



Improving RST-based analysis of long-term TIR satellite observations in relation with earthquake occurrence

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In order to build and implement a multi-parametric system for a time-Dependent Assessment of Seismic Hazard (t-DASH) the preliminary assessment of the selected parameters is required. To this aim a long-term correlation analysis - among anomalous transients and earthquake occurrence - has to be performed to establish the corresponding forecast capability and particularly the expected false-positive rate. In fact, more than the missing rate (i.e. how many earthquakes occurs in absence of specific precursors) the reliability of the forecast is much more important when the continuity of the observations cannot be guaranteed. This is the case of satellite observations in the optical band whose continuity can be prevented by the presence of meteorological clouds. Among the others candidate parameters anomalous transients in the Earth's emitted Thermal Radiation observed from meteorological satellites in the Thermal InfaRed band (TIR) have been since long-term proposed in the framework of a multi-parametric t-DASH system. Results achieved by RST (Robust Satellite Technique) analyses of multi-annual (more than 10 years) time series of TIR satellite images in different continents and seismic regimes, allowed to identify (isolating them from all the others possible sources) those anomalies (in the spatial/temporal domain) possibly associated to the occurrence of major earthquakes. Main lesson learnt until now can be summarized as follows:

- a) Thanks to a clear definition of (Significant Sequences of TIR Anomalies (SSTAs) and well-defined validation rules, for earthquakes with magnitude greater than 4 the false positive rate is around 25% (average value over Greece, Italy, Japan, Turkey) oscillating from 7% up to 40% strongly depending on the considered region;
- b) Molchan error diagram analyses gave a clear indication that a non-casual correlation exist between RST-based SSTAs and earthquake occurrence time and location;
- c) SSTAs are quite rare (sporadic) with quite limited (less than 0,05% of the total investigated) alerted space-time volumes;
- d) The approach based on the application of the RETIRA index (Robust Estimator of TIR Anomalies)

showed some limitation related to the contextual approach that, in order to take into account of possible large scale changes of the thermal background, consider not just the TIR signal itself but its excess respect to the background (large scale spatial average of the TIR signal) introducing, this way, a strong dependence on the presence and distribution of meteorological cloud across the scene.

In order to overcome the d) issue an alternative possibility has been investigated which can locally filter-out the contributes of occasional warming (typically associated to meteorological fronts) without the need of analyzing the TIR signal at the large-scale. In this paper RST approach is implemented by introducing the RETIRSA (Robust Estimator of TIR Slope Anomalies) devoted to identify anomalous Nocturnal TIR Gradients in relation with the preparation phases of earthquakes. The impact in reducing the overall false-positive rates will be particularly discussed in the case of recent earthquakes occurred in Italy, Japan and California.