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CALCULATING STATION BIAS FOR UNCALIBRATED GNSS STATIONS USING CLOSE-RANGE CALIBRATED GNSS STATION DATA

Abstract

Global Navigation Satellite Systems (GNSS) provide continuous navigation data to study the ionosphere's everchanging characteristics and effects on radio communication. Total Electron Content (TEC) is one of the primary parameters that describe the ionosphere. It can be calculated using navigation data and other supplementary data to account for certain errors, such as satellite and station biases. Satellite bias is readily available, and it has the benefit of being uniform in all TEC calculations by GNSS stations across the globe. However, station bias is specific to the station location and hardware, and it is not readily accessible for uncalibrated stations. The SHJ1 GNSS station at the Sharjah Academy for Astronomy, Space Sciences, and Technology (SAASST) is one of the very few stations studying the ionosphere of the Arabian Peninsula. As the station is not calibrated, a new technique that uses data from a close-range calibrated station was tested and adopted to calculate the station bias.

In this paper, we used two stations that are apart by about 496.9 km: SHJ1 station in Sharjah (UAE) and BHR4 station in Manama (Bahrain). Unlike the SHJ1 station, the BHR4 station is fully calibrated, receiving its daily station bias values from sources such as the Chinese Academy of Sciences. Our technique involves first calculating TEC for each station using only data points from satellites measured by both stations concurrently. We should note that the BHR4 TEC calculation includes both station bias and satellite bias, while the SHJ1 TEC calculation includes only satellite bias. A plot of TEC vs. time reveals up-turned curves, or arcs, each representing the TEC calculated using both phase and code measurements from different satellites as they appear in the sky. Following that, the TEC arcs of the SHJ1 station are shifted onto the BHR4 arcs, and the average error per satellite between the SHJ1 arcs and BHR4 arcs is calculated. Finally, SHJ1's station bias is calculated by averaging the error for all 32 satellites. Initial findings reveal promising and accurate results, where the station bias is within a range of 0.6 nanoseconds compared to bias calculated by other previously existing techniques such as the minimum scalloping method. Our technique's accuracy allows us to reliably calculate TEC for SHJ1 or any uncalibrated station around the globe.