Spatiotemporal changes of strain rate field in Japan island inferred from GNSS data

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We obtained strain rates in the Japanese islands except for Hokkaido from the GEONET data. We corrected offsets caused by coseismic crustal deformations and antenna exchanges, and subtracted annual and semi-annual periodic signals and common-mode errors from original time series. Firstly, we calculated the crustal deformations from 2004 to 2010 annually. Then, we calculated strain rates, by using the method proposed by Shen et al. (1996). Distance Decaying Constant was taken to be 25 km. Strain rate was estimated at a target calculation point, by using observation stations within 50 km from the target calculation point. The interval between calculation points was set to be 0.2° for dilatation strain rates and maximum shear strain rates, and 0.4° for principal strain rates. As for observation errors, we used standard deviations obtained from the analysis of crustal deformations.
From this analysis, we obtained the following results:
1) Regarding distribution of principal strain rates, compressional axes were oriented to the plate convergence direction in most of the Japanese islands except for the southern Kanto district to the Izu Peninsula and northern coast of the Chubu district. It is considered to be due to the plate motion, which is consistent with Sagiya et al. (2000). Extensional axes of principal strain rates around Ibaraki Prefecture in 2008 oriented to the source area where some earthquakes have occurred during this period. Their maximum value was estimated to be 2.1×10^{-7}/yr. It is considered to be due to the postseismic deformation of the earthquakes (M6.4, 6.3, 7.0) that occurred off the coast of Ibaraki Prefecture on May 8, 2008.
2) Regarding distribution of dilatation strain rate, the values showed negative in most of the Japanese islands, indicating compressive strain field. The strain rates in Niigata Prefecture were less than those of the average value of the entire region by 2.0 to 4.0×10^{-7}/yr throughout the entire period. Especially, the minimum value there was estimated to be -5.2×10^{-7}/yr in 2005. It is considered to be due to the effect of the 2004 Chuetsu earthquake (M6.8). The minimum value in central Tohoku district was estimated to be -5.2×10^{-7}/yr in 2008. It is considered to be due to the effect of the 2008 Iwate–Miyagi nairiku earthquake (M7.2). Strain rates around Ibaraki Prefecture reached a value of 1.3×10^{-7}/yr in 2008. It is thought that this region was expanded by the postseismic deformation associated with the above-described a series of earthquakes on May 8, 2008.
3) Regarding maximum distribution of shear strain rates, the value in Shikoku was found to be larger than that in its neighboring region by 1.0 to 2.0×10^{-7}/yr, and in and around the Boso Peninsula to the Izu Peninsula by 1.0 to 3.0×10^{-7}/yr. The maximum values in Niigata Prefecture and central Tohoku district were estimated to be 6.3×10^{-7}/yr from 2005 to 2006, and 5.4×10^{-7}/yr in 2008, respectively.
4) In this study, the Niigata-Kobe Tectonic Zone (NKTZ) (Sagiya et al., 2000) was also identified from the distribution of principal strain rates. For example, the average value of compressional principal strain rates in the NKTZ was estimated to be approximately -1.2×10^{-7}/yr, whereas that in Chugoku district was approximately -0.6×10^{-7}/yr. These values were almost consistent with Sagiya et al. (2000). On the other hand, although the NKTZ was found mainly from the distributions of dilatation strain rates and maximum strain rates by Sagiya et al. (2000), in this study, the NKTZ was not identified from them remarkably. It is considered to be due to the difference in the analysis period and the calculation method of the crustal deformations.

Keywords: crustal deformation, GNSS, strain rate

