A Seismically Sound Foundation: Reference Models and Datasets

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One-dimensional reference Earth models (e.g. PREM) serve as a foundation for earthquake location, imaging of interior structure, and understanding material properties under extreme conditions. Over the past three decades, 3D models of how properties vary both laterally and with depth have proliferated, based on ever-growing datasets processed from waveforms collected by the Global Seismic Network, PASSCAL deployments, and regional networks. Though these models exhibit compelling similarities at large scales, differences in the methodology, representation of structure, have prevented the creation of 3D community reference models. Furthermore, the consistency among underlying datasets has not been extensively studied, limiting our insights into the uncertainty associated with commonly used measurement techniques.

A 3D Reference Earth model (REM-3D) should ideally represent the consensus view of long-wavelength heterogeneity in the mantle through the joint modeling of large and diverse seismological datasets. To this end, we are compiling and reconciling reference seismic datasets of body wave travel-time, fundamental mode and overtone surface wave dispersion, and normal mode frequencies and splitting measurements. The resulting reference dataset will contain quality-controlled and comprehensive set of seismic observations and enable the construction of REM-3D. The community response has been enthusiastic with several groups across the world contributing datasets containing over 100 million measurements.

Here, we summarize progress made in the construction of the reference dataset and present a preliminary version of REM-3D in the upper-mantle. In order to determine the level of detail justified in REM-3D, we analyze the spectrum of discrepancies between models inverted with different data subsets. As a community reference model with quantified uncertainties and tradeoffs and an associated publically available dataset, REM-3D will facilitate Earth imaging studies, earthquake characterization, inferences on temperature and composition in the deep interior, and be of improved utility to emerging scientific endeavors, such as geo-neutrino study.

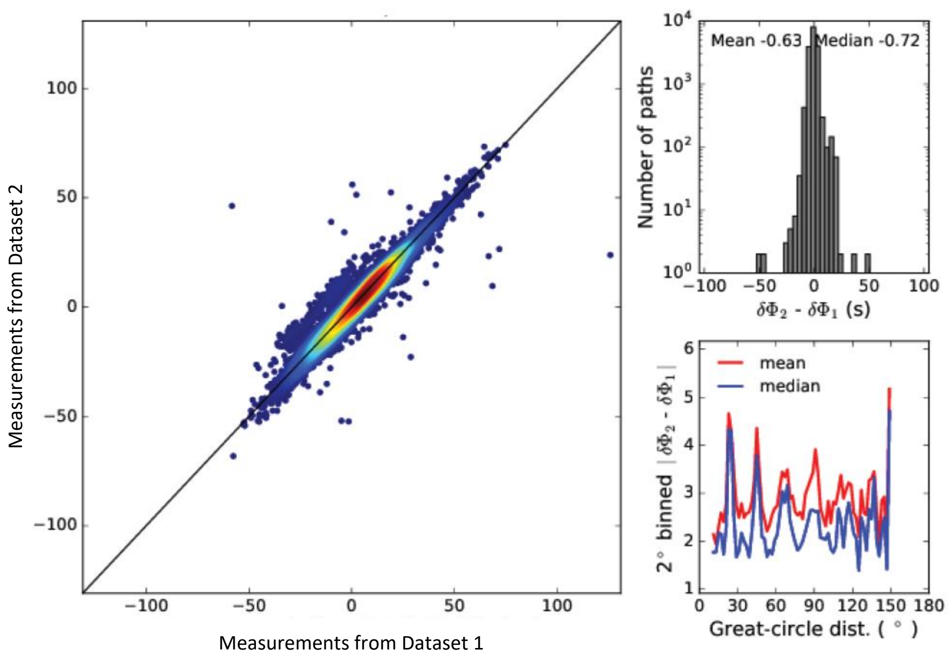

Figure 1 – Analysis of inter-dataset consistency of phase velocity measurements of 100 s fundamental Love waves along identical paths. Colors in the scatterplot (far left) are proportional to the density of points. Note the periodicity in mean and median discrepancy between datasets vs. epicentral distance (lower left), potentially due to overtone interference. This type of analysis allows measurement uncertainty to be quantified (top left).