Response to Reviewer 2:

We are very grateful to your comments for the manuscript. They have important guiding significance for our manuscript and our research work. We have revised the manuscript according to your comments. The response to each revision is listed as follows:

1. The manuscript is mostly well organized and written, the figures are mostly of sufficient quality excepted Fig.1 which is too dark and lack details about the active faults and the earthquake rupture location.

Response:

Thank you for your suggestion. Fig.1 in the manuscript is not professional enough. We have updated the figure with the active faults and the earthquake rupture location. Besides, we have supplemented three stations aiming to discuss our findings in the "Confusion discussion" Section.

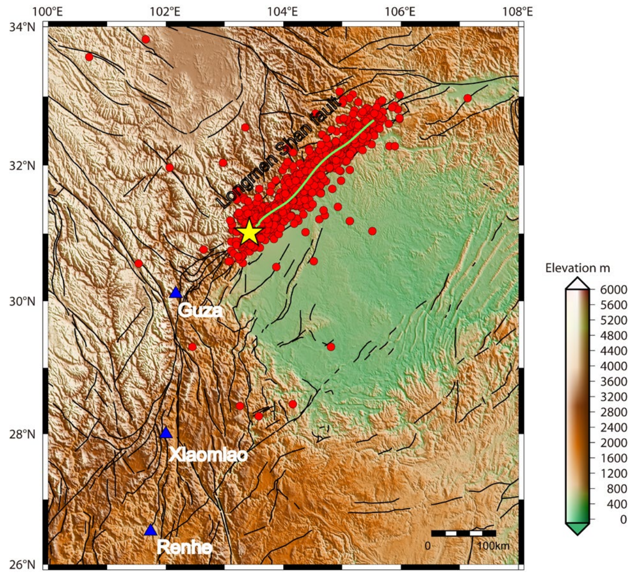

Fig. 1 Location map showing the epicentre of the Wenchuan earthquake and three stations. The epicentre was located in Wenchuan County, Sichuan Province, at 31.01°N, 103.42°E. The red circles are aftershocks (Ms>3.0) from the main shock to October 2008. The green curve is the schematic curve of the main rupture zone and the black curves are faults.

2. Major comment 1:

- *In particular, the nearest strain station (GUZA) is located far from the earthquake source (150 km), so that the network configuration to study strain precursors is far to be optimal. If the precursory phase implied widespread crustal changes, some changes should have been detected by other sensors, therefore other set of data (GPS? Seismometers? Groundwater? ...) located in the near-field of the earthquake should be analyzed. Despite strainmeters are highly sensitive instruments, I have concerns about their capability to detect subtle strain changes at such large distance. Strain signals are mostly sensitive to local variations (hydrology, rain, air pressure, ...), so it would be interesting to see precipitation, groundwater and barometric records near*

GUZA station if available. I agree that the observed strain changes are spurious and the fact that they may roughly coincide with the onset time of the event makes them even more interesting, but there is absolutely no evidence that they are linked to the precursory phase of the earthquake. If the negentropy increased before the earthquake, why did it stay to a high level months after the rupture (Fig. 4)?
In particular at L. 305-307 (and also L. 296-299), the authors stated that Â´n negentropy anomalies ... may be a reflection of the subsurface medium and fault activities in the focal area associated with the Wenchuan earthquake Â˙z. This is a strong conclusion which came with no proof. Thus, based on only one station, the authors should point out that some strain changes are spurious but they shouldn't try to link these changes to the precursory phase with such a few observations. Therefore, the Discussion section should be modified and it should be clearly stated that further data are required to decipher a potential precursory phase.

Response:

Thank you very much for your suggestion.

We agree the "Discussion and Conclusion" section is kind of unreasonable based on the borehole strain data of one station.

Referring to your guiding suggestions above, we have studied the correlation between the negentropy anomalies and the Wenchuan earthquake through three parts. 1. Comparison of random time periods. 2. Comparison of different stations. 3. Exclusion of co-seismic events and weather factors.

We first introduce the three supplemented parts and answer your other specific questions next.

Changes:

We have divided the "Discussion and Conclusion" Section into "Confusion Discussion" Section and "Conclusion" Section.

We have also discussed our findings more carefully in the "Confusion Discussion" Section and objectively stated further researches are required to decipher a potential precursory phase in the "Conclusion" Section.

To study the correlation between extracted anomalies and earthquakes, Parrot (2011) proposed a method for random earthquake distribution. The location of the earthquake epicentre is randomly changed, but the size of the study area and the study time is kept unchanged. The anomalous variation is compared between the random region and the actual seismic region, and the correction between the anomalies and the earthquake is determined. In order to verify the relationship between negentropy anomalies and the Wenchuan earthquake, we did a similar random earthquake distribution study as follows.

1. Comparison of random time periods.

We randomly selected March 20, 2011 and March 24, 2014 as the random earthquake days, and study the strain data for 200 days before and after the earthquake days at Guza station. The selected periods are required to be in the absence of strong earthquakes and with higher quality. We performed negentropy analysis on these two random periods and compared them with the results of negentropy analysis associate with the Wenchuan earthquake as shown in Fig. 2.

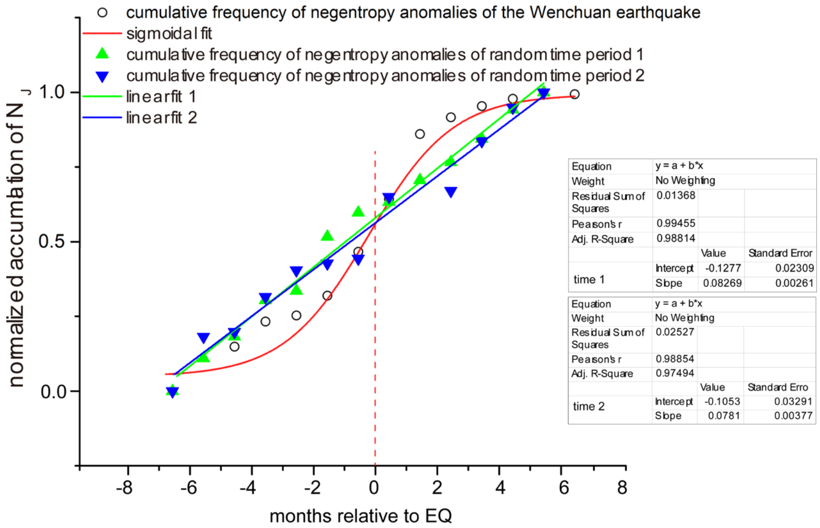

Fig. 2 The comparative analysis of cumulative frequency of negentropy anomalies between earthquake period and random time periods. The green triangles correspond to the random earthquake on March 20, 2011, the blue triangles correspond to the random earthquake on March 24, 2014.

As we can see in Fig. 2, the cumulative frequency of negentropy anomalies of random periods have statistical linear increases. However, in the Wenchuan earthquake periods, as the earthquake approaches, the cumulative frequency of negentropy anomalies increases rapidly and recovered to a slow growth after the earthquake.

2. Comparison of different stations.

We supplemented two other stations to find out if their observations received strain changes. We chose Xiaomiao station and Renhe station, their locations are shown in Fig. 1. Corresponding to the Guza station, we did the negentropy analysis of the two stations as shown in Fig. 3.

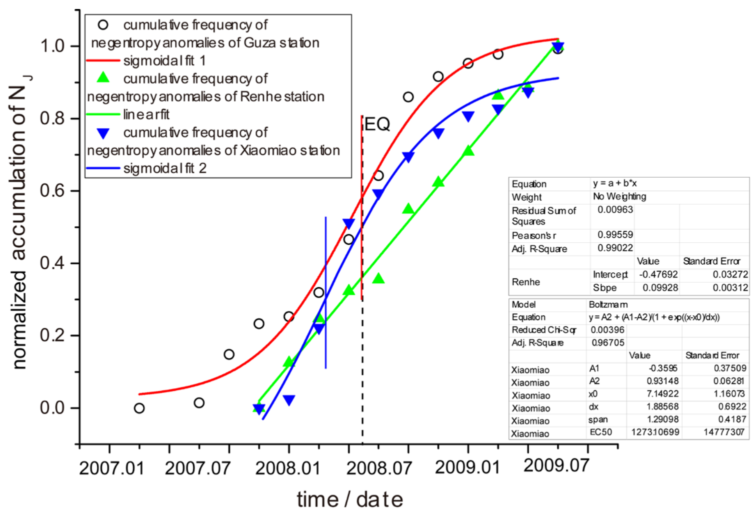

Fig. 3 Cumulative frequency of negentropy anomalies of Xiaomiao station and Renhe station from September 16, 2007 to June 30, 2009. The negentropy analysis of Guza station is from January 1, 2007 to June 30, 2009, because of the different installation time of the instruments. The red vertical line is the inflection point of the fitting curve of Guza station. The blue vertical line is the inflection point of the fitting curve of Xiaomiao station. The black dashed line is the earthquake day.

As we can see in the Fig. 3, the cumulative frequency of negentropy anomalies of Xiaomiao station are also well fitted by the sigmoid function. The accumulation curve is growing rapidly before the earthquake and concave downward after which is similar to the Guza station, although the inflection point of Xiaomiao station is about two months preceding the earthquake moment. However, since the curve is approximately linear before and after the inflection point, the value of inflection point exists a range.

Cumulative anomalies of the Renhe station are basically linear, indicating that the Renhe stations may don't receive pre-earthquake anomalies.

Renhe station is far from the end of the Wenchuan earthquake fault, according to the fracture mechanics, so it is reasonable that no abnormal changes are observed. However, Xiaomiao station is located between the Guza station and Renhe station, it may receive some changes. The fitting result also shows that there is a similar trend to the Guza station, with a weaker curvature. So, for the nearest station to the epicentre, Guza station may able to receive more pre-earthquake anomalies.

Furthermore, Qiu (2012) found that the anomalies at Ningshan station were similar to the anomalies at Guza station. Such two stations have observed similar Wenchuan earthquake precursor anomalies, which may not be accidental. Since the Ningshan station is actually located at the northeastern end of the Longmenshan fault zone. This location is a correspondence with the southwestern end of the fault where the Guza station is.

3. Exclusion of co-seismic events and weather factors.

We studied the Earthquake events data from the USGS National Earthquake Information Center (NEIC) catalog instead of continuous seismic waveforms recorded by seismometers, and consider all the Ms3.0+ events in the catalog which occurred in the study region during the study period as shown in Fig. 4(a). We count the multiple earthquakes occurred in one day as one event. Comparing the results in the manuscript, we accumulate the earthquake event as Fig. 4(b). Before the earthquake, the cumulative frequency of earthquake events increased linearly, indicating there was no rapid growth phase of earthquake events in the region. This phenomenon is different from the cumulative frequency of negentropy anomalies extracted by borehole strain, which also verify that the co-seismic events didn't cause the pre-earthquake anomalies recorded by borehole strain before the Wenchuan earthquake at Guza station. While after the Wenchuan earthquake, there is a rapid growth rate of the cumulative frequency due to numerous aftershocks. With the restoration of the crust in the seismic source region, the accumulation after the Wenchuan earthquake is gradually slow, which is similar to the accumulation of negentropy anomalies after the earthquake at Guza station.

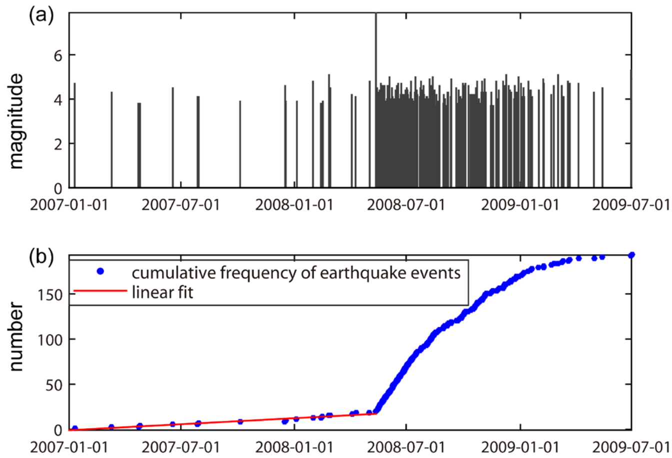

Fig. 4 Earthquake catalog (Ms>3.0) of the study region during the study period and the cumulative frequency of earthquake events.

We also agree that strain signals are mostly sensitive to a few meteorological factors, such as the air pressure, temperature and rainfall. The water level data of Guza station are not available before 2009. As shown in Fig. 5, we display the detrend borehole strain, pressure variations, temperature variations recorded at Guza station and the daily rainfall measured by Tropical Rainfall Measuring Mission (TRMM) satellite which are downloaded through the NASA GIOVANNI-4 for the same period and the same area (http://giovanni.gsfc.nasa.gov/giovanni/) . There are clearly annual variations in the strain, air pressure, temperature and rainfall data. The air pressure and temperature have been steadily fluctuating within a certain range, and the rainfall is also shown to be more in summer and less in winter.

While we calculated the differential data of the strain for negentropy analysis. So, we make differential calculations for all three influencing factors as shown in Fig. 6.

We observed that the air pressure, temperature and rainfall didn’t change abnormally during the period when the extracted anomalies increase, whether we do differential calculation.

To further examine the correlation, we calculated the correlation coefficient in each sliding window (win=15 days) between the factors and the strain, and the results are shown in the Fig. 7. Although the original factors and the original strain are not strongly corrected, the correlation coefficients of differential data are far less than those of the original data. Therefore, we consider that the abnormal variations on the processed strain signals are not caused by these factors.

Thanks for your suggestion, we revisited the strain for different time periods, different stations and factors, then discussed them carefully. Considering the structure of the manuscript, for the meteorological factors, we have only briefly discussed and excluded them. A revised manuscript was attached in the updated manuscript.

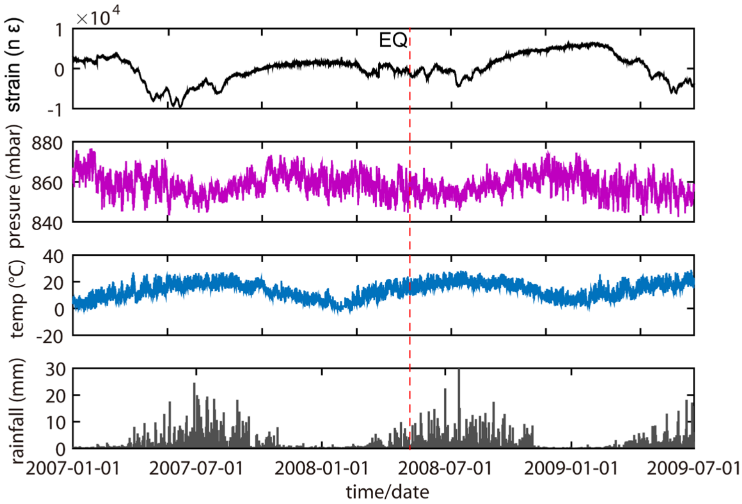

Fig. 5. Borehole stain, air pressure, temperature and rainfall variations during study period at Guza station

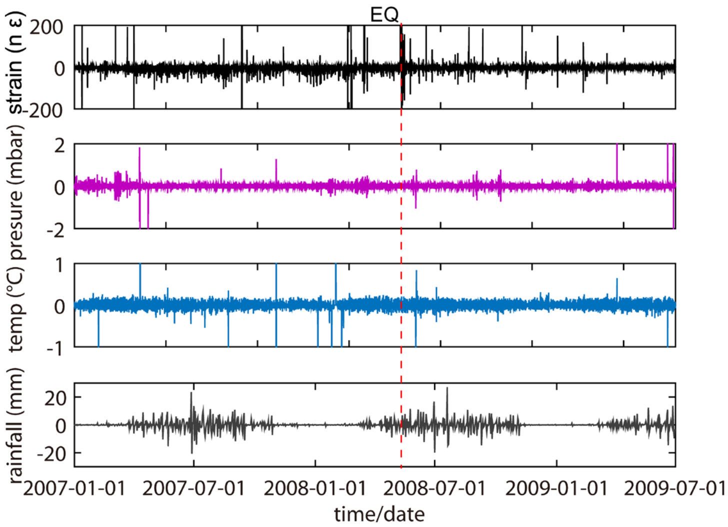

Fig. 6. Differential borehole stain, air pressure, temperature and rainfall variations during study period at Guza station

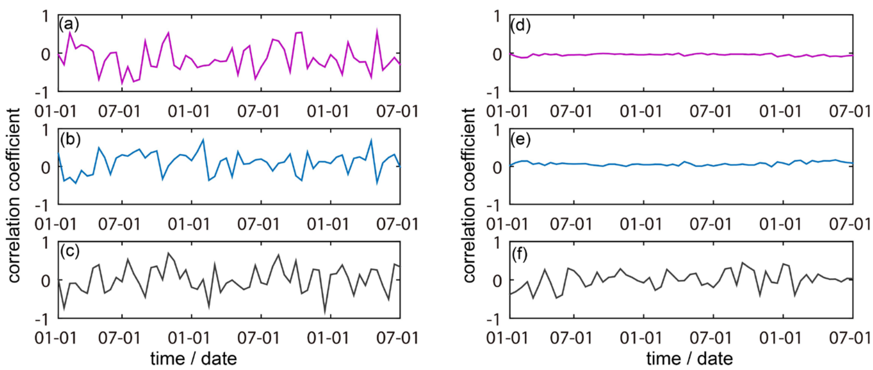

Fig. 7 (a), (b) and (c) are the results of correction coefficient between air pressure, temperature, rainfall and strain. (d), (e) and (f) are the results of correction coefficient between differential air pressure, differential temperature, differential rainfall and differential strain.

We detailed the method of data pre-processing in major comment 2.

 # [1] In particular, the nearest strain station (GUZA) is located far from the earthquake source (150 km), so that the network configuration to study strain precursors is far to be optimal.

Response:

As for the earthquake-monitoring capability of the borehole strain, Su Kaizhi (1991) comprehensively considered the time characteristics of the strainmeters detection capability, the amplitude distribution of the strain precursor and the occurrence time of the strain precursor, started with the general relationship between the time scale and the detected minimum strain amplitude, the epicenter distance and the magnitude, and magnitude and the occurrence time of the strain precursors, combined with observations of Chinese borehole strainmeters, and therefore obtained the estimated monitoring and controlling extent of long- and medium-term, short-term, and impending precursors. For the long-term precursor phase of the earthquakes of Ms8.0, the borehole strainmeter has a monitoring capability radius of about 430 km, and for the short-term and impending precursors, the scope is more than 700 km. So, the Wenchuan earthquake source is within the monitoring capability of the borehole strainmeter at Guza station.

Besides, in the Fig. 1, we find the Guza station stands on the southwestern end of the Longmenshan fault zone. From the point of view of fracture mechanics, the end point of the fracture is where the stress concentrated or even the singularity occurs (Qiu Z. H., 2012). According to this view, we think that the strainmeter is possible to record information related to earthquakes at Guza Station.

Changes:

We have supplemented a short explanation for this distance in Line 56-58.

 # [2] If the precursory phase implied widespread crustal changes, some changes should have been detected by other sensors, therefore other set of data (GPS? Seismometers? Groundwater? ...) located in the near-field of the earthquake should be analyzed.

Response:

We agree that it would be better to analyze other sets of data such as GPS and seismometers which may record some changes. Unfortunately, some data are limited for us for now. However, we can provide a few explanations.

Firstly, because borehole strainmeters are designed to record deformation that lies between the spectral coverage of seismometers and GPS, and are ideal for capturing strain transients that occur in periods of hours to years as shown in Fig. 8, we choose borehole strain to study the pre-earthquake changes.

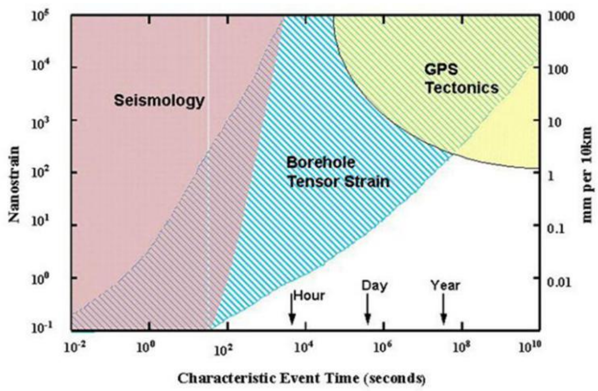

Fig. 8 shows Instrumental characteristics of seismology, borehole tensor strain and GPS tectonics. Source: http://www.earthscope.org. Borehole strain are ideal for revealing short-term (from seconds to years); Seismographs are mainly used to determine relevant seismic parameters; GPS is a relatively long-term observation (from weeks to decades).

Secondly, we studied the Earthquake events data from the USGS NEIC catalog instead of continuous seismic waveforms recorded by seismometers. The comparison result is in Fig. 4.

However, different instruments record signals of different characteristics. We are not sure about the possibility that the crustal changes are recorded by other sensors. Besides, we investigated the outgoing longwave radiation (Kong X., et al., 2018), radon concentrations in water (Yan R., et al., 2011), water level and water temperature data (Sun X. L., et al., 2016) before the earthquake. There are some similarities between their results and the results in our manuscript. (We quoted their results at the end of this response.)

Thirdly, according to the principle of the YRY-4 strainmeter, the four observations *Si*, (*i=1,2,3,4*) are sampled by four independent sensors. This means that the sensors in the four directions do not affect each other. We can think that the anomalies before and after the Wenchuan earthquake were recorded simultaneously by four sensors.

Changes:

We have stated the further data and further researches are needed to confirm a potential precursor phase in “Conclusion” Section.

***# [3]** If the negentropy increased before the earthquake, why did it stay to a high level months after the rupture (Fig. 4)?*

Response:

This is the empirical phenomenon after the main shock in the hypocentral region. The Wenchuan earthquake is main-aftershock type. After the Wenchuan earthquake, the earth's crust was still in a very unstable stage. As of October 2008, more than 900 aftershocks (Ms>3.0) occurred as shown in the Fig. 1. Therefore, the negentropy stay to a high level after the rupture.

In addition, with the restoration of the crust in the seismic source region, the accumulation of negentropy anomalies after the earthquake is growing slower as shown in Fig. 8 in the manuscript.

 # [4] In particular at L. 305-307 (and also L. 296-299), the authors stated that Ân negentropy anomalies ... may be a reflection of the subsurface medium and fault activities in the focal area associated with the Wenchuan earthquake. This is a strong conclusion which came with no proof.

Response:

Thank you for your suggestion. This conclusion is indeed too positive. The mechanism for these abnormal changes is needed to be discussed further. What we want to express is the extracted negentropy anomalies may be related to the Wenchuan earthquake.

We have modified the conclusions more prudently in “Conclusion” Section.

Major comment 2:

It’s not clear which data the authors use for the statistical analysis. Equations (1) and (2) describe the protocol to derive areal strain from borehole gauge measurements and they show that the 3 ways provide roughly similar areal strain signal. However, in L. 91-92, the authors calculate the difference in the data. Why that? And what does this sentence (L. 91-92) means? Is it the difference in strain data which is used for negentropy analysis? If yes, why not using directly the areal strain signals which are a robust measure of crustal strain changes? The authors removed tidal strain, but what about borehole trend and air pressure correction? The description of the data is confusing and should be improved.

Response:

Thank you for your suggestion. We did not describe the data pre-processing part clearly, especially in L. 91-92. The detailed process is as follows.

First, equations (1) and (2) in the manuscript describe the protocol to derive areal strain from borehole strainmeters. Then we show the component data satisfy self-consistent through Fig. 2 in the manuscript to illustrate that the areal strain can replace the observations of four components.

Second, we processed the areal strain. The procedures and reasons of data pre-processing are as follows.

Step 1: Differential calculation

We set the areal strain data as $X(n)$ and differential areal strain data as $Y(n)$, we know $Y(n)=X(n)-X(n-1)$, $F_X(e^{j\omega})$ is frequency characteristic of $X(n)$, $F_Y(e^{j\omega})$ is frequency characteristic of $Y(n)$ according to differential properties based on Fourier transform

$$F_Y(e^{j\omega})=(1-e^{-j\omega})F_X(e^{j\omega})$$

This process can be equivalent to a filtering system, let the frequency response of this system be $H_1(e^{j\omega})$, then

$$|H_1(e^{j\omega})| = \left|\frac{F_Y(e^{j\omega})}{F_X(e^{j\omega})}\right| = |1 - e^{-j\omega}|$$
$$= \sqrt{2(1-\cos\omega)}$$

It can be seen that when ω is very small or 0, the frequency response is 0, indicating that the Step 1 removes the low frequency information of the signal, including borehole trend and low frequency effects of the air pressure and temperature on the signal.

Step 2: Harmonic analysis

We remove the periodic term that still exists through daily harmonic analysis. We set the fitting function as Fourier series. The reserved signal $Z(n)$ can be simplified as

$$Z(n) = Y(n) - \sum_{k=1}^{n} A_k \sin(k\omega_0 n + \varphi_i)$$

$F_Z(e^{j\omega})$ is frequency characteristic of $Z(n)$, this process can also be seen as a filtering system, let the frequency response of this system be $H_2(e^{j\omega})$.

$$|H_2(e^{j\omega})| = \left|\frac{F_Y(e^{j\omega}) - \sum_k \pi A_k[\delta(\omega - k\omega_0) - \delta(\omega + k\omega_0)]/2}{F_Y(e^{j\omega})}\right|$$

Minimize $Z(n)$ by least squares method in time domain, then ideally for the system gain

$$|H_2(e^{j\omega})| = \begin{cases} 0 & \omega = k\omega_0 \\ 1 & \omega = others \end{cases}$$

The frequency response after two steps is

$$|H(e^{j\omega})| = |H_1(e^{j\omega})H_2(e^{j\omega})| = \begin{cases} 0 & \omega = k\omega_0 \\ \sqrt{2(1-\cos\omega)} & \omega = others \end{cases}$$

Therefore, the Step 2 removes the periodic terms in the signal. We think the period terms here mainly includes the periods related to the solid tide, also includes the periodic effects of air pressure.

Finally, we performed the negentropy analysis for the processed data.

We randomly selected one day to explain the effects of the data pre-processing as shown in Fig. 9.

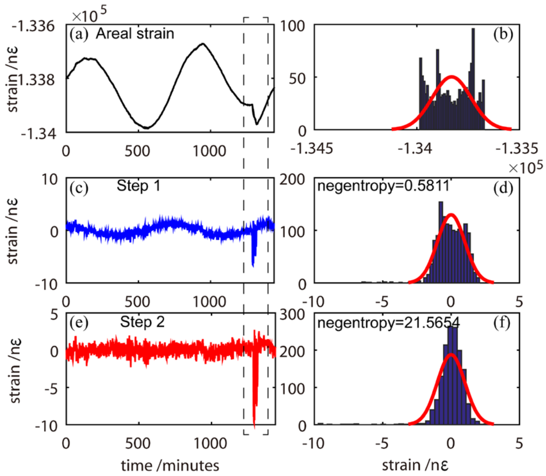

Fig. 9. (a). Areal strain of January 19, 2009. (c). Areal strain after differential calculation. (e). Differential areal strain after harmonic analysis. (b), (d), and (f) are the data distribution of (a), (c) and (c).

There is an abnormal change on the original areal strain curve at about 1400 minutes in Fig. 9(a). The areal strain is obviously non-Gaussian in Fig .9(b). The data presents a U-shaped distribution, and its negentropy has no meaning. This change becomes obvious after the differential calculation (Fig. 9(c)), but the negentropy is small due to the amplitudes of the periodic terms (Fig. 9(d)). After the harmonic analysis, the negentropy value increases significantly (Fig. 9(f)). Therefore, the small changes in the curve are amplified by the data pre-processing.

Our ultimate goal is to study negentropy (non-Gaussian characteristic) of the signals. The low frequency components and periodic components affect the Gaussian characteristic of the areal strain signals. This is why we processed the areal strain signals, although the areal strain is a robust measure of crustal strain changes. We are more concerned about the remaining high frequency variations. This is what we want to express in L. 91-92 in the manuscript.

Since the data processing part is not the most important part of this manuscript, we have not added all the description to the revised manuscript.

Changes:

We have updated the description of data processing in Line 64-71.

Other comments :

- Abstract (L. 7) : 12 May 2012 → 12 May 2008.

We have modified.

- Introduction : L. 22-27 is confusing as it gives the impression that precursory strain has been detected prior to the 2013 Ruisui earthquake (Canitano et al., 2015), which has not.

Besides, as the study involves the use of strain signals to study preseismic changes, it *would be interesting to have exemples of previous studies which aimed to detect changes in the hypocentral regions of large earthquakes using strain data. For instance, short- period strain observations prior to the 1987 Supersition Hills earthquake (Agnew & Wyatt, 1989), 1989 Loma Prieta EQ (Johnston et al., 1990), 2010 L'Aquila (Amoruso & Crescentini, 2010) or 2013 Ruisui (Canitano et al., 2015) were all unsuccesfull. Note that those studies have been conducted on several stations located in the near-field of the shock, therefore under more optimal detection conditions.*

Response:

Thank you for your suggestion. Canitano also gave us a short comment about his research. We have updated our expression.

Besides, we have supplemented these references in "Introduction".

- L. 25: 'borehole strain data, which record the direct crustal changes' →borehole strainmeters which detect the crustal changes. Why 'direct' crustal changes ?

Response:

Earthquake occurrence is the process of mechanics. "Direct" indicates that the borehole strain also record force, to distinguish from other kinds of observations. Strictly speaking, "direct" is a little inaccurate.

We have modified as "Borehole strainmeters which detect the crustal changes"

- L. 43 : non-Gaussian → non-Gaussian distribution

We have modified.

- L. 57-58 : Â' n Hence, it is implied ... preparation processes Â˙ z : do you have a reference for this sentence ?

Response:

This is our language expression problem. In fact, this sentence follows the last two paragraphs. There are 3 references among them indicate this point of view, then, there are 2 other references in this paragraph also support this sentence.

We have modified this sentence into in Line 36. "Thereby, it is possible that precursor anomalies lead to an increase of disordered components in observation data."

-L. 65-66 : 'dozens of meters' : can you be more specific ?

Yes, we have been more specific.

"… have been deployed at depths of more than 40 metres …"

- L. 178-180 : it is not clear why negentropy anomalies clustered on the left side of the parabola could be a signature of crustal deformation related to earthquake ?

Response:

There are two main reasons. First of all, these anomalies are different from this normal background. Since after the data processing, it is normal for the daily strain to be Gaussian distribution. Secondly, since the similar characteristics of the anomalies cause the cluster phenomenon to appear on the parabola before and after the Wenchuan earthquake.

Whether the negentropy falls on the left or right side of the parabola is determined by the sign of the skewness. The relationship between skewness and data distribution is as shown in Fig. 10. Negentropy anomalies (red points in Fig. 6 in the manuscript) clustered on the left side of the parabola shows that the observations of these abnormal days have negative skewness. In other words, there are a lot of negative extreme values in the observations of these days.

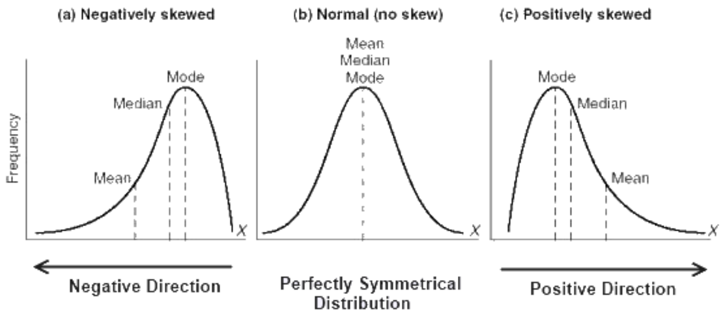

Fig. 10. Schematic diagram of the relationship between skewness and data distribution. Source: https://ss.csdn.net/p?https://mmbiz.qpic.cn/mmbiz_png/heS6wRSHVMkoXmWbecSLSvBtFqZRJW9MPickoP99bO1zu6cbtBuI34xjKpOObcRGErLkeSVGRrToJgd8Cria3tqw/640?wx_fmt=png.

From Fig. 6 (b) in the manuscript, we can see as the earthquake approaches, the abnormal days are basically clustered on the left side of the parabola. According to W. Marzocchi et al. (2014), spatio-temporal clustering is generally believed to represent the most striking departure from randomness for the large earthquake occurrence process.

Therefore, we suspect negentropy anomalies clustered on the left side of the parabola could be related to the earthquake. In order to study the possible correspondence with the earthquake process, we calculate the cumulative frequency of negentropy anomalies later in the manuscript.

Changes:

We have updated this sentence as “Besides, the extracted negentropy anomalies are clustered strongly on the left side of the parabola, which exhibit similar characteristics different from the normal Gaussian distribution.”

- L. 200: please consider remove ’famous’.

We have removed “famous”.

- L. 237-238: the authors stated that anomalies increased in 2008 when earthquake approaches and decreased after. That’s no so obvious according to Fig. 4 for which

anomaly rate seems to increase after the earthquake. Can you explain why?

Response:

The anomalies there refer to the frequency of anomalies. In fact, the anomalies did not decrease immediately after the earthquake, since the earth's crust was still in a very unstable stage. As of October 2008, there are more than 900 aftershocks (Ms>3.0) as shown in the Fig. 1.

However, after extracting the negentropy anomalies that greater than the threshold in Fig. 4 in the manuscript, we calculated the cumulative frequency of negentropy anomalies and fit them by sigmoid function as shown in Fig. 8 in the manuscript. Based on the fitting result for the entire process in Fig. 8, we see the inflection point is almost at the earthquake moment. And before the inflection point, the accumulation of anomaly frequency has an exponential increase trend. After the inflection point, there is an opposite increase trend. Therefore, we stated that anomalies increased when earthquake approaches and decreased after.

- L. 244-245: Can you explain how you link the earthquake moment with the estimate of the inflection point based on negentropy analysis? What does that mean that the earthquake moment is proved to be a critical time during the earthquake?

- Fig. 8: where is the critical point? Can you explain it further?

Response:

We calculated the cumulative frequency of negentropy anomalies. Since in general, accumulated value of a typical random process usually has a linear increase. In particular, in case of critical phenomena, we would expect more frequent anomalies when they approach the critical point, and less frequent anomalies after (De Santis, A. et al. ,2017). However, the cumulative frequency of negentropy anomalies is well fitted by sigmoid function.

Sigmoid function is expressed as

$$y = A2 + \frac{(A1 - A2)}{(1 + e^{\frac{x - x0}{dx}})},$$

where $A1$, $A2$, $x0$ and dx are calculated by fitting and $x0$ is the inflection point of the function. The sigmoid function is a power law temporal behavior with an upper concavity and a subsequent power-law behavior after the inflection, with an opposite concavity.

Also, the value of $x0$ obtained in the fitting result is very close to the time of the Wenchuan earthquake as shown in the Fig. 8 in the manuscript. The inflection point is the black vertical solid line, the earthquake day is the black dashed line. The two lines almost coincide in the Fig. 8 in the manuscript.

Therefore, we link the earthquake moment with the estimate of the inflection point.

Since the fitting curve is concave upward before the earthquake and concave downward after the earthquake. As the earthquake approaches, the slope of the curve increases, reaching its maximum near the earthquake, and then slowly decreasing.

Therefore, we stated the earthquake moment is proved to be a critical time during the earthquake. We also learned from De Santis, A. et al. (2017), they calculated the cumulative number of magnetic anomalies detected by Swarm satellite and also fit it by the sigmoid function. They thought inflection point in this function is a reasonable estimation of the time of the significant change in the critical dynamical system.

In Fig. 8, the critical point refers to the inflection point. We have unified the words as “infection point” and supplemented a brief explanation in Line 169-171 and Line 177-181.

Reference:

Su K. Z., Earthquake-monitoring capability of borehole strainmeter Earthqauke, vol (5): P38-46, 1991.

Qiu Z H，Tang L，Zhang B H，et a1．Extracting anomaly of the Wenchuan Earthquake from the dilatometer recording at NSH by means of Wavelet-Overrun Rate Analysis．Chinese J．Geophys. (in Chinese), 2012, 55(2): 538-546，2012.

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We tried our best to improve the manuscript and made some revisions in the manuscript. These revisions will not influence the content and framework of the paper.

We appreciate for Editor and Reviewers' warm work earnestly, and hope that the correction will meet with approval.

Once again, thank you for your advice, hope to be able to learn more knowledge from you.

Appendix:

Kong X., et al. (2018) extracted the anomalies of the outgoing longwave radiation (OLR) data by calculating CD value (they defined).

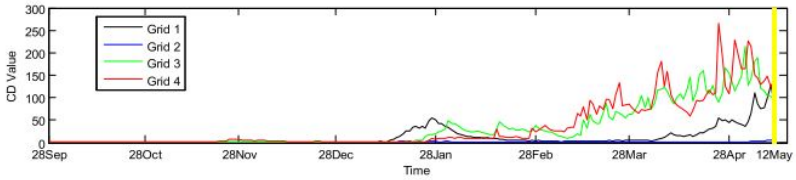

Fig. 8. Comparative CD value of grids 1, 2, 3, 4 in Wenchuan area, from 28th September, 2007 to 12th May , 2008, yellow line represents Wenchuan earthquake date.

Sun X. L., et al. (2016) extracted the anomalies of the fluid data by calculating λ^2.

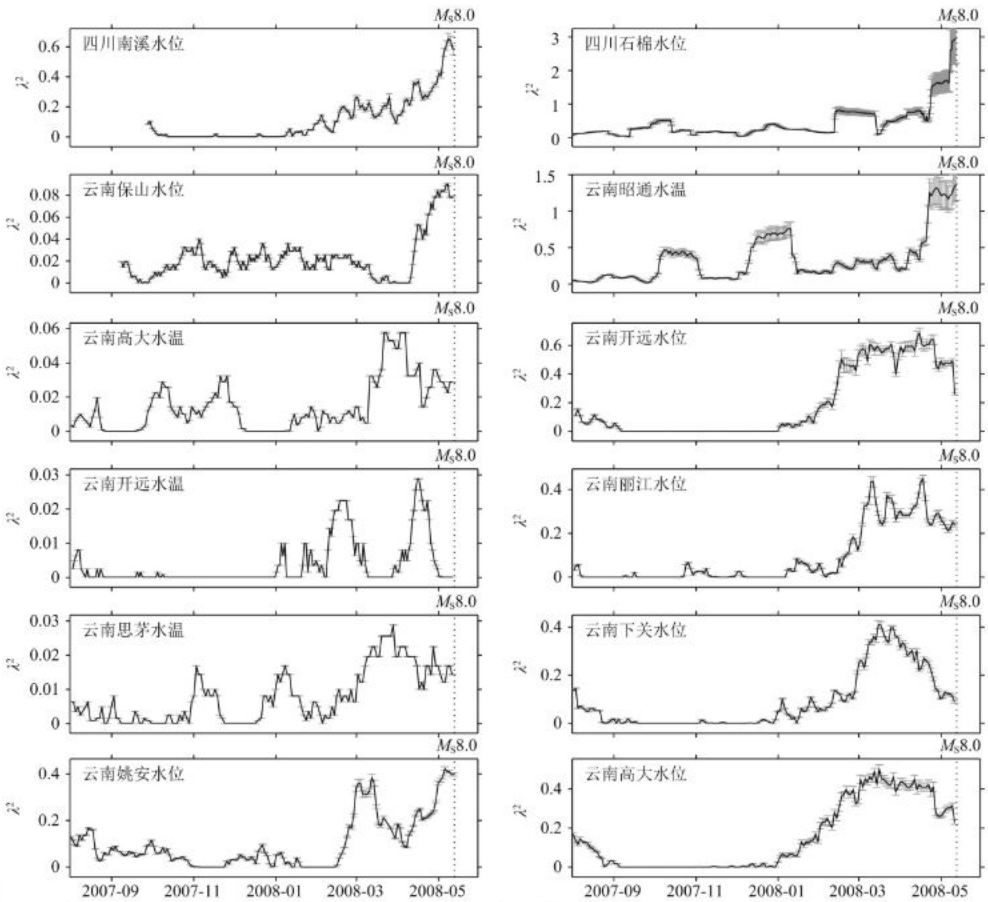

图 6 汶川 8.0 级地震前流体高频信息异常曲线

Fig. 6 Curves of high-frequency fluid anomaly information before Wenchuan M_S8.0 earthquake

Yan R., et al. (2011) extracted the anomalies of the radon concentrations by calculating AR(1) coefficient (they defined).

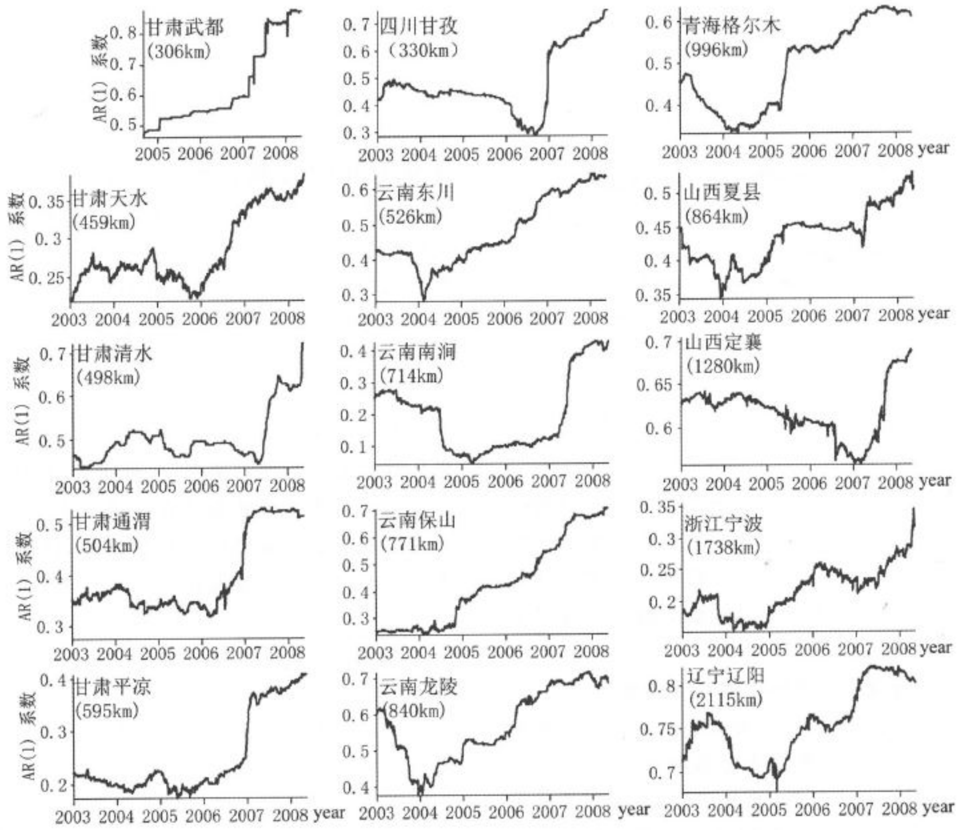

图 10 汶川 8.0 级地震前中国大陆水氡存在临界慢化现象的 AR(1)系数曲线
(括号中的数字表示距离汶川 8.0 级主震震中的距离)

Fig. 10 AR(1) coefficient curves of water radon for the existence of critical slowing down phenomenon before Wenchuan 8.0 earthquake in China mainland. (Numbers in parentheses denote the distance from epicenter of Wenchuan 8.0 main earthquake)