LETTERS TO THE EDITOR

A NOTE ON THE OCCURRENCE OF N ECHOES IN THE EQUATORIAL REGION

THE presence of sporadic E (Es) ionisation is well known to be a regular day-time feature of the equatorial ionosphere and it usually manifests on bottomside ionograms in the two forms, equatorial sporadic-E (E_{sq}) and equatorial slant sporadic-E (E_{sl}). Substantial evidence exists in literature to show that the blanketing sporadic-E (E_{sb}), a characteristic feature of the temperate latitude ionosphere, also occurs during daytime at and in the vicinity of the geomagnetic dip equator[1–5]. The partial transparency of the sporadic-E layers causes ray paths of the multiples to be complicated, sometimes giving rise to reflections referred to as M and N echoes. Assuming the E_s layer thickness to be negligible, the virtual heights of the M and N echoes (h'M and h'N) are given as:

$$h'\mathrm{M} = 2\,h'\mathrm{F} - h'\mathrm{E}s$$
$$h'\mathrm{N} = h'\mathrm{F} + h'\mathrm{E}s.$$

It was reported earlier that, in the temperature latitude zone, M echoes occur for about 80 to 90% of all E_s occurrences and that they never occur with E_s configurations characteristic of the equatorial region[6]. Bhargava and Saha[7] were the first to show that M and N echoes do occur in the vicinity of the geomagnetic dip equator. A recent detailed investigation by us using Kodaikanal ionogram data confirmed this earlier observation. It was found that the occurrence of M and N echoes is characterised by the presence of either an isolated M echo or a combination of M and N echoes, but very rarely as an isolated N echo[8]. This rather abnormal property appears to be a unique feature of sporadic-E layers in the equatorial region as a similar pattern is also noticed on ionograms at Huancayo, an equatorial station at the 75° W meridian[9]. In this brief communication, we present observational evidence to show that an isolated N reflection sometimes occurs on equatorial ionograms in association with short lived secondary E_s layer at an altitude of 140 km, well above the height domain (95–100 km) of regular E_s layers.

Vertical ionospheric soundings at 1 min intervals were carried out during day-time at Kodaikanal (Geo. lat. 10° 14′ N, geo. long. 77° 28′ E, dip 3·5° N) on several selected days during the winter months of 1974–75, with a view to monitor the short period changes in the ionospheric F-region. Careful scrutiny of this high time resolution ionogram data showed the occurrence of N reflections around noon on 12 January 1975. The salient details of this event are as follows. On 12 January 1975, a geomagnetically quiet day ($Ap = 4$), a weak secondary E_s layer around an altitude of 140 km was first seen on ionograms at 1306 hrs I.S.T., in addition to the regular E_{sq} around 100 km. The secondary E_s layer grew in intensity and turned into a fairly extended trace thereafter, and gave rise to isolated N reflections over the short interval of time from 1309 to 1316 hrs I.S.T. This can clearly be seen from Fig. 1 wherein, the ionogram at 1312 hrs I.S.T. is presented. It is quite evident from Fig. 1 that the N-reflection corresponds to the secon-

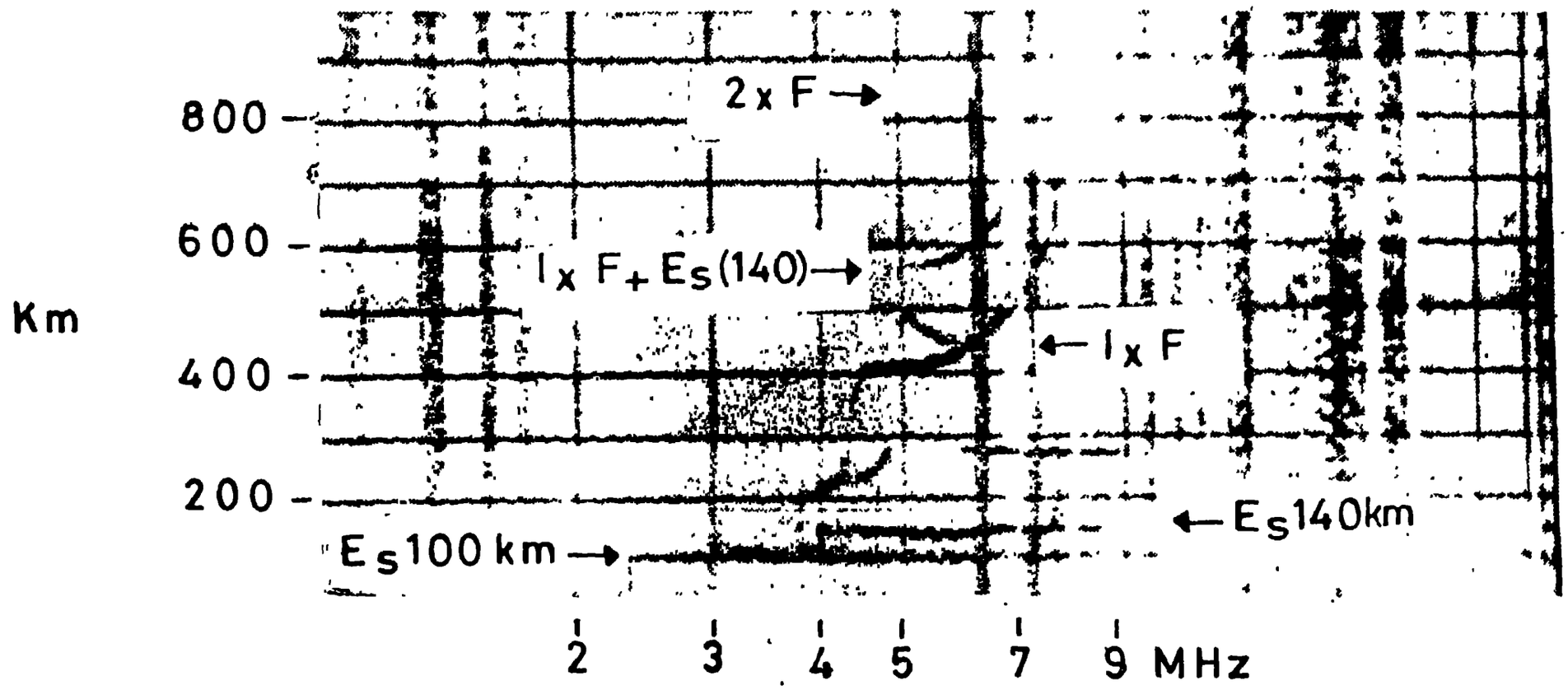

FIG. 1. Ionogram at Kodaikanal on 12 January 1975 at 1312 hrs I.S.T. showing the occurrence of N reflection in association with a secondary sporadic-E (E_s) layer around 140 km. The small high frequency ripple on the height markers is of instrumental origin.

dary E_s layer around 140 km and not to the regular E_{sq} around 100 km. The secondary E_s layer lost its identity by 1334 hrs I.S.T. During the entire period of its manifestation, the secondary E_s layer is essentially non-blanketing, although multiple reflections of this layer are clearly seen. The observation that the secondary E_s layer gave rise to N reflections alone (*i.e.*, without M reflections) suggests the presence of sharp electron density gradients at the bottom of this E_s layer and that the irregularities embedded in this layer are strong scatterers for radio waves propagating upward and weak scatterers for waves propagating downward. Further investigations are required to throw light on the origin of these transient secondary layers of sporadic-E ionisation in the equatorial region.

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Kodaikanal 624 103, *March* 24, 1980.

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