

Scheda della Linea di Ricerca

Tema/Denominazione: From high temporal resolution to enhanced radiometric resolution: Night Thermal Gradient results

Gruppo di ricerca			
N°	Componente	Qualifica	SSD
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Parole chiave: Earthquake physics, pattern anomalies, time series analysis, TIR, Night Thermal Gradient, geostationary satellite data, NASA, EUMETSAT, remote sensing, geophysics, geology, tectonics, georeferencing, thermal inertia, heat diffusion, aerial archaeology

Descrizione della Linea di Ricerca⁽¹⁾ (MAX 3000 caratteri)

The research is focused on the study of thermal infrared (TIR) signals detected from high temporal resolution platforms. Signals are processed in order to obtain more detailed maps and to have global information from discontinuous data time series.

Anomalous TIR emissions have been widely detected by satellite sensors prior to major earthquakes. A recent processing technique for data from geostationary satellites, here demonstrated for the case of the April 06, 2009 magnitude 6.3 L'Aquila earthquake, allows us to identify areas of enhanced TIR emission around the epicentral region within a distance of about 100 kilometers. The index, called Night Thermal Gradient (NTG) identifies TIR anomalies by following the temperature trend during the night, when the surface of the Earth normally cools. However, leading up to the earthquake, an anomalous warming trend was observed. We compare the anomalous NTG pattern to the expected normal trend, taking into account the overall tectonic setting, the seismogenic faults and lithological spatial features, the orography, and the world stress map for the epicentral region. While a certain lithological selectivity can be recognized, the main

¹ Evidenziare ovunque possibile la collocazione della Linea di Ricerca all'interno delle aree di interesse di Horizon 2020:

1. *Personalising health and care*
2. *Sustainable food security*
3. *Blue growth: unlocking the potential of seas and oceans*
4. *Digital security*
5. *Smart cities and communities*
6. *Competitive low-carbon energy*
7. *Energy Efficiency*
8. *Mobility for growth*
9. *Waste: a resource to recycle, reuse and recover raw materials*
10. *Water innovation: boosting its value for Europe*
11. *Overcoming the crisis: new ideas, strategies and governance structures for Europe*
12. *Disaster-resilience: safeguarding and securing society, including adapting to climate change*

stress field and known seismogenic faults seem to be less important than topographic heights. The strong correlation between topography and TIR anomalies agrees with the proposed physical mechanism for the generation of TIR anomalies, namely the role played by stress-activated positive hole charge carriers, which tend not to stay in the valleys but to spread to mountain tops. This relation is apparent in the association of two tectonic features, which are to be classified as non-seismogenic, with thrust, where strong – horizontal – compressive stresses seem to provide favorable conditions for the generation of TIR anomalies. The modification of these stress fields prior to the L’Aquila event have triggered the failure of the Paganica Fault. It is important to note that the distances, over which the TIR anomalies occurred, are an order of magnitude larger than the estimated length of the main fault rupture. Pixel-by-pixel time series comparisons between the maximum TIR anomaly area and the epicentre of the main shock show that the increase in radiative emission was associated with the areas of highest TIR anomalies, not with the area immediately surrounding the epicenter

Recently NTG method has been applied to near range remote sensing field on an archaeological test site with good results. With this method we were able to recognize probable buried archaeological features confirmed also by other well known geophysical methods and by the subsequent archaeological digs. The results are now published on a high rank journal.

The results in the seismological field have conducted to the presentation of various research projects to funding institutions. Actually two projects with University of Cagliari as leader are under evaluation, for a Horizon2020 and the MIUR SIR calls, and one independent project from University of Kansas is under evaluation for the NASA ROSES call on the basis of standard and automatic application of NTG method eventually integrated into multi-parametric protocols. The method was invited to be published on the Encyclopedia of Natural Hazard from Tandf and has been presented to some of the most important sector conferences.

Publicazioni prodotte relative al tema (MAX 3 pubblicazioni)

L. PIRODDI, **2015**, "TIR Anomaly as Earthquake Precursor", Encyclopedia of Natural Hazard, Taylor & Francis, 21 pages, submitted - under review (INVITED);

L. PIRODDI, G. RANIERI, F.T. FREUND, A. TROGU, **2014**, "Geology, tectonics and topography underlined by L’Aquila earthquake TIR precursors", Geophysical Journal International, (June, 2014) 197 (3): 1532-1536; ISSN: 1365-246X, doi: 10.1093/gji/ggu123 (**IF 2.724**)

L. PIRODDI, G. RANIERI, **2012**, "Night thermal gradient: a new potential tool for earthquake precursors studies. An application to the seismic area of L’Aquila (central Italy).", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing – JSTARS; February 2012, Volume: 5 Issue:1 pp. 307 - 312; ISSN: 1939-1404; DOI 10.1109/JSTARS.2011.2177962; (**IF 2.827**)

Prospettive di sviluppo e potenziali collegamenti interdisciplinari (MAX 1500 caratteri)

Inquadrare le prospettive di sviluppo nelle aree di interesse di Horizon 2020⁽¹⁾

La presente linea di ricerca è stata presentata anche per un bando Horizon 2020 con due progetti:

- Crisis management topic 7: Crises and disaster resilience – operationalizing resilience concepts; chiamata DRS-7-2014: Disaster-resilience: safeguarding and securing society, including adapting to climate change

Il titolo del progetto presentato in Horizon 2020 è TOGETHER: inTegrated Operational Guidelines to increase Europe’s resilience to volcanic, Tsunami and earthQuake Risk. European Coordinator prof. Gaetano Ranieri

Il titolo del secondo progetto presentato in Horizon 2020 è ARCHIMEDES : emergency

mAnagement and ResilienCe of smart cities in areas at High environMental and manmade risk: the procEss of DEcision-making between territory monitoring and right to Safety . Unità di ricerca partecipante con responsabile prof. Gaetano Ranieri

In essi la previsione sismica e vulcanologica, e lo studio dei fenomeni associati alle fasi preparatorie del sisma e dell'eruzione vulcanica sono il presupposto per l'incremento della resilienza dei territori e delle popolazioni esposti agli specifici rischi naturali. Sulla base delle risultanze delle attività di monitoraggio ed interpretazione dei parametri ambientali si studieranno dei protocolli di reazione sistemica alle variazioni nel tempo della pericolosità dei vari siti pilota. Tali protocolli saranno sperimentati puntualmente su alcune città e territori particolarmente esposti ai rischi di terremoto, eruzione vulcanica, maremoto e degli effetti a cascata. La progettazione, validazione e applicazione sperimentale dei protocolli di risposta agli specifici rischi ambientali saranno effettuate in collaborazione con stakeholders quali ad esempio dipartimenti di protezione civile, reti di monitoraggio sismico e vulcanologico, forze di polizia, ospedali, telecomunicazioni, municipalità, vie e nodi di comunicazione, ed altri.

All'interno del progetto è prevista la valorizzazione di competenze e professionalità nei campi:

- GIS;
- Urbanistica e pianificazione territoriale;
- Crowdsourcing;
- Campi elettromagnetici e telerilevamento;
- Fisica della frattura;
- CyberSAR competenze calcolo e informatica;
- Management delle emergenze.

Legami col territorio e possibilità di sviluppo riguarderanno l'installazione presso l'Università di Cagliari di un centro di previsione dei terremoti con il coordinamento dei dati raccolti a livello Europeo e provenienti da diversi tipi di sensori e sorgenti. Specifici obiettivi scientifici riguarderanno l'ottimizzazione e la risoluzione dei problemi dei falsi positivi e falsi negativi da ottenersi attraverso l'integrazione di dati di diversa natura e/o diversa condizione di acquisizione.

La linea di ricerca si colloca nell'area di interesse 12 di Horizon 2020:

Disaster-resilience: safeguarding and securing society, including adapting to climate change.