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Earthquake, Volcano and Earth Rotation Harmonics

Sheng Zhao

Retired, Vancouver, Canada
Email: zhao@shaw.ca

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Abstract

Earthquake prediction is considered impossible for there is no scientific way to find the date and time, the location, and the magnitude of an earthquake. A new idea is introduced in this paper—earth rotation harmonics triggered natural volcano and earthquake. With earth rotation harmonics response model for a location, it could be possible to calculate the earthquake date and time, and the magnitude. Properties of earth rotation harmonics triggered earthquake are discussed and verified with earthquake data from USGS website. Also, both earth tide and ocean tide effects on earthquake are discussed and verified with earthquake data—tides did not trigger the natural earthquake, they only affect the earthquake activities and time.

Keywords

Earthquake, Volcano, Prediction and Forecast, Tidal Effects, Earth Rotation Harmonics

1. Introduction

Earthquake prediction is considered impossible for there is no scientific way to find the date and time, the location, and the magnitude of an earthquake [1] [2] [3] [4]. It is well known that earth rotates in 24 hours period, but the rotation speed could not be a perfect uniform speed, so there should be harmonics (the harmonics), the harmonics could be considered as regular disturbance and could affect our earth system (solid earth, ocean, atmosphere) in certain ways. Many natural phenomena could be related to the harmonics. Earthquake and volcano might be one of them.

Due to the nature of the solid earth, there should be nonlinear response to the harmonics; certain portion of the solid earth could be compressed, stretched or relatively moved (deformed). When the accumulated deformation exceeds cer-

tain critical thread, a sudden change in solid earth could be triggered and result in certain portion of the solid earth moving suddenly.

If the suddenly moved portion run into magma, or the compressed portion is magma itself, the magma could be pushed to erupt out—this triggered the volcano. Otherwise, the sudden move could cause the land to shake—this triggered the earthquake. From the harmonics point of view, both natural earthquake and volcano are earth events triggered by earth rotation harmonics with the same mechanism.

From the harmonics point of view as discussed above, where a natural earthquake (volcano) occurred should meet the conditions:

1) A geostructure with nonlinear response to the earth rotation harmonics;

2) Deformation caused by nonlinear response accumulated;

3) Accumulated deformation could exceed certain critical thread and cause sudden change.

If the deformation caused by the nonlinear harmonics' response did not accumulate, a timed event might be generated, such as the famous Old Faithful Geyser at Yellowstone National Park in the US.

If accumulated deformation did not exceed certain critical thread, it would generate a continue changing, such as magma flow out from a volcano and continent shifting.

In this paper, just earthquake is discussed, and verified with earthquake data.

2. Theoretical Analysis

2.1. The Harmonics Amplitude Effects

The earthquake activities should be proportional to the harmonics' amplitude. The bigger of the harmonics' amplitude, the sooner the accumulated deformation exceed the critical thread, so that there should be more earthquake activities, and vice versa.

2.1.1. Earthquake Distribution along Longitude

Along Longitude, the harmonics amplitude should be no change, so that there should be a flat earthquake distribution.

2.1.2. Earthquake Distribution along Latitude

Along Latitude, the harmonic amplitude should be changed follows cos function from southern pole to northern pole. There should be maximum harmonic amplitude at equator, and decrease follows cos function toward to both northern and southern pole, and became 0 at both northern and southern pole, so that there should be more earthquake activities near equator, and decreasing toward to northern and southern pole, and becoming 0 at both northern and southern pole.

2.1.3. Earthquake Vertical Distribution

For the simplicity, assume the harmonics source is the axis of the earth rotation,

the amplitude should be proportional to the radius from the axis and the energy of harmonics attenuated follow e function toward to the earth surface, so the harmonics amplitude A could be expressed as:

$$A = k * r * e^{-r/M}$$

where r is the radius from the axis of the earth rotation, k and M are constants. The harmonics amplitude A and radius r is shown in Figure 1.

2.2. Tidal Effects

Tides are the rise and fall both of sea levels (ocean tide) and the solid earth's surface (earth tide) caused by the combined effects of the gravitational forces exerted by the Moon and Sun. These two tides will affect the harmonics response and earthquake activities in turn.

2.2.1. Earth Tide Effects

Earth tide will make the solid earth more elastic, so that there should be less resistance to the harmonics and makes the response more linear, the earthquake activities should decrease.

The higher earth tide, the less earthquake activities.

If the earthquakes are triggered equally both in positive and negative half cycle (average) of the harmonics, there should be a lowest earthquake activity when earth tide in the highest point.

If more earthquakes are triggered in the half cycle of the harmonics wave swing direction same as earth rotation direction (positive), the lowest earthquake activities should be leading earth tide peak.

If more earthquakes are triggered in the half cycle of harmonics wave swing in opposite direction as earth rotation direction (negative), the lowest earthquake activities should be lagging earth tide peak.

The effects of a full cycle of earth tide over earthquake activities are shown in Figure 2.

2.2.2. Ocean Tide Effects

Ocean tide will push the earth surface down and make solid earth more rigid, so that there should be more resistance to the harmonics and makes the harmonics response more nonlinear, the earthquake activities should increase.

The higher ocean tide, the more earthquake activities (Figure 3 Ocean tide effects).

2.2.3. Both Earth and Ocean Tide Effects

If both earth tide and ocean tide work together, it could not be a simple linear combination due to the ocean water flow-ability, and mostly like switching to each other at certain point. Assume earth tide and ocean tide synchronized for simplicity and same tide gravitational force both to solid earth and ocean water, so that the analysis could simply base on the balance between elastic force inside solid earth and loading of ocean water on solid earth.

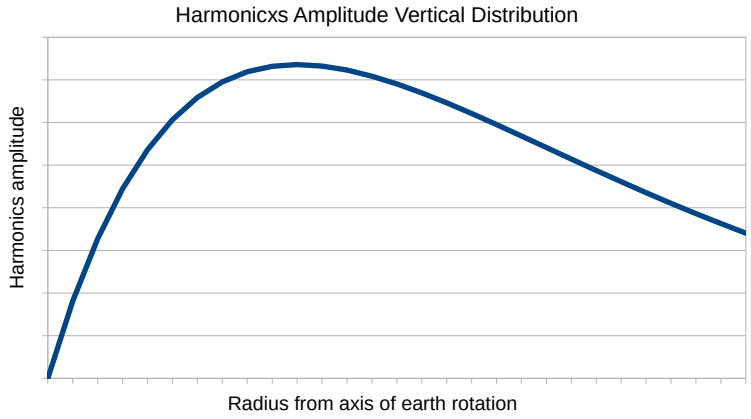


Figure 1. Vertical harmonics amplitude.

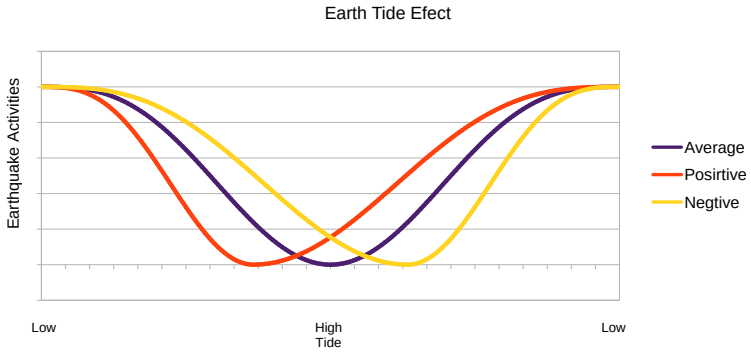


Figure 2. Earth tide effects.

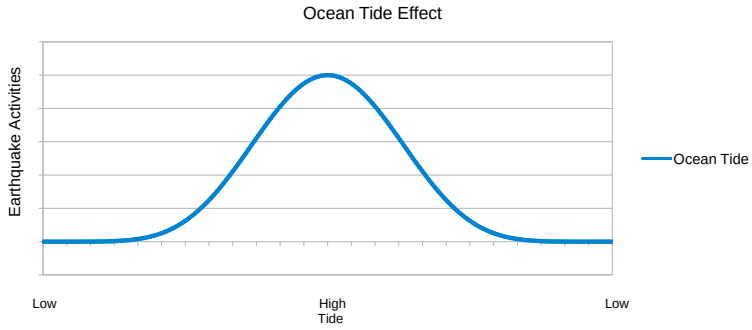


Figure 3. Ocean tide effects.

Starting from low tide, both solid earth's surface and water go up, but some water would flow away along with solid earth's surface going up and reducing the loading on solid earth to make the earth surface going up, the earth tide dominate the tide effect at this time. with solid earth's surface going up, the elastic force of the solid earth will decrease and slowdown the water flow away, when reach a balance point, water stop flowing away, and the raised water will add loading on solid earth and push surface of solid earth down and result in a water flow back, the ocean tide will take over the act roll till high tide point.

Starting from high tide, both solid earth's surface and water level are tending going down, some water would flow away for less gravitational force to keep it, so the loading on the solid earth reduced, the elastic force will push the solid

earth's surface going up, ocean tide dominate the tide effect at this time. with solid earth's surface going up, the elastic force of the solid earth will decrease and slowdown the water flow away, when reach a balance point, the solid earth's surface will go down, the earth tide will take over the act roll till low tide point.

The effects of both earth tide and ocean tide over earthquake activities are shown in Figure 4. Both earth and ocean tides effects.

2.3. Sun and Earthquake Activities

Sun pass anywhere on earth in a 24 hours period, and the distance between Sun and earth changed year around, so it is easy to define earthquake activities related to Sun according above description.

2.3.1. Daily Earth Tide Only

There should be more earthquake activities around midnight, less earthquake activities around noon if earth tide dominated.

2.3.2. Daily Ocean Tide Only

There should be less earthquake activities around midnight, more earthquake activities around noon if ocean tide dominated.

2.3.3. Daily Both Earth and Ocean Tides

There should be more earthquake activities around midnight, less earthquake activities around noon if earth tide dominated.

2.3.4. Yearly

Earth reaches aphelion point on 3-6 July with a greatest distance from sun, there should be more earthquake activities around that time for the lower earth tide effect makes earth more rigid.

Earth reaches perihelion point on 2-4 January with a smallest distance from sun, there should be less earthquake activities around that time for the higher earth tide effect makes earth more elastic.

2.4. Spectrum

If earthquakes are triggered by the harmonics, it is possible to find the harmonics triggered earthquake from earthquake time by Spectral Analysis.

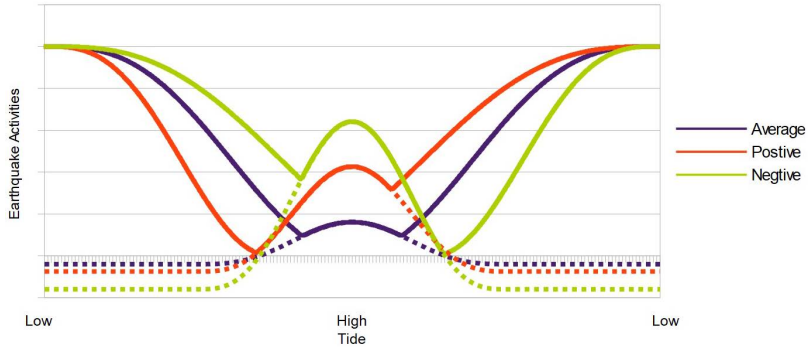


Figure 4. Both earth and ocean tide effects.

The earthquake could be triggered at any time with unknown delay, it makes the Spectral Analysis more difficult. But as discussed above, the earthquake activities should be proportional to the harmonic amplitude, so that there should be a lower probability around harmonics zero amplitude to trigger earthquake, and increase along with the harmonics' amplitude increase, there is still a chance to find the harmonics if there are enough earthquake data. If the harmonics could be found, it should be strongly confirmed that there is a correlation between earthquake and earth rotation harmonics.

The possible spectrum could include:

1) The harmonics triggered the earthquake.

2) Sun caused tide and its harmonics.

3) Moon caused tide and its harmonics.

4) Mixed frequency of 1) and 3) for the nonlinear response.

5) If the harmonics triggered the earthquake only in positive half cycle or negative half cycle, Spectral Analysis should find those spectrums.

6) If nth harmonic triggered the earthquake both in positive and negative half cycle (average) equally, only 2nth harmonic spectrum should be found instead of nth. Otherwise, both nth and 2nth harmonics should exist.

3. Earthquake Data Analysis

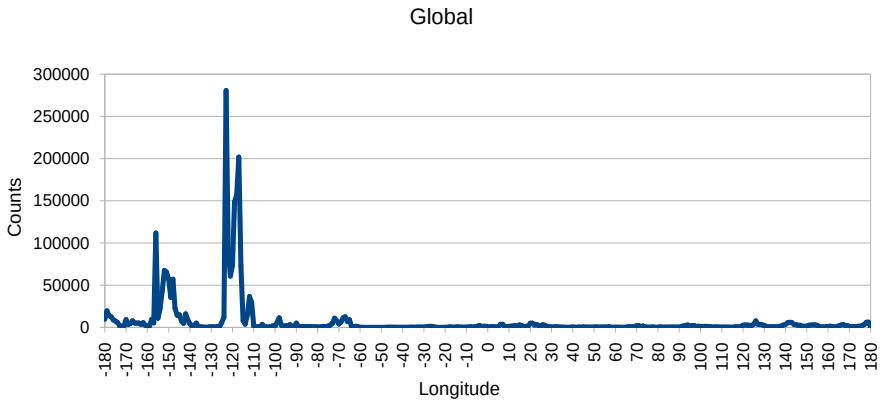
Data used for analysis are from https://earthquake.usgs.gov in date range of 2000-01-01 00:00:00UTC to 2019-12-31 23:59:59UTC worldwide.

3.1. Longitude Distribution

Longitude distribution is shown in **Figure 5** Longitude distribution.

Most of the earthquake data shows a flat distribution except two peaks at northern hemisphere and two peaks at southern hemisphere as shown in **Figure 6**.

Two regions with more earthquakes at northern hemisphere located at Hawaii and Alaska, west coast of Canada and US. Two regions with more earthquakes at southern hemisphere located at New Zealand (Tonga Trench and Kermadec Trench), the coast of Peru and Chile (Peru–Chile Trench).



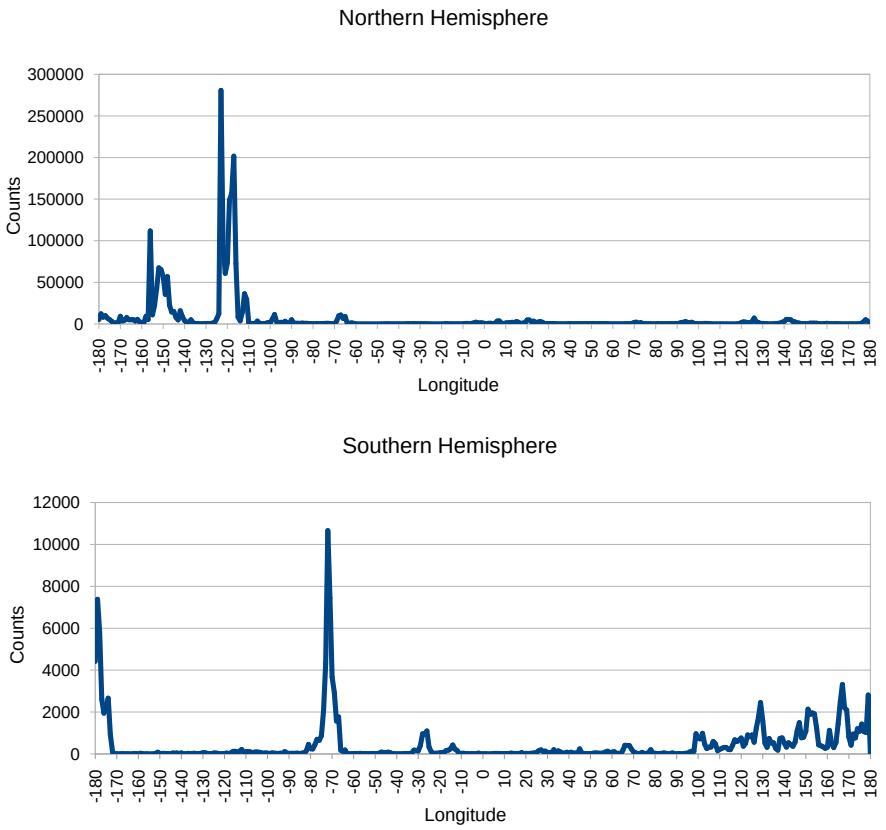


Figure 5. Longitude distribution.

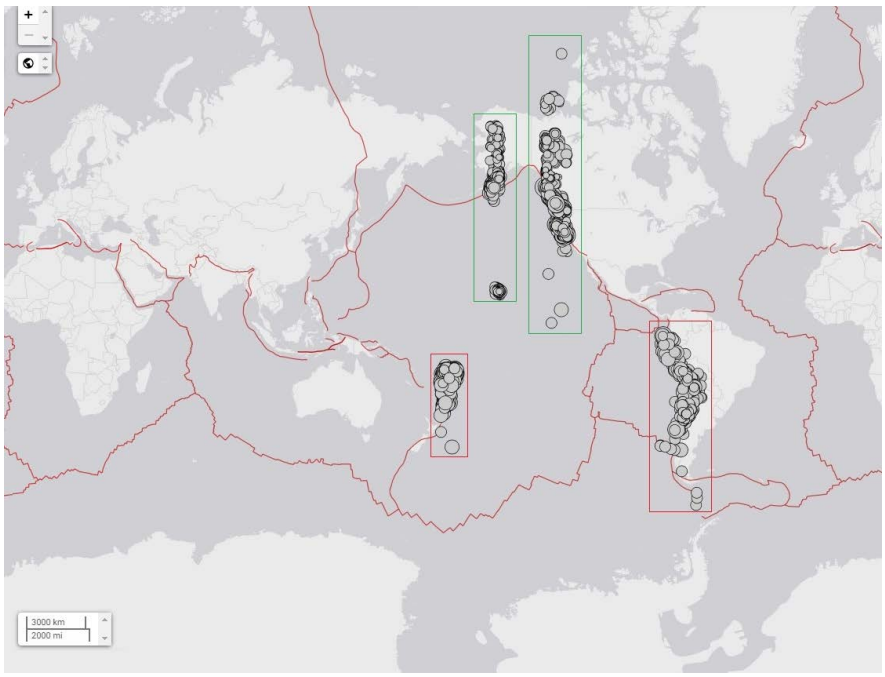


Figure 6. Map of more earthquake activities in longitude distribution.

3.2. Latitude Distribution

Latitude distribution of all earthquake data is shown in Figure 7 compared with

cos function. It could be confirmed that earthquake activities decreasing toward to both northern and southern pole.

All of the above figures (Figures 8-11) could confirm the analysis in 2.1.2.

3.3. Vertical Distribution

Vertical distribution is shown in Figure 12 Vertical distribution.

Earthquake started as deep as more than 700 km depth, and increase obviously from 20 km depth up. The earthquake reaches a maximum activity at depth of about 2.0 km, then decrease rapidly toward to earth surface as described in 2.1.3.

3.4. Sun Tide Effects—Daily

There is no any location with enough earthquakes to perform a meaningful daily sun tide effect on earthquake. But any earthquake with the same position to the Sun can be considered as the earthquake occurred at same time and same location, in this way, all earthquakes over the world can be mapped in one day to perform daily sun tide earthquake effect analysis. Consider that the Sun position relate to latitude will changing year around, use same related longitude between earthquake and sun instead. This can be done just by converting the UTC earthquake time to local geological time to map all of the earthquake into 24 hrs range.

Daily Sun tide effects for all earthquakes with 1 hour step are shown in Figure 13.

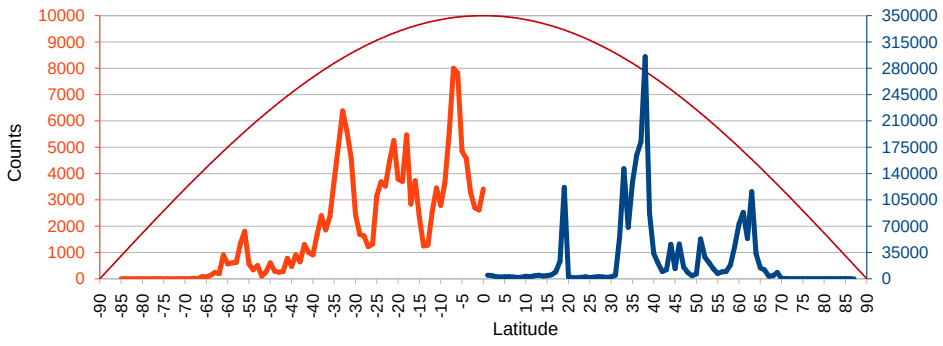
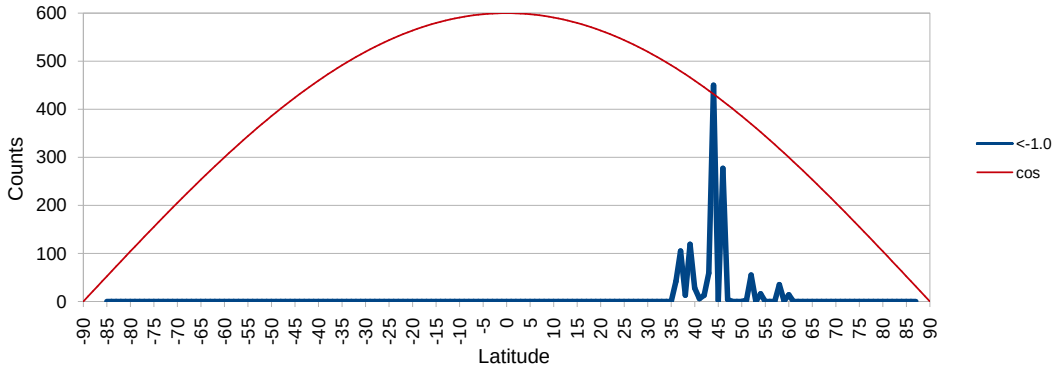


Figure 7. Latitude distribution—all data.



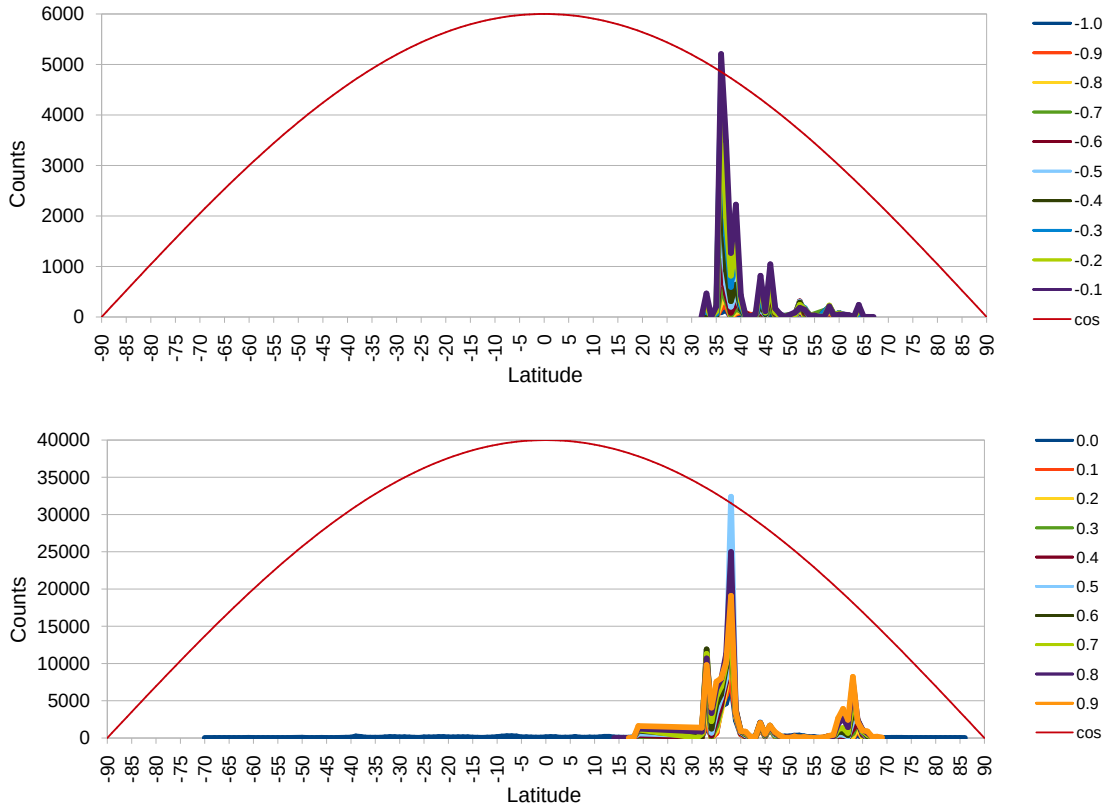
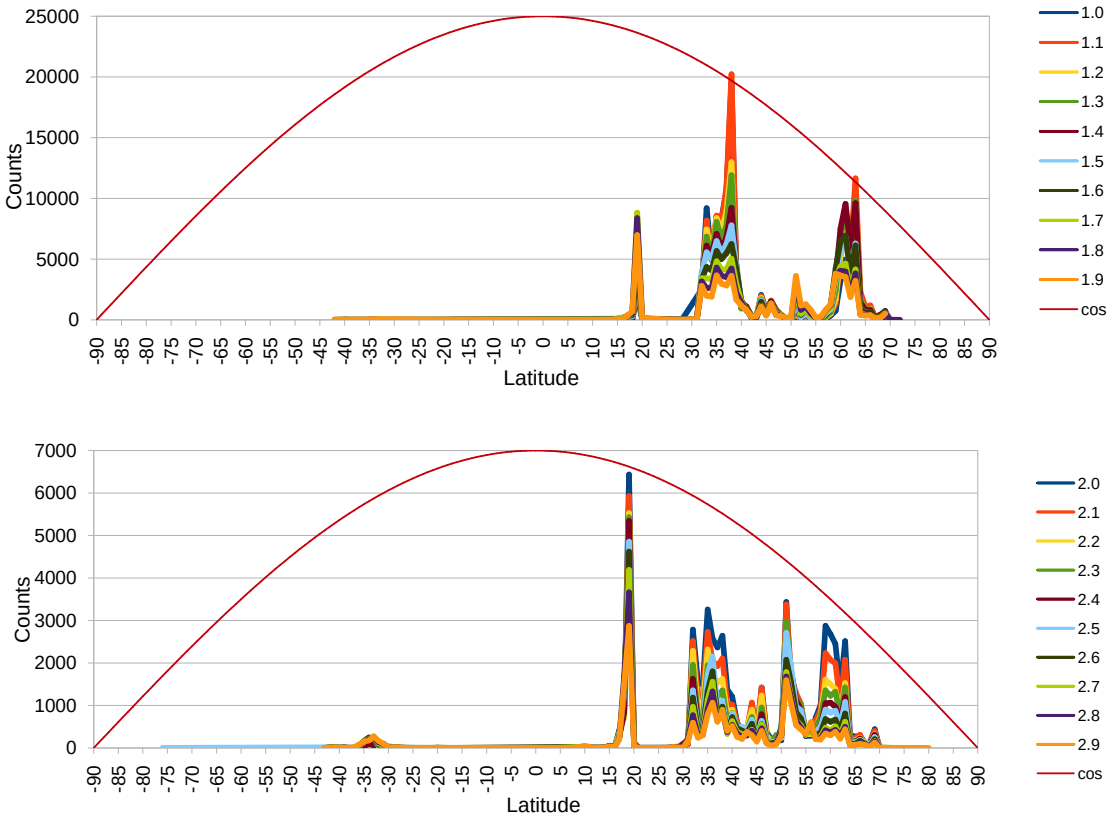


Figure 8. Latitude distribution—magnitude < 1.0.



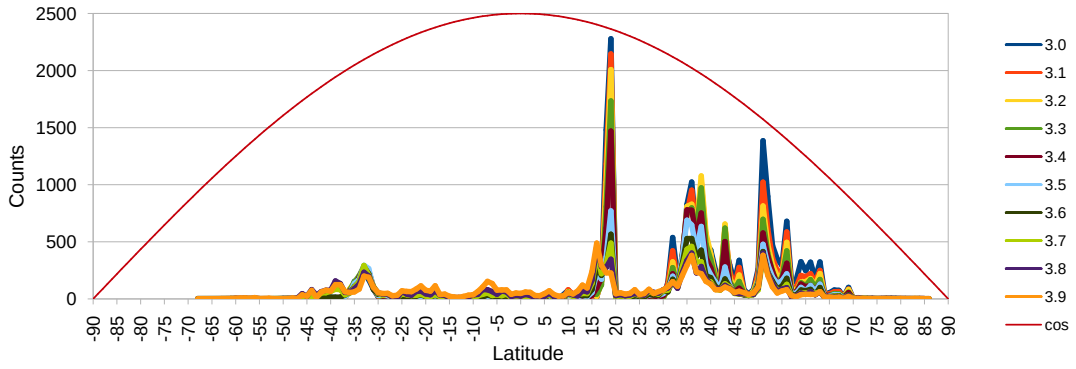


Figure 9. Latitude distribution—magnitude 1.0 to 3.9.

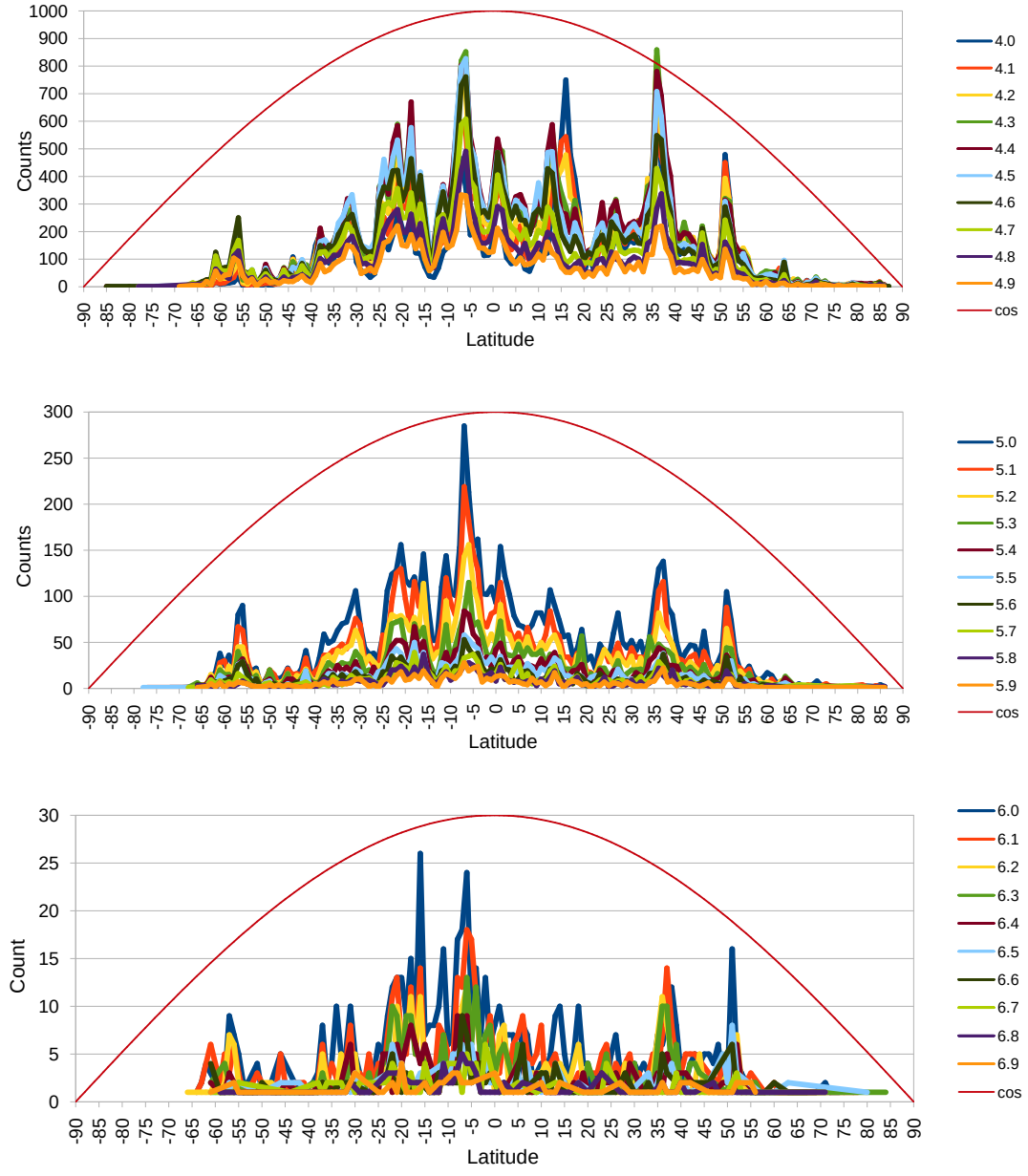


Figure 10. Latitude distribution—magnitude 4.0 to 6.9.

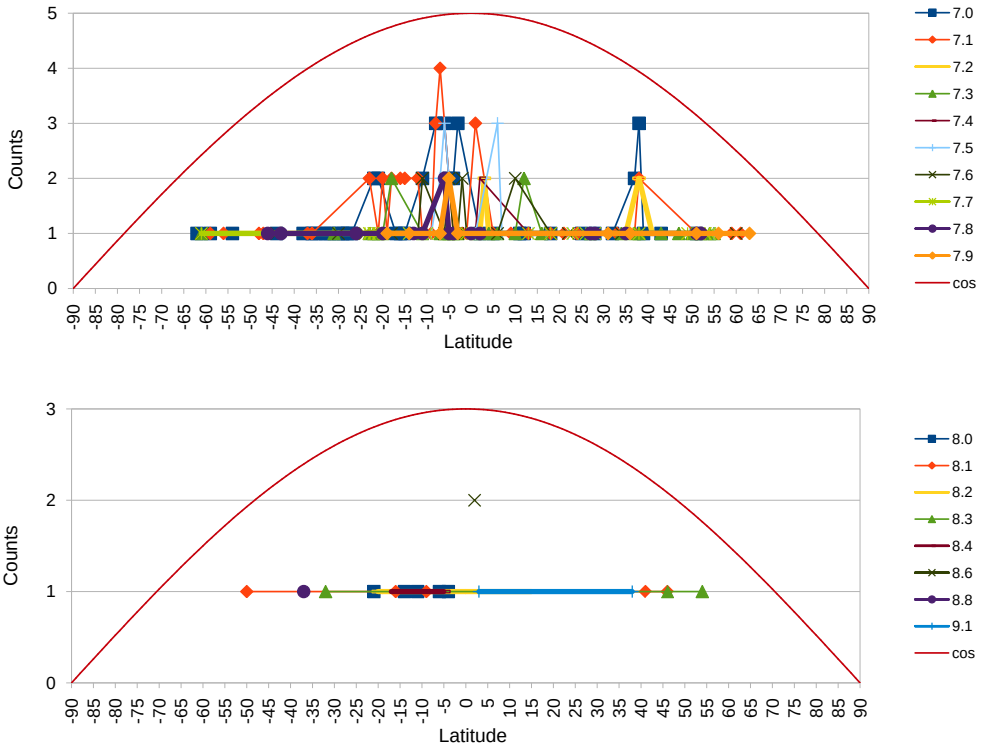


Figure 11. Latitude distribution—magnitude 7.0 and up.

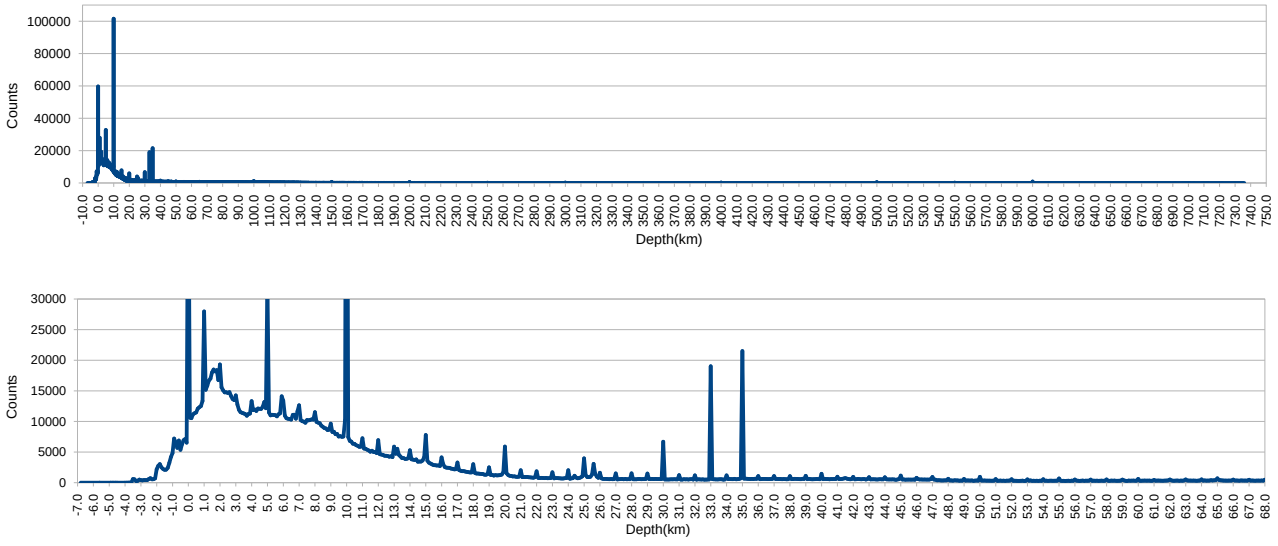


Figure 12. Vertical distribution.

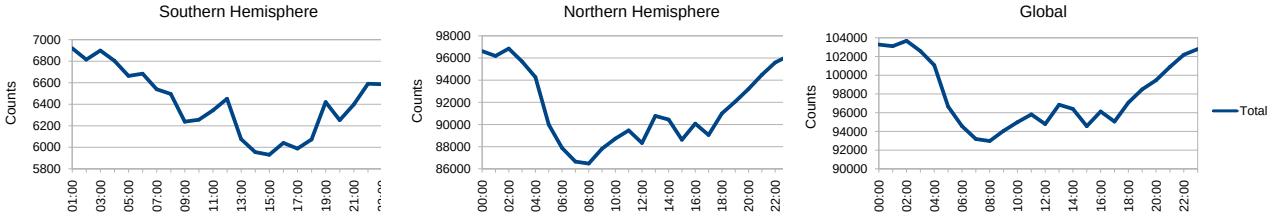


Figure 13. Sun tide daily effects—all data.

Figure 13 shows that more earthquakes occurred in the harmonics negative half cycle on southern hemisphere, and more earthquake occurred in the harmonics positive half cycle on northern hemisphere, both with ocean tide effect.

Figure 14 shows the distribution of magnitude <0.0 on northern hemisphere with only earth tide effect and more earthquakes occurred in the harmonics positive half cycle, there is no such data on southern hemisphere.

Figure 15 shows the distribution of magnitude 0.0 to 1.9, mainly with earth tide effect for magnitude 0.0 to 0.9 on northern hemisphere. For magnitude 1.0 to 1.9, there is only ocean tide effect on southern hemisphere, and there are more earthquakes in the harmonics positive half cycle on northern hemisphere with a strong ocean tide effect.

Figure 16 shows the distribution of magnitude 2.0 to 3.9. For magnitude 2.0 to 2.9, there are more earthquakes in the harmonics positive half cycle on both northern and southern hemisphere with both earth tide and ocean tide effects. For magnitude 3.0 to 3.9, there are more earthquakes in the harmonics positive half cycle on both northern and southern hemisphere with both earth tide and ocean tide effects.

Figure 17 shows the distribution of magnitude 4.0 and up. There are more earthquakes in the harmonics negative half cycle on both northern and southern hemisphere. For magnitude great than 5.0, there are no enough data to make a judgment.

Figure 18 shows that harmonics half cycle with more earthquakes changed from positive half cycle to the negative half cycle from magnitude 3.4 to 3.6.

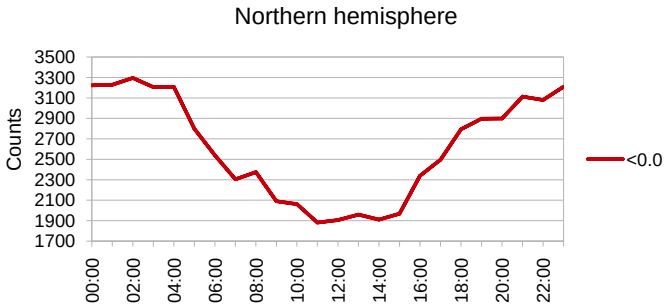


Figure 14. Sun tide daily effects—magnitude <0.0.

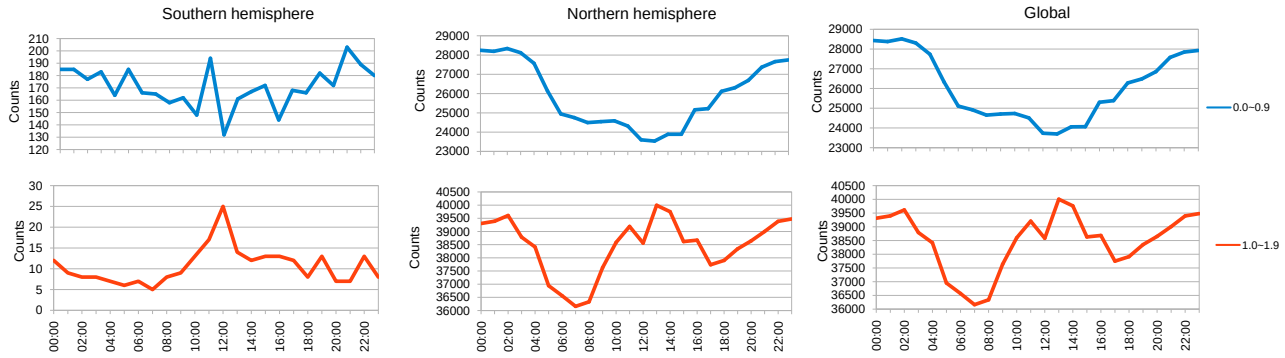


Figure 15. Sun tide daily effects—magnitude 0.0 to 1.9.

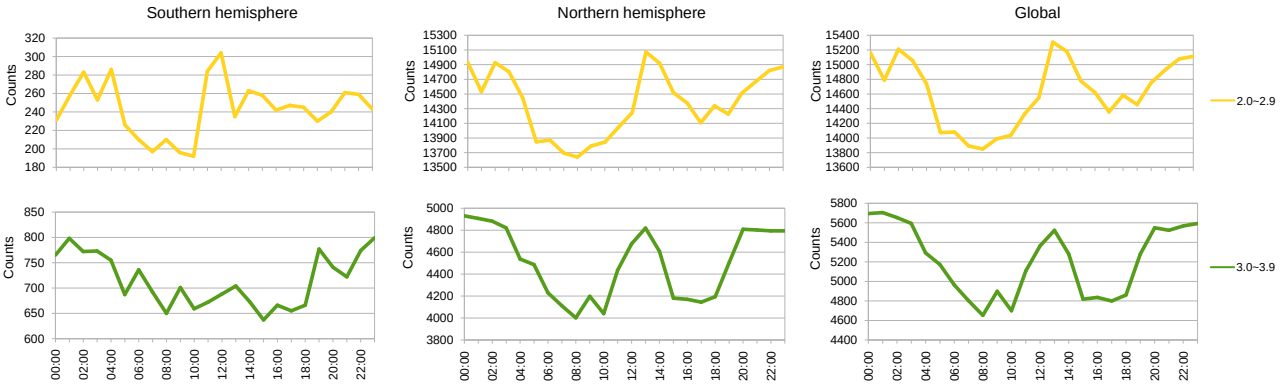


Figure 16. Sun tide daily effects—magnitude 2.0 to 3.9.

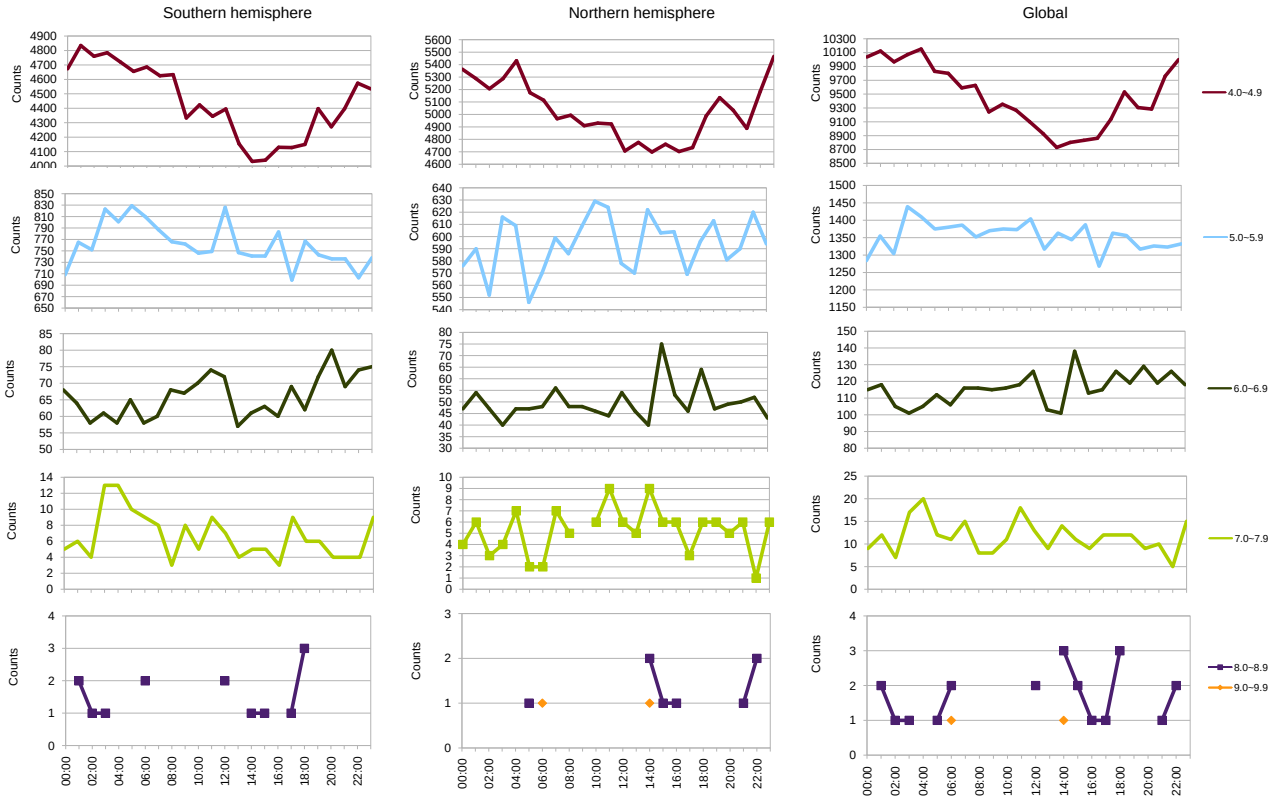


Figure 17. Sun tide daily effects—magnitude 4.0 and up.

3.5. Sun Tide Effects—Year Around

Yearly earthquake distribution can be obtained by just simply putting the earthquake in the same date together, Figure 19 shows the yearly distribution with 1 day step. February 29th is a special day; it is only a quarter of other days. Earthquake are lower activities in January, and a little bit higher activities in July as described in 2.3.4.

3.6. Spectrum

The following function is used to calculate nth harmonics.

$$f(n) = 1/M\sum e^{-j2\pi n(tm-t0)/24}$$

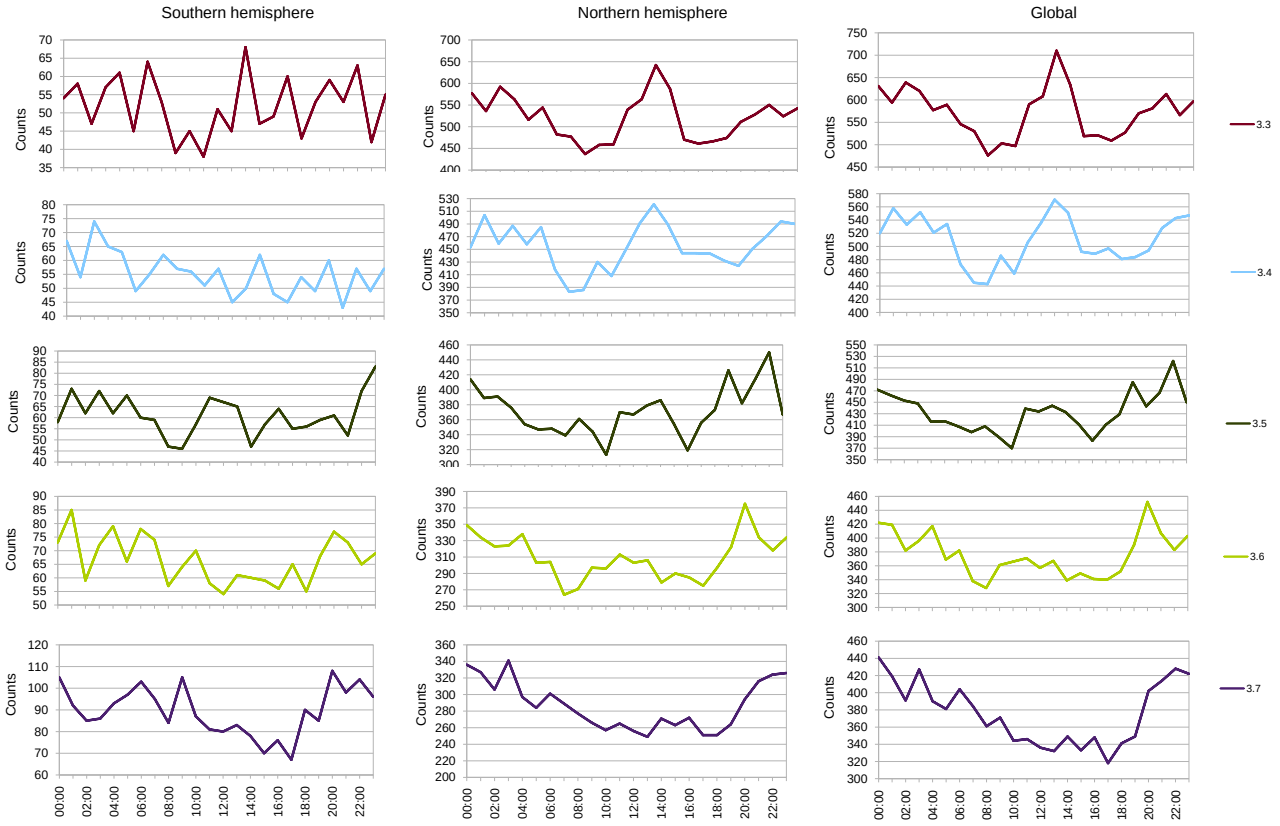


Figure 18. Sun tide daily effects—magnitude 3.3 to 3.7.

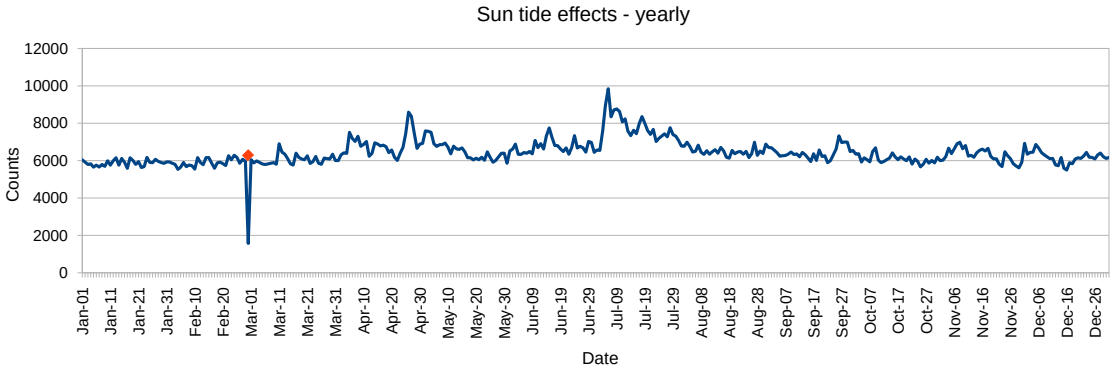


Figure 19. Sun tide yearly effects.

where M is total earthquake counts, tm is the mth earthquake time, t0 is selected reference origin and 2000-01-01 00:00:00 UTC is used in this Spectral Analysis. The Spectral Analysis is just intended to find out if the harmonic peaks exist. the order step of 0.25 is used for harmonics calculation, and a 0.25 day step is used for tide harmonics above 1day. Spectrum for all earthquake data is shown in Figure 20. Many peaks of earth rotation harmonics and tide caused harmonics can be seen in the figure.

Earthquake near earth's surface could be considered less interference by other earthquake. Spectral Analysis for depth of 0.0 km is shown in Figure 21. Spectral Analysis for depth above 0.0 km is shown in Figure 22. Both figures show strong-

er earth rotation harmonics. Two stronger tides caused harmonics of 3.5 day and 7 day can be seen in Figure 22.

3.7. Earthquake Magnitude Distribution

Figure 12 shows that there are more earthquakes at certain depths. More detailed data is shown in Figure 23. There is a pattern of 100.0 km major step and 50.0 km minor step below 100.0 km, and a pattern of 5.0 km major step and 1.0 km minor step above 100.0 km. Earthquake magnitude distribution at those depths is shown in Figure 24.

Figure 25 shows the magnitude distribution of all earthquake data. It shows that from magnitude 3.5, earthquake activities stop decreasing as normal, and start increasing until magnitude 4.4, then decreasing again until 5.0 to the normal level. From the harmonics point of view, the possibilities of more earthquake magnitude range from 3.5 to 5 should be:

1) sensitive to certain harmonics, and/or

2) sensitive to tides.

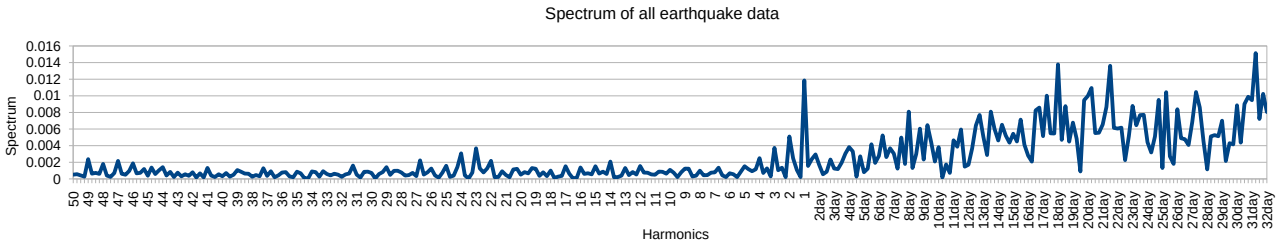


Figure 20. Spectrum—all earthquake data.

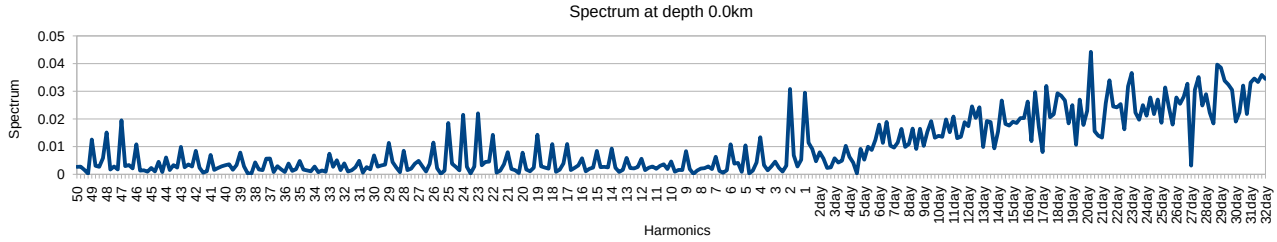


Figure 21. Spectrum at depth 0.0 km.

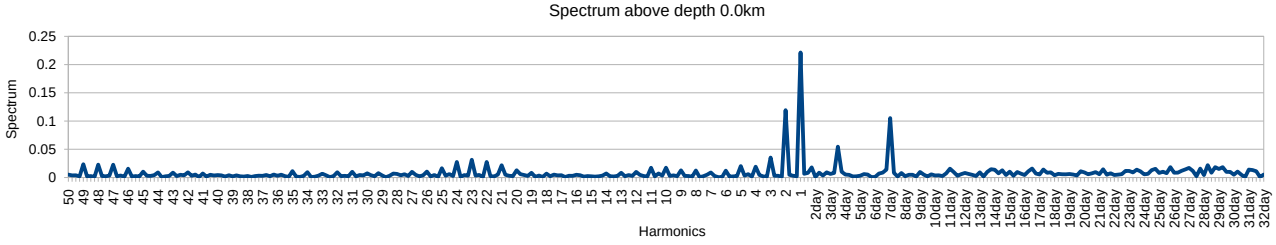


Figure 22. Spectrum above depth 0.0 km.

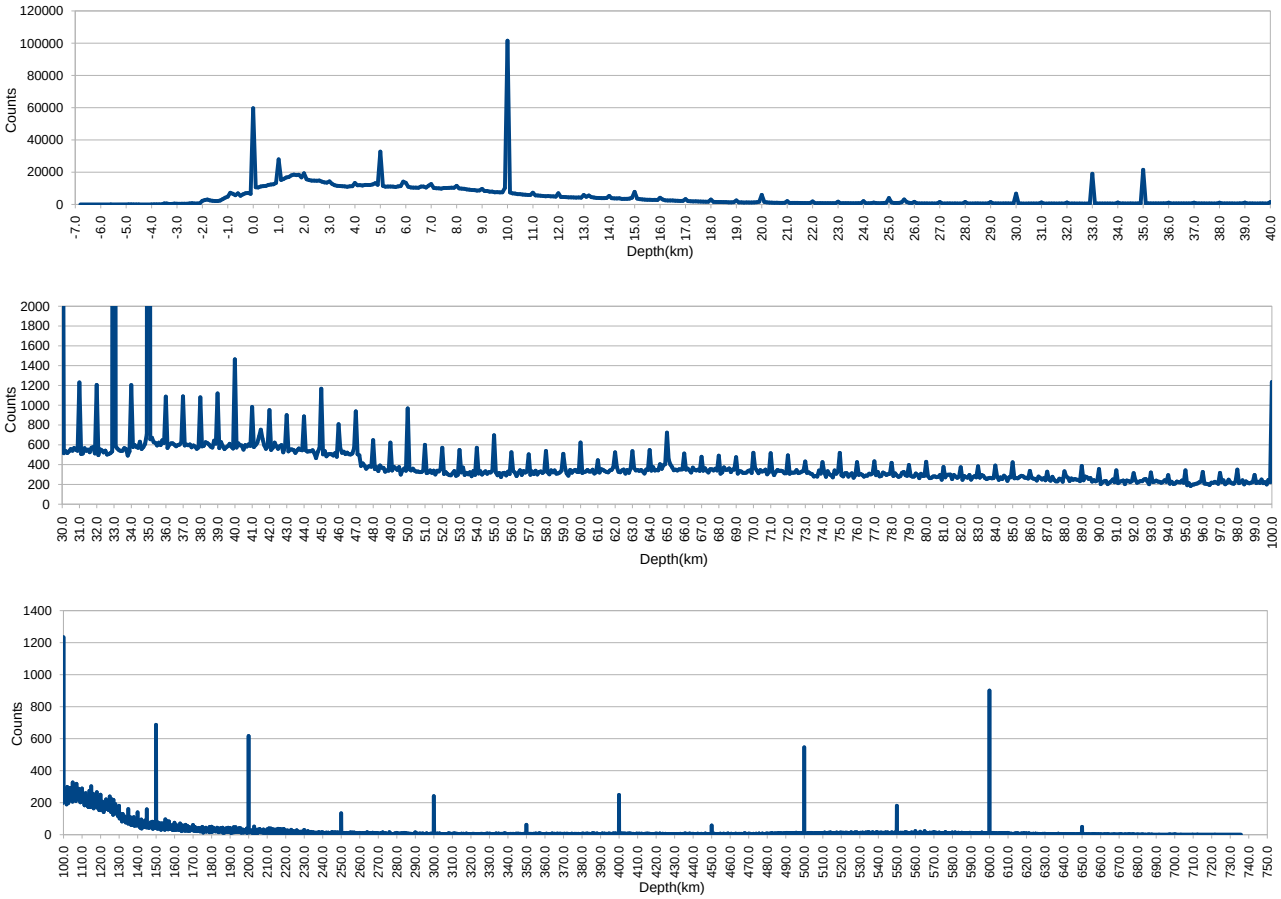
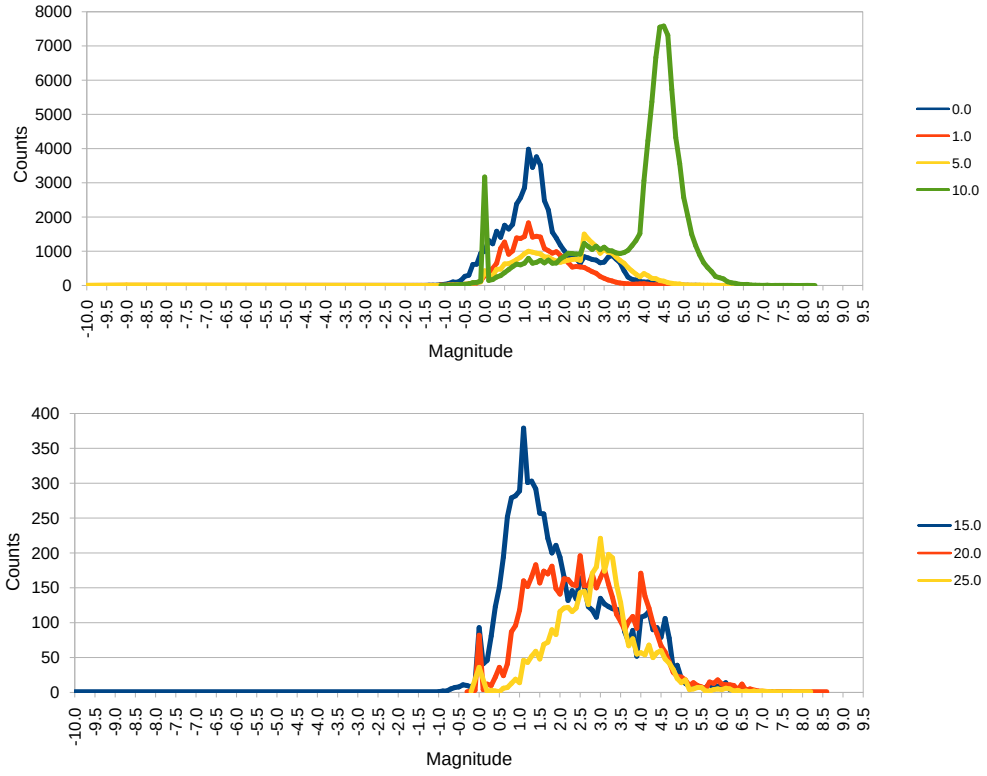


Figure 23. Depths with more earthquakes.



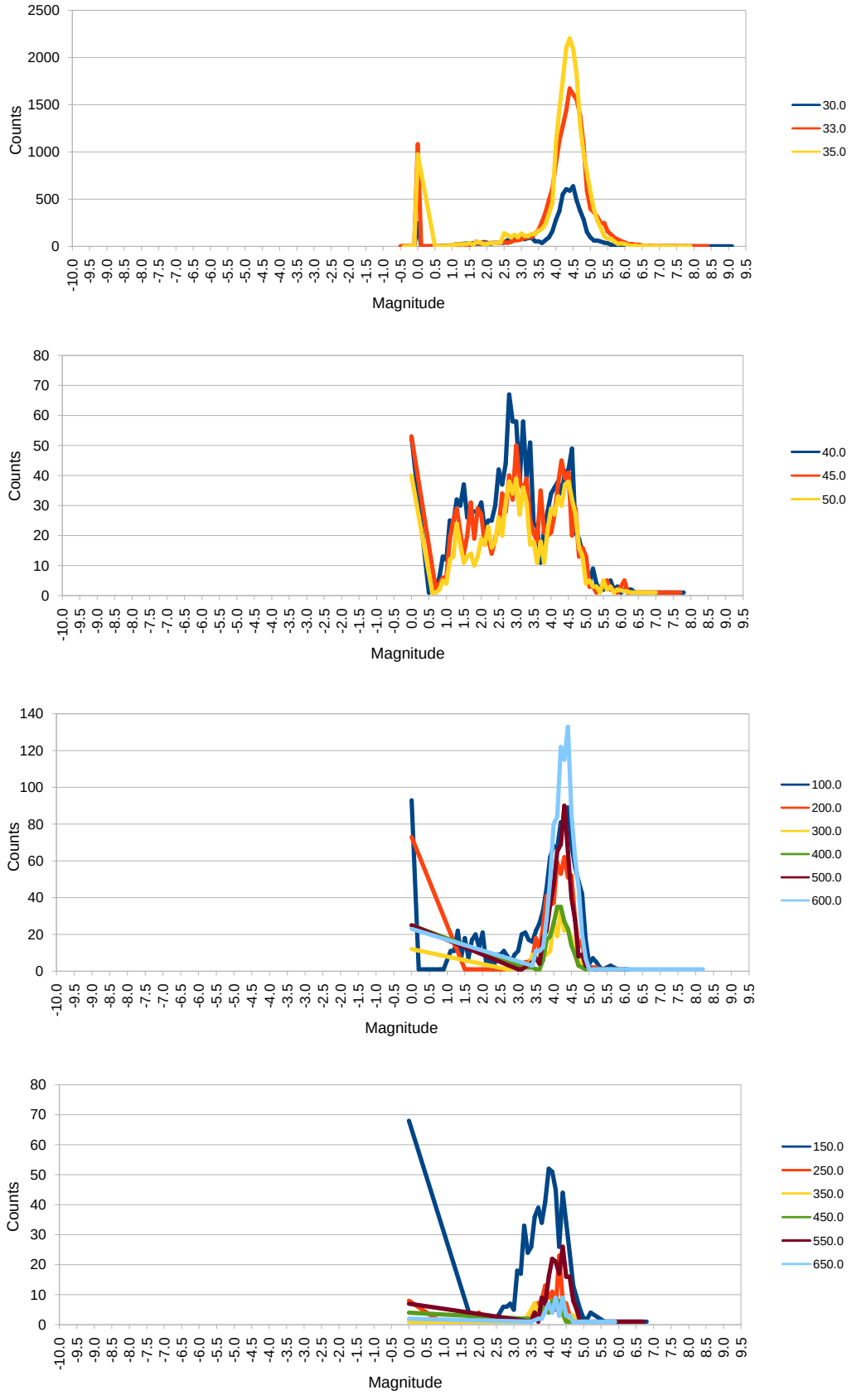


Figure 24. Magnitude distribution at depths with more earthquakes.

Spectrum for amplitude from 3.5 to less than 5.0 is shown in Figure 26. There is no any stronger earth rotation harmonics found, two strong tides related harmonics found—7 day and 31.5 day. This means that earthquake magnitude from 3.5 to 5.0 could be tides sensitive, it is suggested that this should be a kind of earthquake type—sliding between layers. This could be identified easily by earthquake monitoring system; the earthquake should be shaking mainly in west-east direction. And it is possible to identify which half cycle of earth rotation harmonics triggered the earthquake.

Figure 27 shows the spectrum below and above 100.0 km. Below 100.0 km, there is a more stronger 7 day peak and a very week 31.5 day peak. Above 100.0 km,

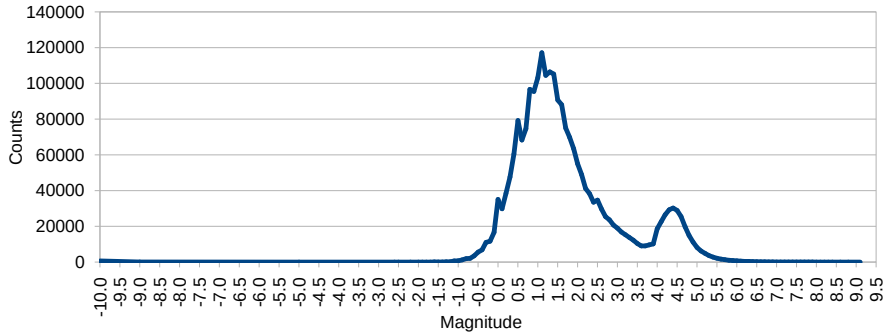


Figure 25. Magnitude distribution of all earthquakes.

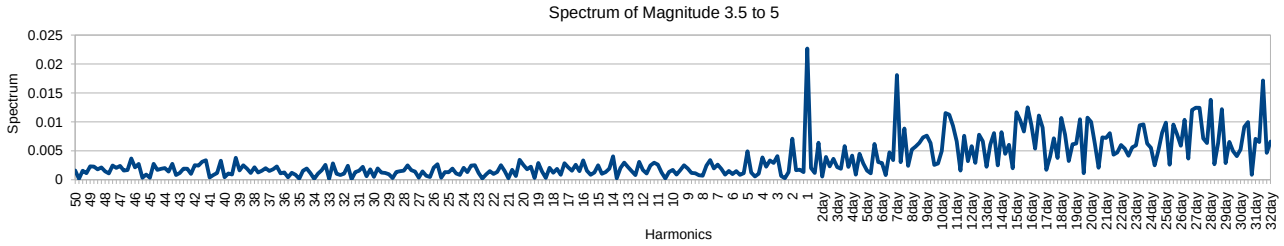


Figure 26. Spectrum of magnitude 3.5 to 5.0.

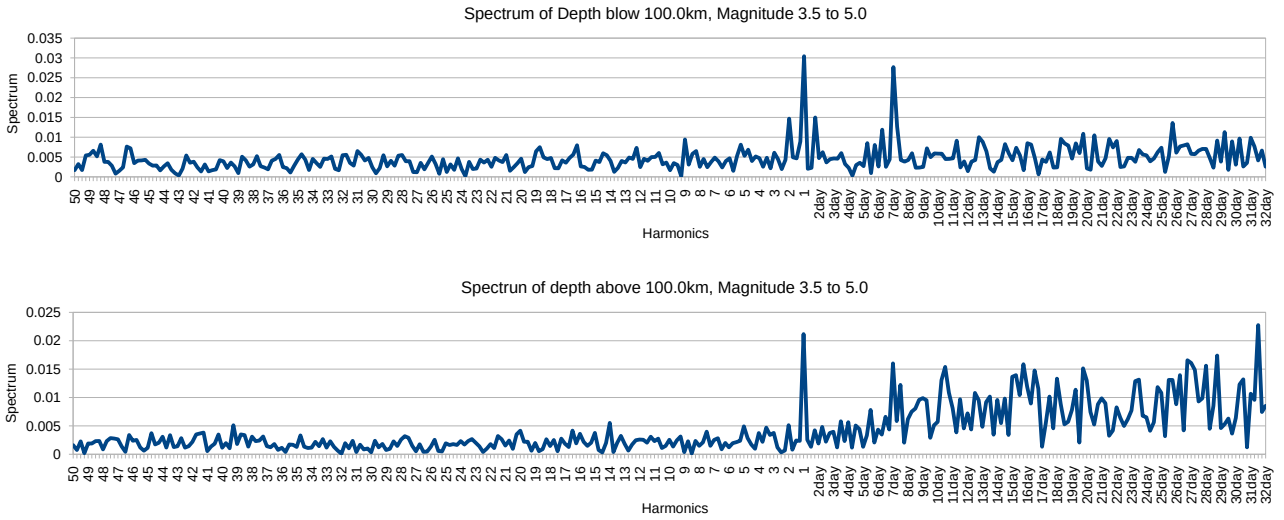


Figure 27. Spectrum of magnitude 3.5 to 5.0 – above and below 100.0 km.

31.5 day peak is stronger. This is just implying there are some relations to the harmonics' effects for these vertical distribution pattern, and will not be discussed in this paper.

4. Results and Discussion

The data analysis results are in accordance with the theoretical analysis except longitude distribution. For longitude distribution, the region with more earthquakes are related to special geostructure such as ocean trench (Tonga Trench and Kermadec Trench, and Peru–Chile Trench), volcano zone (Hawaii), etc., it did not affect the correlation between the harmonics and earthquake.

The most important data analysis results are:

1) The earth rotation harmonics found in earthquake time spectral analysis, strongly confirmed the correlation between the earth rotation harmonics and earthquake.

2) Tidal effects on earthquake are the same as the theoretical analysis, and this further confirmed the correlation between the earthquake and earth rotation harmonics.

For the correlation between tides and earthquake, most researches are focus on how tides triggered earthquake [5] [6] [7] [8] [9]. The theoretical analysis and data analysis in this paper clearly answered this question—tides did not trigger the natural earthquake, they only affect earthquake activities and time.

Data analysis of Sun tide daily effects and earthquake magnitude distribution showed that when magnitude less than 3.5, more earthquake occurred in the positive half cycle, and when magnitude greater than 3.5, more earthquake occurred in the negative half cycle, earthquake became tide sensitive from magnitude 3.5 to 5.0, more research needed on this.

Based on earth rotation harmonics, it could be a new way to predict and forecast earthquake for it could make earthquake calculable. With proper earth rotation harmonics response model for a location, it is possible to calculate the earthquake trigger time and scale.

Currently, there is no any information found related to the harmonics research and nothing is known about the earth rotation harmonics. It is suggested that, first, earth rotation harmonics monitoring equipment should be built, working with the earthquake monitoring system, study the harmonics characteristics, build and improve the earthquake model, and make the earthquake prediction and forecasting available in the near future.

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Conflicts of Interest

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

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