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LOW FREQUENCY SWEEP GROUP
HEIGHT AND
POLARIZATION RECORDS

by

J. D. Hardy
February 15, 1963

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Scientific Report

on

"Low Frequency Sweep Group Height and
Polarization Records"

by

J. D. Hardy

February 15, 1963

(Project 8605, Task 860501)

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SCIENTIFIC REPORT NO. 179
Ionosphere Research Laboratory

Submitted by: A. J. Ferraro, Assistant Professor of Electrical Engineering

Approved by: A. H. Waynick, Professor of Electrical Engineering, Director, IRL

THE PENNSYLVANIA STATE UNIVERSITY
College of Engineering and Architecture
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ABSTRACT

This report is a presentation of the records obtained during the period March 5, 1962 to August 22, 1962 on a low frequency group height and polarization instrumentation covering the swept frequency range of 100 - 1000 Kc/s. Included in these data are the preliminary results of a stepped frequency experiment. These appear to be the only such records being obtained in the world at this time. In view of this, it was deemed advisable to make them available to the scientific community by this process.
I. Introduction

Automatic h'-f recordings over a range of about 1 to 30 Mc/s are made regularly in different parts of the world, from which the structure of the ionosphere from about 100 km to the height of maximum electron density can be deduced. For determining the structure of the lower ionosphere, lower frequencies are required since their depth of penetration before reflection is smaller. Equipment for this purpose involving the recording of virtual height in the range 100 - 1000 Kc/s has been designed and constructed at the Ionosphere Research Laboratory.\(^{(1)}\)

As an adjunct to the long wave h'-f equipment it is imperative to determine the sense of rotation of the ionospheric echoes as a function of frequency to aid in the analysis of the very complicated structure of the low frequency echoes. Parkinson\(^{(2)}\) used a crossed pair of loop antenna at a fixed frequency of 150 Kc/s to measure the complete polarization characteristics. In this technique, the phase of the signal in one loop is advanced by \(\pi/4\) and that of the other loop retarded by the same amount. The circular components, ordinary and extraordinary, are formed by the sum and difference of the phase shifted loop signals.

Carlson\(^{(3)}\) adapted Parkinson's fixed frequency method to sweep frequencies as far as polarization sense determination is concerned. Carlson's polarimeter, which is in operation at the Ionosphere Research Laboratory at the
present time, was used to obtain such recordings in this report.

Figure 1 is a block diagram of the transmitter and polarimeter. The output from the variable frequency oscillator (3.1 Mc/s-4 Mc/s) of the transmitter is mixed with received signals (100 Kc/s-1000 Kc/s) resulting in a 3 Mc/s signal for intermediate frequency amplification.

The Parkinson technique is applied, but at the I.F frequency of 3 Mc/s, producing two outputs corresponding to the North into West and North into East circular components. These outputs are further subtracted by a video amplifier and then used to intensity modulate the recording oscilloscope. In this manner, records are obtained with black and white traces corresponding to a predominantly North into East rotation and North into West rotation; respectively. For a more detailed description and the theory of operation it is suggested that the reader refer to Carlson's Scientific Report No. 129(3).

II. INTERPRETATION OF RECORDS

All the records presented in the Appendix of this report cover the period March 5, 1962 to August 22, 1962. The times are Eastern Standard and the twenty-four hour system was used to indicate the time. Times and dates are marked at the bottom of each page, while times of individual records are printed adjacent to each of the records to facilitate their reading.
It will be noted that the length of some of the records are longer than others; those which were recorded before May were on a four minute sweep length and those afterward on a two minute sweep.

Frequency markers occur every 100 Kc/s and the corresponding height intervals are 10 Km steps. During March and April a mechanical frequency marker was used and its accuracy at times was in question; however, the drawn-in frequency scale on each of these pages will give a fairly accurate indication of frequency. After April the electronic frequency marker was in use again and now gives accurate frequency markers.

On some of the records, frequency increases from right to left; in this case, a frequency scale has been drawn in on the lower right hand corner of each page. For the majority of prints the frequency increases from left to right.

On the side of one of the bottom prints there is a height scale in hundreds of kilometers. This scale may be used with those records on that page. At times it may be noted that the 100 Km marker may appear closer to the base of the record. This is caused by occasional drift of the image on the oscilloscope.

At the bottom of the page along with the time and date is the magnetic C-figure for that day. The C-figure is the arithmetic mean of the subjective classification by all observatories of each day's magnetic activity on a scale of
O(quiet) to 2(storm). These values were obtained from The Solar Geophysical Data, published by The National Bureau of Standards, Central Radio Propagation Laboratory, Boulder, Colorado.

The dark echoes indicate a north into east polarization sense and light echoes indicate a north into west sense.

Occasionally an experiment was made in which the frequency was stepped across the range 100 - 400 Kc/s instead of being swept continuously from 100 - 1000 Kc/s. Five steps were used of approximately ten minutes each, corresponding to 100, 150, 200, 300 and 400 Kc/s. These were the only licensed fixed frequencies which were feasible for use. The 100 Kc/s step does not usually produce any echoes and serves as a frequency origin. The frequency of each step is printed in with white ink, with the frequency coming at the beginning of the step. Care in reading these must be exercised because of the reversed prints in some cases. On most of the step records, the frequency and height markers appears at equal intervals. These are triggered by a motor and time switch at the rate of one per minute.
III. BIBLIOGRAPHY


IV. APPENDIX

Sample low frequency sweep records, covering the frequency range 100 to 1000 Kc/s, obtained during the interval March 5, 1962 to August 22, 1962. These include group height and polarization sense information.