ELECTRIC FIELD IN THE EQUATORIAL E-REGION OVER AMERICAN AND INDIAN ZONES-A COMPARISON

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INTRODUCTION

The role of solar and geomagnetic declination angles in controlling the mapping of electric fields generated by dynamo action in the non-equatorial latitudes, onto the E- and F-regions over the equatorial latitudes was discussed in detail by Muralikrishna and Abdu (1988). From a comparative study of the daytime variation in the average east-west drift velocity of electrons in the E-region over Jicamarca (0.9°N dip lat.; 12°S geograph. lat.), Peru and the variation in the horizontal component of the geomagnetic field at a nearby staion Huancayo, on magnetically quiet days, they concluded that differences in sunrise times between the equatorial latitudes and the magnetically conjugate non-equatorial latitudes caused by the large magnetic declination angle at Jicamarca and the solar declination angle changing with season of the year, influence to a great extent the development of electric fields in the equatorial E- and F-regions. In addition to a strong forenoon-afternoon asymmetry in the strength of the distributed currents above the electrojet region, they reported significant seasonal changes in the intensity of these currents mainly due to the changing solar declination angle acting in conjunction with the large magnetic declination angle.

As an extension of these studies and also as a strong supporting evidence for the hypothesis presented by Muralikrishna and Abdu (1988) similar results for the Indian sector are reported here and compared with the results for the American sector. Daytime variation in the E-region east-west electric field estimated from Doppler spectra of VHF backscatter radar signals at Thumba (56'S dip lat.; 9°N geograph. lat.), India, reported by Reddy et al. (1987) and the variations in the horizontal component of the geomagnetic field at a nearby station Trivandrum, reported by Vikramkumar et al. (1987) for five magnetically quiet days-two days in March 1979 and three days in October 1983 - are used here to examine the forenoon-afternoon asymmetry in the ratio of $\Delta H_T/E_Y$, and its average behaviour in the equinoctial months of March and October. Indian sector being of very low geomagnetic declination angle, unlike the American sector where the geomagnetic declination angle is large due tothe large deviation between the geographic and geomagnetic equators, a comparative study between these two stations can conclusively establish the control of geomagnetic declination angle in the mapping of non-equatorial dynamo electric fields on to the equatorial E- and F-regions and thus controlling the intensity of distributed currents over the eletrojet region.

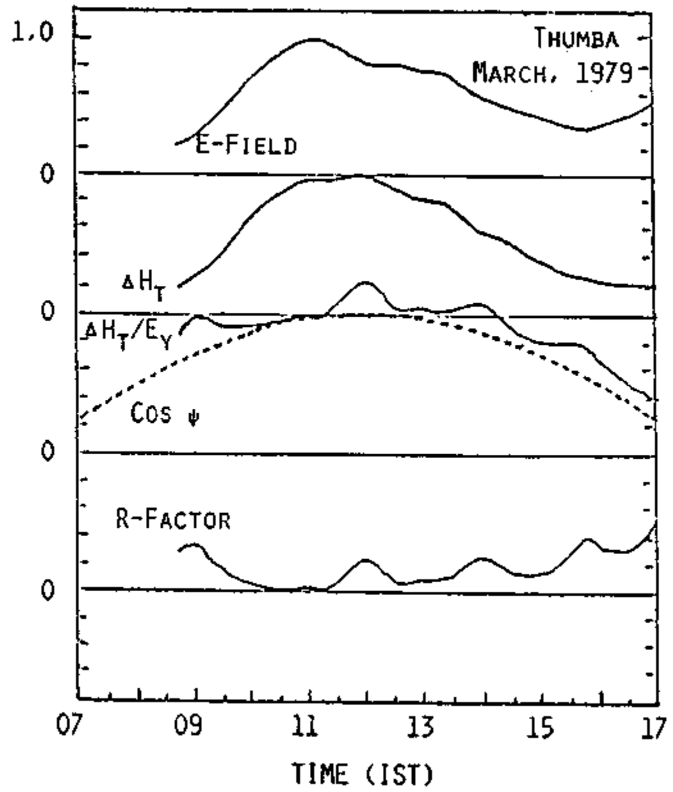

Fig. 1 – Mean daytime variation in the horizontal east-west electric field in the E-region over Thumba, India compared with the mean variation in the horizontal component of the geomagnetic field at Trivandrum, India for the month of March, 1979. Also shown in the figure are the mean variations in $\Delta H_T/E_y$ and R.

RESULTS

Mean daytime variation in the horizontal east-west electric field in the electrojet region over Thumba, India (estimated from Reddy et al., 1987) and in the horizontal component of the geomagnetic field at the nearby station Trivandrum (estimated from Vikramkumar et al, 1987) normalised to their respective noontime peak values are presented in Figures 1 and 2. Figure 1 represents the mean behaviour of the parameters in the month of March, 1979 and Figure 2, that in the month of October, 1983. Also presented in the figures are the daytime variations in the ratio $\Delta H_T/E_y$ and in the factor R = $\Delta H_T/E_y/\cos\psi - 1$, where ψ is the mean solar zenith angle (see Muralikrishna and Abdu, 1988 for more details). For the purpose of comparison daytime variations in the ratio $\Delta H/V_E$ and the factor R for Jicamarca are presented in Figure 3 (reproduced from Muralikrishna and Abdu, 1988). It should be noted here that the geographic latitude of Thumba being 9^oN and that of Jicamarca 12^oS, the months of both March and October, from the point of view of solar declination angle, correspond to equinoctial months also at Jicamarca and hence the curves presented in Figure 3 correspond to the equinoctial months.

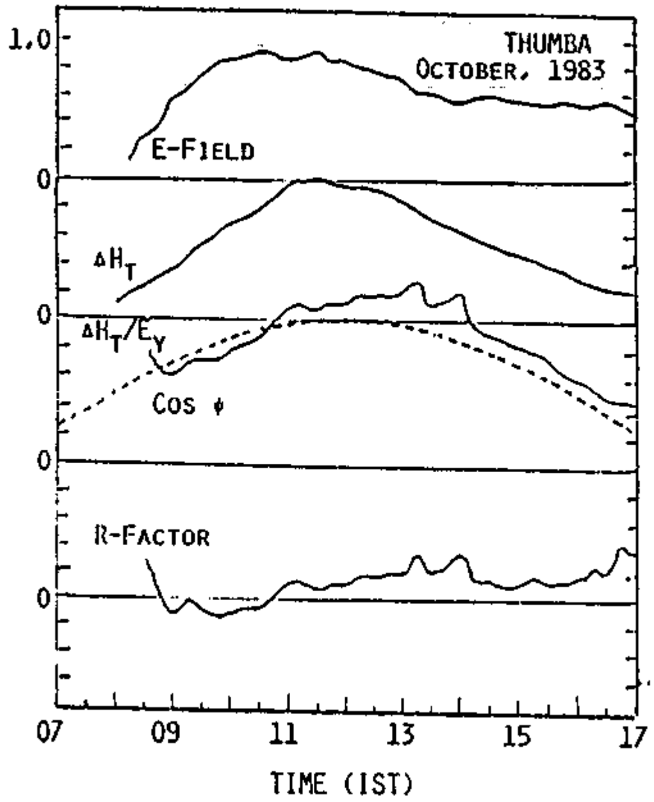

Fig. 2 - Mean daytime variation in the horizontal east-west electric field in the E-region over Thumba, India compared with the mean variation in the horizontal component of the geomagnetic field at Trivandrum, India for the month of October, 1983. Also shown in the figure are the mean variations in $\Delta H_T/E_y$ and R.

DISCUSSION

A comparison of Figures 1 and 2 with figure 3 shows that:

i) The curve representing the time variation of the ratio $\Delta H_T/E_y$ for Thumba for the months of both March and October rather closely follow the cosψ curve except at a few points unlike the corresponding curve for Jicmarca shown in Figure 3, which shows the presence of a clear forenoon-afternoon asymmetry.

ii) Time variations in the ratio R, which represent the relative intensity of distributed currents flowing in the region above the electrojet, are significantly different at Thumba and Jicamarca.

To understand these notable differences between the American and Indian sectors clearly one has to look into the geometry of magnetic field lines at both the places. The hypothesis given in Muralikrishna and Abdu(1988) for explaining the asymmetric nature of the daytime variation in $\Delta H/V_E$ is based on the large declination angle in the American sector which causes considerable time differences in the sunrise times at the geomagnetically conjugate points and in the equatorial E- and F-regions. These time differences result in one region becoming more conducting than the other thus affecting the mapping of the dynamo electric fields from the non-equatorial latitudes to equatorial latitudes. According to this hypothesis one does not expect a large forenoon-afternoon asymmetry in the daily variation of $\Delta H_T/E_Y$ at Thumba due to the low declination angle in the Indian sector. As can be seen, present observations conclusively establish this hypothesis.

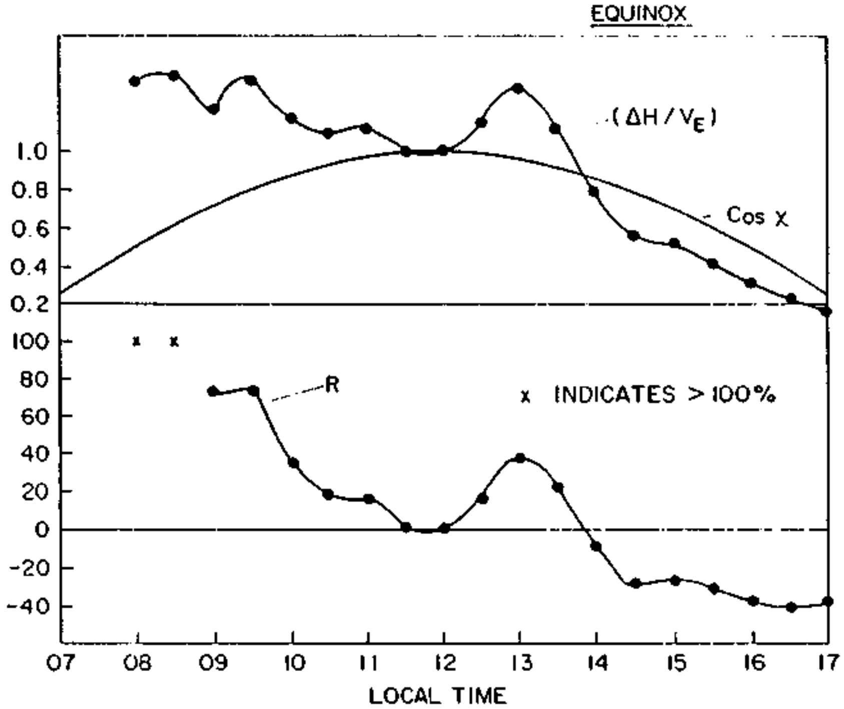

Fig. 3 – Mean daytime variations in the ratio $\Delta H/V_E$ and the factor R for Jicamarca, Peru during the equinoctial months.

CONCLUSIONS

In support of the hypothesis reported by Muralikrishna and Abdu (1988) regarding the solar and magnetic declination control on the electrojet and distributed currents in the ionosphere, the present results obtainned for the Indian sector, where the geomagnetic field lines are almost north-south, clearly show that the distributed currents flowing over the electrojet region over Thumba during daytime, are very much less than those flowing over the electrojet region over Jicamarca. This seems to be a conclusive evidence for the magnetic declination control on the mapping of dynamo electric fields generated at non-equatorial latitudes onto equtorial latitudes and thereby on the intensity of the distributed currents above the electrojet.

ACKNOWLEDGEMENTS

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REFERENCES

MURALIKRISHNA, P. and M. A. ABDU, "Solar and magnetic declination control on the electrojet and distributed currents in the ionosphere over Jicamarca", J. Geophys. Res., 93, 1017-1022, 1988.

REDDY, C. A., B. T. VIKRAMKUMAR and K. S. VISWANATHAN, "Electric fields and currents in the equatorial electrojet deduced from VHF radar observations - I. A method of estimating electric fields.", J. Atmos. Terr. Phys., 49, 183-191, 1987.

VIKRAMKUMAR, B. T., P. B. RAO, K.S. VISWANATHAN and C. A. REDDY, "Electric fields and currents in the equatorial electrojet deduced from VHF radar observations - III. Comparison of observed H values with those estimated from measured electric fields.", J.Atmos. Terr. Phys., ,49, 201-207, 1987.