

MODIS detected land surface temperature (LST) anomalies preceding earthquakes

- Within weeks before an earthquake, thermal anomalies may occur that manifests as a sudden increase in LST (Fig. 1) [1-3].
- Tectonic stresses change the thermal regime of the epicentre region prior to an earthquake event [1-3].
- These stresses release greenhouse gases at the surface, creating a localized greenhouse effect that augments LST [1-3].
- The magnitude of these thermal anomalies varies with size of earthquake, focal depth, and geological setting among other factors [1-3].
- LST thermal anomalies can be detected by MODIS using thermal infrared bands.

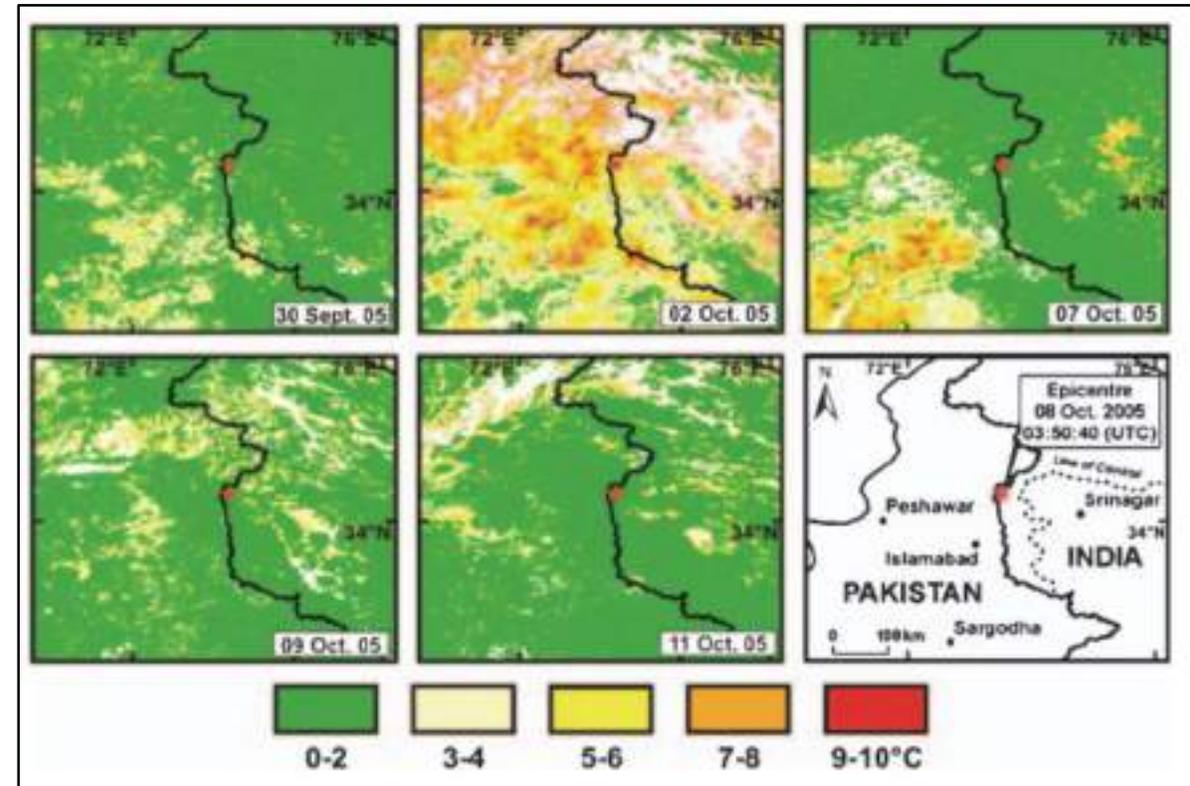


Figure 1. Increase in LST preceding a magnitude 7.6 earthquake on 8 October 2005 with a subsequent return to normal conditions. Temperatures illustrate deviation from the 2000-2004 average on each day [1].

MODIS data

Table 1. MODIS LST&E band information.

Application	Band	Bandwidth (nm)	Pixel size (m)
Cloud Properties	29	8.40 – 8.70	1000
Cloud/Surface Temperature	31	10.78 – 11.28	
	32	11.77 – 12.27	

- MODIS data includes a preprocessed Land Surface Temperature and Emissivity (LST&E) product that can be used to map land surface temperatures (Fig. 2) [4-5].
- The algorithm calculating LST&E uses the three thermal infrared bands: 29, 31, and 32 (Table 1) [4].
- Temperatures are derived in the Kelvin scale at 1 K accuracy [4].

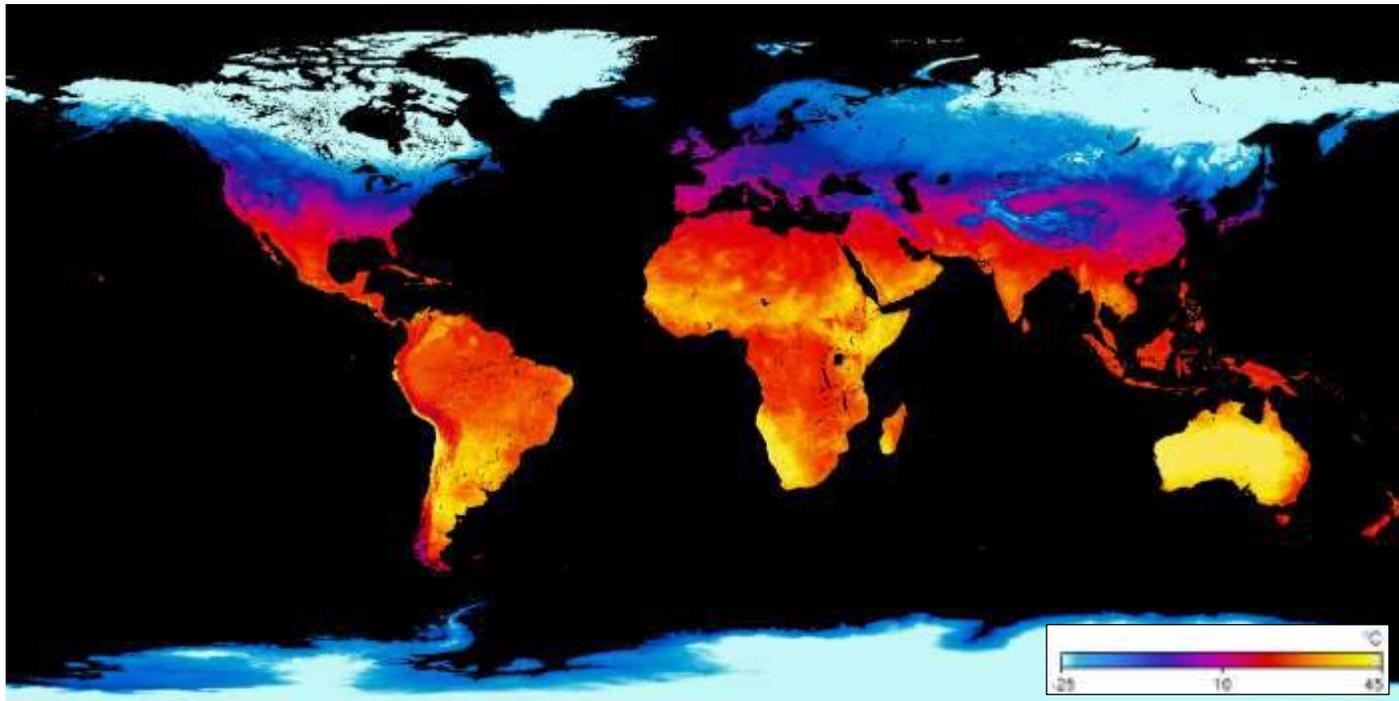


Figure 2. Average LST over January 2022 [5].

Figure 3. Maps of LST thermal anomalies preceding earthquake [3].

Applications

- Fig. 4 reveals a gradual increase in LST preceding the magnitude 6.0 earthquake on 4 June 2000 in Kharan, Pakistan with a subsequent return to normal conditions [3].
- Found significant LST anomalies within the two weeks prior to the main earthquake (Figs. 3-4) [3].
- Results are promising and implementation of this monitoring technology may help forecast potential earthquakes in the future.

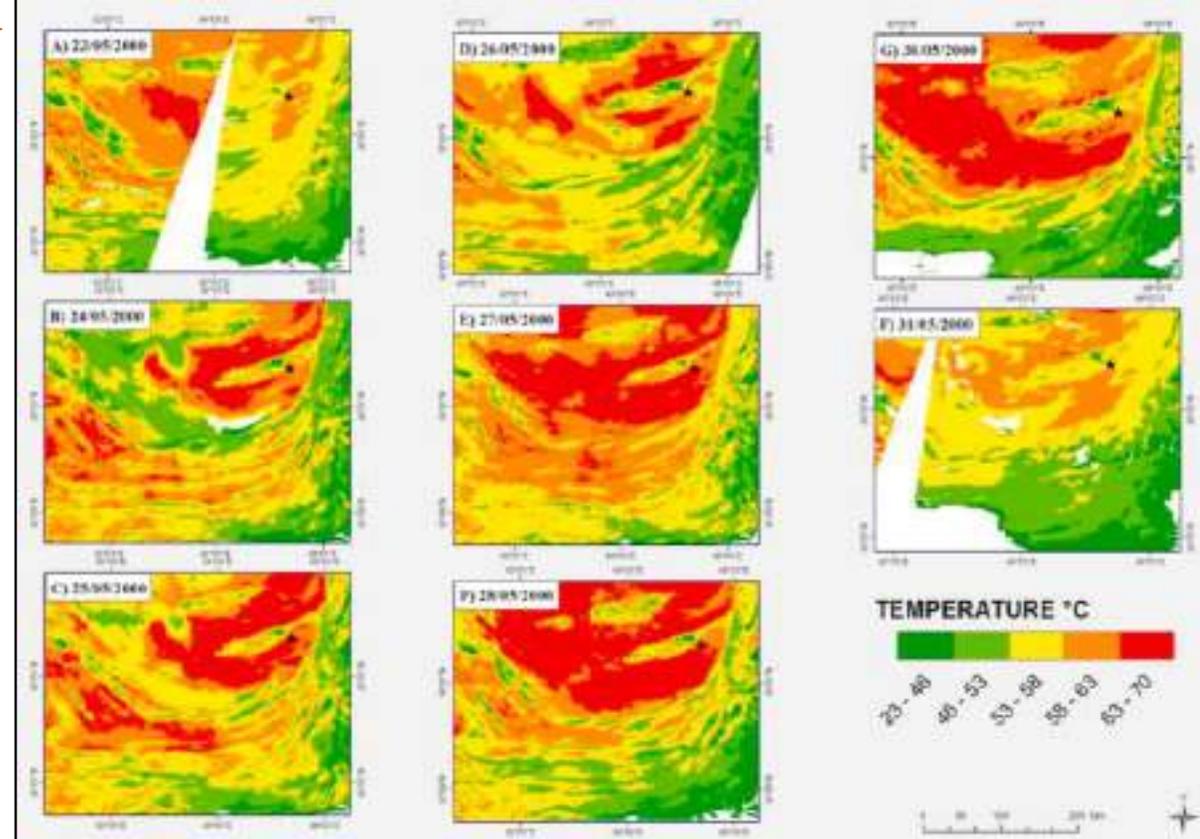
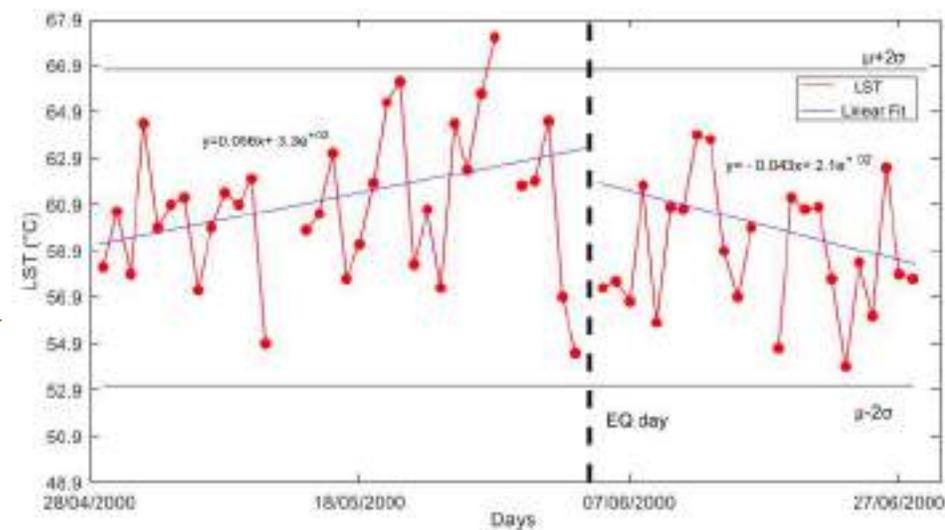


Figure 4. Daily LST time series 2 months before and 1 month after earthquake [3].



References and resources

Journal articles

1. S. K. Panda , S. Choudhury , A. K. Saraf & J. D. Das (2007) MODIS land surface temperature data detects thermal anomaly preceding 8 October 2005 Kashmir earthquake, International Journal of Remote Sensing, 28:20, 4587-4596, DOI: 10.1080/01431160701244906
2. Maria Zoran (2012) MODIS and NOAA-AVHRR land surface temperature data detect a thermal anomaly preceding the 11 March 2011 Tohoku earthquake, International Journal of Remote Sensing, 33:21, 6805-6817, DOI: 10.1080/01431161.2012.692833
3. Shah, M., Qureshi, R. U., Khan, N. G., Ehsan, M., & Yan, J. (2021). Artificial Neural Network based thermal anomalies associated with earthquakes in Pakistan from MODIS LST. Journal of Atmospheric and Solar-Terrestrial Physics, 215, 105568.

Websites

4. <https://modis.gsfc.nasa.gov/data/dataproduct/mod21.php> (MODIS Land Surface Temperature and Emissivity Overview)
5. https://neo.gsfc.nasa.gov/view.php?datasetId=MOD_LSTD_M (NASA Global LST portal)