A Statistical Analysis of the Performance of High Frequency (HF) Propagation Prediction Models in the Arctic Region

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Ionospheric communication in the high frequency (HF) band (3-30 MHz) is known for its ability to provide a world-wide coverage using relatively little power and low-cost equipment. However, it has been shadowed by the invention of new technologies such as satellite communication yet it is still a necessity for various civil and military applications. The efficient use of the ever-varying ionosphere as a propagation medium is dependent on the reliability of ionospheric and HF propagation prediction models. Most available models are empirical implying that data collection has to be sufficiently large to provide good intended results. The models we present were developed with little data from the high latitudes which necessitates their validation. Adequate data is an essential requirement for validation and development of empirical models. This work takes advantage of the availability of data obtained from the Canadian High Arctic Ionospheric Network (CHAIN).

This paper presents a statistical analysis of the performance of three long term High Frequency (HF) propagation prediction models over two paths within the Arctic region. Measurements of the Maximum Usable Frequency for a 3000 km range (MUF (3000) F2) for Resolute, Canada (74.75° N, 265.00° E) and Pond Inlet (72.69° N, 282.04° E) are obtained from hand-scaled ionograms generated by the Canadian Advanced Digital Ionosonde (CADI). The standard deviation of the observations have been compared with the Root Mean Square Errors (RMSE) computed from the observations and the predictions obtained from the Ionospheric Communication Enhanced Profile Analysis Program (ICEPAC), Voice of America Coverage Analysis Program (VOACAP) and International Telecommunication Union Recommendation 533 (ITU-REC533) for 2009, 2010, 2011, 2012 and 2013.

Results show that there is a noticeable increase in standard deviation computed from observations as well as RMSE with solar activity. There appears to be a seasonal variation in the standard deviation which is clearly depicted by the ICEPAC RMSE and fairly by the VOACAP RMSE but not so evident in the REC533 especially during high solar activity. The ICEPAC model performs poorly during low solar activity but there is a noticeable improvement as solar activity increases, especially during spring and summer. VOACAP performs well for the most part of the analysed period except during winter in low solar activity. REC533 performs well during winter and equinox except during summer especially during high solar activity.