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C 会場 ：11/5　AM1 （9:00-10:30）
09:15〜09:30

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Preliminary results on the ionospheric delay gradient as a threat to GBAS in the equatorial ionization anomaly crest region

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In recent years, Ground-based augmentation system (GBAS), which is an aeronautical navigation system for precision approach and landing based on the single-frequency differential GNSS technique, has been put into practical use, and its installation is expected to expand in the low magnetic latitude region including Japan. Although GBAS provides accurate position solutions by broadcasting ionospheric delay corrections based on observations by ground reference receivers, steep and narrow ionospheric gradients may be undetectable and poses a threat to the system.

It is known that the steep ionospheric gradient caused mainly by the equatorial plasma bubbles (EPBs) in the low magnetic latitude region. Previous studies have also suggested that such a steep spatial gradient is generated by EPB. Previous studies also confirmed that the generation of such steep spatial gradients is consistent with the generation characteristics of EPB.

International Civil Aviation Organization (ICAO) has conducted data collection and analysis, and characterized the ionospheric delay gradient variation, which is called an ionospheric threat model for GBAS in the Asia-Pacific (APAC) region [1]. It treats all the equatorial and low latitude regions together. However, due to different geometries between the ground station, GNSS satellites, and the ionosphere, the ionospheric threat model could be different within the region. Especially, the equatorial ionization anomaly (EIA) crests and EPBs develop into the EIA crests would result in spatial variations of the characteristics of the ionospheric gradient observed at a certain location on the ground. Therefore, the ICAO APAC GBAS ionospheric threat model could be a conservative one, and could be optimized for each location to reasonably reduce the conservativeness. Therefore, more observations in different locations within the equatorial and low magnetic latitude regions are necessary. Therefore, In order to understand the variation of the GBAS ionospheric threat model within the magnetic equatorial and low latitude region, ENRI has deployed networks for a steep ionospheric gradient observation from 2021 in Vietnam, and from 2022 in Indonesia, which is located in the EIA crest regions.

In this study, we will show the initial results of the ionospheric steep gradient analysis in Vietnam.

References

[1] Saito, S. et al. (2017), Ionospheric delay gradient model for GBAS in the Asia-Pacific region, GPS Solutions, 21:1937-1947, doi:10.1007/s10291-017-0662-1.