Study on tropospheric delay variations extracted from a short baseline analysis and their application to meteorological observation

*Takayuki Yoshihara[1], Susumu Saito[1], Atsushi Kezuka[1], Shinji Saitoh[1]

1. Electronic Navigation Research Institute, National Institute of Maritime, Port and Aviation Technology

This paper discusses variation of 10cm order in tropospheric delay differences between two ground-based GNSS stations, which are located with a horizontal scale of about 2km. This typical value of tropospheric delay differences is represented as a tropospheric delay difference projected to the zenith direction for a common satellite between the two stations. The variation also corresponds to an order of 50 mm/km in tropospheric delay spatial gradient. Such large differences of tropospheric delay with short baselines of several 100m had been reported in safety assessment and validation activities for aircraft high category precision approach and landing system called as GBAS (Ground-Based Augmentation System) [1,2,3]. They also reported that their temporal variations are highly correlated with the surface wind velocities under fine weather conditions.

A GBAS ground station typically has four GNSS stations with separation of several 100m each other. Electronic Navigation Research Institute (ENRI) participated in the safety assessment and validation activities, which were performed to validate draft international standards for high category GBAS. As one of the activities, ENRI developed a prototype system and installed it in New Ishigaki airport (24.40N, 124.25E). The system has the typical four GNSS stations within a horizontal scale of 400m and an additional GNSS station called as ionosphere field monitor (IFM), which is located as about 2km away from the four stations. These GNSS stations consists of dual frequency antenna and receiver and continuously collect GNSS data. Additionally, we set up a different GNSS receiver which can accept multi-RF signal inputs. Combining the receiver with Radio-over-Fiber (RoF) devices, we can use a common clock for signal processing two GNSS signals received at the both ends of the baseline with a length of 2.3km [4]. This additional system enables us to examine a tropospheric difference for each GNSS satellite without correction of difference of receiver clock drift components between two received signals although it is required to distinguish tropospheric delay differences from ionospheric effects and multipath errors using dual frequency measurements and characteristics of multipath variations [5].

In this study, we mainly examine tropospheric delay difference data with the baseline length of 2.3km, including GNSS data collected from the prototype system. Considering geometry of GNSS satellite propagation paths and observational errors, we will discuss candidate meteorological phenomena and application to future meteorological observation.

[1] K. Alexander et al., WP16, ICAO NSP/WGW, May 2014.
[2] F. Salbert et al., ICAO NSP WG1&2, Sept. 2014.
[3] S. Saito et al., Proc. of ION 2015 Pacific PNT, pp. 815-820, Honolulu, HI, April 2015.
[4] T. Yoshihara, et al., Proc. of the ION 2017 Pacific PNT, pp. 885-896, Honolulu, Hawaii, May 2017.
[5] T. Yoshihara et al., IEICE Technical Report, vol.118, no.105, pp.19-24, SANE2018-16, June 2018 (Japanese).

Keywords: GNSS, Tropospheric delay, Short baseline, Application to meteorological observation

