On the earthquake's prediction

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Contents

Complex Research of Earthquake's Prediction Possibilities, Seismicity and Climate Change Correlations - BlackSeaHazNet

BlackSeaHazNet, Project ID: 246874, Funded under: FP7-PEOPLE, Country: Bulgaria

Enhancing 'when' weekly seismic activity forecasting

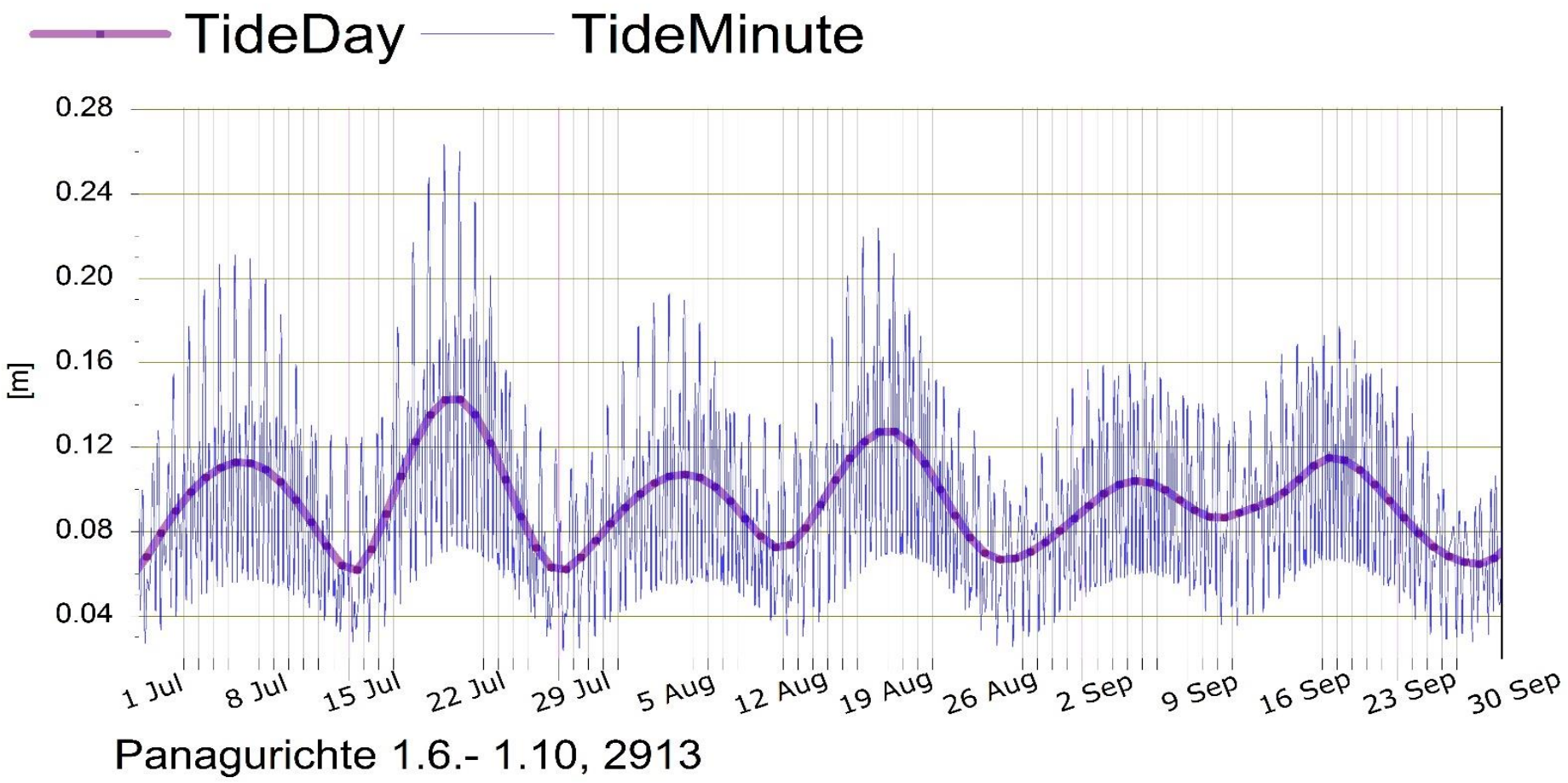
In the review published at CORDIS is cited that:

Extensive scientific research in the Black Sea region addressed the global question of determining the reliable precursors for imminent earthquake prediction. The models proposed by BLACKSEAHAZNET may very well hold the key to achieving the ultimate goal of seismologists and save thousands of lives in the future.

http://cordis.europa.eu/result/rcn/148955_en.html

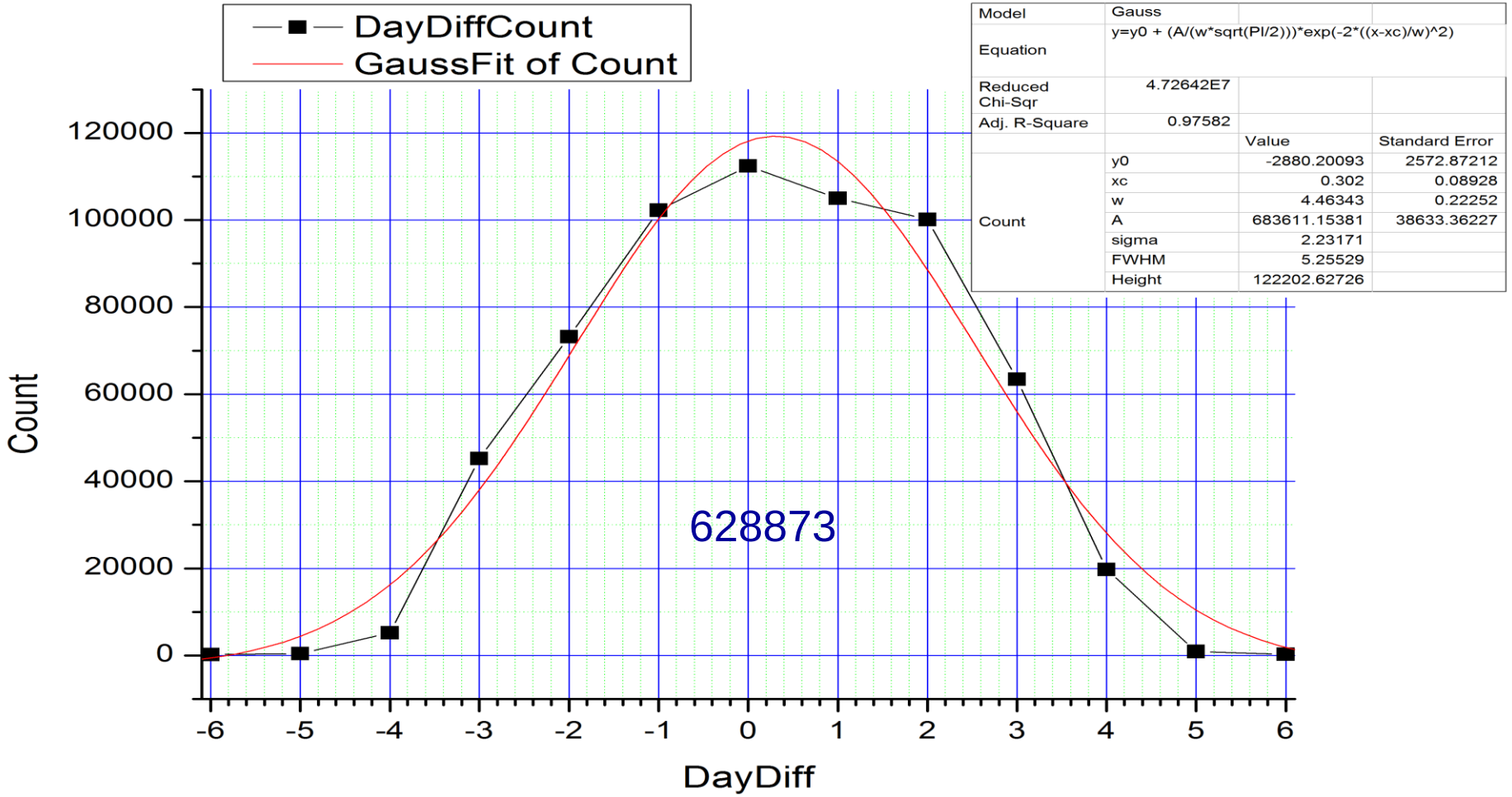
The Sun-Moon tides in Earth as earthquake's trigger

Earth tide (NASA, Dennis Milbert, http://home.comcast.net/~dmilbert/softs/solid.htm)



Panagurichte 1.6.- 1.10, 2913

$$DayDiff_i = TimePredictedEq_i - TimeOcurredEq_i$$



The distribution of variable **DayDiff** for 628873 world earthquakes with magnitude M>=3.5 of occurred since 1981 (International Seismological Centre: http://www.isc.ac.uk/data)

Is one can see 92% of all analyzed earthquakes are occurred in the time window +/- 2.23 days around the time of tide extreme in their epicentre.

Forecasting system for weekly regional seismic activity

The Forecasting system for weekly regional seismic activity is based on the analysis based on monitoring of the geomagnetic field and calculated Earth tide movement data. After the observation the **geomagnetic judder** one can forecast the increase of regional seismic activity in the time window (approximately +/- 2 days) around the next extreme of the diurnal mean value of the Sun-Moon tide vector module.

The geomagnetic signal is defined as positive derivative of geomagnetic field variability ***Gs.*** The variable ***Gs*** is daily averaged of standard relative deviations of geomagnetic field. The Sun storms influence is avoided by using data for daily A-indexes (published by NOAA). The **precursor signal** for forecasting the behaviour of imminent regional seismic activity is a simple function of the present and previous day ***Gs*** and A-indexes values. The condition for observation of positive derivative of the **geomagnetic judder** is the **precursor signal**.

Methodology

The Number Comparison of Experimental Series

The number estimation of the variability of one experimental series of measurements data

$$SdT = \sqrt{\frac{\sum_{i=1}^{n} \left(1 - \frac{T_i}{\overline{T}}\right)^2)}{n}}$$

$$\overline{T} = \frac{\sum_{i=1}^{n} T_i}{n}$$

The Variables

The modified earthquake's surface energy density in the monitoring point

$$S_{ChtM} = \frac{10^{(1.4M+4.8)}}{(40+Depth+Distance)^2} \quad [J/km^2]$$

$$dX_h = \frac{\sum_{m=1}^{60}\left(1-\frac{X_m}{\overline{X}_h}\right)^2)}{60}$$

$$\overline{X}_h = \frac{\sum_{m=1}^{60} X_m}{60}$$

$$GeomHourSig_h = \sqrt{\frac{dX_h^{\,2}+\ dY_h^{\,2}+\ dZ_h^{\,2}}{X_h^{\,2}+\ Y_h^{\,2}+\ Z_h^{\,2}}}$$

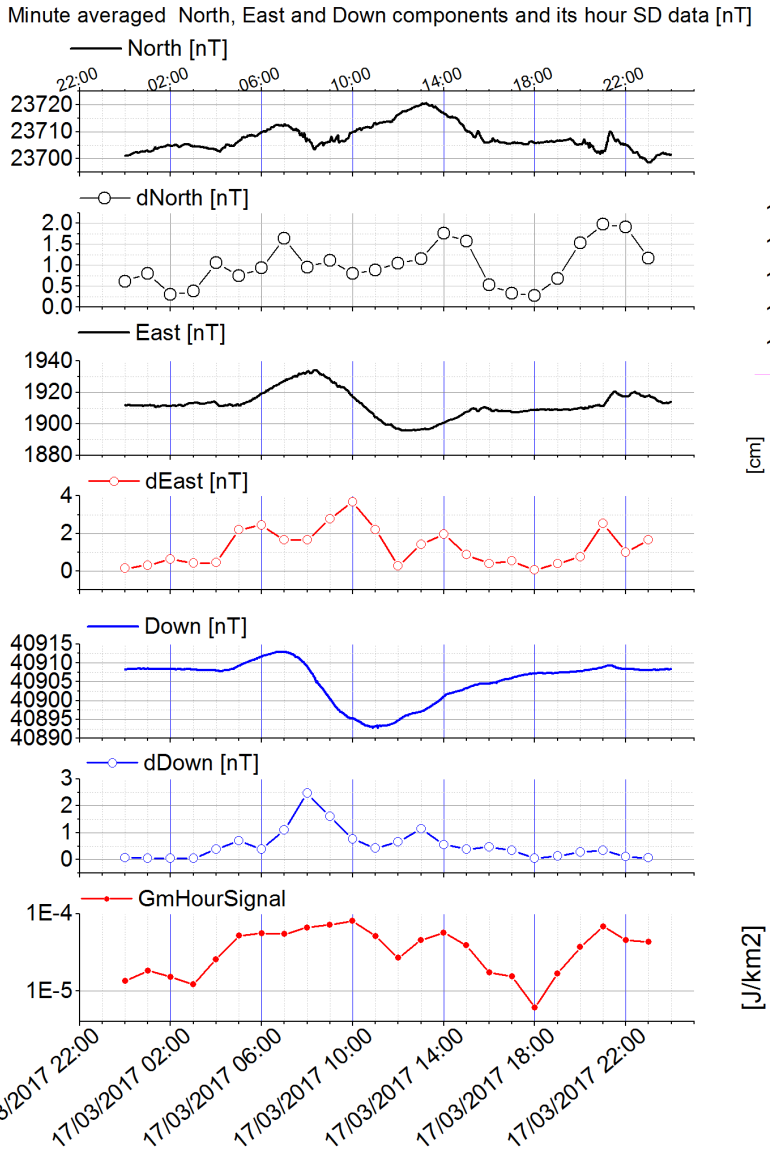
$$GeomSig_{day} = \frac{\sum_{h=1}^{24} GeomHourSig_h}{24}$$

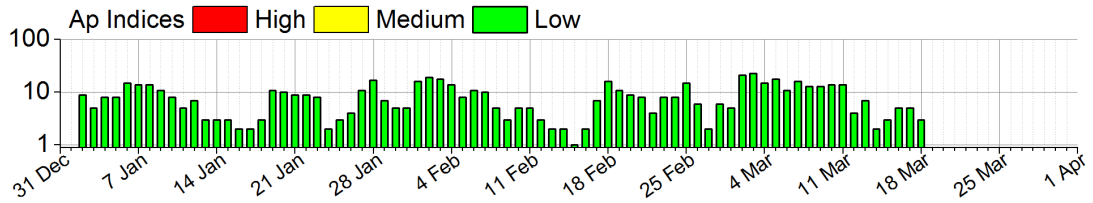
$$PrecursorSig_{day} = 2\,\frac{GeomSig_{day} - GeomSig_{yesterday}}{Alow_{day} + Alow_{yesterday}}$$

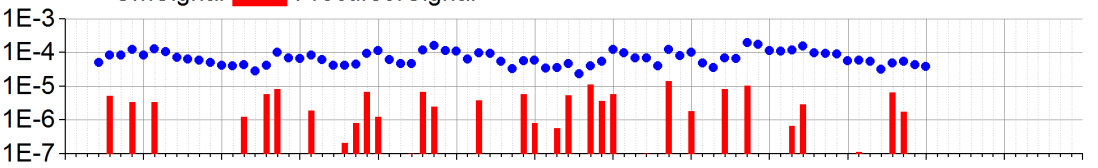
PAG diurnal geomagnetic and earthquake monitoring (700 km)

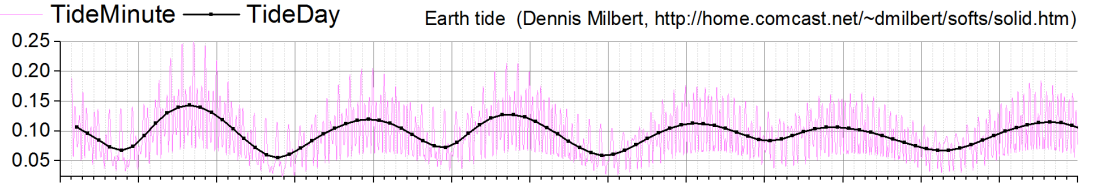
INTERMAGNET PAG Observatory, Panagurishte, Bulgaria
Lat 42.515 N, Lon 24.177 E

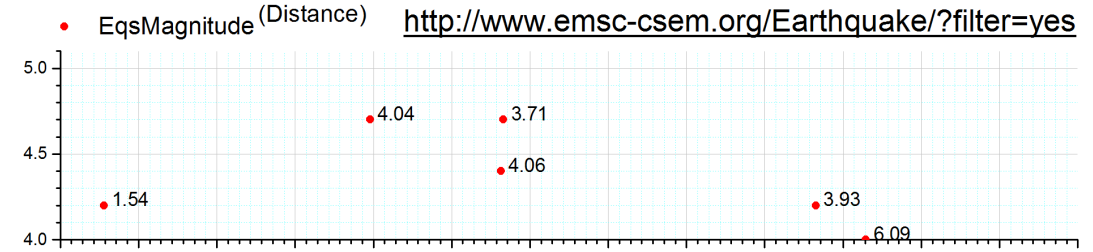
ftp://ftp.swpc.noaa.gov/pub/indices/DGD.txt

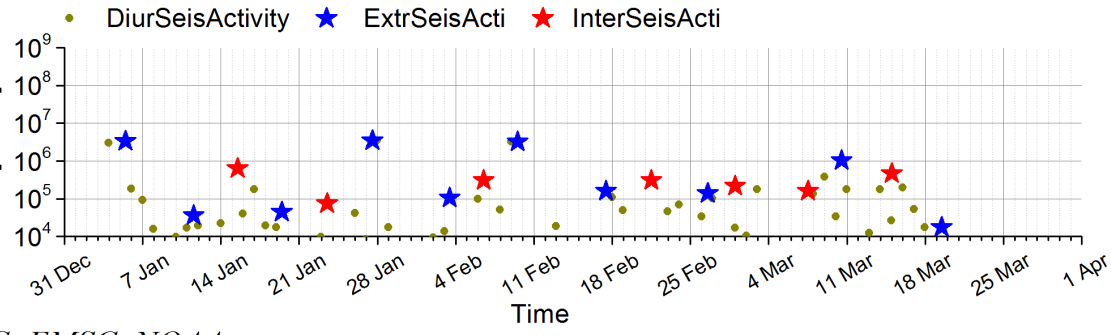












18 Mar, 2017

Data by: Intermagnet PAG, EMSC, NOAA

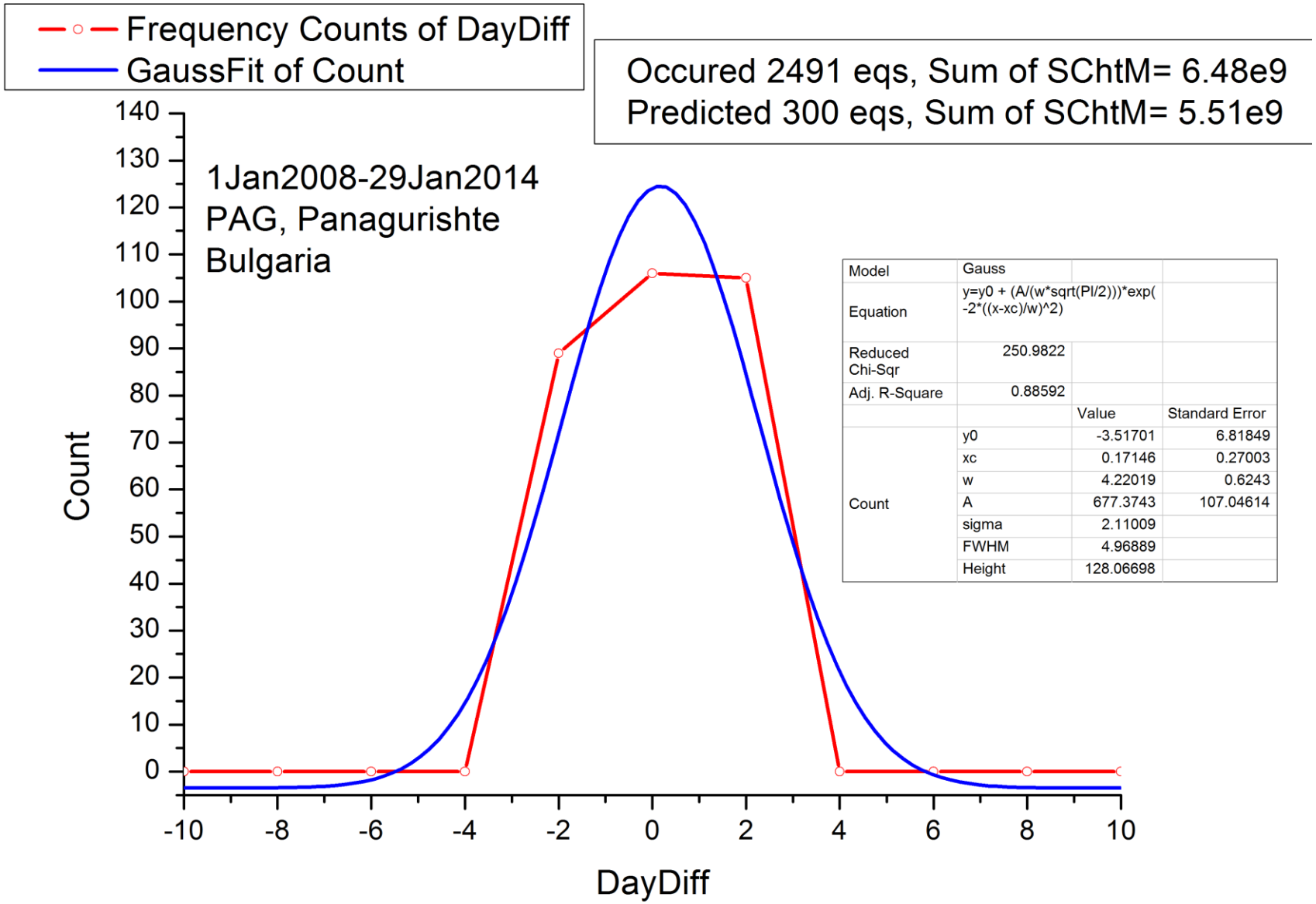
The **reliability** of the **geomagnetic judder** “when, regional” p**recursor** - **Bulgaria, Romania, Italy and Japan**

The reliability of the **geomagnetic judder** “when, regional” **precursor** is demonstrated by using statistical analysis of day difference between the times of “predicted” and occurred earthquakes.

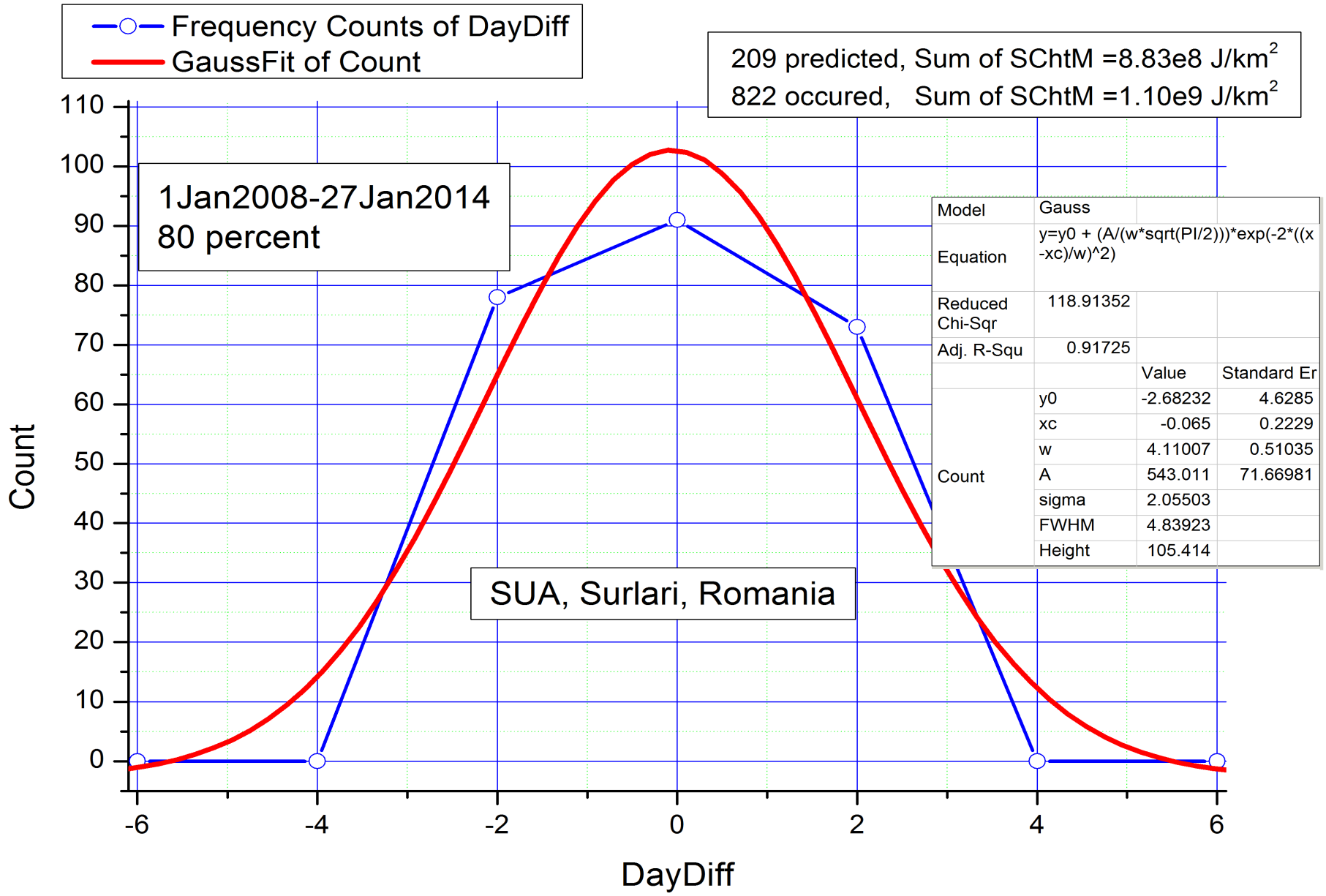
The base for analysis is a natural hypothesis that the **“predicted**” an earthquake is the one whose surface energy density ***Schtm*** in the monitoring point is bigger than the energy densities of all occurred earthquakes in the same period and region.

The reliability of the approach was tested using the INTERMAGNET stations data located in Bulgaria, Panagurishte, PAG (Jan 1, 2008-Jan 29, 2014), Romania, Surlari, SUA (Jan 1, 2008-Jan 27, 2014), Italy, L’Aquila, AQU (Jan 1, 2008-May 30, 2013), Japan, Memambetsu (Jul 1, 2014 –Jan 1, 2015), . Kakioka (Jul 1, 2014 –Jan 1, 2015), Kanoya (Jul 1, 2014 –Jan 1, 2015).

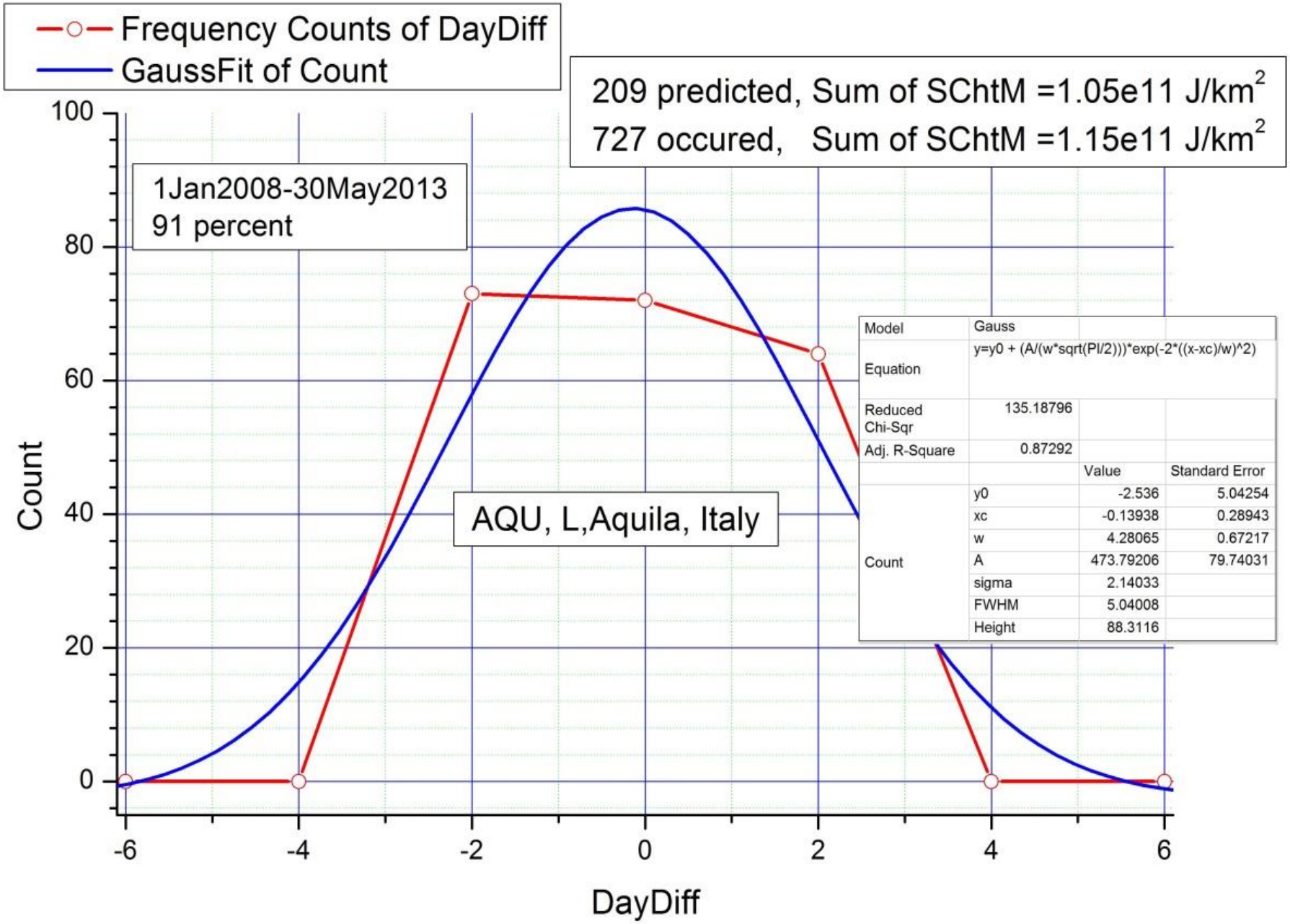
Reliability of the forecasting



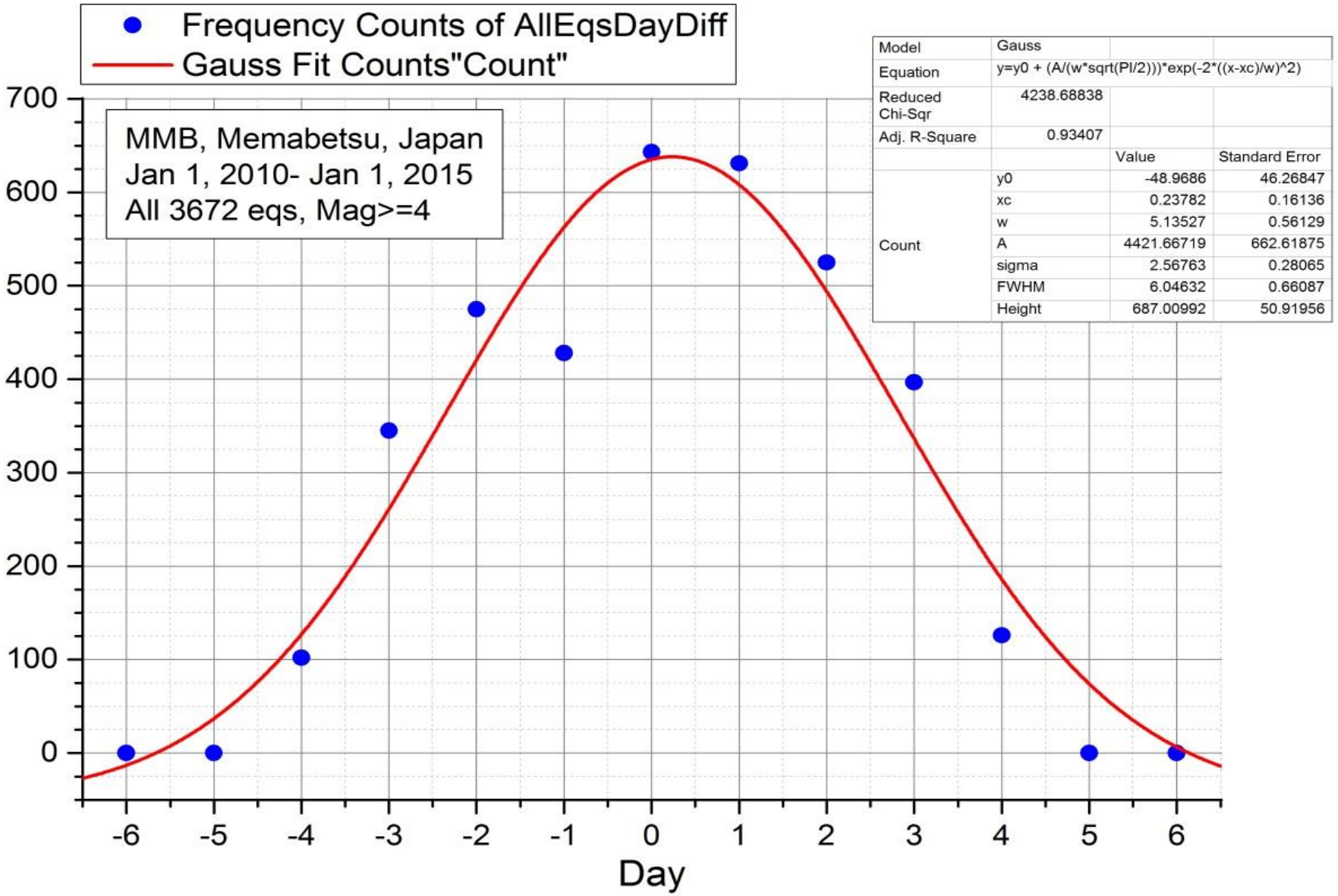
Reliability of the forecasting



Reliability of the forecasting

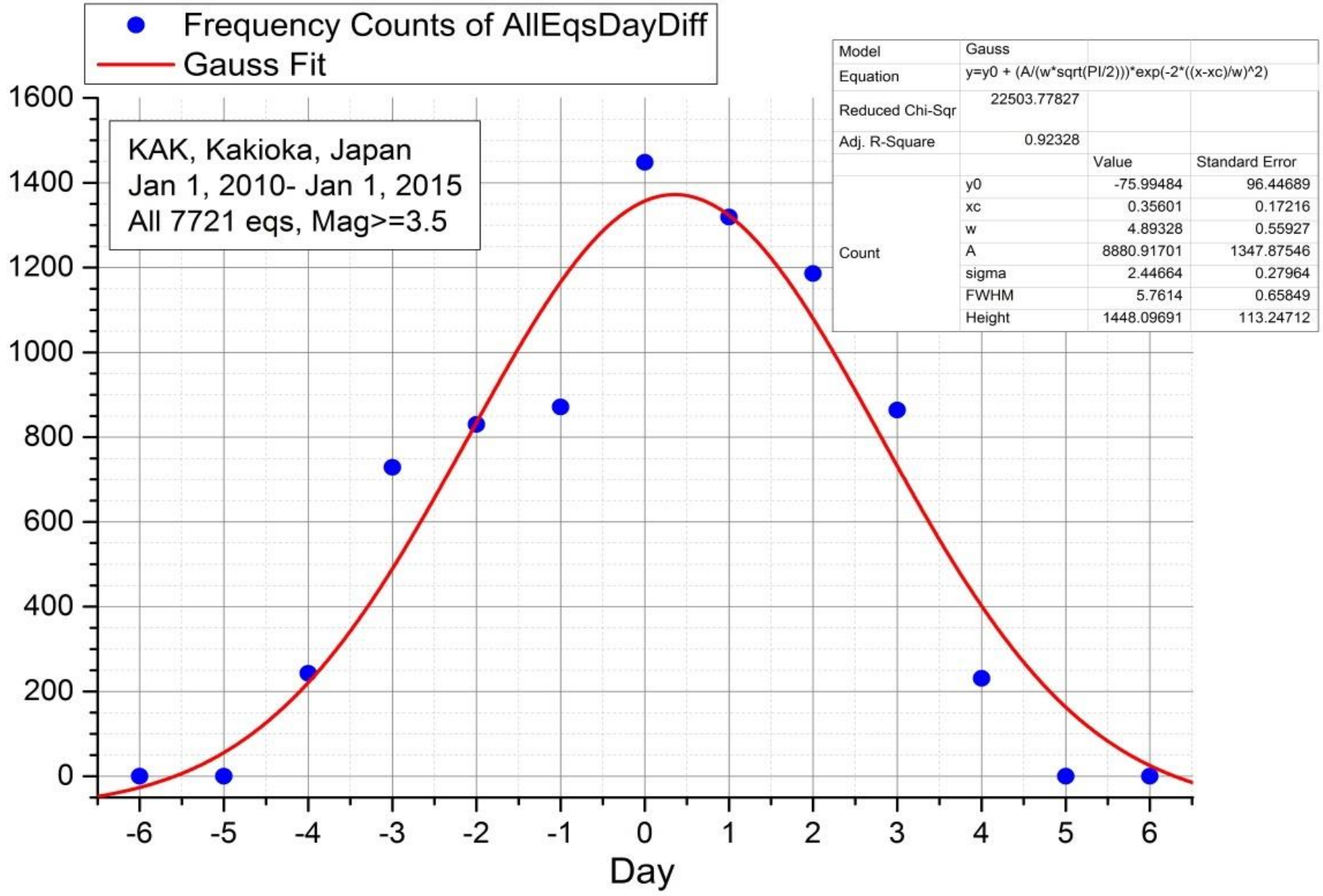


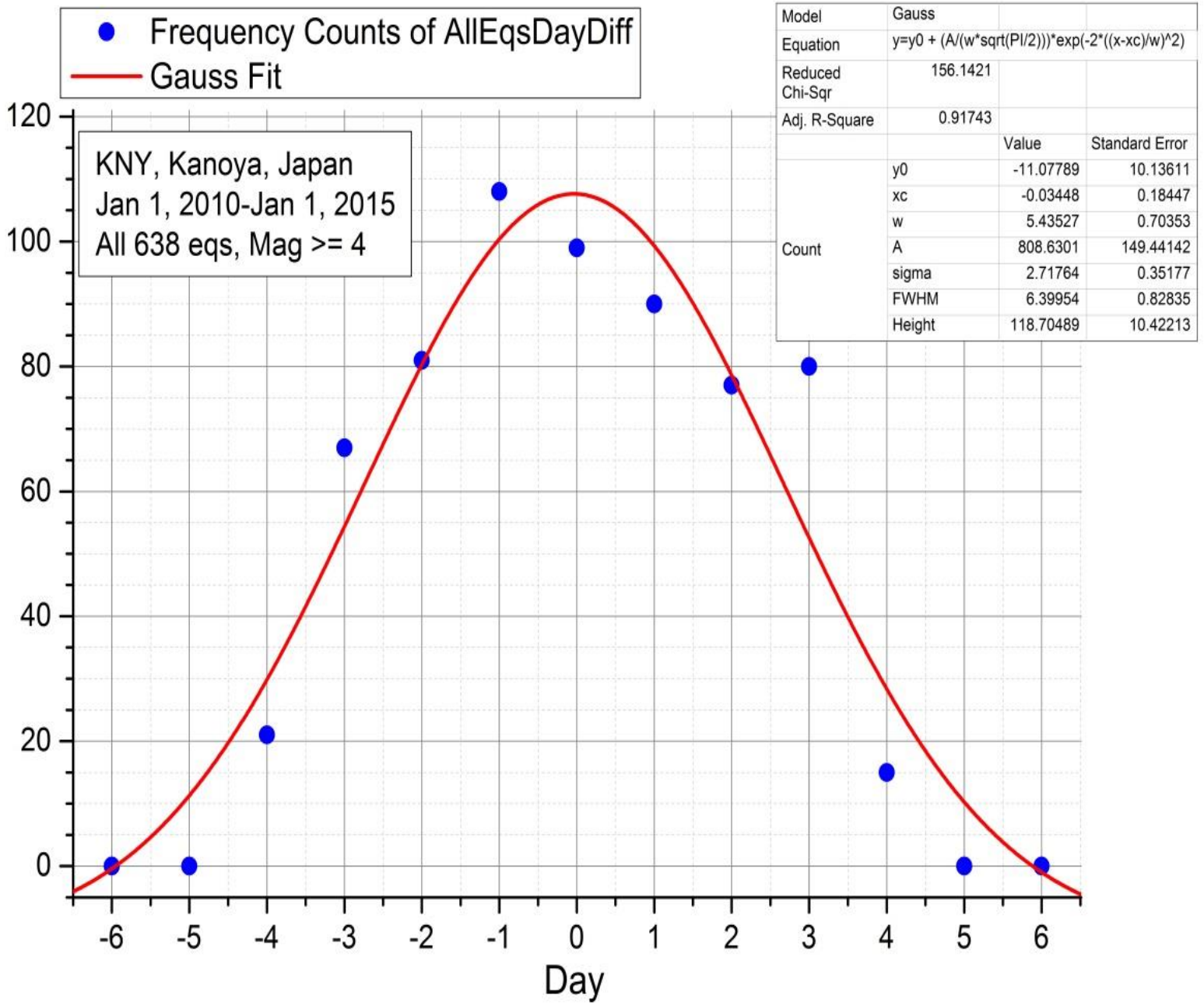
Reliability of the forecasting



Model	Gauss		
Equation	y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)		
Reduced Chi-Sqr	4238.68838		
Adj. R-Square	0.93407		
		Value	Standard Error
Count	y0	-48.9686	46.26847
	xc	0.23782	0.16136
	w	5.13527	0.56129
	A	4421.66719	662.61875
	sigma	2.56763	0.28065
	FWHM	6.04632	0.66087
	Height	687.00992	50.91956

Reliability of the forecasting





Model	Gauss		
Equation	y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)		
Reduced Chi-Sqr	156.1421		
Adj. R-Square	0.91743		
		Value	Standard Error
Count	y0	-11.07789	10.13611
	xc	-0.03448	0.18447
	w	5.43527	0.70353
	A	808.6301	149.44142
	sigma	2.71764	0.35177
	FWHM	6.39954	0.82835
	Height	118.70489	10.42213

Reliability of the forecasting

Station	PrEqs SChtM Sum [J/km^2]	AllEqs SChtM Sum [J/km ^{2}]	Pr/All %	Gauss fit width all [day]	Gauss fit width prediction [day]
MMB	4.01E+12	4.11E+12	97.6	5.14+/-0.56	4.32+/-0.72
KAK	1.48E+13	1.68E+13	88.1	4.89+/-0.60	3.75+/-0.37
KNY	1.96E+10	1.98E+10	99.0	5.44+/-0. 0	3.74+/-0.51

Some explanation-the natural GM mechanism

The role of geomagnetic variations as a precursor can be explained by the obvious hypothesis that during the time before the earthquakes, the crust strains, deformations or displacements change, in certain interval of Earth soil density, the conditions in the volume where the earthquake will occur.

There appears a chemical phase shift which leads to electrical charge shift. The increasing of the electro potential leads to the increasing of the regional Earth currents, which influence the geomagnetic field variability.

On the possibilities of "when, where and how" earthquakes prediction

The inclusion of additional information in the analysis for a possible precursors like the geo-electromagnetic field, the boreholes water level, the radon earth-surface concentration, the local heat flow, the ionosphere variables, low frequency atmosphere and Earth core waves, ionosphere variables can define the time period, the coordinates of epicentre, the depth, magnitude and intensity of the incoming earthquake?

Complex monitoring System for when, where and how" earthquake's prediction

- One have to note the use of Dubna method for definition and solving the inverse problems for discovering the hidden dependences
- One possible way for imminent prediction of earthquakes' magnitude, depth and epicenter coordinates can be the solving the inverse problem using a data acquisition network system for geophysical variables – reliable precursors.
- Among many possible precursors the most reliable are the geo-electromagnetic field, the boreholes water level, radon earth-surface concentration, the local heat flow, ionosphere variables, low frequency atmosphere and Earth core waves.

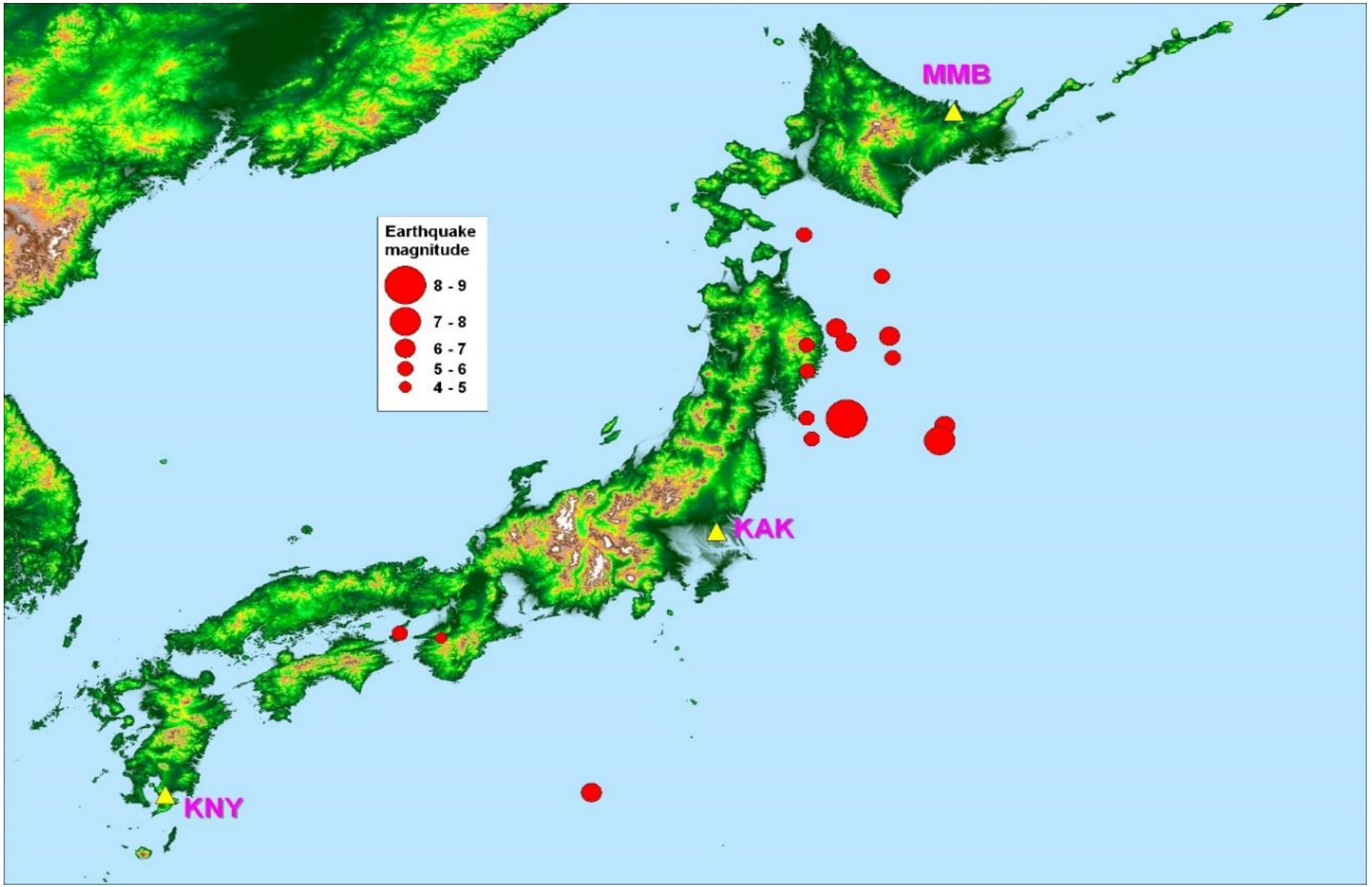
The analysis of Japan Memambetsu, Kakioka, Kanoya INTERMAGNET stations and NEIC earthquakes data (Jan 1, 2010 – Jan 1, 2015)

The analysis on the basis of *Schtm* hypothesis permits to formulate and solve the inverse problem for explicit form of Precursor signal (PrecSig) like a function of magnitude, depth and distance from a monitoring point of occurred earthquakes

PrecSig(M, Depth, R(x,y), a)

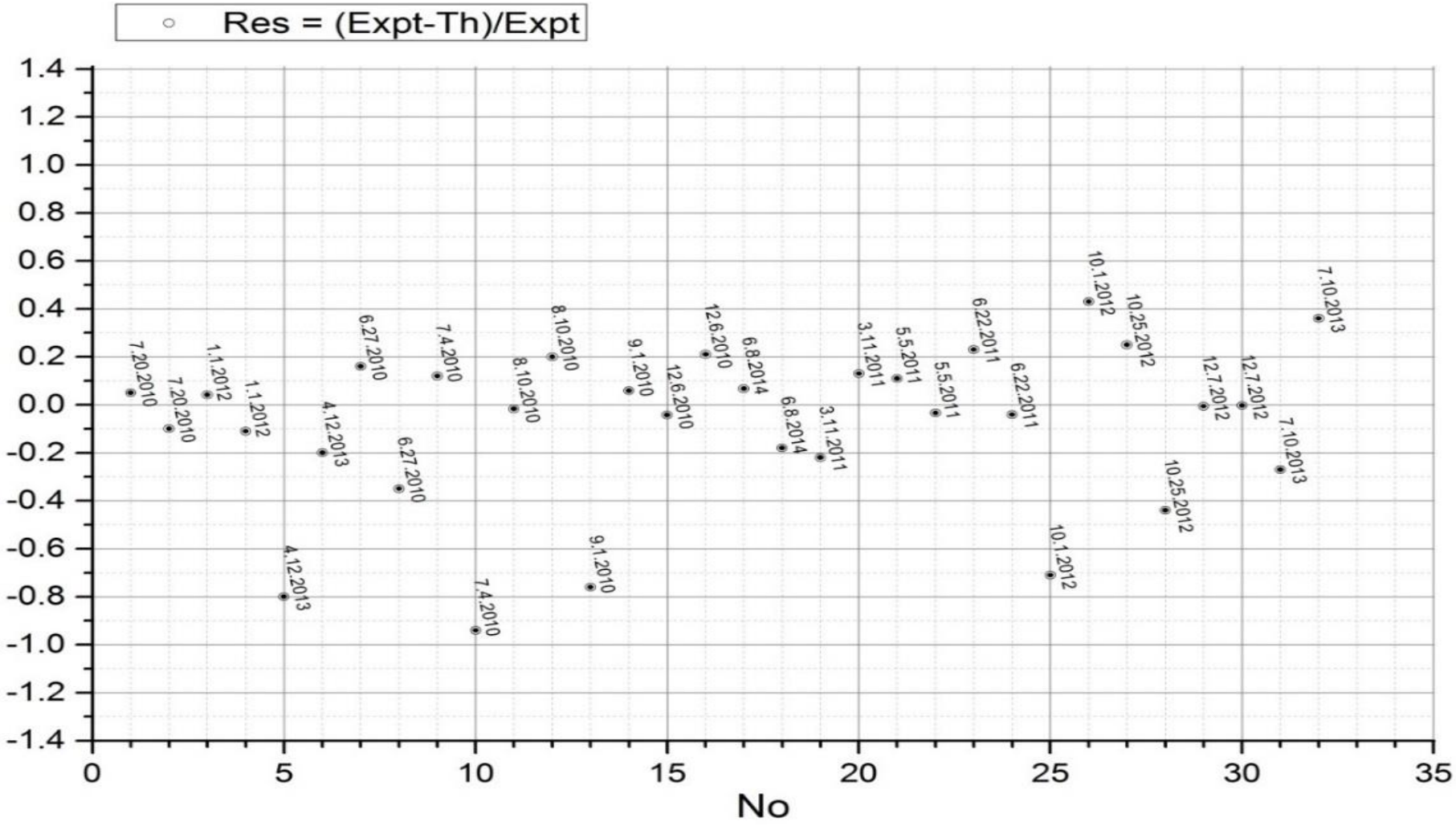
where a is a set of inverse problem digital parameters.

Origin of geomagnetic and earthquake data



The figure presents the description of measured geomagnetic signals from discovered explicit form theoretical (model) function of M, Depth and coordinates of epicenter R(x,y)

PrecSig(M, Depth, R(x,y), a)



Formulation of inverse problem for earthquake's magnitude, depth and epicentre coordinates

In this section is presented the possibility for solving the inverse problem for the parameters **established** for an incoming earthquake – the time period, magnitude, depth and epicenter coordinate.

If our hypothesis for predicted earthquake is true, it means that after a geomagnetic quake in the following tide extreme with the accuracy of +/- 2 days in the region an earthquake will occur.

From the previous section we know the explicit form of precursor signal depending on the magnitude, depth and coordinates of the epicenter- 4 parameters.

It means that the number of unknown parameters ***N***:

$$N=2+2.Mp$$

where ***Mp*** is the number of geomagnetic monitoring points.

But the number of equations is **Mp**, which means that with a Network for only one precursor it is **not possible to solve** the problem for calculation of Mag, Depth and Coordinates of an incoming earthquake.

The condition to have sufficient data for defining the over-determined system of equations is condition

$$2 + 2.Mp <= P.Mp$$,

where ***P*** is the number of used **linear independent and reliable precursors** (Earth Geomagnetic filed, Earth currents filed, Borehole water level, Radon concentration, Soil temperature, Atmosphere and Earth core low frequency waves, Ionosphere variability.

The condition is ***P*>3 at *Mp*>=2.**

Conclusions

1. It is possible to create a system for weekly regional seismic activity forecasting on the basis of geomagnetic regional monitoring.
2. It is possible to formulate the inverse problem for imminent prediction the time period, magnitude, depth and epicenter coordinates of incoming earthquake under the conditions:

   2.1. The number of linear independent earthquake's precursors P is $P >= 3$;

   2.2. The number of monitoring points Mp is $Mp >= 2$

The continuation

1st step – To submit a proposal to NATO Science for peace program to support an Advanced research workshop named "**System for imminent regional seismic activity on the basis of geomagnetic field monitoring and research of possible reliable earthquakes precursors."** (30 000 – 40 000 USD). **Supposed dead line: 31 March 2017**

2nd step – To apply for financial support from NATO, Science for peace program for creating the regional hardware monitoring system. **Supposed dead line: 1 month after finishing of ARW** (500 000 – 1 000 000 USD, approximate duration – 24 months).

3rd step – To submit a proposal to EU, H2020 for supporting the participants in the researching work (2 – 4 million EUR, approximate duration – 3 – 4 years)

Thank you for the attention!

Questions or proposals?