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Mapping fine-scale structure near the core-mantle boundary beneath USArray

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Recent studies agree that weak (r.m.s of 0.1%) small-scale (∼6 km) random velocity fluctuations distributed throughout the lowermost mantle explain globally-averaged PKP precursor amplitudes in the 0.7-2.5 Hz frequency band. Precursor amplitudes in individual seismograms, however, exhibit much variability, suggesting that some regions in the lower mantle are more heterogeneous than others. It is difficult to reliably map differences in scattering strength from single seismograms due to reciprocity considerations, but seismic arrays provide a means to distinguish between source- and receiver-side scattering. We use a traditional beamforming method to measure the slowness and azimuth of scattered energy incident upon the array, and a migration method to map coherent precursor energy to points of origin near the core-mantle boundary.

The focus of this paper is to test the robustness of these methods with the wealth of USArray data. We conduct several tests to address the following questions: 1) how well does traditional beamforming agree with results from the migration method?, 2) how consistent are structures resolved by different subsets of receivers for a given event?, 3) how consistent are structures resolved by a given set of stations for distinct, but nearby, events?, and 4) how consistent are structures resolved when using seismograms filtered at different frequencies?

The coarse spacing (∼75 km) of USArray limits our ability to make reliable slowness measurements because of spatial aliasing. It may be possible, however, to make measurements of longer-period precursors scattered by larger-scale (∼100 km) structures. Another possible solution to the spatial aliasing problem is to include additional data from PASSCAL experiments with densely-spaced stations that were deployed as the Transportable Array rolled across North America.