STUDY ON THE ELECTRONIC DENSITY PERTURBATION DETECTED BY DEMETER SATELLITE BEFORE WENCHUAN EARTHQUAKE

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1. Introduction

With the development of space science and the research of lithosphere-atmosphere-ionosphere coupling, extracting earthquake-ionosphere precursor information by satellite has gradually become short-term and impending earthquake prediction method which has been drawn greater attention in recent years [5, 6, 7, 8, 9, 10, 11].

DEMETER(Detection of Electro-Magnetic Emission from Earthquake Regions) satellite was launched by France on June 29, 2004, and has accumulated the observation information of ionosphere for 4 years[1, 2, 3, 4]. In this article, we study the datum of Wenchuan earthquake (31°N, 103.4°E) on May 12, 2008, and find that the perturbation phenomena of electron density in ionosphere are obvious before earthquake, and study deeply on the abnormal characters.

2. Data analyzing and processing

The selected datum of electron density are ascending orbits(that is, from south latitude to north latitude) datum which have been observed by Langmuir probe of DEMETER satellite since April 25, 2008 to May 11, 2008, and involve 28 orbits which are lower than 2000 km from the epicenter. In this article, we will apply different data analyzing and processing methods to study the electron density.

2.1 Slope analysis method

Slope analysis method could better reflect the rate changes of curves, that is, based on the space change continuity of plasma parameters, we can extract the abnormal information of value mutant points. In order to reflect the situation around epicenter, we analyze 20~40°N slope in point, and plot the curves arranged by time. Through the analysis, you find that the slope values change on an even keel from April 25 to April 30, but overstep 4 times standard deviation values in May 1, 2, 3. Corresponded the Kp indexes in this period, it can be known that April 30 and May 2 have happened mid-strong magnetic storms, and there are also substorms on

May1 and May 3~6 to make the Kp indexes at relatively high phases. As a result, the bigger positive and negative abnormal values on May 1, 2, 3 are the outcomes affected by mid-strong magnetic storms and substorms. Geomagnetic activities have been relatively calm since May 7 to May 11, but the slope curve has obviously positive abnormal value on May 7, which may be affected by violent changes of electron density before the earthquake. Furthermore, the ion density curve changing with latitude also rapidly ascends on May 7 around the 40° N.

2.2 Sliding median method

The main object of sliding median method is to wipe off the background information through proper glide average, in order to extract the abnormal information related to earthquake from the datum. In this article, we resample electron density datum of 28 orbits by 0.1°latitude interval, and then calculate their median (figured by pink line) taken as background values of next orbit at the same latitude of 5 orbits. Choosing one orbit as the gliding step, we plot a time series chart just shown 20~40°range. Besides that, we adopt 1 time standard deviation as the upper and lower abnormal threshold figured by yellow curve and blue-green curve in Fig.1.

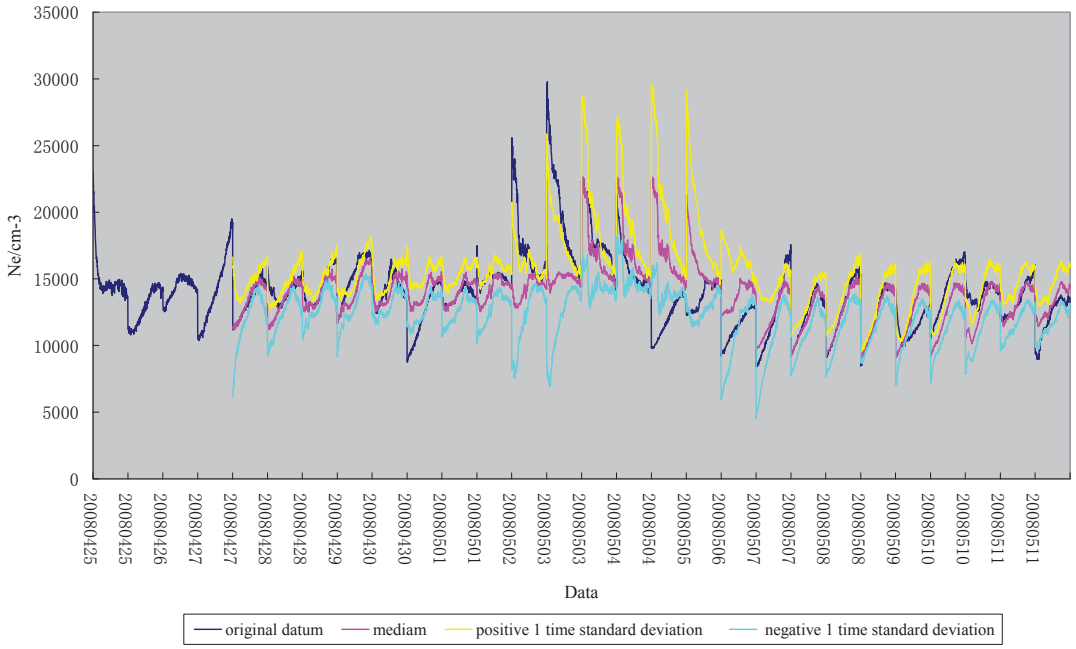

Fig.1 Gliding median chart of electron densities at 20~40°N range

The abnormal values on April 28, 29, 30 and May 2 may be related to relatively high Kp indexes, that is, they are affected by mid-strong magnetic storms, substorms and so on. The curves on May 3, 4 obviously

overstep upper or lower threshold, which may be influenced by magnetic storms, but compared the others Kp indexes and abnormal values, there may be included some earthquake perturbation information. At the same time, electron temperature on May 3, 4 observed by Langmuir probe has risen in the contour maps. The geomagnetic activities has come to calm after May 7, so the abnormal values of May 7, 9, 10, 11 might be relevant with Wenchuan earthquake, furthermore, the abnormities on May 7 have been depicted in above method. It's also shown that the electron densities on May 7, 10 are rising, but they are declining on May 9, 11.

3. Discussion and conclusion

(1) Whether slope method or sliding median method, electron density on May 7 reflects obviously abnormal information. Used sliding median processing method, electron densities on May 9, 10, 11 have overstepped thresholds before Wenchuan earthquake.

(2) In weak information of earthquake perturbation, slope analyzing method could give a good way to reflect the change rates from observation datum, so it's applied to extract abnormal values with rapid change features; sliding median processing method can give the average backgrounds by proper gliding windows and steps, in order to get earthquake abnormities from all the datum. Through this article research, it's proved that both of the two methods can be more effectively applied to spatial datum processing.

(3) On May 7, not only electron density increased, but also ion density did above the epicentral area. This may be ionospheric perturbation caused by acoustic-gravity waves, electromagnetic waves and so on in seismic areas, which leads to heat the above ionosphere, and then electron densities and ion densities happen to rise or decline. The coupling of earthquakes and ionosphere abnormities is rather complex, and couldn't be completely explained by single model, so perturbation interpretation of parameters will continue to be explored.

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