Seismic imaging of the entire northeast Japan arc by a joint inversion of land and sub-oceanic data

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In the last two decades many tomographic studies have been made for the northeast (NE) Japan arc by using local earthquake arrival time data. However, all these studies are for the crust and upper mantle under the NE Japan land area; the 3-D structure under the surrounding Pacific Ocean and the Japan Sea is still unclear because of the lack of offshore seismic stations. Recently, Zhao et al. (2002) and Mishra et al. (2003) have determined the 3-D structure in the NE Japan forearc region under the Pacific Ocean by using the arrival time data recorded by the land seismic networks from the sub-oceanic events whose hypocenters were located accurately by using the sP depth phase data (Umino et al., 1995).

To better understand the structure and seismotectonics of the entire NE Japan arc, in this work we have tried to combine the arrival time data from the earthquakes beneath the land area and the Pacific Ocean to image the 3-D P and S wave velocity structure under the entire NE Japan arc from the Japan trench to the coast area of the Japan Sea. We used 136,636 P and 77,690 S wave arrival times from 4296 local earthquakes occurred under the land area and 690 events that occurred under the Pacific Ocean and are well located with the sP depth phase data.

Our inversion results confirmed the major features delineated by the previous studies and revealed some new features of structural heterogeneity beneath the NE Japan arc. The cold subducting Pacific slab and the hot mantle-wedge low-V are clearly imaged. Strong lateral heterogeneities are revealed on the upper boundary of the Pacific slab under the forearc region, which show a good correlation with the spatial distribution of the large interplate earthquakes. Widespread slow anomalies are visible in the forearc mantle above the subducting Pacific slab, which may reflect the serpentinization of the forearc mantle associated with the dehydration process of the subducting slab.