



Long term (2004-2013) correlation analysis among SSTAs (Significant Sequences of TIR Anomalies) and Earthquakes ($M > 4$) occurrence over Greece: examples of application within a multi-parametric system for continuous seismic hazard monitoring.

Valerio Tramutoli (1,2,3), Irina Coviello (1), Alexander Eleftheriou (4), Carolina Filizzola (2), Nicola Genzano (1), Teodosio Lacava (2), Mariano Lisi (1), John P. Makris (4), Rossana Paciello (2), Nicola Pergola (2), Valeria Satriano (1), and filippos vallianatos (4)

(1) University of Basilicata, School of Engineering, Potenza, Italy (valerio.tramutoli@unibas.it), (2) Institute of Methodologies for Environmental Analysis of the National Research Council, Tito Scalo (PZ), Italy, (3) International Space Science Institute, Bern, Switzerland, (4) Technological Educational Institute of Crete - School of Applied Sciences, Department of Environmental and Natural Resources Engineering, Chania, Crete

Real-time integration of multi-parametric observations is expected to significantly contribute to the development of operational systems for time-Dependent Assessment of Seismic Hazard (t-DASH) and earthquake short term (from days to weeks) forecast. However a very preliminary step in this direction is the identification of those parameters (chemical, physical, biological, etc.) whose anomalous variations can be, to some extent, associated to the complex process of preparation of major earthquakes. In this paper one of these parameter (the Earth's emitted radiation in the Thermal Infra-Red spectral region) is considered for its possible correlation with $M \geq 4$ earthquakes occurred in Greece in between 2004 and 2013. The RST (Robust Satellite Technique) data analysis approach and RETIRA (Robust Estimator of TIR Anomalies) index were used to preliminarily define, and then to identify, Significant Sequences of TIR Anomalies (SSTAs) in 10 years (2004-2013) of daily TIR images acquired by the Spinning Enhanced Visible and Infrared Imager (SEVIRI) on board the Meteosat Second Generation (MSG) satellite. Taking into account physical models proposed for justifying the existence of a correlation among TIR anomalies and earthquakes occurrence, specific validation rules (in line with the ones used by the Collaboratory for the Study of Earthquake Predictability – CSEP – Project) have been defined to drive the correlation analysis process. The analysis shows that more than 93% of all identified SSTAs occur in the pre-fixed space-time window around ($M \geq 4$) earthquakes time and location of occurrence with a false positive rate smaller than 7%. Achieved results, and particularly the very low rate of false positives registered on a so long testing period, seems already sufficient (at least) to qualify TIR anomalies (identified by RST approach and RETIRA index) among the parameters to be considered in the framework of a multi-parametric approach to time-Dependent Assessment of Seismic Hazard (t-DASH). The added value of real-time integration of such observations with others, independently performed from ground and satellite sensors, is also shown in the case of recent events occurred in Greece.