Receiver function analysis reveals lateral variations in temperature and water content in the mantle transition zone beneath eastern North America

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Using recently collected high-resolution seismic data along a dense linear transect across Ohio, West Virginia, and Virginia (called MAGIC profile), we analyse P-to-S receiver functions to investigate the undulations of the mantle transition zone (MTZ) discontinuities (410-km and 660-km) beneath the central Appalachian region. Our results incorporating the effects of local crustal and mantle structures suggest shallowing of both the 410-km and the 660-km discontinuities from the northwest (inland) to the southeast (coast) along MAGIC profile. Hydro-thermal upwelling beneath the eastern U.S. coastal plain due to a hydrated MTZ and hot upwelling return flow associated with the descending lower mantle Farallon slab is consistent with our observations of MTZ structure considering 3D velocity heterogeneity. The inferred hydrous hot upwelling rising into the upper mantle may trigger dehydration melting atop the 410-km discontinuity, which may help to explain the presence of a low velocity upper mantle anomaly beneath the region today.