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Interactive comment on "Antarctic ice sheet thickness estimation using the H/V spectral ratio method with single-station seismic ambient noise" *by* Peng Yan et al.

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General comments:

The use of horizontal-to-vertical spectral ratios (H/V) is a well-established method for geophysical shallow sub-surface investigations which is mainly used within the context of seismic site-effect studies and to infer sediment depths. It has been recently applied on glaciers to infer ice thickness for the first time which showed the potential of this passive seismic method to provide complementary observations for cryospheric research. To my knowledge the H/V method has not been applied to measure ice sheets thickness before. Therefore, this study is highly appreciated. The paper is well-written

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Discussion paper

and presents conclusive and encouraging results. I have no major concerns about this manuscript, however, there are a few issues and details I would like the author to comment on and to add in the paper.

Specific comments:

(1) I suggest to briefly discuss the origin of the H/V spectra. A full discussion is beyond the scope of this study, but it would be helpful for future applications to know more about the basic assumptions and their reliability. Different contributions to the H/V amplitudes have been discussed since the emergence of this method such as SH wave resonance, Rayleigh wave ellipticity, and Love wave Airy phases. Recently, forward-modeling schemes based for example on the diffuse field theory have been proposed that take into account all seismic wave types (Jose Pina-Flores et al, 2017; Garcia-Jerez, 2016, Lunedei and Malischewsky, 2015). In the present paper this new method is used to invert the spectral ratios for the sub-surface structure. As far as I understood the code of Garcia-Jerez (2016) allows for separate computation of the contribution from different wave types. In the considered frequency band, ocean microseisms usually contribute most to the background seismic noise, so I would expect the contribution from Rayleigh wave ellipticity to the H/V spectra shape to be dominant. Is this the case here?

(2) What are the limitations of the H/V inversion method (e.g., non-uniqueness) and, most important, what are the error bars of the inverted velocity structures (please add in Figure 5)? How much is the velocity allowed to vary in the parameter space?

(3) I am also curious to what extent the other H/V peaks directly tell us something about the sub-surface structure. Can they be interpreted as multiples / overtones of the main peak, or do they correspond to other interfaces within the ice? Is there a peak or a through in the spectrum which corresponds directly to the interface within the ice that you invert for (Model B)?

In their paper, Picotti et al (2017) discuss the implication of soft-bed vs. hard-bed

sub-glacial conditions on the H/V spectra, and interpret the presence of a H/V peak or a through to be related to these conditions. Do you have any indications that the presence of sediments (soft-bed) or sub-glacial lakes lead to similar observations, i.e., a trough in the H/V spectrum that is related to the interface depth, e.g. at station N060? Is the inversion scheme you use able to take this into account? Or in other words, is the halfspace velocity allowed to become lower than the ice-sheet velocity?

(4) What is the physical model behind the two layer ice sheet model (model B)? What is the explanation for the low-velocity ice layer and are the inverted velocity values realistic? Does it make sense or have you tried to use a more complicated structure in the inversion (allow more layers and low velocity layers everywhere)? Maybe this could improve the fit even more.

(5) How is the peak frequency and it's error estimated? For example in Fig 4 the picked frequency does not seem to correspond to a maximum in the H/V spectra for stations N198 and ST07.

(6) Write some words about the spatial resolution (or footprint) of the H/V method. To what extent and where could existing ice sheet maps in Antarctica (or elsewhere) be improved using the H/V method in future seismic field experiments?

(8) Fig 6: It is unclear to me why the synthetic spectra are divided by 2. Isn't this supposed to be the best fit of the data? Then, why do the amplitudes do not match?

Technical corrections:

In references: Change "Jean-Jacues L. to "J.-J. Leveque"

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