

Correction's method of the electron density model in ionosphere by ray tracing techniques

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When applying the ray tracing in ionospheric propagation, the electron density modelling is the main input of the algorithm, since phase refractive index strongly depends on it. Also the magnetic field and frequency collision modelling have their importance, the former as responsible for the azimuth angle deviation of the vertical plane containing the radio wave, the latter for the evaluation of the absorption of the wave. Anyway, the electron density distribution is strongly dominant when one wants to evaluate the group delay time characterizing the ionospheric propagation.

From the group delay time, azimuth and elevation angles it is possible to determine the point of arrival of the radio wave when it reaches the Earth surface. Moreover, the procedure to establish the target (T) position is one of the essential steps in the Over The Horizon Radar (OTHR) techniques which require the correct knowledge of the electron density distribution. The group delay time generally gives rough information of the ground range, which depends on the exact path of the radio wave in the ionosphere.

This paper focuses on the lead role that is played by the variation of the electron density grid into the ray tracing algorithm, which is correlated to the change of the electron content along the ionospheric ray path, for obtaining a ray tracing as much reliable as possible. In many cases of practical interest, the group delay time depends on the geometric length and the electron content of the ray path.

The issue is faced theoretically, and a simple analytical relation, between the variation of the electron content along the path and the difference in time between the group delays, calculated and measured, both in the ionosphere and in the vacuum, is obtained and discussed.

An example of how an oblique radio link can be improved by varying the electron density grid is also shown and discussed.