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The Use of Artificial Intelligence on the Planetary Gravitational Field for Earthquake Forecasting

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Abstract

The fluctuating planetary gravitational field not only influences activities on the sun, but also has an impact on the earth. A special correlation function describes the harmonics of these fluctuations. Groups of earthquakes form oscillation patterns that differ significantly from randomly selected control groups. These patterns are suitable as an element of an AI for earthquake probability. From a list of earthquakes (*Earthquakes of magnitude 6.5 or greater or ones that caused fatalities, injuries or substantial damage. BRK: Berkeley. PAS: Pasadena.*) in the time period 1997-01-05 to 2002-06-18, a pattern for calculating the change in the probability of earthquakes was optimized. This AI pattern is applied to the top 20 earthquakes of 2023 in this article. It shows the suitability of this method for forecasting earthquakes in a larger AI system.

Keywords

Planetary Gravitational Field, Earthquake Prediction, AI

1. Introduction

A study on the non-linear interaction of the fluctuating planetary gravitational field with the lithosphere indicates that the higher harmonics are particularly influential [1] [2]. In the meantime, resonances caused by fluctuating gravity can also be detected on small scales in the laboratory [3]. The kinematics of the planets correspond to a system of oscillators that are stable over billions of years of evolution. The forces at work are very small, which is why there is still much debate as to whether they can trigger an earthquake at all. Several studies have found no correlation between the tides and the occurrence of earthquakes, e.g. Kennedy *et al.*, 2004 [4]. Other studies report low positive correlations, e.g. Kasahara, 2002

[5].

A correlation function constructed to indicate changes in the probability of stable (harmonic) and unstable (disharmonic) states is also applied to earthquake triggering.

As shown in previous publications [1] [2] [6], characteristic vibration patterns can be found for earthquake groups that differ significantly from randomly selected control groups. In [6], it was proposed to use these vibration patterns as an element for earthquake prediction, similar to an AI. The investigations published here show initial results and specify this method.

2. The Correlation Function of Planetary Interactions

The correlation function (for the derivation of the function, see [1] [2]) is a Fourier expansion of a periodic process and can be optimized both in its order and in its frequencies for the respective problem. It has the function of a high-pass filter:

$$H_{i,j} = \sum_{s=1}^{N\cdot 12-1} a_k \cos(s\cdot\alpha); m_{it} \left(k = s \bmod 12\right) \qquad (1)$$
$$a_k = \{0,1,-2,3,-5,0,3,0,-5,3,-2,1\}$$

$H_{i,j}$ is the correlation of two celestial bodies; *a* is the angle between two celestial bodies; a_k is the 12 coefficients of the Fourier series, which are repeated N times; N is the order of the correlation function. The coefficients a_k were obtained from a Fourier transformation, which describes the change in the probability of stable or unstable processes.

The calculation of the harmonics of the planetary gravitational field results in a matrix in which each element in turn consists of the superposition of several oscillations. These oscillation patterns of the individual earthquakes can in turn be superimposed and form the characteristics of this group. If these group characteristics are compared with a large number of randomly selected comparison groups in the same period, it is possible to assess whether the group of earthquakes deviates significantly from the expected values.

Four matrices of the correlation function (1) are examined:

$\boldsymbol{H_{i,j}}$: for the harmony and disharmony,

$\boldsymbol{I_{i,j}}$: for the absolute value (energy) of the superimposed waves,

$\boldsymbol{D_{i,j}}$: for the speed of the change in the oscillation state (1st derivative),

$\boldsymbol{DA_{i,j}}$: for the acceleration (force) of the change in velocity.

Group of 513 earthquakes (*Earthquakes of magnitude 6.5 or greater or ones that caused fatalities, injuries or substantial damage. BRK: Berkeley. PAS: Pasadena.*) is used for the AI pattern formation. All events are superimposed. This matrix is now correlated with 10,000 groups of 513 randomly selected events (**Figure 1**).

3. Optimization of the AI for the Earthquake Probability

The function for the change in probability W for earthquakes is set up:

$$W = a_1 * H_{i,j} + a_2 * I_{i,j} + a_3 * D_{i,j} + a_4 * DA_{i,j} \tag{2}$$

This function is optimized with the aim of detecting as many events as possible from the group of 513 earthquakes and as few as possible from the group of randomly selected events. Only the coefficients a_i are variable.

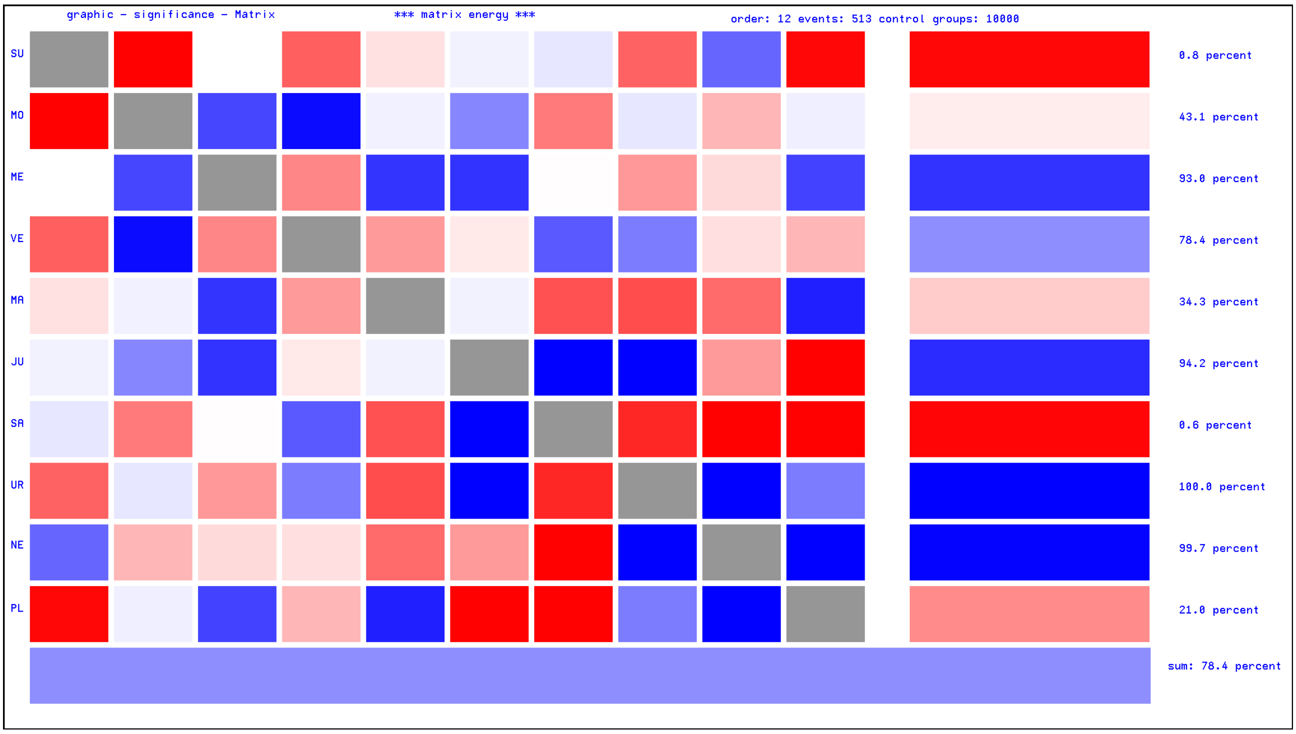

Figure 1. The figure shows the deviations of the "Energy I" pattern from the expected values for the individual correlations. The row sums (planets) are shown on the right of the figure. The lower bar indicates the value for the entire matrix. Weak energies are marked in blue, strong energies in red. A strong color indicates a strong deviation from the statistical mean. In this example, all correlations of Neptune (row sum) have a value of 99.7% (this means that 99.7% of the 10,000 control groups have a higher energy).

The list of 513 earthquakes in the time period 1997-01-05 to 2002-06-18 poses a particular challenge for pattern formation. A function that shows a change in the probability of earthquakes must show the earthquakes from the list, but not very many randomly selected events. 513 earthquakes in 112 months, which corresponds to an average rate of 4.58 earthquakes per month.

The result of the optimization:

Of the group of 513 earthquakes, 87.3% are recognized as earthquakes. Of the group of 1000 randomly selected events in the period from 1900 to 2100, 38.9% are recognized as earthquakes. It was not checked whether the 1000 random events actually included earthquakes of magnitude $m \geq 6.5$.

The goal of the optimization is to increase the difference, which in this case is 48.4%.

This could mean, for example, that 74.2% of the earthquakes that actually occurred in a selected period are recognized as such.

Can the pattern created in the period (1997-01-05 to 2002-06-18) achieve a similar hit rate in the period of 2023? The constellation of the major planets is completely different and could influence the quality of the pattern.

For this purpose, the strongest 20 earthquakes of the year 2023 are examined. Table 1 contains the earthquake events used, sorted by magnitude.

As the 12th order correlation function reacts very sensitively, only the probability curve for December 2023 is shown in Figure 2 (*printout from the computer program*).

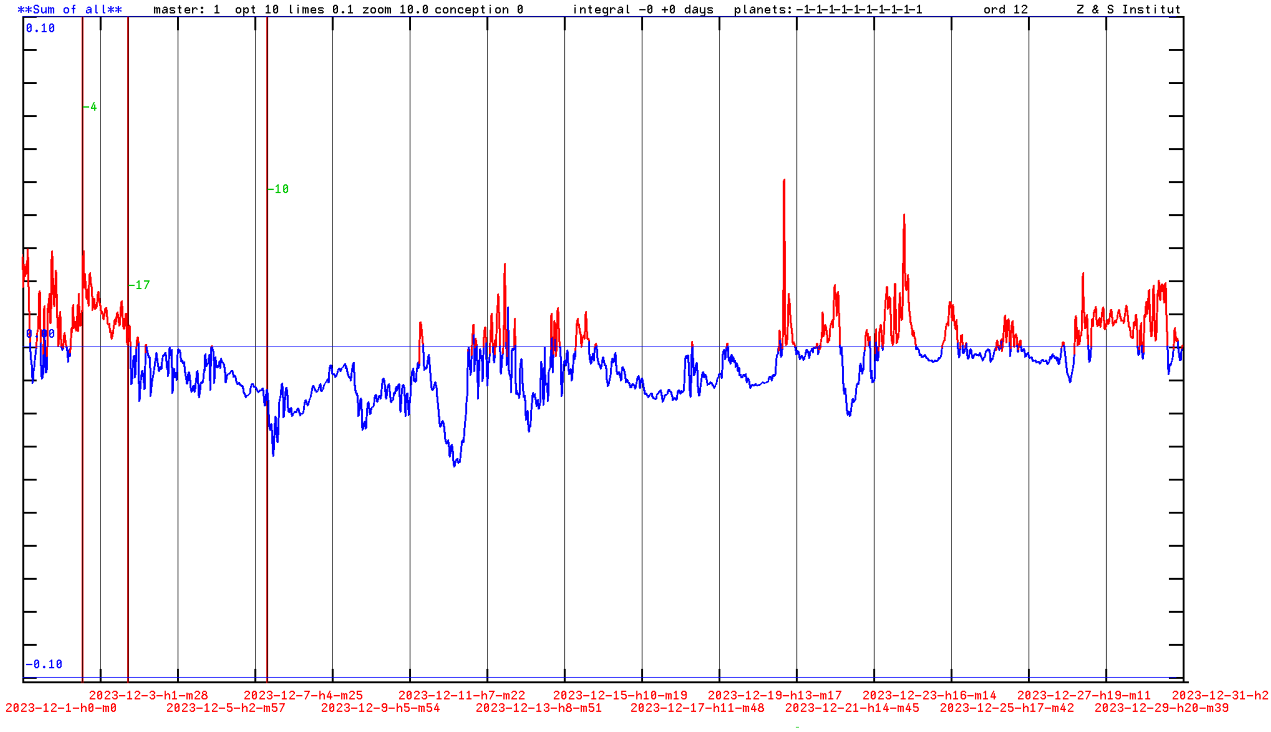

Figure 2. Period December 2023; 2 earthquakes out of 3 are detected; The red area above the center line indicates an increased probability of earthquakes (magnitude ≥ 6.5). The probability with uniform distribution for a hit in the area above the center line (red area) is p = 0.3058; the expected value with uniform distribution is: 0.92 hits. The probability of error for 2 or more hits is 0.223 (22.3%). This is outside the significance range. This example of the month of December is only intended to demonstrate the method. The earthquake events are marked by highlighted vertical lines and the (green) number from Table 1.

For the year as a whole, 14 out of 20 (70%) of the earthquakes were detected. This is slightly below the expected 74.2% of the pattern. Fluctuations of this kind are nothing out of the ordinary with only 20 earthquakes. The probability of error for 14 or more hits is 9.9%.

4. The Optimization of the AI for the Temporal Environment of an Event

From the various investigations [1] with the correlation function (1), it was found that the time periods around the event are also significant. The optimization of the time period resulted in a hit rate of 17 out of 20 (85%) for the integration of 3 days before the earthquake and 3 days after the earthquake. The probability of error for 17 and more hits is now 2.8%. This is in the significance range < 5% (Number 10 in Table 2).

Table 1. Top 20 strongest earthquakes in 2023, somewhat simplified here. Source: https://www.volcanodiscovery.com/de/top20/erdbeben/archive/2023.html.

Number	Magnitude	Depth/km	Year	Month	Day	Hour	Minute	Place
1	7.9	131	2023	1	9	17	47	Di Laut
2	7.8	10	2023	2	6	1	17	Türkiye
3	7.7	18	2023	5	19	2	57	sea
4	7.6	40	2023	12	2	14	37	Mindanao
5	7.6	210	2023	5	10	16	2	Tonga
6	7.5	7	2023	2	6	10	24	Ekinözü
7	7.3	84	2023	4	24	20	0	Di Laut
8	7.2	25	2023	7	16	6	48	Alaska
9	7.2	179	2023	6	15	18	6	Houma
10	7.1	48	2023	12	7	12	56	Isangel
11	7.1	6	2023	11	8	4	53	Sea
12	7.1	525	2023	8	28	19	55	Di Laut
13	7.1	36	2023	5	20	1	51	Sea
14	7.1	64	2023	1	18	6	6	Di Laut
15	7.0	70	2023	4	2	18	4	New Guinea
16	7.0	29	2023	1	8	12	32	Port-Olry
17	6.9	20	2023	12	3	19	49	Minanao
18	6.9	22	2023	11	24	9	5	Maug Islands
19	6.9	52	2023	10	7	8	40	Madang
20	6.9	100	2023	9	8	9	9	New Zealand

Table 2. Excerpt from the optimization of the temporal environment of the event. The optimum here is integration over 3 days before and 3 days after the event.

Number	Day before	Day after	Hits from 20	Probability Zone	Expected value	Probability of error
1	0	0	14	0.5320	10.64	0.099
2	−1	0	13	0.5762	11.52	0.333
3	−2	0	15	0.5886	11.73	0.102
4	−3	0	16	0.6003	12.01	0.051
5	−4	0	16	0.6126	12.25	0.064
6	−5	0	15	0.6239	12.48	0.176
7	−6	0	15	0.6324	12.65	0.197
8	−3	1	16	0.6124	12.25	0.064
9	−3	2	17	0.6342	12.68	0.033
10	**−3**	**3**	**17**	**0.6258**	**12.52**	**0.028**
11	−3	4	15	0.6362	12.72	0.207
12	−3	5	15	0.6360	12.72	0.206

The effect of the integration is a smoothing of the curve (Figure 3), so that the entire year 2023 can be presented more clearly in one image.

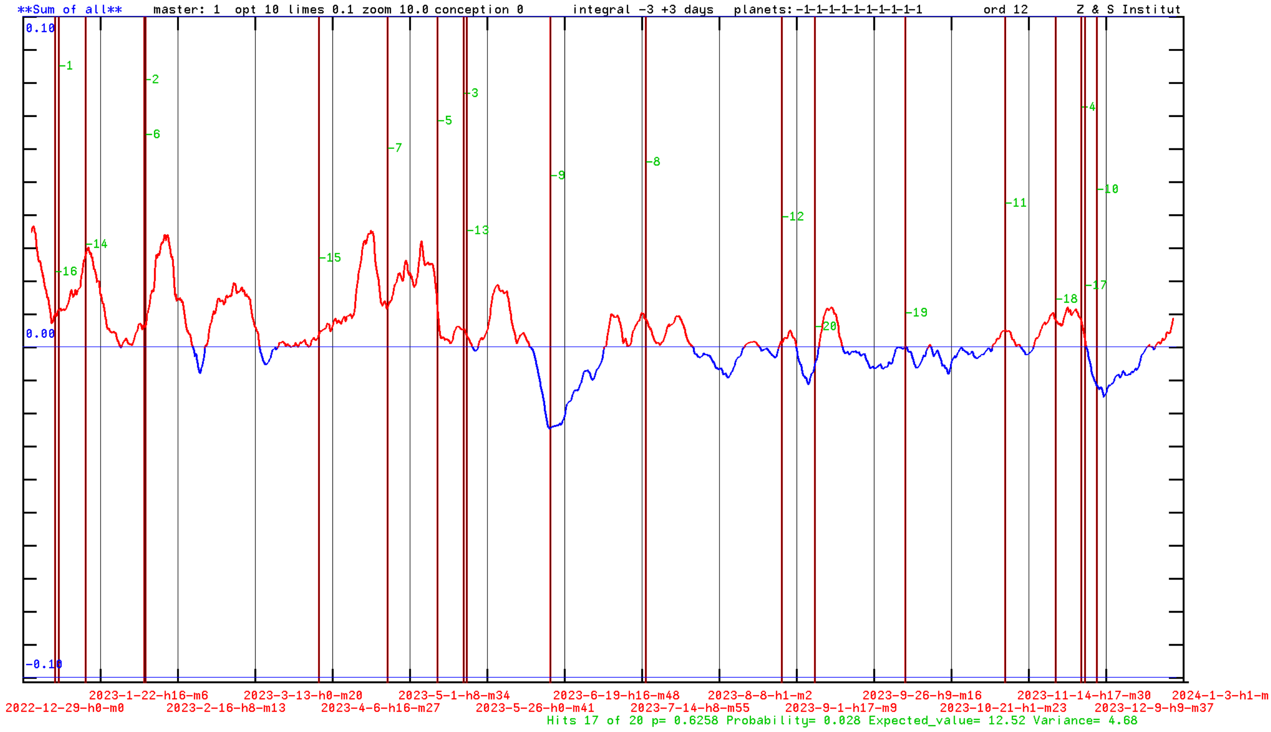

Figure 3. Period January to December 2023; 17 hits out of 20; The red area above the center line indicates an increased probability of earthquakes (magnitude ≥ 6.5). The probability with uniform distribution for a hit in the area above the center line (red area) is 0.6258; Expected value with uniform distribution: 12.52 hits. The probability of error for 17 and more hits is 0.028 (2.8%). This is within the significance range of 5%. The earthquake events are marked by highlighted vertical lines and the (green) number from Table 1.

5. Concluding Remarks

AI based on the planetary gravitational field cannot specifically predict earthquakes. There are several different factors that can trigger an earthquake. In addition, the stresses in the lithosphere must have a value that makes triggering possible. The AI presented here can only be one element of a larger AI for better prediction of earthquakes.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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