Estimation of Deformation Fields from GNSS Data Using Basis Function Expansion: Comparison with the Method by Shen et al. (1996)

*Tomohisa Okazaki[1], Yukitoshi Fukahata[2], Takuya Nishimura[2]

1. Center for Advanced Intelligence Project, RIKEN, 2. Disaster Prevention Research Institute, Kyoto University

Crustal displacements can be accurately measured by GNSS at observation stations. Many methods have been developed to estimate continuous velocity and strain-rate fields from discrete GNSS data to interpret crustal deformation. Shen et al. (1996) proposed a method to simultaneously estimate velocity and strain-rate fields, in which observed data are weighted according the distance to an estimation point in the least-square calculation. Their method is intuitive and widely used particularly in Japan. From a theoretical viewpoint, however, their method has a serious problem that the estimated strain-rate field does not coincide with the derivative of the estimated velocity field (Okazaki and Fukahata, JpGU 2018). In addition, there is no objective criterion to determine the form of the weighting function in the least-square calculation.

As an alternative consistent method, we present a fitting of velocity fields using basis function expansion. On the estimation of crustal movements, Fukahata et al. (1996) developed a method to reconstruct time variation of vertical crustal movements using levelling data. We modify their formulation to estimate a 2D horizontal velocity field using GNSS data. Since the velocity field is represented by a linear sum of a finite number of basis functions, its derivative, i.e. the strain rate field, can be analytically obtained. A hyperparameter that controls the smoothness of the velocity field can be objectively determined from observed data using ABIC (Yabuki and Matsu'ura, 1992, GJI). In addition to these theoretical advantages, we practically demonstrate the characteristics and merits of this method compared with the method by Shen et al. (1996) by applying them to GNSS velocity data in Japan.

Keywords: GNSS, basis function expansion

