4th URSI AT-RASC, Gran Canaria, 19-24 May 2024

Monitoring ionospheric GNSS scintillation on the research vessel

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Ionospheric free electrons cause refraction of radio waves, including those used for Global Navigation Satellite System (GNSS). This refraction adds an error term to positioning calculations. Additionally, if the electron distribution is uneven, GNSS signals can experience rapid diffraction, weakening or even blocking the signal at the receiver. This phenomenon, known as GNSS scintillation, can significantly degrade communication and positioning accuracy. A multitude of factors, including solar activity, seasonal changes, latitudinal distribution, and temporal dynamics, can contribute to the variability of ionospheric irregularities and scintillations. Despite the extensive deployment of ground and satellite GNSS receivers for ionospheric monitoring, the scarcity of suitable deployment platforms in oceanic regions and the fleeting nature of satellite observations present significant challenges. Therefore, bridging the ocean data gap in ionospheric observations promises not only more accurate models but also enhanced GNSS-powered navigation for maritime activities. In order to fill up the observation gap in the ocean, we conducted a special observation campaign operating the GNSS scintillation receiver on the icebreaker, ARAON, which is a research vessel of the Korea Polar Research Institute. We collected high-resolution GNSS observation data during 276 days along to the research voyages including both the Arctic and Antarctic routes. Although the data was observed while the ship was moving, the well-known daily variations of total electron contents (TEC) appeared, and TEC increased when the ARAON passed through the equatorial region. For scintillation observations, phase scintillations almost always occurred while the ship was in motion. Hence, we concluded that it was difficult to effectively observe phase scintillation while the ship was moving. On the other hand, amplitude scintillations seemed to be not affected by the ship motion, and they were very similar to the results of Rate of TEC Index (ROTI), which means a TEC fluctuation, using TEC measurements. Amplitude scintillations and ROTI clearly showed a hemispheric asymmetry which more frequently occurred in the Arctic routes. In addition, number of the GNSS satellites for positioning of the navigating sensor of the ARAON decreased and the horizontal dilution of precision increased in the Arctic routes. Contrarily, the motion sensor of the ARAON showed more rolled and pitched ship movements in the Antarctic routes. These indicate that there were more ionospheric irregularities along the Arctic routes and their effects such as scintillation were successfully observed by GNSS scintillation receiver on the ship. In this presentation, we show the campaign research results.