

REAL TIME RAYTRACING THROUGH MEASURED NE
PROFILES IN THE PRESENCE OF IONOSPHERIC TILTS

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High frequency direction finding systems measure the angles of arrival of signals at selected frequencies. Ray tracing techniques can accurately determine the location of the transmitter if the 3-D electron density distribution between the DF site and the transmitter location is known. A collocated digisonde at the DF site can measure the vertical electron density profile and the local ionospheric tilt in real time providing the inputs for the construction of the 3-D Ne distribution. The vertical profile is obtained from the ARTIST-scaled ionogram, and the local tilt from the skymaps recorded after each ionogram. The characteristics of each layer, e.g., critical frequencies and peak heights, are expressed as function of latitude Λ , and longitude Φ . In the neighborhood of the DF site, (Λ_0, Φ_0) , each characteristic, e.g., f_0F2 , is given as

$$f_0F2(\Lambda, \Phi) = f_0F2(\Lambda_0, \Phi_0)[1 + C_1(\Lambda - \Lambda_0) + C_2(\Phi - \Phi_0)] \\ \times [1 + C_3(\Lambda - \Lambda_0) + C_4(\Phi - \Phi_0)]$$

For a given azimuth measured by the DF sensors, the coefficients C_1 and C_2 are determined with the URSI / CCIR coefficients that are also used by IRI, and calculation of C_3 and C_4 makes use of the measured tilt data. At any time when the measured density profile and tilt data are available, the 3-D density distribution represents the instantaneous ionosphere structure near the site. The calculated distribution reproduces the measured vertical profile and tilt.

The numerical raytracing includes the effects of the magnetic field and properly treats the spitz effect making the program useful also for small distances. Ray tracing through simulated tilts shows differences of the ground distances for one hop HF propagation to vary from about 1 km to 200 km depending on the assumed tilts and distances. Operational tests have demonstrated very good results in determining the transmitter location for a distance up to ≈ 100 km, and have illustrated the importance of using the current ionospheric profiles and tilts in the ray tracing.

Abstract Submission Form

2004 National Radio Science
Meeting

Abstract: huang14350

Date Received: October 1, 2004

1. (a)

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2. G - Ionospheric Radio and
Propagation

3. (a)

4. C - Contributed Paper

5. No special instructions