Adjoint Tomography of the 3D Seismic Velocity Structure in the Japan Subduction Zone

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Both forward modeling and adjoint tomography techniques based on spectral-element method (SEM) are used to investigate the 3D velocity structure in the Japan subduction zone. From our previous study (*Chen et al.*, 2007), a very low velocity layer (LVL) on top of the slab beneath NE Japan has been revealed and modeled using complex waveforms. LVL plays a very important role in subduction zone water transportation and the dynamic evolution of the slab. However it's still unclear whether the LVL is a general feature in the entire subduction zone, which can only be resolved by high-resolution seismic tomographic images. Adjoint tomography technique is an effective tool for using 3-D models as initial models and refining them by iteratively minimizing the misfit between synthetics and data (*Tromp et al.*, 2005). For more detailed images of the mantle beneath Japan we can exploit the dense data coverage provided by a total of 818 stations and 206 earthquakes (Figure 1). According to finite-frequency theory, the sensitive region along the ray path is given by a 3-D 'banana-doughnut' kernel. The weighted sums of the banana-doughnut kernels for all event-station pairs, with weights determined by the traveltime measurements, are used to construct misfit kernels (Figure 2). These gradients are then used in a non-linear conjugate gradient algorithm to further improve the existing 3-D models.

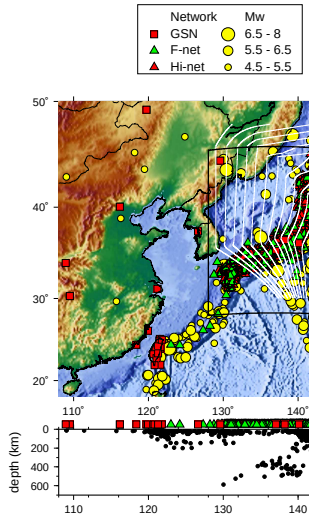

Figure 1: Map of the event and station distribution in the study area. 206 events occurring between 2000 and 2006 with M_w in the range of 4.5–8 (yellow circles) are selected for tomographic inversion. There are a total 818 stations from three different networks located in this area: GSN (red squares), F-net (green triangles), and Hi-net (red triangles), amongst which GSN and F-net provide broadband records, whereas Hi-net only provides high-frequency records. The bottom plot shows the distribution of all the events and stations projected onto a WE striking vertical plane. The region of the high-resolution Japan model is identified by the black box on the map. Inside the box, the white lines indicate the contours of the upper boundary of the Pacific plate with a 50 km contour interval.

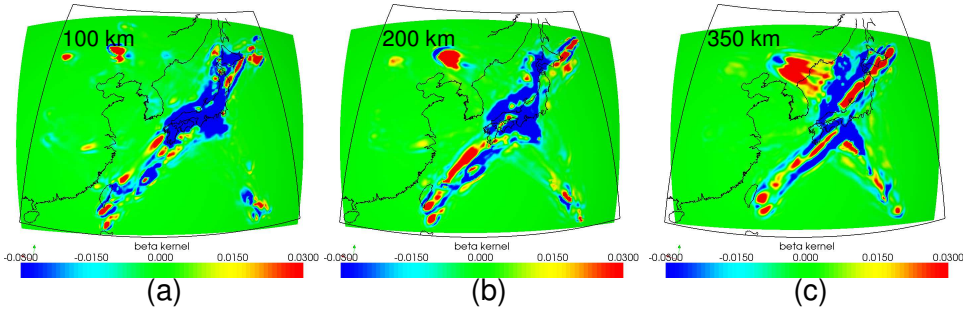

Figure 2: Map view of the spherical cross-sections of the misfit kernels, summation of 206 event kernels, for shear-wave velocity (β) at depths of (a) 100 km, (b) 200 km, and (c) 350 km. The spatial distribution of these 206 events are shown in Figure 1.

References

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