# THE EQUATORWARD AURORAL BOUNDARY DETERMINED FROM IK - BULGARIA - 1300 SATELLITE MEASUREMENTS

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**Abstract**

On the basis of data from the IK - Bulgaria - 1300 satellite the location of the auroral oval in the winter period 1981 - 82 is investigated. The equatorward auroral boundary is determined using the photometric measurements of the 557.7 nm, 630.0 nm emissions and the measurements of the 1 keV electron flux and the total energy flux. The dependence of this boundary on the magnetic activity ( as monitored by Kp index ) and the magnetic local time is investigated.

## 1. Introduction

The ground - based and the satellite observations of the aurora both in integral light and in separate emissions have definitely shown that equatorward from the auroral oval, a region of subvisual diffuse glow exists, less eccentric towards the geomagnetic pole than the oval itself. [ Eather, 1975; Snyder et al., 1975 ]. The configuration and the dynamic behaviour of the equatorward boundary of the nocturnal difuse aurora are an object of investigation of different scientists. In these investigations different criteria have been used for the determination of this boundary. According to Slater et al. [ 1980 ] the equatorward boundary diffuse aurora can be defined as a boundary of the region where the OI 630.0 nm emission intensity exceeds the airglow by 100 R which coincides with a boundary of the precipitating electron energy flux $10^{-2}$ erg / cm$^2$ s sr. Lui et al. [ 1975 ] use a threshold of approximately 1 kR of the OI 557.7 nm emission measured by a satellite, and Galperin et al. [ 1977 ] define the boundary as threefold increase of the 1keV electron flux ( measured at an altitude of 400 - 1000 km ).
By data from simultaneous photometric observations of the glow and the precipitating particles fluxes of the ISIS 2 satellite it has been determined that the diffuse aurora boundary approximately coincides with the boundary of diffuse precipitation of auroral electrons with small energies [ Deehr et al., 1976 ]. Galperin et al. [ 1977 ] define the location of the diffuse precipitation boundary, using the measurements of the AUREOL 1 and AUREOL 2 satellites by the leap in the intensity of the electron flux with energy of 1 ÷ 2 keV. This leap in magnetic quiet periods coincides with the latitude of abrupt increase of the precipitating electrons energy flux ( E > $10^{-2}$ erg / cm$^2$ s sr ).

The purpose of this paper is, on the basis of the photometric measurements of OI 630.0 nm and OI 557.7 nm and the spectrometric measurements of the precipitating electron fluxes, realized on board the IK - Bulgaria - 1300 satellite, to determine the average equatorward boundary of the diffuse aurora and the average equatorward boundary of the diffuse precipitation in the midnight and the predawn sector, depending on the level of the geomagnetic activity ( Kp ) for the winter period of 1981 - 82.

## 2. Observations and procedures

For the purposes of the present investigation, the measurements by the EMO - 5 and ANEPE instruments on board the IK - Bulgaria - 1300 satellite have been used [ Gogoshev et al., 1983; Ivanov et al., 1983 ]. The nocturnal passes in November 1981 - February 1982 over the Northern hemisphere have been analyzed. After taking into account the periods when the photometric measurements are considerably influenced by the Moon, about 50 orbits have been selected. These measurements are in nadir and they haven't been corrected for albedo. According to Kuzmin [ 1992 ] the correction for albedo results in displacement of the auroral forms boundary and it can reach more then 0.5° invariant latitude and the form latitude - more than 1° which is essential for the data interpretation since the latitude of the characteristic structures of auroral electrons precipitation is ~ 0.1 + 1.0 ° in latitude. The orbits have been grouped into two zones by cwo criteria have been used for the determination of the equatorial diffuse auroral boundary according to the OI 630.0 nm intensity increase by 100 R over the airglow and to the OI 557.7 nm - over 1 kR. The equatorward boundary of the diffuse precipitation is defined by the leap of 1 keV electron flux ( EF ) and the total energy flux ( TEF ) increase by $E > 10^{-2}$ erg / $cm^2$ s sr. Figure 1 shows the average equatorward boundaries of the auroral oval diffuse zone, thus obtained. As it should be expected, the average equatorward boundaries of the diffuse zone are dislocated to lower latitudes with the Kp increase. We have to mention the fact that the diffuse precipitation boundary defined by the electron flux is at ~ 1° more to the south than the energy flux boundary while the boundary defined by OI 557.7 nm almost coincides with the one defined by the energy flux. The two boundaries of diffuse aurora are displaced with ~ 2.5 ° at lower Kp and with ~ 1° at Kp = 5. It can be observed that the straight lines outlining the average boundaries of the diffuse precipitation and aurora have different slope. It is possible this difference to be result of the fact that the altitude where the charged particles fluxes have been measured is ~ 900 km while the maximums of the OI 557.7 nm and OI 630.0 nm intensities refer to the altitude of the emission layers at ~ 110 km and ~ 250 km, respectively. For the purpose of comparison the regression dependence, introdused by Slater [ 1980 ] has been presented which is at higher latitudes for lower Kp and practically coincides with the boundary defined by OI 557.7 nm for Kp > 4. The location of these boundaries, depending on the level of the geomagnetic activity has been obtained discounting the temporal displacement [ Feldstein et al., 1967 ]. The linear regression equations, describing the boundaries we've obtained look like as follows;

- for the diffuse aurora boundaries:
  - by OI 557.7 nm - $\Phi = 65.76° - 0.565°$ Kp
  - by OI 630.0 nm - $\Phi = 63.23° - 0.462°$ Kp
- for the diffuse precipitation boundaries:
  - by the electron flux - $\Phi = 65.241° - 0.692°$ Kp
  - by the total energy flux - $\Phi = 66.164° - 0.651°$ Kp

while Slater et al. [ 1980 ] have obtained:

$\Phi = 67.40° - 2.04°$ Kp.

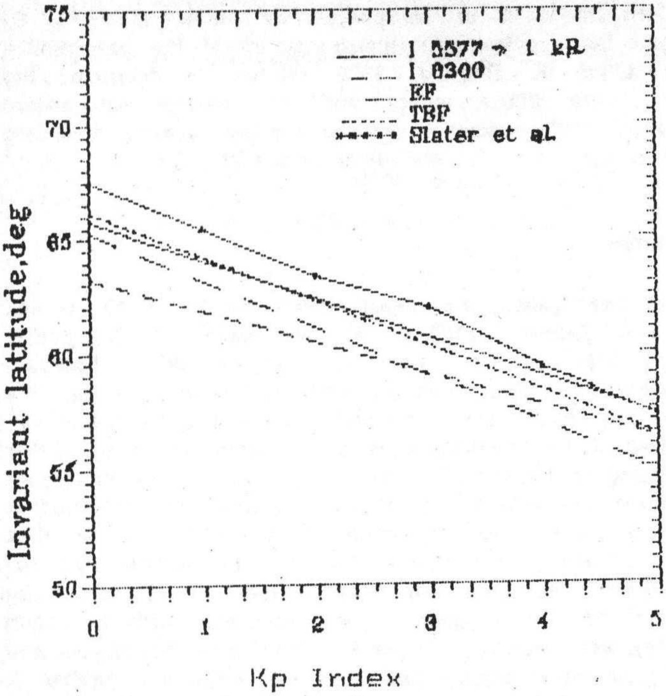



Fig. 1. Dependance of mean equatorward auroral boundary on magnetic activity. The lines indicate linear fito determined by the standard least aquares method.

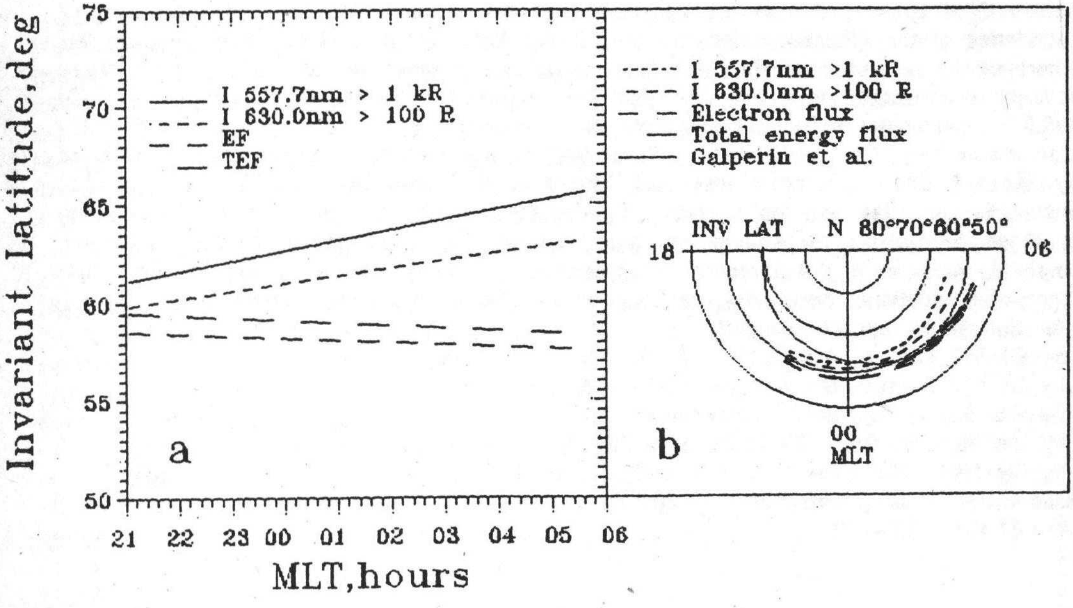
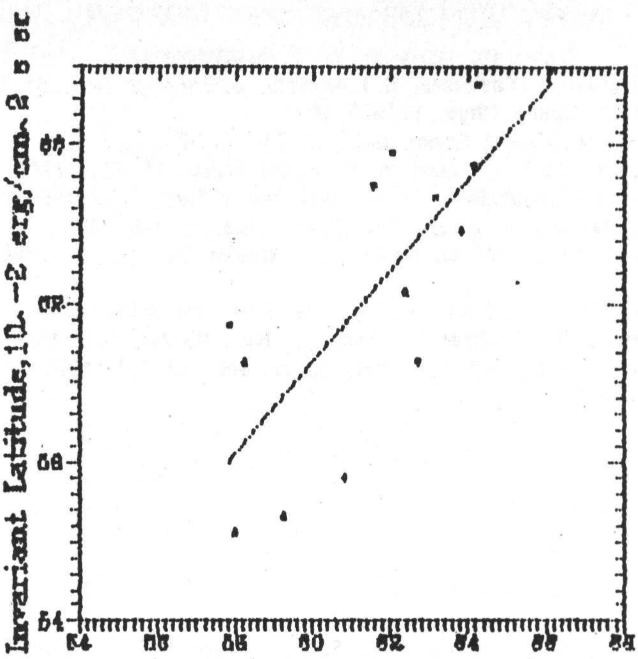



Fig. 2. Locatioh of mean equatorward auroral boundary versus magnetic local time.



Invariant Latitude, 100 R 830.0 nm

Fig. 3. Determined 630.0 nm emission boundary at 100 R above airglow vereus electron pressipitation boundary, defined to be 10↑-2 erg/cm↑2 ar. Least aquarea linear fit to the data is also shown.

The dependence of the diffuse aurora and precipitation boundaries on the magnetic local time at Kp < 3 is presented in Figure 2 ( a, b ). At 22 h MLT the average boundaries are in the latitude interval 58.8° + 61.5° . A distancing is observed of the average boundaries defined by the emissions and by the charged particles fluxes ( at 5 h MLT - Φ (557.7 nm) is at 65.3°; Φ ( 630.0 nm ) - at 63°; Φ ( EF ) - at 57.6°; Φ ( TEF ) - at 58.4° ).
Figure 2 b shows also the model of Galperin et al. [ 1977 ], where the correlation ratio:
$( 90^\circ - \Phi ) = 19.2 + 0.35\,Kp + 0.17\,Kp^2 + ( 1.3 + 2.56\,Kp - 0.34\,Kp^2 ) \cdot \cos ( MLT ) + 0.13$
has been used.
A good coordination of this model and the obtained average boundaries of diffuse precipitation in the predawn sector is observed while at 22 h MLT the deviation is maximum ~ 8° invariant latitude.
A correlation dependence is sought between the boundaries defined by OI 630.0 nm and the total energy flux ( Figure 3 ), but due to the relatively small volume of data used in this investigation, the correlation coefficient is not high.

## 3. Conclusion

On the basis of data from IK - Bulgaria - 1300 satellite the average boundaries of diffuse aurora and of charged particles precipitation have been obtained. A small eccentricity of these boundaries towards the geomagnetic pole in the midnight sector at low geomagnetic activity has been ascertained as well as an increase in the eccentricity of the diffuse aurora boundaries in the predawn sector. The obtained diffuse aurora boundaries are located at higher latitudes than those of diffuse precipitation and this tendency increases in the predawn sector.

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