Thermal and chemical properties of the mantle transition zone from seismic observations

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The mantle transition zone (MTZ), bounded by 410 and 660 discontinuities, is a key region to understand the thermal, chemical, and dynamical evolution of the mantle. Mantle dynamics is primarily thermally driven and the topography of 410 and 660 has been widely used to infer the temperature of the MTZ. However, in a number of recent studies, we have found that properties of transition-zone discontinuities may also provide insight in the distribution of compositional heterogeneity. We will present preliminary results from a global study of PP and SS precursors using a curvelet-based seismic array processing technique, where we successfully extract P⁶⁶⁰P signals, which are traditionally difficult to observe, over a wide distance range. Comparison with thermodynamic models suggests that on a global scale, amplitude trends of SS and PP precursors from both 410 and 660 are consistent with predictions from a pyrolitic mantle transition zone. We also find that global variation in MTZ thickness has a positive correlation with velocity anomalies within the MTZ. Both of them are likely controlled by thermal anomalies, consistent with mineralogical phase transitions of the olivine system. In an application of this method to data from Hawaii however, we found evidence of compositional variations, consistent with the analysis of tomographic images below a few other hotspots. Further compositional heterogeneity linked to recent subduction has been found from a receiver-function study below the US. Results thus indicate a quite well mixed background mantle with more heterogeneity in areas of recent up-and-downwelling.