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An Improved Two-step Method and Retrieved MBT Anomalies of May 2008 Wenchuan Earthquake Sequence

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Although reports declared there exists satellite microwave radiation anomaly before, during and after some great earthquake including the Ms8.0 Wenchuan earthquake, May 12, 2008 in China, the spatio-temporal correlation between the region of abnormal microwave brightness temperature (MBT) and the seismogenic faults don't satisfied well with the DTS criterion, which are presented as a criterion to search for and to make validation of possible earthquake anomalies. New method and algorithm to extract and analyze potential MBT anomaly as earthquake warnings need to be developed.

With the average of MBT values of multiple years without earthquake as historical background to remove general trend, and with the average of MBT values of four corner pixels in a window as regional background to remove meteorological disturbance, the two-step method was firstly developed in 2009 to extract MBT anomaly related with Ms8.0 Wenchuan earthquake. However, the terrain effect, coversphere coverage and meteorological disturbance are inhomogeneous in weight but decrease with distance away from the central pixel or from the shocking date. Referring to the first Law of Geography and its application in time domain, we endow the adjacent pixels and historical time slice with varied space-weights and time-weights, respectively, to count for the above mentioned spatio-temporal effects. The original two-step method is then improved and a group of algorithms are developed to extract MBT anomaly related with tectonic earthquake.

In consideration of the size of earthquake preparation zone from Dobrovolsky's equation, a $10^\circ \times 10^\circ$ geographical region centered with the epicenter of Ms8.0 Wenchuan earthquake on Longmenshan faults, is selected for MBT analysis with the improved two-step method applied to satellite data from AMSR-E sensors (6.9GHz, 10.7GHz, 18.7GHz and 36.5GHz). Obviously localized and strip-shaped positive MBT anomalies before and after the main shock are uncovered at multiple frequencies and in H- and V-polarization. For further testing the suitability of the improved two-step method, the Ms7.0 Ya'an earthquake occurred also on Longmenshan faults on April 20, 2013, are applied also for case study with data from FY-3B sensors (10.65GHz, 18.7GHz, 23.8GHz, 36.5GHz and 89.0GHz).

The comparison proves that the improved two-step method behaves much better than the original one. The general results on retrieved seismic MBT anomalies are summarized as: 1) significant MBT variation of maximum 10K appeared close to the epicenter at the east of the Longmenshan faults one week before the main shock; 2) the abnormal strip-shaped positive MBT region distributed along the east side of Longmenshan faults and migrated northeastward with the occurrence of aftershocks; 3) the amplitude of abnormal MBT value, the spatial distribution and details of MBT anomaly at H- and V-polarization are of particular characteristics at different frequencies, and the H-polarization behaves better than V-polarizationt. Furthermore, the retrieved MBT anomaly of Ya'an earthquake is a little different from that of Wenchuan earthquake, which is of special meanings for interpreting the seismogenious process and crust stress field alteration.

Keywords: remote sensing, earthquake anomaly, microwave brightness temperature, extraction method, algorithms