International Journal of Electronics and Applied Research (IJEAR), Vol.3 Issue 2, December, 2016
Published online (*http://eses.co.in/online_journal.html)* ISSN 2395 0064

Some Longitudinal Features of Low latitude Ionosphere Response to Geomagnetic Storm of March 29 , 1979

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Abstract

The low and equatorial latitude ionosphere response to the March 28, 1979 geomagnetic storm is studied based on Interkosmos-19 satellite topside sounding data for three longitudinal sectors − 280, 180 and 80° E. It is shown that the development of equatorial anomaly has the prominent features specific to each of the considered longitudinal sector. These regional features along with the main characteristics geomagnetic storm time factors (intensity, duration, onset time etc.) combine to generate the development and manifestation of the diverse storm effects. Therefore these features have to be taken into account in the process of construction of ionospheric models.

Key words: 1; low-latitude and equatorial ionosphere. 2; geomagnetic storm. 3; topside sounding; 4; ionosphere model.

1. Introduction

In spite of long-term efforts, the problem of low and equatorial latitude ionosphere modeling is still far from the final solution. Though the basic physics of its formation (**E**x**B** drift and neutral component movement) and morphological features are known, a number of intriguing problems still remain unsolved. The so-called longitudinal variability of the ionosphere, or in other words, a steady dependence of ionospheric parameters on a longitude in particular, is one of such problems.

It has become possible to study these features with the advent of satellites. The geophysical data from observatory based on Intercosmos-19 are actively used in studies of low-latitude and equatorial ionosphere features during high solar activity periods [1979−1981]. Thus Ben'kova et al., [1988] and Gdalevich et al., [2010] established longitude dependence in appearance of equatorial F-spread.

Kochenova [1988] studied variability in electron density profiles at equatorial latitudes. Longitudinal fine structure in the distribution of foF2 in the night-time low-latitude ionosphere for quiet geomagnetic conditions was analyzed by Deminova [2002, 2003]. Global ionospheric changes in response to IMF-variation were reviewed by Karpachev et al. [1995].

In this work the vertical sounding data of Intercosmos-19 ionosonde used for analysis of longitudinal features in geomagnetic storm manifestation at low latitudes.

2. Helio- and geophysical conditions

The strong geomagnetic storm with two active phases that started at 08:30 UT of March 28 and lasted about 50 hrs is considered here. The planetary Dst index reached −129 nT at 21:00 UT of March 29, and Kp index increased to a maximum value of 7, daily F10.7 has reached $190 \cdot 10^{-22}$ W/m^{2}s.

The storm under consideration was one of the sequence of geomagnetic storms occurred during the extremely disturbed period from March 22 till April 4, 1979. High level of auroral electrojet variability (AE index) preceding the storm is also to be noted.

2. Data processing

For further analysis, the data of topside sounding from satellite Intercosmos-19 (http://antares.izmiran.ru/projects/IK19/), received on March 25−26 and 28−30, 1979 in three different longitudinal sectors − 280, 180 and 80^o E had been used. Descending parts of orbits over the day-light side of the Earth in a latitude range of ±50 degrees were considered, the satellite height changed from 1000 to 600 km. The time of crossing a plane of equator by the satellite (it is marked in Figure 1. by vertical bars) corresponded to local midday and changed slightly from March, 25th till March, 30th. Topside ionograms were produced in a frequency range of 0.3−16 MHz each of 64 seconds or at intervals of approximately 2.5^o of latitude near equator. Ionograms were inverted to electron density profiles Ne(h) to obtain the ionosphere main peak parameters. These parameters (F2-layer peak density NmF2, its height hmF2 and topside layer thickness B2u) were used as input to NeQuick model to restore a full profile of electron density from 100 to 1000 km. The method was reported in [Nava et al., 2001].

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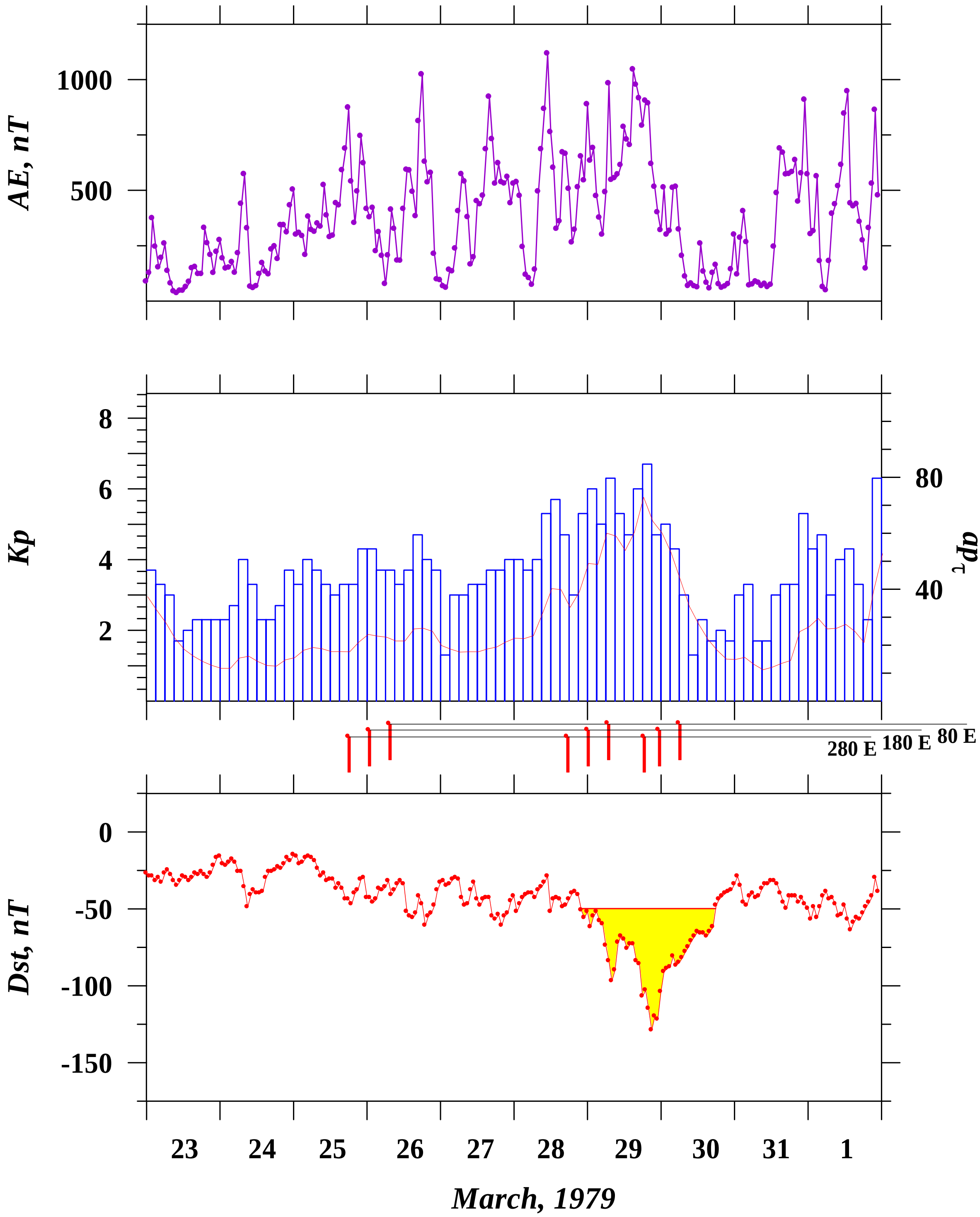

Figure 1: Variations in geomagnetic indices (AE, Kp, time-weighted ap$_\tau$, Dst, from top to bottom) during period of March 23−31, 1979. Vertical bars mark time of Intercosmos-19 crossings a plane of equator on longitudes 280, 180 and 80^o E.

4. Results and discussion

In Figure 2 ionospheric electron content close to a longitude of 280° E, obtained for March 25 (Figure 2a), March 28 (Figure 2b) and March 29, 1979 (Figure 2c) are presented. The satellite crossed the geographical equator respectively at 12:30, 12:00 and 11:45 LT.

Distributions of electron concentration are very similar for all three passes in Figure 2. Equatorial anomaly is developed poorly, its trough, according to a configuration of a geomagnetic field, is displaced to the South Pole. In a slightly disturbed period preceding the magnetic storm, asymmetric ionization maxima (Figure 2a, 2b) exist, electron concentration being larger in a southern hump, than in a northern one. During a growth phase (Figure 2c) typical super-position of crests occurs and Ne increases over the geomagnetic equator.

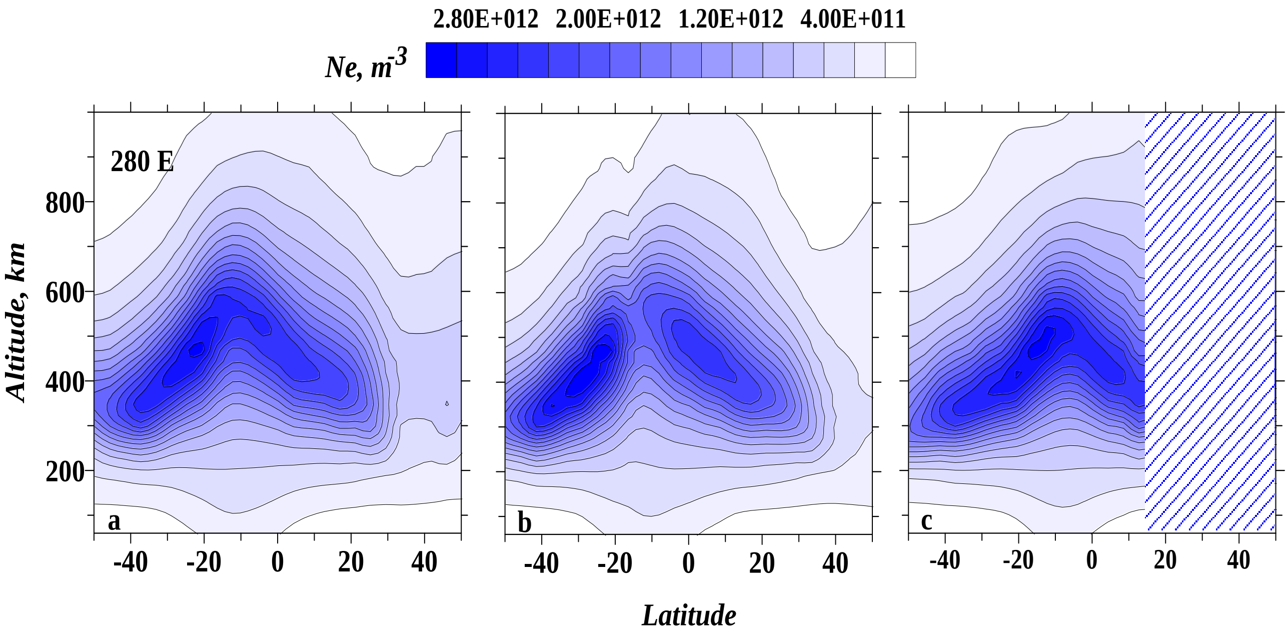

Figure 2: Meridional cross-sections of ionosphere in American longitude sector (280° E) (March 25, 28, 29 from left to right).

Figures 3 and 4 show ionospheric electron content cross sections vs ionospheric height at latitude sectors and along longitudes of 180 and 80° E. Local time of the satellite flights for Figure 3 (a), (b), (c) coincide with that presented in Figure 2.

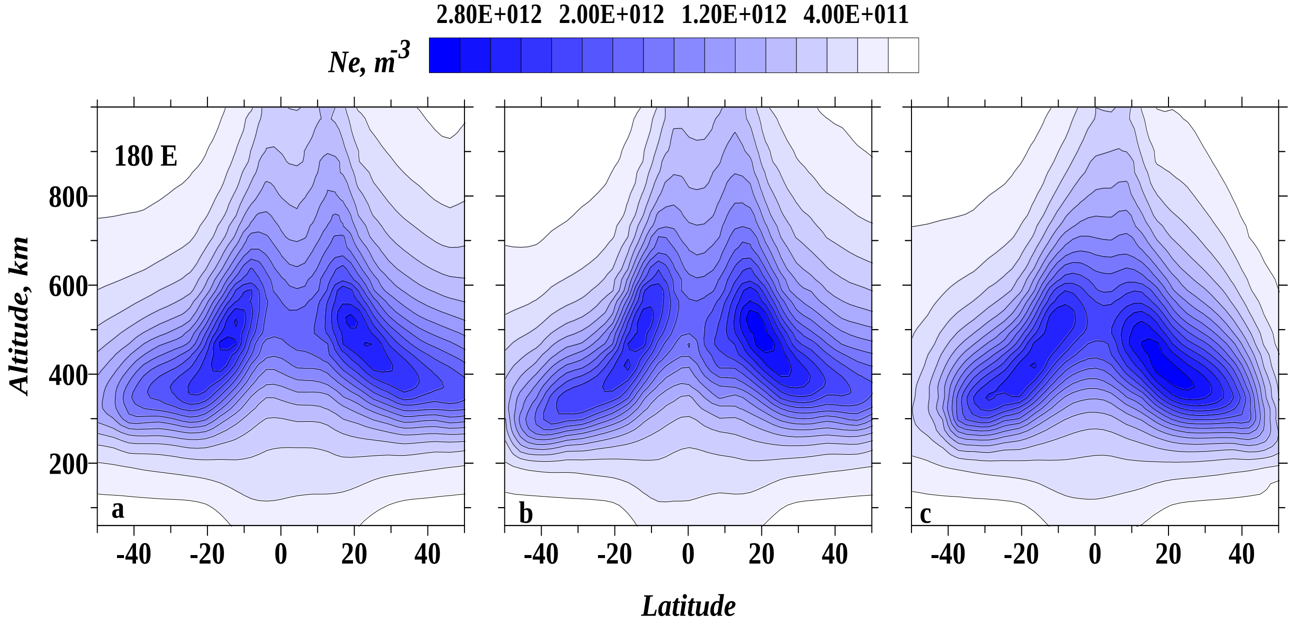

Figure 3: Meridional cross-sections of ionosphere in Pacific longitude sector (180° E)
(March 25, 28, 29 from left to right).

In the Pacific sector, equatorial anomaly is displaced to the north, has accurately expressed crests up to height of 900 km observed before a storm (Figure 3a, b). In the beginning of recovery phase of the storm (Figure 3c), a reduction of the main maximum height (hmF2), the displacement of crests towards the geomagnetic equator and increase of electron concentration between them are observed.

The electron content in Indian longitudinal sector (Figure 4) also has peculiar features. First of all, we have to note a depressed strength of the Appleton anomaly on March 26, 1979 with only one maximum in latitudinal distribution of electron concentration (Figure 4a) above 600 km. Then the typical positive disturbance pattern appears during recovery phase (Figure 4c).

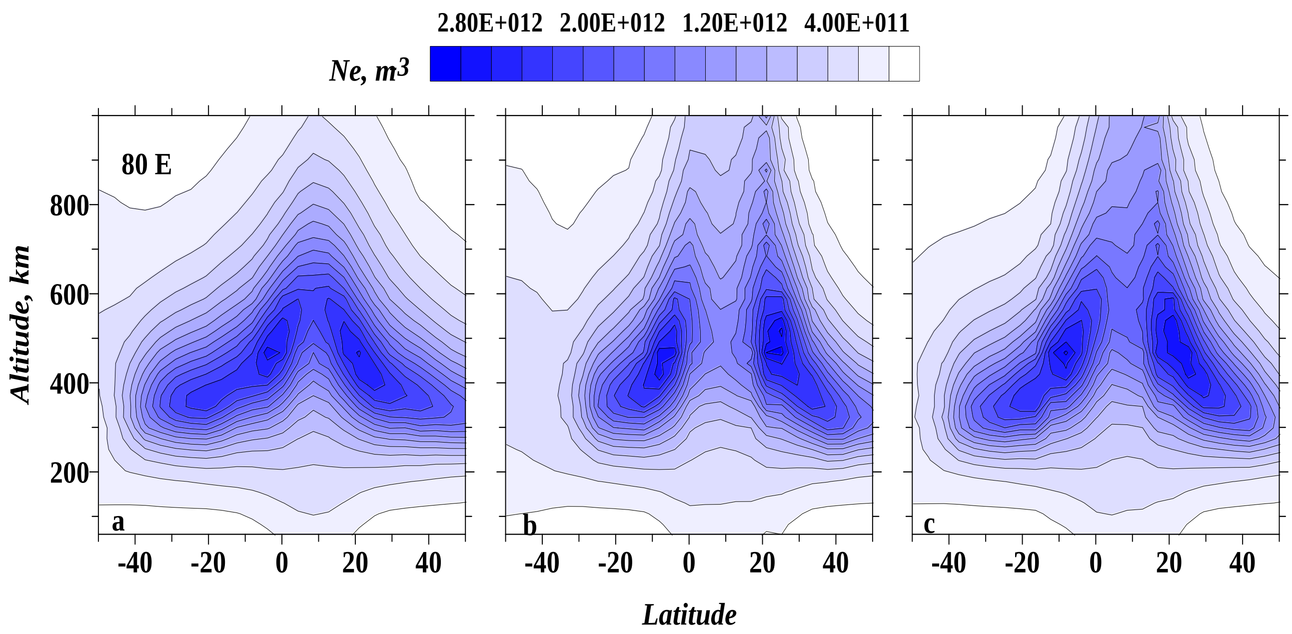

Figure 4: Shows meridional cross-sections of ionospheric electron content in Indian longitude sector (80° E) (March 26, 29, 30 from left to right).

5. Conclusion

Undoubtedly, geomagnetic storm is very complex geophysical phenomenon and for understanding of processes in ionosphere both co-ordinated multi-tool observations and good statistics are necessary. In this paper just the results of topside sounding which accidentally coincided with the time of strong storm are presented.

The analysis of the data of satellite based ionosphere sounding during a storm occurred on March 29, 1979 allows to receive a view on development of equatorial anomaly prominent features specific to a given longitudinal sector. These regional features, together with the parameters of geomagnetic disturbances (intensity, onset time, duration, etc.), influencing storm effects manifestation have to be considered in the process of ionosphere empirical model construction.

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