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Anomaly Identification and Validation for Winter 2017 Iraq and Iran Earthquakes

Lixin Wu (1), Yuan Zhou (2), Zelang Miao (1), and Kai Qin (2)

(1) Central South University, Geosciences and Info-Physics, Department of Geomatics and Remote Sensing, Changsha, China (awulixin@263.net), (2) School of Environment Science and Geo-informatics, China University of Mining & Technology, Xuzhou, China

Several medium earthquakes struck Iran and Iraq from November to December, 2017. To explore possible pre-seismic anomalies in these events, this paper utilized a multiparameter method to analyze three satellite retrievals, including surface latent heat flux (SLHF), surface skin temperature (SST) and aerosol optical depth (AOD). We observed that, for Ms.7.8 Iraq-Iran border earthquake shocked on November 12, 2017, a spot-shaped region with highly anomalous SLHF values occurred in the west of epicenter two weeks before the mainshock. A strip-shaped high-value AOD anomaly was also found at the north Iraq-Iran border 12 days before the mainshock. For Ms.6.0∼6.2 Iran earthquake series occurred on December 1-12, 2017, a hook-shaped high-value SLHF anomaly occurred at northeast around the epicenter two weeks before the preliminary shock, and a spot-shaped high-value AOD anomaly occurred simultaneously to the east of the epicenter.

The regional meteorological and atmospheric information (e.g., wind field and aerosol Angstrom exponent) and satellite optical images were applied to validate if the anomalies are pre-seismic anomalies of these earthquakes. Optical images show that a regional severe sandstorm originated in Iraq and Saudi Arabia on October 29, 2017 and moved northeastward to Iran; while a local sandstorm occurred at southwest Afghanistan on November 13-14, 2017, and moved to southeastward. A spatio-temporal comparison between SLHF, AOD and meteorological data revealed that the remote transported sandstorm, concentrating along Iraq-Iran border where the plain uplifts to high mountains, had leaded to the strip-shaped high-value AOD anomaly on October 31. The sandstorm concentrated along the mountain front was jointly triggered by the wind field of splitting directions and uplift terrain of great difference in altitude. On the other hand, the Angstrom exponent of the aerosol anomaly on October 31 was extremely high, suggesting that the aerosol was comprised basically of sandstorm particulates, not underground gas-leak resulted from pre-earthquake crust fracturing. The hook-shaped high-value SLHF anomalies on November 13-14 were independent of the homogenously distributed AOD except for that amplified by the local sandstorm. The aforementioned analysis indicates that SLHF values were abnormal before both two earthquakes. Although the AOD anomaly was also detected in two cases, it cannot regard as a pre-seismic indicator, because the frequent sandstorms in the Middle East during winter time also result in the anomaly of AOD.

This study presents exemplary results that indicate the potential for further use of the multiparameter algorithm in detection of pre-seismic anomaly from satellite observations. A natural progression of this work is to evaluate the impact of regional terrain, topography and meteorology on satellite observations and its influence on pre-seismic anomaly recognition.