Solid Earth Discuss.,
https://doi.org/10.5194/se-2020-122-RC1, 2020

Solid Earth
Discussions
Open Access

Interactive comment on "Imaging Seismic Wave-Fields with AlpArray and Neighboring European Networks" *by* Marcel Tesch et al.

Anonymous Referee #1

Received and published: 17 September 2020

The authors proceed to an interesting and rather recent exercise in the field of passive seismology, which consists in processing the seismological records of natural earthquakes at dense large-aperture arrays and visualize ground motion vibrations as a function of space and time in a map (see e.g. IRIS Data Products http://ds.iris.edu/ds/products/gmv/).

As pointed out in the conclusion section of the article, this exercise is interesting for reaching a broad audience public, and there is probably also a potential for using such animations in joint science and graphic art experiments.

However, my first major comment is to question the general relevance of the exercise in the broad context of Geophysics: * What do we learn about the Earth? * What do we learn about the physics of wave-propagation? * Apart the images and videos, what

Printer-friendly version

Discussion paper

are the results/products of this analysis, and how and why other scientists should use these? This information is not missing but spread over small portions of the manuscript, in result sections associated to each earthquake. Consequently the reader does not immediately grasp the full utility of such an approach. I would recommend better introducing the approach in introduction, with its impacts and benefits.

My second major comment is about the displayed goal of revealing the resolution capabilities of the network and the spatial complexity of the wavefield through seismogram sections, times slices and wavefield animations. Are these standard ways of judging the resolution capabilities of an array? What about other tools classically used in array seismology (array response functions, beamforming, importance for eikonal tomography or time reversal imaging, in tomography)? Such a goal does not seem to be completely fulfilled because the analysis is mostly qualitative, and would require being more quantitative. The authors suggest that the wavefield spatio-temporal complexity should be accounted for in tomography, but a question is what is the amount of the deviation with respect to an unperturbed case, and is this amount so large that tomography, with its parameterization, damping, or smoothing, makes a large mistake by taking wave propagation in 1D Earth's reference models? Could a quantitative estimate of the spatio-temporal complexity come from the extraction of first-order perturbations (scattered wavefield) with respect to a reference state (direct wavefield)? The records could for instance be processed with a principal component analysis to separate both components. Another mean of judging the capability of the Array could be comparing the wavefield reconstruction with and without AlpArray.

Finally, my third major comment is about the organization of the paper. The Discussion section is a mixture between a result section for each individual earthquake, and in each of these result sections, a discussion of the significance of the results. The article would benefit in presenting instead the results by type of observations of interest, e.g. 1. Spotting polarity and timing errors; 2. Wavelength of the wavefield; 3. Examples of scattering and resolution. 4. Spotting exotic phases. 5. Dispersion anomalies.

6. Amplitude anomalies; and then discuss the significance for the physics of wave propagation.

Minor comments:

Page 1 line 31, left: Deviation from a plane wave. Any quantitative estimate? Page 1 line 25, right: Seismic arrays: why not using classical tools from array seismology? Page 1 line 35, left: I would say that the goal of tomography is to use (not really correct) this spatio temporal variability to image the structure at the origin of the variability. Page 3 line 26, right: Why these 6 events and not others? Why are they representative? Page 3 line 40, left: Maybe compare with Hi-Net / F-Net? Page 3 line 55, left: Is Faccenna et al. (2001) the first reference to introduce the concept of nappe stacking? This is ambiguous. Page 3 line 37, right: how to go beyond the "illustration" of spatial resolution capabilities? Page 4, line 13, right: I am quite surprised that the large amplitude surface-wave past 45 s appears as small oscillations in your gray-scale background plot when the earlier long period wavetrain appears a lot stronger in the image. Is the result of amplitude normalization by the envelope, or an effect of time sampling (binning)? Page 4, line 8, left, and Page 5, line 17, left: Concerning the processing, it is said that "all traces are detrended, instrument response-corrected, band-pass filtered between 100-500 s, and resampled to 1Hz" (page 4 line 8, left). This is long-period. Ok for looking at surface waves but what about body (P, S) waves? Figures 16 & 17 show ∼3 cycles of a P-wave in a 1 min window, so I suppose that this particular figure does not use the same bandpass as in the basic processing. Page 5, line 48, left: 8S, 9S, [. . .] →1. These are faint. 2. How can you be sure that these are corresponding phases? I think a close-up is needed for better demonstration... Page 5, line 47, right: Discussion → Is this a discussion or a result section? In a discussion, instead of focusing on events themselves, maybe you could focus on the particular features that you recognized in this data (see my major comment #3). Page 6, line 7, left: "artifact of projection" but what is the projection used here? Page 7, line 7, left: Aren't body-waves little dispersive? What difference in frequency content is there between the early and late part of the P-wave coda? Why do long-periods arrive late? Maybe a spectrogram could help? Which mechanism do you think is at the origin of this dispersion? Page 8, line 8, right: Fig. 7 -> Fig. 6 Page 8, line 11, right: spot instrumental problems → This is an interesting application, that could be introduced / listed in introduction and possibly abstract. Page 9 line 28, left: Fig. 8-12 → why this reference to 4 figures when considering only the P/Pdiff case? Page 9 line 45, right: Is this dispersion opposite to the one observed on R1? If so why? Page 15 line 14-16, left: "Furthermore, amplifications in narrow bands often oriented almost parallel to the propagation direction are frequently observed". Could you show examples of these?

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2020-122, 2020.