Evaluation of various models for HF propagation prediction

Proposed Hons Research Project.

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Objective
The objective of this study is to estimate the accuracy of the ICEPAC model for the prediction of High Frequency (HF) Radio propagation frequencies (3-30 MHz) by comparison with measured propagation conditions as recorded at the Amateur Radio frequencies by means of the NCDXF/IARU International Beacon Project (http://www.ncdxf.org/beacon/).

Background
High Frequency (HF) Radio communication is widely used in Air Traffic control and for ship-to-shore communication. HF Radio signals are transmitted over long distances by selecting appropriate frequencies that will be reflected from the ionosphere and return to Earth at a selected location which depends on the ray path through the ionosphere.

The Space Weather Centre at SANSA Space Science does daily predictions of optimal frequencies to use for HF Radio Communication over specified links. There are several packages for predicting the MUF. The object of the project is to compare the simple expression for the Maximum Useful Frequency (MUF=foF2/cos(theta)) with predictions using the ICEPAC software (http://www.voacap.com/itshfbc-help/icepac-tech-intro.html) and actual measurements done with the receiver at SANSA of the NCDXF/IARU International Beacon Project (http://www.ncdxf.org/beacon/).

SANSA hosts an Amateur Radio band HF receiver equipped with software to log the signal strengths of transmissions from the HF beacon stations of the NCDXF/IARU Beacon Network (http://www.ncdxf.org/beacon/) at selected frequencies in the HF Radio band. The project will comprise the use of various models to predict the signal strength at Hermanus of HF radio signals transmitted from various beacon signal sources and to compare the predictions with the actual measurements for various times of the day. This will establish confidence limits for the accuracy of the prediction models for long-distance communication.

This project will equip the student with an understanding of the role of the ionosphere in HF Radio propagation, and the use of various methods of predicting the ray paths and optimal frequencies to use for HF Radio communication and prepare the student for MSc research in the field of ionospheric physics and HF radio propagation.

Data sources & software
Data from the HF receiver at SANSA of the NCDXF/IARU Beacon Network is available on the SANSA data server. The ICEPAC software for the analysis of ionospheric radio propagation conditions will be used. The student will be required to develop relevant software in Excel, Python or MATLAB for selecting, comparing and plotting the results of the comparisons of the model and measurements.

Deliverables
The results should be presented in the form of a paper which is suitable for submission to a scientific journal.

References:
1. About the HF DX project: http://www.ncdxf.org/beacon/
2. About the ICEPAC propagation prediction tool: http://www.voacap.com/itshfbc-help/icepac-tech-intro.html

3. About HF Radio propagation prediction: Rush, C.M., 1986. Ionospheric radio propagation models and predictions--A mini-review. Antennas and Propagation, IEEE Transactions on, 34(9), pp.1163-1170.
4. On experimental verification of HF propagation predictions: Watterson, C.C., Juroshek, J.R. and Bensema, W.D., 1970. Experimental confirmation of an HF channel model. Communication Technology, IEEE Transactions on, 18(6), pp.792-803.
5. Poole, I. 1999. Radio waves and the ionosphere. Qst, 83(11): 62-64.
6. Zolesi, B. & Cander, L. R. 2013. Ionospheric prediction and forecasting. Berlin: Springer.