Effect of the Ionosphere on Space Systems and Communications

Editor

John M. Goodman

Based on

Ionosphere Effects Symposium

Held in

Crystal City, Arlington, Va.
January 20-22, 1975

NAVAL RESEARCH LABORATORY
Washington, D.C. 20375

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $10.20
Stock Number 008-051-00064-0

RAY TRACING THROUGH REALISTIC IONOSPHERE GRAVITY WAVE MODELS :

A COMPARISON WITH EXPERIMENTAL DATA FROM SEVERAL DIFFERENT TECHNIQUES.

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ABSTRACT

Model ionospheres using experimentally measured parameters are constructed from a realistic medium scale ionospheric gravity wave model. The ray tracing technique is then employed to simulate the results of the original experimental measurements from the model ionospheres. The technique is found to be limited by the gravity wave model which uses only one gravity wave period in the construction of the ionospheric model whereas realistic ionospheres contain in general a spectrum of medium scale gravity waves.

1. INTRODUCTION

Travelling ionospheric disturbances (TIDs) have been observed by a large number of workers using many different techniques since the pioneering work of Munro (1958). However it was not until the theoretical work of Hines (1960) and Hooke (1968) that the nature of these disturbances was interpreted successfully as wave like fluctuations of the electron density induced by gravity waves in the neutral atmosphere. There are two major classes of TIDs, large scale and medium scale. (Georges, 1968). The large scale waves are generally associated with magnetic storms whereas the medium scale waves occur much more frequently, their sources being uncertain.

Many techniques have been used in the past and are being used to detect the presence of these TIDs. Depending on the technique. and the ionospheric parameter measured, various properties of the TIDs can be determined. The intent of this. paper is to report the results of a simulation of the results of some of these techniques using ray tracing techniques. The experimental techniques to be simulated include high frequency doppler, group and phase paths at oblique incidence, vertical incidence ionograms, total electron content measurements using the Faraday rotation of the plane of polarization of a signal from a VHF beacon, and the refraction of a signal from a VHF beacon on a geostationary satellite.

Before the ray tracing studies can be performed a suitable ionospheric model of TIDs is required. This is provided by the medium scale TID model as described by Francis (1973). Experimentally measured TID parameters were inserted in the model and a time varying ionospheric model generated for the ray tracing program.

2. SIMULATION METHOD

(a) Travelling Ionospheric Disturbance Model

The Francis (1973) TID model was used to simulate a realistic ionosphere. This model differs from previous models by including dissipation (viscosity and thermal conductivity) and by using a realistic sound speed profile throughout the thermosphere. The model assumes that the wave dependence on the time t and horizontal co-ordinate x is a sinusoidal function of wt - k x. It derives the vertical profile[x] by solving the coupled Navier-Stokes and electron continuity equations. The basic inputs to the model are the wave-length, period, amplitude and azimuth of propagation of the neutral gravity wave underlying the TID which is to be modelled. The ambient ionosphere, specified by an a Chapman profile (unless otherwise indicated) is used to compute the electron density as a function of space and time for the TID perturbed ionosphere