L Band Ionosphere Scintillation Impact on GNSS Receivers

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Ionosphere scintillation is a natural interference encountered by RF signals propagating through the ionosphere. It can affect the performance of Global Navigation Satellite Systems (GNSS) signals and receivers. Since 2009, our research team has established several ionosphere scintillation monitoring and data collection system in Alaska, Singapore, and Hong Kong to collect both naturally occurring and artificially controlled L band scintillation data. As we enter the current solar maximum period, these data has provided us with a good opportunity to obtain statistical impact of high-latitude and equatorial scintillations on GNSS receivers.

This paper presents the analysis results based on measurements obtained from a GNSS array in HAARP, AK and commercial receiver measurements from Singapore and Hong Kong. For the HAARP, AK setup, scintillation event triggers have been implemented to initialize RF front ends data recording systems during strong scintillations. A conservative event filter was created to allow us to extract all scintillation events with amplitude scintillation index S4 greater than 0.12 and phase standard deviation sigma phi greater than 6 degrees [3]. The low filter cutoff values are set to automatically flag both strong and weak scintillation events for further analysis. We are interested in both strong and weak scintillation because strong scintillation events have major impact on robustness of GNSS receiver operation, while the weak events are good indicators of ionosphere irregularities occurrence and plasma drift.

Large number scintillation events were identified and extracted from the extensive data sets. Based on these events, we established a number of amplitude and phase scintillation distributions which are useful for scintillation event prediction and modeling in the future. The paper will present these results including the scintillation indices magnitude distributions, event duration distributions, and events frequency diurnal, seasonal, and spatial dependency. These results also showed the trend of increased scintillation events and magnitude as we stepping into a solar max. Additionally, a strong correlation between event occurrence probability and the local geomagnetic field fluctuation is also observed.