R-06-012-088

Traveling Disturbances Observed at Jicamarca

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INTRODUCTION

Electron density profiles taken every three minutes at Jicamarca with the back-scatter radar show the existence, at times, of weak wave-like disturbances in the F region. The perturbations in density from the mean value are typically of the order of ± 1-3% and the phase of the perturbation varies with height. The period of the oscillation is roughly 20 minutes. The disturbances can also be seen on ionograms taken simultaneously.

MEASUREMENT TECHNIQUE

Our electron density profiles were obtained by measuring the Faraday rotation of the scattered signal. This technique yields absolute electron densities, without any need for a separate normalization. The altitude range covered was 200 to 600 km, and the pulse length used was 233 usec, giving a height resolution of 35 km. The integration time was 3 minutes. The raw results were smoothed somewhat by taking a three point (9 minute) running average in time, and the final results are shown as contours of constant electron density. The interval between contours is logarithmic (for example, the contour labeled 6.0 corresponds to a density of 10^6 electrons/cm^3) in 1/4 dB steps.

RESULTS

One such contour map, taken on 10 January 1967, is shown in Fig.1. The smeared points are due to noisy data. Wave-like perturbations can be seen on the individual contours. These waves are very prominent on the contour map at the height of 350 km, and have an amplitude of about one-half a contour interval, or ± 3% . This amplitude appears to be fairly independent of altitude. By drawing lines through corresponding points of maximal density variations, surfaces of constant phase are defined. These are shown in

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Fig. 2 superimposed on the density contour map, and they represent wave fronts of constant electron density variation. The fronts appear to be almost vertical in the upper part of the ionosphere above 350 km, but are gradually retarded below; the total amount of retardation or lag from top to bottom is about 20 minutes. The period of the wave is also about 20 minutes, and it persists without interruption throughout the five hour period shown.

Another contour map, for 6 March 1967, is shown in Fig.3. The contours show similar periodic perturbations, but of smaller size. The amplitude of the wave is about 1-2% and the period is about 30 minutes.

COMPARISON WITH IONOGRAMS

Ionograms were also examined for similar perturbations. Plots of virtual height versus time at fixed frequencies are shown in Figure 4 for March 7,1967. The contours of constant frequency correspond to density contours of 5.800 through 6.125. For comparison purposes, the electron density contour map taken by the backscatter radar is shown in Figure 5. The two contour maps show similar variations. There is little change on either until 1430. At this time a slight shift upwards occurs. This is followed at 1515 by a strong downward change which then oscillates until the end at 1715.

The sweep frequency sounder at Huancayo was operated also on March 7,1967. A similar frequency contour map is shown in Figure 6. Except for a 3 minute difference the two maps agree. However, 3 minutes is about the uncertainty of the measurements since the time on the Huancayo ionograms is not known to better than 2 minutes. Since Huancayo is 172 km to the East of Jicamarca, it appears that the disturbances travel in a North-South direction.

Fig 1
Fig 2
Fig. 3
Fig 4
Fig 5
Fig 6

COMPARISON WITH ARECIBO RESULTS

Traveling disturbances were observed by Thomel who used the backscatter radar at Arecibo. He assumed temperature equilibrium. He also averaged the total observation time in order to normalize the individual density profiles taken at 100- second intervals. His results show wave periods of 20 minutes to several hours. Our observations show periods of 20 minutes to one-half hour.

The amplitude of the Arecibo disturbances are 10 to 20 percent from the mean electron density. Ours are 1 to 3 percent. Also the largest amplitudes at Arecibo occur near the maximum of the F region. Our amplitudes appear height independent. The phase relationships both at Arecibo and Jicamarca are similar.

FIGURE CAPTIONS.

Fig.1. Electron density contours. Electron densities are given in logarithmic intervals of 1/4 decibel.

Fig.2. Surfaces of constant phase. Lines through points of maximal electron density deviation are superimposed on the electron density contour plot.

Fig.3. Electron density contour showing surfaces of constant phase. The drawn lines which represent the wave surfaces connect points of maximal deviation.

Fig.4. Plots of virtual height versus time at fixed frequencies. Ionograms were taken at Jicamarca.

Fig.5. Electron density contours for comparison with Figs. 4 and 6.

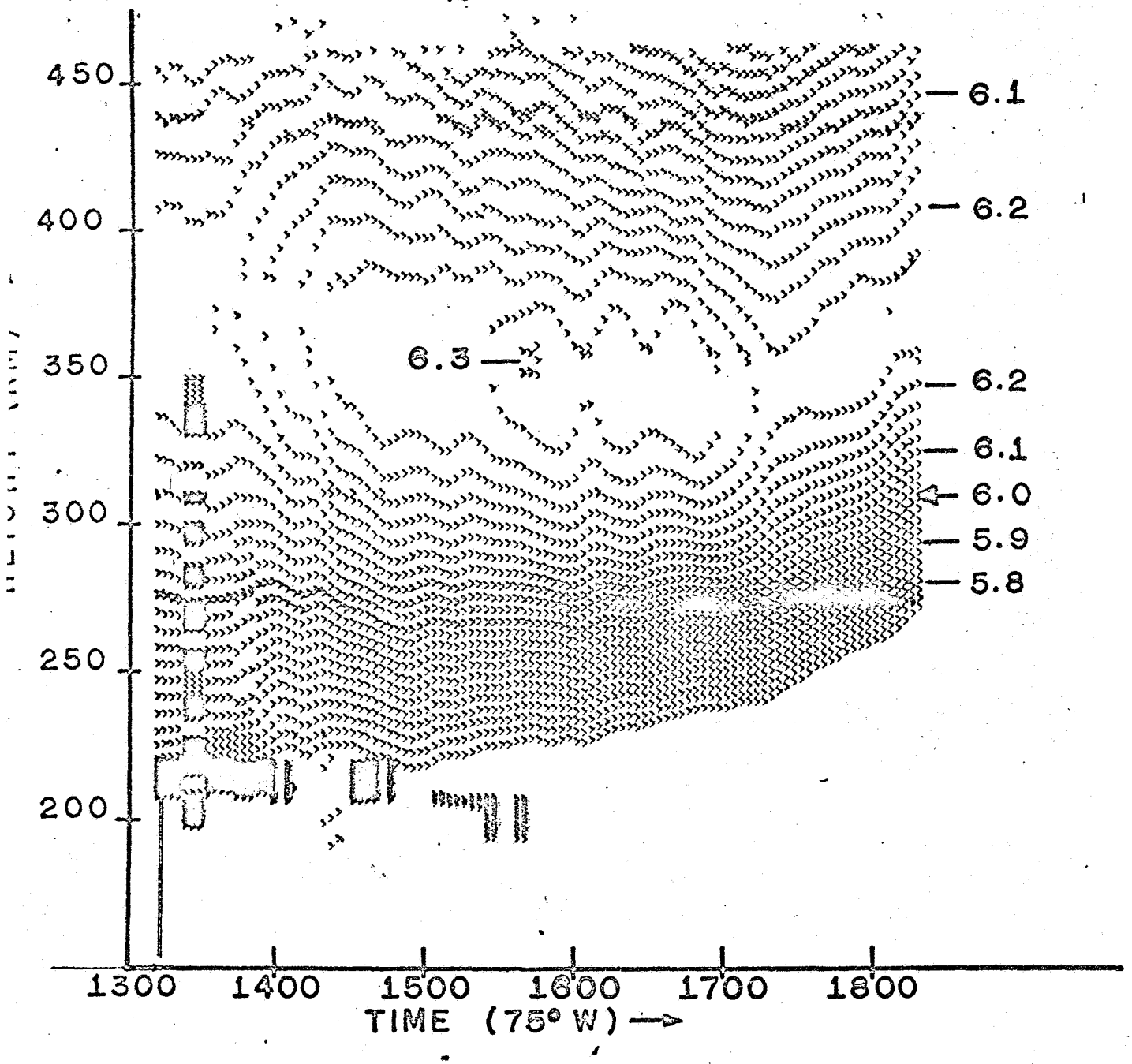
Fig.6. Plots of virtual height versus time at fixed frequencies. Ionograms were taken at Huancayo, Peru.

REFERENCES

(1) Thome, G. D., J. Geophys. Res., 69, 4047, 1964

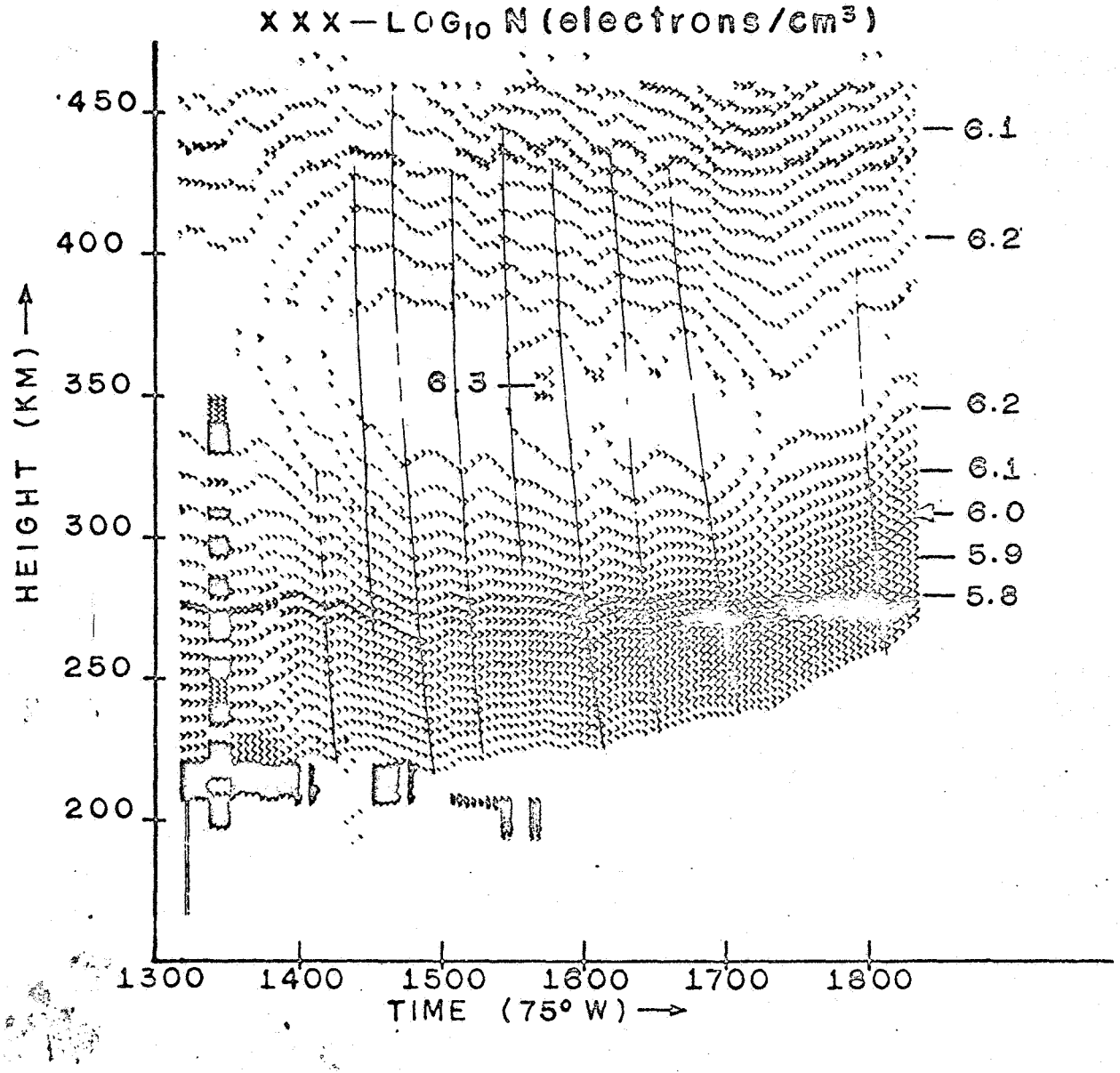
JICAMARCA — PERU

JANUARY 10, 1967



JICAMARCA — PERU

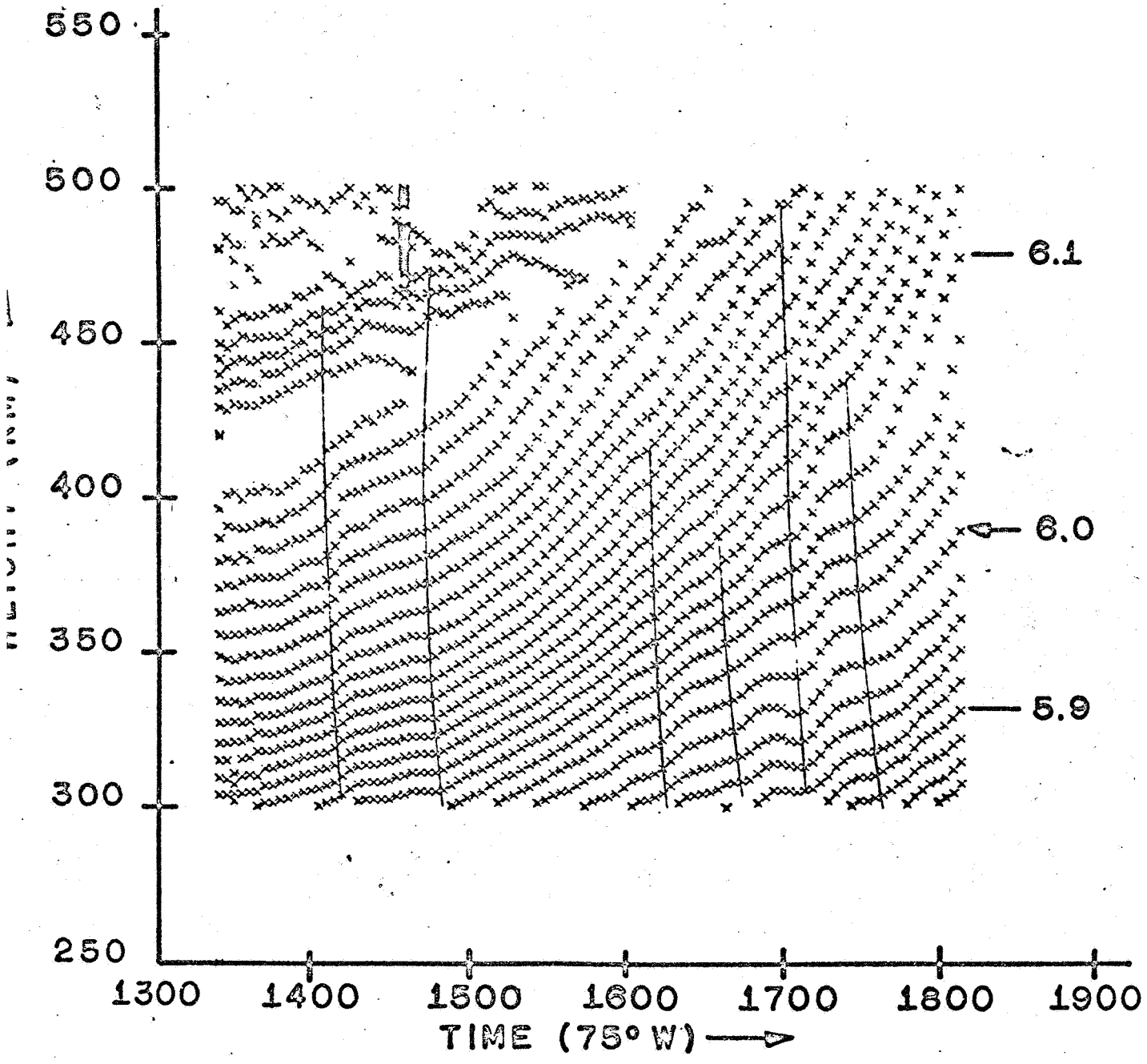
JANUARY 10, 1967



JICAMARCA — PERU

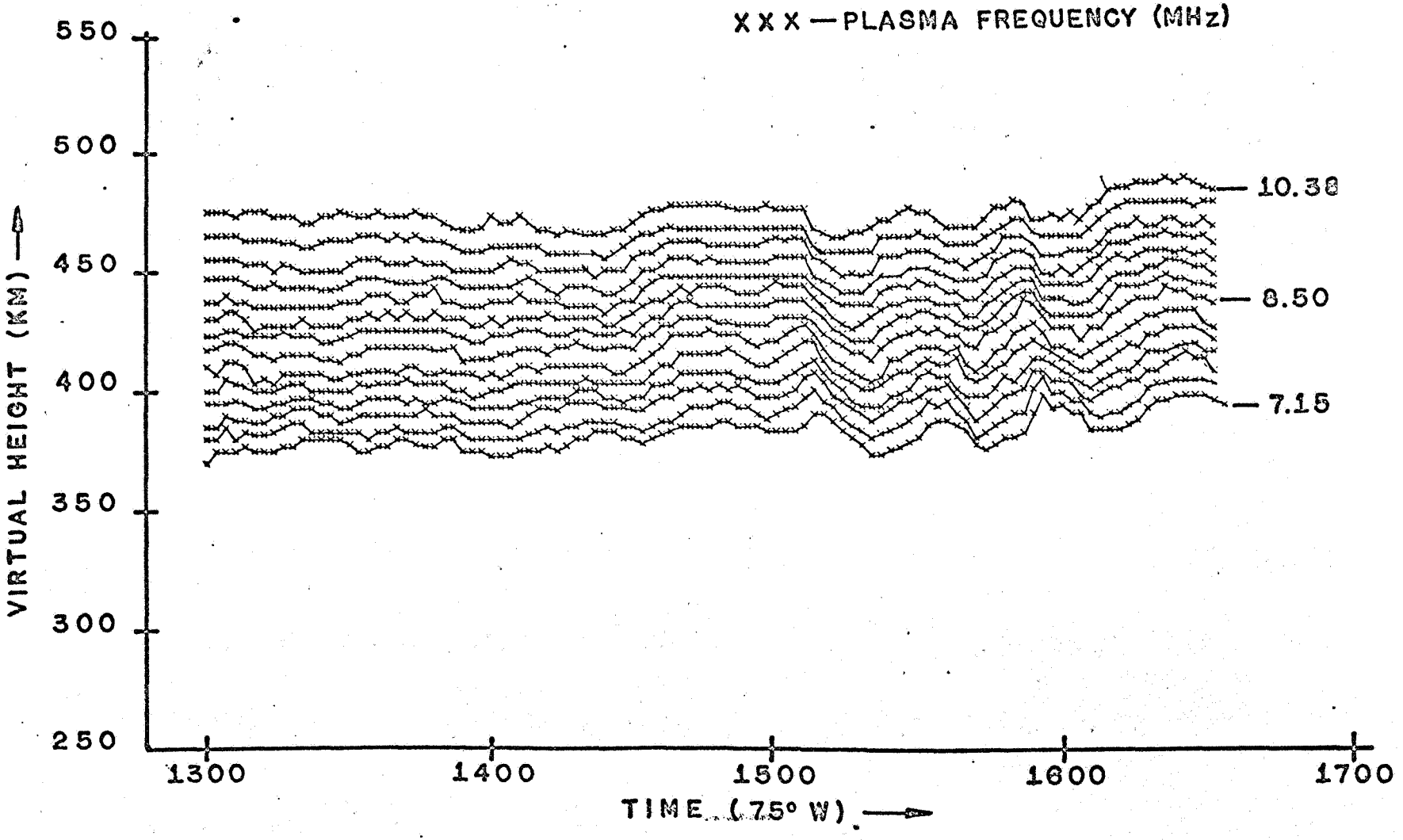
MARCH 6, 1967

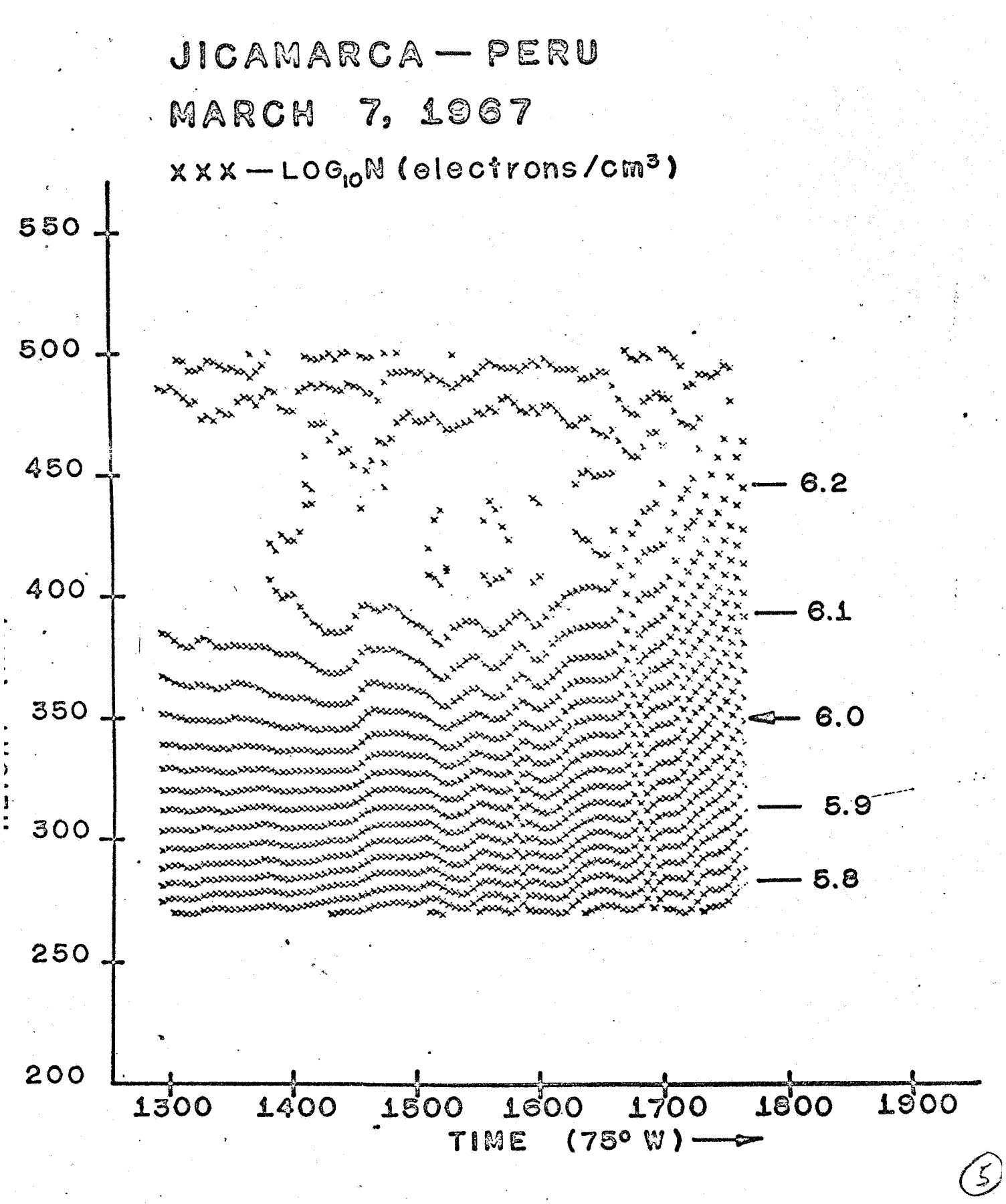
XXX — $LOG_{10}N$ (electrons/cm^3)



JICAMARCA — PERU

MARCH 7, 1967




JICAMARCA — PERU
MARCH 7, 1967
xxx — LOG10N (electrons/cm3)
550
500
450
400
350
300
250
200
6.2
6.1
6.0
5.9
5.8
1300
1400
1500
1600
1700
1800
1900
TIME (75° W)

HUANCAYO — PERU

MARCH 7, 1967