Accuracy evaluation of a crustal deformation model with velocity in terms of maintaining the Japanese geodetic datum

*Yu Takagi[1], Kensuke Kokado[1], Yasuhiro Koso[1], Hiromi Yamao[1], Takashi Tsutsumi[1], Masao Iwata[1]

1. GSI of Japan

Geospatial Information Authority of Japan (GSI) introduced semi-dynamic correction in the field of surveying in 2010 (Hiyama et al., 2010) to reduce the effect of the strain due to steady-state crustal deformations such as caused by plate motion so that the accuracy of Japanese geodetic datum, a static datum, is maintained. In semi-dynamic correction, the effect of the strain that has accumulated from the reference epoch of the datum to the current epoch is corrected by using the crustal deformation model constructed with the use of the data of about 1,300 GNSS Continuously Operating Reference Stations (CORSs). The model, representing the accumulated crustal deformation at each point of the latitude-longitude grid whose spacing is about 5 km, are obtained by interpolation of the CORS’s coordinate differences between the 1st of January in every year and the reference epoch by means of Kriging method (Tanaka et al., 2007). In order to accurately correct the effect of the strain accumulating over time, it is updated every year.
As mentioned above, the present model has been applied exclusively to the field of surveying, in which relative positioning technique is used. Recently, however, more and more satellite positioning communities, especially real-time precise positioning service providers, other than those in the surveying field are starting to use the deformation model, as recent technical development enables us to obtain accurate coordinates more easily than ever before. A crustal deformation model that can correct the effect of the accumulating crustal deformation constantly and accurately is needed in order to use the coordinates obtained by highly accurate satellite positioning together with geospatial information based on the geodetic datum, as in the case of overlaying the positioning results on maps. The present model, however, cannot accurately reproduce the crustal deformation such as the post-seismic deformation observed after the 2011 off the Pacific coast of Tohoku earthquake, or 2011 Tohoku-oki earthquake.
This study aims to develop a crustal deformation model that can reproduce crustal deformation including post-seismic deformation more accurately in order to provide the geodetic datum that can work with precise positioning. Although Tobita (2016) and others used models with logarithmic and exponential functions to represent post-seismic deformation, a sufficient period of data is needed to estimate reasonable time constants and coefficients for those functions. On the other hand, a model with simple velocity, which is derived from the difference of coordinates between two epochs divided by the time, can be readily constructed compared to the above models. In this study, we make model with logarithmic and exponential functions and one with simple velocity, and evaluate to what degree these models can reproduce the actual crustal deformation observed after the 2011 Tohoku-oki earthquake. In this presentation, we will report the results of the evaluation and discuss the effectivity and limitations of the model with simple velocity from the point of view of maintaining the geodetic datum.

Keywords: geodetic datum, crustal deformation, post-seismic deformation, GNSS Continuously Operating Reference System, semi-dynamic correction

