J. Ind. Geophys. Union, 30(5) (2026), 385-391
https:doi.org/10.71122/JIGU.30(5)2026.0037

Behaviour of surface temperature during high-magnitude earthquakes (M ≥ 6.0)

Pooja Sharma[1], Ananna Bardhan[1], D. K. Sharma[1] and Rajkumari[2]
[1]Department of Sciences, Manav Rachna University, Faridabad-121004, Haryana, India
[2]Department of Physics, DAV Centenary College, Faridabad-121001, Haryana, India
*Corresponding author: ananna@mru.edu.in

ABSTRACT

As the Earth prepares itself before an earthquake, different anomalous signs in the atmospheric parameters, such as surface temperature, are generally observed. A thorough examination of these anomalous signs assists us in understanding the earthquake mechanisms and seismic predictions. In the present work, the surface thermal parameter - surface temperature (ST) during the twelve recent earthquakes of high magnitude (M≥ 6.0) are studied. All the earthquakes considered in the study originated on land. The data of surface temperature have been retrieved from the NCEP/NCAR website re-analysis. The value of ST considered is one month pre- and post- to the earthquakes. It is observed that all the earthquakes show an anomaly during the seismic-affected periods (pre- and post). Most of the earthquakes considered show a maximum anomalous surge in ST within ~ 1–9 days prior to the mainshock. Also, post-seismic anomalies are observed during most of the events. In some of the events, the maximum anomalies occurred on the day of the earthquake. The anomalous behaviour of normalised ST varied from ~ 6.15% to 116.6% as compared to background noise during the pre-seismic period of the considered earthquakes. During the post-seismic period, this variation spans from ~ 17.69% to 83.95% compared to the background noise.

Keywords: Surface temperature (ST) anomaly, Earthquake, Magnitude, Precursors, Atmospheric parameters, Earthquake preparation zone (EPZ).

INTRODUCTION

Earthquakes are among the most destructive natural disasters, striking without warning and highlighting the urgent need for effective prediction methods to mitigate their impact. Despite of ongoing research, accurate forecasting of seismic events, remains a significant challenge due to their complex nature. Prior to a strong-magnitude earthquake, the Earth undergoes preparatory processes during which multi-parametric precursors are recorded within a timeframe and specific region known as Earthquake Preparation Zone (EPZ), introduced by Dobrovolsky et al. (1979). Various precursory studies that encompass ionospheric precursors (Pulinets and Boyarchuk, 2004), mechanical stress changes (Niu, 2008), electromagnetic signals (Kondo, 1966), hydrological precursors (Rikitake, 1979) and thermal irregularities (Pulinets et al., 2006; Bardhan et al., 2022; Sharma et al., 2024) have been carried out. Thermal anomalies within earthquake preparation zones, have been observed several days before major shocks (Tronin et al., 2002) and are often associated with increased thermal flux originating from the Earth's crust in tectonically active regions (Ouzounov and Freund, 2004). These anomalies, frequently detected through satellite-based thermal infrared (TIR) sensors, manifest as enhanced TIR emissions from the Earth's surface prior to seismic events and are collectively referred to as thermal anomalies (Freund et al., 2005). Surface Temperature (ST), a key parameter, reflects the thermal state of the Earth's surface and is commonly monitored using satellite TIR observations.

Thermal precursor detection methodologies primarily involve comparing land surface temperatures (LST) from the days leading up to an earthquake with temperatures from the same season in a non-seismic year (Bhardwaj et al., 2017). Different studies have identified LST anomalies appearing at various time intervals before an earthquake, ranging widely from 2 to 24 days. Ouzounov et al. (2006) reported LST anomalies occurring 4 to 14 days prior to seismic events and Tronin et al. (2002) observed anomalies within a window of 6 to 4 days before the earthquake. Similarly, Boudriki Semlali et al. (2024) analyzed thousands of earthquake events with magnitudes greater than 4 (M > 4) using GOES and AQUA satellite observations and found that the LST increased before the earthquakes and thereafter decreased. Studies have shown that LST can exhibit anomalous increases, typically between 1°C and 5°C, several days to weeks before major earthquakes (Tronin et al., 2002; Pulinets and Ouzounov, 2011). Tibet's 2025 Dingri study confirmed MODIS LST anomalies (STL/RST validated) up to 6 months pre-event, fault-aligned (Li et al., 2025). These anomalies are believed to be triggered by underlying processes such as stress-induced deformation of rocks, the release of geothermal energy, and the emission of gases like radon, which collectively enhance the thermal conductivity of surface materials. Presently the study focuses on thermal precursors-temperature anomalies near the surface that appear prior to seismic events. This study examines the potential of Surface Temperature (ST) as a thermal precursor by analysing its behaviour before and after twelve high-magnitude earthquakes (M ≥ 6.0) across various global regions.

DATA SELECTION AND SURFACE TEMPERATURE ANALYSIS

In this study, the twelve high-magnitude earthquakes were analyzed (M≥6.0). Comprehensive information such as event location, date, time, epicentre coordinates and focal depth was obtained from the National Earthquake Information