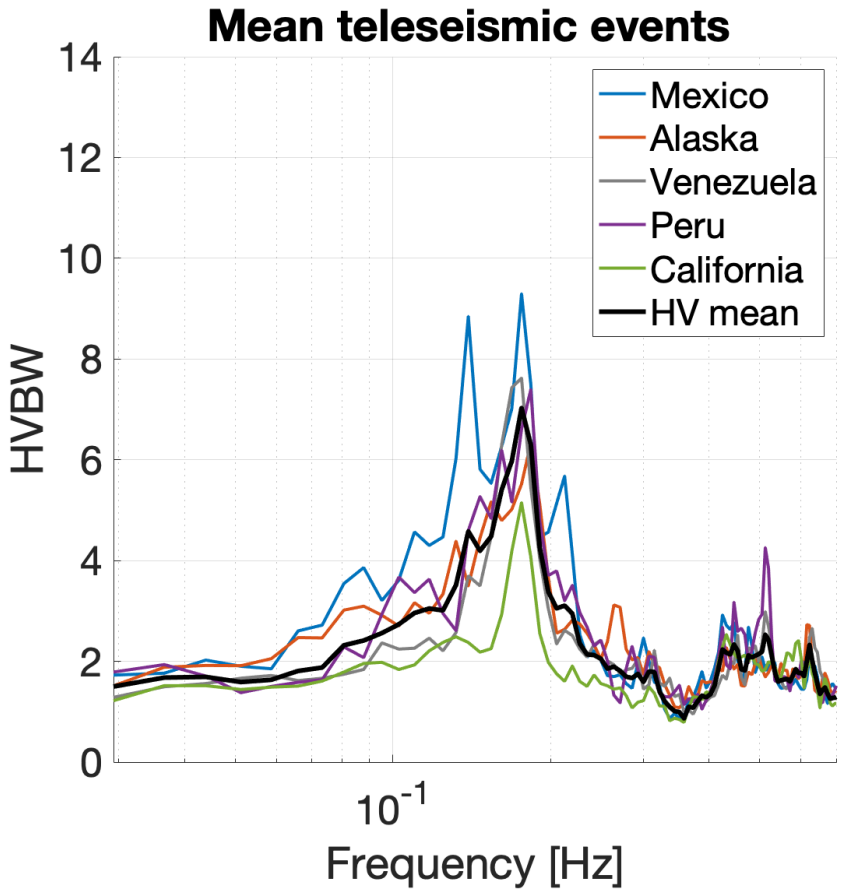

Fig. 1. extra panel for figure 5 with mean of all HVBW

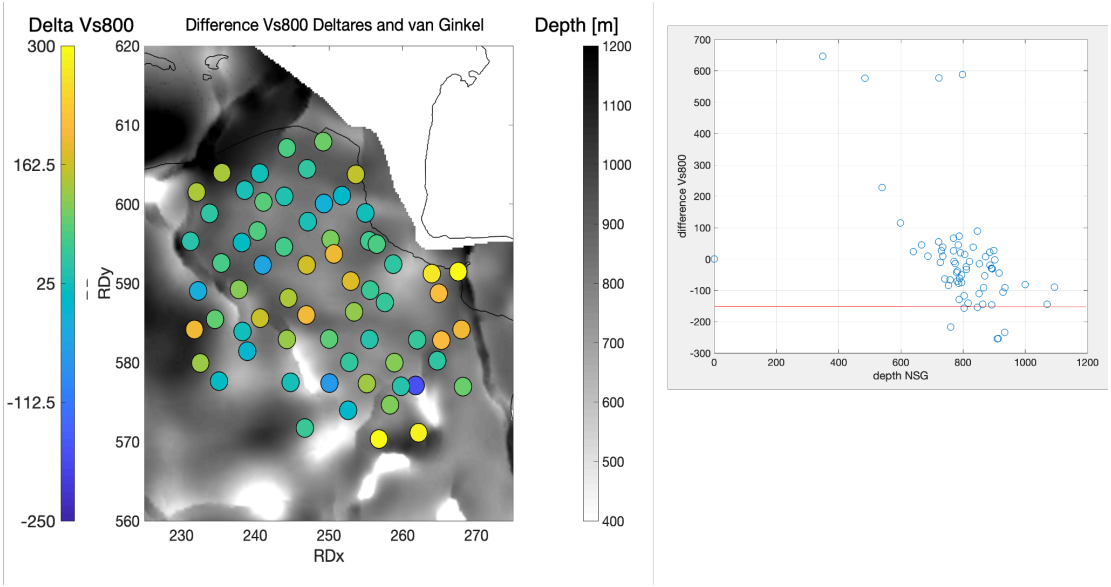

Fig. 2. a) Delta Vs spatially. b) Delta Vs in relation to depth NSG

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