Dear Dr. van Driel,

Thank you very much for reviewing our manuscript. In the following paragraphs we reply each of your comments. For each reply we detail what we changed in the manuscript accordingly.

Kind regards,

Sebastian Heimann

Comments by Martin Van Driel

I.

Comment: There is a paper about IRIS's syngine service, not just a website, so it should be referenced: Krischer, L., Hutko, A., van Driel, M., Stähler, S., Bahavar, M., Trabant, and Nissen-Meyer, T. (2017). On-demand custom broadband synthetic seismograms, Seismol. Res. Lett. 88, no. 4, https://doi.org/10.1785/0220160210.

Thank you. We added this missing reference.

Changed: "... for seismological applications, like e. g. Instaseis (Van Driel et al., 2015) or Syngine (IRIS DMC, 2015; Krischer et al., 2017)."

II.

Comment: P8, L13: "The program INSTASEIS (Van Driel et al., 2015) is suited to calculate approximative wave solutions for a 3D Earth structure with radial symmetry" - This statement is completely wrong, instaseis (not fortran, hence no capitalization in the name), does not solve the wave equation and is hence also not limited to radial symmetry. We use AxiSEM to compute the databases, which is where the limitation to spherical symmetry comes from, but that is completely independent of instaseis, which could easily include any other database source

We apologize for this incorrect statement. We changed the description accordingly.

Changed: "~~The program INSTASEIS (Van Dliel et al., 2015) is suited to calculate approximative wave solutions for a 3D Earth structure with radial symmetry.~~ The program AxiSEM (Nissen-Meyer et al., 2014), as employed by Instaseis (Van Driel et al., 2015), provides seismic wavefields for a 3D axisymmetric Earth structure."

III.

Comment: One of my main concerns when I wrote instaseis was to be accurate enough in space to place receivers anywhere and still get the phase correct so you can apply array methods. Similarly, we wanted to be accurate in the presence of discontinuities. This is in fact a non-trivial interpolation, and we approach it using the spectral element basis, which we discus in some length in our paper. The statement on P10 L2 makes me very suspicious that this issue is treated appropriately here.

Thank you for this comment. We are aware of the importance of interpolation effects and the need for appropriately fine GF component grid spacing for sufficient accuracy in space and time. We agree that the reader should be made aware of it more explicitly and provide advise. We added text to that effect in Section 3.3 "Source Design" and explain the influence of the user defined grid spacing and interpolation with an expanded paragraph and an additional figure.

Changed:

Section 3.3, from second paragraph on: "The calculation of an observed quantity of interest (e. g. seismic waveforms) for a point source with delta-force excitation at a particular source-receiver constellation is given in section 2. As described above, the specific combination of GF components is defined by the source type and the observed type of quantity (e. g. a full moment tensor or a single force, generating far-field waveforms or surface displacements, see Tab. 1).

The observed quantity at the receiver is a linearly weighted combination of the spatially closest GF components. Often, this requires interpolation to match the requested source-receiver configuration. The interpolation ~~between neighbouring grid nodes can be simple~~ of GF components requires an ap-

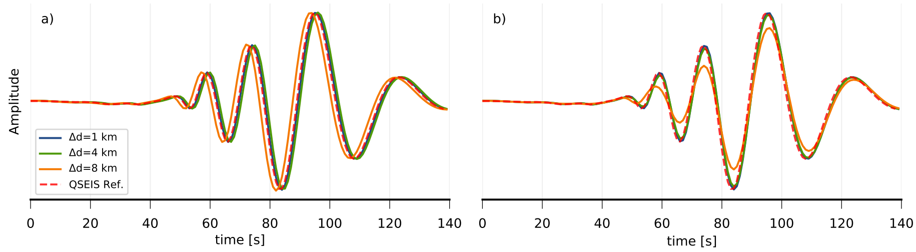

Figure 1: Comparison of interpolation artifacts on synthetic waveforms with different GF grid spacings (a: nearest-neighbour, b: multi-linear). Shown are vertical component displacements, based on GF stores with 1 km, 4 km and 8 km spatial grid spacing (blue, green and orange, respectively) against a reference for the exact source-receiver distance (QSEIS; red). The sampling rate is 2 Hz and the signal contains information up to close to the Nyquist frequency (1 Hz). The waveforms are filtered with a pass band from 0.05 Hz to 0.1 Hz, after interpolation. The medium is layered with important discontinuities of upper crust, lower crust and mantle at 20 km and 35 km depth, respectively. The slowest seismic velocity in the medium is 3.5 km/s. The waveform is simulated for a 10 km deep moment tensor source at a distance of 553.3 km.

propriate density of grid nodes to result in seismograms that are accurate in amplitude and phase (Fig. 1). Furthermore, simulated seismograms vary for different interpolation methods such as nearest-neighbour or multi-linear ~~interpolations. As described above,~~ interpolation. For standard applications with multi-linear interpolation, we could require that the grid spacing d_{grid} should be less than a quarter of the ~~specific combination of GF components is defined by the source type and the observed type of quantity (e. g. a full moment tensor or a single force, generating far-field waveforms or surface displacements , see Tab. 1)~~ minimum wavelength. It can be estimated using the minimum wave velocity v_{min} and the maximum signal frequency of the GF traces f_{max} with $d_{\mathrm{grid}} = v_{\mathrm{min}}/(4f_{\mathrm{max}})$. For applications requiring higher accuracy, a smaller grid spacing must be used. For static displacements in the near-field of finite sources discussed below, an appropriate gird spacing is smaller than half the minimum source-receiver distance. In general, smaller grid spacing leads to higher accuracy at the cost of forward-modelling performance and larger GF stores. Interpolation of GF components in the spectral domain is superior but computationally more demanding (Gülünay, 2003)."