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CONTRIBUTION TO MODELLING THE ELECTRON DENSITY AND TEMPERATURE IN THE DISTURBED LOW LATITUDE TOPSIDE IONOSPHERE

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ABSTRACT

The crest structure is well marked in the quiet lower topside ionosphere while it is absent at heights around 2500 km. At the 500 km level disturbances seriously weaken this structures while electron density and temperature increase. Near 2500 km the disturbed density is also increased while the electron temperature decreases.

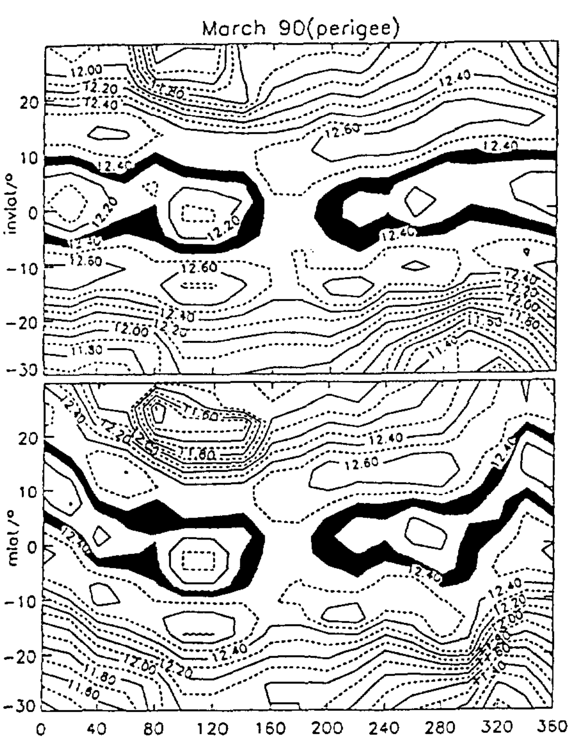

Fig. 1 Log electron density/m^{-3} as function of invariant (top) or magnetic latitude (bottom). Log density range 12.3 to 12.4 is blackened.

INTRODUCTION

Třísková *et al* (1996a,b) have shown an empirical model of electron density and temperature for the March equinox and December solstice during early morning conditions in the height range 2200 to 2500 km and for early evening in the range 500 to 700 km, based on data acquired in the ACTIVE project. The model holds for all longitudes and for a ±30° range in invariant latitude (invlat). It was found that in low latitudes in heights of approximately 500 km during magneticaly disturbed periods both density and temperature increase, while around 2500 km the density increases, but the temperature decreases. In the following we investigate electron density and temperature distributions in latitude and longitude for quiet and disturbed periods during March 1990, in particular during the SSC storm of 20 March 1990.

DATA AND DATA PROCESSING

We use data from the main satellite of the ACTIVE mission (perigee 500 km, apogee 2500 km, inclination 83°). For a given height data is limited to sections in solar local time (SLT) and latitude.

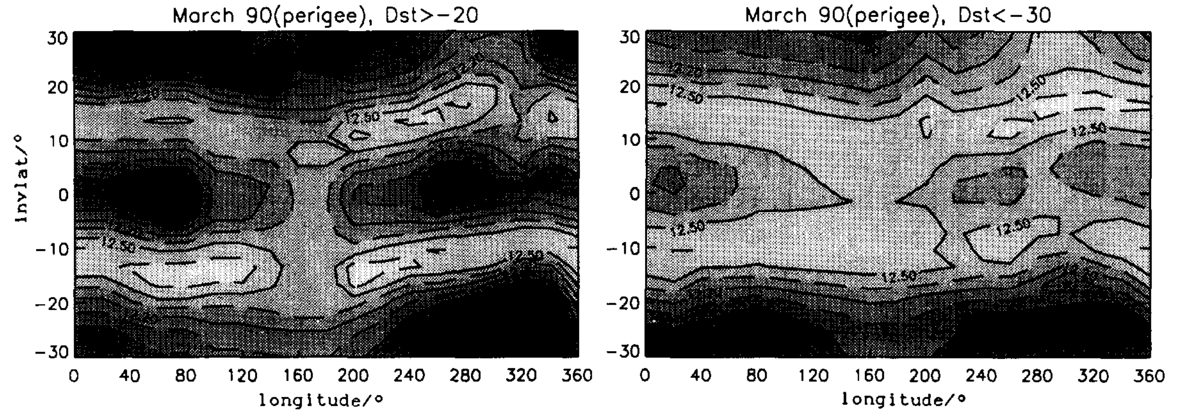

Fig. 2 Log electron density/m^{-3} near perigee in 500 km between 17 and 19 h SLT.

Out from the spatial electron temperature measurements of three mutualy perpendicular components by planar sensors only the component Ty perpendicular to the orbital plane (and, approximately, to the magnetic field) was used. The total ion density was measured by a planar ion trap (Retarding Potential Analyzer) in the x (velocity vector) direction. In both cases 5s-averages were evaluated. The floating potential of the electrode directed along the x axis was measured as well, see Afonin *et al.* (1994).

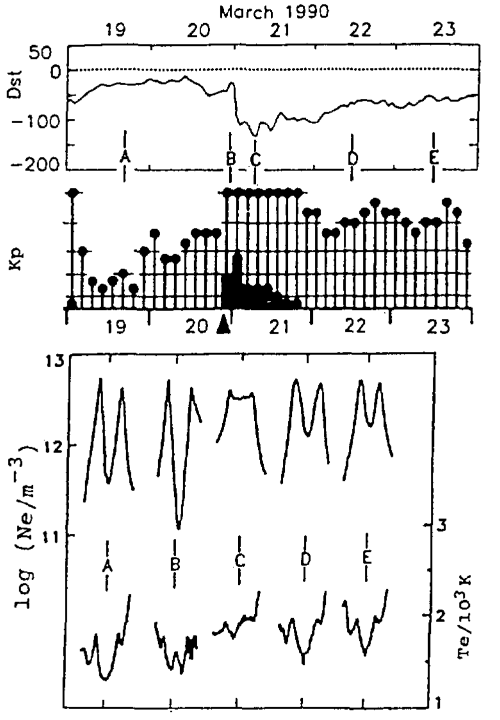

Fig. 3 a) Development of geomagnetic activity in a 5 days period around the SSC storm of 20 March 1990 (SSC at 23:30 UT); A...E - times of equator crossings.
b) Electron density and temperature as measured during the marked equator crossings in ±30° invariant latitude.

Satellite data from November 1989 to January 1991 cover a period of high solar activity. Due to the orbit not all hourly sections could be assessed. Data from intervals of 2 hours in SLT, 200 km in altitude and periods of about 4 weeks were processed and bin-wise averaged.

RESULTS

Electron density and temperature being controlled by the invariant rather than by the magnetic latitude (see Figure 1) we use a grid of invariant latitude vs geographical longitude. Data of March 1990, first near perigee (17-19 h SLT), then near apogee (05-07 h SLT) will be considered.

Perigee (Heights around 500 km)

Figure 2 shows the total ion density for all longitudes in the latitude range of ±30° invlat for heights of about 500 km separately for quiet (Dst>-20) and disturbed (Dst<-30) conditions. As expected, under disturbed conditions the ion density near the equator is higher and the anomaly crests are less marked.

The lowest equatorial density under quiet conditions is 5.6×10^{11}m^{-3} (average), during disturbed conditions, however, 1.6×10^{12}. The equatorial anomaly, i.e. the density ratio at the equator to crests under quiet conditions is 1:10 on the average, under disturbed conditions it is only 1:2.

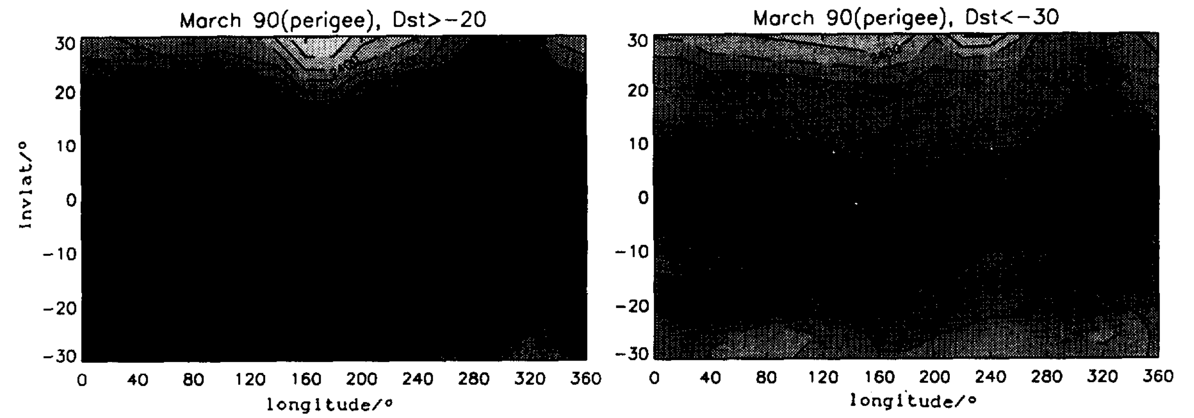

Fig. 4 Electron temperature/K near perigee in 500 km between 17 and 19 h SLT.

Distinct from these findings, the anomaly may disappear during the expansion phase, or, contrarily, increase substantially after the SSC (Matsushita, 1976, Tanaka, 1981). In Figure 3 the crest density did not change notably when the storm began, but at the equator it decreased to one third of its quiet value, and during the expansion phase it increased by one order.

The average perigee electron temperature (Figure 4) shows an enhancement of about 500 K at the equator under disturbed conditions in agreement with the situation shown in Figure 3, and is symmetric around the invariant equator.

<u>Apogee (Heights around 2500 km)</u>

Figure 5 shows that here the electron density has its maximum above the equator, increasing by about a factor of 2, under disturbed conditions. The electron temperature shown in Figure 6 decreased under disturbed conditions by 200 to 500 K. These features are not apparent in the longitude range 330 to 10°E, possibly due to insufficient data coverage.

A meridional stratification appearing in Figure 6 might suggest a longitude effect in the vicinity of 2500 km around 06 h SLT.

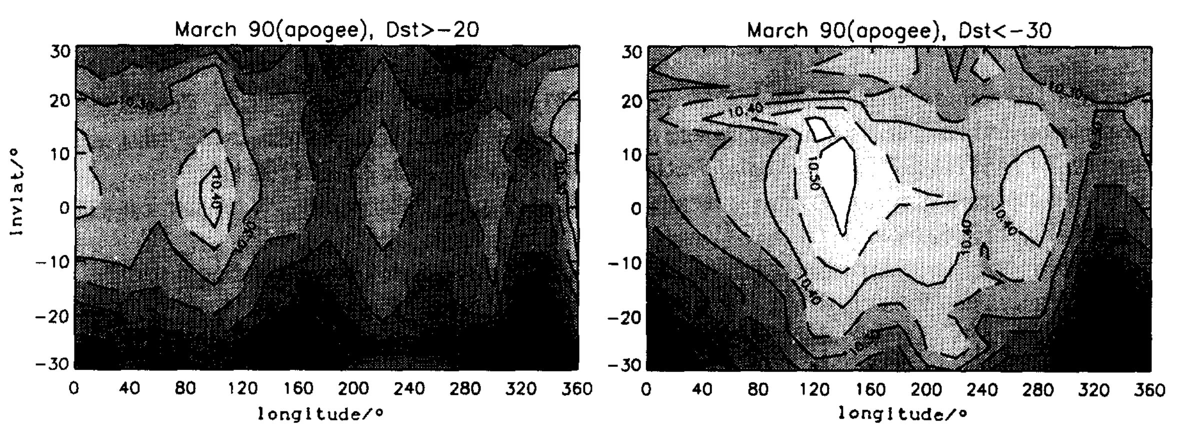

Fig. 5 Log electron density/m^{-3} near apogee in 2500 km between 05 and 07h SLT.

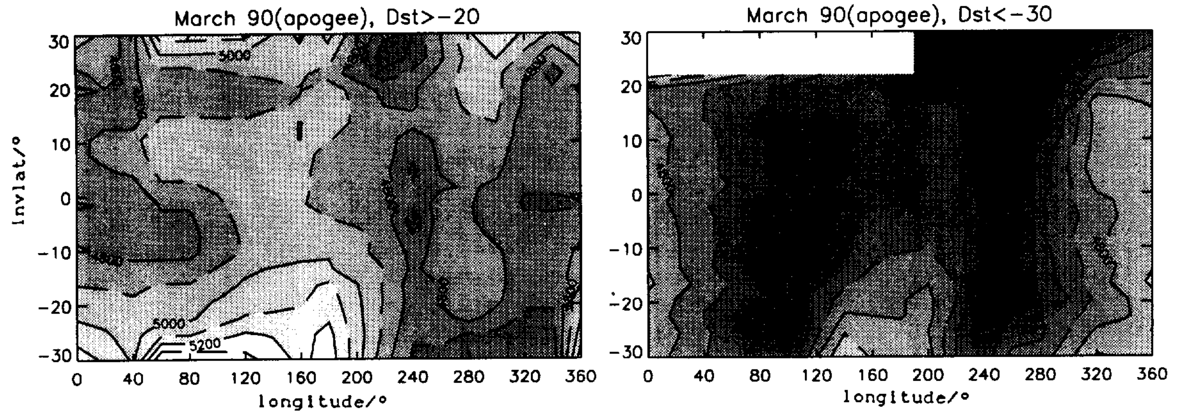

Fig. 6 Electron temperature/K near apogee in 2500 km between 05 and 07 h SLT.

CONCLUSION

In the topside ionosphere, in heights of about 500 km, geomagnetic disturbances simultaneously enhance density and temperature of the ionized components which is in contradiction with the generally anticipated anticorrelation of both. This may be explained by an adiabatic compression that might flatten the crest pattern.

In the outer ionosphere, in heights of about 2500 km, crests are no more seen. Distinct from the lower topside, the electron temperature decreases during the disturbance.

These statistical results do not apply to any kind of disturbance. During strong substorm activity and the development of an asymmetric ring current, the equatorial anomaly can become more pronounced whereas during the main and recovery phases of a storm it may totally disappear.

ACKNOWLEDGEMENT

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