EGU21-13730
https://doi.org/10.5194/egusphere-egu21-13730
EGU General Assembly 2021

Long-term analysis of the Ionospheric-Total Electron Content (TEC) parameter for the detection of anomalous behaviours potentially related to seismic activity

Roberto Colonna et al.

In recent decades, many advances have been made on the study of the complex processes involved in the preparatory phases of earthquakes. Over time, different types of parameters (chemical, physical, biological, etc.) have been proposed as indicators of variability potentially related to this process. Among these, space weather parameters are assuming an increasingly important role due to their possible connection to the occurrence of strong and imminent earthquakes. The variations of the Total Electron Content (TEC) have been investigated as an indicator of the ionospheric status potentially affected by earthquake related phenomena.

In order to discriminate TEC variations related to normal ionospheric cycle as well as to non-terrestrial forcing phenomena (both mostly dominated by the solar cycle and activity) a key role is played by an in-depth and systematic analysis of multi-year historical data series.

In this work, a multi-year (>20 years) dataset of TEC measurements recorded by the GPS satellite constellation, was analysed using a modified InterQuartile Range (IQR; Liu et al., 2004) method in order to identify anomalous TEC transients. A correlation analysis was performed with seismic events (M≥4) occurred in Italy in between 2000-2020 considering all the period both in presence and in absence of seismic events.

The results obtained are discussed and compared with the results achieved through an independent RST analysis (Robust Satellite Techniques; Tramutoli, 1998; 2007) carried out on the Earth's Thermal Infrared Radiation (TIR) parameter.

Both methodologies, while using a different approach, aim to discriminate anomalous signals from normal fluctuations of the signal itself related to other causes (e.g. meteorological, geographical, etc.) independent on the earthquake occurrence.

The joint analysis of the results obtained by the two parameters, TEC and TIR, is carried out in order to evaluate how and to what extent a multi-parametric approach can improve (compared with a single parameter approach) Time-Dependent Assessment of Seismic Hazard (T-DASH; Genzano et al., 2020; 2021) in the short-medium term.

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How to cite: Colonna, R., Filizzola, C., Genzano, N., Lisi, M., Pergola, N., and Tramutoli, V.: Long-term analysis of the Ionospheric-Total Electron Content (TEC) parameter for the detection of anomalous behaviours potentially related to seismic activity, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-13730, https://doi.org/10.5194/egusphere-egu21-13730, 2021.