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Author: Ms. Sahar Sowdagar
Sharjah Academy for Astronomy, Space Sciences and Technology (SAASST), United Arab Emirates, U19102963@sharjah.ac.ae

Mr. Mohammad Musharraf
University of Sharjah, United Arab Emirates, u18102398@sharjah.ac.ae
Dr. Muhammad Mubasshir Shaikh
Sharjah Academy for Astronomy, Space Sciences and Technology (SAASST), United Arab Emirates, mshaikh@sharjah.ac.ae
Prof. Ilias Fernini
Sharjah Academy for Astronomy, Space Sciences and Technology (SAASST), United Arab Emirates, ifernini@sharjah.ac.ae
Prof. Hamid Al Naimiy
Sharjah Academy for Astronomy, Space Sciences, and Technology (SAASST), United Arab Emirates, alnaimiy@sharjah.ac.ae

REGIONAL IONOSPHERIC RANGE ERRORS – A COMPARISON BETWEEN SHARJAH AND BAHRAIN REGIONS

Abstract

Global Navigation Satellite System (GNSS) is used to approximate user locations, yet it currently averages an error of around 3-5 meters globally. The errors may be due to satellite clock errors, orbit errors, ionospheric delays, tropospheric delays, receiver noise, or multipath errors. A common way to study the errors and improve GNSS signals' accuracy is through GNSS data receiving stations with a fixed and known position. A GNSS station collects data from the satellites and uses it to approximate its position, and it then compares the approximated position to its correct position, thereby calculating the error and deviation from the true position. Furthermore, it sends the error to the control stations, which estimate the corrections and upload them to the respective satellites to eliminate future errors. The most significant error source in GNSS-based position, navigation, and timing (PNT) solutions is the ionosphere, a dense layer of electrically charged plasma in the upper atmosphere, which lies approximately between 60 to 1000 km above the Earth's surface. Due to its dynamic nature, the ionosphere's properties and density may differ from one geographical region to another, resulting in different ionospheric errors for regional PNT solutions. In this paper, we have studied ionospheric range errors (IRE) over the Arabian Peninsula region. GPS data collected over two years (Nov 2018 to Oct 2020) from GNSS receivers based in Manama, Bahrain (26.209o N, 50.608o E) and Sharjah, United Arab Emirates (25.282o N, 55.462o E) has been analyzed and compared with the empirical model NeQuick2. The average annual IRE differences between observed and modeled values range from 0.3m to 1.2m for early morning hours and from 2m to 3m for afternoon hours when the local ionosphere has peak density over Bahrain GNSS station. For the Sharjah GNSS station, these values are 0.2m to 1m and 2.1m to 3.1m in the early morning and afternoon hours, respectively. It has been anticipated that such low values of IRE are observed due to the prevailing low solar activity. The IRE values are expected to be higher in coming years when the solar activity is expected to be higher. Detailed seasonal analysis of the observed and modeled values has also been presented.