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ON THE LOW LATITUDE TOPSIDE MODELS: II. ELECTRON TEMPERATURE

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ABSTRACT

Electron temperature measured within the scope of the ACTIVE Project was analyzed for range of ±30 invariant latitude. Apogee (2500 km) and perigee (500 km) electron temperature data of December 1989 and March 1990 are in general agreement with the IRI. In morning hours there appears in high altitudes a longitude effect that is due to the variable illumination of the zone of main electron production. Geomagnetic activity causes an increase of electron temperature near 500 km, a decrease near 2500 km.

INTRODUCTION

Similarly as /1/, this paper is based on data measured onboard the Intercosmos 24 satellite. The introduction to /1/ which will not be repeated here represents the introduction to this paper as well. In recent years attention to the electron temperature modelling has been steadily mounting /2/ and the aim of our paper is to contribute to solving this problem.

DATA

Onboard Intercosmos 24 (the mother satellite of the ACTIVE mission) three planar sensors measured the electron temperature in three directions: Tex along the velocity vector, Tey perpendicular to the orbit plane and Tez in zenithal direction. The Radio Frequency Probe method was used.

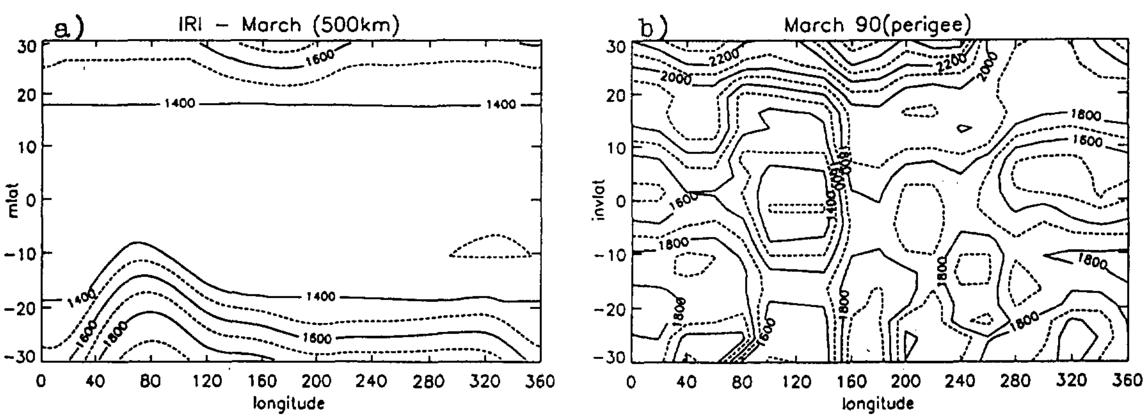

Fig. 1 Electron temperature/K in the vicinity of 500 km, March 1990. a) IRI 90 calculated for March 21, 18 h SLT, b) measured.

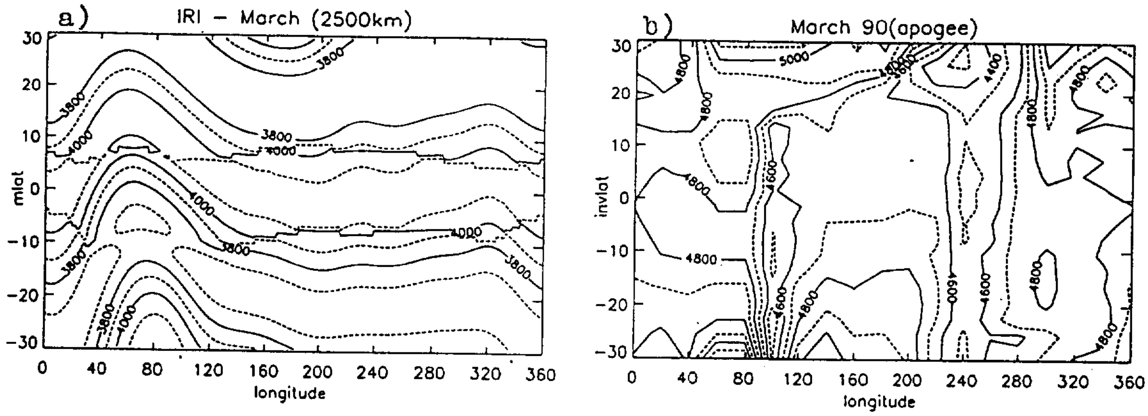

Fig. 2 Electron temperature/K in the vicinity of 2500 km, March 1990. a) IRI 90 calculated for March 21, 06 h SLT, b) measured.

Two measuring modes were applied, either a 120 min mode with one measurement every 0.32 s, or a 16 h mode with one measurement per 2.56 s. In the following only Tey data are used sensitive always only to the component of Te perpendicular to the magnetic field. The orbit parameters of the mission were: perigee 500 km, apogee 2500 km, inclination 83 . Detailed description of the measurement technique is given in /3/.

As in /1/, concentrating our effort to the low-latitude ionosphere, we have chosen the range of ±30 invariant latitude and heights in the vicinity of 500 km (perigee) and 2500 km (apogee) for analysis. The satellite orbit and mission period allowed us to study a period of high solar activity in time sections corresponding to certain seasons. We show as examples the results of March equinox, 17 to 19 h SLT near perigee and 05 to 07 near apogee and for December solstice, 15 to 17 h near perigee and 03 to 05 near apogee.

RESULTS

The measured data were compared to the IRI 90 model /4/ (options: Te model, Ni standard, F10.7 = 190). It is necessary to bear in mind that we are comparing the model calculated for a definite day, definite hour and definite altitude with measured data averaged over intervals of 2 hours in SLT, 200 km in altitude. The data set used covers about 4 weeks. Smaller scale features in the measured Te contours (Figures 1 to 4 sub b) may not all be statistically significant.

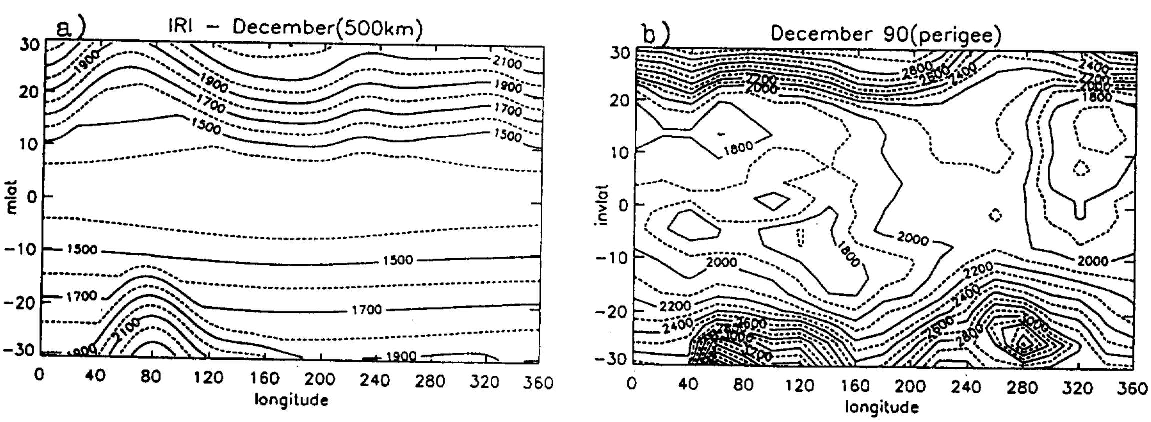

Fig. 3 Electron temperature/K in the vicinity of 500 km, December 1989.a) IRI 90 calculated for December 21, 16 h SLT, b) measured.

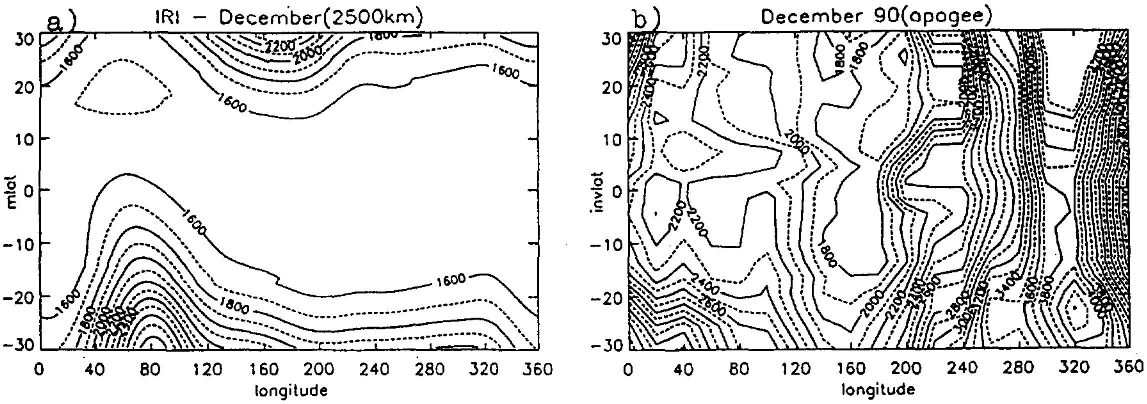

Fig. 4 Electron temperature in K in the vicinity of 2500 km, December 1989. a) IRI 90 calculated for December 21, 04 h SLT, b) measured.

The structure of contours shown in Figures 1b and 2b can be considered as the consequence of a great variability of geomagnetic activity, since the Dst values between +26 and -182 occurred in March 1990. In perigee, around 18 h SLT, the enhanced geomagnetic activity (Dst<-30) manifest itself by increasing of both electron temperature (Figure 6) and density /1/, which might correspond to an adiabatic compression. In apogee, around 06 h SLT, decrease of electron temperature (Figure 6) and increase of electron density /1/ occurred under disturbed conditions. The variation of the perigee and apogee electron temperature with geomagnetic activity is comparable to the latitudinal variation between ±30.

The measured and calculated patterns of Te for December perigee are in qualitative agreement (Figure 3), for apogee (Figure 4) there are in contradiction. As mentioned in /1/, a certain longitude effect occurred at December apogee around 04 h SLT. According to the position of the invariant equator at the given longitude, magnetic field lines corresponding to the same altitude are going ones through the production region fully illuminated over the Southern Hemisphere and another time through the production region in full shadow over both hemispheres. Figure 5 shows this effect in detail.

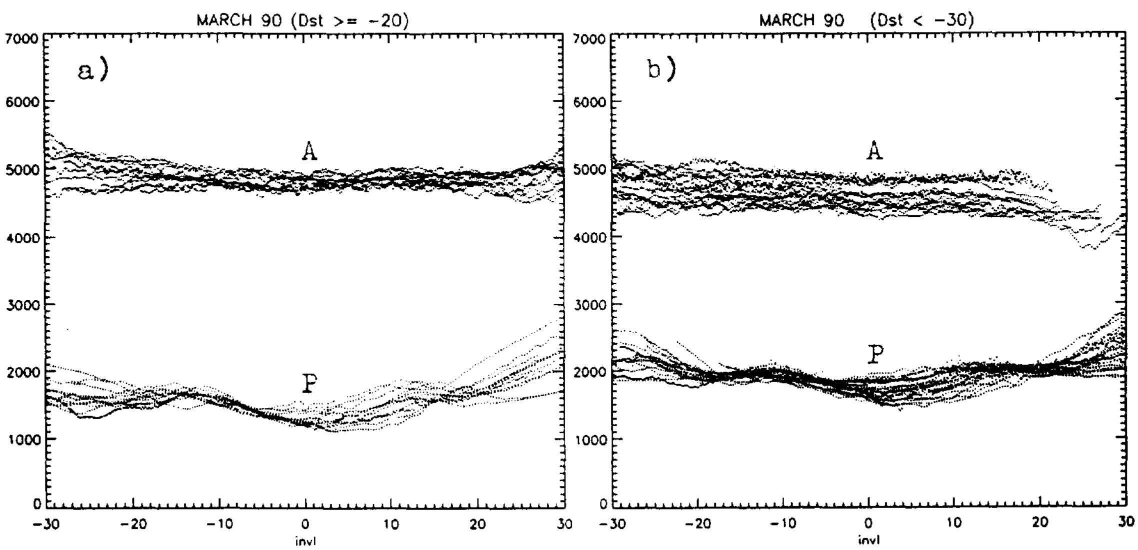

Fig. 5 Manifestation of geomagnetic activity in the electron temperature for March 1990 near perigee in 500 km at 18 h SLT and apogee in 2500 km at 06 h SLT. a) small geomagnetic activity (Dst>-20), b) high geomagnetic activity (Dst<-30)

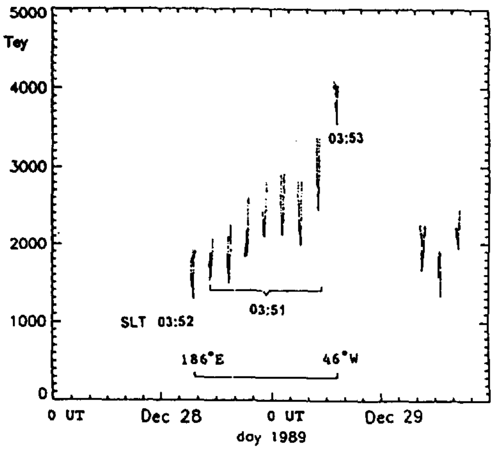

Fig. 6 Electron temperature/K between ±30 inv. lat.as measured onboard the Intercosmos 24 satellite in a sequence of equator crossings between 186 E and 46 W close to the apogee (altitudes 2480-2500 km).

CONCLUSIONS

Our data confirm the decisive role of the invariant latitude, altitude and solar local time in most cases for the electron temperature pattern in the low-latitude topside ionosphere. The fact that in morning hours in high altitudes the corresponding magnetic line of force for given altitude, latitude and local time passes either through fully illuminated or through shadowed zones according to the configuration causes a longitude effect that is some order greater than the latitudinal variation. Changes of geomagnetic activity cause changes in electron temperature comparable to the latitudinal variation.

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REFERENCES

1. L. Třísková, J. Šmilauer, V. Truhlík and V.V. Afonin, this issue.

2. D. Bilitza, K. Rawer, L. Bossy and T. Gulyaeva, International reference ionosphere - past, present, and future: II. Plasma temperatures, ion composition and ion drift. *Adv. Space res.*, 13, (3)15-(3)23 (1993).

3. V.V. Afonin, K.V. Grechnev, V.A. Ershova, O.Z. Roste, N.F. Smirnova, J. Šmilauer, Yu.A. Schultchishin, Ion composition and temperature of ionosphere at maximum of the 22 solar activity cycle from satellite Interkosmos-24 (ACTIVE Project). *Kosmicheskie issledovaniya.*, 32, #2, 82-94 (1994).

4. D. Bilitza, International Reference Ionosphere 1990, National Space Science Data Center, NSSDC 90-22, Greenbelt, Maryland.