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IDENTIFYING IONOSPHERIC SCINTILLATION IN THE SOUTH ATLANTIC MAGNETIC ANOMALY USING MOTION-AFFECTED GPS DATA FROM A SHIP-BASED RECEIVER.

Abstract

This paper reports the novel use of a geodetic-grade, dual-frequency GPS Ionospheric Scintillation and Total Electron Content Monitor (GISTM), located on the polar research vessel SA Agulhas II, to identify instances of ionospheric scintillation over the South Atlantic Magnetic Anomaly (SAMA). The SAMA is a region in the South Atlantic Ocean where the Earth's magnetic field is weakest at comparable latitudes resulting in the precipitation of high energy particles into the ionosphere during geomagnetic storms.

Ionospheric Scintillations are rapid fluctuations in the phase and amplitude of trans-ionospheric radio signals resulting from electron density variations along the ray path. In this study the radio signals from Global Positioning System (GPS) satellites are specifically used to quantify these fluctuations.

Traditional scintillation measurements are done using dedicated dual-frequency GPS receivers at fixed terrestrial locations. Most of the SAMA lies beyond the reach of the land-based sensors operated by the South African National Space Agency (SANSA) in Southern Africa, at Marion Island, Gough Island, and SANAE-IV in Antarctica. The GISTM installed on board the SA Agulhas II in 2012 has enabled for the first time the terrestrial measurement of scintillation in the SAMA.

In this project, the amplitude (S_4) and phase scintillation (σ_ϕ) indices from 50Hz L1 signals recorded during the 2014 and 2015 voyages of the SA Agulhas II will be analysed for the first time. Position and movement data, as well as Total Electron Content (TEC), number of satellites, and satellite lock time values, are used in this study. The goal is to develop an understanding of the effect of motion on the quality of data recorded by the receiver.

It is shown that the movement of the receiver induces significant noise in the data. The noise levels are proportional to the motion of the ship. The resonant frequency response of the ship is determined from position data with the purpose of improving data quality by filtering out specific frequencies. Comparisons are done with data from the nearest stationary GISTM receivers.

Scintillation events are examined during incidents of significant geomagnetic storms. The Geometric Dilution of Precision (GDOP) factor is calculated as the geometry of visible satellites is a very important factor in obtaining high quality positioning results. A test is performed to identify any potential correlation between the GDOP, the number of satellites locked, the theoretical number of visible satellites, and the scintillation levels.