Editor  
Comments to the Author:  
Both reviewers think that your paper could be published. I recommend minor revision following their arguments.  
  
Please provide self-contained information by pointing clearly the literature when needed in order to avoid extensive repetition.  
  
In order to avoid a new reviewing procedure, provide clear answers to questions raised by reviewers.  
  
Thank you for submitting your work to GJInt.

Our thanks to the Editor and the two Reviewers for the helpful comments.  
  
Reviewer: 1  
  
Comments to the Author(s)  
In this paper, authors presented detailed analysis of S-p converted wave sensitivity kernel, which is very informative for S wave receiver function imaging, such as LAB. Here are some comments:  
0) I am very surprised that the isochron of S-p is so flat, compared with Ps, which explains that short period topography of LAB can not be well imaged. If possible, please include some formula or references to make it self-contained. 

The isochrons can be obtained by ray tracing through an elastic halfspace. We have added language at the bottom of page 4 (section 2.2) and an additional diagram (Figure 2) to clarify how they are generated. We are confident that these isochrons are correct because they closely agree with the shape of the SEM derived kernels.

1) in page 11, section 2.7: For the benchmark, is is for half-space case or layered model, since two cases are given in 2.6 in ray-based approximation.

The benchmark was carried out for the halfspace case. We have clarified this in the text on page 11, section 2.7.

2) in page 12, section 3.2: It is well known that the back-projection operator or adjoint operator cannot preserve true amplitude. One can compensate it by (approximate) inverse of its Hessian matrix. That is why the amplitude of deep interfaces are weaker in your synthetic cases.

Thank you for this suggestion. We ruled out the use of the Hessian for this problem at early stage given considerations about the large size of the inverse problem. In this paper we have focused on outlining a method that accurately retrieves discontinuity depths, but future work should indeed pursue more accurate amplitude retrieval, and the use of the inverse Hessian matrix is one promising approach, and conjugate-gradients is another. We have added discussion of this to our manuscript (see changes on page 17).   
  
  
Reviewer: 2  
  
Comments to the Author(s)  
This is a well-written and clear manuscript that presents the sensitivity kernels for S-to-P converted phases. The authors demonstrate that these are well-approximated with ray theory. They also demonstrate that these kernels may be used to invert for complicated structures such as discontinuities with lateral depth variations. It is a good idea and well-presented and I think it is suitable for publication in GJI after minor revisions.   
  
The authors test discontinuities at a variety of wavelength, total depth variability, and filtering. A 5 km station spacing is assumed for most structures.   
  
It would be interesting to see recovery for 10 and 20 km (or more) station spacing for some of the other models considered, since 10  - 20 km (or more) spacing is more commonly the reality. 

Although 5 km spacing is finer than found in many real-world applications, we think that it is a good starting point to test the abilities and limitations of this imaging method. In general, as the station spacing increases, the dominant period of the data must be increased (by lowpass filtering) to avoid the spatial aliasing problem. This is shown succinctly by Figure 12 (in revised version). In our new discussion of error surfaces (see comments below), we have added a few sentences about how interstation distance contributes to uncertainties. We have also decided to add two new Figures (10 and 11) that show the some suite of models from Figure 8, but for greater station spacing.

It would also be helpful to see how a dipping structures like subducted slabs are resolved, although this may be beyond the scope.

We would argue that the suite of undulating structures tested in our paper *do* place a constraint on maximum resolvable dip (please see section 3.3). A recently accepted paper by Hansen and Schmandt explores the issue of subducting slabs in detail, so we prefer to cite their work rather than repeat their analyses here.

Are there error surfaces that could also be useful here? What do they look like?

We agree that it is important to provide an estimate of uncertainty in our back-projection images. The uncertainty in retrieved amplitude is depicted in Figure 13 (revised version), but we did not previously discuss the uncertainty in retrieved discontinuity depth because we had deemed it to be minor based on visual inspection of Figure 8.

In the revised manuscript we have added a discussion of this at the top of page 15. In cases of mild topography, the RMS residual in depth retrieval is on the order of 1 km. The RMS residual becomes slightly larger if (1) the topography wavelength is decreased; (2) the topography amplitude is increased; or (3) the discontinuity interface is moved to greater depth.

Hansen & Schmandt have also recently been working on ray theoretical kernels for mulit – mode P-to-S and S-to-P Receiver Functions with a focus on subduction structures. I don’t think this work has been published yet, although the authors should look for it and cite it if possible. 

Thank you for this suggestion. We have personally contacted Hansen & Schmandt who recommended we cite their paper which was accepted in G-Cubed last week. The citation can be found in our revised manuscript on page 19.

The reference list could be expanded slightly to include the other groups that have worked on S-to-P receiver functions. 

We have added more citations on page 2 to include more groups that work on Sp converted waves.

Typos:  
  
Page 11 line 31, is the dependence of omega written correctly?

This is a problem with my typesetting. It has been fixed in the revision.

Page 10 line 60/61 are you referring to Figure 5f or 5h? check.

5f is correct. \*\*\*Note: This is Figure 6f in the revised version.

Page 13 line 41 write pi as the greek symbol.

Thanks for pointing this out. It has been fixed in the revision.