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Interactive comment on "*Instaseis*: instant global seismograms based on a broadband waveform database" *by* M. van Driel et al.

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General comments

This paper is based on the long-held concept of generating synthetic seismograms from Green's functions, and it demonstrates the capabilities of this approach in a modern (and future-looking) computing environment. The capabilities of the package, called Instaseis, are emphasized in the scientific applications in Section 5. The authors have done very well to demonstrate how Instaseis can be used, including finite source inversions, global tomography, ambient noise cross correlations, and waveform modeling. Instaseis could also have exceptional potential in helping to teach seismology; this point is explicit in Figure 17 but perhaps undersold in the paper. This is a "code paper," and the authors have gone to great lengths to provide a usable, documented code that

is open-source and based on a stable framework (python). I have several minor points that may help, but overall this is an outstanding, complete treatment of a fundamental tool in seismology: the calculation of global synthetic seismograms in a 1D model.

Specific comments

Section 5.3. I am confused about what is meant here by finite-frequency. My understanding is that this means volumetric sensitivity kernels are used in the place of rays. There is no mention of kernels in this section. The opening sentence (and reference) is insufficient if this is not what is meant by "finite-frequency tomography". Are we talking about databases of seismograms, of finite-frequency kernels, or of both?

p. 959, L27. This is an important paragraph to distinguish the current code from existing ones. One point that is not obvious is how readily available the alternative codes (fk, WKBJ, Yspec) are. Are these other packages available? Is there a single version or are there various copies at various places? Are they documented? It would be helpful to discuss these aspects, as one of the strongest points of Instaseis is the perceived commitment by the developers to maintain it "for the next couple years" (p. 967, L20), but of course the reader and community will hope this can last longer!

On a related note, there are many references to codes, libraries, and software. I wonder whether any of this will make sense 15 years from now. If 15 years from now was the goal, then I would recommend shifting these specific software names and details to an appendix; what is left behind would be more science, algorithmic, and performance details that may last 15 years. This is something for the authors to think about.

Axisem applies to axisymmetric models. So if someone wanted a database for some hypothetical plume, wouldn't Instaseis work? If so, then doesn't this give Instaseis (or axisem) a slight advantage over the other techniques, which require a 1D model?

The scientific applications, notable Figures 21 and 23, are excellent. In Figure 21, even within the direct P window there are significant differences between axisem and fk.

p. 964, Eq 2. Where are sp and zp defined? In general, I'd rather see explicit notation, like s(xi, eta) and z(xi, eta) in Eq (2).

p. 972, L16. "With Instaseis, we can now build the whole database for all possible sources with only two runs of AxiSEM." This is quite misleading. Just add a line like this: "(Of course, this means that the database of Green's functions has to be completely computed in advance, as described in Section XX.)"

Figure 6. It might help to also include an example time series of time series for some chosen source depth. This might help the reader comprehend what is being shown. (Also, the "1 / N" label is odd to me.) You need to explain what the phase and envelope misfits are of. I'd recommend an (a), (b), (c), and an expanded caption here.

Figure 14. My reading of the caption is that the dashed lines are some kind of best fit to the points. But the residuals seem to be highly systematic (and also discussed in the caption). Is the line-fitting being applied to the first few points (or first point), perhaps? Please clarify.

Speed is certainly a theme in this paper. But something that is conspicuously missing is the benefit from speed, in terms of an operational setting. On the data side, early warning systems are very concerned with the speed that earthquake source parameters can be estimated. Would it be worth mentioning this motivation?

Technical corrections

Title. This is a matter of personal preference, but I think that this title is stronger Instant global seismograms based on a broadband waveform database People will probably never find the code based on the title of the paper, so I don't see why it has to be in the title. Somehow it feels like the authors are trying to sell me "Instaseis" with the current title. (They do a good job!) I recommend putting "synthetic" in the title (either before seismograms or waveform), just to be clear.

p. 958, L14. Maybe: "1-D Earth models" (since the implication is that the 1-D models

are for Earth, not Mars)

p. 960, L18. Comma: "sources, two."

p. 960, L5. widespread (not wide spread)

italics are overused and are a distraction (e.g., Section 2.2). I don't see why they are present.

p. 962, L7. "The displacement u [move to here: within each element]"

p. 963, L26. The "Instead . . ." is ambiguous. Maybe "We follow a two-step, non-analytical approach to finding the reference coordinates. First, . . ."

p. 966, L19. Isn't open-source a big reason for choosing python?

p. 966, L22. Might want to avoid the term "use case," which may not be familiar to readers. (What about "uses for Instaseis"?) Or perhaps point the reader toward Section 5, where these use cases are listed.

p. 969, L10. Comma after "2 s period" or rewrite this sentence.

p. 969, L11. Replace "them".

p. 969, L20. "which allows to do" (fix)

Figures. I was thrown off by the "/" used to separate the axis label from the units. Is that conventional? I think of / as division.

Figure 10. Would it be more appropriate to show the downsampled version as just points (unconnected)? This might also convey that it is not "bad" like the blocky one that is plotted.

Figure 13. "EM and PM [add: in the subplot title]"

Figure 17 caption. Change to "shows a three-component seismogram" (right?)

Figure 20 caption. "southern California". Also you might want to mention that the

beachball provides the orientation and predominant sense of slip. (Since a beachball usually implies a point source, which is not the case here.)

Figure 22. Is it possible to improve the perspective on this impressive figure? Perhaps adding a white equatorial great circle for each of the shells would do the job? And a white line running from the North Pole to the South Pole.

Figure 23. Just to be clear, you might want to start this caption with “Synthetics ambient seismic. . .”

p. 968, L19. Give a parenthetical calculation for the 800 wavelengths number.

some native English editing could help in places; some examples are here:

p. 960, L13. Change “AxiSEM was from the beginning designed” to “AxiSEM was designed from the beginning”

p. 967, L16 “from a usage perspective it thus does” to “thus from a usage perspective it does”

Interactive comment on Solid Earth Discuss., 7, 957, 2015.