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Research of cosmic rays' variations in july-august 2016 with use of data of the carpet detector

Abstract. The paper reviews the CARPET cosmic ray detector placed into operation at physics and technical faculty of Eurasian National University in 2016. Observation data of the detector provide opportunity of researching nature of cosmic rays induced by processes on the Sun within interplanetary medium and earth's magnetosphere for different time intervals. It also considers results of analysis of cosmic rays' variations and solar flare activity in the period of July-August 2016 taken on the basis of the detector's experimental data, information of neutron monitor network and parameters of solar and geomagnetic activity. The dynamics of experimental data is considered.
Key words: cosmic ray, detector, telescope, astronomic complex, solar activity, secondary cosmic ray.

Introduction

In 2016 at physics and technical faculty of Eurasian National University named after L.N. Gumilyov (Astana, Kazakhstan, 51°10′48″ S, 71°26′45″ W; geomagnetic cutoff rigidity Rc~2,5GV), the first part of integrated unit for measuring flux density of general ionizing component of secondary cosmic rays - the CARPET detector - has been put into operation.

The detector [1] was designed and created in Physical Institute of Academy of sciences named after P.N. Lebedev in the framework of agreement on international cooperation between PIAS(Russia) and ENU (Kazakhstan).

The CARPET cosmic ray detector is designed for continuous monitoring of general ionizing component of secondary cosmic rays flux at the level of the Earth. Experimental data allow conducting analysis of secondary cosmic rays fluxes' variations, analyzing influence of geomagnetic and solar activity on the processes defining behavior of cosmic rays in near-Earth space and Earth's atmosphere, carrying-out monitoring of its radiation situation.

In 2006 prototypes of the detector CARPET/ASTANA – CARPET/CASLEO were installed in astronomical complex of CASLEO (Argentina), in 2009 CARPET/GCR was installed in European Nuclear Research Center (at Geneva, Switzerland) [2-4].

In the present work there are results of cosmic rays' variations within the period of July-August 2016 on experimental data of CARPET/ASTANA detector.

Experimental device and measured methods

The CARPET cosmic ray detector is the unit of 120 gas-discharged STS-6 counters mounted in vertical blocks (telescopes) located on metal platform. Each block consists of 10 counters and 7mm. aluminum filter that separates horizontal layer of upper counters (5 pieces) and lower counters (5 pieces). The filter absorbs all low-energetic particles (radioactivity) and passes only energetic particles of cosmic rays. The general view of the unit is shown in Figure 1.

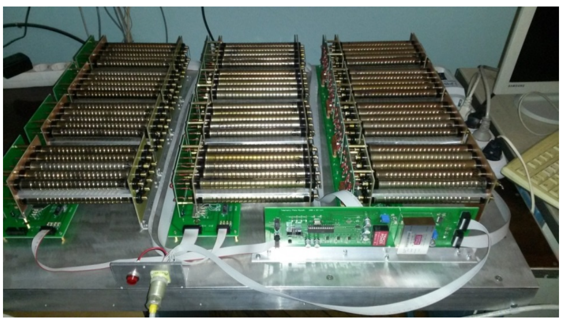


Figure 1 – General view of the CARPET cosmic ray detector

 Printed in Kazakhstan

The CARPET detector is the integral register-summator of charged particles' flux: it counts and accumulates impulses from the flux of flying charged particles in the entire area of the device. The detector consists of 2 detecting vertical modules united with registering and summarizing electronics. The two-detector module – «telescope» - possesses upper and lower gas-discharged counters. The summarizing electronics of CARPET registers and accumulates impulses from the telescopes in such a way that:

– all the impulses from upper counters of all CARPET telescopes are summarized in the counter of 1st channel (data channel CH1);

– all the impulses from lower counters of all CARPET telescopes are summarized in the counter of 2nd channel (CH2 - channel);

– all the coincidences of simultaneous actuations of upper and lower counters of any telescope are summarized in the counter of 3rd channel(channel TEL). All the counters are placed into single rectangular-shaped case.

In table 1 there are energetic characteristics of charged particles' flux registration.

Table 1 – Registration ranges for charged particles of counter-telescope on the basis of STS-6 gas-discharged counter

	SinglecounterCTC-6 (CH1 andCH2 -channels)	Counter-telescope CTC-6 (TEL – channel)
electrons	>=0.2 MeV	>=5 MeV
protons	>=5 MeV	>=30 MeV

The CARPET detector consists of own detecting module described above, module of calculating and interfacing electronics and a computer.

All the interactions with the detector are performed by PC program via single standard serial communication port RS-232. The program of the detector performs full control for strokes of continuous fully-automatic experiment, including visualization of experiment's stroke on the screen of control PC.

The device logs time (milliseconds) of particle registration in data channel, the reference point is 00:00:00 of every day.

The CARPET complex includes telemetering sensors (temperature, pressure, voltage parameters U- 5V, 12V, 380V).

It also performs recalculation of data corrected to temperature and barometric effect with account of complex telemetering data.

Measurement data is logged, processed and recorded with help of specialized software. At the end of each day it forms two files: the file of particle registration data by three channels and the telemetering data file.

For processing of experimental data the CARPET detector uses a package of programs realized in R environment. At the current time the R language is in fact being a standard in the area of statistic data analysis[5].

The program pack includes:

a) pre-processing of experimental data:

– uploading and conversion of data into the system;

– data analysis – emissions, missing values, normality of distribution, etc.;

– standardization of experimental data;

b) Experimental data base formation (daily, monthly, annual);

c) Experimental data analysis;

d) visualization of obtained results (tables, diagrams, statistical values, etc.).

In figure 2 there is temporal variation of general ionizing component of secondary cosmic rays flux in three channels of the CARPET detector as on July 2016. The time of data integrator (accumulation) is 1 min.

In figure 3 there is dynamics of deviations in three channels of the CARPET detector (as on July 2016).

As opposed to land neutron monitors the CARPET detector is sensitive to low energetic charged secondary component of cosmic rays formed by primary galactic and solar cosmic rays in Earth's atmosphere.

In figure 4 there is temporal variation of data of telescope and neutron monitor in Almaty as on July 2016.

In figure 6 (a,b,c) there is temporal variation of general ionizing component of secondary cosmic rays flux in three channels of the CARPET detector as on July-September 2016 and the dynamics of variation of K-index - the geomagnetic activity [6].

In figure 5 there is temporal variation of data of counter and neutron monitor in Almaty as on July 2016.

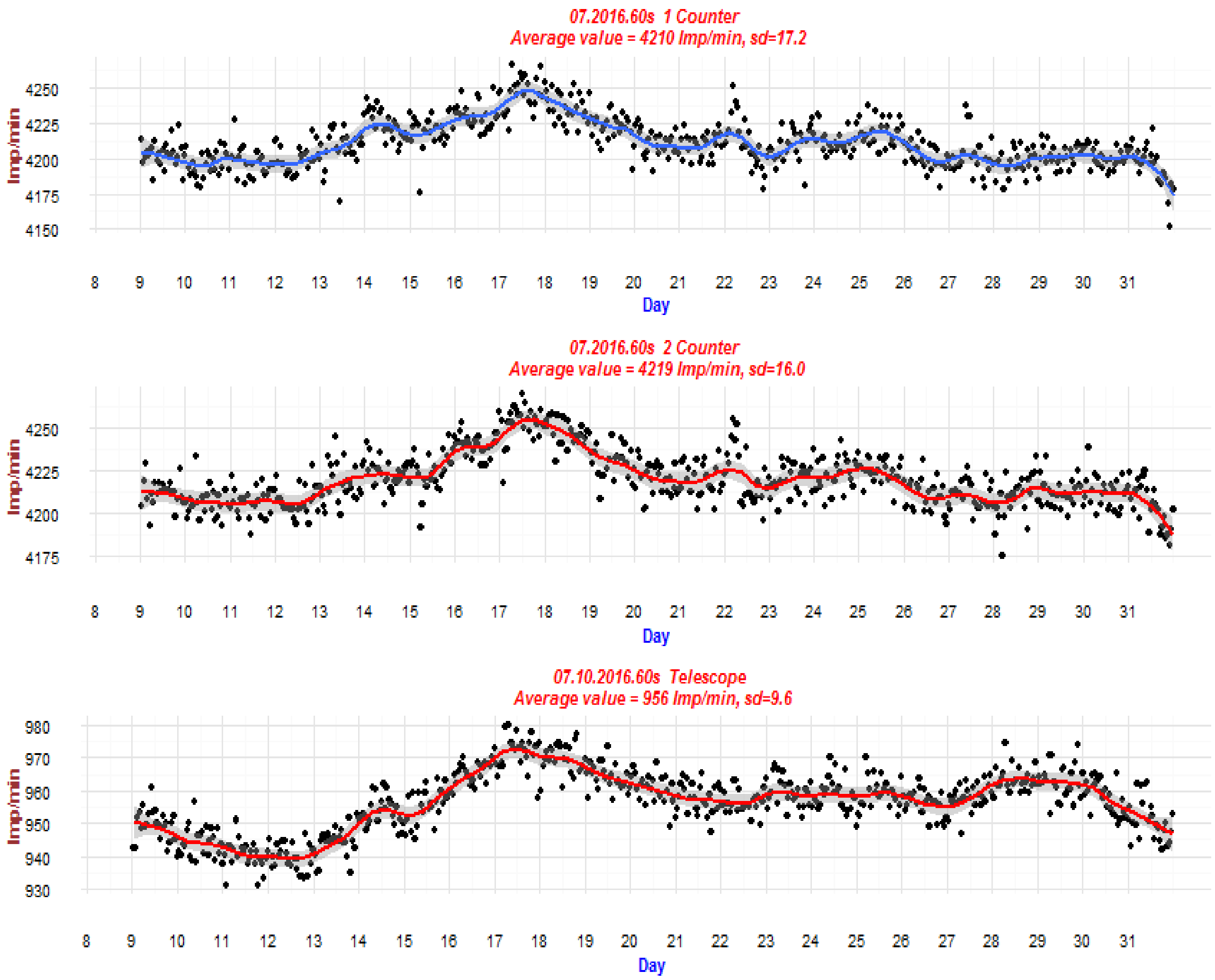


Figure 2 – Temporal variation of general ionizing component of secondary cosmic rays flux in three channels of the CARPET detector as on July 2016

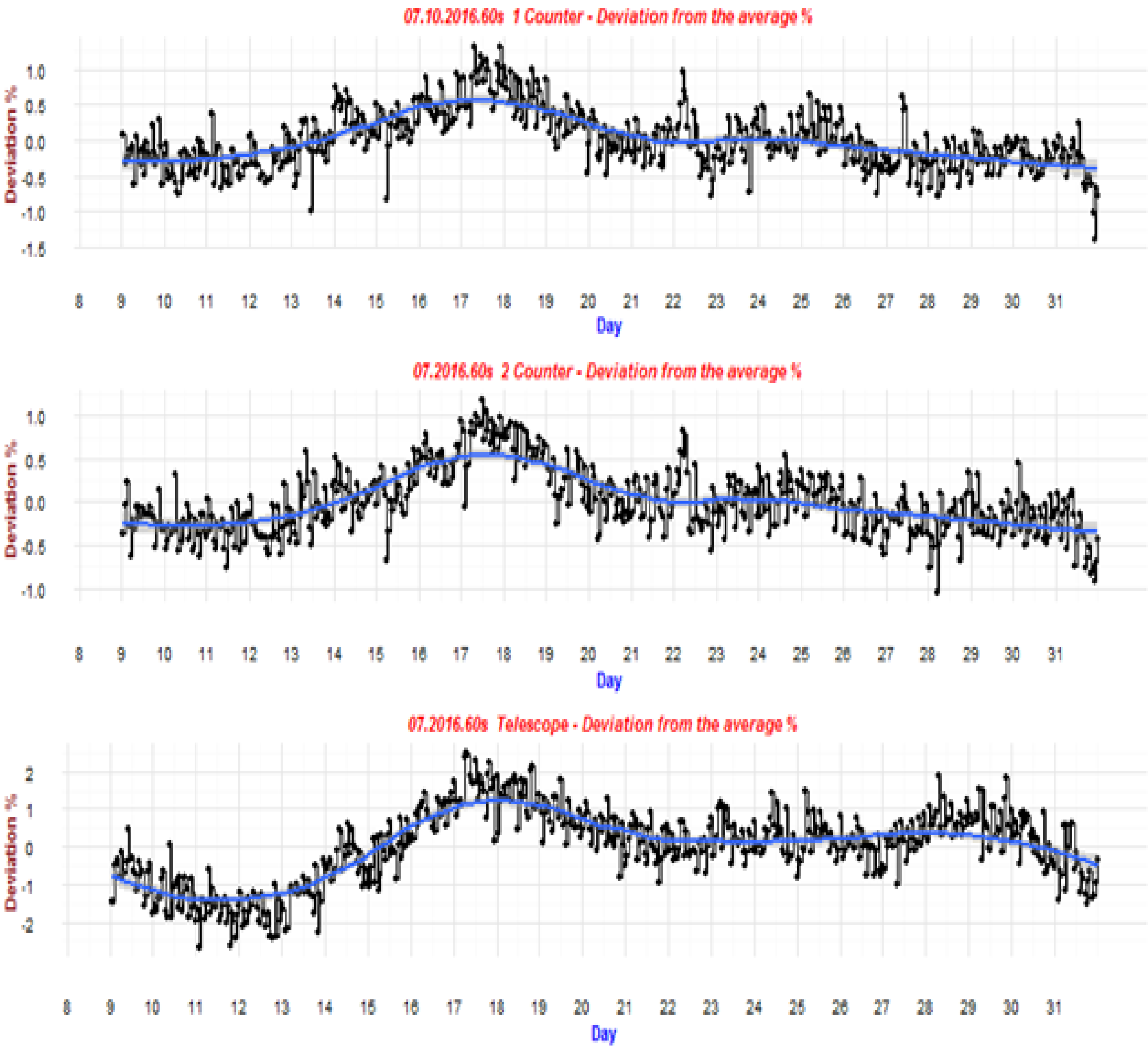


Figure 3 – Dynamics of deviations in three channels of the CARPET detector as on July 2016

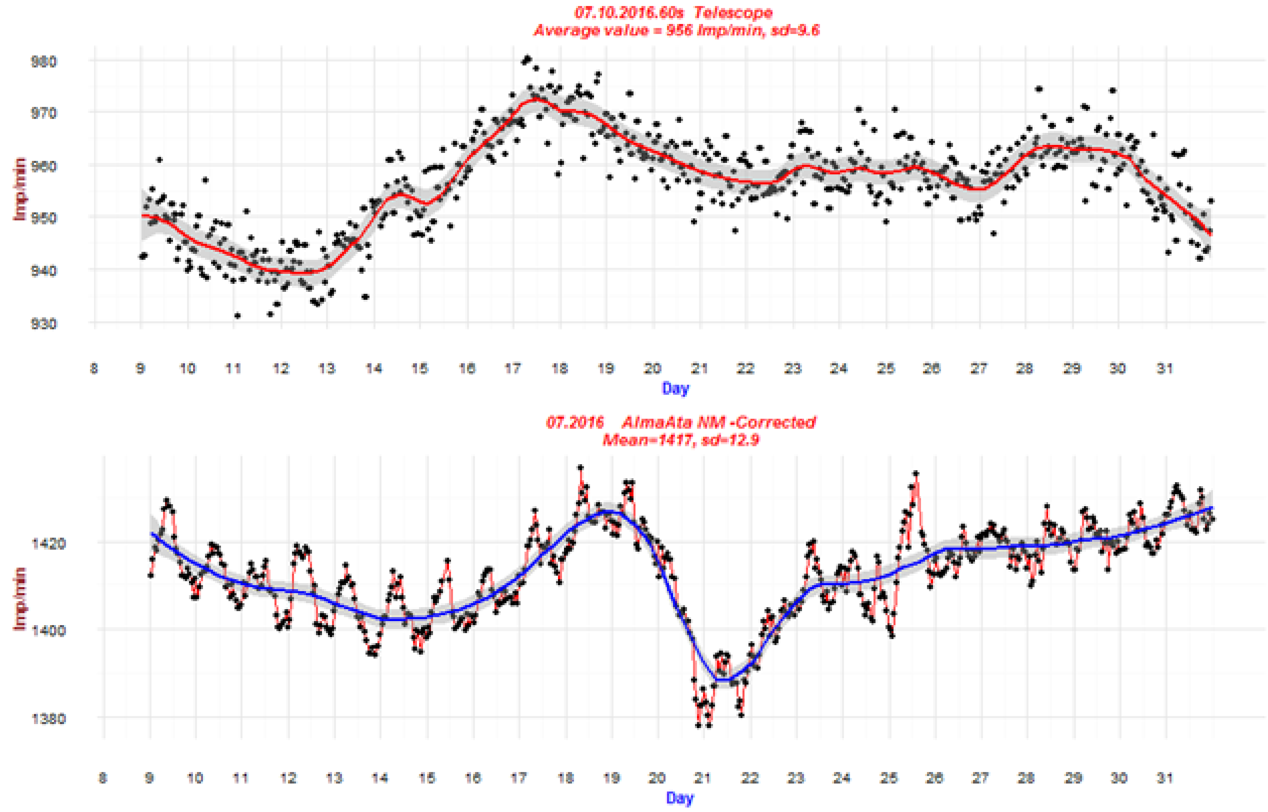


Figure 4 – Temporal variation of data of telescope and neutron monitor in Almaty (July 2016)

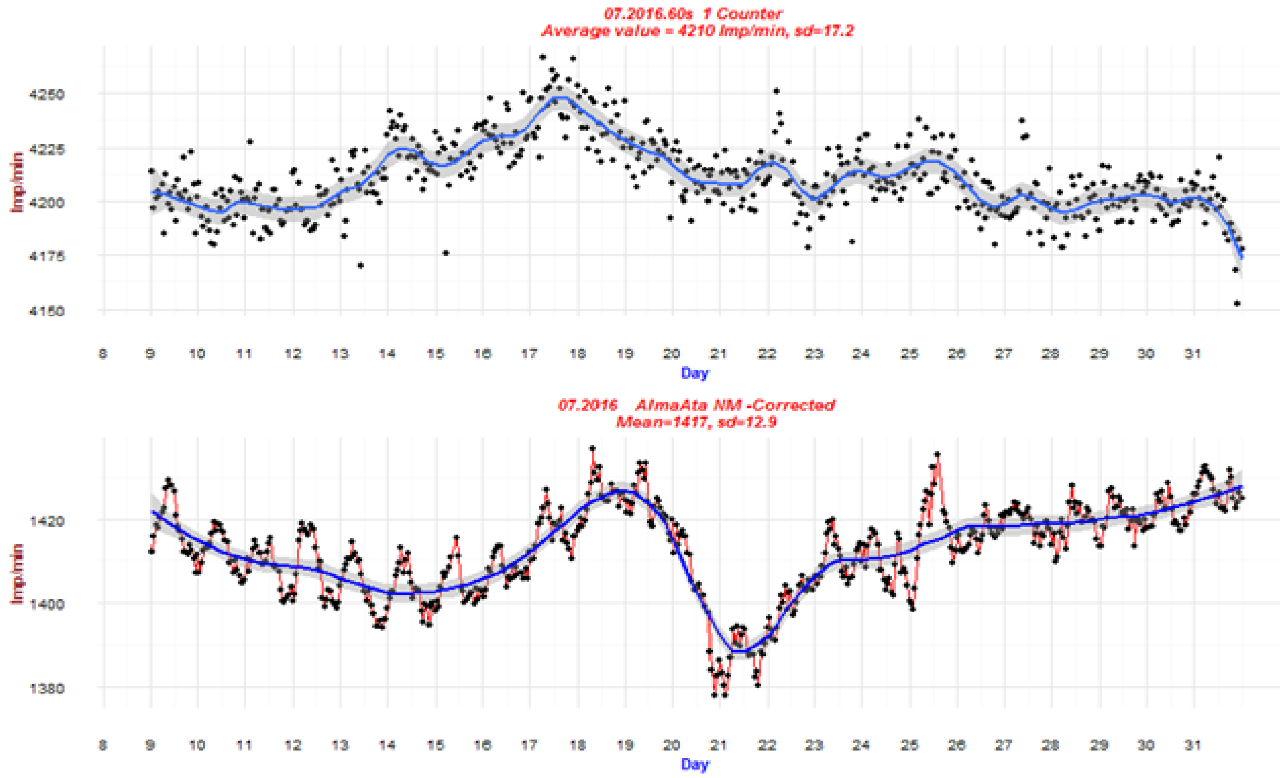
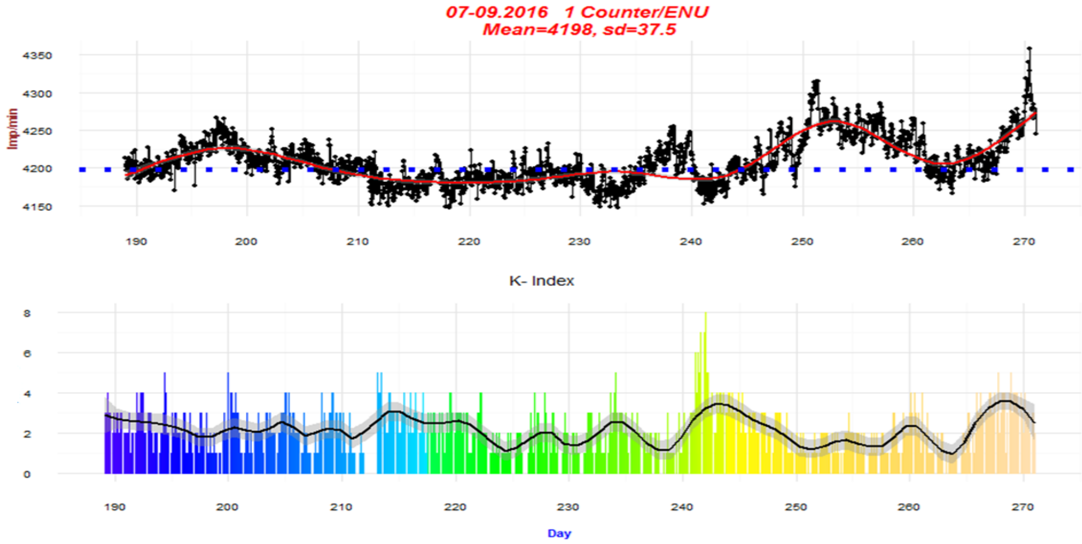
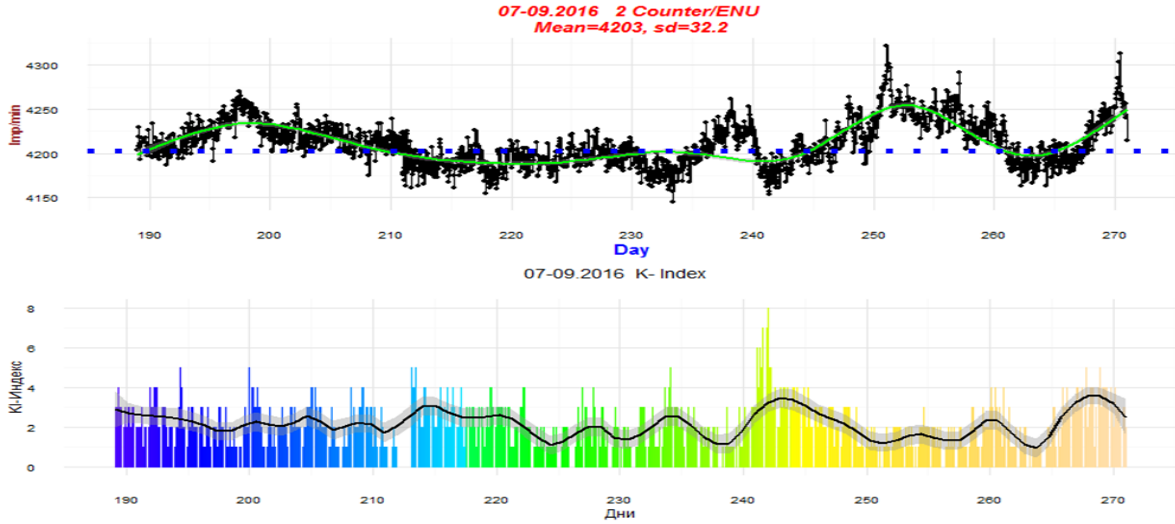


Figure 5 – Temporal variation of data of counter and neutron monitor in Almaty (July 2016)



a)



b)

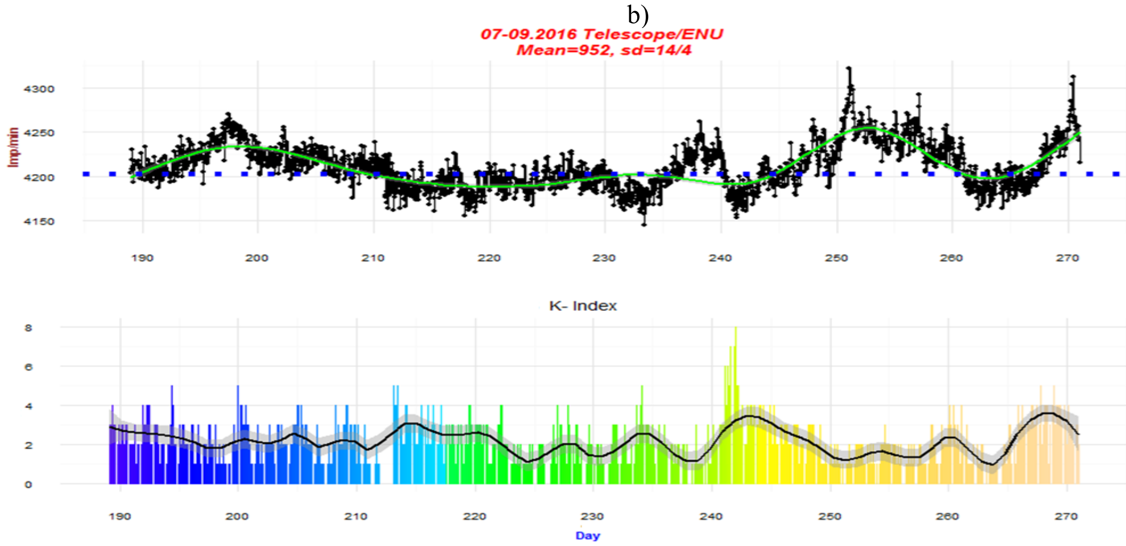


Figure 6 – Temporal variation of general ionizing component of secondary cosmic rays flux in three channels of the CARPET detector and the dynamics of variation of K-index - the geomagnetic activity

Experimental data of secondary cosmic rays of the CARPET detector provides researching wide time spectrum of variations of secondary cosmic rays - the short-term ones (Forbush decreases, solar flares, etc.) and long-term ones (27-day, 11-year, 22-year, etc.).

In figures 7-8 there are measurements of counting rate in TEL channel of the CARPET device and the data of land neutron monitors (NM Data Base – NMDB) in Almaty and Yakutsk.

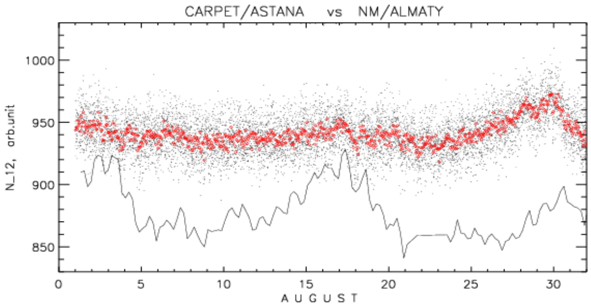


Figure 7 – Counting rate in TEL channel of the CARPET detector and neutron monitor of Almaty as on 2016

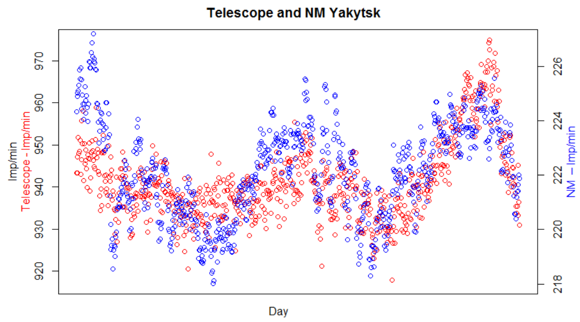


Figure 8 – Counting rate in TEL channel of the CARPET detector and neutron monitor of Yakutsk.

Conclusions

In the paper there is a review of the CARPET cosmic ray detector that has been put into operation at physics and technical faculty of Eurasian National University named after L.N.Gumilyov in 2016 within the framework of scientific project. The dynamics of experimental data is considered.

Acknowledgment

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References

1. Mizin S.V., Makhmutov V.S., Maksumov O.S.// Kratk. Soobshch.Fiz. – 2011. – Vol.2. – P. 9-17.

2. http://www.casleo.gov.ar

3. Kirkby J. et.al. Role of sulphuric acid, ammonial and galactic cosmic rays in atmospheric aerosol nucleation // Nature.– 2011. – Vol. 476. – P. 429-1409.

4. De Mendonça R.R., Raulin J.-P., Bertoni F.C.P. Echer E., Makhmutov V.S., Fernandez G. Long-term and transient time variation of cosmic ray fluxes detected in Argentina by CARPET cosmic ray detector // J. Atmos. Solar-Terrestr. Phys. – 2011. – Vol. 73. – P. 11–12. – P.1410–1441.

5. R Development Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. – 2009. ISBN 3-900051-07-0.

6. http://www.swpc.noaa.gov / products / planetary-k-index