EXTRACTING SEISMIC ANOMALIES BASED ON STD THRESHOLD METHOD USING OUTGOING LONGWAVE RADIATION DATA

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1. INTRODUCTION

The satellite thermal infrared anomaly related to earthquake was first discovered by Gorny, a former soviet union scientist,[1] when he studied the activity of the faults in Mid-Asia region. After that, some relevant studies have been carried out by many researchers [2-6]. Many kinds of infrared physics parameters can be used to study the anomalies associated with earthquake, including TBB (Temperature of Brightness Blackbody), OLR (Outgoing Longwave Radiation) and SLHF (Surface Latent Heat Flux) etc. In this paper, OLR data will be used in studying thermal anomalies prior to earthquakes. OLR data describe the radiation information from the top of the atmosphere and can be downloaded from the web site of NOAA (National Oceanic and Atmosphere Administration) Climate Prediction Center (http://www.cdc.noaa.gov). The data are estimated from Infrared channel data of NOAA polar-orbit satellites and computed to 2.5º×2.5º or 1.0º×1.0º (latitude×longitude) grids by the National Environmental Satellite Data and Information Service (NESDIS). The algorithm description of interpolation can be found in related references [7]. OLR data whose spatial resolution is 1.0º×1.0º have been selected as data source in order to obtain more accurate spatial location of the seismic anomalies.

2. METHODOLOGY

The theory of STD (standard deviation) threshold method is based on multi-years OLR data in the same position. The purpose is to find the point of abnormal change. The process are (i) calculating the difference between the daily value and the multi-years mean value of the day ;(ii) analyzing the relationship between this difference and the standard deviation of multi-years data;(iii) determining the possible earthquake anomaly by setting the appropriate threshold. The related formulas are as follows:

$$OLR\_mean = \frac{\sum_{n=1}^{n} OLR\_daily(n,i,j)}{n};$$

Where OLR_mean is the multi-years mean OLR value; $OLR\_daliy(n,i,j)$ is the OLR daily value of one day (n) in the position whose geographical coordinate is i (Latitude) and j (Longitude) ;

$$OLR\_std = \sqrt{\frac{\sum_{n=1}^{n} (OLR\_current_n - OLR\_mean)^2}{n}};$$

Where OLR_std is the standard deviation of multi-years OLR data; $OLR\_current_n$ is the OLR value in one day (n);

Then the scale of anomalies can be obtained:

$$OLR\_anomaly = (OLR\_daily - OLR\_mean) / OLR\_std ;$$

At last, the possible seismic OLR anomalies can be determined by selecting the appropriate scale threshold. At the same time, the anomalies irrelevant to earthquakes can be detected according to the character of the location and size of the anomalous region. Ms 8.0 Wenchuan earthquake and Ms 6.3 Delingha earthquake of China in 2008 have been analyzed by using this method.

3. RESULTS

3.1 Ms 8.0 Wenchuan, Sichuan, earthquake

Wenchuan earthquake (Ms 8.0) on May 12, 2008 is the most catastrophic in China since the 1976 Tangshan Earthquake. The epicenter (30.1ºN, 103.4ºE) was located 80 kilometers west-northwest to Chengdu, the capital of Sichuan, with a depth of 18 kilometers.

The obvious OLR anomaly appeared thirteen days (April, 29, 2008) before Wenchuan earthquake in the epicenter area and the scale of the anomaly can reach 1.7. This kind of anomaly appeared frequently in the epicenter region until the day before this earthquake (May 11, 2008), and the scale decreased gradually. Then the anomalies disappeared completely after the earthquake. This phenomenon is probably related to this earthquake.

3.2 Ms 6.3 Delingha, Qinghai, earthquake

Ms 6.3 earthquake was occurred on Novermber 10, 2008 in Delingha, Qinghai. The epicenter location was 37.6 ºN, 95.9 ºE and the focal depth was only 10km.

The anomaly only appeared one day before this earthquake (Novermber, 9, 2008) over the epicenter area and disappeared after it. Is it a seismic anomaly or a non-seismic anomaly (such as climatic anomaly)? This question deserves a more in-depth discussion in future.

4. CONCLUSIONS

STD threshold method can detect the abrupt change points in a region. The possible seismic OLR anomalies can be detected using this method. But, it was critical to distinguish a seismic anomaly from a non-seismic anomaly in the course of data processing and analysis. In addition, more earthquake cases should be analyzed by using this method in order to obtain more significant statistical results.

5. REFERENCES

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