NEW IONOSPHERIC STRUCTURES FROM THE DATA OF SATELLITE 350 KM HEIGHT RADIO SOUNDING

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The ionospheric radiosounding from heights is lower than F2 layer maximum has enabled to observe a new type of ionograms [1]. These ionograms differ by unusual behavior of a trace of reflection from the Earth. The low-frequency end of this trace does not break on critical frequency of the F2 layer. It is bent and proceeds in the direction of the large frequencies constantly were of a below usual trace of reflection from the Earth. Thus its virtual heights (distances) are continuously increased also.

Fig.1 illustrates this case. We see in the bottom part of a figure an usual ionogram for a case, when the Mir station is lower than a height of a ionosphere maximum and there is an appropriate ionospheric irregularity. The fact the ionosonde is situated slightly below the layer maximum being confirmed by very narrow tracks of the reflection from the ionosphere of all three components of the magneto-split signal. The track of the reflection from Earth is also distinctly seen. Situated below is the second well-seen track which stretches in frequency much further than critical frequency, the latter being easily determined from the reflection from the ionosphere. We shall conventionally call tracks of the considered type as a "lower track".

The number of ionograms with the track of cited irregularities exceeds the quantity of "correct" ionograms and the former were obtained under different geophysical conditions and in various parts of the Earth

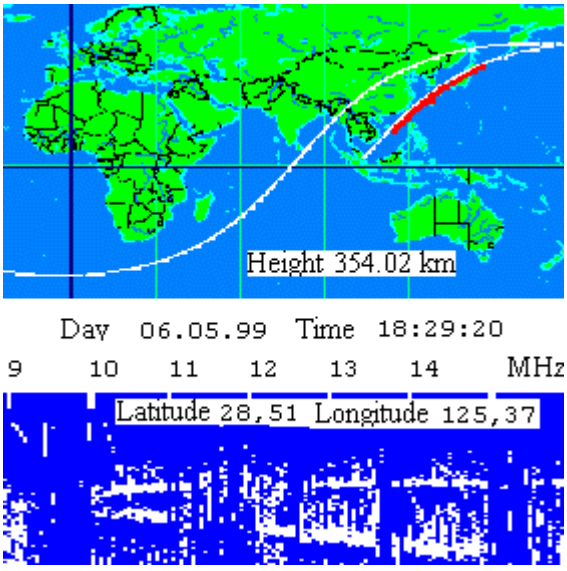

Fig. 1.

The upper part of a figure shows a projection of a trajectory of station on a surface of the Earth. The red color specifies a part of a trajectory, where are obtained ionograms of that type, that is shown below.

The qualitative and quantitative analysis [2] of this phenomenon on a basis of the trajectory calculations has resulted in understanding of the reasons of occurrence of this trace. Presence of the strong steady isolated ionospheric irregularities of plasma density in a zone about 50 - 700 km from the satellite is this reason.

For understanding of a degree of a prevalence of the given structure we have reduced a Table 1. Table 1 presents information on the ionograms with the cited irregularities obtained on board OC Mir. It shows three groups (3 various days) in which ionograms of the considered type were observed. A daily series of observations was carried out on March 31, 1999 since 0949 UT till 0930 UT of the next day. This group is shown to illustrate the quantitative side of the phenomenon. During this time 6 groups of ionograms of the type described were observed, the corresponding data being shown in the top part of Table 1 (lines 1-6). They were observed mainly in the latitudinal belt from 20^o S to 20^o N. However at high latitudes the satellite also sometimes was below the F -layer maximum. Line 7 shows information about such case. Lines 8 and 9 illustrate particularly long periods of observation of the ionograms considered. The latter fact demonstrates that the region forming the irregularities is very vast spatially and is a structure of the global scale.

The quantitative analysis on the base of calculation of ray trajectories of radiowaves shows only one boundary site of the appropriate heterogeneity. However in majority of all investigated cases, probably, steady irregularities were observed of large global sizes.

Table 1

N	Time Ut+3 hour, min, sec	Start Lat – Long Geogr.	End Lat – Long Geogr.	MMSS Height km
31.03.1999 - 01.04.1999				
1.	16:55:48-17:02:44	-24.03 -82.08	-2.97 -65.66	344
2.	18:30:17-18:35:36	-14.95 -97.7	-0.07 -86.87	344
3.	20:04:15-23:06:55	-7.17 -115.15	+1.12 -109.27	345
4.	23:04:46-23:07:22	-14.39 -167.01	-6.39 -161.09	344
5.	02:13:14-02:17:26	+2.94 +159.02	+15.87 +168.55	345
6.	05:13:39-05:14:41	-4.68 +107.15	-1.47 +109.42	344
21.04.1999				
7.	05:24:03-05:24:51	+51.61 +68.33	+51.81 +73.50	346
8.	07:14:26-07:18:26c	+15.12 +125.41	+2.81 +134.45	350
06.05.1999				
9.	15:25:44-15:33:12	+18.02 +115.83	+38.66 +138.07	354

Sometimes upper track on the ionograms occurs together or in some sequence with an event, which has received a name “bubbles” [3]. Fig. 2 shows a typical situation.

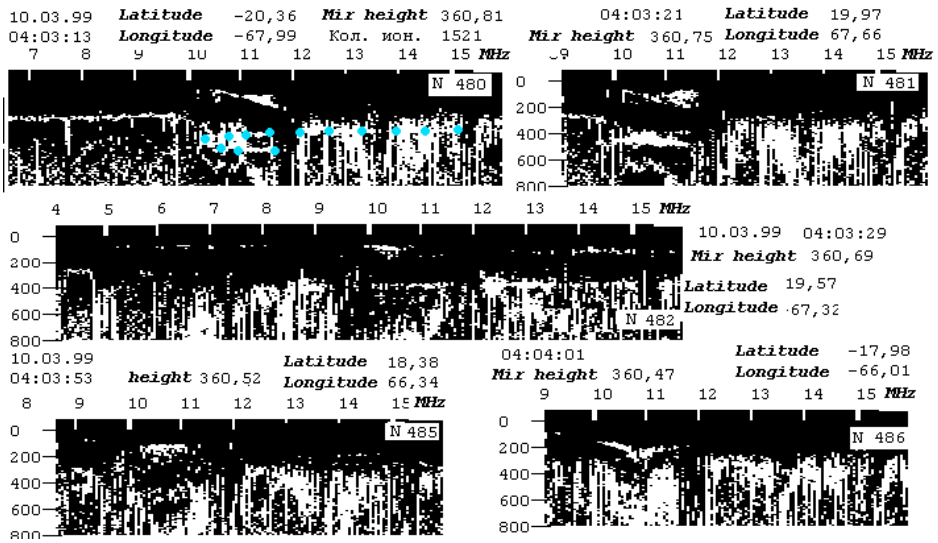

Fig. 2.

One can see that the upper track appears (frame 480) in the conditions when the station is below the F layer maximum height. It is evident from the lower track which is also distinctly seen in this ionogram. Further on it "develops" (frame

482) and covers a vast region of the sounding frequencies (from 5 to 16 MHz), the reflection density being lower than in the previous figure. In the frame 486 one can see again a group delay and therefore the end of the phenomenon.
Other characteristic case of these structures in a southern hemisphere is shown in Fig.2.

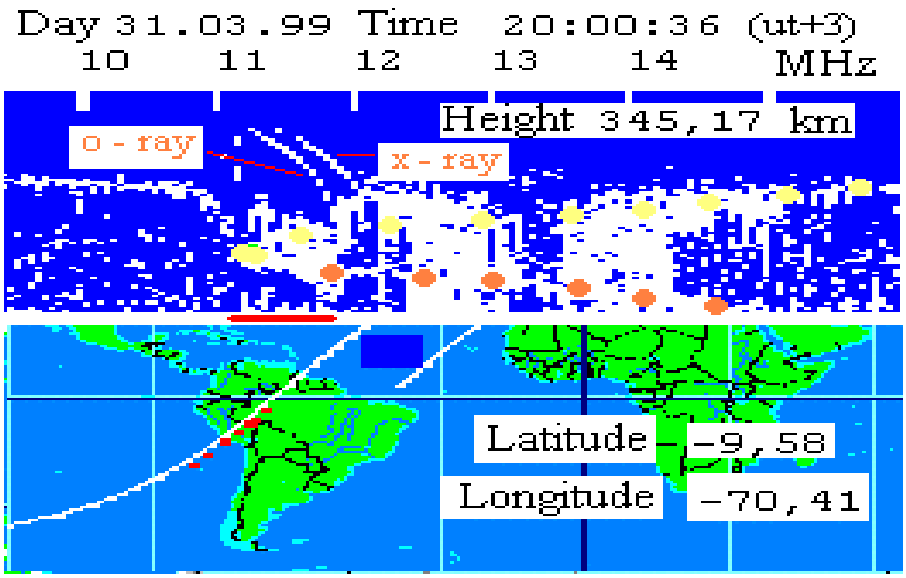

Fig. 2.

The station is on the 345.17 km height in a point with geographical coordinates and time, which are shown on Figure. The disposition of station on a height is specified to within 10 m. It means, what exactly with such exactitude is known a height, concerning which the plasma frequency near to station is determined.
The station is below than height of the ionospheric maximum. It is well visible on an incongruity of a critical frequency of the F2 layer, defined on to a reflection from ionosphere and the least frequency of sounding of vertical radio waves, which were reflected from the Earth. This segment of plasma ionosphere frequencies is shown on a figure by red feature. A reflection from the Earth of a vertical ray (as against a figure 1, where the ionograms is in a natural aspect) specially is highlighted by yellow points. The oblique reflection from the Earth and heterogeneity is highlighted by red points.

Summary:
The long existence of steady reflections from the sited irregularity shows, that the found out structure is a steady ionosphere cloud of the increased electronic concentration of global sizes and time of existence not less than hour.

References
[1]. N. P. Danilkin. “The Results of the satellite radio sounding of the ionosphere below the F -layer maximum,” *J. Geomagn. Aeron.*, Vol. 2, No. 3, pp. 173-180, 2001.
[2] Danilkin N. P. and N. G. Kotonaeva. “Quantitative explanation of the satellite ionograms taken within the F 2-layer maximum,” *J. Geomagn. Aeron*., “in press”.