Crustal thickness variations in eastern North America: Implications for the geometry of 3D tectonic boundaries within the crust

Cong Li* and Haiying Gao

Department of Geosciences, University of Massachusetts Amherst, Amherst, Massachusetts,

Abstract

Teleseismic P-wave receiver functions are calculated to image the Moho geometry in eastern North America in order to explore crustal thickness variations and possible linkages with tectonic units. Waveforms from 2010 - 2018 are analyzed for a total of ~ 670 broadband seismic stations, yielding a well-distributed data set with high lateral resolution. Consistent P-to-S phases converted at Moho can be clearly observed. Our receiver function analysis has revealed significant Moho depth variations, which are well correlated with the distribution of Bouguer gravity anomalies. We observed a complex Moho depth distribution pattern, both across and along the orogenic strike, which provides insights into the formation and modification of the crust during and after the major orogenic events. A detailed study of the Moho depth variation in northeastern United States reveals a sharp east-west Moho step in southern New England, near the interpreted surface boundary between Laurentian and the accreted terranes. This may indicate a nearly vertical or steep dipping Laurentian basement within the crust, reflecting the cumulative effects of subsequent tectonic events after the Appalachian orogenies. In contrast, the Moho variation is more gradual in northern New England, in correspondence with the widening of the Appalachian orogen. The lateral offset between the Moho step and the Appalachian front in the north may indicate a generally eastward-dipping Laurentian basement. In the near future, we will analyze variations of the Moho depth and lithosphere-asthenosphere boundary within entire eastern North America and explore probable interpretations.

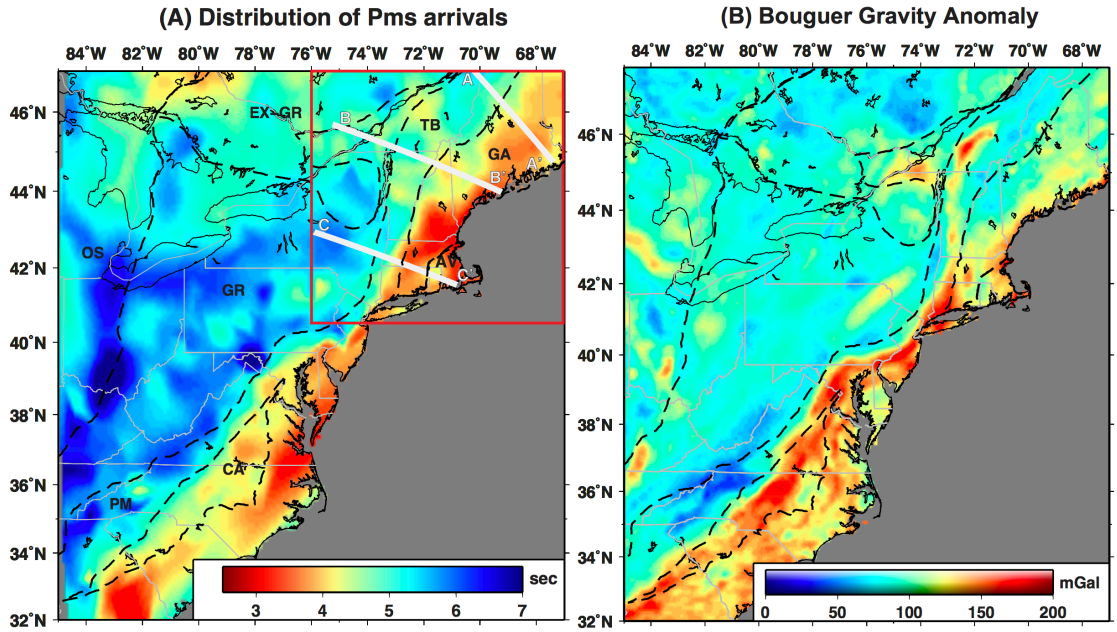

Figure 1. (A) Distribution of the P_ms arrival time (in seconds) interpolated in this study. Gray lines mark the state boundaries. Black dashed lines mark the interpreted Grenville-to-accreted-terrane boundaries and the interpreted Grenville front by Hibbard et al. (2006) and Karabinos et al. (2017). White solid lines mark the location of three profiles in Figure 2. AV - Avalon, GA - Gander, TB - Taconic Belt, EX-GR - Exposed Grenville province, GR - Subsurface Grenville province, OS - old shield of Laurentia. (B) Distribution of Bouguer gravity anomalies from Bonvalot (2012).

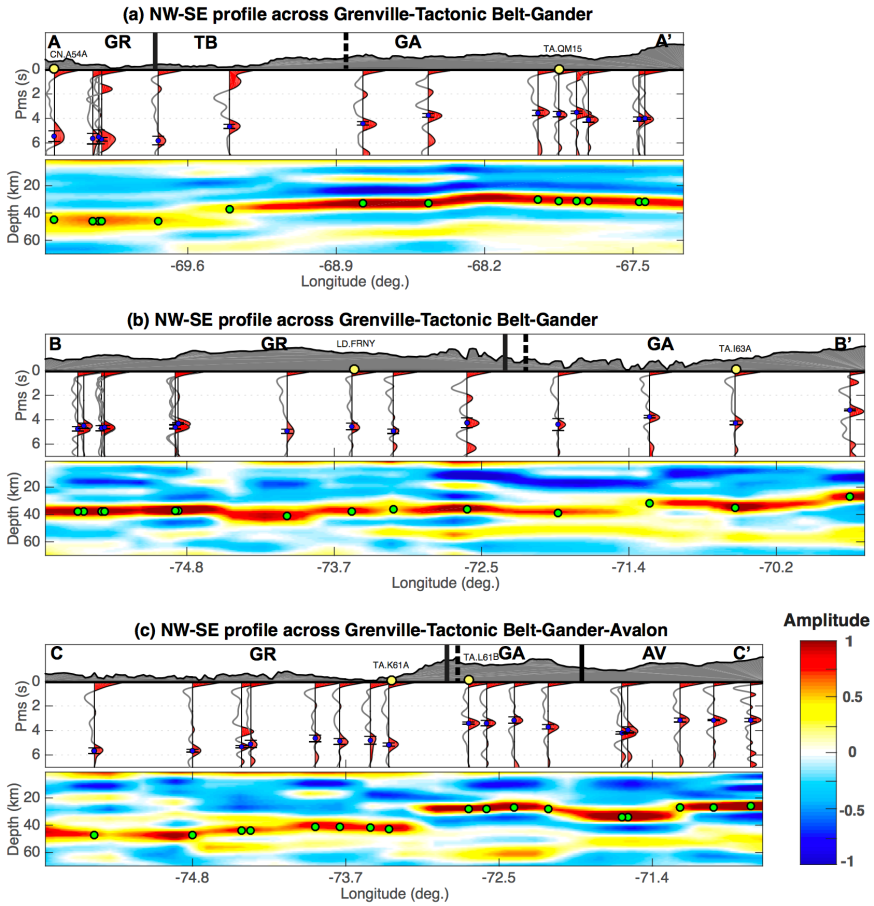

Figure 2. Cross sections of stacked radial receiver functions in the time domain along the three profiles (upper panel) and corresponding depth profiles from the common conversion point stacking (bottom panel). The Bouguer gravity anomaly and major tectonic units are marked above each profile. Blue dots denote the P_ms arrival times with estimated uncertainties, and green dots denote the Moho depth. This figure is from Li et al. (2018, GRL, in review).