The seismic structure of the central Mexico subduction zone, particularly the interface between the slab and overriding plate, is studied using shallow (40-80 km) intra-lithospheric earthquakes of moderate magnitude (Mw 4-7). Regional waveforms from the Mapping the Rivera Subduction Zone (MARS) seismic array are compiled and used to deduce detailed information about the subduction zone structure. Identification of seismic phases, their arrival times, and any possible complexities in their waveforms provide evidence of lateral variations in structure. The detailed waveform information obtained is used to model the structure of the slab. Plots of individual stations, particularly on the Rivera-Cocos plate boundary region, where recent studies have shown evidence for possible slab tearing. Initial 1D modeling is conducted in order to learn more about the origins of seismic phases present in the data. A sensitivity test is performed in which synthetic waveforms produced using five different 1D models are compared to observed waveforms. The results of this test show that no single model can accurately predict all of the major seismic phases at all distances, but individual models fit the data well in particular distance ranges. These 1D models will be combined and fine-tuned in 2D forward modeling in order to provide a more accurate representation of the lateral variations in the subduction zone structure.

1D Modeling Results

The sensitivity of observed waveforms to subduction zone structure is tested in 1D using five different models. The synthetics produced from each of these models are compared to the data in order to assess how well the model predicts major seismic phases. The model output for all three seismic components are ordered from left to right by decreasing accuracy. While no single model can accurately predict all of the major seismic phases at all distances, individual models fit the data well in particular distance ranges. Overall, the 'alex_ykim' model provides the most accurate prediction of the data, with the best fits to P, S, and SH phases at all distances, along with an S-wave multiple at large distances. The SoCal model provides a comparable fit to these phases, but fails to predict some of the waveform complexities seen in both the data and the 'alex_ykim' model, such as the "shoulder" following SV. The uppermost slab structure in the 'alex_ykim' model, particularly the ultra-slow velocity layer, is likely responsible for reproducing the observed waveform complexities that the simpler SoCal model fails to predict.

Array Profile

Profile across the MARS array along NW-SE line using the 'alex_ykim' model. Data are in black, synthetics are in red. Model synthetics predict P and S$^\prime$ phases reasonably well at all distances, as well as SH arrivals. For stations located within the TMVB, complex waveforms are observed after the arrival of the S$^\prime$ wave in the data (indicated by blue box) and are most prevalent on the transverse component. These complexities are not predicted by the model synthetics and may be indicative of a change in crustal structure within the TMVB region.

Future Work

Future backprojection analysis of P-wave traveltimes used in order to locate and identify observed high velocity structures.

- Contrast and perhaps 1D models in forward modeling of the 2D structure using a non-linear inversion algorithm in order to provide constraints on the thickness, velocity, and geometry of each slab's subduction zone in the region. Of particular interest is the region where the slab transitions from flat to normal dip angle near the Oaxaca Fracture Zone, where slab tearing may have occurred.

- Incorporate regional waveforms from the contemporaneous MASE array in all modeling efforts.

References