Positioning by Virtual Reference Station Method GPS

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Nationwide continuous GPS array of the GSI has illustrated crustal deformation field of the Japanese Islands. However, its average station spacing of 15-30km is sometimes too sparse to detect local phenomena such as postseismic aftereffect or volcanic deformation. One possible solution to overcome this problem is a deployment of compact, lightweight, and low power-consuming single-frequency GPS receivers. Moreover virtual reference station (VRS) method may be a good solution to reduce the effects of ionospheric and tropospheric delays of GPS signal which are the main error sources in single-frequency baseline determination approximately longer than 10km.

We carried out single-frequency GPS measurements in eastern Shikoku for about one week to evaluate short-term repeatability of station coordinates determined by the VRS method. The procedures we employ in this study are as follows: (1) A single-frequency GPS receiver is installed inside a triangle that consists of three dual-frequency receivers at the continuous stations of the GSI. (2) Virtual data are produced at a VRS that is supposed to exist near the observation site, by spatially interpolating real dual-frequency data. We check several cases changing a combination of dual-frequency receivers so that station spacing varies from 10 to 70km and station altitude from a few tens meters to about 1400m. Distance from the single-frequency receiver to the VRS is also checked up to 10km. (3) Coordinates of the single-frequency receiver are determined by processing a short baseline from the VRS. In advance, the coordinates have been determined by ordinary baseline analysis (shorter than 10km) using Bernese GPS Software, which we assume true values throughout this experiment.

The results show a short-term repeatability of the coordinates of 3-6mm in horizontal and 6-21mm in vertical. We confirm that different combination of three dual-frequency receivers used for spatial interpolation of real data does not make a significant effect on the final results as far as high-quality data are collected there, though VRS should be constructed in close vicinity of the observation site. Thus single-frequency GPS receivers and VRS method are applicable to crustal deformation monitoring, especially good for monitoring local phenomena with dense space coverage and limited time span.