

# SEASONAL VARIATIONS OF THE IONOSPHERE SCINTILLATIONS PARAMETERS OBTAINED FROM THE LONG OBSERVATIONS OF THE POWER COSMIC RADIO SOURCES AT THE DECAMETER WAVE RANGE

O. A. Lytvynenko, S. K. Panishko

Observatory URAN-4, Institute of Radio Astronomy NASU  
Pushkinskaya str., 37, Odessa, 65125, Ukraine, spanishko@ukr.net

**ABSTRACT.** Observations of the four power cosmic radio sources were carried out on the radio telescope (RT) URAN-4 during 1987-1990 and 1998-2007 at the frequencies 20 and 25 MHz. Effects of ionosphere and in particular existence of intensity fluctuations on the cosmic radio sources records, or scintillations, are essential at the decameter wave range. Long series of the ionosphere scintillations parameters such as indices, periods and spectrum slopes were obtained after observation data proceeding. Behavior of the seasonal variations was investigated on this data. Obtained dependencies were compared with the indices of the solar and geomagnetic activity.

**Keywords:** radio sources: ionosphere scintillations, seasonal dependence

## 1. Introduction

Ionosphere scintillations are essential effect during observations in the decameter range of the radio waves. Long series of the ionosphere scintillations parameters such as indices, characteristic times (periods) and spectrum slopes of the signal from source might be obtained after processing of long standing measurements of discrete cosmic radio sources records. Previous investigations of the scintillation parameters time variations were showed an existence of the year cycle or seasonal-daily dependence in parameter's behavior (Kravetz et al., 2004; Panishko et al., 2008). This behavior is very variability on the small time intervals because intensity fluctuations (scintillations) are arises in such variable medium as ionosphere. Monthly meaning is the most optimum interval for studying of the scintillation parameter long time variations. The aim of this work is investigation of ionosphere scintillation parameter behavior on the base of the long measurement series.

## 2. Observations

The index, period and spectrum slope values of the ionosphere scintillations were calculated by processing of the four power radio source (3C144, 3C274, 3C405, 3C461) records, which were obtained on the radio telescope URAN-4 during 1987-1990 and 1998-2007 at the frequencies 20 and 25 MHz. Processing method was presented in the work (Derevyagin et al., 2005). Observations that carried out during 1987-1990 were

registered on the paper tape of recorder and processed by manual manner. The spectrum calculating do not carried out in this case therefore only scintillation index and period data are available. Time interval 1998-2007 was decided to 1998-2002 and 2003-2007 because the long data interruption was in the beginning 2003 on the technique reasons. The monthly mean values of studying parameters were obtained from initial data.

## 3. Results and their discussion

The ionosphere scintillation index data would considered in this work. Monthly mean values of scintillation indices  $SI$  for interval 1987-2007 at frequencies 20 and 25 MHz are plotted in the Fig. 1. The long time variations are remarkable in a behavior of the values  $SI$ , which corresponds previously observed seasonal-daily dependence. Others scintillation parameters – periods and spectrum slopes – are showed similar behavior but do not considered here because paper volume is limited.

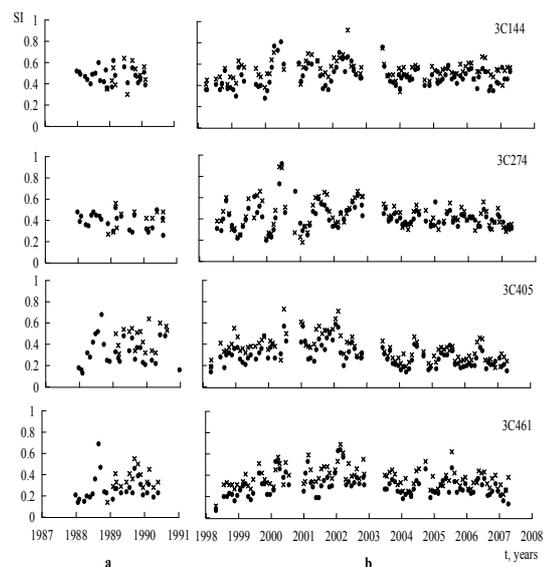


Figure 1: Monthly mean values of the ionosphere scintillation indices for 4-th radio sources: a – for time interval 1987-1990; b – for 1998-2007. Here and further crosses are marked values obtained at frequency 20 MHz, circles – at 25 MHz.

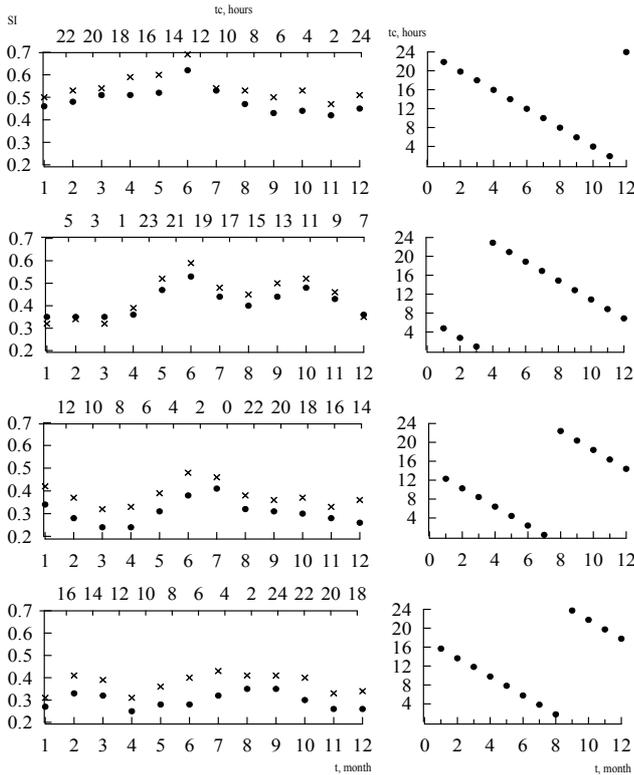


Figure 2: Scintillation indices for 4-th radio sources and 2-th frequencies meaning during month interval for all years observed. On the top axe are showed radio source culmination times for middle of the month. On the right: changing of the culmination time during year

Table 1: Correlation coefficients between data series at two frequencies

Years	1987-1990	1998-2002	2003-2007
Source			
3C144	0.84	0.77	0.99
3C274	0.51	0.69	0.53
3C405	0.40	0.79	0.73
3C461	0.34	0.87	0.71

It can be note that this is sufficient coincidence between scintillation index data on two frequencies. Corresponding values of the correlation coefficients are presented in Table 1. This result demonstrates similar conditions in which ionosphere scintillations arises at two frequencies.

The values meaning during the month intervals for all scintillation index data considered are presented in the Fig. 2. It can be seen that behavior of the index *SI* is similar at two frequencies but different for radio sources. If compared graphics in the Fig. 2 with contour maps in the Fig. 3 we can see that scintillation index behavior depends on that how culmination time of the radio sources change during the year. In general it may be noted that scintillation index maximum values reached in June-August and October and minimum values – in March-April, August-September and November.

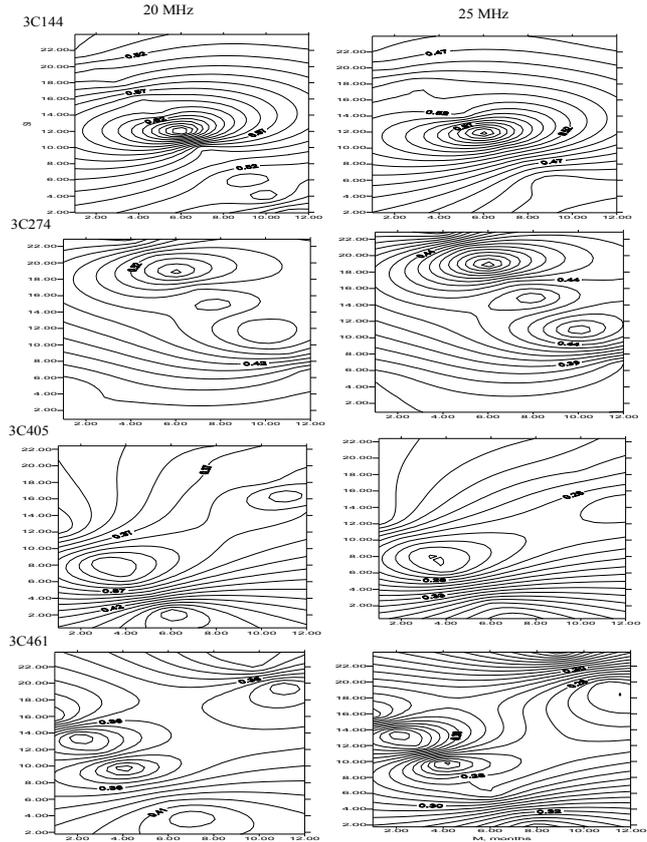


Figure 3: Contour graphics of scintillation index dependence on month of year and radio source culmination time

Besides year cycle scintillation indices are showed long time trend which caused by influence of the solar activity cycle. For second and third observation time intervals the low frequency part was distinguished by fitting of the second order polynomial function. Such procedure was fulfilled for the monthly mean of solar and geomagnetic indices – number of solar spots, radio flux at the frequency 10 cm and *Ap*-index. In result we obtained those values of the correlation indices between low frequency part of scintillation indices dependence and solar and geomagnetic index behavior change in following limits with:

- a) number of solar spots: 0.38-0.99;
- b) radio flux at the frequency 10 cm: 0.39-0.99;
- c) geomagnetic index *Ap*: 0.46-0.96.

It's sufficiently high means and confirmed the connection with solar activity.

#### 4. Conclusions

Investigations of the ionosphere scintillation index seasonal dependence were carried out for 4-th power cosmic radio sources at two frequencies in the decameter wave range. Following results were obtained.

Previously known seasonal-daily dependence in behavior of the scintillation index monthly mean of the 4-th power discrete cosmic radio sources at the

frequencies 20 and 25 MHz was confirmed for a long time interval of data.

It was established that scintillation index series at the two frequencies of the decameter range of radio waves have sufficiently good correlation.

It was investigated that the type of changing of scintillation index behavior during season and daily depended on that how culmination time of the radio source change during year.

Low frequency part of ionosphere index dependence has sufficiently high values of the correlation coefficients with solar number spots, radio flux at the frequency 10 cm and geomagnetic Ap-index.

## References

- Kravetz R.O. et al: 2004, *Odessa Astron. Publ.*, **17**, 42.  
Panishko S.K. et al.: 2008, *Radiofizika i Radioastronomiya*, **13**, S130 (in russian).  
Derevyagin V.G. et al.: 2005, *Astron. and Astrophys. Trans.*, **91**, 421.