Elastic Deformation due to Interplate Coupling and Internal Inelastic Deformation in the Hokkaido-Tohoku Region, Japan

Chihiro Hashimoto[1]; akemi noda[2]; Takeshi Sagiya[1]; Mitsuhiro Matsu'ura[3]

[1] Environmental Studies, Nagoya Univ.; [2] Earth and Planetary Sci., The Univ of Tokyo; [3] Dept. of Earth & Planetary Science, Univ. of Tokyo

In subduction zones around Japan, where the four plates of North American, Pacific, Philippine Sea and Eurasian are interacting with one another, large interplate earthquakes have occurred repeatedly. The occurrence of interplate earthquakes can be regarded as the process of tectonic stress accumulation and release in source regions, driven by relative plate motion. The fundamental causes of interseismic crustal deformation are steady slip along curved plate interfaces and its perturbation (slip excess/deficit) in earthquake source regions. Thus, we applied a unified inversion method based on Bayesian modelling with direct and indirect prior information to GPS horizontal and vertical velocity data for the interseismic calm period of 1996-2000 to obtain precise slip-deficit rate distribution on the North American-Pacific plate interface around Japan. In our modelling the lithosphere is assumed to be perfectly elastic. Actually, the Japanese Islands is locally deformed by internal brittle fracture and plastic flow. Small block rotation due to local inelastic deformation causes serious systematic errors in inversion analysis. Then, in order to remove the effect of block rotation, we take only the changes in distance between adjacent GPS stations as data, instead of the horizontal velocity vectors. We also take the changes in relative-height between adjacent GPS stations as data, instead of the vertical velocities. We used the triangle network composed of 256 GPS stations, determined by the Delaunay triangulation, to take the 698 side-length changes 698 relative-height changes for the present inversion analysis. The result of the inversion analysis shows that a trench-parallel slip-deficit belt with six peaks is distributed in the depth range of 10-40 km (Hashimoto et al., 2009, Nature Geoscience). From the inverted slip-deficit distribution, we computed the horizontal velocity vectors and compared them with the observed ones. The magnitudes of the computed horizontal velocity vectors agree with the observed ones in both the Tohoku and the Hokkaido regions. However, in the Hokkaido region, the directions of the computed horizontal velocity vectors turned clockwise systematically compared with the observed ones. This indicates that the GPS horizontal velocity vectors contains not only the effect of interseismic elastic deformation due to interplate coupling but also the effect of the local counter-clockwise block-rotation of the Hokkaido region relative to the Tohoku region. The local block-rotation in the Hokkaido region would be cumulative, since intraplate inelastic deformation cannot be cancelled out by the occurrence of interplate earthquakes.