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Variation of Surface Latent Heat Flux (SLHF) observed during high-magnitude earthquakes

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ABSTRACT

Various precursory signatures are observed over the ocean-land-atmosphere due to seismic activities. Earthquakes create a lot of destruction to life and property. Therefore, understanding and monitoring various anomalies in geophysical parameters are required to understand the precursory signature for the early warning and the prediction of earthquakes. In the present work, the Surface Latent Heat Flux (SLHF) has been analysed for recent seven high-magnitude ($M \geq 6.0$) earthquakes. For this purpose, data on SLHF has been retrieved from the NCEP website. The climatological analysis for seismic precursor identification (CAPRI) methodology was adopted to study the SLHF before the earthquakes. A significant anomalies change in the SLHF was observed. Maximum increase in SLHF was found to be ∽20 days prior to the main earthquake events. The maximum and minimum anomalies in SLHF during all seven events were analysed. The variation in maximum and minimum anomaly is the least over the earthquakes events that occurred over land. This variation increases for the earthquakes that occurred over the ocean or near the vicinity of the ocean. The outgoing radiation trapped via accumulated water vapours results in increased heat over the surface of epicentres and nearby areas. This has contributed to the rise in surface latent heat flux before all the seven major earthquake events.

Keywords: Surface Latent Heat Flux (SLHF), EPZ, Lithosphere–Atmosphere–Ionosphere Model (LAIC), Seismic precursor identification, Earthquake magnitude.

INTRODUCTION

Unstable plate tectonic movements over the lithosphere are the major cause of increased seismicity. The increased seismicity results in the accumulation of stress which further causes crack. When a crack reaches a specific distortion that it can no longer tolerate, it breaks, releasing most of the energy that has developed over the years, and decades. The earthquake preparatory phase is often referred to as the final stage before the advent of an earthquake. The time scale of the preparatory phase ranges from months to years. Various phenomena associated with the preparatory phase of an earthquake, as well as the interaction of the solid ground with the atmosphere are widely discussed (Tanimoto, 2015). The metrological and ionospheric parameters vary during earthquake affected period (Bina, 1998; Chan and Wu, 2012; Chowdary et al., 2012; Beig et al., 2013; Sharma et al., 2013; González-Zamora et al., 2015; Aggarwal et al., 2016; Bardhan et al., 2017; Kumar, 2021). The process of an earthquake involves various phenomena in the earth's core and the magnetosphere. Therefore, understanding, monitoring, and prediction of earthquakes becomes complex and its monitoring remains difficult (Holliday et al., 2008; Sharma et al., 2013; Aggarwal et al., 2016; Bardhan et al., 2017). If we study the characteristics of atmospheric conditions, we might be capable of predicting when an earthquake will occur.

In recent years, several destructive earthquakes have occurred often along the earth-ocean surface (Kumar and Singh, 2014; Huang et al., 2015; Kumar, 2016; Ruiz-Pinilla et al., 2016; Chauhan et al., 2018). The lithosphere–atmosphere–ionosphere model (LAIC) couples the transportation of energy and particles from the earth's crust to the atmosphere and then to the ionosphere as studied by Pulinets and Ouzounov (2011). They analysed various anomalous changes in meteorological and atmospheric variables and integrated the results to predict the forthcoming earthquakes. Further, they observed anomalous behaviour such as thermal infrared radiation (TIR), air temperature, humidity, radon/ion activities, electromagnetic (EM) variations, and electron density (Ne) in the ionosphere. Even though the LAIC model has not been fully proven, it predicts TIR in the Earth's atmosphere that is also confirmed by satellite detection from the above. Thermal abnormalities are observed within a few days to two months before the earthquakes, which can last for up to a week thereafter (Piscini et al., 2017). The anomalies extend from a few kilometres to hundreds of kilometres. Subjected to tectonic and continental stress, the convective fluid beneath the earth's surface separates into water liquid and water vapor. The heat, vapor, and liquid accumulated in this process oyez out through various faults, cracks, and fissures. The increased rate of this preparatory stress finally results in a major fault rupture. The heat transfer in this process changes the surface temperature and, henceforth moisture content of the soil and its physical and chemical properties. Furthermore, according to Pullinets and Ouzounov (2011), the latent heat released during the water vapor condensation on the ion due to air ionization by the radon, results in an increase in air temperature. It is also observed by them that the relative humidity drops and the air temperature increases before major earthquakes.

Similarly, Dey and Singh (2003) analysed multi-sensor data and observed anomalies in atmospheric water vapor content prior to the Gujarat earthquake on January 26, 2001. Singh et al. (2001) also reported significant changes in the land/surface/subsurface parameters. Although earthquake detection remains a difficult