SUN, SOLAR SYSTEM AND ASTROBIOLOGY

DYNAMIC CHARACTERISTICS OF THE MAIN INDEXES OF SPACE WEATHER AND THEIR APPLICATION TO THE ANALYSIS MONITORING OBSERVATIONS FLUX DENSITIES OF POWER RADIO SOURCES ON RT «URAN-4»

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ABSTRACT. On radio telescope "URAN-4" of the Odessa observatory of Radio-astronomical Institute during twenty five years (since 1987 till present) monitoring of power galactic and extragalactic radio sources on frequencies 25 and 20MHz has been carried out. Data of the observation was spent in a current of the 22-23th cycles of solar activity and in the beginning of the 24th cycle. Long-term variations density fluxes of radio sources connection with change of a condition of ionosphere in a cycle of solar activity are considered. Means Fourier and Wavelet analysis determine dynamics of changes of the main indexes of space weather and the basic periods of activity are revealed. The obtained data will be used for interpretation of the observation changes flux of radio sources for during all investigated cycle of activity and periods of extreme developments of space weather.

Introduction

The program monitoring fluxes of power galactic and extragalactic sources on radio telescope «URAN-4» began in 1987.. The monitoring program includes investigation variation flux densities cosmic radio sources: Cas A (3C461), Virgo A (3C274), Taurus A (3C144) and Cygnus A (3C405). Observations of variation flux densities were conducted in directs ± 2 hours before and after the culmination of sources. In these directions the method is supplied at high values of the effective area the antenna of the radio telescope. The propagation time of radio sources 3C144, 3C274, 3C405 through the directional antenna beam made 40 minutes, for a radio source 3C461 – 60 minutes. As a whole the every day's general time of diurnal monitoring exceeded 13 hours. Processes in the upper atmosphere of the Earth it were investigated determined by a method «examine» radiation by a radio source. As a result of observations essential variations in level of radiation sources flow are marked. These changes are called by the phenomena and processes which characterize solar and geomagnetic activity. Thus, investigating data received as a result of monitoring of radio sources fluxes can be determined a degree and character of space weather influence on the upper atmosphere of the Earth.

Observational data

Results of data processing of observations cosmic of radio sources 3C144, 3C274, 3C405, 3C461 on frequency 25MGz, during the period from 1998 to 2005 are considered. In Figure 1 variations of level of a radiation source flux 3C461 in November, 2003, in the high level solar and geomagnetic activity are presented.

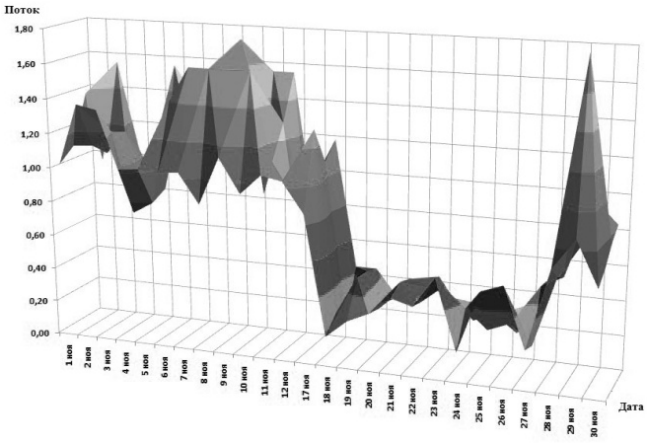

Figure 1: Variations flux densities of a radio source 3C461 on 25 MHz (November, 2003)

During the period of activity which began on November 17th. This day registration long time decrease level flux dencites of a radio source 3C461. In this period on the Sun there were 8 flares; the most high-power is M1.2 and M4.2 on X-ray scale classifications. On November 18th on the Sun disk there were 9 flares with the maximum M3.2, M3.9 and M4.5. The most geoeffective flare occurred on November, 18th which was accompanied by M3.2 and M3.9. The given flare created a large magnetic storm. Impulsive flare M1.7 was observed on November, 19th. On November, 20th the activity period has been continued by flares M9.6/2b and M5.8. From 21 to 23 November were marked flares B9.2, B8.8, C4.3 All these active events became the cause of long decrease flux densities radio sources in interval 17-27 November 2003.

Analyzing long-term variations of radio sources fluxes it is possible to track influence 11-th cycle of solar activity and the local periods by extreme developments of space weather (Fig. 2).

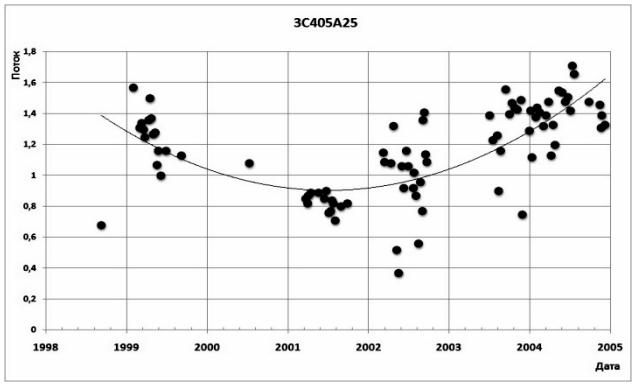

Figure 2: Variations of a radiation source flow 3C461 And 25MHz (November, 2003)

Fourier and Wavelet analysis

For definition of dynamics of changes of the basic indexes of space weather have been conducted them Fourier and Wavelet analysis. Were thus used Ap-index (Ap index characterizing a condition of geomagnetic activity) and F10.7 (Flux of a solar radio emission on a wavelength of 10.7 cm).

To calculation of the basic periods of indexes change of space weather the Fourier analysis has been applied. The analysis was conducted separately for each year of the 23rd cycle of Solar activity therefore 5 leading periods have been recorded in tables 1 and 2, for indexes F-10.6 and Ap, accordingly.

Table 1: The most significant periods of a solar radio emission on a wave of 10.7 sm (days)

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
183.0	13.5	8.9	182.0	366.0	182.0	364.0	21.4	13.6	8.9	6."	26.0
30.5	15.2	19.2	28.0	16.6	8.9	182.0	91.0	26.1	9.1	28.0	9.1
26.1	9.3	364.0	6.5	13.1	5.8	121.3	13.5	61.0	60."	9.1	30.3
13.1	12.6	24.3	8.5	8.9	14.0	91.0	19.5	18.3	121.	4.9	5.3
14.1	182.0	5.3	22.8	4.6	9.6	"2.8	10.4	15.3	364.0	4.4	6.9

Table 2: The Most significant periods of Ap – index (days)

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
26.1	28.0	364.0	26.0	61.0	40.4	182.0	60."	30.5	28.0	"2.8	182.0
183.0	26.0	182.0	121.3	26.1	52.0	91.0	30.3	61.0	30.3	".9	364.0
15.9	36.4	121.3	182.0	183.0	121.3	19.2	14.0	26.1	24."	6.2	121.3
122.0	40.4	91.0	18.2	28.2	15.2	22.8	15.6	36.6	14.0	8.5	30.3
366.0	24.3	"2.8	28.0	"3.2	20.2	"2.8	364.0	28.2	45.5	6.5	26.0

Thus as much as possible significant there were such periods variability of indexes :

F10.7 – 182 days, 28 days.

Ap – : 182 days, 26 days, 14 days, 8 days.

To data retrieval about spectral-space characteristics of a signal on all temporary number it was applied Wavelet the analysis. Wavelet the analysis supplies obtaining of data on presence of the basic periods and time of their existence.

As a result of such analysis time-and-frequency Wavelet a spectrum of energy density distribution has been constructed (Fig. 3).

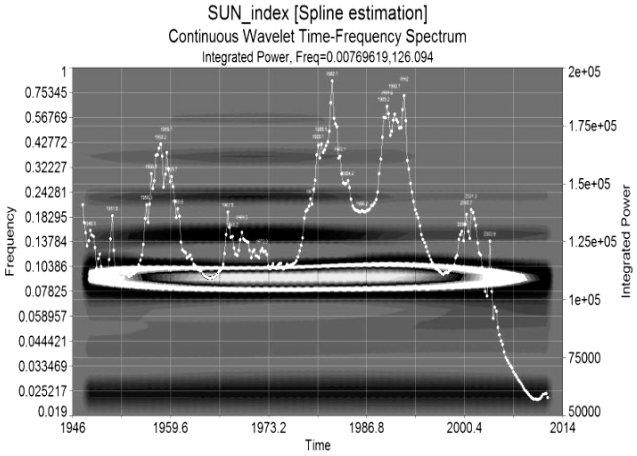

Figure 3: Time-and-frequency Wavelet spectrum of energy density distribution (f10.7)

On this spectrum the 11th year-old period which is the most intensive is essentially allocated. For a trend exception, has been calculated time-and-frequency Wavelet a spectrum for data with the filtered eleven-year period (figure 4). As a result of such analysis maxima of spectral activity. The following stage began to track, what basic periods make them. In figure 5 are shown 3 basic spectral maxima of the 23rd cycle of solar activity. The given maxima are formed by the long-period processes, corresponding to the periods: 575 days, 370 days.

The same procedure has been conducted for the Ap geomagnetic index. At the first stage the time-and-frequency spectrum for an initial number of data (figure 6) has been constructed, and then the basic period present on all time intervals about 5 years (figure 7) has been subtracted. Thus, long-period processes (the periods – 627 days and 374 days) and short-period processes (the periods – 53 days, 19 days and 13 days), shown on figure 8 have been determined.

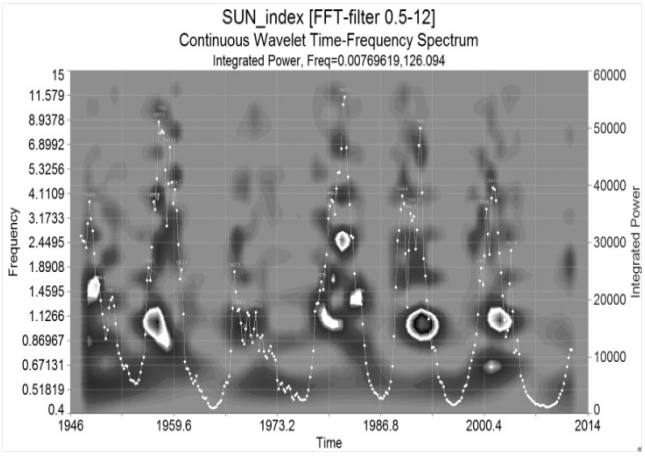

Figure 4: Time-and-frequency Wavelet spectrum of energy density distribution with a deduction of the 11th year period (F10.7)

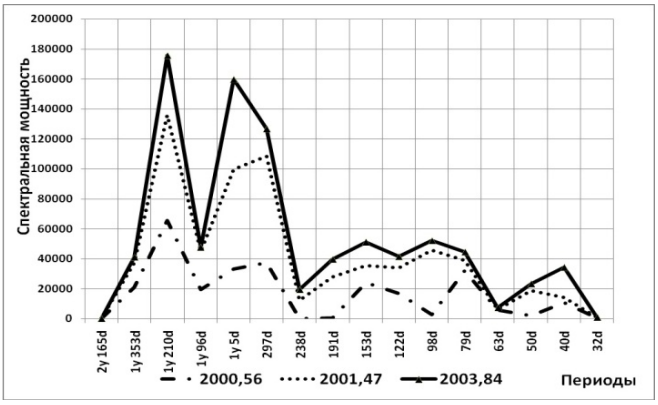

Figure 5: Spectrum of periods index F10.6

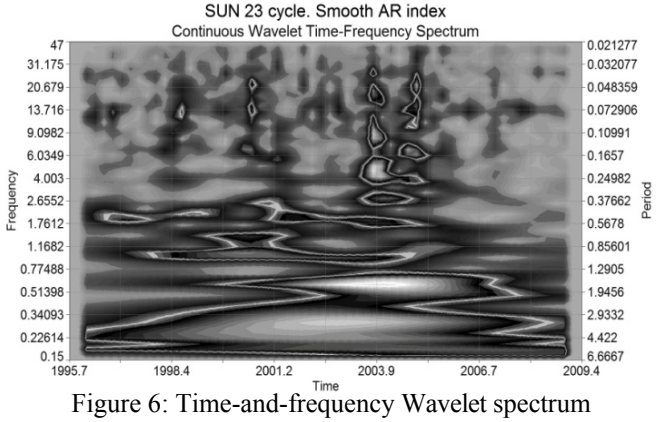

Figure 6: Time-and-frequency Wavelet spectrum of energy density distribution (Ap- index)

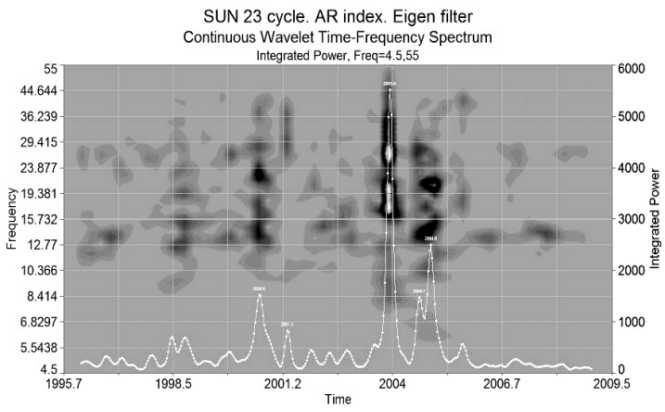

Figure 7: Time-and-frequency Wavelet spectrum of energy density distribution (Ap-index)

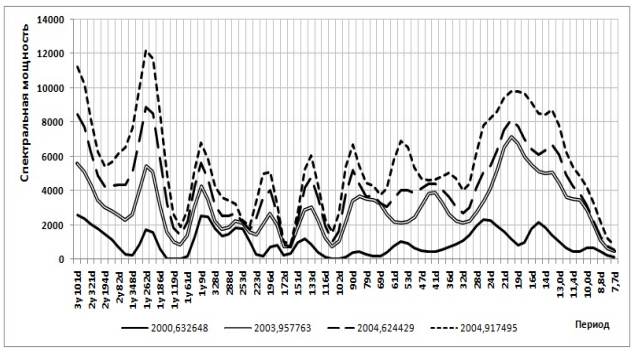

Figure 8: Basic spectral maxima of an Ap-index

Conclusions

1. While using the monitoring of flux densities power cosmic sources observations on radio telescope "URAN-4" allows to "examine" all upper atmosphere of the Earth and determines integrated effect of exhibiting solar and geomagnetic activity. The same results cannot be received by means of land radio physical and radar methods.

2. On results of construction Fourier of spectra the basic periods on each year the 23th cycles have been revealed.

For index F 10.7 the periods – 182 days and 28 days are received. For Ap-index – 182 days, 26 days, 14 days, 8 days.

3. By means of application of Wavelet analysis a detailed information on the periods, making the most intensive phases of activity have been received more.

For index F 10.6 the periods are found out: 575 days, 370 days. For Ap-index: 627 days, 374 days (long-period processes) and 53 days, 19 days, 13 days (short-period processes).