The use of single station GPS receiver bias estimation techniques in the Polar Cap and Auroral Oval regions

David R. Themens* [1], P.T. Jayachandran [1], and Richard B. Langley[2]
(1) Department of Physics, University of New Brunswick, Fredericton, NB, Canada
(2) Department of Geodesy and Geomatics Engineering, University of New Brunswick, Fredericton, NB, Canada

The problem of receiver Differential Code Biases (DCBs) in the use of GPS measurements of ionospheric Total Electron Content (TEC) has been a constant concern amongst network operators and data users since the advent of the use of GPS measurements for ionospheric monitoring. This problem is particularly notorious in highly variable ionospheric environments, where horizontal gradients stretch the limits of the assumptions made in standard bias estimation techniques.

In this study, we examine the use of the Least Squares (LS) and Minimizations of Standard Deviations (MSD) receiver bias estimation methods in their application to several high latitude sites operated by the Canadian High Arctic Ionospheric Network (CHAIN). We demonstrate that the standard mechanisms for applying these techniques at mid latitudes must be modified to accommodate the high latitude environment; namely, we show that: 1) increasing the elevation cut-off used in bias estimation leads to a systematic overestimation of the bias for both methods tested, 2) changing to a magnetic coordinate system in the application of the LS method results in a significant improvement in performance.

To examine the effect of the method assumptions, namely that of a horizontally homogeneous ionosphere and the thin shell ionosphere assumption, we present a series of simulation studies that assess the individual components of the assumptions made in these methods. These simulations demonstrate that in the absence of horizontal gradients these methods perform exceptionally well with errors in estimated DCBs of less than 0.1TECU. In fact, the absence of horizontal gradients allows us to simultaneously derive both the bias and the ionospheric shell height. Unfortunately, once gradients are introduced, significant errors begin to propagate, no longer allowing these methods to provide shell height information. These gradients also lead to moderate DCB estimation errors through an increased sensitivity to the assumed shell height.