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Space weather effects on airline communications in the high latitude regions

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In the polar regions, ground-based VHF facilities for air-traffic control are lacking (and non-existent on the Russian side of the pole) and satellite communication systems either not available or expensive to retrofit to current aircraft and hence there remains a need for HF communication systems. Unfortunately, at these latitudes space weather can significantly affect the propagation of HF radio signals and the forecasting techniques currently employed by the airline industry are somewhat crude. In this paper, a new project that aims to provide forecasting of HF propagation characteristics for use by civilian airlines operating over polar routes will be described and preliminary results presented. Previous work in this area [e.g. Stocker et al., 2007] has focussed on taking HF signal measurements (e.g. SNR, delay and Doppler spread, and direction of arrival) on a limited number of propagation paths and developing an ionospheric model that incorporates high latitude features (e.g. polar patches and arcs) which, when combined with raytracing, allows the broad characteristics of the observations to be reproduced [Warrington et al., 2012]. The new project will greatly extend this work and consists of a number of stages. Firstly, HF measurements from an extensive network of purpose built transmitters and receivers spanning the Arctic regions will be collected and analysed.

In order to test a wide variety of scenarios, the propagation paths will have different characteristics, e.g. different lengths and covering different parts of the northern ionosphere (i.e. polar cap paths where both terminals are in the polar cap, trans-auroral paths, and sub-auroral paths) and observations will be taken at a range of HF frequencies for a period covering the current (so far weak) solar maximum and part of the declining phase. Simultaneously, high latitude absorption measurements utilising the Global Riometer Array (GLORIA) will be collected and analysed. Next, the observations of the signal characteristics (i.e. both reflection and absorption properties) will be related to prevailing space weather parameters. Following on from this, an auroral absorption prediction model based on solar wind and interplanetary data will be developed together with the further refinement of the existing ionospheric model taking into account the new observations and adding auroral and polar cap absorption models.

Algorithms for nowcasting and forecasting of radio propagation conditions for trans-polar aircraft
will then be developed from the ionospheric model. In addition to the approach described above, the benefits of ground station diversity using both the experimental data and the models developed during the project will also be investigated.

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Warrington EM, Zaalov NY, Stocker AJ, Naylor JS, HF propagation modelling within the polar ionosphere, Radio Science, 47, Article number RS0L13, doi:10.1029/2011RS004909, 2012.