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Multi-parameter study of the pre-earthquake phase associated with the Kahramanmaraş sequence in Türkiye on February 6th, 2023.

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We study critical lithosphere/atmosphere /ionosphere coupling processes that precede earthquake events. Soon after the M7.8 and M7.5 in Kahramanmaraş, Türkiye on Feb 6, 2023, Kahramanmaraş earthquakes, we started collecting and processing multi-parameter data from ground, atmosphere, and satellite observations, such as 1/ Vertical static pendulums data from the European network; 2/ Hydrogeochemical data for electrical conductivity and major ion contents from the spring water samples near Kahramanmaraş ; 3/ Outgoing long-wavelength radiation (OLR) obtained from satellites NPOESS; 4/ Ionospheric plasma observations from China/Italy Seismo-Electromagnetic Satellite (CSES1);5/Electron density variations in the ionosphere via GPS Total Electron Content (GPS/TEC) and 6/ Atmospheric chemical potential (ACP) obtained from NASA assimilation models. We have detected two temporal groups of pre-earthquake anomalies: A/few months in advance - hydrogeochemical anomalies lasting up to six months and vertical static pendulums lasting two months ahead of the seismic rupture and B/few days in advance - OLR and ACP anomalies showed an abnormal increase on Jan 15-30, along with the plasma electron and oxygen ion density from the CSES1 satellite which is highly correlated with electron density variations in the ionosphere from GPS/TEC. Two groups of identified anomalies relate to different stages of Kahramanmaraş earthquake preparation processes. The first type was linked to the crustal deformation phase and was associated primarily with the coupling processes of the lithosphere-atmosphere. Based on the cross-event analysis of major seismicity in the regions, we found similarities in the pre-earthquake pattern occurrence between the M7.8/M7.5 2023 Kahramanmaraş sequence and the M7.2 Van Earthquake of 2011 and two other major events.

We show that we could extract new information about the different stages of earthquake preparation processes by combining ground and near-space data according to the physical concept of LAIC.