A RELATIONSHIP BETWEEN SPREAD-*F* AND THE HEIGHT OF THE F_2 IONOSPHERIC LAYER

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Summary

The variation, throughout the night, of range-spreading spread-*F* widths, at Brisbane, is investigated. Evidence is presented to support the hypothesis that the ripple amplitude of the spread-*F* ionospheric irregularities varies directly with the layer height. This leads to an association between the range-spreading width and the height of the layer.

Certain aspects of frequency-spreading are also discussed.

I. INTRODUCTION

In a previous paper on spread-*F* at Brisbane (Bowman 1960,† subsequently referred to as I) the diurnal variation of spread-*F* was considered statistically, the existence or not of spread-*F* traces being taken as a measure of its occurrence. No account was made of the widths (in range) of the spread-*F* traces. Treated in this way, the diurnal variations suggested increased spreading occurrence when the F_2 layer increased in height. It was postulated that, possibly, this resulted from an increased amplitude for the spread-*F* " ripples ", as the height

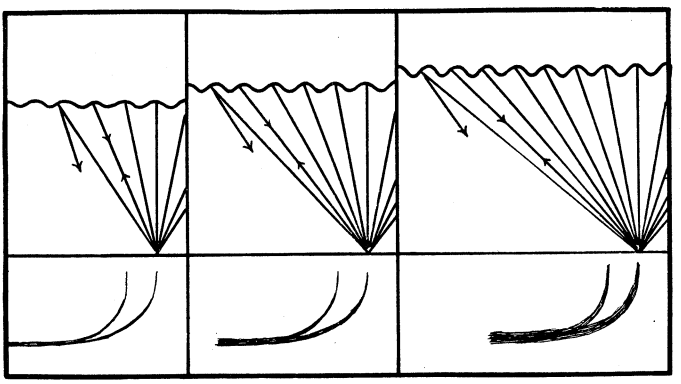

Fig. 1.—Diagram illustrating suggested dependence of range-spreading width on the amplitude of the irregularity ripples.

of the layer became greater. In this case, it would be expected that the width of range spreading, at any particular time, should also be related to the height of the layer, for this spreading width is determined by the range of zenith angles from which satellite signals are possible, and this range should increase with ripple amplitude, as indicated in Figure 1. The present paper deals with this aspect of the phenomenon.

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† BOWMAN, G. G. (1960).—*Planet. Space Sci.* **2**. (In press.)

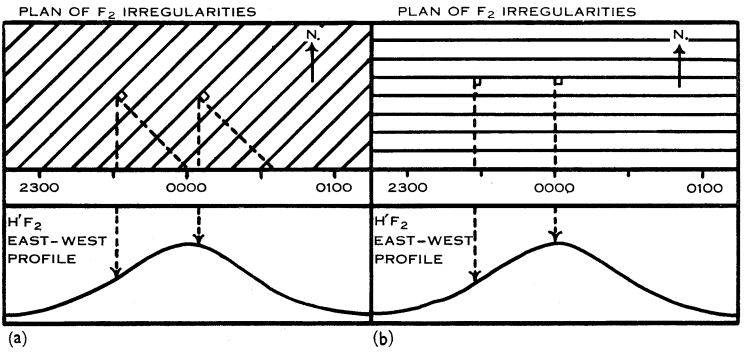

Fig. 2.—East-west profile of height changes and plan position of F_2 irregularities, (*a*) leading to a maximum range-spreading width some time later than time of maximum layer height, (*b*) leading to a maximum range-spreading width at the time of maximum layer height.

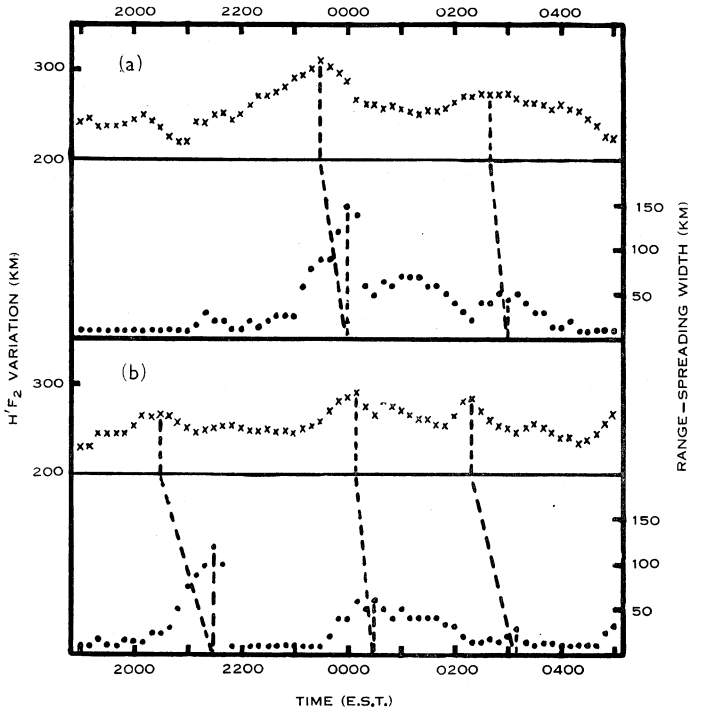

Fig. 3.—A comparison between $h'F_2$ variation and range-spreading spread-F widths, (*a*) for the night of August 16/17, 1956, and (*b*) for the night of July 23/24, 1956.

II. Analysis and Discussion

If the hypothesis discussed in Section I is correct, it would be expected that a relationship could be established between height changes and the relative widths of the range-spreading trace. However, this will be complicated by the fact that, in general, the frontal orientation of the ripples is not the same direction as that of the gradient of height changes. In I it was established that the most favoured azimuth-of-arrival for spread-*F* echoes occurred in the north-west quadrant. Therefore, if it is assumed that height changes have an east-west gradient, and the orientation of the ripples is at an angle of 45° to this direction, the arrangement is as illustrated in Figure 2 (*a*). In this figure the height profile is imagined as remaining stationary, while the position of the station moves.

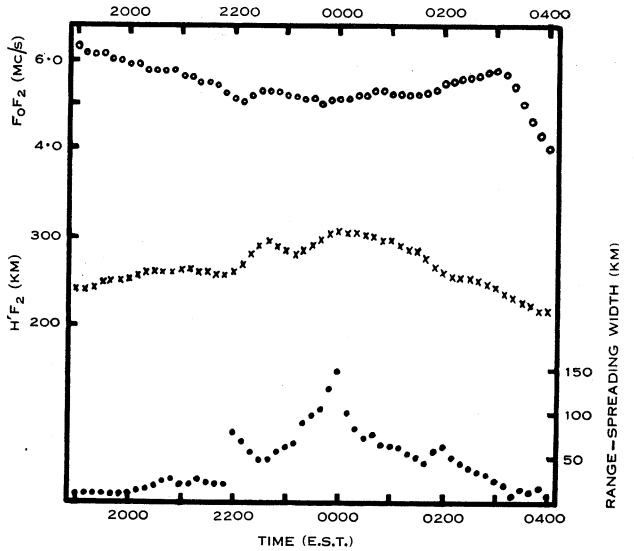

Fig. 4.—A comparison between f_0F_2 variation, $h'F_2$ variation, and range-spreading spread-*F* widths for the night of May 3/4, 1956.

The frontal irregularities are closely spaced, and, as an approximation, they are considered to have infinite length. This figure illustrates that, since the ripples, which are responsible for the extreme edge of the range spreading, are appreciably displaced from the zenith, they will correspond to the layer height over the station some minutes earlier. Thus maximum spreading width can be expected some minutes after the maximum layer height. This can usually be observed in the records. Figures 3 (*a*) and 3 (*b*) show examples. For the F_2-layer height the quantity $h_{\min}$ is used.

The nature of the spread-*F* phenomenon at Brisbane for the night of May 3/4, 1956 is such as to suggest that some of the complicating parameters are absent. The layer height does not oscillate throughout the night, as it usually does, but shows a more or less gradual rise to midnight, followed by a gradual fall. The peak in range-spreading width coincides with maximum height of the layer, so

possibly the frontal orientation of the ripples, at this time, lies in the same direction as the height change gradient. Figure 2 (*b*) shows the suggested configuration. Figure 4 illustrates the f_0F_2, $h'F_2$, and range-spreading width variations on this night, the readings being taken from the ionograms made at 10-min intervals. The range-spreading width variation follows closely the $h'F_2$ variation.

It was explained in I that, possibly, when the ripple amplitudes become relatively small, the ripples can still be detected in the form of frequency spreading, provided there is a sufficiently large f_0F_2 gradient across the ripple structure (cf. I for definitions of range spreading and frequency spreading). The ionograms on this night are particularly clear in showing the transition from range spreading to frequency spreading. It is seen that, by 0300 hr, the range-spreading width has been reduced to a low value, but after this time the ionograms show increasing frequency spreading. Also, after 0300 the f_0F_2 value changes at a fast rate. This appears to be evidence for the mechanism, proposed in I, to explain frequency spreading.

Sample ionograms at various times throughout the night of May 3/4, 1956 are shown in Plate 1.

III. Acknowledgments

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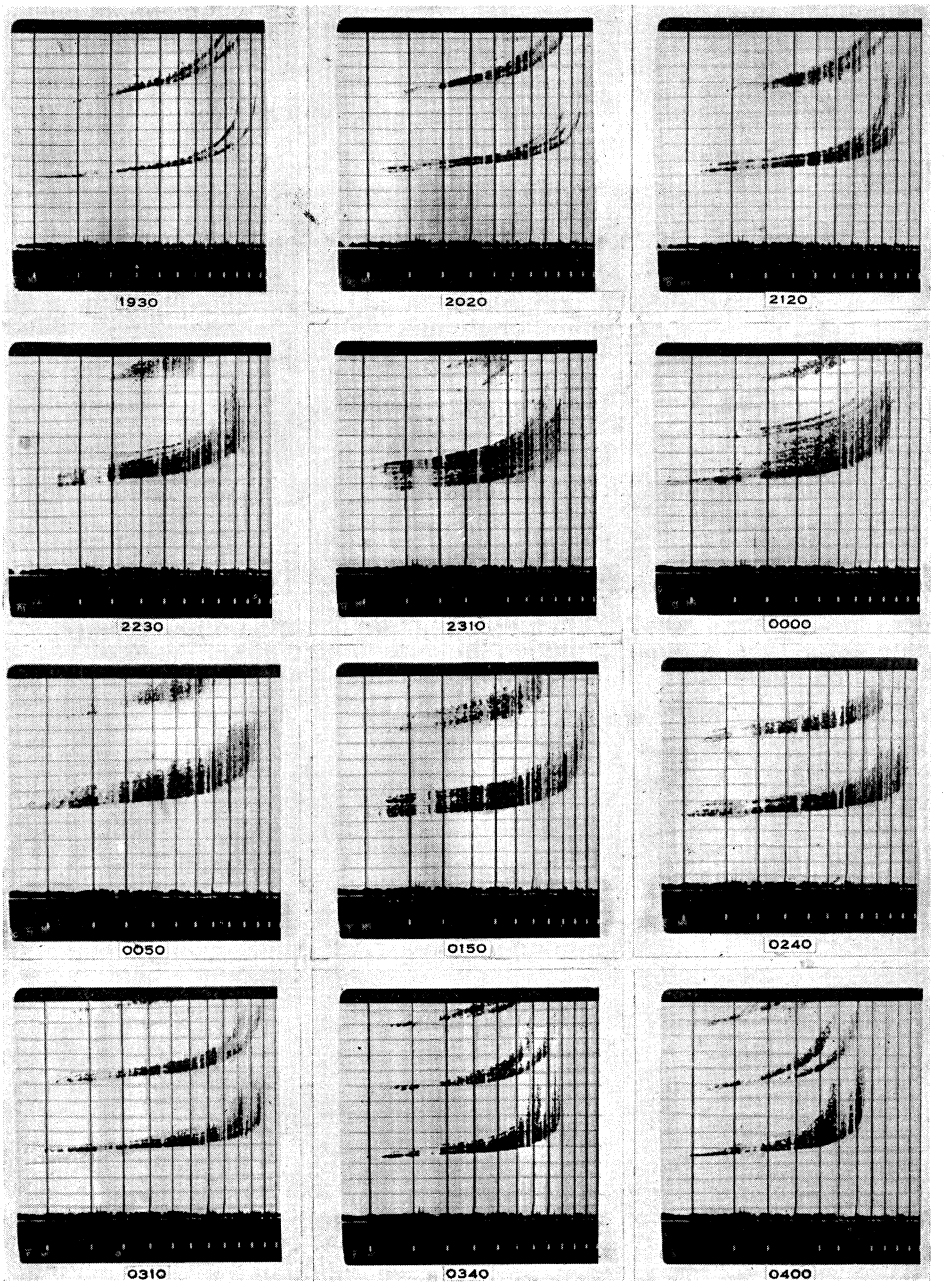
SPREAD-F AND THE HEIGHT OF THE F_2 LAYER



Several ionograms on the night of May 3/4, 1956, illustrating the varying nature of spread-*F* traces.