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Research Article

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Triggering Earthquakes Fluctuations of The Planetary Gravitational Field and Nonlinear Interactions with Matter

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Abstract
This research investigates the extent to which a non-linear correlation function can describe the influence of the planetary gravitational field on the triggering of earthquakes. This method differs from the methods I have known so far, which have only investigated the position of the Sun and Moon. A correlation function is developed that can describe changes in the probability of stable and unstable states in matter. It can be shown that about 6% of the investigated earthquakes can be triggered by the planetary gravitational field. The method could also be suitable as an element for artificial intelligence.

1 Introduction

Tidal stresses are very small, so there is still a lot of debate about whether they can trigger an earthquake at all. Several studies have found no correlation between tides and the occurrence of earthquakes, e.g. Kennedy et al., 2004 [1]. Other studies report small positive correlations, e.g. Kasahara, 2002 [2]. Some recent research by Metivier et al. (2009) suggests evidence that tidal- induced uplift may reduce the normal stresses that hold faults together [3].

Susan E. Hough even found that the frequency of earthquakes was unrelated to the position of the Moon or Sun relative to the Earth. "The data are completely random" is her statement [4]. Previous studies related to the triggering of earthquakes do not take into account the gravitational interactions of the planets e.g. [6-8].

In this work, a new investigation method is applied that leads to unambiguous results for the earthquakes investigated. The lithosphere earthquakes have non-linear dynamics [9]. The Sun, Moon and planets represent natural oscillators on a large scale. As the studies show, they interact nonlinearly with matter, as do other physical processes, e.g. in nonlinear optics. A non- linear correlation function is therefore a good way to describe these processes:

$H_{ij} = a1\ \cos(\alpha_{ij}) + a2\ \cos(2\alpha_{ij}) + a3\ \cos(3\alpha_{ij}) + \ldots$ (α is the angle between planets i and j).

It can be shown that this correlation function can also be interpreted as a non-linear interaction of the planetary fluctuations of the gravitational field with other material structures [11]. The oscillations of the planetary gravitational field lead to higher oscillations, to higher harmonics, in material structures. In my research, I have limited myself to the polar properties associated with the terms "stability" and "instability". The change from stable to unstable states and vice versa, can be observed in the evolution of many complex systems. In addition to the previous research [12], [13], further statistical investigations are presented that show this non-linear influence.

The Model of Nonlinear Interactions

Fluctuations of The Planetary Gravitational Field

Galaxies in space, planetary systems, clouds, geological formations, plants and animals, human societies, our nervous system, quantum physical systems form simple and also complex structures on different scales. Possibly, the formation of such structures can be described from a model of more or less strongly coupled, oscillating subsystems. One such oscillating subsystem is the planetary system. Sun and moon are weakly coupled with the system of the oceans and make them oscillate even in ebb and flow. Cause and effect are connected relatively simple and proportional. But are there also non-linear connections in which cause and effect are not directly proportional to each other?

The publication aims to draw attention to this oscillating subsystem (the solar system) and to stimulate further research. The computer program developed for this purpose is freely available for research projects [14].

A correlation function that indicates stabilizing and destabilizing states with a certain probability is suitable for describing these processes.

Nonlinear interactions

The fundamental Newtonian equation of motion of N mass points has the form:

$$\ddot{r}_i = G\sum_{\substack{j=1 \\ j\neq i}}^{N} M_i \frac{r_i - r_i}{\left|r_i - r_i\right|^3} \qquad (1)$$

ri, rj = position vectors of the planets i, j with the masses Mi and Mj; G = gravitational constant

This equation is the starting point for the derivation of the "cosmic fluctuations", it is but not yet in the form favorable for the present problem of fluctuations. For this purpose, it becomes necessary to consider first ordering points of view, which result from the structure and dynamics of the planetary system. The planets of the solar system all move on almost in one plane circular orbits around the sun. They represent natural oscillators whose couplings generate the superposition frequencies of the cosmic fluctuations.

A cosmic cycle begins with the conjunction (seen from the earth) of two planets i, j and ends after the opposition with the next conjunction. Heliocentrically considered, circular frequencies i, j can be given for the cosmic cycles, which are relatively stable and change only little with time.

$$\omega_{i,j} = \frac{2\pi}{T_{i,j}} \qquad (2)$$

$T_{i,j}$ = time duration from conjunction to conjunction of planets i, j.

Without considering the direction of the resulting planetary forces (only direction-invariant processes are studied), one can apply for the changes of the planetary forces (in first approximation).

$$\mathbf{F}_{i,j} \propto \mathbf{f}_{i,j}(t) + \mathbf{k}_{i,j}(t)\cos(\boldsymbol{\omega}_{i,j}) \quad t = \text{time} \qquad (3)$$

**The relation (3) follows from the vectorial addition of the forces Fi and Fj.*

$$\mathbf{F}_{i,j} = \mathbf{F}_i + \mathbf{F}_j$$

$$\mathbf{F}_{i,j}^2 = \mathbf{F}_i^2 + \mathbf{F}_j^2 + 2\,|\mathbf{F}_i||\mathbf{F}_j|\cos(\boldsymbol{\omega}_{i,j}) \qquad (4)$$

From a geocentric point of view, cosmic cycles are not quite as stable, so instead of i, j (t), it is easier to substitute the angle i, j at which planets i, j appear from Earth into (3).

$$\mathbf{F}_{i,j} \propto \mathbf{f}_{i,j}(t) + \mathbf{k}_{i,j}(t)\cos(\boldsymbol{\omega}_{i,j}) \qquad (5)$$

The quantities fi,j(t) and ki,j(t) contain the slowly and little regularly changing components resulting from distance changes of the planets.

For the further investigations only the faster and more "regular" changing cosine part in (4) is considered for the cosmic fluctuations. For a conjunction ($\alpha_{i,j}$ = 0°) Fi,j is maximum and for the opposition ($\alpha_{i,j}$ = 180°) minimum.

The weak gravitational field changes, especially their cosine part, can be considered as a kind of excitation field strength on matter. The quantities $f_{i,j}(t)$ and $k_{i,j}(t)$ are set approximately constant, because they change weakly and less regularly with time.

$$\mathbf{F}_{i,j} = \mathbf{f}_{i,j}(t) + \mathbf{k}_{i,j}(t)\cos(\alpha_{i,j}) \qquad (6)$$

The interactions of these "waves" (5) with matter and their different structures will be nonlinear. It must be noted that these are not the gravitational waves derived from a linearization of Einstein's General Relativity. In analogy to other nonlinear interactions with matter (e.g. nonlinear optics), with

$$\gamma_1 = \frac{k_1}{k_0}; \gamma_2 = \left(\frac{k_2}{k_0}\right)^2; \ldots\ldots \qquad (7)$$

a general correlation function Hi,j for the influence of two planets i, j can be established.

$$H_{i,j}(\alpha) = \gamma_1 F_{i,j} + \gamma_2 F_{i,j}^2 + \gamma_3 F_{i,j}^3 + \ldots \qquad (8)$$

Better suited is the transformation of (8) into a Fourier series.

$$H_{i,j}(\alpha) = a_0 + a_1\cos(\alpha) + a_2\cos(2\alpha) + a_3\cos(3\alpha) + \ldots. \qquad (9)$$

with $\alpha = \alpha_{i,j}$

The form (9) of the correlation function shows the emergence of "higher harmonics" at the interaction of the cosmic fluctuations with matter.

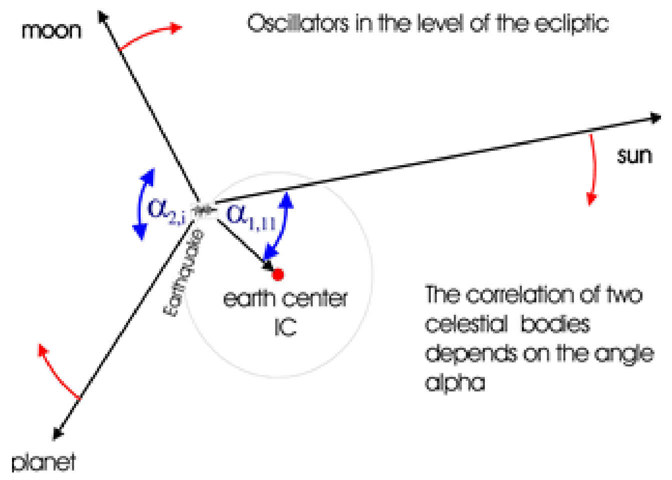

Figure 1: Angle α_2,i is the distance between the moon and and planet i. Angle $\alpha_{1,11}$ gives the angular difference between the sun and the center of the earth IC.

The Correlation Function

The problem of the correlation function is to determine the coefficients ak in (9) and to establish the meaning of H. It is not intended to measure a force or a "deflection" with H. That would certainly cause insurmountable difficulties experimentally, if one wanted to determine the influence of the fluctuations on test bodies with rotating lead balls. Moreover, the evolution, which has extended over millions of years, can hardly be simulated in the experiment.

It is obvious to construct a correlation function H which interacts with stable (harmonic) and unstable (disharmonic) states in areas a) to d). These states can then act as exciters or triggers The determination of the coefficients ak from statistical investigations of labile or chaotic processes, in which small disturbances can have an effect, is very time-consuming. Therefore, it seems reasonable to first obtain an approximation for the coefficients ak from theoretical considerations, which can then be adjusted by optimization procedures, if necessary. Since these are cosmic cycles from conjunction to conjunction, one can take structural considerations to these oscillations as a starting point. If one takes as a basis the circle division (fig. 2), then the following structure points can be found:

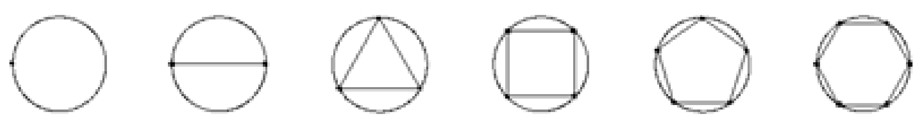

Figure 2: Structures of the circle division. The starting point is the conjunction, followed by the opposition and so on.

1. Point: "Starting point" (conjunction)
2. Points: polar structure; opposites that require balancing. Due to their tension and, if necessary, the impossibility of balancing them, they can nevertheless form a unity over a longer period of time. Score: strongly discordant
3. Points: very stable structure; especially in engineering, it is a prerequisite for stability in mechanical constructions.Score: very harmonious
4. Points: unstable, dynamic structure; in engineering, this structure is often the basis for lever gears. Score: discordant
5. Points: quasi-stable pentagram - structure; borderline between stability and instability. Complicated patterns and structures can be formed, which do not repeat.Score: indifferent
6. Points: Honeycomb - structure; near-circular, relatively stable structure in the compound with good utilization of space.

Score: harmonious

The addition of further points is possible, but the changes in the qualities become smaller as the structure becomes more similar to the circle. These qualitative statements are quantified step by step and plotted in a diagram (Fig. 3).

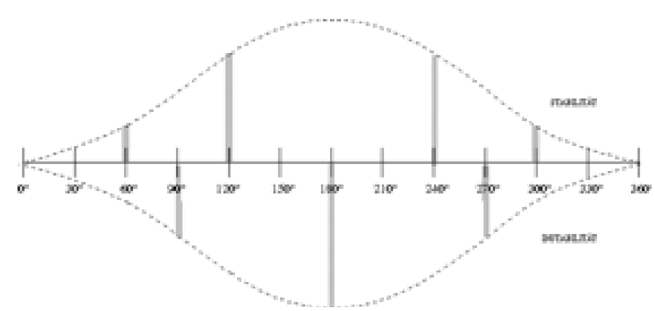

Figure 3: Quantification of the district division subdivided according to structural aspects.

A symmetrical oscillation and decay process is assumed. The image is the basis for a Fourier transform for the 1st approximation of the coefficients a_k.

Since it is a periodic cycle, a Fourier transform can be performed. The obtained coefficients are the first Fibonacci numbers (alternately mirrored (11). The correlation function takes the following form:

$$Hi,j = \sum_{s=1}^{N\cdot 12-1} a_k \cos(s \cdot \alpha); mit(k = s \bmod 12) \qquad (10)$$

(α computing after [5])

$$a_k = \{0,1,-2,3,-5,0,3,0,-5,3,-2,1\} \quad (11)$$

The 1st order correlation function is shown in Fig 4, which is a first approximation for studying the influence of cosmic fluctuations on the stable and unstable states of complex systems.

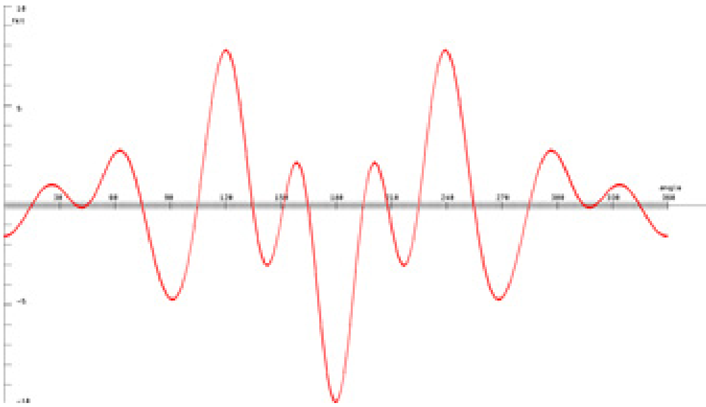

Figure 4: Correlation function 1st order. H i,j according 1st order to equation (10) with N=1. It was obtained via a Fourier transform from the structural aspects of Fig 3.

Consideration of higher orders may need to be made dependent on the problem under investigation. In general, it can be said that the higher orders will be more suitable for resonance and triggering.

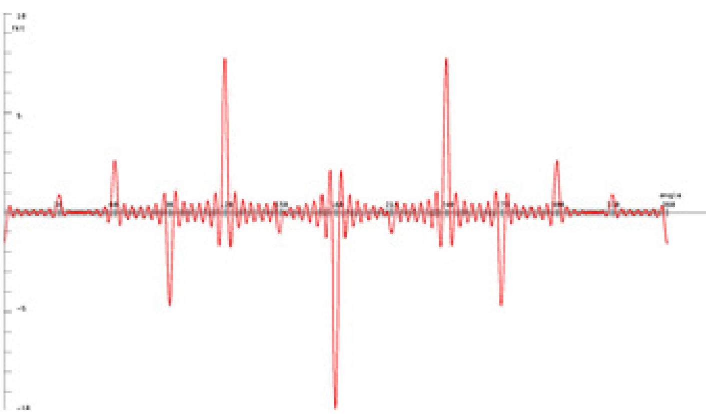

Figure 5: Correlation function Hi,j according 7st order to equation (10) with N=7. The higher orders of the correlation function are suitable for resonance problems.

It must be said at this point that the hypothesis: "Stable and unstable processes of complex systems are reflected in the structures of the circle division" seems daring at first. Only practical investigations can bring the confirmation that these assumptions are sufficient for a first approximation.

For this purpose, it must be ensured that the correlation function (10) is not only suitable for describing one process, but also provides useful results for different processes and states. These investigations were carried out in [11] and [14]. Expected values, at least in the tendency, must occur and no negative correlations must occur, in that z. e.g. the correlation function (10) indicates a higher probability for stability, but in reality there is a higher probability for an unstable state.

Earthquake

A First Study of the 41 Strongest Earthquake

(The 41 strongest earthquakes from 1900 to 2000. [15])

Are earthquakes triggered by the planetary gravitational field? This is particularly interesting because when strong earthquakes occur in densely populated areas of the earth, there is usually also great damage to buildings and, above all, many human lives are often lost.

Prior to an earthquake, stresses build up in the earth's crust, which then reach a critical state after a certain time. Generally starting with fore-shocks, these stresses are discharged in an earthquake, and it is not possible to predict the magnitude of the earthquake.

The investigations on the influence of planetary fluctuations on the triggering of earthquakes are based on the hypothesis that the reaching of a critical state of the stresses in the earth's crust happens within a certain time window. For this extremely unstable state, large-scale excitation field strengths of certain frequencies of the planetary fluctuations can then lead to the triggering of the earthquake and thus the relaxation of the earth's crust.

Can these expectations be confirmed?

They are the "strongest earthquakes" of the last century and the quakes with the most loss of life, overall events 41 that are being studied.

To evaluate the influence of planetary fluctuations on "earthquake" events, the following calculations were performed:

1.

a) Superposition of the correlation function $\Sigma H_{i,j}$ (harmonic function)

b) Superposition of the absolute amounts $| \Sigma H_{i,j} |$("energy" function)

c) Superposition of the derivative1. according to the correlation function Σ Di,j (time dynamics)

d) Superposition of the absolute values of the derivative1. according to the correlation function $| \Sigma D_{i,j} |$ (time dynamics absolute)

a) to d) Superposition of all earthquake 41 events related to sun, moon and selected planets.

2. Events in 100000the period from to 1900end were correlated.2000 The events are equally distributed over the period. The superposition, normalized to a group strength (here the 41 earthquakes), gives the statistically expected mean values.

3. Monte Carlo simulation was used to calculate the density function, since an exact calculation for 41 events leads to unacceptable computation times. As a control, the exact density function was calculated numerically for up to events.6

10 000 groups of 41 events each were randomly selected during the period from 1900 to the end of 2000.

4.To test the hypothesis: "The correlation function of the 41 earthquakes is significantly discordant", a one-sided significance test is performed. It is calculated what percentage of the randomly selected event groups have equal or smaller values for the superimposed correlation function $\Sigma H_{i,j}$. This percentage value represents the probability of error of the hypothesis.

If we first look at the density distribution of $\Sigma H_{i,j}$ (Fig 6) for the Sun, Moon and all planets and compare both with the mean value (expected values), the sum of all 41 earthquakes $\Sigma H_{i,j}$ is definitely still in the range of the expected values.

The correlations of sun, moon and all planets are below the expected value and also the "energy" is below the expected value but all in all there is no significant influence of the planetary fluctuations.

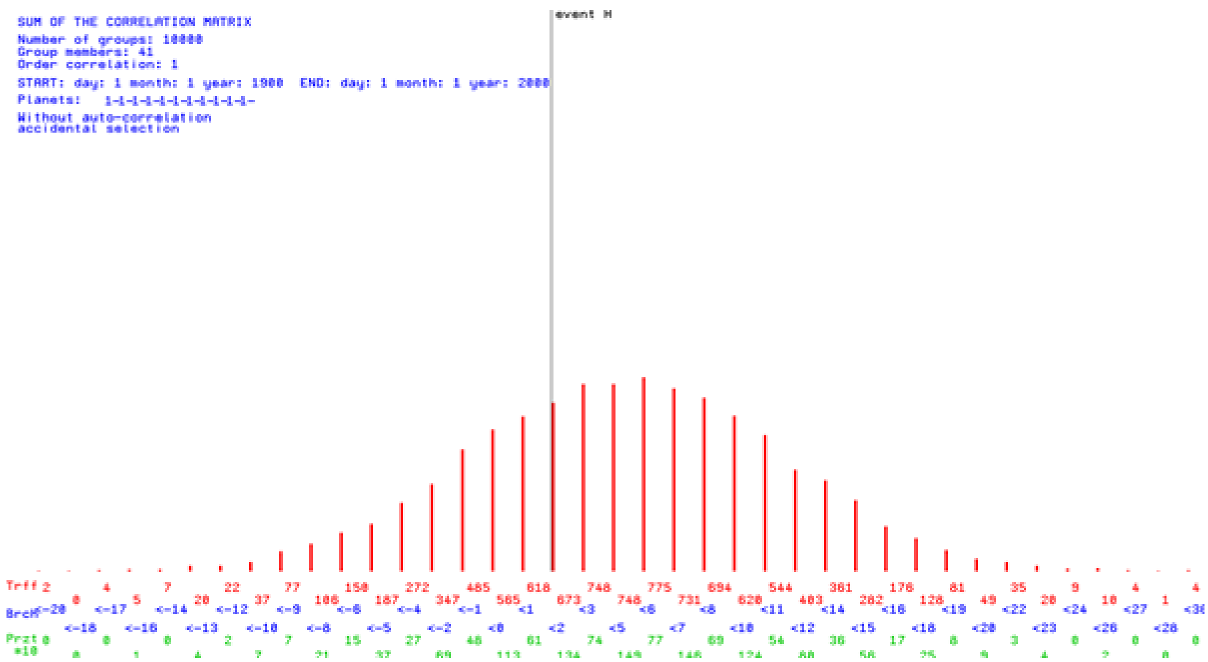

Figure 6: 1st order density function $H_{i,j}$ according to equation (10) with N=1. All planets were correlated. The blue numbers indicate the range, the red numbers indicate the hits in this range, and the green numbers indicate the relative hits in per mil.

This changes immediately, if the influences of sun, moon, Jupiter, Uranus and Neptune, which are to be expected according to the hypothesis, are considered separately. The harmonic function Hi,j is now highly significant far below the expected value (0.03% probability of error for the hypothesis). If Saturn, whose frequencies do not play a major role here, is added, the result is still highly significant 0.85% (99.15% of the 10 000 control groups are more harmonic).

Here is the computer printout for all major planets (red and blue indicate significance):

Statistics 4: Probability of events: correlation matrix H Order of the correlation: 1; time shift d: 0 h: 0; GROUP-MEMBERS: 41; NUMBER OF THE GROUPS: 100000

Julian-date-start: 2415019.458333 Julian-date-end: 2451544.458345 Accidental selection; TEST: Number of accidental selection >= correlation

Statistics 4: Probability of events: correlation matrix H
Order of the correlation: 1 ; time shift d: 0 h: 0;
GROUP-MEMBERS: 41 ; NUMBER OF THE GROUPS: 100000
Julian-date-start: 2415019.458333 Julian-date-end: 2451544.458345
Accidental selection; TEST: Number of accidental selection >= correlation

CORRELATION-MATRIX H AS INPUT

	1	2	3	4	5	6	7	8	9	10
1	*	-1.07	*	*	*	-0.72	0.56	-0.52	-0.56	*
2	-1.07	*	*	*	*	0.09	0.60	-0.73	-0.72	*
3	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*
6	-0.72	0.09	*	*	*	*	-0.75	-0.50	-0.96	*
7	0.56	0.60	*	*	*	-0.75	*	-0.27	1.08	*
8	-0.52	-0.73	*	*	*	-0.50	-0.27	*	-1.05	*
9	-0.56	-0.72	*	*	*	-0.96	1.08	-1.05	*	*
10	*	*	*	*	*	*	*	*	*	*

Matrix H of the probability of error:

	1	2	3	4	5	6	7	8	9	10		
1	*	97.47	*	*	*	93.26	15.43	84.00	85.56	*	PR	97.71
2	97.47	*	*	*	*	43.76	13.44	90.97	90.57	*	PR	93.14
3	*	*	*	*	*	*	*	*	*	*	PR	0.00
4	*	*	*	*	*	*	*	*	*	*	PR	0.00
5	*	*	*	*	*	*	*	*	*	*	PR	0.00
6	93.26	43.76	*	*	*	*	91.65	82.20	96.36	*	PR	99.00
7	15.43	13.44	*	*	*	91.65	*	72.51	1.79	*	PR	15.19
8	84.00	90.97	*	*	*	82.20	72.51	*	81.46	*	PR	98.49
9	85.56	90.57	*	*	*	96.36	1.79	81.46	*	*	PR	91.59
10	*	*	*	*	*	*	*	*	*	*	PR	0.00

bigger are: 99.15 %

1=SUN; 2=MOON; 3=MERKUR; 4=VENUS; 5=MARS; 6=JUPITER; 7=SATURN; 8=URANUS; 9=NEPTUN; 10=PLUTO; 11=IC;
BEGIN: year: 1900 month: 1 day: 1 hour: 0 END: year: 2000 month: 1 day: 1 hour: 0

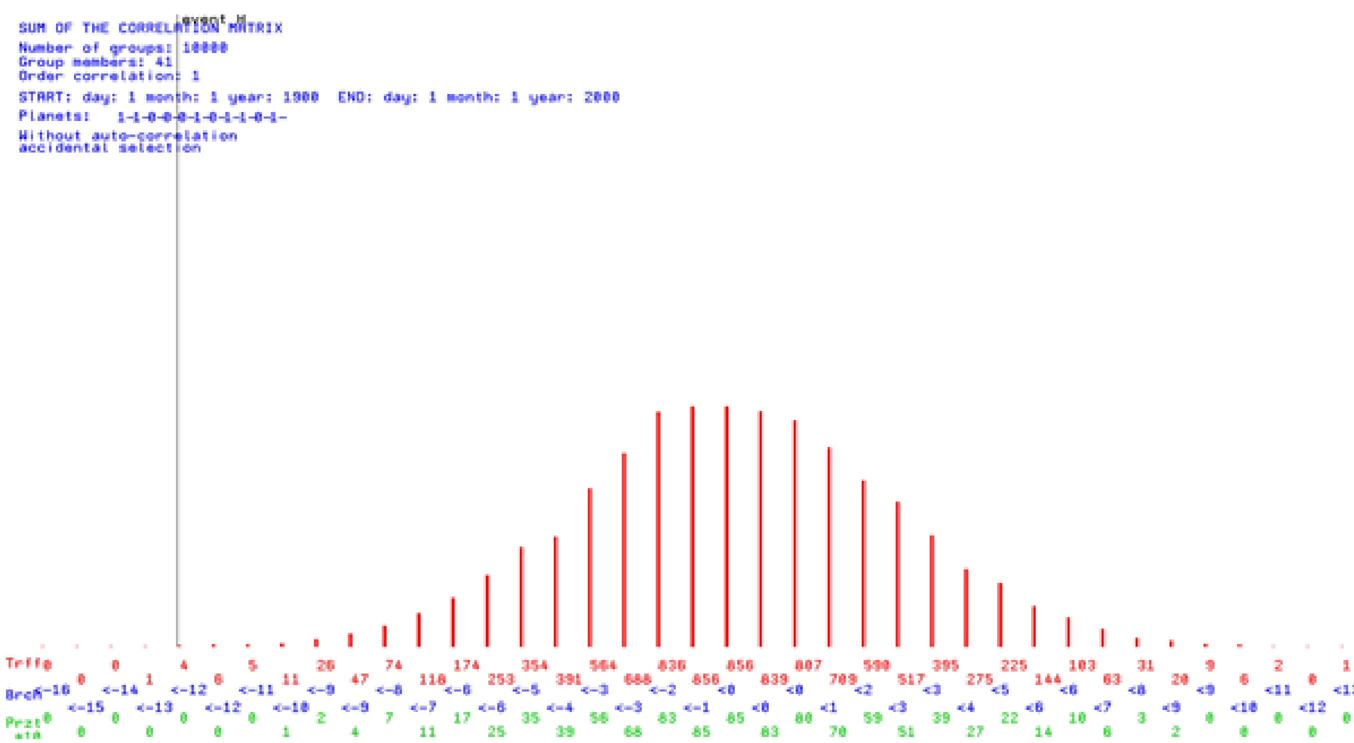

Figure 7: 1st order density function $\Sigma H_{i,j}$ according to equation (10) with N=1. Sun, Moon, Jupiter, Uranus and Neptune were correlated. The significance is very high 0.03% (99.97 % of the 10 000 control groups are more harmonic).

The expected values of the correlation Uranus - Neptune are caused by the large oscillation period (approx. T 1= 172 years in the fundamental frequency) of this correlation. According to equation (10) the following shorter periods still occur for this correlation: T2 = 86 years, T 34= 57 years, T6 = 43 years, T 8= years29, T = years22, T9 = years19, T10 = 17 years and T11 = 16 years (all values rounded). The two planets had an opposition in the last century in 1906/1908, a trine in 1935/1937, a square in 1949/1951, a sextile in 1963/1965, and a conjunction in 1992/1994. In the last century the negative parts of the function H8,9 predominate.

It was not the aim of this first investigation to derive concrete probabilities for the triggering of earthquakes. First of all, it is important to prove the effectiveness of planetary fluctuations of the gravitational field on highly complex processes on Earth, as represented by earthquake dynamics. This has been confirmed with the above investigations with an error probability of less than 1%. On the other hand, the correlation function derived from structural considerations on stability and instability is to be tested for its ability to describe the probability of stability and instability of complex processes and structure formation processes. It was therefore logical to apply this function also and perhaps primarily to a process which makes an influence of gravitational fluctuations on complex physical systems seem plausible from the outset.

Two investigations are still connected here:

1. Are the higher orders (harmonics) better at indicating triggering of earthquakes?
2. Is the period before and after the earthquake more meaningful?
3. Which frequencies could be relevant for triggering?

The following table shows the probabilities for orders 1 to 12 of the correlation function for Sun, Moon, Jupiter, Saturn, Uranus, Neptune.

Table 1: Probabilities in % for the correlation function and its 1st derivative. The significant values are drawn in blue. The correlation function shows relatively high values up to order 6. From the order 2 on, the energy becomes significant (with the exception of the order 3.)

Order/Probability	1	2	3	4	5	6	7	9	12
Correlation	99.15	77.29	85.26	95.82	94.59	87.11	45.78	34.87	36.59
Energy	45.32	98.06	85.80	98.40	95.03	98.84	96.99	96.99	98.14
Dynamic	90.49	23.32	64.51	43.03	51.67	62.31	88.69	53.53	32.19
Dynamic absolut	44.68	43.78	36.78	83.49	52.92	95.56	81.71	82.81	80.01

Table 2: Time shift to 5 days before and after the event for the order 1.

Order 1 time-shift/ Probability	-5d	-3d	-2d	-1d	-6h	0	+6h	+1d	+2d	+3d	+5d
Correlation	74.90	96.95	87.26	97.84	99.18	99.15	99.32	93.35	91.22	95.66	63.02
Energy	67.46	87.18	86.37	56.45	46.27	45.32	50.21	59.80	64.61	30.93	23.89
Dynamic	30.35	73.59	31.18	76.54	90.42	90.49	93.60	65.70	49.11	94.54	64.58
Dynamic absolut	78.70	66.45	80.57	57.62	53.92	44.68	36.46	55.88	64.52	71.83	88.74

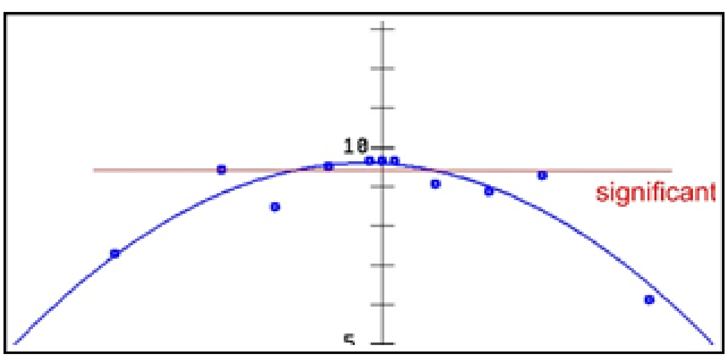

Figure 8: Graphical representation to table 2 for correlation. The compensation curve indicates the maximum significance for 8 hours before the event. However, this is not certain and would need further verification.

Table 3: Time shift up to 5 days before and after the event for the 7th order. The energy is relatively low for the entire period. A trend cannot be identified with certainty. While the 1st order correlates more strongly with the quality of time (stability-instability), the triggering effect of the higher frequencies of the 7th order is remarkable for the energy.

Order 7 time-shift/ Probability	-5d	-3d	-2d	-1d	-6h	0	+6h	+1d	+2d	+3d	+5d
Correlation	66.42	77.35	52.19	26.07	67.48	45.78	50.14	33.28	25.50	79.75	17.83
Energy	97.87	94.69	72.97	95.27	88.58	96.99	97.97	96.46	98.30	63.50	69.23
Dynamic	44.61	45.91	33.62	46.74	10.58	88.69	64.40	17.84	42.15	40.13	98.96
Dynamic absolut	90.39	87.67	74.76	54.04	81.56	81.71	78.54	92.18	62.45	45.11	21.25

Generally, it is expected that the energy for triggering could be high. In addition, the high frequencies of the sun and moon should be particularly suitable. The correlation function for the 12th order does not indicate this:

```
Statistics 4: Probability of events: correlation matrix H
 Order of the correlation: 12 ; time shift d: 0 h: 0;
  GROUP-MEMBERS: 41 ; NUMBER OF THE GROUPS: 10000
  Julian-date-start: 2415019.458333 Julian-date-end: 2451544.458345
  Accidental selection;  TEST: Number of accidental selection >= correlation
   CORRELATION-MATRIX H AS INPUT
            1        2        3        4        5        6        7        8        9       10

   1        *      -0.19      *        *        *      -0.02    -0.12    -0.02     0.06      *
   2      -0.19      *        *        *        *       0.33     0.19    -0.04    -0.03      *
   3        *        *        *        *        *        *        *        *        *        *
   4        *        *        *        *        *        *        *        *        *        *
   5        *        *        *        *        *        *        *        *        *        *
   6      -0.02     0.33      *        *        *        *       0.03    -0.08    -0.11      *
   7      -0.12     0.19      *        *        *       0.03      *       0.06     0.04      *

   8      -0.02   -0.04     *       *       *     -0.08    0.06     *      0.03     *
   9       0.06   -0.03     *       *       *     -0.11    0.04    0.03     *       *
  10        *       *       *       *       *       *       *       *       *       *

   Matrix H of the probability of error:
            1       2       3       4       5       6       7       8       9      10

   1        *     89.47     *       *       *     57.89   80.66   57.86   31.86     *    PR  80.92
   2      89.47     *       *       *       *      2.02   10.35   63.91   59.03     *    PR  22.38
   3        *       *       *       *       *       *       *       *       *       *    PR   0.00
   4        *       *       *       *       *       *       *       *       *       *    PR   0.00
   5        *       *       *       *       *       *       *       *       *       *    PR   0.00
   6      57.89    2.02     *       *       *       *     41.61   68.11   78.90     *    PR  30.23
   7      80.66   10.35     *       *       *     41.61     *     27.41   41.16     *    PR  26.67
   8      57.86   63.91     *       *       *     68.11   27.41     *     34.58     *    PR  47.75
   9      31.86   59.03     *       *       *     78.90   41.16   34.58     *       *    PR  47.10
  10        *       *       *       *       *       *       *       *       *       *    PR   0.00
   bigger are:   36.59 %
  1=SUN;  2=MOON;  3=MERKUR;  4=VENUS;  5=MARS;  6=JUPITER;  7=SATURN;  8=URANUS;  9=NEPTUN; 10=PLUTO; 11=IC;
  BEGIN: year: 1900 month: 1 day: 1 hour: 0  END: year: 2000 month: 1 day: 1 hour: 0
```

Statistics 4: Probability of events: energy I
Order of the correlation: 12 ; GROUP-MEMBERS: 41 ; NUMBER OF THE GROUPS: 10000
Accidental selection; TEST: Number of accidental selection >= correlation
MATRIX I energy AS INPUT (absolute)

	1	2	3	4	5	6	7	8	9	10
1	*	0.31	*	*	*	0.21	0.33	0.24	0.29	*
2	0.31	*	*	*	*	0.65	0.32	0.16	0.34	*
3	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*
6	0.21	0.65	*	*	*	*	0.20	0.37	0.27	*
7	0.33	0.32	*	*	*	0.20	*	0.20	0.22	*
8	0.24	0.16	*	*	*	0.37	0.20	*	0.30	*
9	0.29	0.34	*	*	*	0.27	0.22	0.30	*	*
10	*	*	*	*	*	*	*	*	*	*

Matrix I of the probability of error:

	1	2	3	4	5	6	7	8	9	10		
1	*	61.11	*	*	*	84.07	50.05	79.44	64.15	*	PR	91.69
2	61.11	*	*	*	*	5.29	55.89	98.61	50.47	*	PR	56.65
3	*	*	*	*	*	*	*	*	*	*	PR	0.00
4	*	*	*	*	*	*	*	*	*	*	PR	0.00
5	*	*	*	*	*	*	*	*	*	*	PR	0.00
6	84.07	5.29	*	*	*	*	90.71	40.01	67.73	*	PR	59.01
7	50.05	55.89	*	*	*	90.71	*	91.09	86.20	*	PR	97.17
8	79.44	98.61	*	*	*	40.01	91.09	*	66.55	*	PR	98.00
9	64.15	50.47	*	*	*	67.73	86.20	66.55	*	*	PR	91.07
10	*	*	*	*	*	*	*	*	*	*	PR	0.00

bigger are: **98.14 %**
1=SUN; 2=MOON; 3=MERKUR; 4=VENUS; 5=MARS; 6=JUPITER; 7=SATURN; 8=URANUS; 9=NEPTUN; 10=PLUTO; 11=IC;
BEGIN: year: 1900 month: 1 day: 1 hour: 0 END: year: 2000 month: 1 day: 1 hour: 0

Statistics 4: Probability of events: dynamics
Order of the correlation: 12 ; GROUP-MEMBERS: 41 ; NUMBER OF THE GROUPS: 10000
Accidental selection; TEST: Number of accidental selection >= correlation
MATRIX D dynamics AS INPUT (absolute)

	1	2	3	4	5	6	7	8	9	10
1	*	-14.64	*	*	*	-8.19	-3.41	7.55	25.65	*
2	-14.64	*	*	*	*	-39.52	13.05	7.42	6.41	*
3	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*
6	-8.19	-39.52	*	*	*	*	6.63	10.75	-5.18	*
7	-3.41	13.05	*	*	*	6.63	*	14.83	5.91	*
8	7.55	7.42	*	*	*	10.75	14.83	*	0.32	*
9	25.65	6.41	*	*	*	-5.18	5.91	0.32	*	*
10	*	*	*	*	*	*	*	*	*	*

Matrix D of the probability of error:

	1	2	3	4	5	6	7	8	9	10		
1	*	87.19	*	*	*	75.85	61.24	26.72	2.66	*	PR	39.52
2	87.19	*	*	*	*	99.73	15.21	28.17	29.26	*	PR	82.33
3	*	*	*	*	*	*	*	*	*	*	PR	0.00
4	*	*	*	*	*	*	*	*	*	*	PR	0.00
5	*	*	*	*	*	*	*	*	*	*	PR	0.00
6	75.85	99.73	*	*	*	*	30.92	19.13	65.70	*	PR	89.97
7	61.24	15.21	*	*	*	30.92	*	15.66	35.15	*	PR	12.77
8	26.72	28.17	*	*	*	19.13	15.66	*	50.43	*	PR	9.78
9	2.66	29.26	*	*	*	65.70	35.15	50.43	*	*	PR	13.05
10	*	*	*	*	*	*	*	*	*	*	PR	0.00

bigger are: 32.19 %
1=SUN; 2=MOON; 3=MERKUR; 4=VENUS; 5=MARS; 6=JUPITER; 7=SATURN; 8=URANUS; 9=NEPTUN; 10=PLUTO; 11=IC;
BEGIN: year: 1900 month: 1 day: 1 hour: 0 END: year: 2000 month: 1 day: 1 hour: 0

```
  Statistics 4: Probability of events: dynamics abs
Order of the correlation: 12 ; GROUP-MEMBERS: 41 ; NUMBER OF THE GROUPS: 10000
Accidental selection TEST: Number of accidental selection >= correlation

MATRIX DA dynamics abs AS INPUT (absolut)
         1       2       3       4       5       6       7       8       9      10

 1       *     38.47     *       *       *     31.56   34.31   31.65   40.00     *
 2     38.47     *       *       *       *     79.24   31.09   30.59   39.88     *
 3       *       *       *       *       *       *       *       *       *       *
 4       *       *       *       *       *       *       *       *       *       *
 5       *       *       *       *       *       *       *       *       *       *
 6     31.56   79.24     *       *       *       *     28.32   36.75   40.13     *
 7     34.31   31.09     *       *       *     28.32     *     35.29   36.19     *
 8     31.65   30.59     *       *       *     36.75   35.29     *     34.80     *
 9     40.00   39.88     *       *       *     40.13   36.19   34.80     *       *
10       *       *       *       *       *       *       *       *       *       *
 Matrix DA of the probability of error:
         1       2       3       4       5       6       7       8       9      10

 1       *     54.98     *       *       *     71.64   64.87   77.70   47.62     *    PR  84.09
 2     54.98     *       *       *       *      0.36   79.72   82.15   48.87     *    PR  27.81
 3       *       *       *       *       *       *       *       *       *       *    PR   0.00
 4       *       *       *       *       *       *       *       *       *       *    PR   0.00
5       *       *       *       *       *       *       *       *       *       *    PR   0.00
 6     71.64    0.36     *       *       *       *     86.24   54.86   43.01     *    PR  23.89
 7     64.87   79.72     *       *       *     86.24     *     60.59   54.95     *    PR  91.90
 8     77.70   82.15     *       *       *     54.86   60.59     *     76.56     *    PR  93.07
 9     47.62   48.87     *       *       *     43.01   54.95   76.56     *       *    PR  67.58
10       *       *       *       *       *       *       *       *       *       *    PR   0.00
 bigger are:   80.01 %
1=SUN;  2=MOON;  3=MERKUR;  4=VENUS;  5=MARS;  6=JUPITER;  7=SATURN;  8=URANUS;  9=NEPTUN; 10=PLUTO; 11=IC;
BEGIN: year: 1900 month: 1 day: 1 hour: 0  END: year: 2000 month: 1 day: 1 hour: 0
```

The low energy (***98.14%** of the 10 000 control groups have a higher energy*) at the time of the earthquake seems strange. It is reasonable to assume that before the time of the event the energy is higher.

An investigation can confirm this assumption for sun and moon:

Table 4: Time shift for correlation of sun and moon.

Order 12 time-shift/ Probability So-Mo	**-24h**	**-11h**	**-10h**	**-9h**	**-8h**	**-7h**	**-6h**	**-5h**	**-3h**	**0**	**+3h**	**+6h**	**+9h**	**+12h**	**+18h**	**+24h**
Correlation	17.18	95.33	97.84	95.08	81.22	61.59	63.91	70.05	27.52	89.45	66.08	59.67	69.49	99.09	35.91	83.90
Energy	57.78	15.71	13.17	18.17	4.51	0.95	3.10	30.73	73.21	60.87	67.15	96.44	36.68	11.08	68.76	66.61
Dynamic	85.55	85.62	44.46	11.44	11.90	37.09	62.17	45.59	23.15	86.90	25.11	17.90	98.92	8.47	41.71	88.09
Dynamic absolute	69.35	43.28	21.45	1.80	2.80	53.10	19.60	5.58	78.23	54.10	44.15	61.82	29.24	60.94	73.11	74.05

Accordingly, 10 hours before an earthquake, the correlation is very discordant, with simultaneous increases in energy first in the dynamics and then in the correlation function.
Are these random oscillations? Can this be generalized? Does this only apply to these very large earthquakes?

A study of earthquakes 588

The investigation of the strongest earthquakes of a century has shown that a correlation with the harmonics of the planetary gravitational field can be proved. This could be proved with an error probability of less than one percent.

Nevertheless, it cannot be ruled out that it is an artifact. Therefore further Groups of earthquakes at smaller time periods examined. The addition in magnitude of smaller earthquakes could cause a stronger noise, so that no significant correlations are detectable.

The following studies refer to earthquakes in the years up to a 1996total2002, of earthquakes with a magnitude of m = 6.5 and greater or that caused severe damage [6].

The following questions were examined:
What order of correlation best describes possible triggering of earthquakes. Are there special frequencies that are suitable for triggering?

The results are shown in the following table:

Table 5. 588 Earthquakes unsorted; (*Earthquakes of magnitude 6.5 or greater or ones that caused fatalities, injuries or substantial damage. BRK--Berkeley. PAS--Pasadena.*) ; Time period 1996 to 2003.

Order /Probability 1996-2003 Periode	1	3	4	5	7	9	12	1900-2100 Period
Correlation Harmonie; all planets just sun and moon	31.47	79.43	85.8	65.1	62.13	58.87	60.40	62.37
	78.63	27.33	28.87	35.33	74.90	61.33	63.80	
	73.47	30.53	12.77	15.03	34.10	44.97	41.23	
Energy; all planets just sun and moon all planets with gravity*	19.10	55.93	41.9	39.43	35.90	19.50	27.41	0.20
	4.73	3.07	1.23	1.03	0.97	0.33	0.17	
	21.83	18.57	12.67	11.27	8.07	2.97	1.47	
Dynamic; all planets just sun and moon all planets with gravity*	93.27	38.7	34.23	46.37	16.6	37.0	12.52	61.99
	99.27	79.67	69.73	77.73	23.13	53.13	62.53	
	92.07	40.27	24.57	83.30	75.37	57.37	97.80	
Dynamic absolut; all planets just sun and moon all planets with gravity*	30.7	21.13	56.7	51.0	54.97	82.47	31.40	1.97
	72.10	27.47	27.53	24.03	15.60	21.73	2.00	
	59.47	63.33	64.07	61.90	62.17	69.27	38.69	

* Weighting of the planets, oriented to the effect of gravity	sun weight:	57.20
	moon weight:	10.24
	mercury weight:	0.31
	venus weight:	0.77
	mars weight:	0.30
	jupiter weight:	1.87
	saturn weight:	0.84
	uranus weight:	0.28
	neptun weight:	0.22
	pluto weight:	0.01
	IC weight:	57.20

For this list of earthquakes only the energy of sun and moon is significant and highly significant. This is also true for a larger time period (1900 to 2100) of the comparative calculations according to the Monte Carlo simulation.

The 4th order shows for the matrix of correlation (harmony and dysharmony) the largest values for disharmony. With 85% the control groups are more harmonious than the earthquake group. A look at the matrix shows that strongly differentiated behavior of the individual correlations: strongly disharmonious are Sun-Venus, Moon-Mars, Venus-Saturn, Saturn-Uranus, Moon-Neptune, Venus- Pluto, Mars-Pluto, Venus-IC (Imum Coeli, represents the center of the Earth), Saturn-IC.

Looking at the row sums of the correlation matrix, Venus and the IC are significantly disharmonic. There does not seem to be an explanation for this based on the effect of gravity.

Statistics 4: Probability of events: correlation matrix H

Order of the correlation: 4 ; time shift d: 0 h: 0;
GROUP-MEMBERS: 588 ; NUMBER OF THE GROUPS: 3000
Julian-date-start: 2450083.458333 Julian-date-end: 2452640.458345
Accidental selection; TEST: Number of accidental selection >= correlation

CORRELATION-MATRIX H AS INPUT

	1	2	3	4	5	6	7	8	9	10	11
1	*	0.04	-0.10	-0.06	0.06	-0.08	0.01	0.07	-0.00	0.00	0.09
2	0.04	*	0.04	0.02	-0.13	-0.02	-0.04	0.02	-0.12	0.08	-0.02
3	-0.10	0.04	*	0.11	-0.05	-0.06	-0.05	0.05	0.10	0.15	-0.08
4	-0.06	0.02	0.11	*	0.06	-0.04	-0.09	0.02	-0.06	-0.08	-0.15
5	0.06	-0.13	-0.05	0.06	*	-0.09	-0.17	0.21	0.12	-0.05	-0.08
6	-0.08	-0.02	-0.06	-0.04	-0.09	*	0.03	0.05	-0.02	0.09	0.04
7	0.01	-0.04	-0.05	-0.09	-0.17	0.03	*	0.10	0.32	-0.15	-0.14
8	0.07	0.02	0.05	0.02	0.21	0.05	0.10	*	-0.00	0.56	0.02
9	-0.00	-0.12	0.10	-0.06	0.12	-0.02	0.32	-0.00	*	-0.18	-0.04
10	0.00	0.08	0.15	-0.08	-0.05	0.09	-0.15	0.56	-0.18	*	-0.08
11	0.09	-0.02	-0.08	-0.15	-0.08	0.04	-0.14	0.02	-0.04	-0.08	*

Matrix H of the probability of error:

	1	2	3	4	5	6	7	8	9	10	11		
1	*	29.47	67.13	**100.00**	25.33	93.60	48.90	17.10	50.40	50.23	10.10	PR	39.53
2	29.47	*	32.37	41.20	**96.83**	57.60	68.43	36.63	**95.10**	13.40	61.10	PR	70.90
3	67.13	32.37	*	46.40	82.60	62.93	75.17	61.37	33.97	12.40	86.30	PR	64.80
4	100.00	41.20	46.40	*	50.03	88.90	**94.67**	42.63	62.50	**98.40**	**97.97**	PR	**99.90**
5	25.33	96.83	82.60	50.03	*	25.03	19.87	33.27	7.57	**96.63**	86.27	PR	60.70
6	93.60	57.60	62.93	88.90	25.03	*	93.27	17.10	13.70	6.83	29.73	PR	35.00
7	48.90	68.43	75.17	94.67	19.87	93.27	*	**95.87**	5.13	28.30	**97.83**	PR	81.03
8	17.10	36.63	61.37	42.63	33.27	17.10	95.87	*	90.63	47.80	44.87	PR	43.47
9	50.40	95.10	33.97	62.50	7.57	13.70	5.13	90.63	*	70.57	71.23	PR	21.47
10	50.23	13.40	12.40	98.40	96.63	6.83	28.30	47.80	70.57	*	84.97	PR	49.67
11	10.10	61.10	86.30	97.97	86.27	29.73	97.83	44.87	71.23	84.97	*	PR	**97.50**

bigger are: 85.80 %

1=SUN; 2=MOON; 3=MERKUR; 4=VENUS; 5=MARS; 6=JUPITER; 7=SATURN; 8=URANUS; 9=NEPTUN; 10=PLUTO; 11=IC;

BEGIN: year: 1996 month: 1 day: 1 hour: 0 END: year: 2003 month: 1 day: 1 hour: 0

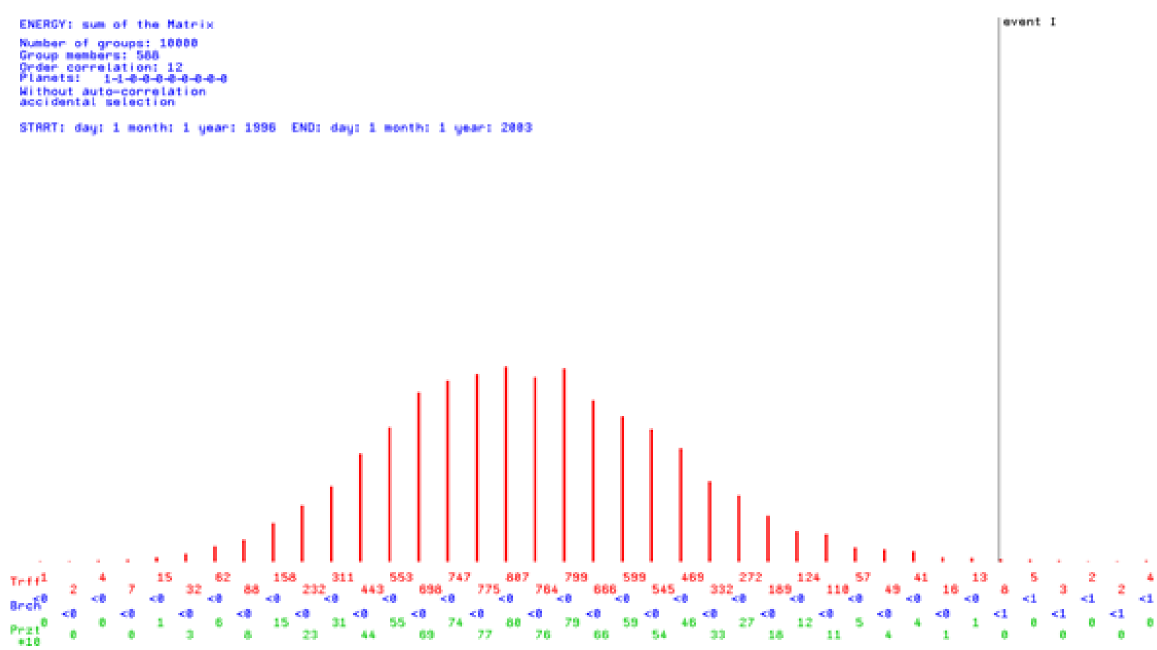

Figure 9: Density function for the 12th order energy of the Sun and Moon for 588 earthquakes.

This result suggests that for this group of earthquakes the energy could be a trigger. 588 earthquakes distributed over 7 years corresponds to an average of 7 earthquakes per month. It is understandable that in such short periods the major planets show only small changes in their correlation function.

The sun and moon are better for that.

To illustrate this, December 2000 is examined in more detail here. During this period 8 earthquakes took place.

Table 6: 8 earthquakes for the period 2000-12 from the list of 588 earthquakes.

Number in list	Magnitude	Länge	Breite	Datum	Zeit
495	7.0	54.48	39.34	06.12.2000	17:11:06
401	6.4	152.43	-4.13	06.12.2000	22:11:06
374	6.1	-82.41	6.90	12.12.2000	05:26:46
174	5.9	31.21	38.27	15.12.2000	16:44:48
532	6.5	-179.74	-21.11	18.12.2000	01:19:22
253	6.2	-74.40	-39.48	20.12.2000	11:23:54
105	6.5	154.21	-9.14	20.12.2000	16:49:43
424	6.4	151.73	-5.42	21.12.2000	01:01:28

The results are shown in Table 7:

Table 7: Correlation function according to the Monte-Carlo-Simulation (10000 control groups, each with 8 random selected events); 8 earthquakes for the period 2000-12 from the list of 588 earthquakes. The high significance's for the high orders are remarkable.

Order Probability in %	1	3	6	9	12
Correlation	1.17	0.15	0.37	0.27	0.34
Energy	1.02	0.03	0.05	0.01	0.03
Dynamic	37.12	82.59	36.09	0.23	0.91
Dynamic absolute	76.63	31.20	2.24	1.86	0.17

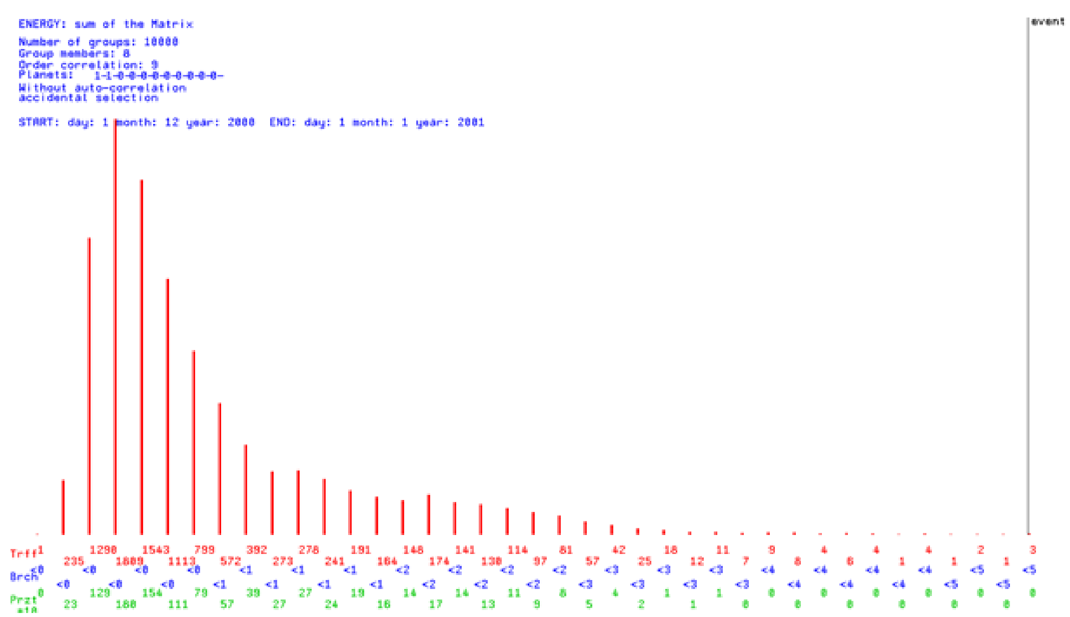

Figure 10: 9th order energy curve of the Sun and Moon for 8 earthquakes during 2000-12. Can these results be used for earthquake forecasting?

Fig 11 shows the correlation function and its first derivative. Assuming an energy level, 5 out of 8 earthquakes could be related to the correlation of the Sun and Moon. The expected value is 1.5 earthquakes out of 8 if there is no influence. Accordingly, about 3 earthquakes would be due to triggering by the Sun and Moon. However, it is only one month out of a period of 84 months (1996-2002).

If the investigations are extended to the entire period, then 96 of 588 events are above the level. The expected value for this entire period is 83 events. According to this, only 13 events would be due to a triggering of the sun and moon, which is 2.2%. This is too low for forecasting, but it clearly shows that there is also a certain increase in probability from the many other influences that can trigger an earthquake. This probability can be increased somewhat by adding other frequencies (those of Jupiter, Saturn and the IC) and the 1st derivative of the correlation function.

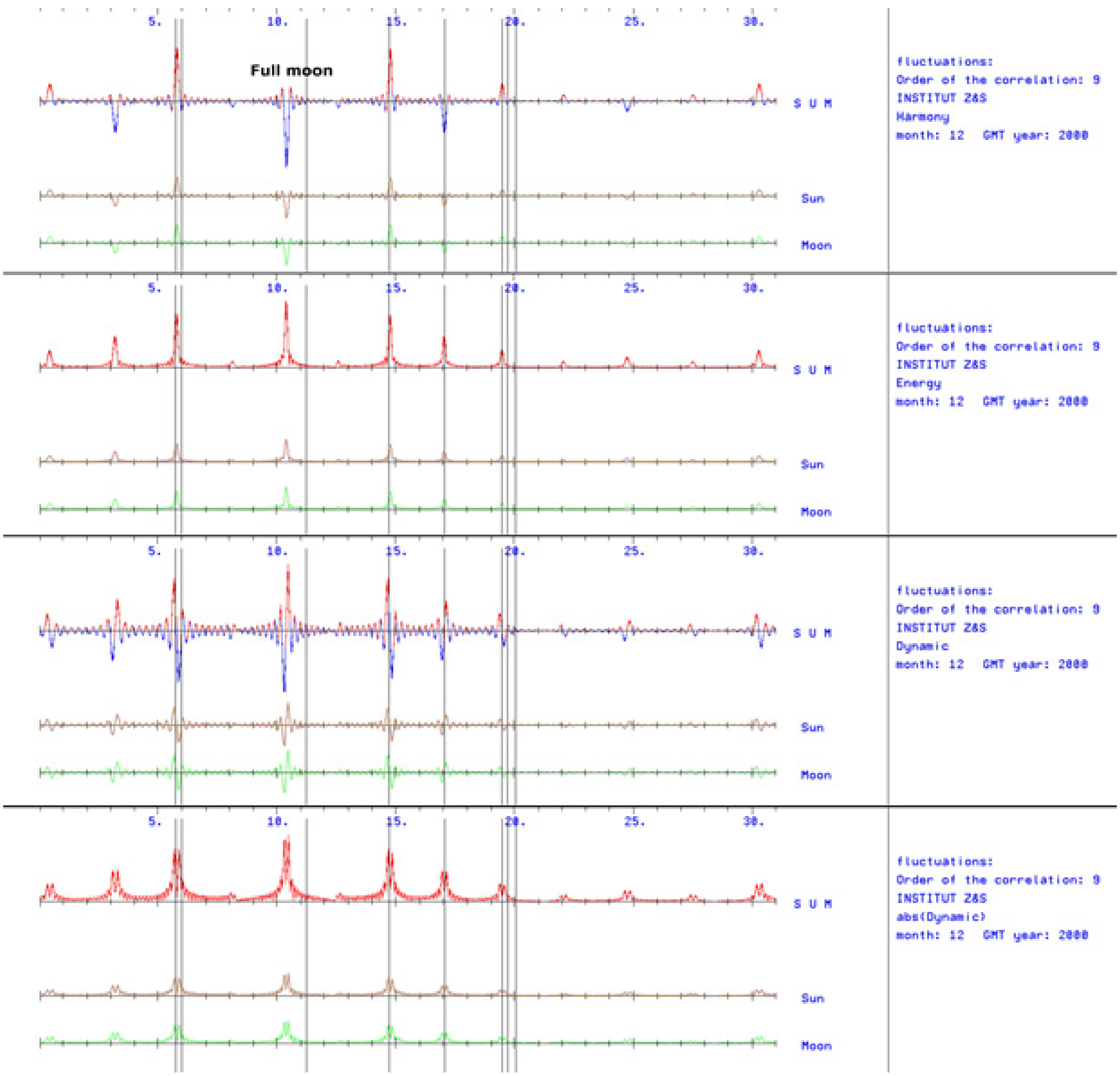

Figure 11: Correlation function and 9th-order first derivative of the Sun and Moon for 8 earthquakes during 2000-12. the solid vertical black lines indicate the events.

The same research applied to the first study of 41 earthquakes gives similar results. Of the 41 earthquakes, 8 are above the level for energy, the expected value is 5.9 earthquakes. There could be 2 of the 41 earthquakes triggered by the sun and moon. These initial investigations are only intended to show that further investigations appear to be useful. As can be seen in Fig. 12, in such a small period of time only high frequencies, as they are given by the sun and the moon, are suitable for a possible triggering of earthquakes. At the time of the full moon no earthquake took place. However about 24 hours later. Further investigations would have to show whether this is significant. Figure 9 shows the correlation function for the 1st order for comparison. It does not seem to be suitable for triggering.

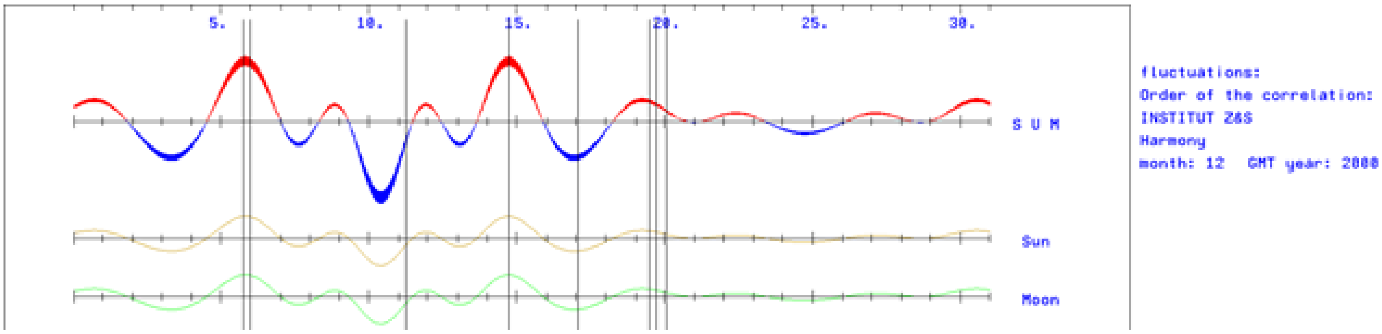

Figure 12: Correlation function (harmonic) for 1st order Sun and Moon for 8 earthquakes during 2000- 12.

Do the 588 earthquakes show similar behavior to the group of 41? Very many smaller earthquakes are certainly not to be compared with few, very large ones. There are also no groups formed according to depth or location!

Table 8. time shift for 588 earthquakes

Order 12 time- shift/ Probability So-Mo	**-24h**	**-11h**	**-10h**	**-9h**	**-8h**	**-7h**	**-6h**	**-5h**	**-3h**	**0**	**+3h**	**+6h**	**+9h**	**+12h**	**+18h**	**+24h**
Correlation	53.60	94.54	84.98	33.52	4.72	4.42	22.16	48.72	35.86	63.20	53.42	17.44	98.88	90.28	99.78	19.30
Energy	71.26	98.96	96.12	92.14	96.20	89.80	67.06	27.30	61.00	0.30	6.90	10.78	2.34	6.46	26.42	81.86
Dynamic	30.26	43.22	6.66	1.26	15.34	80.86	93.16	70.38	35.80	62.86	23.28	91.20	33.70	65.64	83.86	19.14
Dynamic absolute	79.70	65.24	90.64	98.06	85.74	67.26	58.32	77.82	25.20	2.38	0.30	1.50	0.24	0.20	0.36	53.88

In Table 8, we can at least see that at the time of the event, the energy in the correlation function was very high, as was the energy in the dynamics. A low energy (-11h) is driven to a high energy by a high dynamic (1st derivative), likewise the energy of the dynamic increases until the event. Can this scenario also be stated for the much larger period from 1900 to 2100. The results are shown in Table 9.

Table 9. Time displacement for 588 earthquakes during the period 1900 to 2100. Despite the much larger time period, the characteristic remains. That is amazing.

Order 12 time-shift/ Probability So-Mo	**-6h**	**-3h**	**-2h**	**-1h**	**0**	**+1h**	**+2h**	**+3h**	**+6h**
Correlation	20.28	34.63	35.40	51.18	64.58	66.40	61.74	54.10	16.32
Energy	67.96	63.24	67.66	29.32	0.22	0.00	0.86	7.16	10.78
Dynamic	93.08	34.72	63.38	74.16	63.88	51.18	39.88	21.78	91.14
Dynamic absolute	58.10	25.08	15.32	1.78	1.96	32.78	0.06	0.30	1.86

If we add the Earth's rotation as another high frequency, we get the results in Table 10.

Table 10: Time offsets for 588 earthquakes in the period 1996 to 2002. they are the correlations of the Sun, Moon and IC (Earth's rotation).

Order 10 time-shift/ Probability So-Mo-IC	-6h	-5h	-4h	-3h	-2h	-1h	0	+1h	+2h	+3h	+4h	+5h	+6h
Correlation	66.72	36.08	64.64	41.16	32.96	25.90	38.98	69.78	61.64	66.18	9.12	7.36	61.38
Energy	92.06	35.04	64.60	56.82	81.02	30.72	0.10	1.75	19.46	3.24	4.90	80.32	5.70
Dynamic	85.62	95.04	92.36	32.72	6.36	84.56	74.78	84.66	42.46	1.84	4.22	60.60	79.40
Dynamic absolute	65.26	41.40	63.12	48.20	6.98	1.92	60.54	27.70	2.38	17.02	2.92	66.82	4.46

The expected value for high energy is 203 earthquakes. 222 have a higher energy in the correlation function. According to this, 19 earthquakes could be triggered by the sun, moon, and IC, which is 3.23 percent. That's a 1% increase. The IC, as expected, brings an increase in the probability of triggering because the local energy maxima indicated by the IC with the Sun and Moon occur at different times than those of the Sun and Moon. Certainly, the major planets Jupiter and Saturn (lower frequencies) in interaction with the high frequency of the earth's rotation are also of influence. This is shown in Table 11:

Table 11. Time offsets for 588 earthquakes in the period 1996 to 2002. they are the correlations of Jupiter, Saturn and IC (Earth rotation).

Order 10 time-shift/ Probability Ju-Sa-IC	-6h	-5h	-4h	-3h	-2h	-1h	0	+1h	+2h	+3h	+4h	+5h	+6h
Correlation	55.02	7.54	26.24	71.50	64.88	56.24	61.08	69.78	3.16	88.48	55.96	69.50	62.68
Energy	20.76	65.46	83.54	72.32	58.30	43.56	0.58	1.75	0.02	10.30	23.62	84.92	28.32
Dynamic	41.70	26.12	98.00	41.92	78.18	25.58	89.82	84.66	95.94	57.84	83.06	47.34	91.90
Dynamic absolute	36.00	75.98	84.02	72.58	26.74	14.56	14.58	27.70	1.38	19.46	34.08	63.14	14.44

The energy peaks between the IC and the planets Jupiter and Saturn are at different points on the time axis than those from the IC with the Sun and Moon. The expected value is 159 earthquakes. 176 earthquakes show higher energy, which is 2.9% above the expected value.

Summary

According to the calculations it seems possible that about 6% of the 588 earthquakes are triggered by Sun, Moon, IC, Jupiter and Saturn. This figure of 6% can certainly be increased if the energy level is optimized and other elements of the correlation function are added. For further investigation, it can be hypothesized that a trigger or threshold energy exists that is constantly decreasing. Before this threshold energy becomes zero, small external disturbances (e.g., weather events) may be triggering. But this can also be the fluctuations of the planetary gravitational field in the higher frequencies. Earthquakes occur at all times. When the threshold energy drops, they can also be triggered by harmonics of the gravitational field. This seems to be a characteristic of highly complex nonlinear systems that small external energies can trigger large changes.

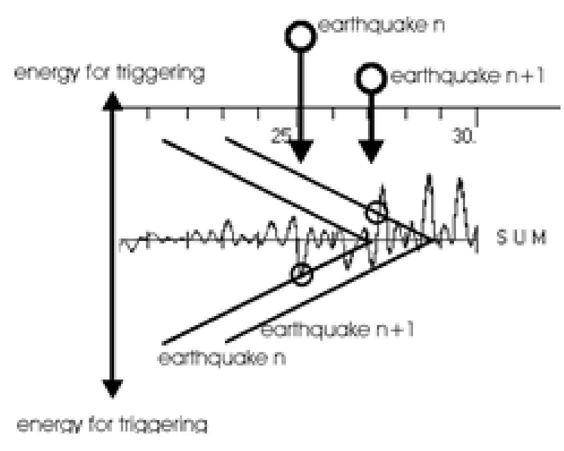

Figure 13: Model of triggering earthquakes.

Our planetary system is highly complex. The nonlinear dynamics of this system also has an influence on the triggering of earthquakes. This now seems to be a fact and opens the door for further investigations. (Figure taken from [12])

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16. Name I Name II Ort Laenge Breite Zone Datum Zeit Sommerzeit

17.

Name I	Name II	Ort	Laenge	Breite	Zone	Datum	Zeit	Sommerzeit
China	Tangshan	Peking	116.041	39.91	8	28 07 1976	12 00 00	0
Japan	Yokohama	Yokohama	141.025	41.6	10	01 09 1923	12 00 00	0
China	Gansu	Peking	116.041	39.91	8	16 12 1920	12 00 00	0
Peru	Norden	Lima	-77.005	-12.5	-5	31 05 1970	12 00 00	0
Iran	Nordwesten	Teheran	51.043	35.6	3	21 06 1990	12 00 00	0
Tuerkei	Osten	Ankara	32.086	39.93	2	26 12 1939	12 00 00	0
Chile	Chillan	Santiago	-70.006	-33.45	-5	24 01 1939	12 00 00	0
Iran	Nordosten	Teheran	51.043	35.6	3	16 09 1978	12 00 00	0
Armenien	Nordwesten	Jerewan	44.050	40.18	4	07 12 1988	12 00 00	0
Guatemala	Guatemala	Guatemala City	90.128	14.10	-6	04 02 1976	12 00 00	0
Indien	SW	Bombay	72.008	18.96	5	30 09 1993	12 00 00	0
Chile	Valparaiso	Santiago	-70.006	-33.45	-5	16 08 1906	12 00 00	0
Mexico	Mexico	Mexiko City	-99.015	19.40	-6	19 09 1985	12 00 00	0
Japan	Kobe	Tokyo	139.076	35.70	9	17 01 1995	12 00 00	0
Afghanistan	NO	Kabul	70.000	35.0	4	04 02 1998	12 00 00	0
Tuerkei	XY	Ankara	32.086	39.93	2	17 08 1999	12 00 00	0
L1-1	Nordjapan	Nordjapan	148.083	44.50	9	06 11 1958	22 58 00	0
L1-2	Kurilen	Kurilen	161.000	53.0	10	03 02 1923	16 01 00	0
L1-3	Mitteljapan	Mitteljapan	144.083	39.33	9	02 03 1933	17 30 00	0
L1-5	Mongolei	Mongolei	98.000	49.0	6	23 07 1905	02 46 00	0

18.

L1-4	Mongolei	Mongolei	99.000	49.0	6	09 07 1905	09 40 00	0
L1-6	Molukken	Molukken	130.083	-5.33	9	01 02 1938	19 04 00	0
L1-7	Chile	Chile	-70.000	-28.83	-4	11 11 1920	04 32 00	0
L1-8	Kurilen	Kurilen	149.083	44.133	10	13 10 1963	05 17 00	0
L1-9	Nordindien	Nordindien	96.083	28.100	6	15 08 1950	14 09 00	0
L1-10	Aleuten	Aleuten	178.100	51.50	13	04 02 1965	05 01 00	0
L1-11	Kolumbien	Kolumbien	-81.083	1.0	-5	31 01 1906	15 36 00	0
L1-12	Nordkurilen	Nordkurilen	161.000	52.50	12	04 11 1952	16 58 00	0
L1-13	Aleuten	Aleuten	-175.133	51.50	-11	09 03 1957	14 22 00	0
L1-14	Alaska	Alaska	-147.100	61.16	-10	28 03 1964	03 36 00	0
L1-15	Chile	Chile	-74.083	-39.83	-4	22 05 1960	19 11 00	0
L2-1	China	China	77.000	40.0	8	22 08 1902	03 00 00	0
L2-2	Japan	Japan	143.000	42.83	9	04 03 1952	06 03 00	0
L2-3	Ecuador	Ecuador	-76.133	-8.0	-5	16 11 1907	10 10 00	0
L2-4	Marianen	Arianen	143.000	22.0	10	24 11 1914	11 53 00	0
L2-5	Samoa	Samoa	-173.000	-15.83	-10	26 06 1917	05 49 00	0
L2-6	Nicobaren	Nicobaren	92.083	12.83	5	26 06 1941	11 52 00	0
L2-7	Suedjapan	Suedjapan	131.000	28.0	10	15 06 1911	12 00 00	0
L2-8	Suedalaska	Suedalaska	-158.000	55.83	-10	10 11 1938	20 18 00	0
L2-9	Westchina	Westchina	77.083	43.83	8	03 01 1911	23 25 00	0
L2-10	Nordneuseeland	Nordneuseeland	-176.066	-28.16	-12	20 10 1986	06 46 00	0

19. Earthquakes of magnitude 6.5 or greater or those that caused fatalities, injuries or substantial damage." Compiled by Waverly J. Person SGS National Earthquake Information Center http://www.usgs.gov/ http://neic.usgs.gov/neis/eqlists/significant.html