Comparison of Model VLF Power Distributions with Satellite Data

***Richard A. Quinn*[1], *Michael J. Starks*[2], *Jay Albert*[3], *Gregory P. Ginet*[4]**

[1]Atmospheric and Environmental Research, Inc., 131 Hartwell Avenue, Lexington, MA 02421-3126, USA, rquinn@aer.com

[2]Space Vehicles Directorate, Air Force Research Laboratory, Hanscom AFB, Massachusetts, USA, Michael.Starks@hanscom.af.mil, [3]Jay.Albert@hanscom.af.mil, [4]Gregory.Ginet@hanscom.af.mil

Abstract

A composite model of wave propagation from terrestrial very low frequency (VLF) transmitters has been constructed to estimate the electric and magnetic fields and wave normal angles of whistler mode waves in the plasmasphere. The model combines a mode-theory simulation of the fields in the Earth-ionosphere waveguide, ionospheric absorption estimates, and ambient magnetic field and plasma density models with a fully three-dimensional ray tracing analysis that includes refraction, focusing, and resonant damping. The field strength outputs of this model have been found to be consistent with those of several pre-existing, simpler simulations, some of which have underlying component models in common, e.g. [1]. A validation of the model outputs using electric and magnetic field data from five satellites shows that away from the magnetic equator, all of the models systematically overestimate the median field strength in the plasmasphere due to terrestrial VLF transmitters by about 20 dB at night and at least 10 dB during the day. In addition, wave field estimates at $L < 1.5$ in the highly variable equatorial region appear to be about 15 dB too low. Consideration of the models' similarities and differences indicates that this discrepancy originates with the methodology common to all of them: combining field estimates valid within the Earth-ionosphere waveguide with ionospheric absorption curves to model the fields in the lower ionosphere. Subsequent adjustment of those field estimates by -23 dB during the night and -10 dB during the day brings the model outputs into closer agreement with satellite observations. It is concluded that past and future use of this widely-employed methodology should be regarded with caution.

References

1. U.S. Inan, H.C. Chang, and R.A. Helliwell, "Electron precipitation zones around major ground-based VLF signal sources," *J. Geophys. Res.,* **89(A5)**, 1984, pp. 2891-2906.