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ON THE LOW LATITUDE TOPSIDE MODELS: I. ELECTRON DENSITY

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ABSTRACT

Ion density measured within the scope of the ACTIVE Project was analyzed for range of ±30 invariant latitude. Apogee (2500 km) and perigee (500 km) data of December 1989 and March 1990, though in general agreement with the IRI, show a distinct equatorial anomaly yet at altitude of 500 km. A small longitude effect appears at local early morning at apogee height. Geomagnetic activity causes an increase of density, particularly in apogee.

INTRODUCTION

In order to create an empirical model of electron temperature (Te) and/or density (Ne) in the topside ionosphere, data from circular orbiting satellites are most useful being limited to a fix altitude. In the case of an elliptical orbit, data are obtained from different heights such that for a given height they are restricted to sections in solar local time (SLT), in latitude, etc. Our contribution is based on data from the main satellite of the ACTIVE mission, hence, from a non circular orbiting satellite (e = 0.126).

In the so far existing models, height, latitude and local time are considered as the most important variables while other factors, e.g. season, geographic longitude, solar and geomagnetic activity, are examined in terms of perturbations on the global patterns /1/. Since the main features of ionospheric electron temperature and electron density such as latitudinal variation and SLT dependence or the anticorrelation between Ne and Te can be considered as confirmed /2/, our attention is directed to the second order influences, e.g. to the longitudinal effect and manifestations of geomagnetic activity. First results are shown.

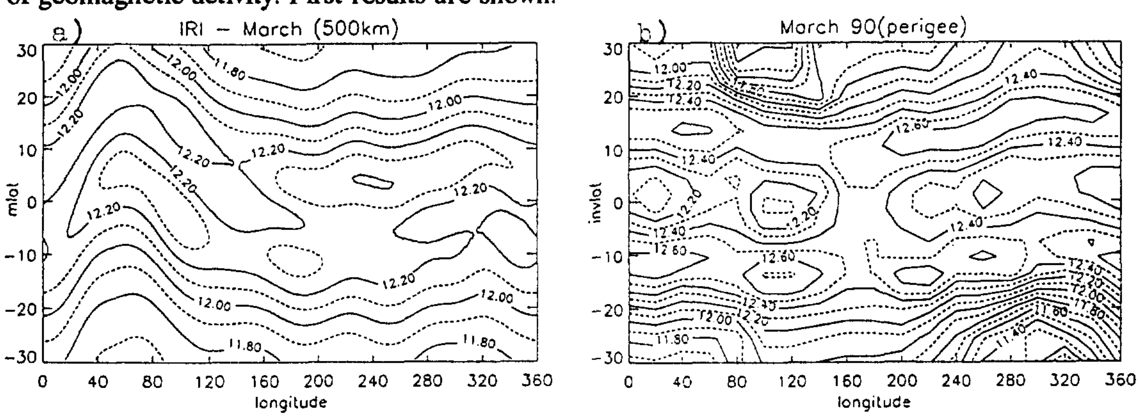

Fig. 1 Log electron density/m^3 in the vicinity of 500 km, March 1990. a) IRI 90 calculated for March 21, 18 h SLT, b) measured

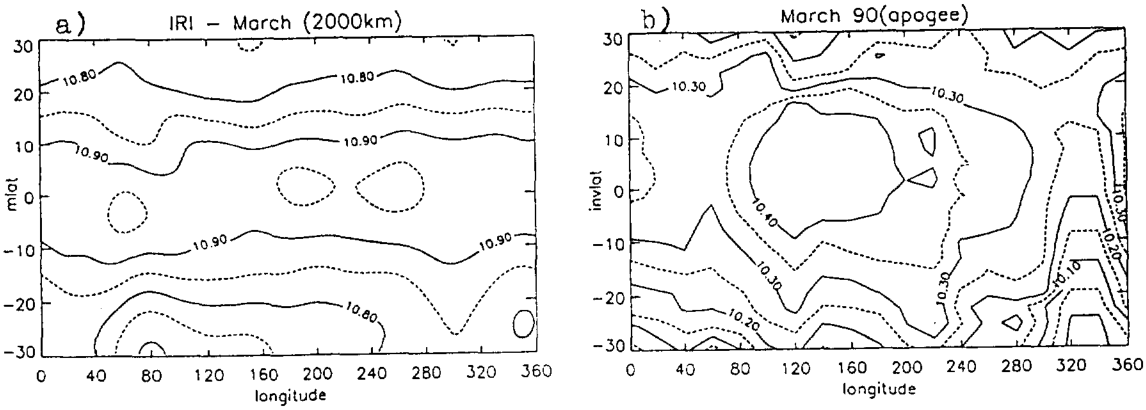

Fig. 2 Log electron density/m^3 in the vicinity of 2500 km, March 1990. a) IRI 90 calculated for March 21, 06 h SLT, b) measured.

DATA

Onboard the Intercosmos 24 satellite (the mother satellite of the ACTIVE mission) with three axis orientation the total ion (electron) density was measured in the x (approximately parallel to velocity vector) and z (to the zenith) directions by planar ion traps (Retarding Potential Analyzer); the floating potential along the x axis was also determined and used as the first point of RPA characteristics.

Two measuring modes were used, 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 both cases 5 s averages were evaluated. 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/.

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, near maximum of solar cycle 22, in time sections corresponding to certain seasons. We show as examples the results of March equinox (1990), 17 to 19 h SLT near perigee and 05 to 07 near apogee and for December solstice (1989), 15 to 17 h near perigee and 03 to 05 near apogee.

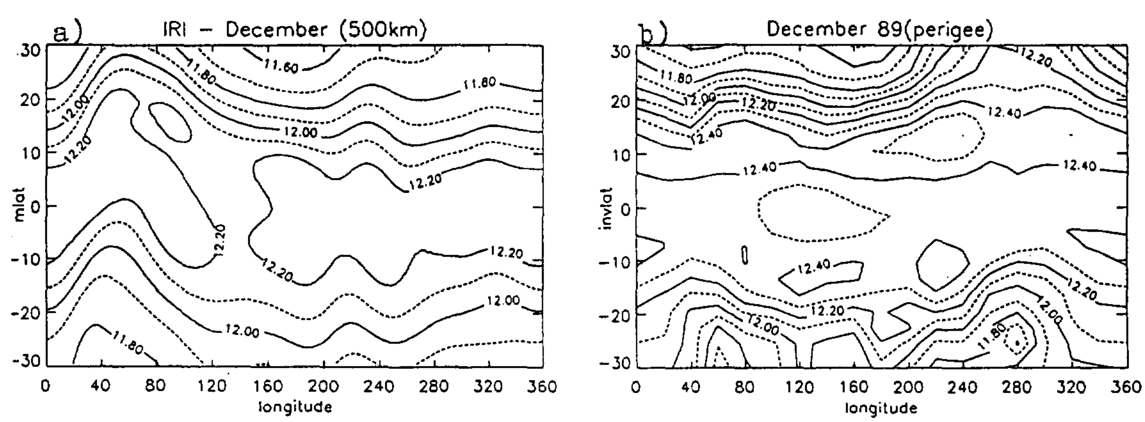

Fig. 3 Log electron density/m^3 in the vicinity of 500 km, December 1989. a) IRI 90 calculated for December 21, 16 h SLT, b) measured.

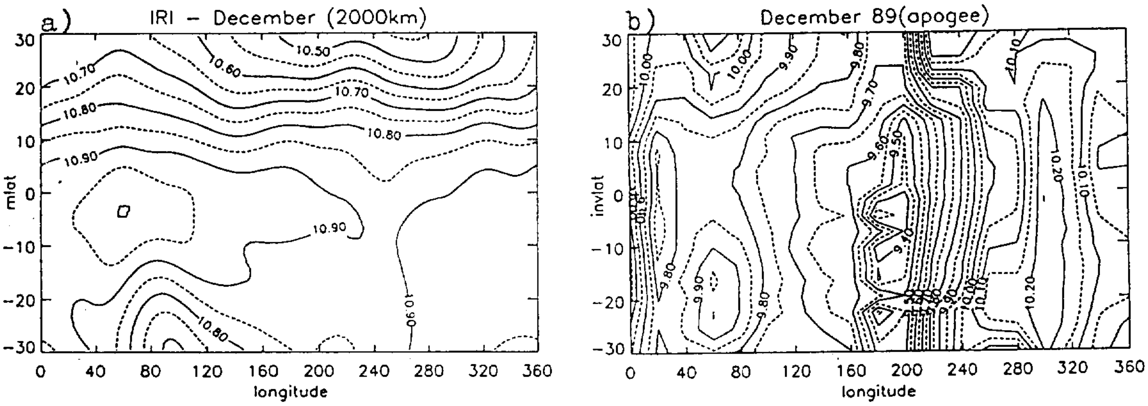

Fig. 4 Log electron density/m^3 in the vicinity of 2500 km, December 1989. a) IRI calculated for December 21, 04 h SLT, Te model, Ni standard, F10.7 = 190; b) measured.

RESULTS

The measured data were compared to the IRI 90 model /4/. 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. Option for IRI 90 calculation are: Te model, Ni standard, F10.7 = 190. Qualitatively the agreement of the measured data with the model is good.

Figures 1 to 3 show that it is preferable to arrange the electron density data after invariant rather than after magnetic latitude. Near apogee (altitude 500 km) the equatorial anomaly with peaks at ±15 is well developed while it has almost disappeared in the IRI, see Figures 1 and 3. No remarkable longitude effect could be detected in our averaged data neither in March apogee and perigee nor in December perigee, the contours in Figures 1b), 2b) and 3b) being rather zonal. Smaller scale features in our empirical patterns in Fifures b) may not all be statistically significant. For the December apogee, the measured and IRI-modeled data are in contradiction. The meridional stratification of contours in Figure 4b) suggests the manifestation of a longitudinal effect in the vicinity of 2500 km around 04 h SLT.

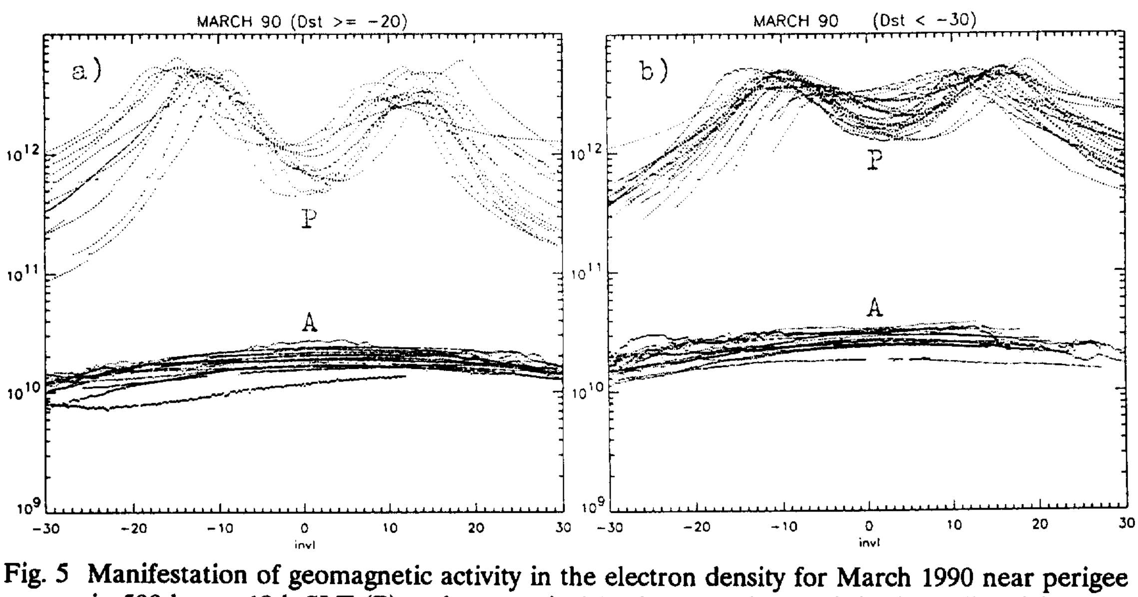

Fig. 5 Manifestation of geomagnetic activity in the electron density for March 1990 near perigee in 500 km at 18 h SLT (P) and apogee in 2500 km at 06 h SLT (A). a) small activity (Dst > -20), b) high activity (Dst < -30)

This type of longitudinal variation can be explained by the fact, that at the same altitude the corresponding magnetic field line goes ones through the production region already fully illuminated over the Southern Hemisphere and another time through the production region in full shadow over both hemispheres, according to the position of the invariant equator at the given longitude.

As shown in Figure 5, higher geomagnetic activity caused enhancement of electron density both in apogee and perigee. In apogee, the changes are comparable with the latitudinal variation between ±30.

CONCLUSIONS

Our data confirm the decisive role of the invariant latitude, altitude and solar local time in most cases for the electron density pattern in the low-latitude topside ionosphere. Distinct from the IRI maps the equatorial anomaly appears yet at altitudes near 500 km. At heights about 2500 km, changes of geomagnetic activity caused electron density changes comparable to the latitudinal variations.

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