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MOVING GRID METHOD ANALYSIS OF GPS TEC MEASUREMENTS

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Abstract. We present an analysis of TEC measurements on moving grid of ionospheric piercing points giving possibility of better spatio-temporal changes treatment. Solar terminator forcing of ionospheric irregularities is shown as an example.

The fact that total electron content (TEC) measurements provide important information for improving stellite positioning abilities gave an impulse for rapid developement of GPS TEC measurement networks spread over large globe areas during last two decades. This, in turn, gave unique possibility to study ionospheric phenomena in a wide range of spatiotemporal scales related to various physical processes. In this work we pesent an analysis of GPS TEC time series in coincidence with the solar terminator (ST) passage over the a of ASG-EUPOS[3] net of receiving GPS stations scattered in Poland. Recently Afraimovitch reported[1,2] a new kind of traveling ionospheric disturbances related to ST. The TEC time series was sampled with 30 sec. time resolution and distance between receivers ranging from 10 to 500 km. The day chosen for analysis was 21st of September 2008 during quiet (Kp less than 3) geomagnetic conditions to avoid possible interferences from ionosphere-magnetosphere coupling mechanisms. The date is close to autumn Equinox which makes terminator lying close to North-South direction. Our idea is to represent the TEC data on the ionospheric sphere i.e. sphere with radius $R_{IO} = Re + h$ with TEC normalized to ionohospheric heigth h by formula:

$$TEC_\nu = TEC \cos\left[\sin^1\left(\frac{Re}{Re+h}\cos\alpha\right)\right] \tag{1}$$

at so called ionospehic piercing point[4].

The intrinsic property of GPS TEC measurements causes that the grid of ionospheric piercing poins is irregular and relative satellite motion with respect to receivers net changes its geometry in time. This is the source of problems in data interpretation, introducing for example changing in time and position frequency doppler shift[4], which depens on relative orientation and velocities of ionospheric disturbances and piercing points, that can change considerably the results of data filtering.

To study ionospheric electron concentration structures independent of time changing geometry of piecing points grid we use TEC gradient estimated at each time instant with components along and accross the local meridian:

$$\Delta f_i = a_\phi(Re + h)\Delta\phi_i + a_\lambda(Re + h)\cos\phi\Delta\lambda_i \tag{2}$$

w here f is a difference of TEC value betwean ith pair of receivers, ϕ_i and λ_i are differences of its coordinates, and vector [a , a] is the TEC gradient estimate in the spherical coordinate system. Formula 2 gives an unique estimate of gradient provided we have at least three points. For larger number of measurements one can use least squares method, providing a way of purelly spatial fitering of TEC data.

We estimated also the drift velocity of TEC structures adopting for moving grid the formula:

$$\frac{\partial f}{\partial t} = v_d \cdot \nabla f \tag{3}$$

We could estimate v_d applying the least squares method to a set of equations resulting from discretization of equation 3 for grid points.

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