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Statistical analysis for the identification of precursory signatures of earthquake occurrence in Total Electron Content (TEC)

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In the last few decades several parameters (chemical, physical, biological, etc.) have been proposed in association with the complex process of preparation of earthquakes. In particular, the variability of space weather has been proposed, since long time, as possible indicator of impending earthquakes. This variability can be optimally captured by the detection of anomalous Ionospheric-Total Electron Content (TEC) variations.

The investigation of the preparation phase of past strong earthquakes could be useful to understand the physical processes involved and to develop a future short-term warning system.

Since 2001, the general change detection approach RST (Robust Satellite Techniques; Tramutoli, 1998; 2005; 2007) has been used to discriminate anomalies in Earth's thermal emission measured by satellite possibly associated to seismic activity, from normal fluctuations of the signal related to other causes (e.g. meteorological) independent on the earthquake occurrence.

In this work are shown the results about the use of a RST-based approach for the preseismic TEC anomalies identification.

The RST methodology has been reformulated and adapted in order to be applied to TEC measurements recorded by the GPS satellite constellation, so as to discriminate anomalous signals from normal fluctuations of the signal itself. To this aim, we studied the behavior of the TEC parameter, proceeding to the construction of a multi-year dataset of observations (>5 years) in Mediterranean seismically active areas, both in presence and in absence, of strong seismic events (M≥5).

The achieved results are discussed and compared with the results obtained through independent RST analyses carried out on the Earth's Thermal Infrared Radiation (TIR) parameter. The comparison of the results obtained using the two parameters is made in order to evaluate how the joint use of both parameters (TEC and TIR) in the framework of a multi-parametric approach can improve the present capability of detection of these perturbations.