Research on the development of rapid and accurate GNSS routine analysis system (3)

*Hiroyuki Nakagawa[1]

1. GSI of Japan

The Geospatial Information Authority of Japan (GSI) routinely analyzes GNSS data obtained by GEONET, i.e. Japanese nationwide CORS array of about 1300 stations, and monitoring crustal deformation all over Japan. The results are used as fundamental data in the field of such as evaluating earthquake activity or monitoring volcanic activity. However, depending on the timing of earthquake occurrence or speed of deformation of mountain body, even up-to-date GEONET routine analysis might not always have enough rapidness or time resolution. New analysis method that is more rapid and with higher time resolution are required.

So GSI started a three-year research project on the April of 2017 to develop more rapid and accurate GNSS analysis method than present based on Precise Point Positioning with Ambiguity Resolution, or PPP-AR, and make prototype system implementing this method. PPP-AR can calculate position of a site for each epoch as accurate as those derived by interferometric analysis with much lighter calculation load. As such, we set an objective of developing a prototype system that can calculate twenty-four-hour-long time series of coordinates of all the GEONET stations by post-processing PPP-AR with one second interval, within two hours after data acquisition, and of the repeatability less than 1cm for horizontal component.

Until March, 2020, we have gotten results as below. In this presentation, we show these in detail.

1. A prototype system that can calculate time series of coordinates for all the GEONET station nationwide in one second interval by post-processing PPP-AR. This system consist of two steps as bellow: First, using last 24-hour observation data from global GNSS observation network operating by organizations such as IGS or UNAVCO, estimating information required for PPP-AR such as precise satellite orbits, satellite clocks and other corrections. Then, using these information and GEONET observation data of last 24 hours, calculating 24-hour long time series of coordinates for all GEONET stations by PPP-AR.

2. Using the prototype system, in good condition, we found to be able to get time series of coordinates for all GEONET stations in about 2 and half hours.

3. We evaluate the quality of GPS orbit estimated by the prototype system by means of the difference from IGS final orbit for one year test period from July 2018 to June 2019. Comparing the error with the error for IGS ultra-rapid orbit w.r.t. IGS final orbit, we found that the error for our GPS orbit is smaller than that of predicted part of IGS ultra-rapid orbit because our orbit does not contain predicted part. Although the error is larger than that of observation part of IGS ultra-rapid orbit, our system can calculate orbits for about 20 minutes, much shorter than IGS ultra-rapid orbits (about three hours).

4. To evaluate the quality of final result, that is, daily time series of all GEONET station position, calculating standard deviations of horizontal component during the same test period as item before. The average of all the standard deviation for all the period is about 1cm. The mean standard deviation is found to be larger in summer season and smaller in winter season.

5. Using prototype system, calculating ground deformation for foreshock of 2016 Kumamoto earthquake and “the largest aftershock of the foreshock” which occurred about three hours after the foreshock. We found that our result can divide those ground deformations, which GEONET routine analysis cannot.

Keywords: GNSS, PPP-AR, GEONET, GEONET routine analysis

