Multi-year analysis on earthquake-related Total Electron Content (TEC) signals over Mediterranean Area

R. Colonna [1,2], C. Filizzola [3,2], N. Genzano [4], N. Pergola [3,2], V. Tramutoli [1,2]

1) School of Engineering, University of Basilicata, Potenza, Italy; 2) Satellite Application Centre (SAC), Space Technologies and Applications Centre (STAC), 85100 Potenza, Italy; 3) Institute of Methodologies for Environmental Analysis, National Research Council, Tito Scalo (PZ), Italy; 4) Department ABC (Architecture, Built Environment and Construction Engineering), Politecnico di Milano, Via Ponzio 31, 20133 Milano, Italy;

Over recent decades, various geophysical parameters — such as electromagnetic field components across multiple frequency bands, Earth's thermal radiation, gas emissions from the ground and ionospheric elements — have been proposed as potential indicators of earthquake activity. In the last decade, the combination of extensive historical satellite data and the rapid development of artificial intelligence techniques has significantly advanced the study of detecting seismic–related anomalies from space. In particular, the variations of the Total Electron Content (TEC) have been deeply investigated as an indicator of the ionospheric status potentially affected by earthquake related phenomena. A thorough and systematic analysis of multi-year historical data series is essential to distinguish TEC variations caused by normal ionospheric cycles and non–terrestrial phenomena, both of which are predominantly influenced by the solar cycle and its activity.

In this work, multi–annual datasets of GNSS-based TEC measurements are matched with multi–year time series of seismic events over the Mediterranean Area and systematically analyzed using an IQR (interquartile range)–based method. The results highlight the presence of anomalous seismic–related sequences that have an extremely low probability of having been detected randomly. The findings obtained are discussed with a view to evaluating how and to what extent it may be possible to develop and implement a TEC–integrated multi-parametric system for a time-Dependent Assessment of Seismic Hazard (t-DASH).