THE NON-LINEAR INTERACTION OF THE PLANETARY GRAVITATIONAL FIELD ON EARTHQUAKES

EGS-AGU-EUG; Joint Assembly Nice, France, 25 - 30 April 2004

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1. Abstract

Research, which refers to triggering of earthquakes, do not take into account the interactions of the gravitation of the planets. Despite the very weak effects of the interaction, an influence of the gravitation cannot always be neglected, specifically in critical conditions in the earth's crust before an earthquake. Tensions in the earth's crust are mostly the cause of earthquakes. If these tensions are in a critical condition, then also the fluctuations of the planetary gravitational field can cause these vibrations [1]. Compared with other interactive forces, the weak fluctuations of the gravitation can only have an effect, if they are considered and observed as a "stimulation-field" over a long period of time. Indeed the system of the planets is very stable. The orbits of the big planets are very stable during millions of years. In addition to this, there is another important circumstance: the orbits of the planets lie almost on the same level. They represent natural oscillators on a big scale. Such a rhythm or such duration of vibration is determined by the time period from conjunction to conjunction of two planets. These are relatively stable frequencies. A non-linear correlation function forms a good way of describing these processes.

$H_{i,j} = a_1 \cos(\alpha_{i,j}) + a_2 \cos(2\alpha_{i,j}) + a_3 \cos(3\alpha_{i,j}) + \ldots$ (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 material structures. The vibrations of the planetary gravitational field lead to higher vibrations, to higher harmonics, in material structures. The problems of the correlation function are the coefficients a_k and the meaning of $H_{i,j}$. In my research I restricted myself to the polar qualities which are associated with the concepts of "stability" and "instability". The change from stable to unstable conditions and vice versa, can be observed in the evolution of many complex systems.

1. Introduction

Global correlations have been found between major earthquakes and other geophysical phenomena, such as Chandler wobble, variations of magnetic field, and the velocity of Earth rotation [2]. This lecture tries to add to the long list of statistical investigations of the question whether earthquakes are related or triggered by periodic changes of celestial phenomenon. Many of these investigations are often problematic, because no physical connection can be made between earthquakes and the celestial phenomenon. Most research refers however to tidal triggering. A highly recommended article is by Emter [3].

I introduce a new method leading away from tidal triggering only: correlation functions of the planetary gravitational field.The most researches, which refer to triggering of earthquakes, do not take into account the interactions of the gravitation of the planets.

It is important to begin by saying that this is not always correct. Because of it, the planet system and its fluctuating gravitational field shows some remarkable qualities.

First, the planet system generates very stable frequencies during millions of years. In my opinion is that a new quality of interactions.

Secondly, the interaction of the gravitational field generates higher frequencies in material structures. That leads to a nonlinear theory.

Despite the very weak effects of the interaction, an influence of the gravitation cannot always be neglected, specifically in critical conditions in the earth's crust before an earthquake.

Before I start to deal with some statistical researches, let me begin with some points of the theory.

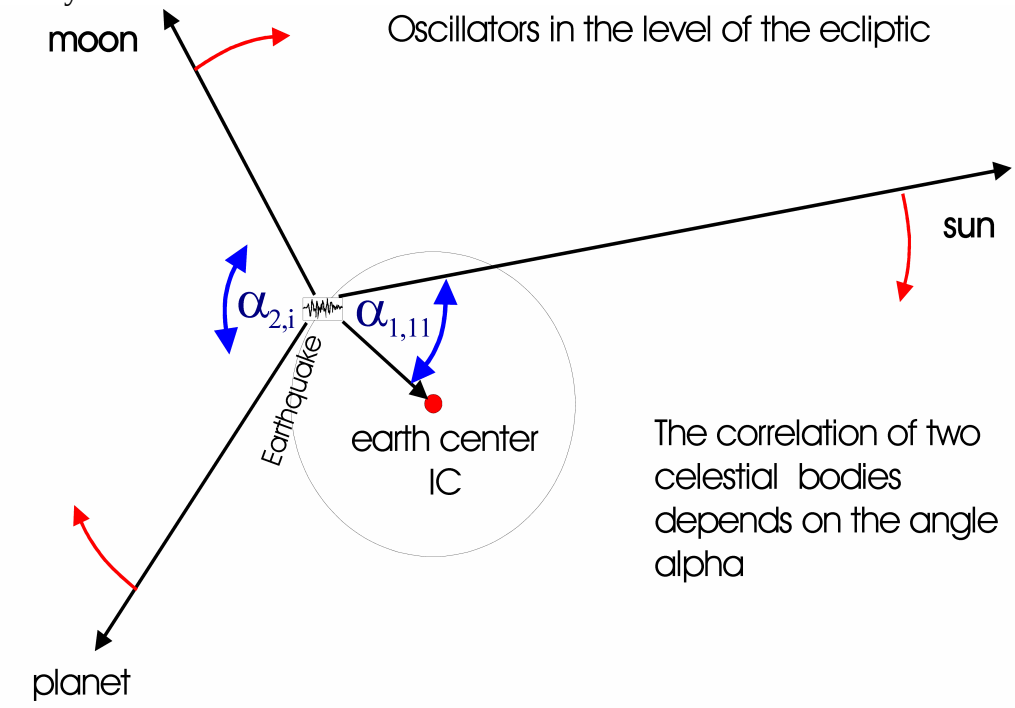


Figure 1 Oscillators in the level of the ecliptic

2. The model of the gravitational interaction

The fundamental Newton's movement-equation of N mass-points has the form:

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

r_i, r_j = vectors of the planets i, j with the masses m_i and M_j; G = gravitational-constant.

It is however not in a favourable form for the present problem.
From the helio-centric view, circle-frequencies $\omega_{i,j}$ can be declared. These circle-frequencies are relatively stable in the time.

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

$T_{i,j}$ = Time from conjunction to conjunction of the planets i and j.

Only directional-invariant processes are examined. One can write for the alterations of the planets - power (in a first approximation):

$$F_{i,j} \propto f_{i,j}(t) + k_{i,j}(t)\cdot\cos(\omega_{i,j}\cdot t) \qquad \text{t = time} \qquad (3)^*$$

** The relationship (3) follows from the vectorial addition of the powers F_i and F_j.*

$$\mathbf{F}_{i,j} = \mathbf{F}_i + \mathbf{F}_j$$
$$\mathbf{F}_{i,j}^{\ 2} = \mathbf{F}_i^{\ 2} + \mathbf{F}_j^{\ 2} + 2 \cdot |\mathbf{F}_i||\mathbf{F}_j| \cos(\alpha)$$

From a geo-centric view, the cosmic cycles are not quite so stable, therefore it is simpler, instead of $\omega_{i,j}$ to put the angle $\alpha_{i,j}$ (under which the planets i, j from the earth appears), in (3).

$$F_{i,j} \propto f_{i,j}(t) + k_{i,j}(t) \cdot \cos(\alpha_{i,j}) \qquad (4)$$

The weak gravitational-field-fluctuations, especially its cosine-share, can be considered as a type of stimulation-field-strength on matter.
The terms $f_{i,j}(t)$ and $k_{i,j}(t)$ are relatively stable.

$$F_{i,j} = f_0 + k_0 \cdot \cos(\alpha_{i,j}) \qquad (5)$$

The interactions of these "waves" (5) with matter and their different structures, will be not-linearly. In analogy to other not-linear interactions with matter (for example not-linear optics) one can put (with 7) a general correlation-function $H_{i,j}$ for the influence of two planets i, j.

$$H_{i,j}(\alpha) = \gamma_1 F_{i,j} + \gamma_2 F_{i,j}^{\ 2} + \gamma_3 F_{i,j}^{\ 3} + \ldots \qquad (6)$$

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

The conversion of (8) into a Fourier-serial is better suitable.

$$H_{i,j}(\alpha_{i,j}) = a_0 + a_1\cos(\alpha_{i,j}) + a_2\cos(2\alpha_{i,j}) + a_3\cos(3\alpha_{i,j}) + \ldots \qquad (8)$$

The form (8) of the correlation-function shows the formation of "higher harmonics" by the interaction with matter.
The problems of the correlation-function are the coefficients a_k and the meaning of H.
The planets represent natural oscillators on a big scale. Such a rhythm is determined by the time period from conjunction to conjunction of two planets. These are relatively stable frequencies over a long period of time.
In my researches I restricted myself to the polar qualities which are associated with the concepts of “stability” and “instability”. The change from stable to unstable conditions and vice versa, can be observed in the evolution of many complex systems.
If one translates such criteria for stability and instability into a planetary cycle, one gets a sequence development (after a Fourier-transformation).

$$H_{i,j} = \sum_{s=1}^{N \cdot 12 - 1} a_k \cos(s \cdot \alpha); mit(k = s \bmod 12) \qquad (9)$$

with $a_k = \{0,1,-2,3,-5,0,3,0,-5,3,-2,1\}$

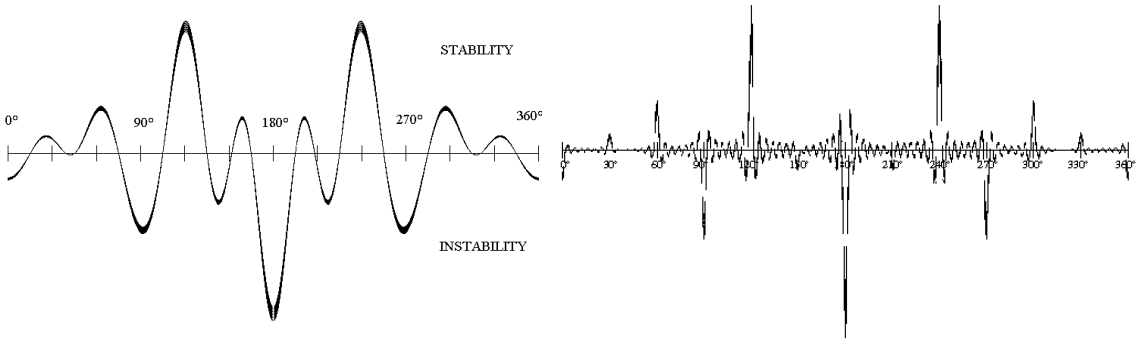
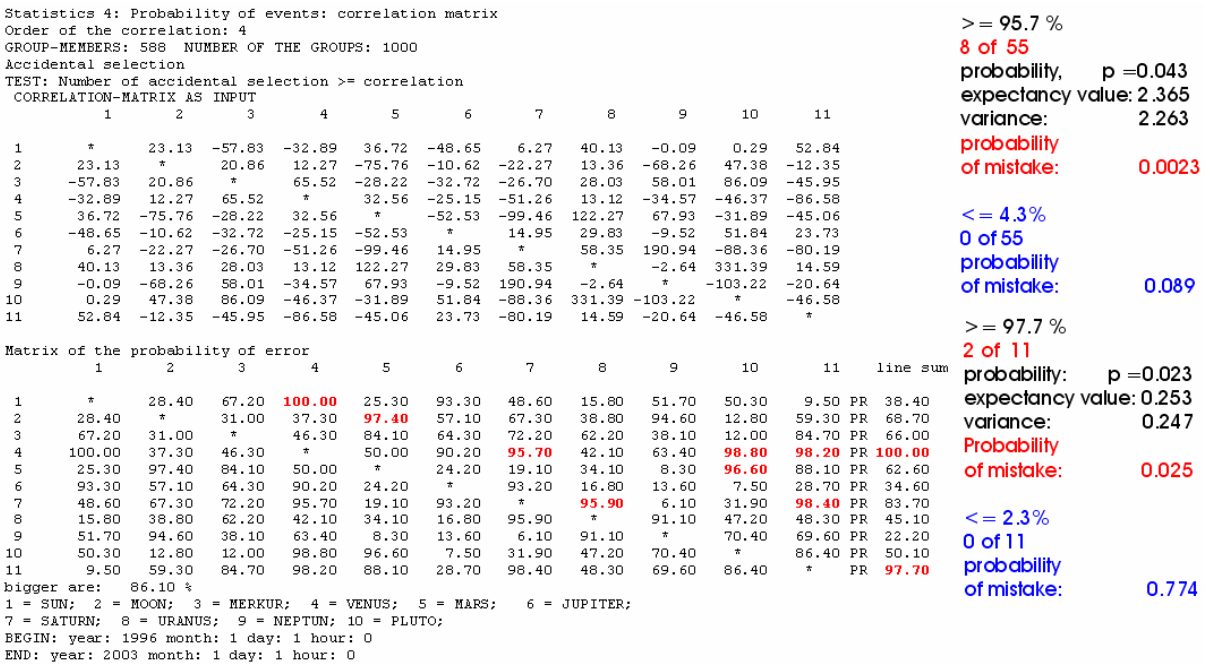


Figure 2. Correlation function 1. order (left) and 7. order (right) after equation (9).

The correlation function H (9) was not only developed for earthquakes.
Tensions in the earth's crust are mostly the cause of earthquakes. If these tensions have reached a critical state, there can be vibrations of different strengths.
The first hypothesis that was explored is as follows: If these tensions are in a critical condition, then also the fluctuations of the planetary gravitational field can cause these vibrations. The probability for an earthquake becomes higher if the fluctuations show unstable conditions.

3. The triggering of earthquakes

First, the 41 strongest earthquakes of the last century were explored.
As a result of this research, we could state the following: earthquakes can also be stimulated by the planetary fluctuations of the gravitational field. This has been proved with a probability of being wrong of 0.6%.
Maybe, that result is only an artefact? Or it is truly valid for strong earthquakes only?
Two groups of earthquakes were examined in a next step in order to explore that [4]. These two groups (157 events) are complete in two time periods (2000 and 2001).
I received the following result: The earthquakes behave abnormally, also in such, relatively small time periods. The event of an earthquake is not always absolutely random to the correlation-function H .
Can one use the result for a forecast of earthquakes?
In order to clarify this question, further earthquakes were examined. These were 420 earthquakes in the years from 1997 to 2001. The results gave cause for hope [5].
The following database was used always: Earthquakes of magnitude 6.5 or greater or ones that caused fatalities, injuries or substantial damage [6].
The list of the earthquakes was widened on 588 earthquakes once again.
They took place in the years 1996 until 2002. In these events the rotation of the earth was considered now.
These were 588 earthquakes in the years from 1996 to 2002.
The following questions were examined:
1. Which order of the correlation function describes triggering of earthquakes best?
2. Which meaning or weight has the individual planet?



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Statistics 4: Probability of events: correlation matrix
Order of the correlation: 4
GROUP-MEMBERS: 588  NUMBER OF THE GROUPS: 1000
Accidental selection
TEST: Number of accidental selection >= correlation
 CORRELATION-MATRIX AS INPUT
          1       2       3       4       5       6       7       8       9      10      11

 1        *     23.13  -57.83  -32.89   36.72  -48.65    6.27   40.13   -0.09    0.29   52.84
 2    23.13       *     20.86   12.27  -75.76  -10.62  -22.27   13.36  -68.26   47.38  -12.35
 3   -57.83    20.86       *   65.52  -28.22  -32.72  -26.70   28.03   58.01   86.09  -45.95
 4   -32.89    12.27   65.52       *   32.56  -25.15  -51.26   13.12  -34.57  -46.37  -86.58
 5    36.72   -75.76  -28.22   32.56       *  -52.53  -99.46  122.27   67.93  -31.89  -45.06
 6   -48.65   -10.62  -32.72  -25.15  -52.53       *   14.95   29.83   -9.52   51.84   23.73
 7     6.27   -22.27  -26.70  -51.26  -99.46   14.95       *   58.35  190.94  -88.36  -80.19
 8    40.13    13.36   28.03   13.12  122.27   29.83   58.35       *   -2.64  331.39   14.59
 9    -0.09   -68.26   58.01  -34.57   67.93   -9.52  190.94   -2.64       *  -103.22  -20.64
10     0.29    47.38   86.09  -46.37  -31.89   51.84  -88.36  331.39 -103.22       *  -46.58
11    52.84   -12.35  -45.95  -86.58  -45.06   23.73  -80.19   14.59  -20.64  -46.58       *

Matrix of the probability of error
          1       2       3       4       5       6       7       8       9      10      11    line sum

 1        *     28.40   67.20  100.00   25.30   93.30   48.60   15.80   51.70   50.30    9.50 PR  38.40
 2    28.40       *     31.00   37.30   97.40   57.10   67.30   38.80   94.60   12.80   59.30 PR  68.70
 3    67.20    31.00       *   46.30   84.10   64.30   72.20   62.20   38.10   12.00   84.70 PR  66.00
 4   100.00    37.30   46.30       *   50.00   90.20   95.70   42.10   63.40   98.80   98.20 PR 100.00
 5    25.30    97.40   84.10   50.00       *   24.20   19.10   34.10    8.30   96.60   88.10 PR  62.60
 6    93.30    57.10   64.30   90.20   24.20       *   93.20   16.80   13.60    7.50   28.70 PR  34.60
 7    48.60    67.30   72.20   95.70   19.10   93.20       *   95.90    6.10   31.90   98.40 PR  83.70
 8    15.80    38.80   62.20   42.10   34.10   16.80   95.90       *   91.10   47.20   48.30 PR  45.10
 9    51.70    94.60   38.10   63.40    8.30   13.60    6.10   91.10       *   70.40   69.60 PR  22.20
10    50.30    12.80   12.00   98.80   96.60    7.50   31.90   47.20   70.40       *   86.40 PR  50.10
11     9.50    59.30   84.70   98.20   88.10   28.70   98.40   48.30   69.60   86.40       * PR  97.70
bigger are:   86.10 %
1 = SUN;  2 = MOON;  3 = MERKUR;  4 = VENUS;  5 = MARS;   6 = JUPITER;
7 = SATURN;  8 = URANUS;  9 = NEPTUN; 10 = PLUTO;
BEGIN: year: 1996 month: 1 day: 1 hour: 0
END: year: 2003 month: 1 day: 1 hour: 0
```

>= 95.7 %
8 of 55
probability, p =0.043
expectancy value: 2.365
variance: 2.263
probability
of mistake: 0.0023

<= 4.3%
0 of 55
probability
of mistake: 0.089

>= 97.7 %
2 of 11
probability: p =0.023
expectancy value: 0.253
variance: 0.247
Probability
of mistake: 0.025

<= 2.3%
0 of 11
probability
of mistake: 0.774

Figure 3; Matrix of the correlation-function H 4th order for 588 earthquakes. Monte Carlo simulation with 1000 control-groups, each 588 members, is used. 8 of 55 elements of the matrix are significant and 2 of 11 Elements of the line sum are significant too.

The results are for 1000 control-groups. Each group has 588 members. The Monte Carlo simulation was used. The control-groups, that have a bigger value, stand in the matrix below (in percent [%] declared)
The correlation function H is printed in the matrix. All elements with a mathematical probability of being wrong smaller than 5% are red and fat-printed.
We can see: the matrix behaves abnormally. There are more “instabilities” then “stabilities” significant. The 588 earthquakes take place during a time in which the correlation function is instable. Maybe, one can uses this result for a forecast of earthquakes.
One can interpret the correlation as a wave-field.
The absolute-value of the correlation-function corresponds to the energy in the wave-field then. The absolute value of H (sum of all matrix-elements) represents the wave-energy of all planetary fluctuations. We can see that in figure 4.
What can we expect?
Earthquakes are stimulated if the effect of the gravity is big. That applies to sun, moon, earth-centre and maybe Jupiter and Saturn.
What don't we expect?
We expect no influence of Pluto and maybe Mercury. Their gravitational-effect is too weak.
We can see however significant correlations for the Pluto. Maybe, that is a coincidence.
Further examinations will clarify that.

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Statistics 4: Probability of events: energy
Order of the correlation: 10
GROUP-MEMBERS: 588  NUMBER OF THE GROUPS: 1000
Accidental selection
TEST: Number of accidental selection >= correlation

 MATRIX energy AS INPUT (absolut)
          1       2       3       4       5       6       7       8       9      10      11
 1        *    0.57    0.11    0.10    0.32    0.39    0.39    0.44    0.39    0.53    0.49
 2     0.57       *    0.40    0.35    0.44    0.40    0.44    0.41    0.45    0.43    0.47
 3     0.11    0.40       *    0.19    0.25    0.32    0.40    0.47    0.50    0.38    0.47
 4     0.10    0.35    0.19       *    0.36    0.45    0.36    0.37    0.45    0.43    0.45
 5     0.32    0.44    0.25    0.36       *    0.45    0.47    0.50    0.52    0.38    0.40
 6     0.39    0.40    0.32    0.45    0.45       *    0.19    0.20    0.42    0.62    0.52
 7     0.39    0.44    0.40    0.36    0.47    0.19       *    0.49    0.68    0.69    0.49
 8     0.44    0.41    0.47    0.37    0.50    0.20    0.49       *    0.06    0.42    0.41
 9     0.39    0.45    0.50    0.45    0.52    0.42    0.68    0.06       *    0.10    0.49
10     0.53    0.43    0.38    0.43    0.38    0.62    0.69    0.42    0.10       *    0.39
11     0.49    0.47    0.47    0.45    0.40    0.52    0.49    0.41    0.49    0.39       *

 Matrix of the probability of error
          1       2       3       4       5       6       7       8       9      10      11      line sum
 1        *    0.10   64.80   14.30   39.30   63.20   64.60   44.10   86.30    2.00    8.50 PR    1.50
 2     0.10       *   79.90   97.50   41.30   85.20   47.40   62.90   24.70   42.40   14.30 PR   35.90
 3    64.80   79.90       *   16.90   92.20   86.20   50.20   14.80   29.50   81.40   20.10 PR   63.10
 4    14.30   97.50   16.90       *   30.90   33.00   72.40   70.50   25.90   47.00   27.40 PR   56.70
 5    39.30   41.30   92.20   30.90       *   91.00   67.70   57.90    9.10   75.60   75.40 PR   76.90
 6    63.20   85.20   86.20   33.00   91.00       *   16.70   55.40   62.60   71.60    2.40 PR   79.20
 7    64.60   47.40   50.20   72.40   67.70   16.70       *   69.90    5.60   64.10    5.40 PR   35.00
 8    44.10   62.90   14.80   70.50   57.90   55.40   69.90       *   28.60   49.70   77.70 PR   69.50
 9    86.30   24.70   29.50   25.90    9.10   62.60    5.60   28.60       *    0.70    1.80 PR    2.50
10     2.00   42.40   81.40   47.00   75.60   71.60   64.10   49.70    0.70       *   66.10 PR   58.50
11     8.50   14.30   20.10   27.40   75.40    2.40    5.40   77.70    1.80   66.10       *  PR    1.20
bigger are:   21.10 %
1 = SUN;  2 = MOON;  3 = MERKUR;  4 = VENUS;  5 = MARS;
6 = JUPITER;  7 = SATURN;  8 = URANUS;  9 = NEPTUN; 10 = PLUTO;
BEGIN: year: 1996 month: 1 day: 1 hour: 0
END: year: 2003 month: 1 day: 1 hour: 0
```

<= 2.4 %
5 of 55
probability, p =0.024
expectancy value: 1.32
variance: 1.29
probability
of mistake: 0.0102

>= 97.6%
0 of 55
probability
of mistake: 0.263

<= 2.5 %
3 of 11
probability: p =0.025
expectancy value: 0.275
variance: 0.268
Probability
of mistake: 0.0022

>= 97.5%
0 of 11
probability
of mistake: 0.757

Figure 4; Matrix of the correlation-function abs(H) 10th order for 588 earthquakes. Monte Carlo simulation with 1000 control-groups, each 588 members, is used. 5 of 55 elements of the matrix are significant and 3 of 11 Elements of the line sum are significant too.

Let's look at the correlation of sun, moon and the centre of the earth first.

3.1 Sun, moon and earth centre (IC)

We can see in figure 5: sun and moon are high significant and the line sum of the IC is significant. The whole matrix is significant with 0.1%.

```
Statistics 4: Probability of events: energy
Order of the correlation: 10     GROUP-MEMBERS: 588
NUMBER OF THE GROUPS: 5000
Accidental selection
TEST: Number of accidental selection >= correlation

MATRIX energy AS INPUT (absolut)
          1       2       3       4       5       6       7       8       9      10      11

 1        *    0.57       *       *       *       *       *       *       *       *    0.49
 2     0.57       *       *       *       *       *       *       *       *       *    0.47
 3        *       *       *       *       *       *       *       *       *       *       *
 4        *       *       *       *       *       *       *       *       *       *       *
 5        *       *       *       *       *       *       *       *       *       *       *
 6        *       *       *       *       *       *       *       *       *       *       *
 7        *       *       *       *       *       *       *       *       *       *       *
 8        *       *       *       *       *       *       *       *       *       *       *
 9        *       *       *       *       *       *       *       *       *       *       *
10        *       *       *       *       *       *       *       *       *       *       *
11     0.49    0.47       *       *       *       *       *       *       *       *       *
matrix-sum: 3.061259

Matrix of the probability of error
          1       2       3       4       5       6       7       8       9      10      11      line sum

 1        *    0.16       *       *       *       *       *       *       *       *    9.26 PR    0.06
 2     0.16       *       *       *       *       *       *       *       *       *   14.30 PR    0.20
 3        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
 4        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
 5        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
 6        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
 7        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
 8        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
 9        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
10        *       *       *       *       *       *       *       *       *       *       *  PR    0.00
11     9.26   14.30       *       *       *       *       *       *       *       *       *  PR    4.92
bigger are:    0.10 %

1 = SUN;  2 = MOON;  3 = MERKUR;  4 = VENUS;  5 = MARS;
6 = JUPITER;  7 = SATURN;  8 = URANUS;  9 = NEPTUN; 10 = PLUTO;
BEGIN: year: 1996 month: 1 day: 1 hour: 0
END: year: 2003 month: 1 day: 1 hour: 0
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Figure 5; Sun, Moon and earth centre; matrix of the correlation-function abs(H) 10th order for 588 earthquakes. Monte Carlo simulation with 1000 control-groups, each 588 members, is used. 1 of 3 elements of the matrix is significant and 3 of 3 elements of the line sum are significant too. The probability of being wrong is 0.1% only.

We get the same result if we calculate the density-function (figure 6).

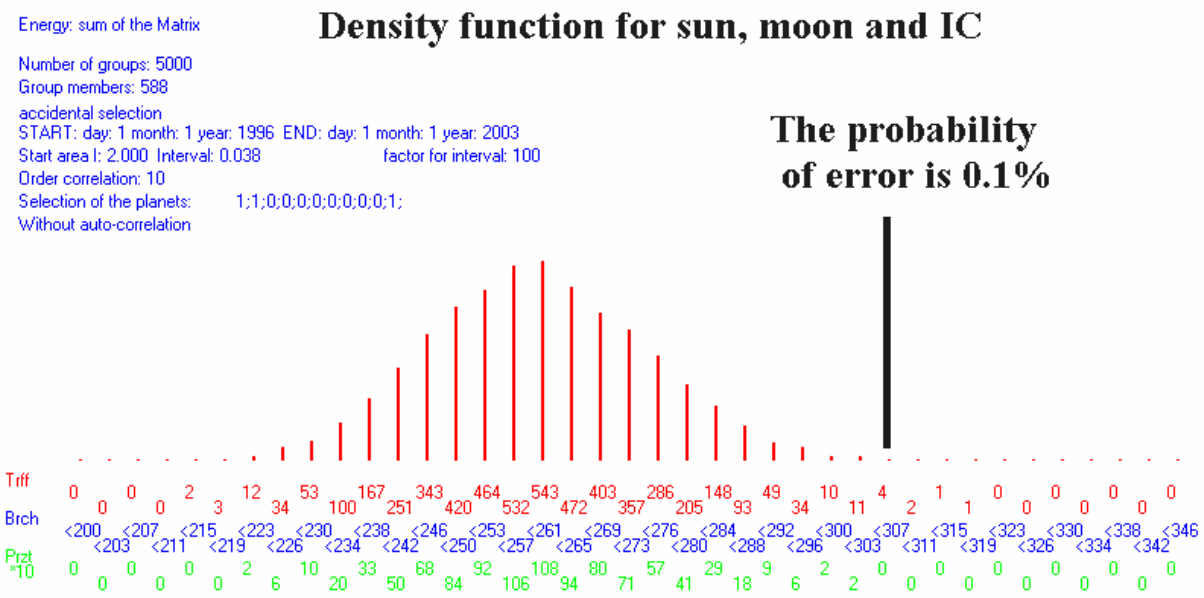

Figure 6; Sun, Moon and earth centre; Density function of the correlation-function abs(H) 10th order for 588 earthquakes. Monte Carlo simulation with 5000 control-groups, each 588 members, is used. The probability of being wrong is 0.1% only.

We expect that Jupiter and Saturn have an influence too because of their large mass.

3.2 Jupiter, Saturn and IC

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Statistics 4: Probability of events: energy
Order of the correlation: 10
GROUP-MEMBERS: 588  NUMBER OF THE GROUPS: 1000
Accidental selection
TEST: Number of accidental selection >= correlation

MATRIX energy AS INPUT (absolut)
    1       2       3       4       5       6       7       8       9      10      11
 1      *       *       *       *       *       *       *       *       *       *
 2      *       *       *       *       *       *       *       *       *       *
 3      *       *       *       *       *       *       *       *       *       *
 4      *       *       *       *       *       *       *       *       *       *
 5      *       *       *       *       *       *       *       *       *       *
 6      *       *       *       *       *       *    0.19       *       *       *    0.52
 7      *       *       *       *       *    0.19       *       *       *       *    0.49
 8      *       *       *       *       *       *       *       *       *       *
 9      *       *       *       *       *       *       *       *       *       *
10      *       *       *       *       *       *       *       *       *       *
11      *       *       *       *       *    0.52    0.49       *       *       *
matrix-sum: 2.401343

Matrix of the probability of error
         1       2       3       4       5       6       7       8       9      10      11
 1       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
 2       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
 3       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
 4       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
 5       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
 6       *       *       *       *       *       *   13.50       *       *       *    3.70 PR   2.10
 7       *       *       *       *       *   13.50       *       *       *       *    5.40 PR   3.10
 8       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
 9       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
10       *       *       *       *       *       *       *       *       *       *       *    PR   0.00
11       *       *       *       *       *    3.70    5.40       *       *       *       *    PR   1.10
bigger are:    0.30 %

 1 = SUN;  2 = MOON;  3 = MERKUR;  4 = VENUS;
 5 = MARS;   6 = JUPITER;  7 = SATURN;  8 = URANUS;  9 = NEPTUN; 10 = PLUTO;
 BEGIN: year: 1996 month: 1 day: 1 hour: 0
 END: year: 2003 month: 1 day: 1 hour: 0
```

Figure 7; Jupiter, Saturn and earth centre IC; matrix of the correlation-function abs(H) 10th order for 588 earthquakes. Monte Carlo simulation with 1000 control-groups, each 588 members, is used. 1 of 3 elements of the matrix is significant and 3 of 3 elements of the line sum are significant too. The probability of being wrong is 0.3% only.

Particularly the reciprocal effects of Jupiter and Saturn with the gravitation center of the earth show an influence on triggering the earthquakes.

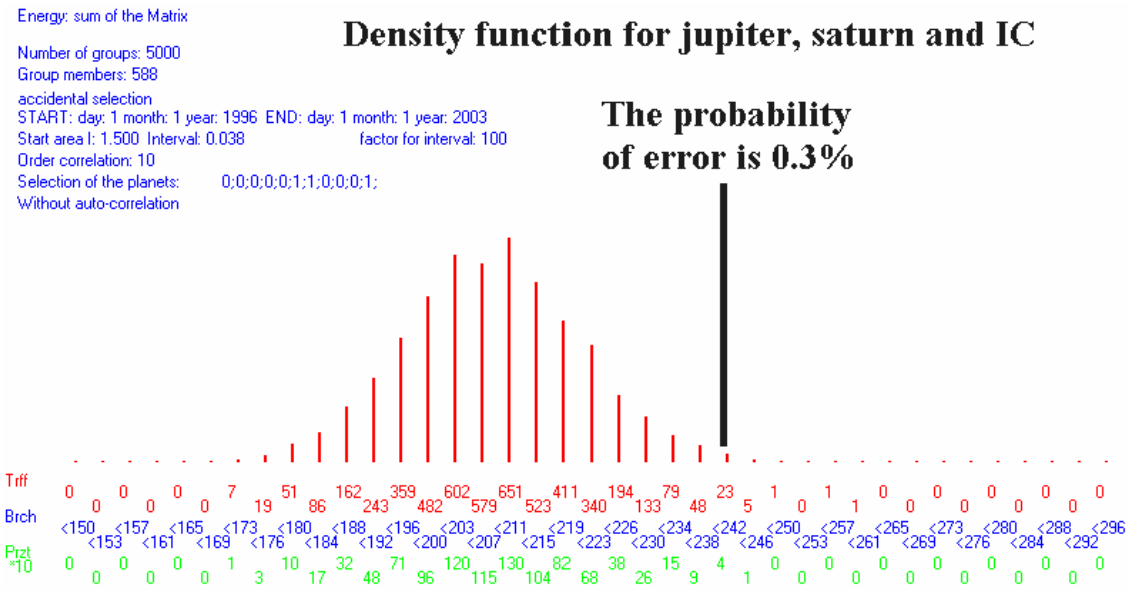


Figure 8; Jupiter, Saturn and earth centre; Density function of the correlation-function abs(H) 10th order for 588 earthquakes. Monte Carlo simulation with 5000 control-groups, each 588 members, is used. The probability of being wrong is 0.3% only.

The density function is not as regular as with sun, moon and IC. That has its cause in the relatively small period of 7 years. Jupiter and Saturn change slowly their position and therefore not all possible angles are reached.

3.3 Cumulative view

How do the individual correlations behave with increase of the earthquakes?
It is to be expected that all those correlations will constantly approach the significance border, which have really an influence.

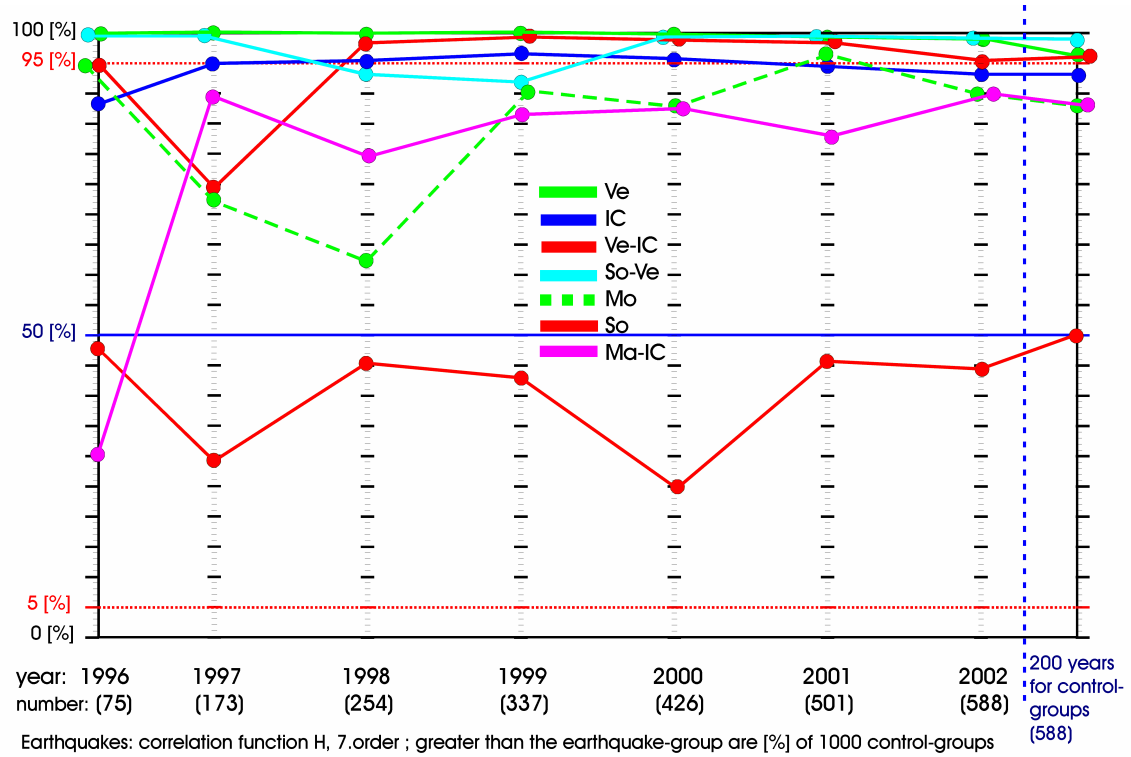


Figure 9; the summation of the values of the probabilities of the correlations-matrix H. There are selected correlations: elements of the matrix and line sums. The control's groups were selected in the period of the events in addition, in one period from 1900 to 2100 (200 years).

The selected correlations become more stable with the increase of the earthquakes. Possibly also still different correlations reach the significance border. Such a candidate is the correlation between Mars and IC.

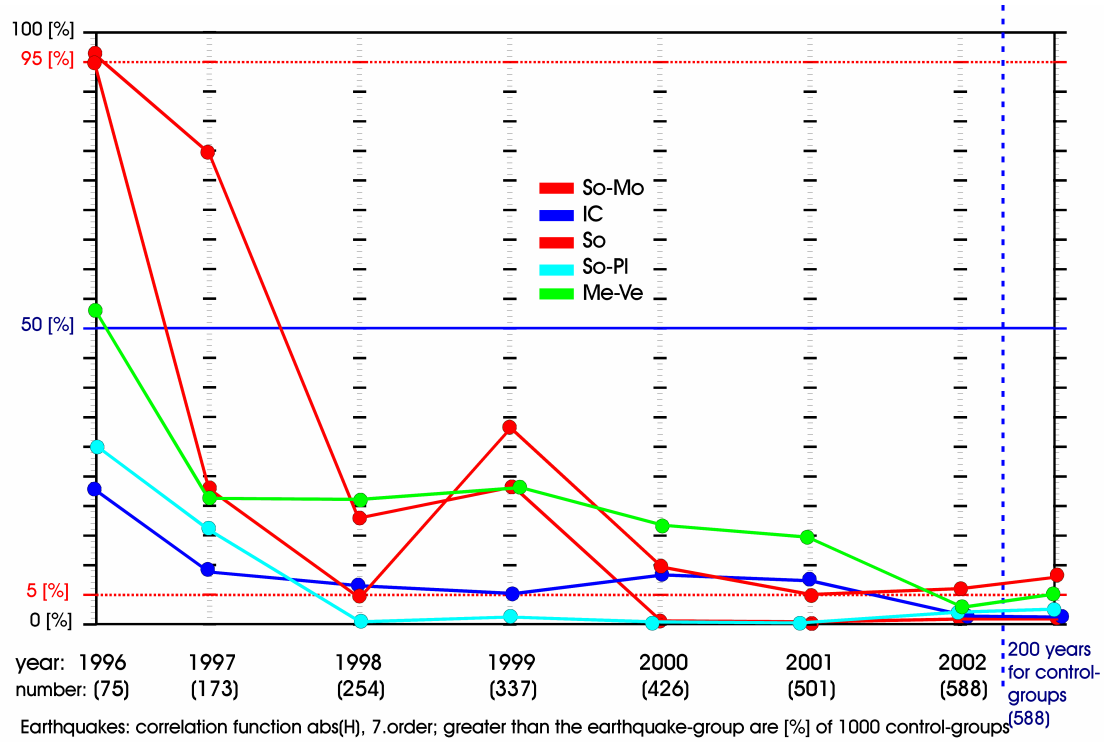
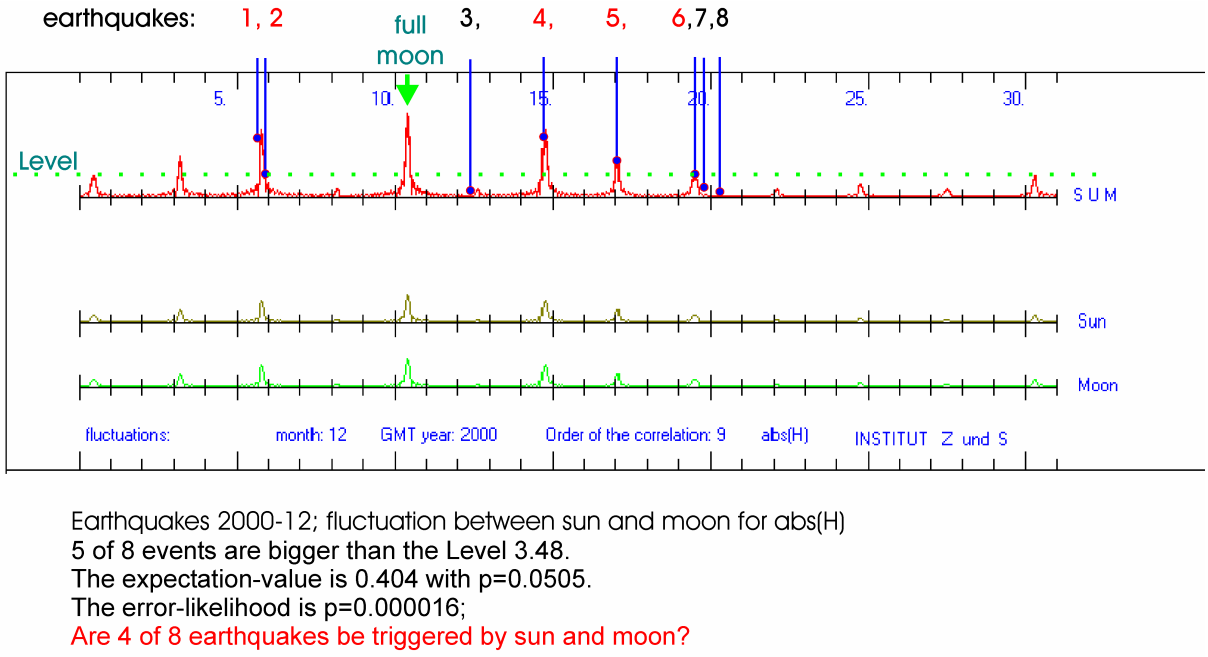


Figure 10; the summation of the values of the probabilities of the correlations-matrix abs (H). There are selected correlations: elements of the matrix and line sums. The control's groups were selected in the period of the events in addition, in one period from 1900 to 2100 (200 years).

The increase of the significance for the energy of the correlations is good to see. One can expect that this trend will continue. Perhaps with an exception: Sun and Pluto.

3.4 Example of a triggering

How many earthquakes triggered by the higher orders of the fluctuations of the gravitational field?



Earthquakes 2000-12; fluctuation between sun and moon for abs(H)
5 of 8 events are bigger than the Level 3.48.
The expectation-value is 0.404 with p=0.0505.
The error-likelihood is p=0.000016;
Are 4 of 8 earthquakes be triggered by sun and moon?

Figure 11; Example of a closely limited period: 2000-December. Only the correlations abs (H) are represented by sun and moon. That is an exception of course.

From 8 events are 5 greater then the level of 3,48. Those are 62.5 %. The expectancy value is only 5%. Are 57.5% of the earthquakes really triggered by sun and moon in this year?

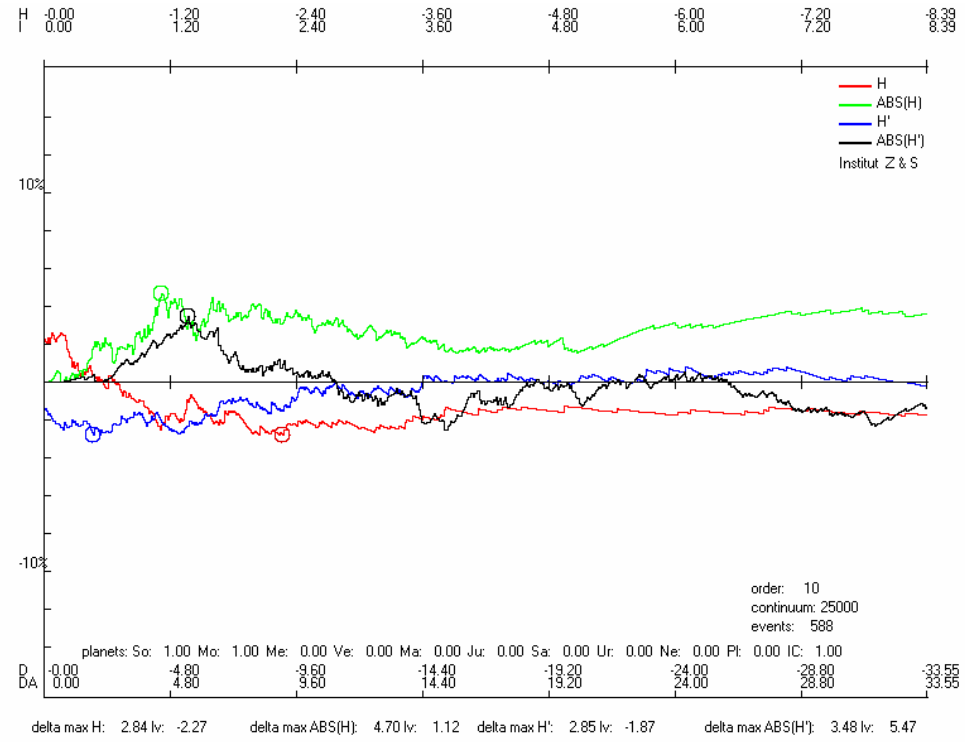


Figure 12; an example of the question: How many earthquakes are possibly triggered by sun, moon and IC? Starting from a certain value for the function abs (H) there is approximate 4% (the green curve).

In Figure 11 are from 588 events are 68,03% greater then the level of 1.12. The continuum value (expectancy value) is 63,32% .
The past investigations show that up to 10% of the examined earthquakes by the higher orders of the planetary correlations are altogether possibly triggered.

4. The model of triggering

For the further investigations a better hypothesis can be accepted. For triggering of earthquakes a threshold energy exists. This threshold energy is constantly reduced. The releasing factors compete with one another. Such factors result also from the fluctuations of the planetary gravitational field.
Earthquakes take place at each time. If threshold energy for triggering constantly decreases, then also the time comes for triggering by the fluctuations of the planetary gravitational field. It is a characteristic of nonlinear systems, also small outside energies can lead to large changes.

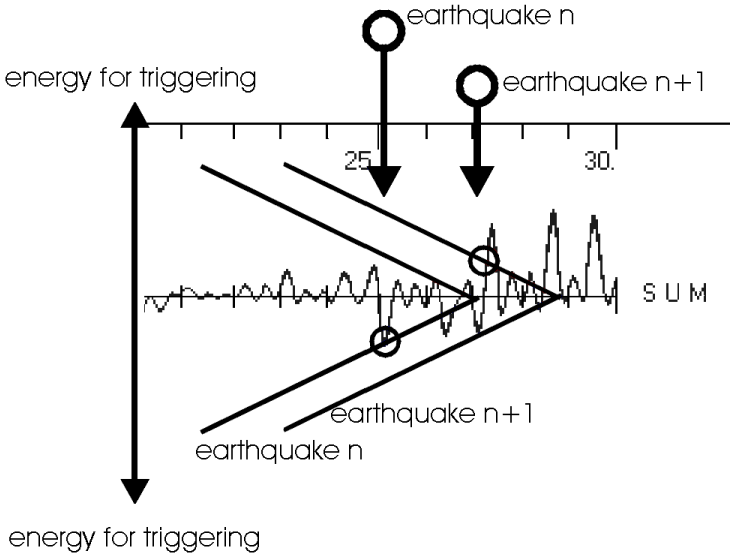


Figure 13: Schematic Model of the earthquake-triggering, released by the fluctuations of the planetary gravitational field. Tensions in the earth's crust can become an earthquake by the fluctuations of the planetary gravitational field. The condition for it is the sinking the threshold energy for triggering.

5. Conclusion and outlook

The research showed that the fluctuations of the planetary gravitational field can make a contribution for triggering of earthquakes. With these results, new strategies for the research can be set up.
It is a large mathematical expenditure to introduce the factor $\gamma_{i,j}$ **(**for $\mathbf{H}_{i,j}$), which helps to find an adaptation to the problem we explored. This factor γ has the function of a frequency-filter. But such an optimisation is necessary for the forecast of earthquakes. It will be an element of a probability based forecasting of earthquakes: maybe in supplement to a model constituted by point processes generated by transitions of a Markov chain.
Our planetary system is a huge complex system. The nonlinear dynamics of this system has an influence on the triggering of earthquakes. That seems to be now a fact and it is the cause for further research.

6. References

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http://www.zunds-institut.de/earthquakes

[6] "Earthquakes of magnitude 6.5 or greater or ones 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