IMPROVED AMBIGUITY AND RESOLUTION FOR MEASUREMENTS OF TOTAL ELECTRON CONTENT

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Differential phase at two frequencies for satellite to ground signals passing through the ionosphere provide a measurement of total electron content (TEC). The differential phase technique for VHF, UHF or L-Band signals passing through the ionosphere is limited by phase ambiguities for multiples of one wavelength. The TEC ambiguity is defined as the ionospheric content equivalent to 360 degrees change in the differential phase. If the TEC ambiguity is much smaller than the absolute TEC, then the determination of the absolute TEC is difficult. For the standard NIMS (TRANSIT) or similar beacon signals using 150 and 400 MHz, the TEC ambiguity is 0.1 TECU (1 TECU = 1016 m-2). Consequently, absolute TEC for the typical ionosphere in the 10 to 100 TECU range is nearly impossible to determine. A new algorithm using three frequencies has been developed to aid the resolution of absolute TEC. The three frequencies for the CERTO beacons launched on C/NOFS, COSMIC, NPSAT1, CASIOPE, EQUARS and other satellites are 150.012, 400.032 and 1066.752 MHz with an 8/3 ratio between successive frequencies. With the frequencies, the three-frequency TEC algorithm (TFTA) has an ambiguity of 8.3 TECU. The development of the algorithm involves finite number theory applied to integer wavelengths at each frequency. The algorithm has been tested with synthetic TEC derived from the NRL SAMI3 global model of the ionosphere. The addition of noise has been considered in the analysis. The algorithm shows the TEC determination is improved with the TFTA by allowing establishing continuity after a loss of lock for at TEC receiver. In practice, system calibrations will require a one time measurements with incoherent scatter radars to determine fixed phase delays for each transmitters and receiver pair. The technique will not work for three frequency GPS signals at the L1, L2, and L5 bands because the algorithm with the GPS frequency ratios is breaks down from phase noise errors.

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