Three-Dimensional Shear-Velocity Model for the Asian Continent From Surface-Wave Dispersion, Receiver Functions, and Gravity Observations

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We present the first three-dimensional shear-velocity/density model for the Asian continent constructed through joint inversion of different geophysical datasets. Our goal is to investigate the crustal and upper mantle structure underneath the region with increased resolution of shallow geological structures. To that end, we jointly invert surface-wave group velocities, receiver functions, and satellite gravity observations. Surface-wave dispersion measurements are primarily sensitive to vertical shear-wave velocity averages, receiver functions are sensitive to shear-wave velocity contrasts and vertical travel times, and the gravity measurements supply constraints on rock density variations. Their combination bridges resolution gaps associated with each individual data set. We use the CUB (University of Colorado at Boulder) Eurasian tomography model for dispersion values in the period range between 8 and 100 s. Receiver functions come from 45 stations across eastern Asia from a joint effort between The Pennsylvania State University and Los Alamos National Laboratory. We use gravity observations extracted from the global gravity model derived from the GRACE satellite mission. To integrate these data, we employ a relationship between seismic velocity and density constructed through the combination of two empirical relations. One determined by Nafe and Drake, most appropriate for sedimentary rocks, and a linear Birch's Law more applicable to denser rocks. An iterative, conjugate gradient-based least squares inversion is used to jointly model the three different data sets, using shear-velocity variations as the primary model parameters. Improved knowledge of the shear velocity structure of the Asian continent is of fundamental importance for understanding the geodynamic evolution and formation of continents, as well as the processes acting within and on the continental lithosphere.