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THE GEOMAGNETIC VARIATIONS IN DUSHETI OBSERVATORY JANUARY- JUNE 2013

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Abstract

Georgia is a part of the far-extending seismically active region, which includes the whole Caucasus, Northern parts of Turkey, Bulgaria, etc. These territories witnessed several intense destructive earthquakes. Thus carrying out possible short-term prognosis of earthquakes is very important for the country. The statistic evidence for reliability of the geomagnetic precursor is based on the distributions of the time difference between occurred and predicted earthquakes for the period January-June of 2013 for Dusheti region. Before strong earthquake magnetic precursors denoted by many authors, but must to say, that more of them don't satisfy stern criterions.

For estimation of the geomagnetic variations as reliable precursor it was discovered the specific time analysis for digital definition of Geomagnetic Quake and proposed way for interval defined from the extremum of local tide variations. The method of earthquake's predictions are based on the correlation between geomagnetic quakes and the incoming minimum (or maximum) of tidal gravitational potential. The geomagnetic quake is defined as a jump of day mean value of geomagnetic field one minute standard deviation measured at least 2.5 times per second. The probability time window for the incoming earthquake or earthquakes is approximately ± 1 day for the tidal minimum and for the maximum- ± 2 days.

1. INTRODUCTION

The precursors list includes usual geophysical and seismological monitoring of the region, including hydrochemical monitoring of water sources and their Radon and Helium concentrations, crust temperature, and hydrogeodeformation field, monitoring of biological precursors and etc. During the monitoring of earthquake precursors including extra information as the variations of electromagnetic fields analysis, it is possible to define earthquakes precursors and estimate earthquake occurrence's intended time what is very actual and important problem.

The problem of "when, where and how" earthquake prediction cannot be solved only on the basis of seismic and geodetic data (1; 10; 6).

The possible tidal triggering of earthquakes has been investigated for a long period of time.

Including of additional information in the precursors monitoring, such as the analysis of the electromagnetic field variations under, on and above the Earth surface, can contribute towards defining a reliable earthquake precursor and estimating the most probable time of a forthcoming earthquake.

Simultaneous analysis of more accurate space and time measuring sets for the earth crust condition parameters, including the monitoring data of the electromagnetic field under and over the Earth surface, as well as the temperature distribution and other possible precursors, would be the basis of nonlinear inverse problem methods. It could be promising for studying and solving the ,,when, where and how" earthquake prediction problem.

Some progress for establishing the geomagnetic filed variations as regional earthquakes' precursors was presented in several papers (7; 9).

The approach is based on the understanding that earthquake processes have a complex origin. Without creating of adequate physical model of the Earth existence, the gravitational and electromagnetic interactions, which ensure the stability of the Sun system and its planets for a long time, the earthquake prediction problem cannot be solved in reliable way. The earthquake part of the model have to be repeated in the infinity way “theory- experiment- theory” using nonlinear inverse problem methods looking for the correlations between fields in dynamically changed space and time scales. Of course, every approximate model (16; 12; 13; 14; 3; 4; 5) which has some experimental evidence has to be included in the analysis. The adequate physical understanding of the correlations between electromagnetic precursors, tidal extremums and incoming earthquake is connected with the progress of the adequate Earth’s magnetism theory as well as the quantum mechanical understanding of the processes in the earthquake source volume before and in the time of earthquake.

The achievement of the Earth’s surface tidal potential modeling, which includes the ocean and atmosphere tidal influences, is an essential part of the research. In this sense the comparison of the Earth tides analysis programs (Dierks and Neumeyer, ws) for the ANALYZE from the ETERNA-package, version 3.30 (Wenzel, 1996 a, b), program BAYTAP-G in the version from 15.11.1999 (Tamura, 1991), Program VAV (17) is very useful.

The role of geomagnetic variations as precursor can be explained by the hypothesis that during the time before the earthquakes, with the strain, deformation or displacement changes in the crust there arise in some interval of density changing the chemical phase shift which leads to an electrical charge shift. The preliminary Fourier analysis of geomagnetic field gives the time period of alteration in minute scale. Such specific geomagnetic variation we call geomagnetic quake. The last years results from laboratory modelling of earthquake processes in increasing stress condition at least qualitatively support the quantum mechanic phase shift explanation for mechanism generating the electromagnetic effects before earthquake and others electromagnetic phenomena in the time of earthquake (2; 11; 15). The future epicentre coordinates have to be estimated from at least 3 points of measuring the geomagnetic vector, using the inverse problem methods, applied for the estimation the coordinates of the volume, where the phase shift arrived in the framework of its time window. For example the first work hypothesis can be that the main part of geomagnetic quake is generated from the vertical Earth Surface- Ionosphere electrical current. Sea also the results of papers (Vallianatos, Tzanis, 2003 ; Duma, Ruzhin, 2003, Duma, 2006) and citations there.

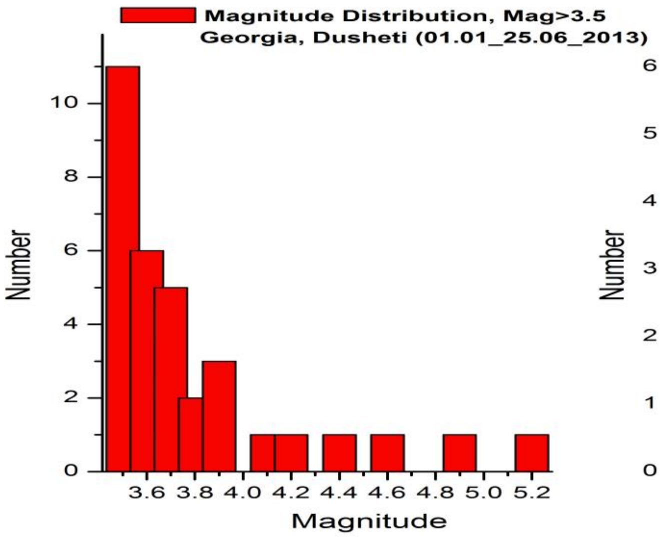
In the case of incoming big earthquake (magnitude > 5 - 6 the changes of vertical electropotential distribution, the Earth’s temperature, the infrared Earth’s radiation, the behaviour of debit, chemistry and radioactivity of water sources, the dynamics and temperature of under waters, the atmosphere conditions (earthquakes clouds, ionosphere radioemitions, and etc.), the charge density of the Earth radiation belt, have to be dramatically changed near the epicentre area- see for example papers .

The achievements of tidal potential modeling of the Earth’s surface, including ocean and atmosphere tidal influences, multi- component correlation analysis and nonlinear inverse problem methods in fluids dynamics and electrodynamics are crucial for every single step of the constructing of the mathematical and physical models.

2. Data

Dusheti Geomagnetic Observatory is located in Dusheti town (Georgia, Lat 42.052N, Lon44.42E), Alt900m). It is equipped with modern precise Fluxgate Magnetometer Model LGI and it accomplishes non-stop registration of X, Y, Z elements. The data includes minute and second records of the field elements. It is measured with 0,1nT accuracy daily.

There was analyzed earthquakes data in region with Lat42.052N and Long44.42E for January-June of 2013, reported in EMSC: Earthquake research results, magnitude range from 3.5 to 9.0, data selection 115 earthquakes; Minute data of Geomagnetic fields elements received from Dusheti Geomagnetic observatory or 60 samples per hour, with 0,1nT accuracy; Coordinate of Dusheti Geomagnetic observatory: 42.052N, Lon44.42E Alt900m. About the method of Earthquake’s prediction see (18).The distributions of earthquakes' magnitudes and depths, (Mgnitude >3.5) are presented in Fig.1 and Fig.2. (Epicentral distances up to 300km and magnitudes M>3.5).



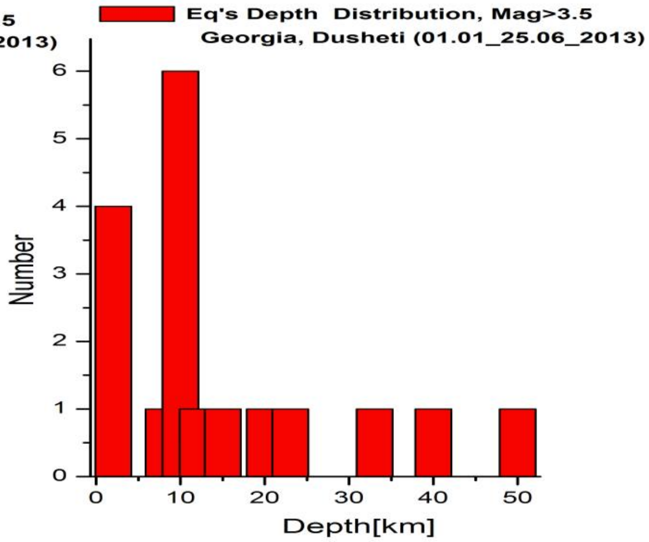


Fig.1 Magnitude distribution

Fig.2 The earthquake's depth distribution

Fig3. Presents the SChtM and magnitude distribution for all occurred in the region earthquakes as function of distance from the monitoring point with magnitude>3.5.

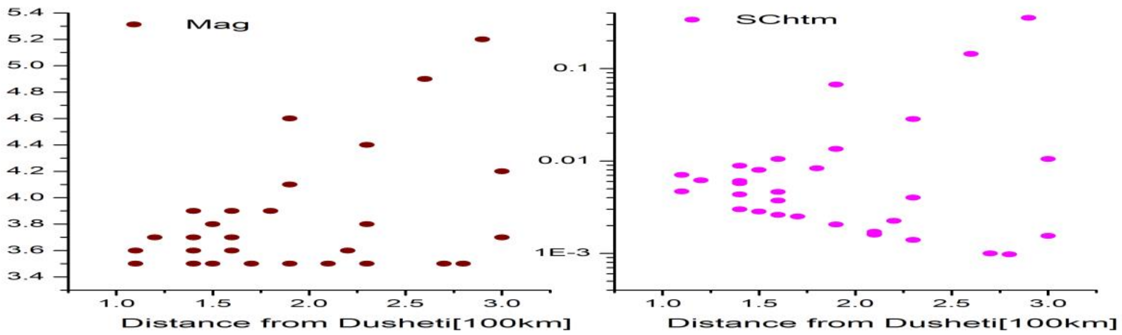


Fig.3. the distribution of SChtM and Magnitude (>3.5) on distances for all occurred earthquakes in the region

The comparison of the distribution in the Fig3 and Fig.4 can give some presentation for distance and magnitude sensibility of the geomagnetic approach.

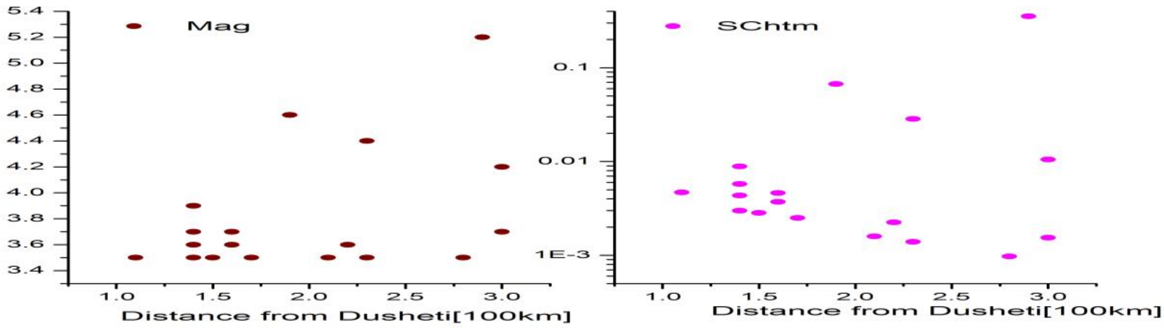


Fig.4. the distribution of SChtM and Magnitude (>3.5) on distances for predicted earthquakes

3. Analysis

The next Table contains the monitoring data for Dusheti and its analysis, described above, which illustrate that the geomagnetic quake is regional reliable earthquake precursor. The columns present: the number of signals preceding the incoming tidal extreme data, information for the tidal minimum (1) or maximum (2), the time of tidal extreme, the time of occurred earthquake, latitude [degree], longitude [degree], depth [km], magnitude, the difference between the time of tidal exstreme and the time of occurred earthquake [in days], distance from monitoring point [in 100 km], the value of function SChtM [J/km2],. The table consists a data for the earthquake with magnitude grater then 3.5

Number of Signals	Tidal min,max	Signal Time	Tidal Min,Max time	Eq Time	Lat	Long	Depth [100km]	Mag	DayDiff	Dist [100km]	SChtM [J/km^2]
1	min	02/02/2013	02/02/2013 10:44	2/3/2013 23:48	40.8	47.9	42	3.7	1.57	3	0.002
1	max	04/26/2013	04/27/2013 11:15	4/30/2013 9:29	40.9	48	5	4.2	2.95	3	0.011
2	max	05/22/2013	05/25/2013 11:07	5/28/2013 0:09	43.2	41.5	2	5.2	2.56	2.9	0.354
		05/24/2013									
2	max	03/20/2013	03/29/2013 11:13	3/27/2013 21:25	40.4	47.2	24	3.5	-0.55	2.8	9.76E-04
		03/23/2013									
1	max	02/20/2013	02/25/2013 12:37	2/22/2013 1:16	43.8	43.2	10	3.5	-3.45	2.3	0.001
2	min	04/09/2013	04/19/2013 12:41	4/18/2013 20:38	41.1	47.2	26	4.4	-0.66	2.3	0.028
		04/14/2013									
1	max	06/01/2013	06/08/2013 11:02	6/7/2013 10:42	43.7	43.4	10	3.6	-1	2.2	0.002
1	max	02/25/2013	02/25/2013 12:37	2/27/2013 4:24	40.9	46.7	18	3.5	1.68	2.1	0.002
2	max	03/27/2013	03/29/2013 11:13	3/31/2013 7:02	42.8	46.8	40	4.6	1.85	1.9	0.067
		03/29/2013									
1	min	06/08/2013	06/16/2013 14:24	6/15/2013 0:46	43.2	46	2	3.5	-1.55	1.7	0.003
3	min	05/15/2013	05/18/2013 13:57	5/18/2013 4:14	43.2	45.8	20	3.7	-0.39	1.6	0.005
		05/16/2013									
		05/18/2013									
1	min	02/02/2013	02/02/2013 10:44	2/2/2013 14:06	43.4	44.4	10	3.6	1.17	1.6	0.004
1	max	04/26/2013	04/27/2013 11:15	4/29/2013 14:26	42.6	46.3	12	3.5	2.15	1.5	0.003
1	min	02/02/2013	02/02/2013 10:44	2/2/2013 8:36	43.2	44.1	10	3.6	0.94	1.4	0.004
2	min	03/15/2013	03/19/2013 11:26	3/17/2013 14:04	43	45.8	15	3.7	-1.86	1.4	0.006
		03/17/2013									
2	max	1/25/2013	1/26/2013 13:25	1/24/2013 11:00	42.8	46.1	40	3.9	-2.08	1.4	0.009
		1/26/2013									
1	max	04/06/2013	04/10/2013 11:01	4/7/2013 17:16	43.3	44.8	10	3.5	3.24	1.4	0.003
2	max	04/23/2013	04/27/2013 11:15	4/28/2013 0:01	42.5	43.5	2	3.5	0.55	1.1	0.005
		04/24/2013									

At the next figures are presented the samples of material work-up for 01.02-23.03_ 2013 Dusheti data. From up to down are presented the curve of tidal gravitational potential, density of earthquake energy (Schtm), earthquake’s distribution at the same period, values of SigD and its standard deviation.

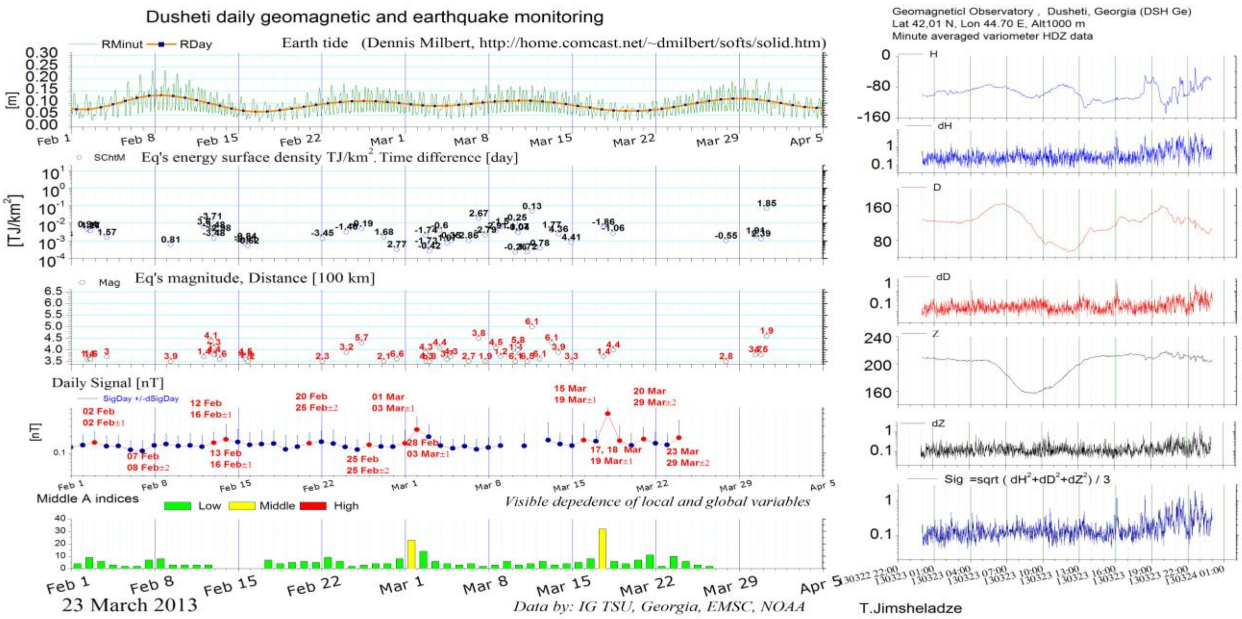


Fig.5 The reliability of the time window prediction for the incoming earthquake.

At Dusheti station, during the period of January-June 2013, there was revealed important disturbances before 26.03.2013 and 28.05.2013 earthquakes, Mag 5.1 and Mag.4.9, epicenter Gagra, which is located from Dusheti in 290km. The disturbance was detected 3 days earlier before earthquake. The disturbance was recorded as before earthquake as its aftershocks period.

Fig.6. Presents the comparison of the number of all occurred and predicted earthquakes For Dusheti. Fig6 Presents the map graphic for earthquakes with magnitude grater then 4 predicted simultaneously from Dusheti measurement.

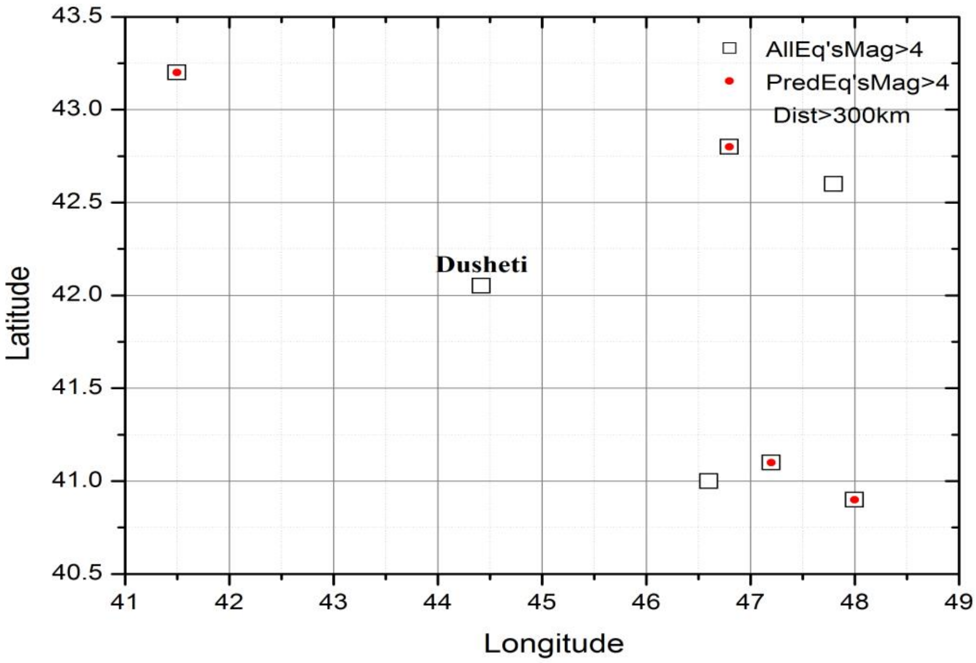


Fig.6 Map graphic for earthquakes with magnitude grater then 4 predicted simultaneously from Dusheti measurement.

It is clear from the picture that among 6 earthquakes for Mag>4; 4 of them were fixed by us.

It is obvious that the occurred in the predicted time period earthquake with maximum value of function SChtM (proportional to the Richter energy density in the monitoring point) is the predicted earthquake. But sometimes there are more than one geomagnetic signals in one day or some in different days. It is not possible to perform unique interpretation and to choose the predicted earthquakes between some of them with less values of energy density. The solution of this problem can be given by the analysis of the vector geomagnetic monitoring data in at least 3 points, which will permit to start solving the inverse problem for estimation the coordinates of geomagnetic quake source as function of geomagnetic quake. The numbering of powers of freedom for estimation the epicenter, depth, magnitude and intensity (maximum values of accelerator vector and its dangerous frequencies) and the number of possible earthquake precursors show that the nonlinear system of inverse problem will be over determinate.

CONCLUSIONS

The correlations between the local geomagnetic quake and incoming earthquakes, which occur in the time window defined from tidal minimum (± 1 day) or maximum (± 2 days) of the Earth tidal gravitational potential are tested statistically. The distribution of the time difference between predicted and occurred events is going to be Gaussian with the increasing of the statistics.

The presented results can be interpreted as a first reliable approach for solving the “when” earthquakes prediction problem by using geomagnetic data. Georgian Geomagnetic station inputs important information for space dependences of precursor intensity as part of complex regional NETWORK of **PrEqTiPlaMagInt** collaboration (**Pr**ediction **E**arth**q**uake **Ti**me **Pla**ce **Mag**nitude **Int**ensity) which includes Bulgaria, Makedonia and Ukraine.

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ВАРИАЦИИ ГЕОМАГНИТНОГО ПОЛЯ НА ДУШЕТСКОЙ ОБСЕРВАТОРИИ
(Январь – Июнь 2013)

Тамар Джимшеладзе, Георгий Меликадзе, Александр Чанкветадзе,
Роберт Гагуа, Тамаз Матиашвили

Резюме

Геомагнитные аномалии перед землетрясениями были зафиксированы многими авторами, однако надо отметить, что большинство из них не удовлетворяет строгим критериям. Этот метод прогноза землетрясений базируется на корреляции между землетрясениями, геомагнитными аномалиями и наступающими максимумами (или минимумами) приливных вариаций гравитационного поля. Геомагнитное отклонение определяется как отклонения в поле средних значений стандартного отклонения, измеряемых минимум 2.5 раз в секунду. Окно вероятности совпадения во времени событий равняется±1 день для приливно–отливного минимума и ±2 дня для приливно–отливного максимума. Статистическая достоверность геомагнитных предшественников, зафиксированных Душетской обсерваторией, еще раз подтверждается данными распределения разницы между прошедшими и спрогнозированными землетрясениями для периода Январь-Июнь 2013 года.

დუშეთის ობსერვატორიაზე დაფიქსირებული გეომაგნიტური ველის ვარიაციები
(იანვარი - ივნისი 2013)

თამარ ჯიმშელაძე, გიორგი მელიქაძე, ალექსანდრე ჩანკვეტაძე, რობერტ გაგუა, თამაზ მათიაშვილი

reziume

მიწისძვრის წინ გეომაგნიტური ანომალიები დაფიქსირებულია მრავალი ავტორის მიერ, თუმცა აღსანიშნიე რომ მათი უმეტესობა ვერ აკმაყოფილებს მკაცრ კრიტერიუმებს. პროგნოზის ეს მეთოდი ეყრდნობა კორელაციას მიწისძვრებსა, გეომაგნიტურ ანომალიებს და მიზიდულობის ველის მიმოქცევითი ვარიაციების მოსალოდნელ მაქსიმუმს (ან მინიმუმს) შორის. გეომაგნიტური გადახრა განისაზღვრება როგორც სტანდარტული გადახრების საშუალო მნიშვნელობებიდან, რომლების განისაზღვრება მინიმუმ 2.5 ჯერ წამში. მოვლენების თანხვედრის ალბათობის ფანჯარა უდრის +-1 დღეს, მიმოქცევითი ვარიაციების მინიმუმებისთვის და +-2 დღეს -მაქსიმუმებისთვის. დუშეთის ობსერვატორიის მიერ დაფიქსირებული გეომაგნიტური წინამორბედების სტატისტიკური დამაჯერებლობა, კიდევ ერთხელ დასტურდება 2013 წლის იანვარ-ივნისის მონაცემებით .