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P01

Characterization of the Multipath Environment of the Global Navigation Satellite System Receivers over Uganda.

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Errors in Global Navigation Satellite System (GNSS) data, particularly multipath, significantly impact the accuracy of positioning and related studies. Traditional mitigation techniques like fixed elevation cutoffs and open environments are often insufficient, especially in complex urban settings. This study investigates the possibility of implementing variable elevation cutoffs tailored to the specific environment of GNSS receivers in Uganda to mitigate multipath. Potential sources of multipath were identified for receivers at MBAR, EBBE, MBA, MAK, and BAKC by analyzing the variation of elevation angle against azimuth angle. The results show that there exists a stationary object at an azimuth angle of $0^0 - 30^0$, $70^0 - 110^0$, $240^0 - 300^0$ and $330^0 - 350^0$ from MBAR receiver. This object can block satellite signals as far as 20^0 elevation angle. Similarly for the case of the receiver at EBBE, stationary objects exist at an azimuth angle of $0^0 - 20^0$ and $220^0 - 330^0$, The stationary structures can obstruct satellite signals at an elevation angle of $0^0 - 20^0$. Based on the variation of elevation angle against azimuth angle, obstacles at MBA exist at azimuth angles of $0^0 - 20^0$ and $340^0 - 360^0$. For this receiver, the satellite paths were not visible at elevation angles of $10^0 - 20^0$. The receiver at MAK has stationary obstacles at azimuth angles of $0^0 - 20^0$ and $340^0 - 360^0$, as observed from the variation of elevation angle against azimuth angle for this receiver. The satellite signals were obstructed at elevation angles of $10^0 - 20^0$. Likewise, the receiver at BAKC has obstacles at $0^0 - 140^0$ azimuth angles. At elevation angles of $0^0 - 20^0$, the satellite signals were obstructed. The results revealed stationary objects at specific azimuth and elevation ranges for each receiver, obstructing satellite signals. Based on these observations, azimuth-dependent elevation thresholds were modeled using splines for each site. Comparing the data retained using these varying elevation thresholds with that from a fixed elevation cutoff, varying elevation thresholds demonstrated the potential for increased data availability while mitigating multipath. This site-specific approach offers a more effective strategy for improving GNSS data quality in diverse environments.

Key words- GNSS, Multipath, Elevation ,Azimuth angle

P02

Performance Evaluation of IRI, NeQuick and ANN in Modeling hmF2 During Quiet and Geomagnetically Disturbed Conditions: A Pan-American Ionosonde Study

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This study evaluates and compares the performance of three models—the International Reference Ionosphere (IRI-2016), NeQuick 2, and a custom-developed Artificial Neural Network (ANN)—in predicting the F2-layer peak height (hmF2) under varying space weather conditions. Ionogram data from 15 American stations during May 2024, including the Mother's Day geomagnetic storm, were processed using autoscaling methods at 2-minute intervals. The resulting hmF2 values were validated against manually scaled data to ensure accuracy. The ANN model, trained on solar and geomagnetic indices (F10.7, Kp) alongside historical ionosonde data, generated hmF2 predictions. These outputs, along with those from IRI-2016 and NeQuick 2, were statistically compared against ground-truth ionosonde observations during both quiet periods and storm events, including CME-driven disturbances. Performance metrics such as Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and correlation coefficients quantified deviations across all three models. Preliminary results indicate that the ANN model outperforms IRI-2016 and NeQuick 2 during rapid storm-phase transitions, demonstrating enhanced sensitivity to dynamic ionospheric conditions. Conversely, NeQuick 2 exhibits better accuracy during quiet conditions but tends to underestimate hmF2 at low solar activity levels. These findings underscore the potential of hybrid modeling approaches to improve storm-time ionospheric forecasts and provide a benchmark for future data assimilation techniques.

P03

Recent results of ionospheric total electron content measurements from low-cost Global Navigation Satellite System (GNSS) receiver and comparison other ionospheric models

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We present first results of ionospheric Vertical Total Electron Content (VTEC) measurements from a recently installed low-cost multi-frequency Global Navigation Satellite System Receiver in Accra, Ghana (Geographic: 5.7° N, 0.04° E; Geomagnetic: 7.0° S). We present data between January and June of 2024. The low-cost VTEC data was compared to the VTEC predictions from the International Reference (IRI) model-2020 and the AfriTEC models. The inaccessibility of GNSS data across the region is the basis for comparison to both models. Similarly presented are the corresponding VTEC measurements obtained from models, thus need for the installation of more receivers in the regions. The aim of this study is to investigate VTEC diurnal and monthly variations. The results showed that the diurnal and monthly mean VTEC variations manifest remarkable seasonal variations. The VTEC yielded maximum values from January to March ($\sim$ 65 TECU) followed by April to May ($\sim$ 60 TECU) and minimum in June ($\sim$ 55 TECU) Local time (LT). The results show a good agreement (i.e., VTEC values) with the AfriTEC model than the with IRI-2020 VTEC model predictions. There was a notable underestimation of VTEC values predicted by IRI-model from January to march and overestimation from April to June, respectively. Meanwhile, VTEC measurements predicted by the AfriTEC showed good agreement with the low-cost VTEC in the months of February, April, May and June. The correlation coefficients between the low-cost VTEC and predicted VTEC from the two models are mostly greater than 0.9. These results summarily indicate that the low-cost GNSS receiver is a good receiver for ionospheric studies TEC studies. These low-cost

multi-frequency receivers can be good alternatives, for space weather and ionospheric studies in areas where access to high-standard receivers is difficult.

P04

Validation of the Ionospheric bubble probability (IBP) model in Fortran

Abstract

The Ionospheric Bubble Probability (IBP) model is used in this work to analyze the global and temporal distribution of ionospheric bubble occurrence probability. The findings are compared to observations from numerous satellite missions, including Swarm A, B, and C, and CHAMP. Ionospheric bubbles, which are places with low electron density, have a substantial influence on satellite communication and navigation systems. Understanding their distribution is critical to reducing these impacts.

The IBP model provides a probabilistic framework for forecasting the occurrence of ionospheric bubbles based on longitude, day of the year, local time, and solar activity for the altitude range of around 350-510 km at low geographical latitudes of +/- 45°. We confirm the model's predictions with in-situ measurements and ground-based GNSS receiver sites along the satellite's path using S4 indices and ROTI. This analysis includes various latitudes, longitudes, and local times, providing a complete picture of the geographical and temporal variability of ionospheric bubbles.

Preliminary results show a substantial connection between IBP model predictions in python and Fortran, with particularly good consistency in equatorial and low-latitude areas. The comparison demonstrates the model's ability to capture both seasonal and diurnal trends in bubble occurrence. Moreover, disparities in high-latitude regions indicate where the model should be improved. Furthermore, the Python version of the model is freely accessible. This comparative analysis emphasizes the need to combine many satellite data sets to better understand ionospheric processes. The findings help to construct more accurate prediction models, which are critical for increasing the dependability of space-based communication and navigation systems.

P05

Statistical comparison of different methods for filtering solar activity in foF2 and hmF2 for long-term analysis at Juliusruh station

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The ionospheric F2 layer plays a crucial role in radio wave propagation and is significantly influenced by various factors. Understanding its long-term variations is essential for analyzing Solar-Terrestrial dynamics and improving ionospheric models. This study uses the critical frequency of the F2 layer (foF2) and the height of the peak electron density (hmF2) from 1964 to 2019. Both parameters are affected by solar activity; thus, modeling their response to solar activity is essential.

An analysis of extreme ultraviolet (EUV) proxies, including Mg II, F30, and F10.7, was carried out to identify the proxy with the highest correlation with the ionospheric parameters. Furthermore, a comparison of five methods for modeling the impact of solar activity on foF2 and hmF2 was conducted using hourly data from Juliusruh. The methods considered were three polynomial regressions based on data clustered by solar cycle, month and hour of the day, and two Fourier Series applied to data clustered by hour of the day. Finally, statistical tools such as the coefficient of determination (R^2), mean absolute percentage error (MAPE), Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC) were utilized to select the most appropriate method.

The results show that F30 is the EUV proxy with the highest correlation with foF2, while for hmF2 is MgII. The third-degree polynomial regression was found to be the most effective method for modeling the ionospheric response to solar activity. This analysis only makes a statistical comparison, and further exploration is needed to assess the explanatory power of each method.