LETTERS TO THE EDITOR

OCCURRENCE OF NIGHT SPORADIC-E (Es) IN RELATION TO GEOMAGNETIC STORMS

THE morphological characteristics of night sporadic-E (Es) in the equatorial region have been studied by several workers[1-4] for stations in the American, African and Asian Zones, which brought to light the existence of a definite longitudinal effect in the occurrence and characteristics of night sporadic-E. However, not much information exists in literature as to the response of the occurrence of night Es to enhanced geomagnetic activity in particular, its behaviour during geomagnetic storms. The only available information on this aspect is the work of Awe[2] which showed that at Ibadan, in the African Zone, there is no significant difference in the occurrence of night Es during magnetically quiet and disturbed days. We have therefore attempted a study of the occurrence characteristics of night Es at Kodaikanal (10·0° N, 77·5°E, dip 3·5° N) during geomagnetic storms, the results of which comprise this brief communication. The study covers periods of both low sunspot activity (January 1964–December 1965) and high sunspot activity (January 1968–December 1969). This is done to infer the influence, if any, of the phase of the sunspot cycle on the response of night Es to geomagnetic storms. Quarter hourly ionogram data at Kodaikanal has been carefully examined to evaluate the occurrence of night Es for seven nights around each of a total of 38 SC type geomagnetic storms that occurred during the four year period under consideration. Out of these 38 storms, 21 correspond to low sunspot activity conditions and 17 to high sunspot activity conditions.

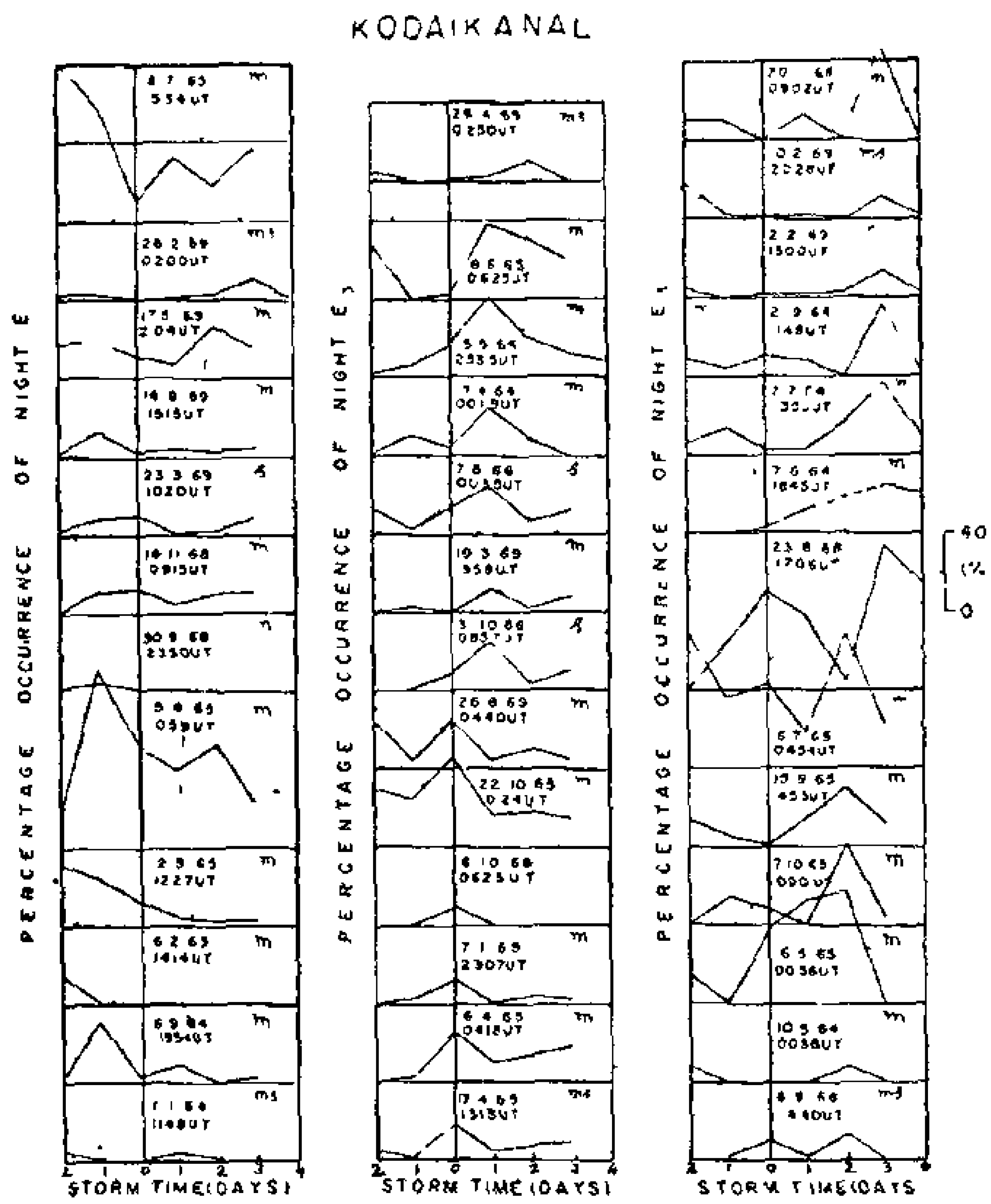

FIG. 1. Variation of the percentage occurrence of night Es at Kodaikanal with storm time for 38 storms that occurred during the periods: January 1964–December 1965; January 1968–December 1969. Also indicated in the diagram are the times of the storm sudden commencement (SSC) in U.T. and the severity of the storms (*m*, *ms* and *s*).

In Fig. 1 are shown the time histories of the percentage occurrence of night Es (defined as the percentage of the number of ionogram frames exhibiting the presence of Es to the total number of ionogram frames available for a particular night) for seven nights around each of the 38 storms studied. The times of the storm sudden commencement (SSC) in U.T. and the severity of the storms are also indicated in the figure. It can clearly be seen from Fig. 1 that, in a majority of the storms, there is a definite trend of an increase in the occurrence of night Es of appreciable magnitude with in 0–3 days of the initiation of the storm. This behaviour of night Es at Kodaikanal during geomagnetic storms appers to be indepedent of the phase of the sunspot cycle (hence the severity of the storm) as the increase in occurrence is noticed during low sunspot activity as well as high sunspot activity condition. Examination of the relevant La Cour normal run magnetogram data at Kodaikanal showed that the noticed increase in the occurrence of night Es is not associated with any significant changes in the horizontal component of the earth's magnetic field. In a recent study we have noticed that at Kodaikanal, night Es manifests not only in the well known flat and now blaketing type (Esf) of configuration but also in two other configurations, blanketing type (Esb) and multiple layered type. A study of the ionogram data showed that there is no preferential occurrence of any particular type of Es configuration during storm conditions. Similarly, there is no indication of any significant change in the values of fb Es (which represents the maximum ionization density in the Es layer) during storm conditions compared to pre-storm conditions.

The present study thus indicates a positive response of the occurrence of night Es at Kodaikanal to geomagnetic storms, although the nature and characteristics of the Es configuration do not appear to change significantly. very recently, Batista and Abdu[5] reported evidence of a significant enhancement of E_s layer parameters: f_bE_s and f_tE_s at Cachocira Paulista (22·6° S, 45·0° W), located near the center of the Brazilian Geomagnetic Anomaly, within 1–3 days after the initiation of geomagnetic storms of moderate intensity. It is known from satellite observations that protons in the energy range 10–1000 kev exist in the equatorial region above 400 km and that their flux gets enhanced significantly during geomagnetic storms[6–7]. Recent calculations have shown that the extra ionization due to the precipitation of these energetic protons in the equatorial region will be significant at E-region altitudes during geomagnetic storm conditions[8]. The results obtained here therefore suggest a possible role of charged particle precipitation in the behaviour of night Es at equatorial latitudes, following geo-magnetic disturbances. The present investigation also suggests the need for further studies of this type at stations in other longitude zones (American and African) to obtain a detailed picture of the behaviour of night Es during geomagnetic storms.

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CRYSTAL STRUCTURE OF $ZnSc_2O_4$

A SURVEY of literature on binary spinels showed that no work has been d ne on this compound. The ionic radii[1] of both cations lie well within the range[2] of spinel formation. Thus it could be expected that the compound would crystallize in a spinel structure.

$ZnSc_2O_4$ was prepared by intimately mixing the composite oxides of AR grade in equimolecular proportions. The mixture was heated in a platinum boat in an electrical furnace at 1200° C for 80 hours. The compound was cooled slowly at the rate of 100° C per hour.

The formation of the above compound was checked by X-ray diffractometer using filtered copper radiation. Absence of lines due to the parent oxides showed the formation of a new compound. All the lines could be indexed for single phase. The crystallographic results are shown in Table I.

TABLE I
X-ray crystallographic data of $ZnSc_2O_4$

'd' observed (in Å)	'd' calculated (in Å)	h k l
1·945	1·946	4 2 0
1·548	1·538	4 4 0
1·456	1·453	4 4 2
1·344	1·339	3 3 5
1·321	1·313	6 2 2
1·208	1·219	7 1 1
1·135	1·136	5 5 3
1·105	1·105	0 0 8
0·9717	0·9731	8 4 0
0·9663	0·9640	5 3 7
0·9475	0·9505	8 4 2
0·9511	0·9337	6 4 6

The crystallographic data show that the unit cell is tetragonal with a and c equal to $8·70 \pm 0·01$ and $8·84 \pm 0·01$ Å respectively. All the observed reflections show that the compound has Hausmanite structure[3] (distorted spinel space group $I4_1/amd$.) In the present case both the cations Zn^{+2} and Sc^{+3} have spherical symmetry, *i.e.*, they are non-Jahn Teller ions. The observed non-cubic symmetry is difficult to understand because the compound does not contain any distortive ion.

The observed symmetry ($c > a$) may be due to slightly greater electronegativity differennce[5,6] between Sc^{+3} and O^{-2} ions and this causes localized small distortions in the coordination polyhedra, which in effect reflects in the bulk symmetry of the compound. For this reason the degree of distortion ($c/a - 1$) is very small (00·016).

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