Journal of the Georgian Geophysical Society, ISSN: 1512-1127
Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v.22(1), 2019, pp. 38 - 45

Study of the Forbush Effect at the Cosmophysical Observatory of Mikheil Nodia Institute of Geophysics According to the Data of the Cosmic Ray Neutron Component

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ABSTRACT

Cosmic ray modulation is a complex process, which includes different physical phenomena in the solar-terrestrial space. At the Cosmophysical Observatory of Mikheil Nodia Institute of Geophysics a constant registration of the neutron component of cosmic rays has been conducted for decades. The article considers 5 cases of Forbush decrease revealed as a result of observing, processing and analyzing the data obtained in 2014-2018 at the observatory. The data of the above period were compared to the data of the stations in Moscow and Irkutsk, which according to the observation data proved the existence of Forbush effect. In our opinion during the above period certain solar flares really took place. Therefore, each separate Forbush effect requires scientific studies for further analysis.

***Key words*:** cosmic rays, Forbush effect, magnetosphere.

The study in the cosmic ray modulation has played a great role in the research of the interplanetary space nature. At the Cosmophysical Observatory of Mikheil Nodia Institute of Geophysics a constant registration of the neutron component of cosmic rays has been conducted for decades [1,2]. Cosmic ray modulation is a complex process and includes different physical phenomena in the solar-terrestrial space [1-6].

The solar control module of the cosmic radiation is generally divided in different types of corresponding time scale variations: 11 years, 27 years, diurnal and Forbush types.

We will touch the Forbush type variations. The first observations on the Forbush decrease were carried out by US physicist Forbush in 1937. The effect considers an instant decrease in the cosmic ray intensity, which is significantly noticeable during a high solar activity. Observations on Forbush decrease effects started from 1838. These effects are commonly characterized with great, asymmetric and instant decrease in cosmic rays, which continues for several days. They are distributed in the whole universe, and consequently they must belong to the great variation of the geomagnetic field or the variation of the interplanetary space magnetic field. The intensity decreases by (1.5-2)% per hour and recovers by (0.02-0.05)% per hour. A whole cycle may take several days [3].

Forbush effect is a geophysical phenomenon, which always takes place when there is a great solar flare. Approximately a day after the solar burst a magnetic disturbance occurs on the Earth. At its beginning a short-term increase in the magnetic field of the Earth – by 0.1% from the normal state (an instant start) is observed. Further the magnetic field tension is decreased by several percent

and this process continues for several hours (the main phase). At the end, during several days, the magnetic field gradually recovers and returns to its normal state [4].

The cosmic rays are observed on by the observatories in different areas of the Earth surface.

During Forbush decrease the intensities of the cosmic rays, like magnetic fields, start to reduce simultaneously and become less by several percent compared to usual, normal conditions. After the restoration of the magnetic field the cosmic ray intensity regains the value conformable to the normal state.

There arises a question: how can we explain a Forbush decrease? Usually, the tension in the magnetic field of the sun is several gausses. In the active solar area, where the flare takes place, the magnetic field is locally intensified. The solar magnetic field causes induction in the electric current of the ionized gas, which flows from the sun. Therefore, the gas becomes an electrical conductor. The current generated in it circulates during the time unless the gas leaves the sun. In their turn, the gases create magnetic field. The solar wind usually also creates a field in the interplanetary space. The plasma ejected during the solar flare, which moves in the direction of the shock wave, i.e., the front, creates a considerably intense field. This intense field forces the cosmic particles out of the solar system that produces a Forbush decrease effect. In case our assumption is correct then Forbush decrease must take place not only near the Earth but in the whole interplanetary space. Indeed, it has been proved by the analyses of the data obtained during spacecraft soundings in distant spaces [1].

The studies of Forbush effects have been actively carried out on the basis of the data of the neutron monitor of cosmic rays in order to analyze the physical processes taking place in the interplanetary space, the atmosphere and magnetosphere of the Earth. The Cosmophysical Observatory of Institute of Geophysics has been continuously recording the neutron component of the cosmic rays for decades [2].

At this stage we will touch the analysis of the data obtained during last 5 years (2014-2018, see Annex). During this time we revealed only 5 periods, when the Forbush decrease effect was clearly manifested. These periods are:

1. June 6-13, 2014;
2. May 20-26, 2015;
3. June 22-30, 2015;
4. July 16-22, 2017;
5. September 7-12, 2017.

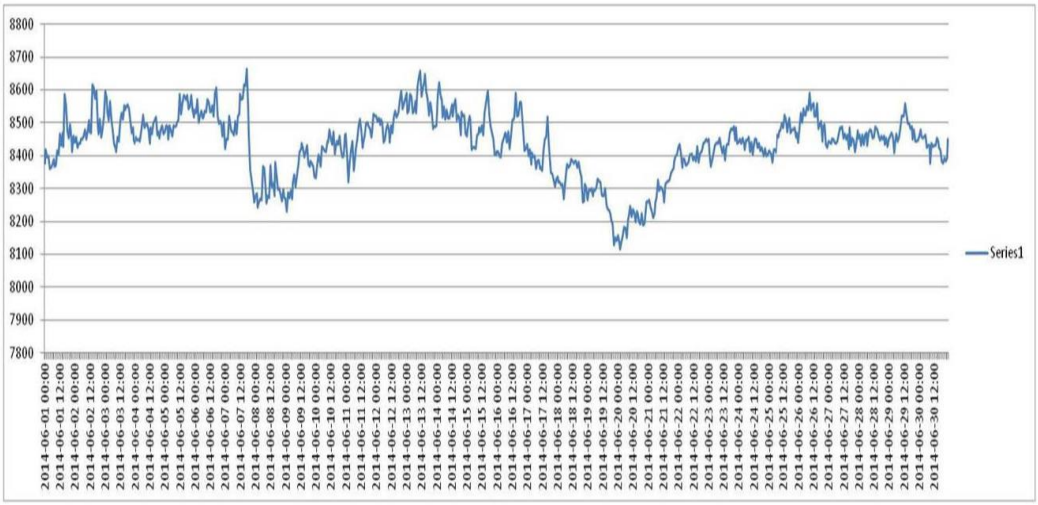
Correspondingly, we present the monthly schemes of all revealed Forbush effects in the article. They clearly show the periods when Forbush decrease effects took place. It will enhance carrying out further scientific researches.

The data of the above periods were compared to the similar neutron monitor data of Moscow and Irkutsk stations. The comparison results show that during the periods observed by us the Forbush decrease effects really took place. This means that during these periods there were solar flares of certain measures, the physical studies and analyses of which are the goals of further scientific researches.

Annex

Variations of intensity of neutron component of galactic cosmic rays
on June 2014, May and June 2015, July and September 2017

June, 2014



June 6-13, 2014

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	8421	8451	8450	8520	8493	8475	8473	8462	8505	8466	8519	8528
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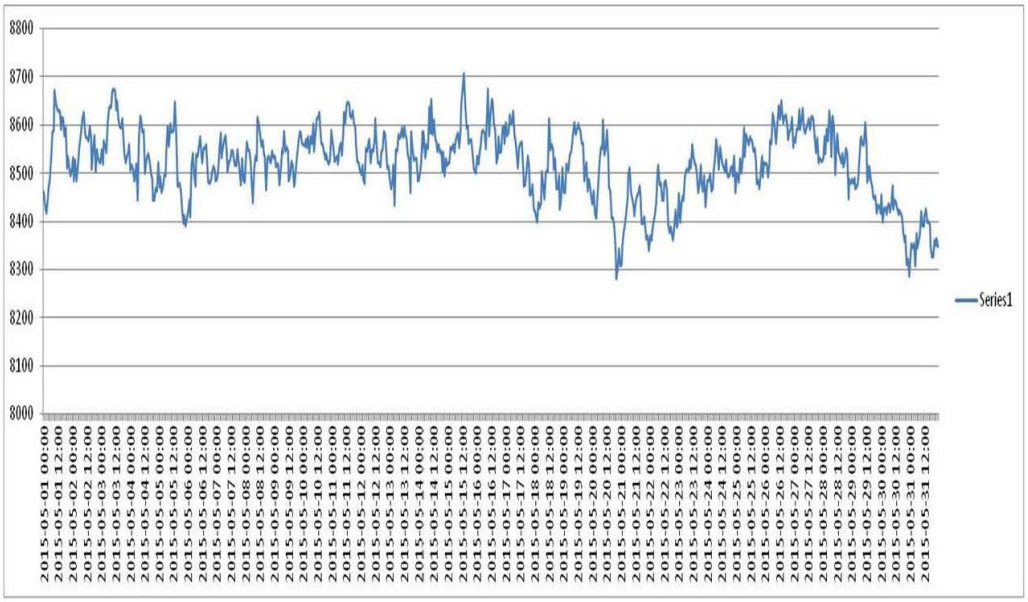
	8580	8605	8626	8649	8593	8570	8524	8562	8533	8481	8489	8489

May, 2015



May 20-26, 2015

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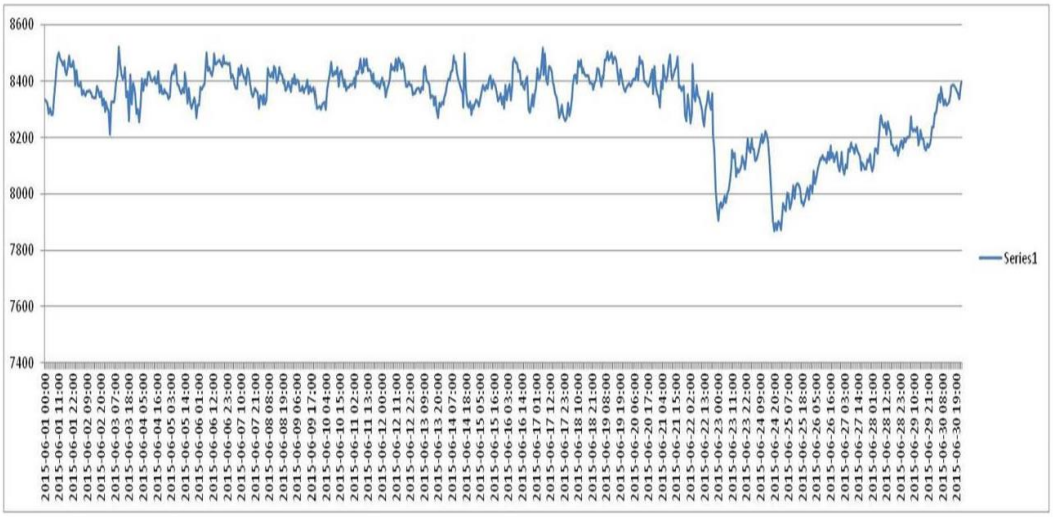
	8614	8649	8628	8605	8618	8621	8597	8571	8586	8591	8615	8553

June, 2015



June 22-30, 2015

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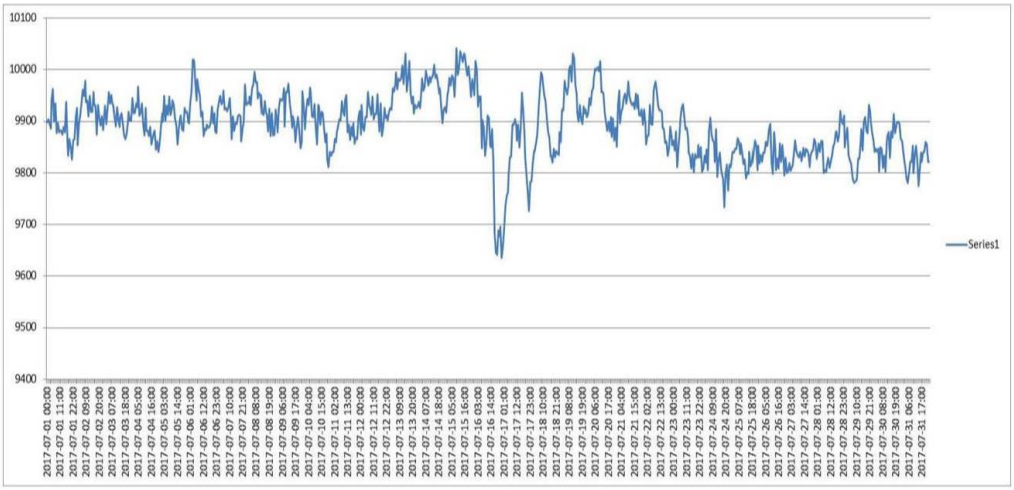
July, 2017



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	9939	9907	9880	9868	9832	9833	9820	9847	9831	9842	9838	9835
19.07.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9879	9860	9922	9921	9978	9963	9952	9970	10001	10008	9977	10031
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	10022	9969	9954	9916	9899	9931	9903	9895	9929	9916	9923	9908
20.07.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9916	9945	9931	9960	9964	9984	10002	9999	10005	9998	10016	9957
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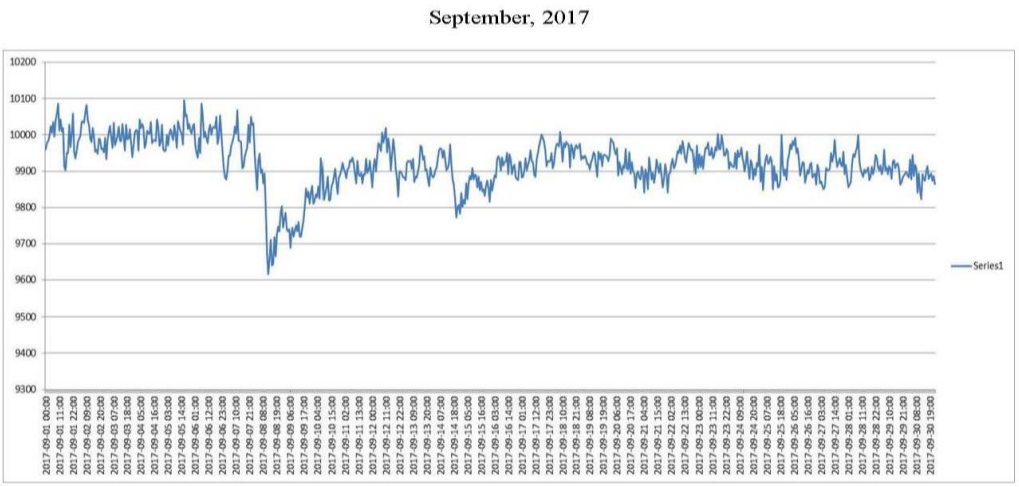
	9956	9953	9917	9900	9881	9900	9880	9908	9870	9905	9862	9887
21.07.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9851	9931	9959	9897	9918	9926	9946	9954	9935	9957	9977	9947
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9938	9931	9936	9924	9953	9926	9950	9912	9911	9922	9894	9922
22.07.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9895	9856	9872	9873	9931	9895	9894	9959	9966	9977	9955	9930
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9921	9921	9919	9888	9885	9858	9861	9834	9847	9889	9872	9854



September 7-12, 2017

07.09.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9908	9882	9877	9905	9943	9943	9969	9981	9993	10022	10005	10067
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9985	9983	9981	9909	9911	9941	9954	9966	10028	9978	10050	10027
08.09.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	10032	9948	9898	9849	9930	9948	9896	9905	9866	9893	9797	9675
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9617	9657	9710	9640	9646	9717	9666	9725	9747	9734	9785	9803
09.09.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9745	9767	9785	9739	9735	9740	9689	9719	9743	9720	9736	9751
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9735	9760	9719	9720	9743	9765	9799	9852	9829	9843	9811	9842
10.09.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9859	9810	9820	9836	9828	9858	9824	9935	9901	9822	9838	9856
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9884	9819	9821	9858	9867	9885	9906	9870	9838	9883	9890	9903
11.09.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9922	9907	9898	9881	9906	9908	9930	9927	9937	9920	9893	9866
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9928	9892	9886	9895	9866	9892	9890	9934	9896	9901	9929	9895
12.09.2017	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**
	9855	9911	9934	9899	9940	9977	9972	9956	10006	9979	9996	10019
	12:00	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**
	9951	9989	9965	9903	9946	9988	9956	9906	9879	9830	9900	9899

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ფორბუშ ეფექტების კვლევა მიხეილ ნოდიას სახ. გეოფიზიკის ინსტიტუტის კოსმოფიზიკურ ობსერვატორიაში, კოსმოსური სხივების ნეიტრონული კომპონენტის მონაცემების საფუძველზე

თ. ბაქრაძე, ი. ტუსკია, ნ. ღლონტი, ტ. ერქომაიშვილი,
ე. ალანია, ზ. ყვავაძე, პ. ბარბაქაძე

რეზიუმე

კოსმოსური სხივების მოდულაცია რთული პროცესია, რომელიც მოიცავს სხვადასხვა ფიზიკურ მოვლენებს მზე-დედამიწის არეში. გეოფიზიკის ინსტიტუტის კოსმოფიზიკურ ობსერვატორიაში უკვე რამოდენიმე ათეული წელია მიმდინარეობს კოსმოსური სხივების ნეიტრონული კომპონენტის უწყვეტი რეგისტრაცია. სტატიაში მოცემულია ჩვენს ობსერვატორიაში 2014-2018 წლების მონაცემებზე დაკვირვების, დამუშავებისა და ანალიზის საფუძველზე გამოვლენილი ფორბუშ დაცემის ეფექტის 5 შემთხვევა. აღნიშნული პერიოდის მონაცემები შედარებულია მოსკოვისა და ირკუცკის სადგურების მონაცემებთან, სადაც დაკვირვების შედეგად იგივე ფორბუშ ეფექტების არსებობა დადგინდა. ჩვენი აზრით, ყველაფერი ეს მიგვანიშნებს იმას, რომ მოცემულ პერიოდებში მზეზე მართლაც ჰქონდა ადგილი გარკვეული სიდიდს აალებებს. შესაბამისად ყოველი ცალკეული ფორბუშ ეფექტი საჭიროებს სამეცნიერო კვლევებს შემდგომი ანალიზის ჩასატარებლად.

Иследование эффекта Форбуша в космофизической обсерватории Института геофизики им. Михаила Нодиа по данным нейтронной компоненты космических лучей

**Т.С. Бакрадзе, И.И. Туския, Н.Я. Глоти, Т.Г. Эркомаишвили,
Э.М. Алания, З.А. Квавадзе, П.А. Барбакадзе**

Резюме

Процесс модуляции космического излучения представляет собой сложное явление, которое включает в себя различные физические события в солнечно-земной области. В космофизической обсерватории Института геофизики уже несколько десятилетий проводится непрерывная регистрация нейтронной компоненти космических лучей. В статье на основании анализа данных 2014-2018 гг. выявлено 5 случаев эффекта Форбуш понижения. Данные за этот период сопоставимы с данными Московской и Иркутской станций, где также наблюдались эффекты Форбуш понижения. На наш взгляд, это указывает на то, что в указанный период на Солнце происходила вспышка, что требует дальнейшего научного исследования и анализа.