

#30 Received 01/10/2015

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The Simulation of a Disturbed HF Channel

Abstract:

The ionosphere experienced by an HF communications channel is rarely benign and modelling, based on a background model such as the IRI (International Reference Ionosphere), only provides an indication of the channel's potential. In reality, the channel will be plagued by phenomena such as travelling ionospheric disturbances (TIDs) and other phenomena related to ionospheric instability. TIDs are of particular importance as they are frequently present and give rise to the phenomenon of fading, a phenomenon that can render an HF channel highly unreliable. Nevertheless, an HF channel still constitutes a cost effective means of communication to remote sites, especially when low data rates are involved. The current work is focused on providing an ability to simulate an HF channel in which strong TIDs are present. Such a facility is intended to provide a test bed for communication strategies in disturbed environments. In addition, however, the work will also provide a test bed for direction finding strategies used to locate the stations involved. The major stumbling blocks in developing such a simulation facility are that we must provide a point-to-point ray-tracing tool that can handle a highly disturbed ionosphere and the need of an effective model of TIDs through which we can ray trace. This paper addresses both issues. Firstly, we describe some modelling work that simulates gravity waves that are then used to modulate a background ionosphere, according to the Hooke theory, and hence provide a TID disturbed ionosphere for ray tracing. (The background ionosphere is based on IRI derived parameters). Secondly, we describe a technique for performing point-to-point ray tracing that is based on a direct variational method. In particular, we show how such an approach can be applied in a disturbed ionosphere. All of this is then brought together to form the channel simulator. The work described in this paper forms part of a study of HF communication channels that includes an experimental program and has the eventual aim of providing reliable low power, low data rate links to remote experimental sites.