

Observations on Spread-F at Kodaikanal

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A study of quarter-hourly ionograms of Kodaikanal (geomag. lat : 0.6°N ; dip : 3.5°N) showed several instances when the spread-F disappears and subsequently reappears in two hrs or less during a night. Investigation of such events for a 2-yr period showed that this feature is not associated with systematic opposite changes in layer height and there does not seem to be any particular threshold height for the irregularities below which they cannot sustain.

1. Introduction

EVER SINCE Booker and Wells¹ reported diffuse echoes on equatorial ionograms, the topic of equatorial spread-F is engaging the attention of many investigators. Several statistical studies have been made to work out the morphological characteristics of equatorial spread-F using published ionospheric data. A survey of earlier work has been made by Clemesha and Wright². The vhf and hf scatter experiments conducted by Cohen and Bowles³ and Clemesha⁴ indicate that the equatorial spread-F is due to scattering from field aligned irregularities. A number of theories have been proposed from time to time to explain the observed characteristics of equatorial spread-F⁵⁻¹¹. However, none of them account for the phenomenon in all its detail although most of the theories mentioned above do explain some feature or the other.

2. Data

It is noticed from the quarter-hourly ionograms of Kodaikanal (geomag. lat : 0.6°N ; dip : 3.5°N), a station in the electrojet region, that there are several instances when the spread-F configuration suddenly disappears and reappears after a lapse of 2 hr or less. One such event observed in our data on 19 Mar. 1968 is illustrated in Fig. 1. It may be seen that the ionogram taken at 0030 hrs showed frequency-spread type configuration, that taken at 0115 hrs showed clear traces with well-defined $f\text{OF}2$ cusp, and that taken at 0215 hrs showed the frequency-spread configuration again. The event described is a typical long duration event where the spread-F configuration is slightly different before disappearance and at the time of reappearance.

It is known that equatorial spread-F is a height-controlled phenomenon, especially around the onset

time. Further, from vhf scatter observation, Farley *et al.*¹² have pointed out that there may be a threshold height that the bottom of the layer must reach before the irregularities are generated, and showed occasions when the disappearance and subsequent reappearance of spread-F is coincident with the bottom of the layer crossing a threshold height. In this paper, we examine instances in our data when spread-F disappears and reappears in a night with a view to understanding the conditions necessary to sustain spread-F in the latter part of the night. We examined ionogram data over a 2-yr period from January 1968 to December 1969. A total of 64 events were noticed, the duration of the events ranging from 45 min to 2 hr. The purpose of the present study is to see whether the disappearance and reappearance of spread-F is associated with opposite changes in the height of the layer at the respective times and whether there is any threshold height below which irregularities and hence spread-F cannot sustain. The parameter $h'F$ is taken to indicate the height of the layer following accepted practice and for the reason that variation of $h'F$ is similar to that of $hmF2$ which cannot be obtained under spread-F conditions. The original magnetograms of Kodaikanal have also been examined for any short duration perturbations in H field coincident with the disappearance and reappearance of spread-F as the association between equatorial spread-F and magnetic activity is more or less well established².

3. Analysis

Out of the 64 events noticed, 26 pertain to the pre-midnight and 38 to the post-midnight period and it is observed that the disappearance and reappearance characteristic applies to both range and frequency spread-F configurations. In most of the cases, the

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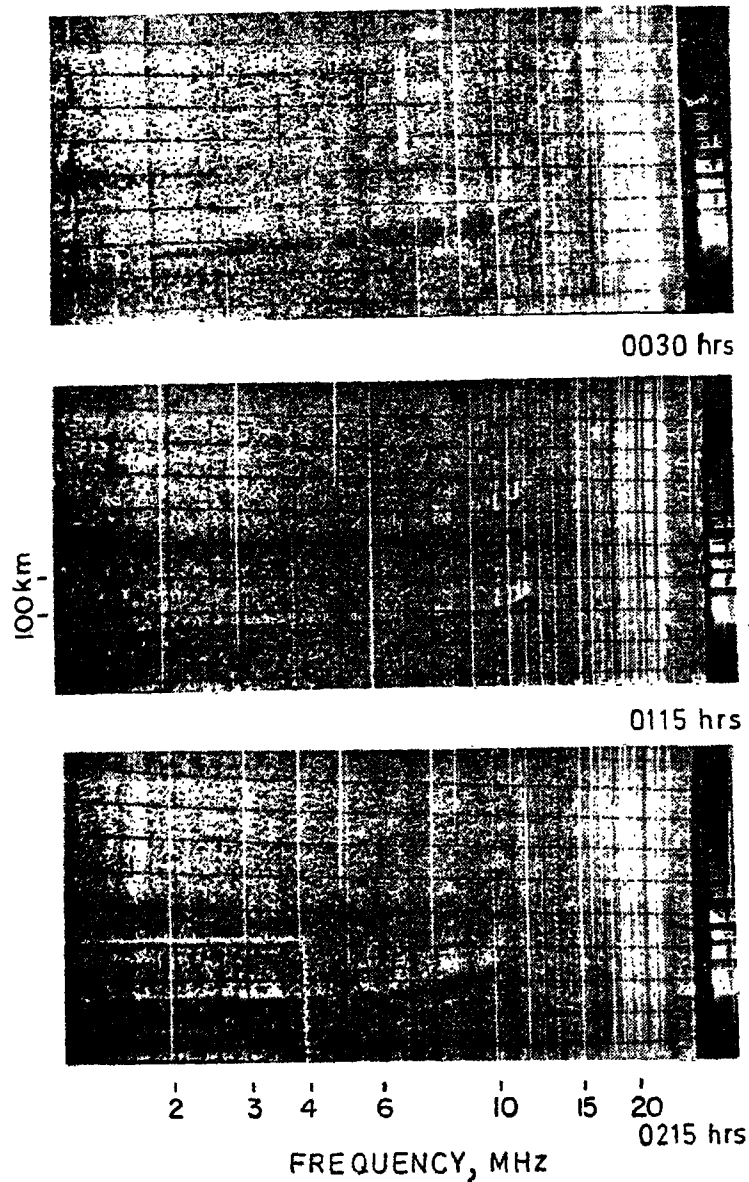


Fig. 1 - A sequence of ionograms illustrating the disappearance and reappearance of spread-F during a night as observed at Kodaikanal on 19 Mar. 1968

spread-F configuration is the same before disappearance and at the time of reappearance, indicating that plasma instability conditions, whatever they be, responsible for spread-F have ceased for a while and have set in again. The change in layer height ($\Delta h'F$) at the time of disappearance and reappearance has been obtained and Fig. 2 shows the same for the 64 events. It can be seen that the change in layer height is small in a majority of the events. In fact, there is no perceptible change in 25 per cent of the cases. Only in 15 per cent of the cases there is a change in $h'F$ of opposite sense at the time of disappearance

and reappearance. In 45 per cent of the cases the layer is in continuous downward motion. There does not seem to be any well defined height or range of heights below which the irregularities do not sustain as the height of the layer when the spread-F disappears is found to vary over a wide range from 230 to 275 km. Further, even in those cases when the height change is of opposite sign, suggestive of the existence of a threshold height, the height of the layer at the time of disappearance and reappearance varies over a wide range. These observations lead to the inference that the disappearance and reappearance of spread-F

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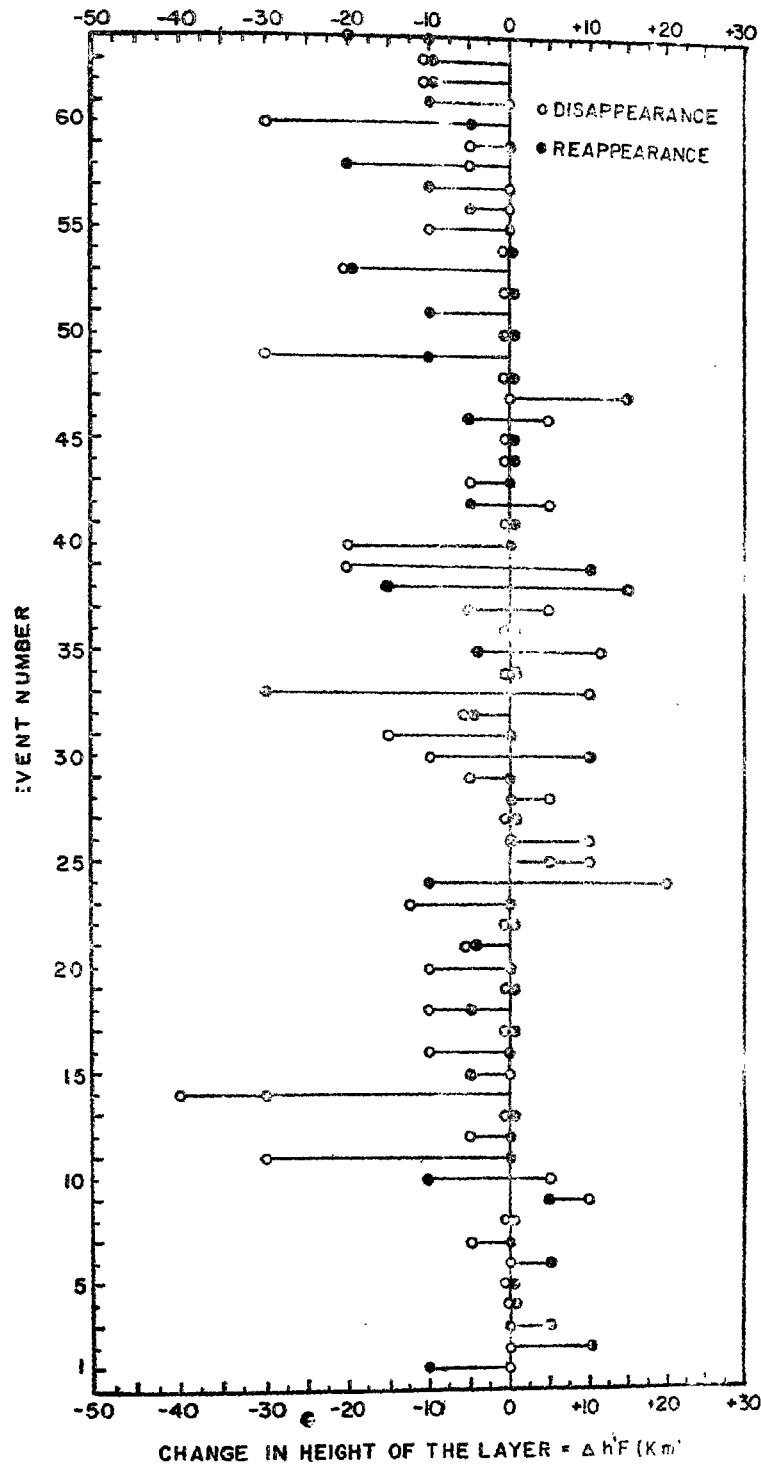


Fig. 2—Change in height of layer ($\Delta h'F$) at the time of disappearance (O) and reappearance (●) of spread-F

is not controlled by change in the layer height. A close examination of the simultaneous magnetograms for the events studied showed that there are no sudden changes in H field coincident with the times of disappearance and reappearance of spread-F indicating no association between the two.

The above reported feature of equatorial spread-F cannot be accounted in terms of the existing theories which invoke height as the control parameter. Our observations do not agree with those of Farley *et al.*¹² from vhf experiment, as they have noticed a threshold altitude for the bottom of the layer below which

irregularities do not sustain. However, exceptions to the above behaviour have also been presented by them. It is also quite possible that the irregularities being looked at in the two experiments are different, at least on some occasions, as weak small scale irregularities are sometimes observed at vhf when no spread-F is seen on ionograms, although there is strong association between strong small scale irregularities observed at vhf and conventional spread-F on ionograms.

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