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Evolution of Satellite MBT Anomalies Related with Great Earthquakes on Longmenshan Faults, China

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Experimental detection on microwave radiation from loaded rock to fracturing have confirmed that stressed rocks can generate additional microwave radiation at frequencies of 300 MHz, 2GHz, 6.6GHz, 18.7GHz, 22.0GHz and 37.5GHz, and that the rock's microwave brightness temperature (MBT) in mode of horizontal and vertical polarization changes with rock stress. Previous studies revealed there exist MBT positive anomalies retrieved from satellite sensors (Aqua AMSR-E and FY-3B) at 18.7GHz (in H- and V-polarization) related with tectonic earthquakes including Ms6.5 Morocco earthquake, Feb.24, 2004, Ms8.0 Wenchuang earthquake, May 12, 2008, and Ms7.1 Yushu earthquake, April 14, 2010. However, the retrieved MBT anomaly at 18.7GHz are based on very local comparison among adjacent pixels with radiation anomaly index (RAI) or on regional spatio-temporal analysis with two-step method developed to remove MBT background influenced by topography and coversphere. Referring to the first Law of Geography and its application in time domain, we improved the two-step method by endowing the adjacent pixels and historical time slice with varied space-weight and time-weight, respectively. In consideration of the size of earthquake preparation zone derived from Dobrovolsky's equation, and by using of the improved two-step method, we extract MBT anomalies related with two great earthquakes happened on China Longmenshan faults, i.e. Ms8.0 Wenchuan earthquake on May 12., 2008 and Ms7.0 Ya'an earthquake on April 20, 2013. The H- and V-polarization MBT data of 6.9GHz, 10.7GHz, 18.7GHz and 36.5GHz from Aqua AMSR-E sensors are applied for both earthquakes, and H- and V-polarization MBT data of 10.65GHz, 18.7GHz, 23.8GHz, 36.5GHz and 89.0GHz from FY-3B sensors are applied additionally for Ya'an earthquake.
The dynamic results and synergic comparisons are summarized as: 1) characteristic positive and negative MBT abnormal regions occurred in the seismogenic regions in sequence of several phases; 2) the MBT anomaly of H-polarization were much more identifiable than that of V-polarization; and 3) the MBT image at high frequency displays more details with pepper like noise, while the MBT image at low frequency displays clear pattern with better relation to seismic fault.
This study uncovered that different microwave frequencies and polarization modes display much different characteristics of MBT anomaly caused by tectonic activity, seismogenic process and earthquake. High frequency microwave behaves sensitivity on details at high spatial resolution, but it is more susceptible to disturbances from rain, clouds and atmospheric water vapor. Nevertheless, low frequency microwave can penetrate coversphere and detect more radiation from ground subsurface stressed by crust motion, which could present direct meanings of seisemogenic activities even at a lower spatial resolution. Reasonable selections of microwave bands and polarization modes are critical to extract and recognize MBT anomaly related with tectonic activity including earthquake. The H-polarization of 10.7GHz demonstrates the best property for seismic MBT anomaly identification. This is important for satellite remote sensing on seismogenic process and for potential earthquake prediction.

Keywords: remote sensing, earthquake anomaly, microwave brightness temperature, crust stress, geodynamics