BULGARIAN ACADEMY OF SCIENCES

SPACE RESEARCH IN BULGARIA, 1
Sofia · 1978

Preliminary Results of Ion Density Measurements Obtained by Intercosmos-12 Satellites

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The Intercosmos-12 satellite was launched on October 31, 1974, with apogee 718 km, perigee 250 km and inclination 74°. The measurements of ion and electron density and of electron temperature are described in [1]. Some measurement results of ion density at the satellite pass through the north and south polar regions are shown in this paper.

The orbital conditions are such that the satellite crosses the north polar region from its day towards its night side at 250-430 km altitude and attains invariant latitude of $\Lambda=73°$. The south polar region from its day is crossed by the satellite during the night from midnight towards downside close to its apogee about 718 km, and attains invariant latitude of $\Lambda=73°$.

The ion concentrations are obtained from the records of the volt-ampere curves of the two spherical ion traps situated symmetrically with respect to the satellite axis. In the orbital parts around the apogee two slopes are recorded in the volt-ampere curves, which, according to the results of our previous studies [2, 3], are interpreted as O^+ and H^+ ions. In view of the fact that mass separation is somewhat approximate, He^+ and N^+ ions are not taken into consideration.

The results obtained from the first Intercosmos-12 orbits show one and the same behaviour of the satellite orbits. Therefore, we present here one typical distribution obtained from the 34th orbit on November 1, 1974, from 12^h02^m UT — a magnetically quiet day with $K_p=1$. The ion density measured is shown on Fig. 1, when the satellite passed through the north (to the right) and through the south (to the left) polar regions.

At the north passage (Fig. 1a) the quick reduction of the O^+ density is due mainly to altitudinal change; from 257 km to about 320 km the satellite comes over F_{max}.

Thereafter, a sharp decrease of the O density almost of an order of magnitude has been observed, and the minimum is at $\Lambda=67°$. On the top of the diagram are plotted the satellite transits through the north and, respectively, through the south polar region. The hatched area represents the soft electron precipitation zone taken from [4]. The average situation of the midlatitudinal trough shown with a dotted line is taken from [5]. The stagnation point from 4 is marked with open circle. The minimum in O^+ density appears when the stagnation point is reached. Thereafter the O^+ den-

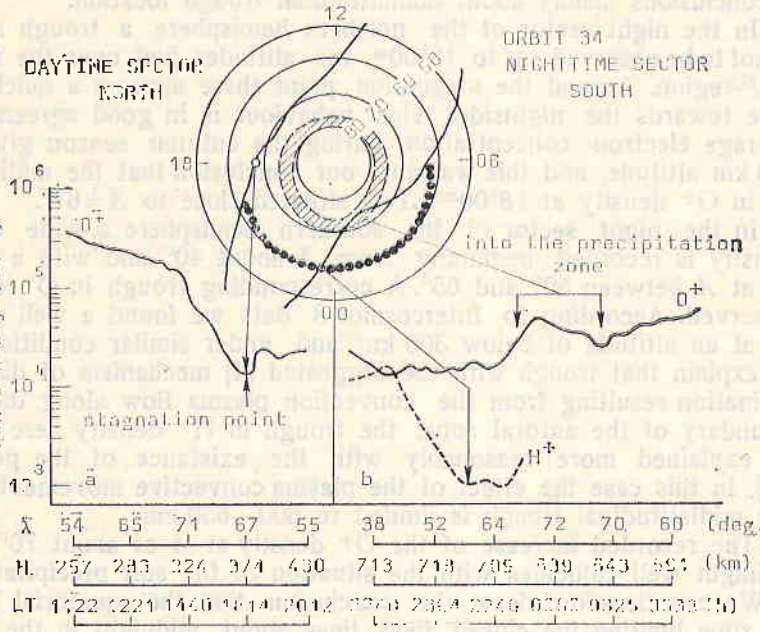

Fig. 1

sity remains low and this probably depends not so much on the satellite introduction in the night ionosphere but on the fact that the satellite is moving along the trough.

Fig. 1b shows the ion concentration distribution along the satellite orbit in the nightside of south polar region. Close to the apogee H has a deep minimum between 60° and 67° just on the spot where the midlatitudinal trough is demonstrated. Here the O^+ density has the lowest value of about 1×10^4 cm^{-3} and forms a broad minimum from $\Lambda=40°$ to $\Lambda=64°$. Here the trough at O^+ density is not to be observed. The O^+ maximum separated by arrows is recorded just at the moment when the satellite passes through the soft electron precipitation zone, as shown on the diagram. It this maximum is indeed due to increased ionization caused by soft energetic electrons, then the equatorial boundary of this zone in the southern hemisphere should be about $\Lambda=55°$ during midnight. However, the O^+ density increase in this region does enable us to follow the H^+ behaviour. In view of the method used, H^+ ions with density lower than one-tenth of the O^+ density cannot be determined. In any case, however, the H^+ density in this zone does not exceed 5×10^3 cm^{-3}. During morning hours in the sunlit ionosphere no trough in O^+ density at about 600 km altitude is to be observed.

This paper is a continuation of the polar ionosphere studies performed by the Intercosmos-12 satellite shown in [6]. Thanks to the other conditions along the Intercosmos-12 orbits, it became possible to draw certain additional conclusions mainly about midlatitudinal trough location.

1. In the night sector of the northern hemisphere a trough in ionization is not to be observed up to 18^h00^m for altitudes just over the maximum of the F-region. Around the stagnation point there appears a quick density decrease towards the nightside. This behaviour is in good agreement with the average electron concentration during the autumn season given in [7] for 350 km altitude, and this warrants our conclusion that the midlatitudinal trough in O^+ density at 18^h00^m LT is situated close to $\Lambda = 67°$.

2. In the night sector of the southern hemisphere a wide trough in H^+ density is recorded beginning from Λ about 40° and with a large minimum at Λ between 59° and 65°. A corresponding trough in O^+ density is not observed. According to Intercosmos-8 data we found a well expressed trough at an altitude of below 300 km and under similar conditions. If we are to explain that trough with the suggested [4] mechanism of dissociative recombination resulting from the convection plasma flow along the equatorial boundary of the auroral zone, the trough in H^+ density here observed can be explained more reasonably with the existance of the polar wind [7, 8, 9]. In this case the effect of the plasma convective movement in creating the midlatitudinal trough is limited to 600—650 km.

3. The recorded increase of the O^+ density at Λ of about 70°—72° after midnight well coincides with the situation of the soft precipitation zone in [4]. We can therefore draw the conclusion that the equatorial boundary of this zone limiting the closed field lines about midnight in the southern hemisphere is at about 65°, where a sharp increase of O^+ density is to be established (Fig. 1b).

4. In the morning sector of the southern hemisphere and at altitudes of about 560-600 km, no trough was to be observed in the O^+ density.

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Предварительные результаты о ионной концентрации, полученные от спутника „Интеркосмос-12“

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(Резюме)

Описано поведение ионных концентраций, измеренных в полярном районе вдоль орбиты спутника „Интеркосмос-12". В северном полушарии, на высотах F слоя, наблюдается резкий минимум в концентрации, который соответствует точке стегнации магнитосферного плазменного потока. В южном полушарии, на высотах около 700 km, имеется глубокий провал в концентрации водородных ионов. Аналогичный провал (для инвариантных широт 59—65°) не наблюдается в концентрации кислородных ионов. Объяснение этого явления связано с полярным ветром, который на высотах около 700 m является важнейшим фактором в формировании провала, в то время как в F слое его влияние пренебрежимо. В утреннем секторе южного полушария провал в концентрации кислородных ионов не наблюдается.