Review of the manuscript :

Fully probabilistic seismic source inversion – Part 1: Efficient parameterisation

By S.C. Stähler and K. Sigloch

General comments

This study is interesting and should merit publication once some points have been corrected (see below). I underline that the structure of the manuscript is good and that several very good ideas are applied in order to reach a valuable goal : quantifying the source uncertainties that have to be taken into account in the context of waveform tomography. Section 4.3 well illustrates that.

I only regret that authors did not pay attention to some « details » (but still important) present in the manuscript. This explains why I have a number of « specific/technical comments » below. Please provide modifications/ clarifications for all these points.

A general comment : Because the scope of future studies will be based on a large catalogue of earthquakes, the reader would like to see some compact results of the analysis for more than one earthquake, in order to better assess how the method is working. It is nice to show a fully worked example (Virginia earthquake), but a last figure showing STFs-depth-moment tensor for a set of ~10 earthquakes, with different magnitude and contexts, would also improve clearly the manuscript. This is not a point which prevents from publication, but I think this would illustrate well the robustness of the method.

Finally, the answer provided by the authors to a first comment I made, about the ability of modelling complex STFs with the basis functions, could be moved in an appendix of the paper.

Specific comments

- Beginning of section 2.1 (page 1129) is not well written :
    - equation (1) is not well introduced by the 2 lines above
    - Use of « Green's function » is incorrect (even if it is right that it is often improperly used in this way) in equation (1) ; derivatives of the Green function should appear in this equation (see e.g. Aki Richards, 2002)
    - Even if the Green tensor is symetric, you have to sum over the 9 components, not 6 ?

- Page 1131 : Why substracting the mean before principal component analysis ?

- Page 1131, line 7-8 : s0 is written to be shown in Figure 2a, but does not appear on the figure ?

- Reading Figure 2b at 5% misfit, N seems higher than 12-14 (chosen at bottom page 1131)

- Page 1132 : Equation (4) appears wrong (just check with a double couple unitary moment tensor :Mxx=1,Myy=-1, and all the other components equal to zero). Equation should be :

M0=1/sqrt(2) . sqrt(Mxx**2 + Myy**2 + Mzz**2 + 2Mxy**2 +2Myz**2 + 2Mxz**2)

- Moreover, the scheme at the bottom of the page 1132 appears strange to me : it did not allow the simple unitary moment tensor shown above, because Mxx=1 imposes Myy=0. Please check the scheme or explain more.

- Crust2 provides an upper, middle, and lower crust. Page 1133, authors write that they use a 2-layered crust from Crust2. Please explain which layers you are using from Crust2.

- Constant k appears mixed with its inverse in equations 7-8-9 (page 1134): please pay more attention.

- Page 1135, your definition of Di implies that your cross correlation is normalized which does not appear the case in equation 12. And even a normalized correlation is usually between -1 and 1, not between 0 and 1. Please be more precise.

- Page 1136 : Why events deeper than 100km have to be treated separately and how ?

Technical corrections

- Table 4 is referenced (page 1127) before the other tables.
- Show a b c in Figure 2
- "sinc based" is shown in figure 2, but explained only very late in the manuscript.
- Text between equation (7) and (8) : make notations consistent.
- Equation 10 : what is N(0, SD) ?
- Page 1134 , line 17 : suppress « to be » ?
- Page 1139 : Your sentence describing the CLVD/double couple character of the moment tensor as a function of epsilon is valid if you have already assumed that there is no volume change. Please also write explicitly that you choose sigmaCLVD=0.2, if it is the case.
- Page 1141 : « Mode of the depth » : What does it mean exactly?

- Page 1145 : what are Si and d (line 11) ? Parameters for STF basis function and depth ? Please write the sentence more explicitly.
- Page 1146 : normalization constant Z : is it normalization constant k of equation (9) ?

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