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ORIGINAL ARTICLE

Determining receiver biases in GPS-derived total electron content in the auroral oval and polar cap region using ionosonde measurements

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Abstract Global Positioning System (GPS) total electron content (TEC) measurements, although highly precise, are often rendered inaccurate due to satellite and receiver differential code biases (DCBs). Calculated satellite DCB values are now available from a variety of sources, but receiver DCBs generally remain an undertaking of receiver operators and processing centers. A procedure for removing these receiver DCBs from GPS-derived ionospheric TEC at high latitudes, using Canadian Advanced Digital Ionosonde (CADI) measurements, is presented. Here, we will test the applicability of common numerical methods for estimating receiver DCBs in high-latitude regions and compare our CADI-calibrated GPS vertical TEC (vTEC) measurements to corresponding International GNSS Service IONEX-interpolated vTEC map data. We demonstrate that the bias values determined using the CADI method are largely independent of the topside model (exponential, Epstein, and α-Chapman) used. We further confirm our results via comparing bias-calibrated GPS vTEC with those derived from incoherent scatter radar (ISR) measurements. These CADI method results are found to be within 1.0 TEC units (TECU) of ISR measurements. The numerical methods tested demonstrate agreement varying from within 1.6 TECU to in excess of 6.0 TECU when compared to ISR measurements.

Keywords Global Positioning System (GPS) · Ionosonde · Total electron content (TEC) · Polar ionosphere · Receiver biases · Differential code biases

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Introduction

The consistent availability and precision of Global Positioning System (GPS) total electron content (TEC) measurements makes GPS an asset in ionospheric research and applications; unfortunately, inherent receiver differential code biases (DCBs) can restrict the use of GPS TEC measurements to analyzing relative variations in TEC. It will be demonstrated that the reliability of previous methods for accounting for these DCBs may be questionable for the analysis of high-latitude observations. In order to increase the versatility of GPS TEC measurements, we must determine a reliable means of removing receiver DCBs from GPS-measured TEC for such observations.

TEC is commonly used as a means of investigating the nature of the ionosphere's variability and structure, and has become an increasingly important parameter in ionospheric research. It is defined as the total number of electrons within a 1-m^2 column along a path through the ionosphere. TEC is measured in TEC Units (TECU), where 1 TECU = 10^{16} electrons/m^2 and can be determined via a variety of different means; the more pertinent to this study being via GPS, ionosonde, or incoherent scatter radar (ISR) observations.