THE NATURE OF ELECTRIC FIELD IN E-REGION CLOSE TO MORNING AND EVENING REVERSALS

S. Prakash and P. Muralikrishna

Physical Research Laboratory, Ahmedabad-380009, India.

Abstract. The nature of electrostatic field driving the equatorial electrojet was studied using a coherent backscatter radar at Thumba. The doppler spectra of radar echoes from ionization irregularities in the E-region, during periods close to the morning and the evening electrojet reversals, show that the electric field, in general, is stronger during the pre-reversal periods than during the post-reversal periods. Similar results for the evening hours were reported earlier from the radar studies conducted at Jicamarca. This indicates that this effect is likely to be present at all the equatorial stations.

The experimental set up and the method of data analysis used during the present studies, is discussed in detail by Muralikrishna (1975). The radar was operated in oblique transmission and reception modes. The antenna beams were oriented at an angle of about 30° with the vertical, towards west. Figures (1) and (2) show the typical nature of the radar spectra observed during morning and evening hours before and after the electrojet reversals, respectively. The time at which a particular spectrum is observed and the relative attenuation in its amplitude are indicated along with the spectrum. The x-axis represents doppler shift in the frequency positive to the right and negative to the left. The graduations correspond to frequencies in the range of -175 Hz to -10 Hz and +10 Hz to +175 Hz at equal intervals of 15 Hz. To determine the radial drift velocity of the irregularities, the doppler shift in the radar echo has to be multiplied by 2.73 meters/sec.-Hz. The drift velocity is proportional to the electric field and, hence, can be used in the study of the nature of the electric field.

During morning pre-reversal periods the radar echoes were observed only on about 30 to 40 per cent of the total number of days. Whenever such echoes were observed, the spectra had type I characteristics. Close to the reversal the type I spectra showed a decrease in the amplitude. An examination of the drift data from Jicamarca published by Balsley and Woodman (1971) also shows that the type I echoes were present prior to the morning reversal on 34 days, out of the total 75 morning observations made. On most of the days the type I spectra were present only for a few hours prior to the morning reversal both at Thumba and Jicamarca. At Jicamarca, on some days, the type I echoes were observed for a longer period during post mid night hours. Type II spectra at Thumba were not observed during the morning pre-reversal period on any of these days, either alongwith the type I spectra or after it had vanished. This indicates that the amplitudes of type II echoes were weak. The rocket studies at Thumba (Prakash et al 1971a,b; 1973) and the radar studies at Jicamarca (Fejer et al 1975) have shown that type II irregularities are generated through cross field instability mechanism. As the Hall polarisation field is downwards during this period, type II irregularities can be generated only in the region of downward gradients. The absence of such irregularities with large amplitude in spite of the existence of large electric fields responsible for the type I echoes, shows that the downward gradients in electron density were weak during these periods. This conclusion is well supported by the in-situ measurements of electron density carried out from Thumba, India, with two rockets, one launched at 0544 hrs IST on March 1967 (Subbaraya, 1968) and another at 0559 hours IST on February 1975 (unpublished). Only very weak downward gradients in electron density were observed during these experiments.

During morning post-reversal period type II spectra were observed. The lower doppler shifts associated with these spectra show that the drift velocity of irregularities is much less than that observed before the reversal; indicating that the electric field is weaker during post-reversal periods than during the pre-reversal periods. This difference in the fields is also seen from the E-region drift data published by Balsley and Woodman (1971).

During pre and post evening reversal periods only type II spectra were obser-

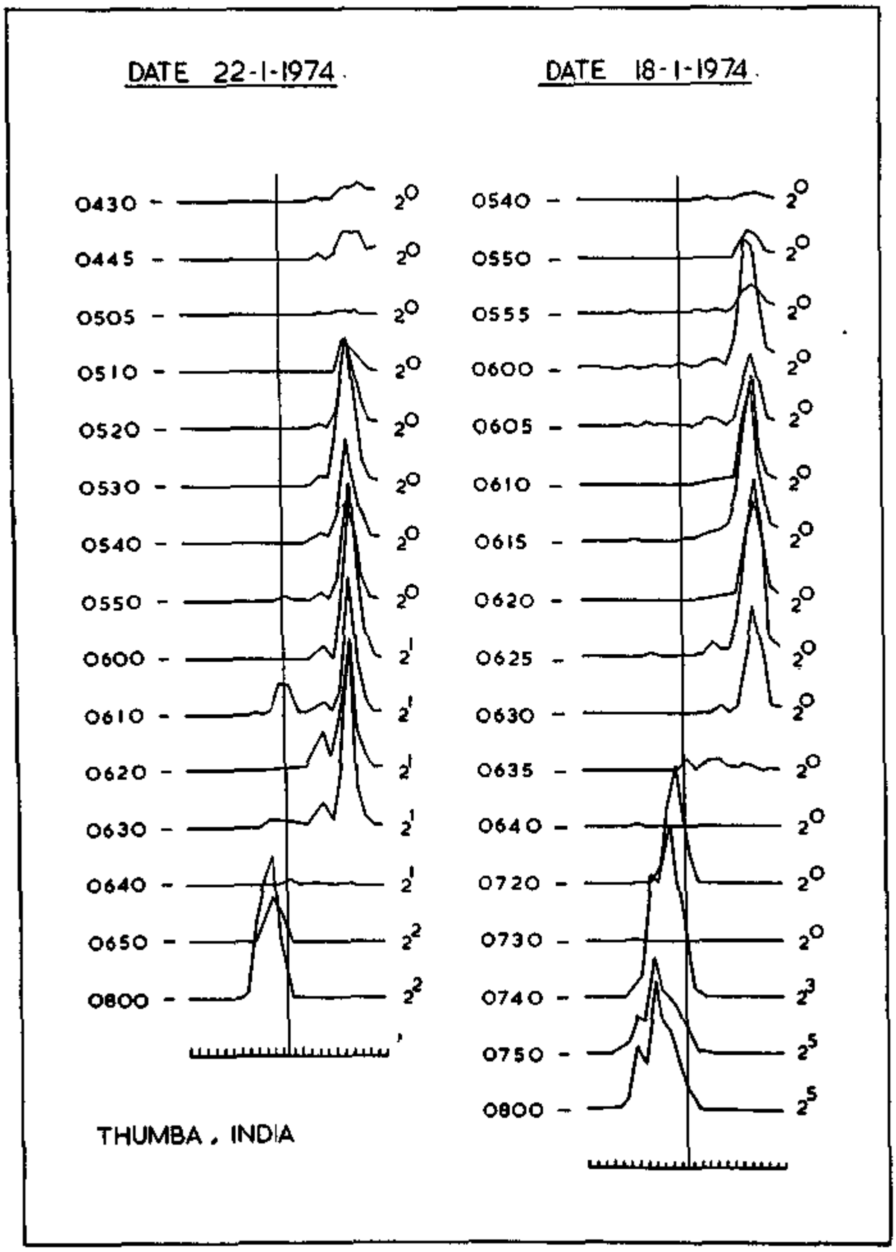

Fig.1. Time variation of spectral characteristics of the radar echoes during morning hours for two days. X-axis represents the Doppler shift and ranges from -175 Hz. to +175 Hz.

ved. Spectra for two different days are shown in fig. (2). The spectra for 2 March, 1973 observed during evening pre-reversal period (Fig. 2) shows that an increase in the amplitude and peak doppler shift associated with the spectra, is observed on some days during evening pre-reversal period. This indicates that the field on such days has a tendency to get enhanced just before the evening pre-reversal period. A similar feature was observed earlier at Jicamarca, Peru, (Balsley and Woodman, 1969; Balsley, 1973).

The above observations show that the fields over Thumba and Jicamarca vary similarly close to morning and evening reversals. An electric field distribution pattern fixed with respect to sun alone can explain the above similarities in the observations as Thumba and Jicamarca are separated by approximately 180° in longitude. This indicates that the above features would be observed at all other equatorial stations.

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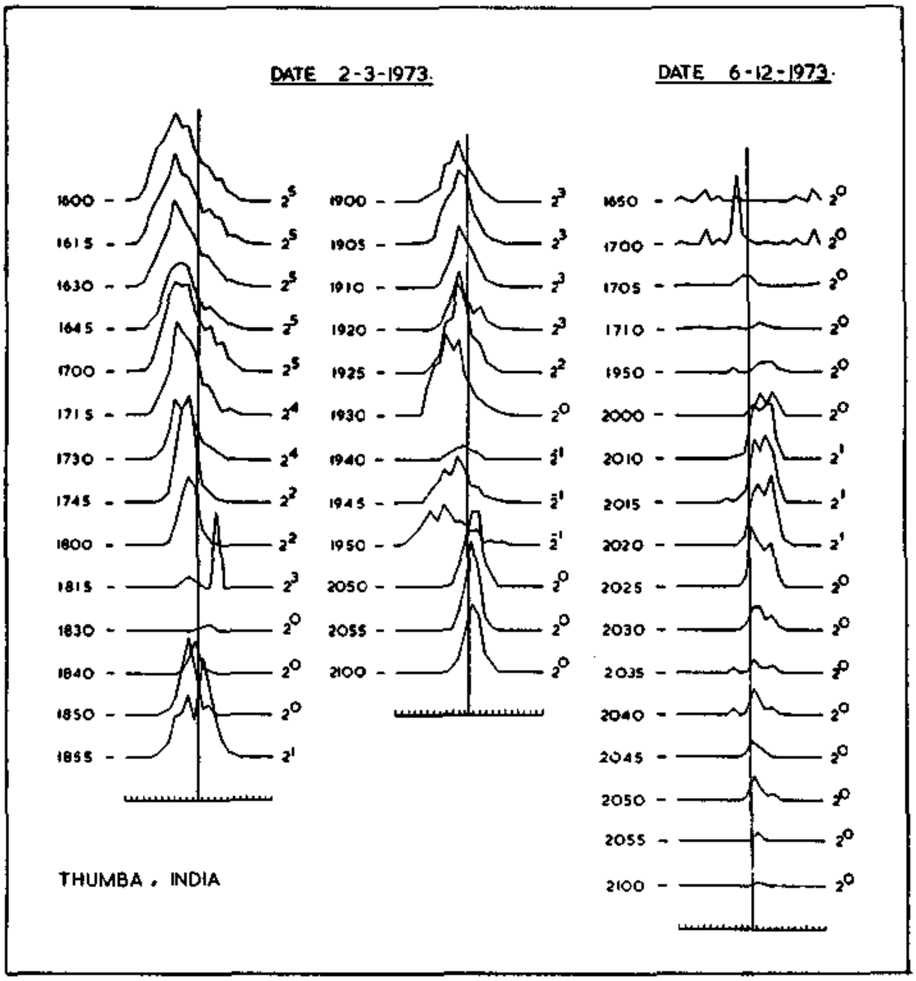

Fig.2. Radar echo, spectral variation during evening hours, shown for two days. X-axis represents Doppler shift and ranges from -175 Hz. to +175 Hz.

Thumba, whose continuous efforts made the early morning and night observations possible.

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