Joint Estimation of Ionosphere TEC, Receiver Inter-frequency Biases, and Carrier Ambiguities Using 3-Frequency GPS Measurements

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One of the principal observations derived from GNSS (Global Navigation Satellite Systems) signals is ionospheric total electron content (TEC), which is a measure of the density of free electrons integrated along the signal path. TEC is usually derived using two signals with different carrier frequencies, thereby taking advantage of the frequency dispersive effects of ionosphere plasma on microwave band propagation. Here we look at using the GPS L5 signal in conjunction with L1CA and L2C to estimate ionosphere TEC along with receiver inter-frequency biases (IFB) and carrier ambiguities. These parameters, which are interrelated and must be estimated together, are of both scientific and engineering interest.

Various authors have investigated the estimation of TEC and related parameters using 3-frequency GPS signals (e.g. "Total Electron Content reconstruction using triple frequency GNSS signals," Justine Spits, 2011). They focus on various linear combinations, sometimes referred to as widelane combinations, of GPS L1CA, L2C, and L5 signals to optimally extract the relevant information. In this work, we present a simple method using iterative least-squares to solve for TEC and related parameters using separate, or uncombined, measurements and a priori estimates of the receiver L1/L2 IFB parameter. The method is flexible and provides the groundwork that can be improved upon once a better understanding is attained of the systematic errors between TEC estimated from any two GPS signal pairs.