Canadian High Arctic Scintillation Model (CHASM): Status Update

Abstract

The high-latitude ionosphere is a dynamic and hostile environment for communication and navigation systems due to its high occurrence rate of instabilities of variable temporal and spatial scales. Small-scale ionospheric irregularities can cause rapid and random fluctuations in the phase and amplitude of Global Navigation Satellite System (GNSS) signals, leading to a phenomenon referred to as scintillation. Scintillation can result in cycle slips or losses of signal lock, which can significantly impair the performance of GNSS-based applications.

Previous studies have shown that at high latitudes, the probability of amplitude scintillation occurrence in GNSS signals is smaller than that of signal phase fluctuations, with typical seasonal, local time, and geomagnetic activity dependences. Despite efforts from different research reports, existing scintillation models are ineffective at high latitudes.

The principal objective of the present work is to develop a high spatial and temporal resolution model to predict the probability of occurrence of amplitude scintillation and phase fluctuations in GNSS signals in the Canadian Arctic. Using data collected by GNSS scintillation monitors of Canadian High Arctic Ionospheric Network (CHAIN) over a fifteen-year time frame, the model will use Bayesian statistical inferences to analyze scintillation patterns based on various levels of solar activity, solar wind conditions, and geomagnetic indices.

In this presentation, the outcomes of an extensive data curation process, encompassing fifteen years of raw GPS data from 25 stations across the Canadian High Arctic, will be discussed. The climatological behavior of scintillation occurrences is analyzed, with emphasis on seasonal, diurnal, and geomagnetic activity patterns. These analyses not only delineate the underlying scintillation climatology but also inform the development of a high-resolution predictive model of the physical drivers, ultimately advancing our capability to mitigate the impacts of ionospheric disturbances on GNSS-based systems.