FORECASTING AN VIBRATION BY MONITORING THE DYNAMICS OF CHANGES ITS PRECURSORS OF VARIOUS PHYSICAL NATURE

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Prediction crosses all fields of Science, being itself the evident manifestation of the Scientific Method. This study addresses the delicate aspect of vibration forecasting, which considers the association and interaction between the variables involved, such as radio anomalies, the proton density of the solar wind preceding strong vibration. The analysis is based on the collection of about 800 data of vibration of range equal to or greater than 6 occurred on a global scale between 2012 and 2014, related to solar wind and radio anomalies detected before the disastrous Tohoku vibration of March 11, 2011. To discuss the data has been applied the deductive logic, which allows to make predictions from the hypotheses, formulated in a mathematical way. In this context, the mechanisms of triggering vibration are hypothesized with an interaction of electrical nature, at subatomic scale. The outcome of the research has shown encouraging results on the application of the prediction formula, reinforced by the control of its parameters.

KEYWORDS

Vibration forecast, solar wind, scientific method, destructive shocks, radio anomalies.

1 INTRODUCTION

Long-term experience of forecasting showed that as a prognostic sign it is necessary to consider not only the current value of the control parameter, but also take into account its change dynamics during the controlled object observation period [Murcinkova 2013]. In other words, the observed phenomenon should not be regarded as a statically frozen picture, but should be presented as a process whose characteristics continuously change throughout the observation period. Externally, this process manifests itself as trajectory (trend) of a change in time of a controlled parameter. This trend contains information necessary for decision-making, both about the current state criticality degree of the controlled object, and about the moment it reaches its limit state [Nagornyi 2017-2020].

This problem fully applies to the earthquake forecast. The forecasting methods adopted in seismology, based on a comparison of the monitored parameters current values with their standard, do not lead to the desired result [Kotsarenko 2004-2007, Ismaguilov 2003, Li 2013, Odintsov 2006, Panda 2014-2019, Valicek 2016 and 2017, Macala 2009 and 2017, Pandova 2018, Balara 2018, Monkova 2013, Gombar 2013, Bielousova 2017, Dyadyura 2017, Duplakova 2018, Krehel 2013, Flegner 2019 and 2020, Markulik 2016, Mrkvica 2012, Modrak, 2019, Chaus 2018, Pollak 2020, Olejarova 2017, Rimar 2016, Zaborowski 2007, Straka 2018a,b, Michalik 2014]. The desire to expand the prognostic signs list, amounting to about three hundred, of course, does not solve the problem [Prattes 2008, Takayama 1990, Takla 2011, Tavares 2011, Yanben 2004, Fraser-Smith 2008, Jusoh 2011, Straser 2014].

The data modelling for the realization of this study is based on previous works [Straser 2011, Straser 2015] that analyze potentially destructive earthquakes and seismic precursor candidates, such as radio anomalies and proton density variation, which preceded the main shocks. It is a holistic approach, that is, it takes into account many variables at stake, for a complex phenomenon such as the earthquake and, more generally, natural phenomena. Being multiple interactions that are established in the Earth's dynamics before a geophysical event, such as a volcanic eruption or earthquakes, it is not possible to assign to the catastrophic event a single cause, such as the mechanical action that is exercised between the tectonic plates. Therefore, it is necessary to select some parameters among the seismic precursor candidates. In this case the choice has fallen on the phenomena of electrical and electromagnetic nature that precede earthquakes. Even if it is not yet clear how to establish the interaction between charged particles, such as solar wind protons, and endogenous dynamics, is instead consolidated in the scientific field the phenomenon of piezoelectricity, the release of electrons in areas subjected to tectonic stress and ionization phenomena generated by radon gas. As it is well known, a moving charge produces an electromagnetic field, what is supposed to be measured, with the use of magnetometers located in monitoring stations and satellite, in the pre-seismic and seismic phases. The greater the tectonic stresses and the greater the amount of charges produced by endogenous and cosmic interactions, the greater the probability of an earthquake of high magnitude occurring. In this study were considered seismic events of magnitude equal to or greater than 6, including the devastating Tohoku earthquake of March 11, 2011.

2 METHODOLOGY

Below we consider examples of earthquake forecasting, based on monitoring the trend of changes in time for two different in physical nature precursors of these natural disasters.

The earthquake time (T_{for}), was determined in the process of minimizing the functional U (1)

$$U = \sum_{i=1}^{n} \left(H - H_{mod}\right)^{2} \qquad (1)$$

where H_{mod} - the value of the controlled parameter, calculated by the predictive model; n - the number of time series values.

The analytical expression for the predictive model is as follows:

$$H_{mod} = H(t_0)\cdot\left[1 + A\cdot\left(\frac{t-t_0}{T_{for}-t}\right)^{\alpha} - B\cdot\left(\frac{t-t_0}{T_{for}-t}\right)^{\beta}\right], \qquad (2)$$

где T_{for} – earthquake time forecast; t_0, t - registration time of the controlled parameter, respectively, at the time of the initial and current measurements; $H(t_0)$ - the value of the controlled parameter, recorded during the first measurement; *A, B, α, β* - experimental parameters, determined together with time T_{for} in the process of approximation of the graph of the parameter *H* by the predictive model (2).

3 RESULTS

3.1 Forecasting by changes in the geomagnetic parameter

Fig. 1 shows a graph characterizing the change in the monitored radio parameter during the observation period [Straser 2014].

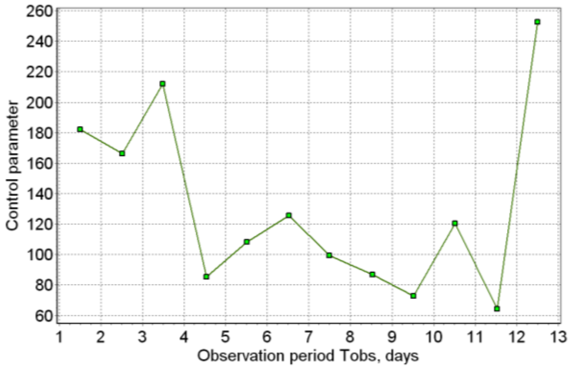

Figure 1. Change in the monitored radio parameter during the observation period [Straser 2014]

The forecasting results are shown in Fig. 2 and in the table 1

Table 1. Earthquake forecast (actual date of the earthquake 11.03.2011)

Forecast execution, Date	5.3.2011	8.3.2011	10.3.2011	11.3.2011
Forecast, Date	12.3.2011	12.3.2011	11.3.2011	11.3.2011
Deviation forecast from the actual date in days	1	1	0	0

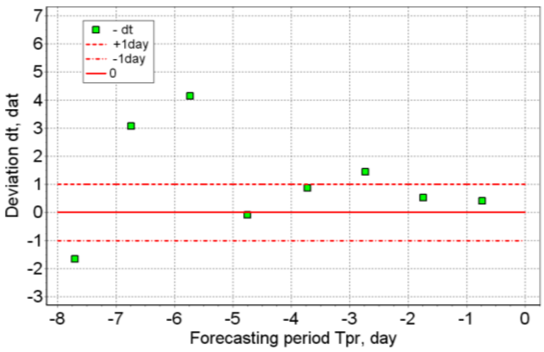

Figure 2. Forecast scatter field

From Fig. 2 and table 1 it follows, that the average deviation of the forecast from the actual time does not go beyond the day.

3.2 Forecasting by changing the parameters of the ionosphere

In this case, the parameter characterizing the state of the ionosphere is considered as a controlled parameter (Fig. 3 [Straser 2015]).

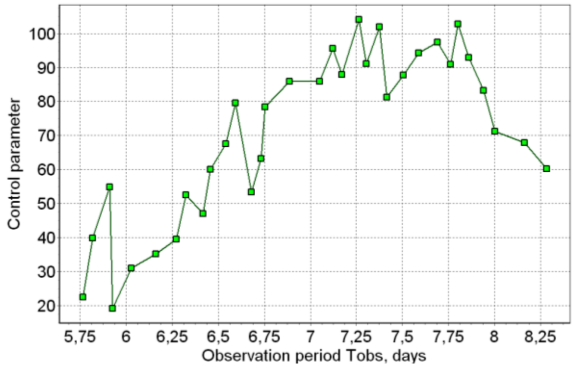

Figure 3. Densitogram of the ions in the interplanetary medium

The forecasting results are shown in Fig. 3 and in Table 2.

Table 2. Earthquake forecast (actual date of the earthquake 9.10.2012)

Forecast execution, Date	5.10.2012	6.10.2012	7.10.2012	8.10.2012
Forecast, Date	9.10.2012	9.10.2012	10.10.2012	10.10.2012
Deviation forecast from the actual Dates in days	0	0	1	1

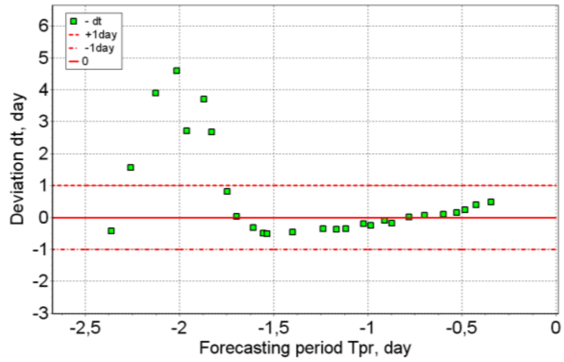

Figure 4. Forecast scatter field

4 DISCUSSION

From Fig. 2 and table 1 it follows, that the average deviation of the forecast from the actual time (Mart 11, 2011) does not go beyond the day.

From Fig. 4 and table 2 it follows that the average deviation of the forecast from the actual time of the earthquake (October 9, 2012) does not go beyond the day.

As you can see, the forecast differs from the actual date of the event within a day. In the period of short-term forecasting, it is necessary to determine the control parameter not once a day, but hourly, and based on this, build a forecast. In this case, the deviation of the forecast from the actual moment of the earthquake will not exceed one hour.

5 CONCLUSIONS

The practical application of the forecasting method considered in the note allows finally and for the first time in the history of seismology to solve the problem of short-term forecasting, indicating the exact date of the earthquake. Knowing this date allows you to proceed to a more detailed observation of the controlled parameters, thereby increasing the accuracy of the forecast.

The presence of several (at least two) control points and data obtained at these points on the eve of previous earthquakes, that occurred in the area of the next approaching earthquake, allows us to determine not only its date, but also the coordinates of the epicentre and strength.

The technique of such forecasting is described in detail on the example of the 2003 Japanese earthquakes (Hokkaido Island) and 2011 (Fukushima).

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