Utilizing DFMC SBAS broadcasted from QZSS in Polar Region

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We conducted the performance evaluations of DFMC SBAS broadcasted from QZSS in Oslo and the Arctic sea. As a next step of the evaluation, we will install a GNSS receiver and DFMC SBAS receiver at Ny-Ålesund National Institute of Polar Research Observatory (78.9 deg. N, 11.9 deg. E). This observation aims to evaluate the DFMC SBAS in the Arctic region long term, and the impact ionospheric disturbances on GNSS and DFMC SBAS signals.

Key Words: DFCM SBAS, Arctic, Scintillation, QZSS

1. Introduction

Aviation and maritime activities in the Arctic are growing with the recession of the Arctic sea ice. A model study suggested that the Global Navigation Satellite System (GNSS), which operates with augmentation systems such as the Satellite-based augmentation systems (SBAS), is effective for the navigation of aviation and maritime in the Arctic because of poor infrastructures[1)]. However, the current L1 SBAS signals are not available practically at a latitude of 72 degrees or higher because they are broadcasted from geostationary (GEO) satellites.

The Quasi-Zenith Satellite System (QZSS) satellites broadcasts the Dual Frequency Multi Constellation Satellite Based Augmentation System (DFMC SBAS) test messages generated by the Electronic Navigation Research Institute (ENRI). Since the QZSS is one of the Inclined Geosynchronous Orbit (IGSO), the DFMC SBAS message is received in the high latitudes.

2. Performance evaluation in the Arctic

We conducted performance evaluations of DFMC SBAS broadcasted from QZSS in Oslo, Norway (10.72 deg. E, 59.94 deg. N) from 24 February 2021 to 17 March 2021. This study suggested that the availability will be improved if three or more monitor stations are newly installed in the European region[2)]. We also installed the GNSS receiver and DFMC SBAS receiver to the oceanographic research vessel Mirai from 20 August 2023 to 4 October 2023. During this time interval, the Mirai entered in the Arctic region. According to this observation data, we found that the error model variance for the vessel should be evaluated[3)].

3. Next Step

As a next step of the evaluation, we will install a GNSS receiver and DFMC SBAS receiver at Ny-Ålesund National Institute of Polar Research Observatory (78.9 deg. N, 11.9 deg. E). In this observation, we needed to receive the L1 and L5 signals from GPS, Galileo, and QZSS to calculate the positioning solution of the DFMC. A JAVAD DELTA receiver will be installed. Ionospheric disturbances associated with the auroral activity sometimes fluctuate signals' carrier phase, so the signals will be recorded by a high sampling rate of 100 Hz. A rubidium atomic clock will be used as a reference clock to perform the precise sampling. A CORE Chronosphere receiver will be installed to obtain DFMC SBAS messages. By using those instruments, we will evaluate the DFMC SBAS in the Arctic region long term and the impact of ionospheric disturbances on GNSS and DFMC SBAS signals with the ionospheric observation such as all-sky camera and EISCAT Svalbard radar.

References

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