

# **Earthquake Prediction Model II**

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## **Abstract**

The objective of this research was to further continue<sup>1</sup> analyzing and investigating correlations between astronomical data and earthquakes, with the intended goal of predicting future earthquakes with a greater advanced warning and higher degree of accuracy than current technology. Specifically, it focuses on severe earthquakes that occurred during the last century, with special emphasis on earthquakes of magnitude 7 or higher. This research work has already shown<sup>1</sup> a correlation between certain inter-planetary configurations (encompassing the relative geocentric positions and angles of all planets) and the occurrence of strong earthquakes. Building on the work done since the last publication<sup>1</sup>, this work focuses on the validation of data employed from other resources<sup>2</sup> wherever possible, and extending the data set to include the earthquakes of magnitude 7 or higher from January 1900 to December 2009. In addition, the model includes 12-degree multiple angles in place of the 15-degree multiple angles. As a result, the new improved model seems to rule out more dates for the earthquake of magnitude 7 or higher. However, further research is necessary to build a useful, predictive model that can assess the probability of a given earthquake occurring during a certain time period at a given geographical location on earth. Predicting earthquakes well in advance of the state of the art will promote, protect, and enhance the world economy, potentially saving millions of lives.

## **Introduction**

There is absolutely no precedent in predicting an earthquake solely based on planetary configuration. An occurrence of an earthquake is a random event and it can sometimes occur more frequently than other times. This research began with the idea that planetary positions along the ecliptic, and therefore, their apparent positions as viewed from earth, may potentially correlate with the occurrence of earthquakes. Based on planetary characteristics and a large amount of earthquake data, several hypotheses were tested to see if these correlations actually exist. The results of this exercise indicate that certain planetary configurations seem to correlate reasonably well with earthquakes. Although the present state of research is primitive, the intent of this paper is to continue to highlight the initial findings on prediction of earthquakes.

Although this paper focuses on earthquake prediction model, since 1993, the research began by studying the influence of planetary configurations on natural calamities in general. Starting in 2000, these predictions have been made available to the public on a monthly basis at my website.<sup>3</sup> While further research is warranted to include the place and type of natural disaster in the predictions, the time periods for the occurrences of natural disasters have been predicted in monthly columns at my website<sup>3</sup>.

Beginning in 2006, the research of the natural calamities was more focused on the occurrence of earthquakes. One reason for this was the availability of accurate data on earthquakes from National Earthquake Information Center, United States Geological Survey<sup>4</sup>.

## **Research Basis - Methodology**

As pointed out earlier the bases for this research are the unique planetary positions (geocentric sidereal or tropical longitude measured along the ecliptic) surrounding earth. Astronomical data provides planetary positions as a function of time. It was observed that the geocentric angles of certain magnitudes between some pairs of planets with respect to the earth appear to correlate well with earthquakes. Correlations between earthquakes of the past and the corresponding planetary angles during those respective periods occur in a statistically significant way.

These correlations reveal that with increasing number of geocentric angles- when they occur as conjunctions (zero degrees) and in multiples of twelve degrees all the way to oppositions (180 degrees), the probability of an earthquake becomes greater. In addition, the larger the sum of these angles, specifically: 0, 12, 24, 36, 48, 60, 72, 84, 96, 108, 120, 132, 144, 156, 168 and 180 degrees, the higher the probability of earthquake severity.

## **The Model**

The objective for model development is to predict earthquakes of magnitude 7 and higher. First a simple model was developed based on the assumption that the earthquake severity depends on the total number of angles ranging from zero degree to 180 degrees with the 12 degree multiples, formed between planetary pairs. In other words, the more the number of angles the higher the severity of the earthquake. However, it was found that the severity of the earthquake is not necessarily proportional to the number of angles formed. As a result, it became necessary to account for the influence of each individual angle for each pair of planets by weighing them differently. The weighted model is developed using a simple linear regression technique. Thus, in theory there are 55 different pairs of planets (6 outer, 2 inner, Sun, Moon and the North lunar node) and 16 distinct angles (from 0 degrees to 180 in multiples of 12), making a total of 837 maximum possible unique variables that can influence the earthquake occurrence. (Note that the maximum angles between Venus and Mercury, Venus and Sun, and Mercury and Sun are 73.5, 47 and 27 degrees respectively; and the angle between Pluto and Neptune ranges only from 15 to 70 degrees). While the previous model dealt with the fifteen-degree angle multiples, this model differs from that model and deals with twelve degree-angle multiples as the planetary data correlated better with the earthquakes.

Since the Moon's average daily variation is about 13 degrees it can form equal number of angles with every other planet during a daily twenty-four hour period. Therefore, the influence of the Moon is assumed to be equal for everyday and is not included in the model. The daily planetary variations on average (excluding the Moon) are within the orb

of one half degree or less, and therefore, the assumption of Moon's exclusion then allows for daily Greenwich noontime data to be employed for the Greenwich date when the earthquakes occurred.

Nevertheless, in order to verify the assumption of insignificant influence of Moon for the daily earthquake prediction, a model up to 837 maximum possible variables that includes influence of Moon was also being developed. A further investigation is required to quantitatively determine the degree of justification of this assumption.

The earthquakes of magnitude 7 or higher that occurred during January 1900 – December 2009 were obtained from the USGS<sup>2,4</sup> website. Two data sets of 1900-1972 and 1973-2009 were combined to create one large data set of 1672 points. If there were more than one earthquake of magnitude 7 or higher occurred in one day, the only one with the highest magnitude was selected for that day for this analysis. The accuracy of the data sets was verified against the Centennial Earthquake Catalog.<sup>2</sup> Then computation of all the corresponding planetary positions and angles were performed. Using an orb of one half degree the planetary data pertaining to angles from zero, 12, and multiples of twelve up to 180 degrees were extracted for all 45 planetary angle pairs for the model. Thus, there are 671 unique variables. A linear model is assumed as follows.

$$\text{Earthquake Magnitude} = \sum C_n * (\text{angle pair})_n + \text{constant} \quad \text{for } n=1 \text{ to } 671$$

where  $C_n$  is the coefficient of the  $n^{\text{th}}$  angle pair; and the  $n^{\text{th}}$  angle pair equals unity when true and zero otherwise.

For example, Uranus-Saturn trine (120 degree angle) is represented by the  $X_{305}^{\text{th}}$  variable which becomes unity only when the angle between Uranus and Saturn lies between 119.5 and 120.5 degrees. For all other angles between Uranus and Saturn,  $X_{305}^{\text{th}}$  variable equals zero.

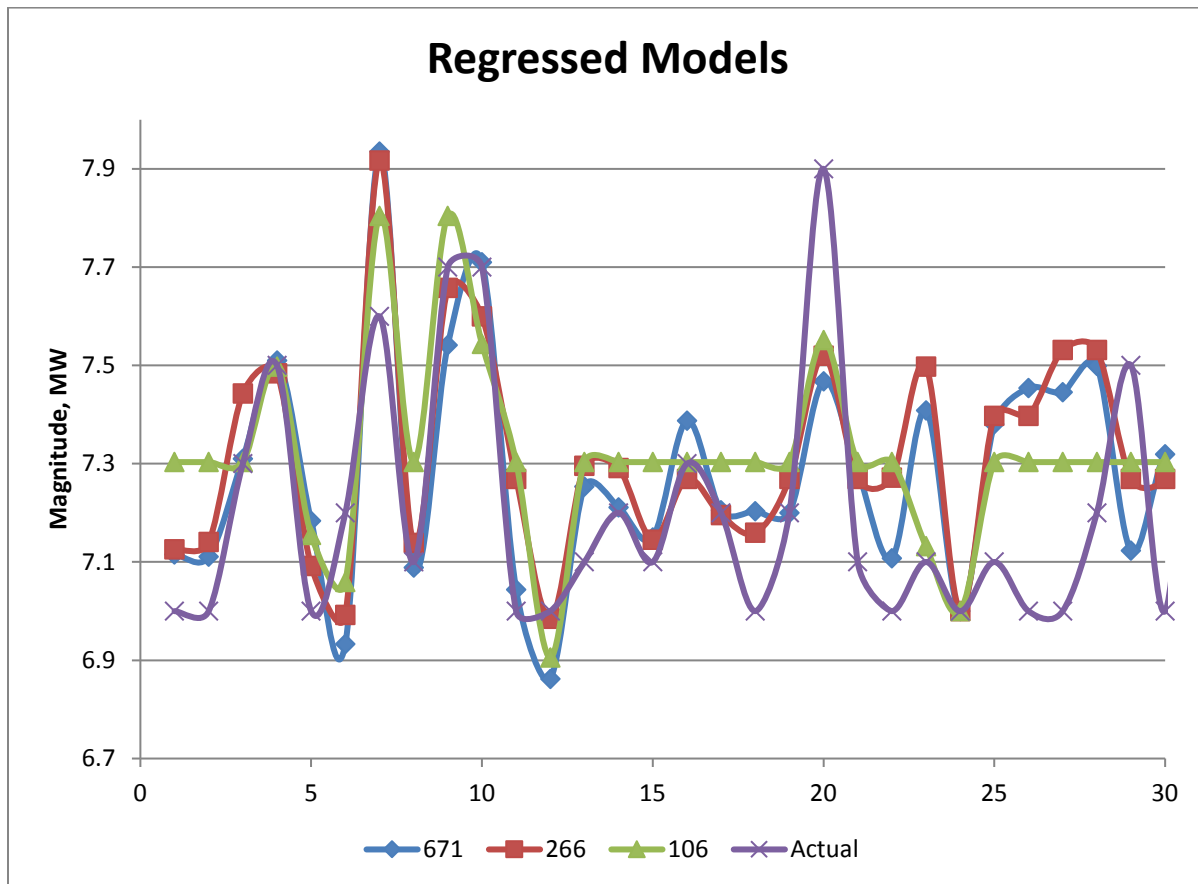
Linear regression was performed and all the coefficients were estimated by generalized least squares. A number of coefficients were so small in magnitude that their influence on the model was deemed negligible. The corresponding variables were omitted one at a time and the regression was repeated to confirm that their influence on the model indeed was negligible.

After running several cases, three models with variables 671, 266 and 106 were obtained for which the influence of Moon was excluded. A typical set of coefficients of model variables are shown in Table-1 for the 266-variable model. There are 45 rows representing planetary pairs and 16 columns for the corresponding angles. Naming of the planetary pairs employ characters Pl, Ne, Ur, Sa, Ra, Ju, Mr, Ve, Mc and Su for Pluto, Neptune, Uranus, Saturn, Rahu (the North lunar node), Jupiter, Mars, Venus, Mercury and Sun respectively. Thus, PlNe represents the planetary pair Pluto and Neptune, and SaRa represents the planetary pair Saturn and Rahu (the North lunar node). The constant term of value 7.27 is listed at the Bottom of the Table-1.

# Table-1: 266-Variable Model

Model based on 0.5 orb with out Moon 1900-2009 Data																	
266 Variables																	
	Angles	0	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180
Pairs																	
1	Pl-Ne				-0.1		0.11										
2	Pl-Ur	-0.1	0.18						-0.1		-0.2		-0.1		-0.1	-0.1	-0.7
3	Pl-Sa			0.1	0.13	-0.4		-0.1		-0.1		0.27	-0.2			0.48	0.22
4	Pl-Ra					0.32			0.24					0.2			0.27
5	Pl-Ju	0.35		0.52		0.24			-0.2	0.14		0.21				-0.1	-0.3
6	Pl-Mr	0.24					-0.1		-0.2					0.76			0.14
7	Pl-Ve			-0.2	-0.1			-0.2	-0.2					-0.1			
8	Pl-Mc	-0.3			-0.2				0.16	-0.2		0.2	-0.2		-0.2		
9	Pl-Su	0.73	0.37	0.16				-0.2				-0.2	-0.2		0.22	-0.2	0.18
10	Ne-Ur			-0.1	0.26				-0.2			-0.2		-0.1	-0.1		
11	Ne-Sa	0.2			-0.2	0.12	0.11			-0.2	0.12	0.29	-0.1		-0.5	-0.1	
12	Ne-Ra	0.5		0.14					-0.1	0.2	-0.3	0.3	-0.2	-0.1		-0.2	
13	Ne-Ju		0.16							0.18	0.18	-0.3			0.16		
14	Ne-Mr	0.33			-0.3		-0.2	-0.1	0.12	0.11	0.16						
15	Ne-Ve	-0.2				-0.1	-0.2	0.25	0.21				-0.2				
16	Ne-Mc		-0.1				0.14		-0.1			-0.1					-0.1
17	Ne-Su		0.11	0.1				-0.1		0.25	-0.2		0.2	0.16		-0.1	
18	Ur-Sa			-0.1				-0.2		0.17					0.24		0.27
19	Ur-Ra	-0.2				-0.2				-0.2	-0.1						
20	Ur-Ju					0.24			0.26			0.35	-0.1	0.21		0.14	-0.3
21	Ur-Mr		-0.2	0.22	-0.1		-0.3			-0.2		0.12			-0.1		-0.2
22	Ur-Ve	-0.4		-0.4					0.61			-0.1		0.2			
23	Ur-Mc	0.34						-0.2		-0.3		0.12				-0.1	0.18
24	Ur-Su					-0.2					0.16	0.1			-0.2	-0.1	
25	Sa-Ra	0.18		0.24	0.46					0.23	-0.2			-0.1			
26	Sa-Ju		0.2						0.13	-0.1				-0.4			
27	Sa-Mr	0.21						0.2				-0.1					
28	Sa-Ve									-0.2	-0.2				0.33	0.29	
29	Sa-Mc	0.41		-0.1	-0.1	0.3			-0.4	-0.1			-0.2	-0.2	-0.2		0.17
30	Sa-Su	-0.3						-0.2		0.23			0.1	0.16			-0.2
31	Ra-Ju			0.32		0.33	0.16			0.25		-0.2		-0.1	0.22		
32	Ra-Mr																
33	Ra-Ve					0.21	-0.3	0.17			-0.2	0.19		-0.1	0.15		
34	Ra-Mc		-0.3			0.21					0.15			-0.1	0.14	0.22	0.41
35	Ra-Su	0.23		0.16	0.12				0.23				-0.1				0.69
36	Ju-Mr	-0.3			0.27		0.2			0.19	0.13		0.16			0.11	
37	Ju-Ve	0.15		-0.1	0.26		-0.3			-0.3		0.18	-0.2		0.26	-0.2	-0.2
38	Ju-Mc	0.22						0.18	0.22	-0.2		0.24	-0.3		0.29	0.19	
39	Ju-Su		0.22	-0.1					0.15				0.14				
40	Mr-Ve		0.15	-0.1		-0.1	-0.1		0.12	0.15		-0.2	0.35		-0.3		
41	Mr-Mc	0.17					0.22							0.41		-0.2	
42	Mr-Su	-0.4							-0.3				-0.2				0.45
43	Ve-Mc	-0.2					-0.2										
44	Ve-Su	-0.1															
45	Mc-Su	-0.2		0.12													
						Constant = 7.27											

The value of the constant in the linear equation of these models as calculated by robust linear regression ranged between 7.27 and 7.30. The simulation results showed that the first two models were almost identical in their performance as the successive omission of coefficients of insignificant magnitude did not seem to degrade the model performance while allowing the data noise reduction. With further discarding of the lowest magnitude coefficients, the model-fit slowly began shifting, and the third model of 106 variables seemed robust enough to apply with the minimum amount of noise in data. The simulated results are shown in Figure 1 for these models for first 30 data points, and although not included in the figure due to space limitation, a similar trend exists for all 1672 data points for each model.



**Figure -1**

Regressed Models of 671, 266 and 106 variables and the corresponding actual earthquake values of seven and higher

Observing the data closely, it is striking that outer planets and the lunar North node have distinct influence on occurrence of severe earthquakes. The inner planets and the Sun also

can contribute to earthquake occurrences by forming similar angles and enhance the probability of the earthquake severity, but the presence of at least four outer planets and the North lunar node seem to be a necessary condition for an occurrence of earthquake of magnitude 7 or higher.

It must be noted that one of the limitations of these models is that they only apply over a narrow range of seven and higher earthquake magnitude. Therefore, all predicted values for earthquakes below magnitude seven are irrelevant and meaningless since they apply for the entire lower range of earthquake magnitudes from zero to 6.9. The other important limitation to these models is that they are based on only 1672 data points (since earthquakes of magnitude seven and higher occur about a dozen time per year). Thus, for example, for the model of 266 variables, the ratio of data points to model variables is just above five, and for the one with 106-variable model it is about 16. Consequently, the R-square term, which is a measure of a model fit, varied from 0.4 to 0.53 indicating a fit not so perfect.

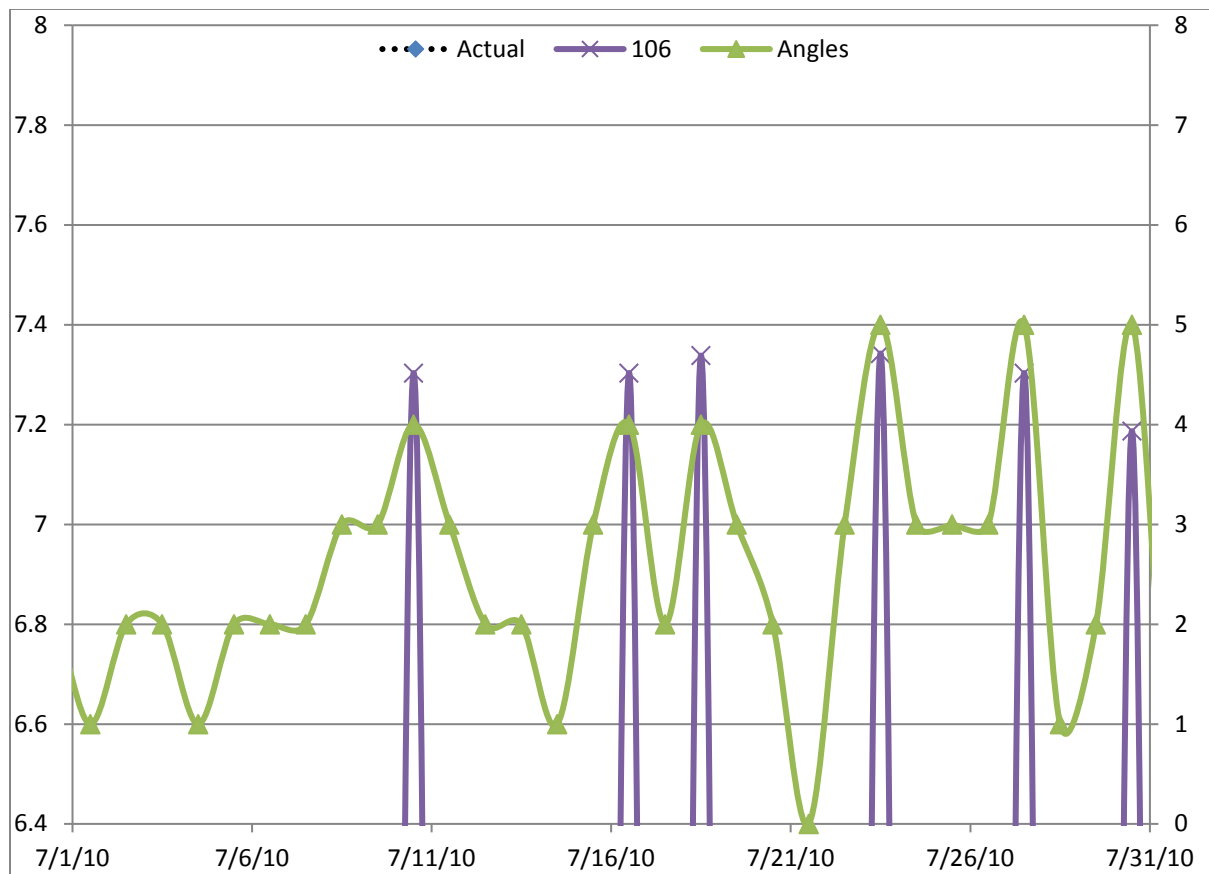
Using Greenwich noontime daily planetary positions, each model (especially the one with 106 variables) was then used to predict the earthquakes for the year 2010. Prior to 2010 the previous model of 15 degree multiples was used to predict the earthquakes of magnitudes 7 or higher. A summary of assumptions reflecting the limitations described above form the basis for the models and are listed below:

1. The predicted earthquakes of magnitude less than 7 are ignored since the model is based on the earthquake data set of magnitude 7 and higher. Thus, the prediction dates of an earthquake of magnitude less than 7 also apply for the dates when earthquake did not occur.
2. As pointed out earlier, the influence of the Moon is assumed to be equal for every day since Moon's average daily variation is about 13 degrees, forming equal number of angles with all other planets during a twenty-four hour period of every day. Therefore, the Moon's influence is not included in the model.
3. Angles ranging from zero to 180 degrees with 12 degree multiples are employed. The minimum number of angles that are required to meet the criteria of realizing the earthquake of magnitude 7 or higher must be greater than the average number of angles for the year 2010. The average number of angles for 2010 is 3.4, and therefore, the minimum number of angles is 4.
4. One-half degree orb is applied for all angles. Thus, for a twelve-degree angle two planets must form the angle that lies between 11.5 and 12.5 degrees.

## **Results and Conclusions**

The 12 degree multiple model was employed for prediction since July 17, 2010. The predicted dates and the corresponding actual dates on which earthquakes occurred are

shown in Figure 2 for only July 2010 based on 106-variable model, and are summarized in Table-2 since January 2010. These monthly predictions were posted at website<sup>3</sup> every month on the last day of the preceding month since August 2007. The monthly predictions based on 12 degree multiple were published since August 2010.



**Figure-2**

Comparison of 106 Variable Model based predictions and the actual earthquake data for July 2010

Figure-2 shows that out of the 2 earthquakes of magnitude 7 and higher that occurred in July 2010, the 106-variable model accurately predicts both of them. Please note that the model picks only 6 days in July 2010 for the earthquake of magnitude 7 or higher. The previous model of 15 degree multiple would, on average, pick 8 to 12 days for a month.

**Table-2**

Earthquake Predictions since January 2010 of magnitude 7 or higher

**2010**

<b>Months</b>	<b>Prediction Dates</b>	<b>Actual Dates</b>
January 2010	11, 18, 22 and 31	3 (7.1), <b>12</b> (7)
February 2010	2-3, 7-9 and 14	26 (7), 27 (8.8) Chile
March 2010	8-11, 17, 19-20, and 25-26	None
April 2010	1-2, <b>6</b> and 17-19	4 (7.2), <b>6</b> (7.8)
May 2010	2-7, 11,16-20, 24-25 and 28-31	9 (7.2), <b>27</b> (7.1)
June 2010	3-5, 9, <b>12</b> , 14-15, 17, 19, and 24	<b>12</b> (7.5), <b>16</b> (7)
July 2010	7-11, 20-21, 24 and 30... <b>old model</b> 10, 16, <b>18</b> , <b>23</b> , 27, 30 .. <b>new model</b>	<b>18</b> (7.3), <b>23</b> (7.6)
August 2010	4-5, 8, <b>10</b> , <b>13</b> , 15, 17-23 and 25-26	<b>10</b> (7.3), <b>13</b> (7.1)
September 2010	1, 4, 6-7, 9-10, 21 and 25	<b>3</b> (7), 29 (7)
October 2010	2, 6-8, 14-15, 17-18, 21, 24, 26 and 30	<b>25</b> (7.8)
November 2010	1-2, 5, 9, 20, 24, 27-28 and 30	None
December 2010	2, 14-16, 18, 20, 24- <b>25</b> , 27-28 and 30	<b>21</b> (7.4), <b>25</b> (7.3)

**2011**

<b>Months</b>	<b>Prediction Dates</b>	<b>Actual Dates</b>
January 2011	<b>1</b> , 5-6, 10, 12, 14, 20, and 22	<b>1</b> (7), <b>2</b> (7.2), <b>13</b> (7), 18 (7.2)
February 2011	6, 13-14, 16-18, 20-21 and 23-25	None
March 2011	1, 3, 5, 8, 21-24 and 29-30	<b>9</b> (7.3), 11(9) Japan
April 2011	1, 3-5, 8, 11-12, 14-17, 21-22, and 28-29	<b>7</b> (7.1)
May 2011	5, 7, 10-12, 17-18, 20, 22, 24-26 and 28-29	None
June 2011	10, 13, 15, 19, and 25-30	<b>24</b> (7.3)
July 2011	1-2, 12, 14-15, 17, 22, 25 and 29	6 (7.6), 10 (7)
August 2011	1, 10-11, 14-16, 18, <b>20</b> -23 and 29	<b>20</b> (7.2), <b>24</b> (7)
September 2011	<b>4</b> , 6-8, <b>14-17</b> and 26-30	2(7.1), <b>4</b> (7), <b>15</b> (7.3)
October 2011	7, 10, 12, 16-18, 22- <b>23</b> and <b>26-29</b>	<b>21</b> (7.6), <b>23</b> (7.3), <b>28</b> (6.9)
November 2011	1, 3-4, <b>8</b> , 10-11, 14-16, and 23-25	<b>8</b> (6.9)
December 2011	2-6, 8, 11, 19, 26 and 29	14(7.3)



## 2012

Months	Prediction Dates	Actual Dates
January 2012	3, 6-7, 9-10, 12-13, 15, 19, 21-23, 28 and 31	<b>10</b> (7.3)
February 2012	3, 12-17, 23 and 27-29	None
March 2012	3-5, 11-12, 14-15, 17, 19 and 28	<b>14</b> (6.9), <b>20</b> (7.6)
April 2012	2-4, 6, 7, <b>11</b> , 15 and 26-28	<b>11</b> (8.2)
May 2012	2, 5, 14-17, 20, 22 and 27-30	None
June 2012	7, 9-10, 13, 15, 18 and 23	None
July 2012	4-6, 8-9, 17-18, 20-28 and 31	None
August 2012	2-3, 6, 8-10, 22, 24 and 30	14(7.7)

The first two columns in Table-1 list months and the prediction dates for the earthquakes of magnitude 7 or higher for the corresponding months. The last column lists the dates on which earthquakes occurred with magnitude shown in the parentheses. If the actual date matches the prediction date, the date is highlighted red. If it misses by between one and twenty three hours, the date is highlighted bold. If it misses by more than a day the date is not highlighted.

As shown in Table-2, the overall monthly predicted dates ranged between 8 to 12 days. In other words the model rules out, on average, between 18 to 22 days every month. This is one of the salient features of this model.

Although the Figure-2 represents a successful case of two for two for only 6 days pick out of 31 days of July, during the second half of 2010, the model predicts the earthquake of magnitude 7 and higher five times out of nine, and eight times out of nine if it misses by a day. The Table-3 summarizes the results for earthquakes of magnitudes 7 or higher as of August 2012.

**Table-3**

Year	Successful Hit	Missed by a Day	Miss	Total
July-Dec 2010	5	3	1	9
2011	5	6	6	17
Jan-Aug 2012	3	1	1	5

In Table 4, the probability calculation summary is shown for the period July 2010-August 2012. The column 2 lists P days (Number of prediction days), the next two columns lists actual number of successful hits and total number of actual earthquakes of magnitude 7 or higher. And the last column lists the corresponding probability. Thus the probability of making three hits out of five during the first 8 months (184 days) of 2012 with 86 number of prediction days is 5.5 percent.

**Table-4**

	P days	No. of Hits	Actual No. of earthquakes	P days/Total		Probability
July - Dec 2010	61	5	9	0.331521739		0.04131965
2011	136	5	17	0.37260274		0.654774246
Jan - Aug 2012	86	3	5	0.352459016		0.055404977
Overall	283	13	31	0.356872636		0.179693692

Furthermore the actual prediction dates amounts to about only 37 percent. The narrowing of the prediction dates-window for each month since 2010 was accomplished by combining the prediction results of the regressed model and the simple model of the number of angles. In Figure-2, the 106 variable model simulation results along with the number of angles formed between all the planetary pairs and the actual dates on which the earthquakes of magnitude 7 and higher occurred are shown for the July 2010.

Clearly, for the model to be applied for earthquakes of magnitude 7 and higher to predict over a narrower range of days would require further improvement and therefore, more research work is warranted. In addition, further research is necessary regarding the locations of earthquakes.

#### **Acknowledgements:**

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