Review #2

PROPOSAL NO.: 0417929
INSTITUTION: U of Colorado Boulder
NSF PROGRAM: GEOPHYSICS
PRINCIPAL INVESTIGATOR: Ritzwoller, Michael H
TITLE: Collaborative Research: CMG: Uncertainty and Physical Constraints in Seismic Inferences
RATING: Very Good

REVIEW:
What is the intellectual merit of the proposed activity?

The PIs propose interdisciplinary work between a seismologist and an applied statistician on quantification of uncertainty in seismic inverse problems, especially in the presence of physical constraints, and approximation in modeling. These problems have been talked about for several decades (at least), and further efforts are certainly justified. The PIs are well respected and productive in their respective fields. Stark has a background in geophysics, is already reasonably knowledgeable about seismology, and has spent his career working on statistical approaches/perspectives in geophysical inverse problems. I am less familiar with Ritzwoller's work, but was favorably impressed with work described in the proposal on surface wave inversion incorporating physical constraints. Together the PIs represent a good team to perform this research, and on this basis I recommend funding if possible.

One thing that bothered me about the actual proposal was that it did not clearly explain (to me at least) how a more sophisticated statistical perspective was going to lead to new or improved ways to quantify uncertainty in geophysical inverse problems. The discussion of the seismic inverse approach was fairly extensive, but it was all from a pretty standard geophysical point of view. The more abstract statistical discussion was separate, and the discussion of how these were going to connect to improve characterization of uncertainty was hardly touched on. I would rate the proposal more highly if the connections had been more clearly thought out (or explained) at this stage.

I also couldn't help but wonder if the specific geophysical inverse problem discussed here is the best problem for developing or illustrating more sophisticated statistical methods. As I understand the surface wave inversion discussed, plan-view tomographic images are constructed for surface wave phase velocities (one frequency at a time), and the results then treated as data to be inverted for 1-D profiles of seismic parameters. There are all sorts of issues with the approximate nature of this inversion (e.g., no forward model is run to see that any of the possible inverse solutions are actually consistent with the data; there are physical constraints on dispersion curves; how are these accounted for in selecting feasible solutions for the tomographic images?) All of this might make sense from the viewpoint of developing a practical geophysical interpretation method, but is this a good test case for developing more rigorous statistical methods?

What are the broader impacts of the proposed activity?

The proposed project will train graduate students and post-docs, both in statistics and geophysics. The more exciting possibility, that may well emerge, would be to train individuals with some reasonable level of expertise in both fields.

This is not really disccussed, except for short (1-2 week) exchange visits, but presumably these young researchers will have significant contact with both PIs and this will happen to some degree.

Summary Statement

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