

## ***Interactive comment on “Green’s theorem in seismic imaging across the scales” by K. Wapenaar et al.***

**K. Wapenaar et al.**

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We thank referee 1 (Andreas Fichtner) for his overall positive review of this paper. We have addressed most of his comments in the annotated manuscript (changes are indicated in blue). Here we discuss a number of specific issues.

First we want to mention that, given the wide range of methods discussed in the paper, the discussion of each method is necessarily brief. We have deliberately chosen for a somewhat informal style, by first introducing a method with intuitive arguments, followed by a more quantitative explanation. Our aim is not to go into depth for each method, but mainly to show connections between the methods, using the acoustic version of Green’s theorem as the unifying basis. We have given plenty of references for

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readers who want to learn more about specific methods, including extensions for full elastodynamic waves.

Having said this, we appreciate the remark of this referee that our explanations are sometimes too brief for readers who are not yet familiar with a specific method, so we have extended the explanations where necessary. In particular, we have significantly expanded the explanation of the focusing function in section 3.1.

The referee is worried about the approximations that are made to derive the expressions for Green's function retrieval by cross-correlation (section 2.3). We have improved the text to explain the approximations better. We would like to add the following. The method of Green's function retrieval from ambient noise, which is widely used by the seismological community, was originally based on rather intuitive arguments. The derivation presented here shows that the method can, at least in principle, not only retrieve the direct wave but also scattered waves, and, more importantly, it reveals the underlying approximations. The limitations of Green's function retrieval by cross-correlation have been recognised by many researchers (including the authors and the referee), who proposed many improvements. Several references are given to improved methods.

Responses to some of the comments on the annotated manuscript:

We have shortened the 'historical review' in the introduction and removed references to full waveform inversion (which is not further addressed in the paper anyway).

We briefly explain equation (7), but do not follow the suggestion to state that it requires that there are no waves parallel to the boundary. To our opinion, for this expression in the space-frequency domain it is sufficient to state that evanescent waves are excluded.

We understand that figures with the label "artist impression, figures not to scale" led to confusion. We have rescaled the figures and removed the label.

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We reduced the contrasts of the scatterers in figures 2 and 4, so that the focus becomes better visible. We think this change is justified because these figures are merely intended to illustrate the principle of the discussed methods.

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