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On the Potential of Multi-Parametric Measurements for Earthquake Precursors Analysis

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Despite the existence of a large number of observational data and physical models describing the preparation, performance and consequences of Earthquakes (EQ) events, scientists still do not know much about this physical phenomena. A vast amount of efforts and financial means have already been invested in searching for possible precursors of geodynamic and EQ events, which might be considered disproportionate to the progress already achieved. Nevertheless, this important task deserves further investigation, as any encouraging obtained result will pay off all efforts.

Here, we propose to investigate a multi-parametric integrated approach, augmented by observation from a wide set of possible/potential EQ manifestations in the Lithosphere, Troposphere and Ionosphere. To better tackle the problem of possible EQ precursor detection, four EQ events with magnitudes of 3.9–4.4 M, which occurred in Lake Kinneret pull-apart basin, Israel from the period of May 1 to September 30, 2018, were examined. The multi-parametric observation were simultaneously collected from several stations within a 100 km radius from the studied EQ epicenters. Thus, the following parameters which were investigated are: gamma-ray emissions both from the subsurface and atmosphere, precipitation, atmospheric temperature and pressure, groundwater level and electrical conductivity measured in two wells, precipitable water vapor (PWV) in the atmosphere extracted from GNSS tropospheric path delays, Total Electron Content (TEC) in the ionosphere extracted from GNSS ionospheric path delays. In addition, geomagnetic and solar parameters such as A- and Kp-indices, 10.7 cm radio flux and sun spot number (SSN), were used to exclude the influence of solar-terrestrial coupling and mitigate false positive signatures.

Preliminary results indicate anomalous signals (exceeding 2σ) at all stations for most of the measured parameters, approximately one month before the studied EQ events. Five significant anomalies, lasting 4-7 days, observed in sub-surface gamma-ray emissions were chosen as reference main precursors. Two of those anomalies (35±2 days and 26±2 days before the EQ events) were accompanied by signal enhancements, measured at other stations located several tens of kilometers apart, in PWV, TEC, groundwater electrical conductivity, Rn and CO2. Another two sub-surface gamma-ray anomalies were correlated with precipitation events, while the last

observed anomaly (11±3 days before the EQ events), which is the weakest among the five, was not accompanied by any enhanced measured parameter. According to these results, the multi-parametric approach seems to provide a powerful analysis tool used to differentiate between signals originated from geodynamic and other sources. It is suggested that future research can benefit tremendously from vast multi-parametric continuous data collection and analysis.