EGUsphere, referee comment RC2
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# Comment on egusphere-2022-279

Emanuel Kästle (Referee)

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Referee comment on "Comparison of straight-ray and curved-ray surface wave tomography approaches in near-surface studies" by Mohammadkarim Karimpour et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-279-RC2, 2022

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Dear Editor,
Dear Authors,

the manuscript entitled "A comparison of straight-ray and curved-ray surface wave tomography approaches at near-surface studies" provides an informative study that is certainly of interest to tomographers who consider applying similar methods. The manuscript is clearly structured and generally well written. The applied methods are appropriate and the authors' conclusions are supported by the results of the two synthetic and of the two real data examples. Nevertheless, there are a couple of points that, in my view, need to be addressed before publication in Solid Earth.

**Remarks**

In the introduction, a few other studies are mentioned that also apply straight and/or curved-ray tomography, but it is not clear for most of these studies whether they performed a comparison of the thwo approaches. There should be an overview of what the conclusions from other authors on the topic were. I am also missing a (short) discussion at the end of the manuscript on whether the results agree with existing literature.

The abstract needs to be rewritten. It gives a very brief introduction and motivation for the study. But an abstract should summarize the key results of the study. The same applies to the conclusions section which should be rewritten.

One of your key results is that in a scenario with low data coverage, the curved-ray approach performs significantly better. But your synthetic examples do not prove that since you run no example with low coverage. I would suggest that you take one of your two synthetic tests and test whether this conclusion holds.

l. 10 "exact paths" - the term 'exact' is quite vague. In this case you calculate Eikonal paths since they are the solution to the Eikonal equation. These represent an approximation and not necessarily the true/exact paths.
l. 35 So did Trampert and Spetzler find a difference between the ray-based and the finite-frequency approach?
l. 38 It sounds like Gouedard did not perform any comparison between straight and Eikonal ray based models. So why cite them here?
l. 50-56 You present several studies where some applied some form of ray tracing and others didn't. But what is your point? Did these studies find any advantage in ray-tracing? If your point is that researchers have applied different methods to approximate the rays but no-one has done a systematic study, then you should write it like that.
l. 70 "shots are defined as a regular grid" sounds wrong to me. I would rather write something like "shot locations located on a regular grid are tested by calculating the number of aligend receivers for each location."
l. 71 How many shots are picked, what are the criteria for the number of picked shot locations?
l. 71 I assume this approach only applies to receiver layouts on a grid and not in case of irregular/random receiver locations? Maybe you should say so.
l. 75 Which values for Vp and rho are you assuming in your study? How are these values chosen?
l. 76-80 I think the way you describe the procedure is a bit complicated. Bascially, you take your 3D model defined by Vs,Vp and rho and extract 1D depth profiles at each point of the model. You then calculate the phase dispersion curve for each profile and join all the dispersion curves to get 2D phase-slowness maps at a set of periods (at how many periods, how do you choose the periods?). The ray tracing is then done in each of the phase-slowness maps separately. I would suggest to rewrite this paragraph.
l. 99, 102 "uneven sampling", "non-uniform sampling"; it would be helpful to your readers if you could say more precisely what you mean. If I understand correctly, it is that the number of samples is not the same at different wavelengths, i.e. periods?
You should also mention how you sample your dispersion curves. From the images, it looks like you have a uniform sampling in frequency. This means that you implicitly put a higher weight on high frequencies (a uniform sampling in period would imply a higher weight on low frequencies). Many researchers therefore apply a log-spaced sampling.
l. 105 "sigma_i,j is the standard deviation of the ith data point of the jth dispersion curve". I think there is a mistake in that description. In your matrix, only the trace is non-zero. Your sentence would then imply that for each dispersion curve, you only have a single measurement. Instead, I think that you have several measurements (at a set of periods) for each dispersion curve, so that the measurements from disp curve 1 have standard deviations sigma_1,1 to sigma_n,n, and from disp curve 2 from sigma_n+1,n+1 to sigma_n+m,n+m, and so on...
l. 109 What is meant by "closest data point"? Please explain. Also, why the delta in delta lambda_j,max if it is the maximum wavelength? (from the delta I would expect a difference)
l. 110 Did you add any error to your synthetic measurements? Please mention in the text.
l. 150 It would be good to give a more quantitative measure for the quality of reconstruction, fo example by providing the variance reduction or simply the misfit to the input model. (I just saw that you did in table 3, I would suggest that you write down these values here or refer to table 3).
l. 199 Are the values of nu and rho in your Table 2 fixed during the inversion? Please mention somewhere in the text. What influence do you expect from the potential errors in these values?
l. 214 What value for the data standard deviation (sigma, eq 4) do you assume in your

synthetic tests and in the real data examples? Is sigma individually determined for each measurement?
l 324 You weighting is based on the wavelength of the signals, but at the same time you argue with the lower number of data at long wavelengths. So should the weight not rather be based on the number of measurements at each frequency? Or, putting the question differently, if I have a dataset with exactly the same number of measurements at each frequency (as is probably the case in your synthetic experiment), do I still need the weighting?

I would like to refer again to my previous comment on the importance of the sampling of your dispersion curves. If you use a uniform sampling in frequency, it is clear to me that the low frequency measurements are underweighted. Maybe run a test with log sampling and compare to the results in Fig. 14.

Fig. 7 There should be a scale on (b). Why is the panel in (d) cropped? It seems that some dispersion curves go also to values slower than 50 m/s.