

A STUDY OF HUNDREDS KILOMETER COMMUNICATION ON POLAR ICE SHEET

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Introduction

The few hundred kilometer link is often required between the survey trip party or advance camp and base station in the polar region. However, the HF communication link which used an ionospheric propagation has many difficulties. One of the most important difficulty is the problem of low Maximum Useable Frequency. The upper limit of frequency is determined by the limit of skip distance and foF2 of polar cap ionosphere. The foF2 in the polar ionosphere keeps always lower than that of the value of low latitude region, and MUF is kept below about 6MHz (1). The almost of all trip party at Antarctica which distanced within few hundred kilometers, they communication frequency are used on the band of lower HF or upper MF. The typical foF2 distribution map at polar cap ionosphere is shown in Fig. 1.(1)

In addition to the problem of MUF, another difficulty is the problem of high absorption at polar cap ionosphere propagation. The value of Lower Useable Frequency of polar region at night and during the event of geomagnetic disturbance is often exceeded over the value of MUF by the increases of Polar Cap Absorption. We named it "Polar Black Out".

The high angle radiation antenna must be designed for HF communications as such distance. The quality factor of HF communication link at polar region falls

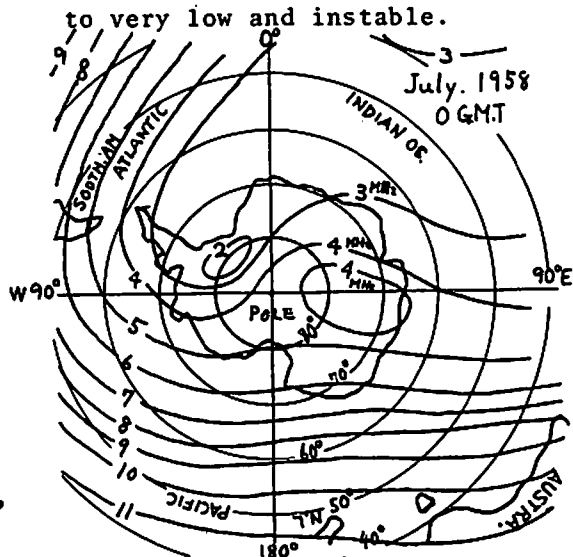


Fig. 1 A typical foF2 map at polar ionosphere (after Atlas Antarctica 1966)

U.H.F Radio Duct Propagation

Another system for a few hundred kilometers communication link on the surface of polar ice sheet is the UHF communication link applied the radio duct propagation. The average appearance frequency of the temperature inversion layer which observed as "mirage" is over 50% by the data taken while six months of winter season at Prince Olav Coast near Syowa base. (2) A sample of observed vertical temperature profile at Syowa base is shown as Fig. 2, and a typical M-curve which calculate from Fig. 2 are shown in Fig. 3.

However, the frequency property of the polar radio duct is

as follows: The calculation results by use of the observation value, the average minimum cut-off frequency of these ducts are about 1GHz, and the lowest value are about 300MHz. And the scintillation of polar duct propagation depend on the micro temperature variation. (3) Fig. 4 shows the value of the relation between micro temperature variation and VHF signal intensity on the measurement near Syowa base. As shown in the results of Fig. 4 and through the experiments at the Antarctica, the signal field intensity increases in invers proportion to the temperature decreases. That maximum fading range at 1GHz with 10Km span is about 18dB as shown in Fig. 5.

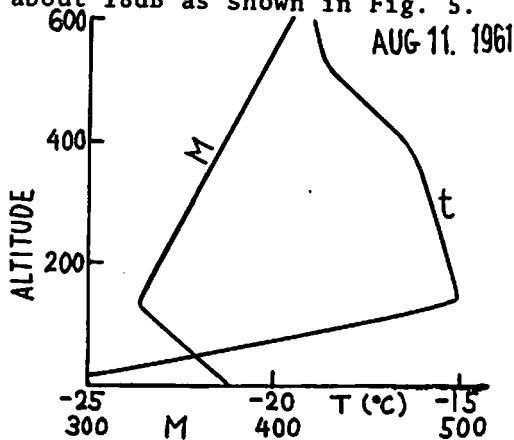


Fig. 2 A typical temperature inversion profile at Syowa base. and Fig. 3 A typical M-curve.

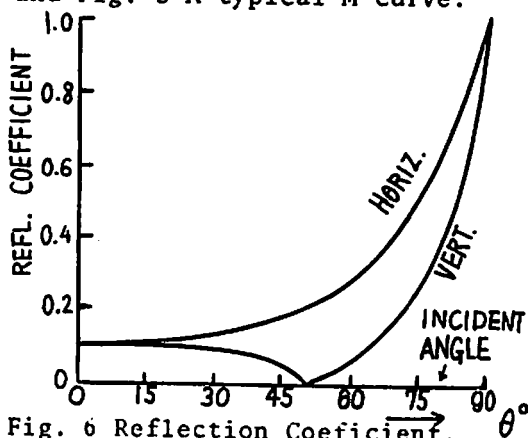


Fig. 6 Reflection Coefficient.

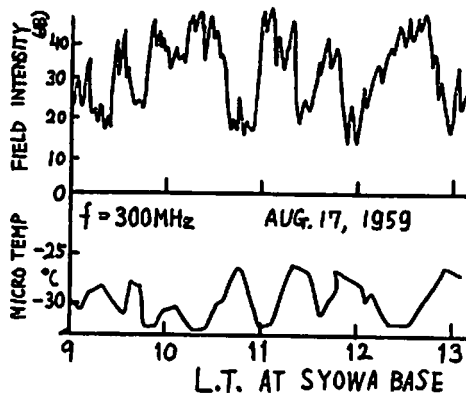


Fig. 4 Micro temperature variation and VHF signal intensity.

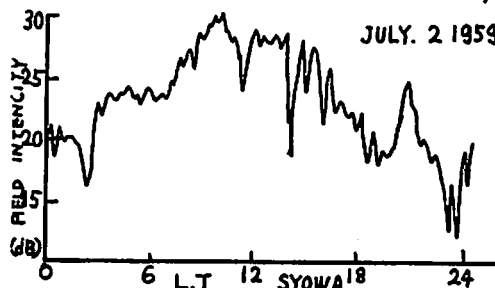


Fig.5 VHF fading characteristics at polar region (1GHz, 10Km)

For the designing of the antenna system for UHF radio duct communication link on the polar ice sheet, some important notice must be considered as follows; the reflection coefficient on the surface of polar ice sheet at high angle incidence is very low (0.1 - 0.2) (4) and Brewster's angle at vertical polarization wave is about 50°. A calculation results of reflection coefficient on the surface of Antarctica is illustrated in Fig.6. Only the horizontal pol. wave and low angle radiation is available the radio duct communication at polar region.

Reference

- (1) Atlas Antarctica vol.1, plate 27, Moscow 1966.
- (2) Antarctic Meteor. Data vol.3 March 1964.
- (3) T.Yoshino; Conv. Rec IECEJ, 1961 July 1967.
- (4) T.Yoshino; IEEE Trans. G-AP,