Full Wave VLF Subionospheric Propagation Modelling with Spherical Geometry

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Introduction

Experimental observations have clearly demonstrated the possibilities of remote sensing events thousands of kilometres from the receiving point. While some simulation codes have been developed, they generally suffer from some limitations. The majority were developed for describing undisturbed propagation conditions, and cannot undertake realistic treatments of disturbed conditions. Those codes which have been developed for disturbed situations ("scattering codes") are largely "bolt-ons" to traditional propagation programs, using weak scattering/small change approximations. This, plus the lack of accuracy that some traditional propagation codes have near the upper reflection boundary, means they cannot undertake realistic modelling in real world situations.

New Method

We have developed a new propagation and scattering model for VLF radio wave propagation within the Earth-ionosphere wave guide, i.e. subionospheric propagation. We use proven full wave methods (Nagano et al., 1975; Nagano et al., 2003) and spherical geometry to attain realistic results which should supersede those of other earlier approaches. We have compared our simulation method to that a well-developed US Navy subionospheric propagation code, LWPC, including a "Wait ionosphere" ß and h' model for D-region electron densities. This ionospheric model has been refined to match experimental observations made throughout the day [Thomson, 1993; McRae and Thomson, 2000]. Based on this comparison, and our ability to include scattering due to inhomogeneities in waveguide properties, we are in a position to remotely sense ionospheric changes. Our technique allows greater accuracy, particularly around the altitudes which define the lower boundary of the Earth-ionosphere waveguide, namely the ionospheric D-region.

References

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