PHYSICAL PROBLEMS OF PARTICULAR RELEVANCE TO ARCTIC COMMUNICATIONS

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Abstract: The complicated physical processes governing the polar ionosphere often interrupt high latitude radio communications. For polar circuits presently used prediction techniques are not adequate and need revision. Specific requirements and means for improving communications in the region concerned are discussed. It is stressed that the possibility for utilizing anomalous ionization structures, such as $E_\parallel$ and the high latitude trough, for sustaining propagation should be further exploited. There is need for a program to establish empirical prediction patterns by synoptic and morphological studies.

1. INTRODUCTION

Radio communications to and from high latitude stations are subject to interruption due to the effects of charged particle precipitation into the ionosphere producing the various well-known geomagnetic and ionospheric disturbance effects. These effects have been observed for some years and the statistics of their occurrence, temporally and spatially, have been studied. However, one is not able yet to trace the path of a particular disturbance from the magnetosphere down to the ionospheric reflecting and absorbing layers and present a morphological picture of the state of these layers for a particular time. On the other hand, present routine data give information which could provide better predictions in polar regions than are now offered to communicators.

There is a requirement for:
1. Reliable statistical maps of the polar ionosphere for communication planning.

2. A method of testing the ionosphere to help to choose the proper circuit frequency and bandwidth characteristics.

3. A short term forecasting method to assist in planning traffic handling.

2. SHORT RANGE COMMUNICATIONS

In spite of the vagaries of the polar ionosphere, the principal method of communicating within the auroral zone is with medium and high frequency transmissions reflected by way of the ionosphere. If a delay time of up to several hours is permissible, failure to communicate arises only infrequently.

For short range (100-1000 miles) communication within the auroral zone, one can get along with one or, at the most, two frequencies. Day-to-night variation of F region ionization over the polar cap is small during most of the year although, admittedly, the fine structure of the ionospheric layers is more variable than at temperate latitudes. In addition, communication can be achieved during many disturbances by reflection from the bottom side of the D region absorbing layer, with proper choice of low or medium frequencies. Another possible system using VHF has just been proposed by Landmark.

If the required antenna installation is warranted, one can largely avoid the ionosphere disturbances problem with VLF communications by ground wave or by taking advantage of the earth-ionosphere cavity for longer distance circuits.

Problems in predicting and choosing frequencies for polar region communications arise from the following:

(a) The F region critical frequencies ($f_{0}F_2$) are determined from ionograms using temperate latitude rules of scaling.

(b) The tabulations of $f_{0}F_2$ from polar ionosondes are not easily related to equivalent MUFs for communications, due principally to the frequent occurrence of spread F. The proper method for determining $f_{0}F_2$ from a spread F ionogram is not known nor is it possible to determine if an ionogram obtained at an isolated Arctic station is typical of the ionosphere environment.

(c) The F1 region is known to be dominant in Arctic regions all