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INTENSIFICATION OF AURORAL ELECTROJET CURRENTS OVER THE INDIAN ANTARCTIC STATION MAITRI, DURING GEOMAGNETIC DISTURBANCE

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ABSTRACT

Geomagnetic observations at high latitudes, markedly in the auroral regions provide a clue to electromagnetic processes at work in deep distant space. Indian Institute of Geomagnetism is conducting and researching geomagnetic measurements at Antarctic station MAITRI (geographic lat. 70°.75 S, long. 11°.75 E; geomagnetic lat. 66°.84 S, long. 56°.28 E, according to IGRF 1990). During 13th Summer Indian Scientific Expedition to Antarctica (1993-94), the geomagnetic changes in 3 orthogonal components magnetometer. Summer data has been analysed and results on intensification of the Auroral Electrojet Currents over Maitri during geomagnetic disturbance have been presented. During magnetically quiet time there is practically no Auroral Electrojet (AE) over sub auroral Maitri, instead it experiences the geomagnetic signature of the Sq current system. With increasing geomagnetic Activity Index (Kp), Maitri comes under the Auroral Electrojet, with current flow from noon to nightside in the auroral oval i.e. directed westward in the Dawn Sector and eastward in Dusk Sector using Biot Savart Law, the auroral electrojet current densities in north-south and east-west directions are calculated from the prenoon and afternoon ranges of Magnetic variations in Y and X components respectively. The current densities show a clear intensification with increasing K_p.

INTRODUCTION

India has been sending scientific expeditions to Antarctica since 1981-1982. Geomagnetic measurements have been made over the past decade first at the ice shelf station Dakshin Gangotri (~ 70 S, 12 E geographic, 66.3 S, 57.2 E Geomagnetic) and since 1989 at Maitri (70.75°S, 11.75°E Geographic 66.8°S, 56.3°E Geomagnetic) located in the rocky schirmacher oasis. For MAI UT is almost equal to LT. The Indian Institute of Geomagnetism records round the year, Daily variations (DV) and Magnetic Pulsations (MP) in the three orthogonal Geomagnetic Components X, Y, Z in both the analog and digital modes.

In this work the DV data at Maitri during Jan. 1994 is used to understand changes in the X, Y, Z components during quiet days, Moderately Disturbed Days and disturbed days. The range values in X and Y during pre-noon and afternoon are used to estimate Horizontal Ionospheric current densities over Maitri in the east West and North South directions respectively.

RESULTS

(a) The North South (X) Component

(i) Fig. 1 shows that on quiet days (lst block of Fig.1), the daily variation of X is negative, minimizing around noon. this Southward magnetic field is clearly the signature of westward-directed limb of the noontime Sq Current loop in the southern hemisphere. Maitri thus experiences the influence of the Sq Current System, during quiet conditions.

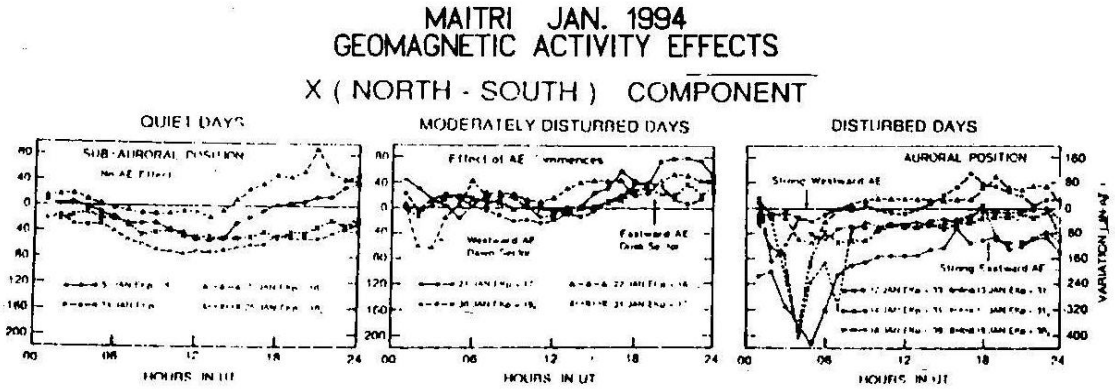

Fig.1: Response of X (North-South) magnetic field component at MAITRI to increasing disturbance, in geospace environment.

(ii) with onset of magnetic disturbance, a negative trend in the down hours and a positive trend in the dusk hours starts showing up (2nd block of fig.1), and is well developed for clearly disturbed conditions (3rd block of fig.1). The southward magnetic field is the signature of the dawnside Westward Auroral Electrojet (WAE) while the northward Magnetic field is the signature of the duskside Eastward Auroral Electrojet (EAE). Thus Maitri during disturbed conditions comes into the Auroral oval and experiences WAE and EAE Currents.

(b) The East West (Y) Component

Fig.2 shows that there is a negative (Westward) signature during pre-noon hours. This is due to the northward limb of the Sq current. Positive (Eastward) signature in post-noon hours is due to Southward limb of the Sq current. fig.2 also shows that on disturbed days strong peaks occur in the post dawn hours and weak peaks in the post dusk

hours. These are signatures of field aligned currents (fac) which flow between magnetosphere-ionosphere over Maitri.

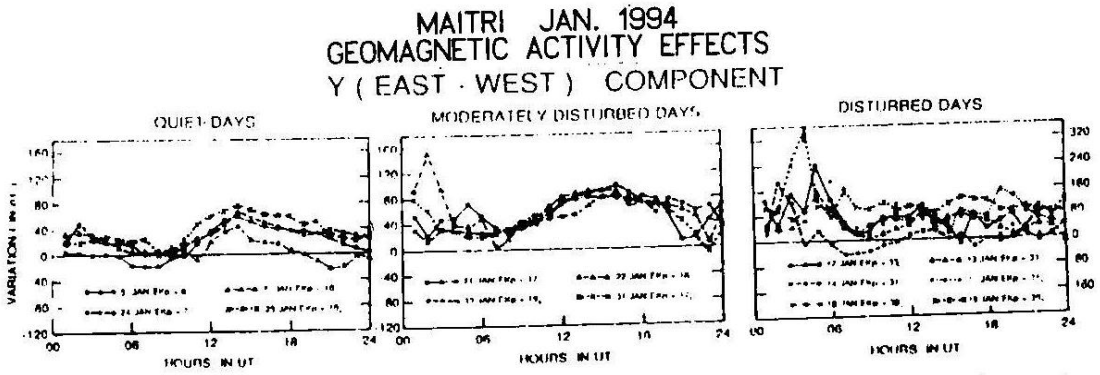

Fig.2: Response of Y (East-West) magnetic field component at MAITRI to increasing disturbance, in geospace environment.

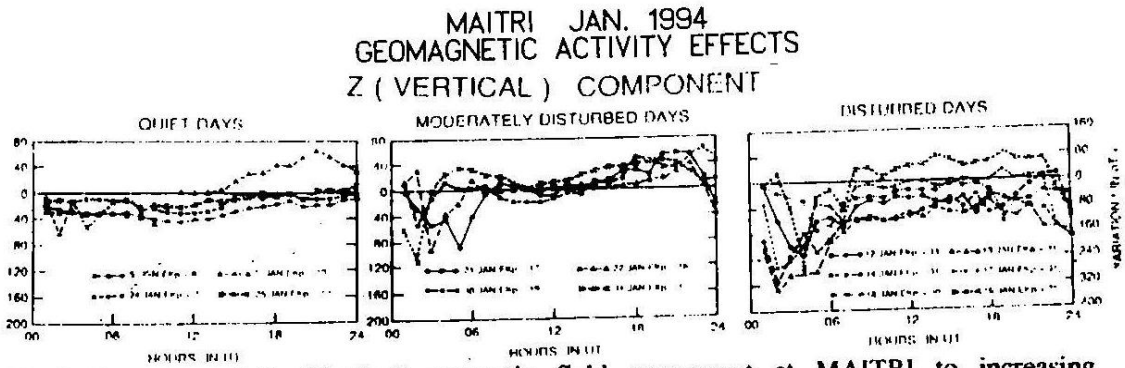

Fig.3: Response of Z (Vertical) magnetic field component at MAITRI to increasing disturbance, in geospace environment.

(c) The vertical (Z) component

Fig.3 shows that on quiet days there is predominantly negative (upward) signature in daytime. this is expected if Maitri is located poleward of the westward southern limb of the daytime Sq current loop i.e. it has a sub-auroral position.

Fig.3 also shows that on disturbed days there is clear negative signature in Z after about 22 UT and positive signature before about 22 UT and positive signature before about 22 UT. This would happen when Maitri rotates through the HARANG DISCONTINUITY

(HD), with a rather southward position on the auroral oval. It sees the positive Z signature of the EAE in the pre mid-night, and negative Z signature of WAE in the post midnight.

INCREASE IN IONOSPHERIC CURRENT DENSITIES OVER MAITRI WITH INCREASING DISTURBANCE

An estimate of current densities in the ionosphere over Maitri is made from the Biot-Savart Law, following Kamide and Akasofu [2]. A horizontal current configuration is assumed, although strictly speaking this is not correct, and field aligned currents (FAC) are present. The horizontal current densities are :

$$ix\ (Amp/Km) = K\ (10/2\pi)\ \Delta\ Ym\ (nT)$$
$$iy\ (Amp/Km) = K\ (10/2\pi)\ \Delta\ Xm\ (nT)$$

where K = 2/3, correction factor for current induced within earth.

Δ Ym = range in Y component
Δ Xm = range in X component.

Ranges in X and Y are taken separately for the forenoon and afternoon hours and the current densities ix and iy are estimate separately for the Dawn and the Dusk sectors.

Fig. 4 and fig. 5 show ix and iy for the dawn sector. The increase in ix and iy with increasing magnetic disturbance is very clear, as is also their variability. Similar results are obtained for the Dusk sectors (not shown here).

CONCLUSIONS

(1) The changes in X, Y, Z geomagnetic components clearly show that Maitri during magnetically quiet condition has a subauroral position during magnetically disturbed condition it comes into auroral oval.

(2) The North-South and East-West horizontal current densities over Maitri both increase with increasing magnetic disturbance, in both dawn and dusk time sectors.

(3) The variability in these current densities (i.e. scatter in points) also increases with increasing disturbance. This is because there is a certain contribution to ΔX and ΔY from the fac, which has not been separated in this work. The contributions to ΔX and ΔY separately from fac and horizontal currents are likely to show less scatter [3].

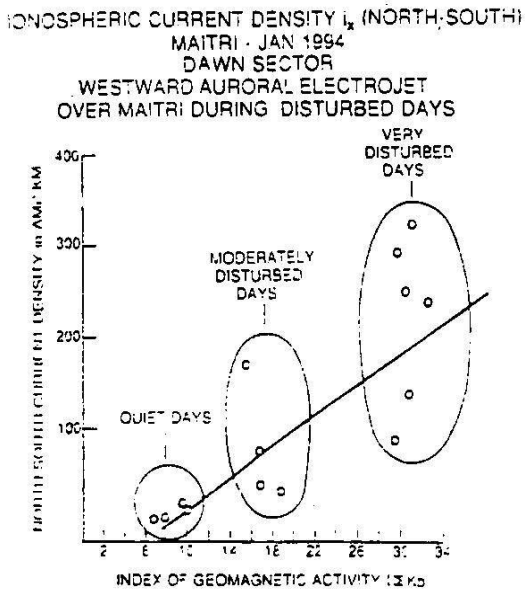

Fig.4: Variation of North-South Ionospheric Current Density i_x(in Amp/km) with index of Geomagnetic Activity ($\sum K_p$) for dawn sector.

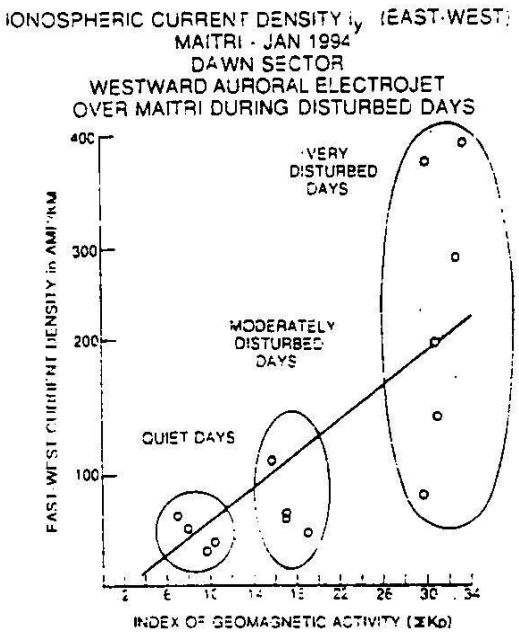

Fig.5: Variation of East-West Ionospheric Current Density i_y(in Amp/km) with index of Geomagnetic Activity ($\sum K_p$) for dawn sector.

ACKNOWLEDGEMENTS

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