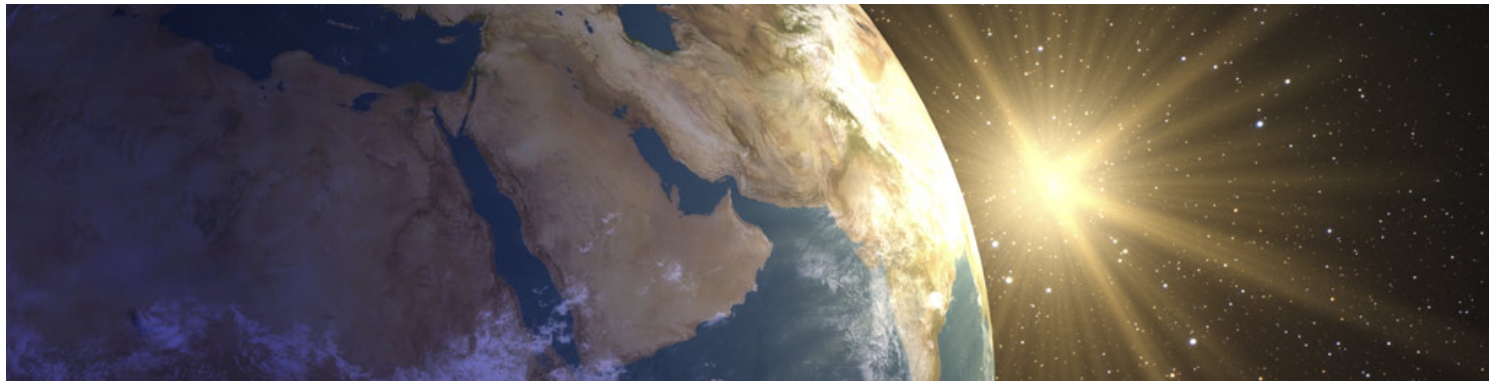
Pre-earthquake processes associated with the M6.4 of Nov 26, 2017 In Albania. A Multi parameters analysis.



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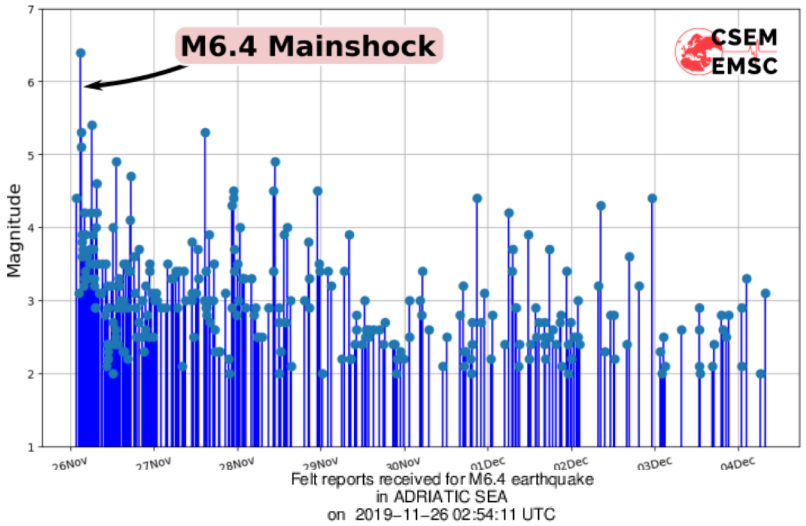
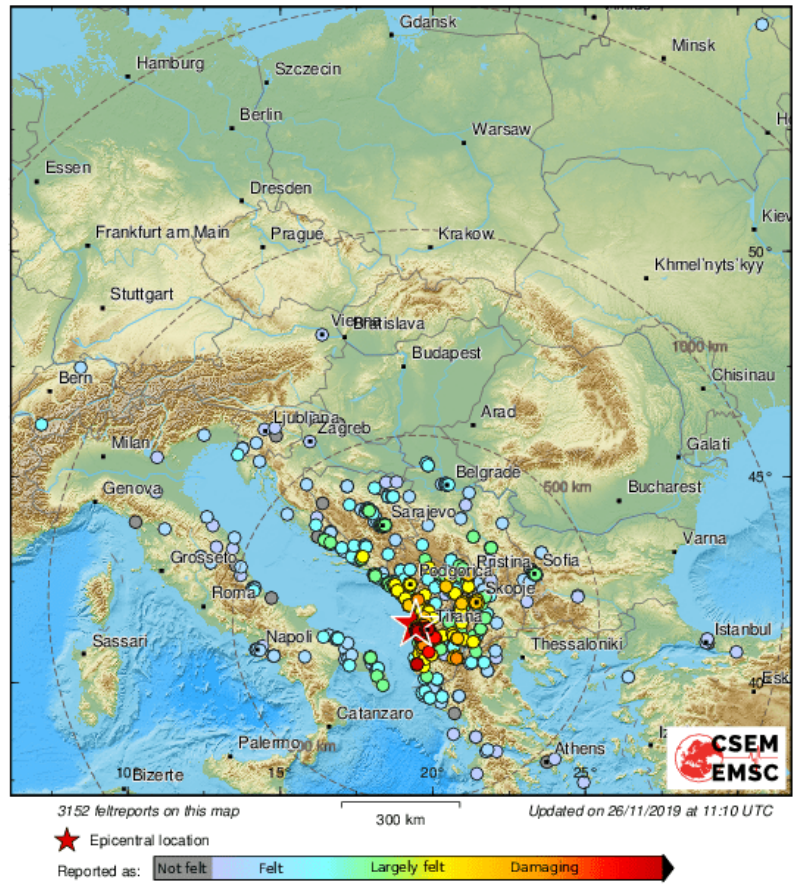
Summary

We present a multi parameters analysis of satellite and ground data that revealed a transient phenomenon in the atmosphere before the M6.4 earthquake in Albania on Nov 26, 2019. The observational methodology consists of data from five physical measurements:
(1) Satellite Thermal Anomalies (data obtained from NOAA) on the top of the atmosphere;
(2) Atmospheric chemical potential (ACP) obtained from the NASA assimilation models;
(3) Measurement of Radon level variations (two gamma stations in Central Italy);
(4) VHF propagation in the lower atmosphere from ground observations (SW Bulgaria)

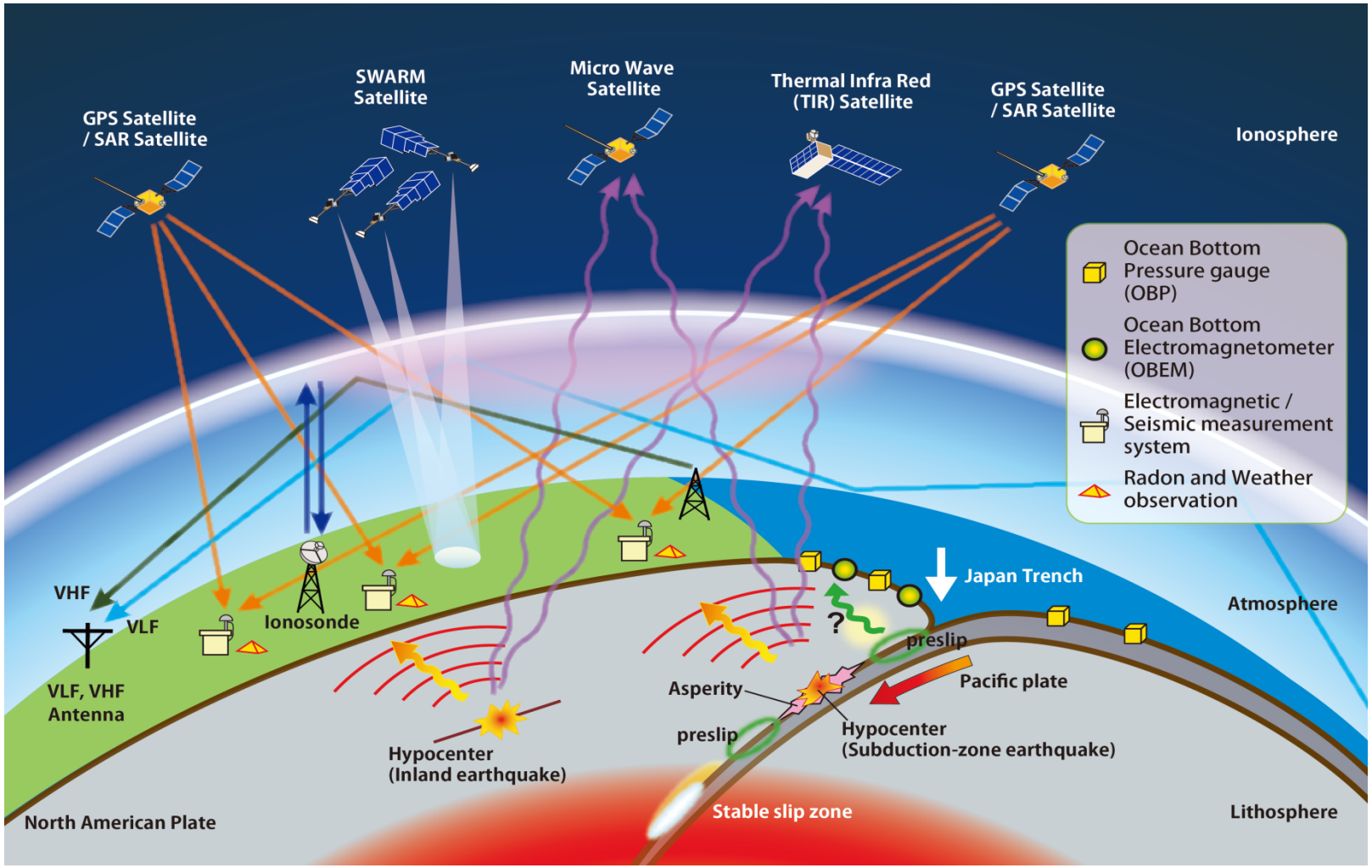
Acknowledgments
The authors thank NOAA's Climate Prediction Center for OLR data to USGS and EMSC for earthquake catalogs. Special thanks to NASA for the GOES5 assimilation data , to Giuliani Foundation (Italy) for radon data and to the MES project lead by the National National Institute in Geophysics (Bulgaria) for the VHF data.

- An earthquake of magnitude M6.4 hit Albania, 34 km of Tirana in the night of Tuesday, November 26th 2019 at 2h54 UTC (3h54 in local time).
- At the time of this report, a lot of buildings are damaged and local authorities report 15 victims. With a foreshock around one hour earlier of magnitude M4.4, a lot of people have left their homes and were outside during the mainshock... and not inside buildings.
- More than 31 earthquakes has been recorded in 10 hours and the majority of them has been felt by the population. This sequence is a reminiscent of the one in September where an M5.6 earthquake hit the same region on 2019-09-21 14:04:27 UTC (info) followed by more than 70 aftershocks.
- It's interesting to note that 7 hours after this M6.4 earthquake in Albania, some seismic events hit Bosnia and Herzegovina, 300km in the northwest. Although they are close, no correlation should be established between them. (EMSC)



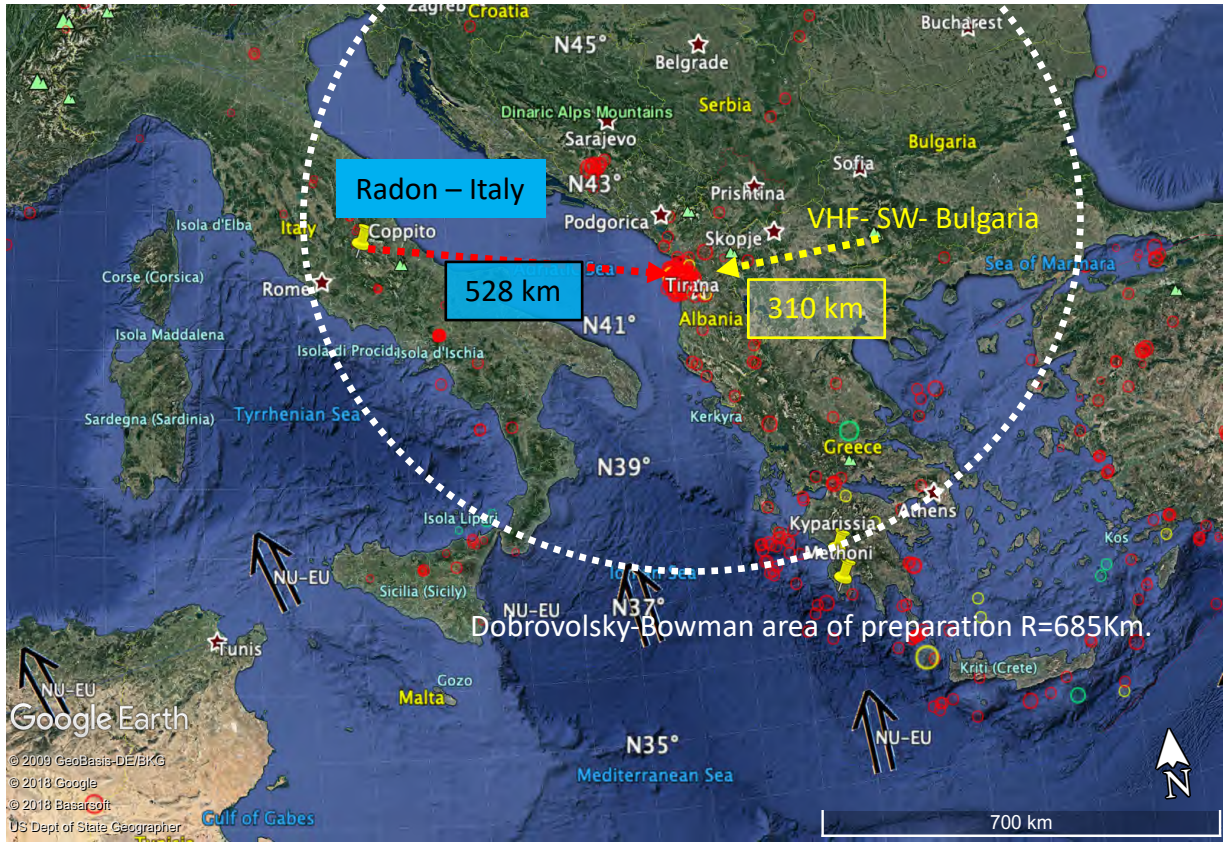


Multi-layer concept for observation of Pre- Earthquake signals

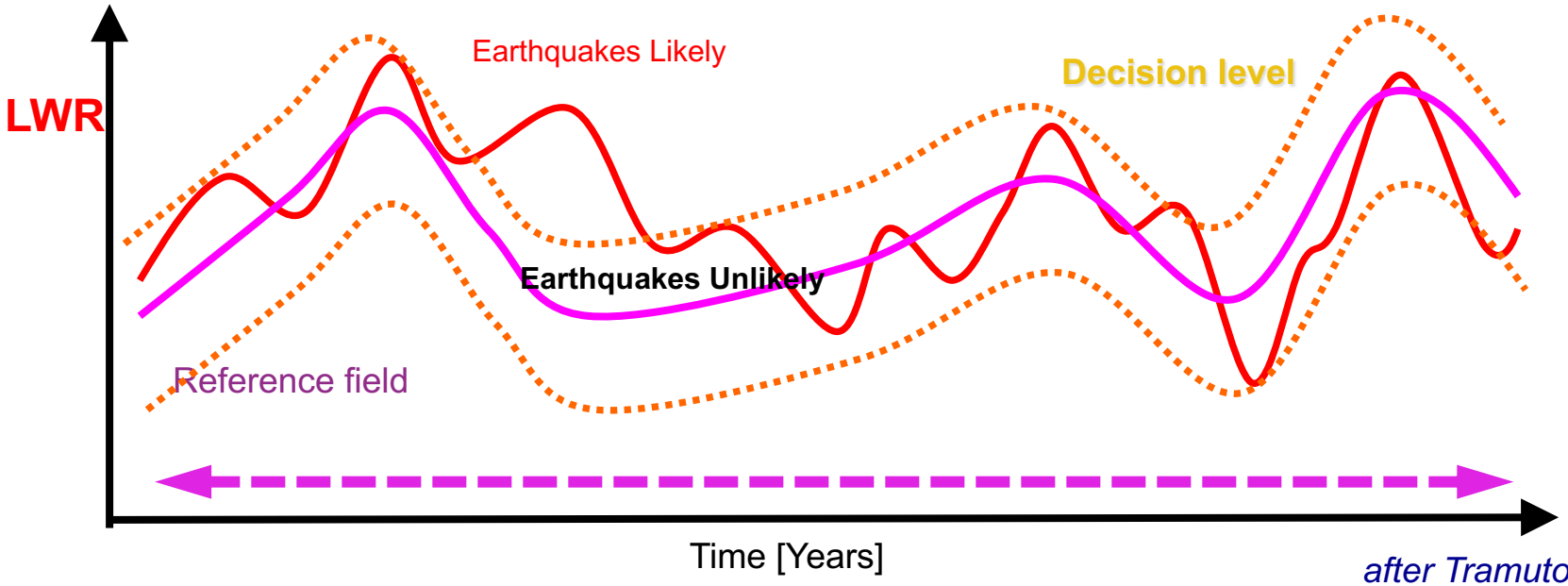


Conceptual Diagram of the integrated satellite and terrestrial framework for multi- parameter observations of pre-earthquake signals in Japan

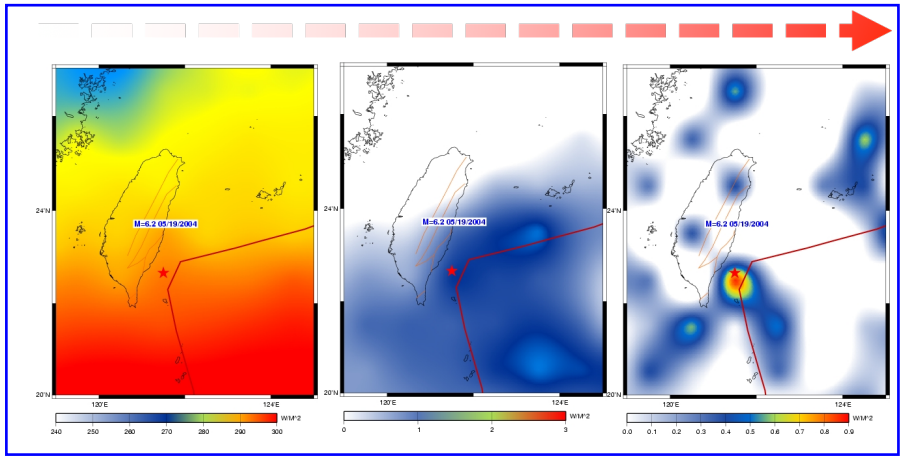
2 gamma sensor located in Central Italy (distance between 45 km) at distance of 528 km from the M6.4 in Albania. 2 VHF antennas (distance between 10 km) Located at distance of 310km in SW Bulgaria. With white circle id shown the estimated Dobrovolsky-Bowman area of preparation for M6.4



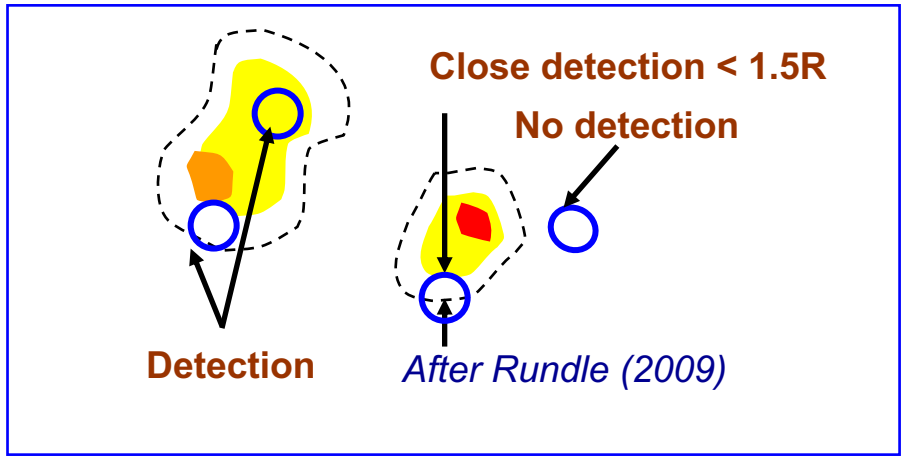
Thermal Radiation Anomalies (TRA) anomaly defined in the Euler frame of reference



after Tramutoli (2007)

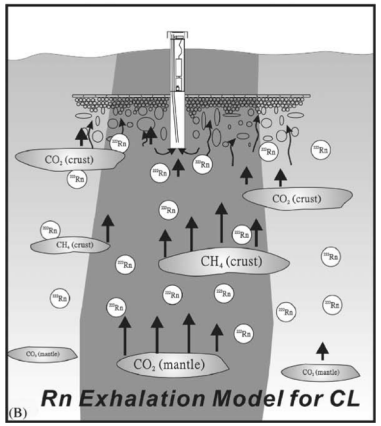


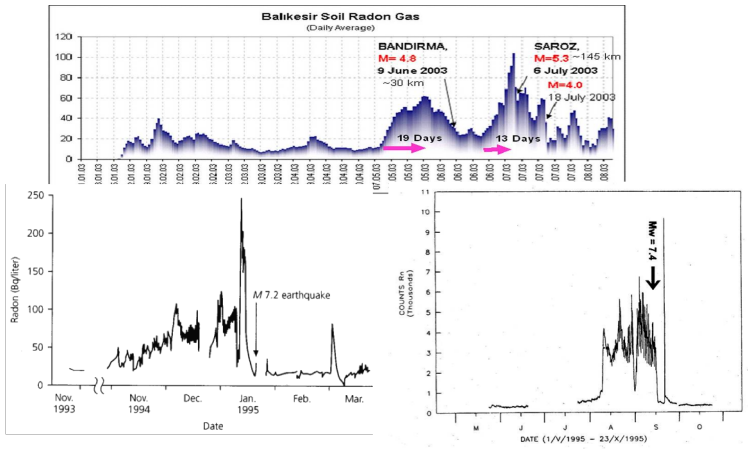
Anomalous index based on Signal/noise detection ratio (Ouzounov et al, 2007)

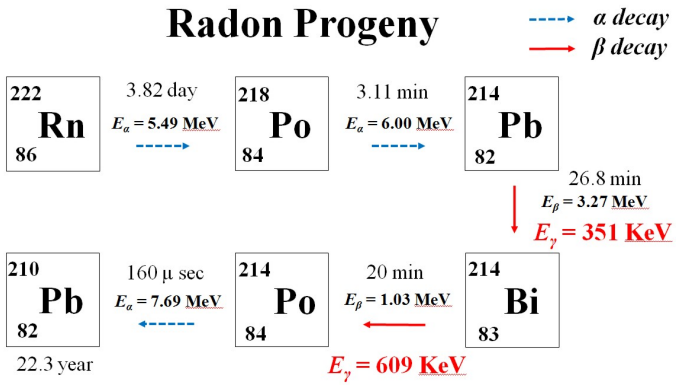


Hotspot Detection Map

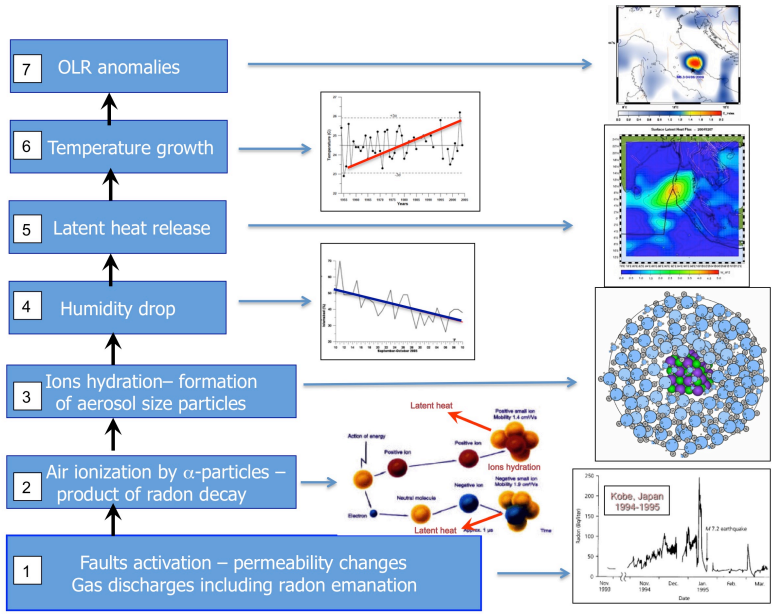
The role of radon and other geogases in the Lithosphere-Atmosphere–Ionosphere Coupling associated with pre- earthquake



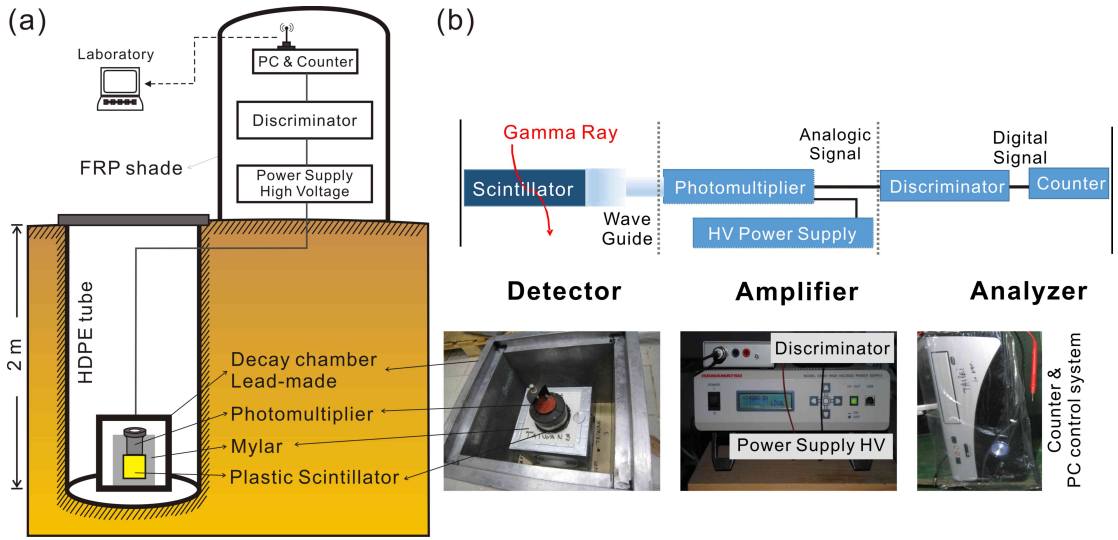




LAIC-Plasmachemistry-Thermal interface



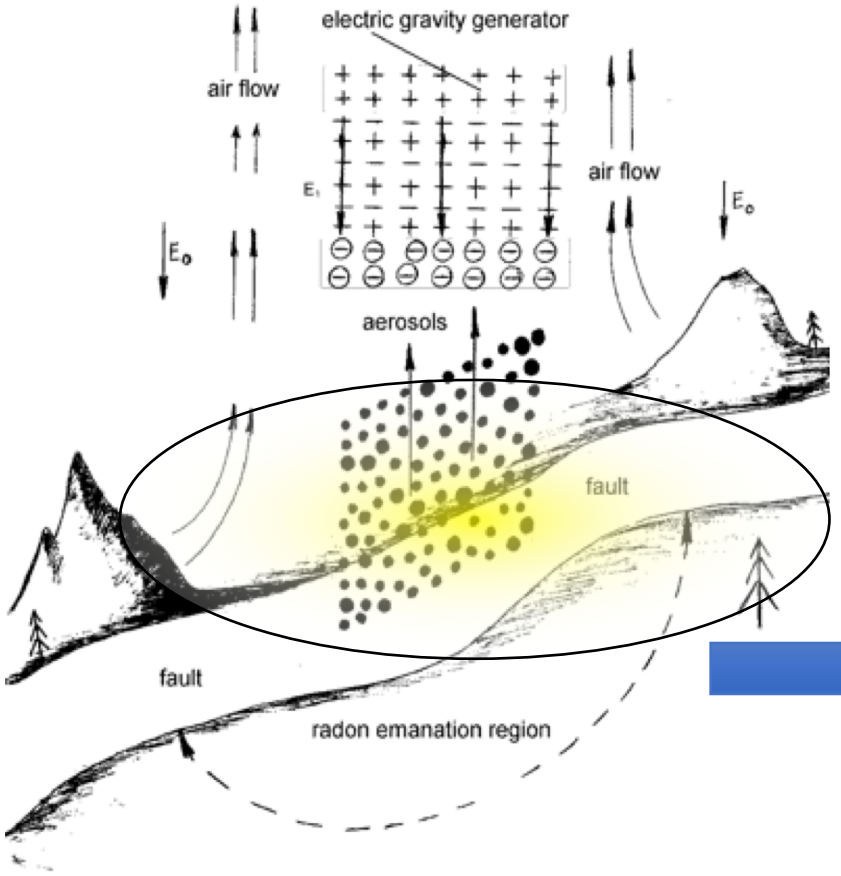
Gamma sensor array for Observation of Radon

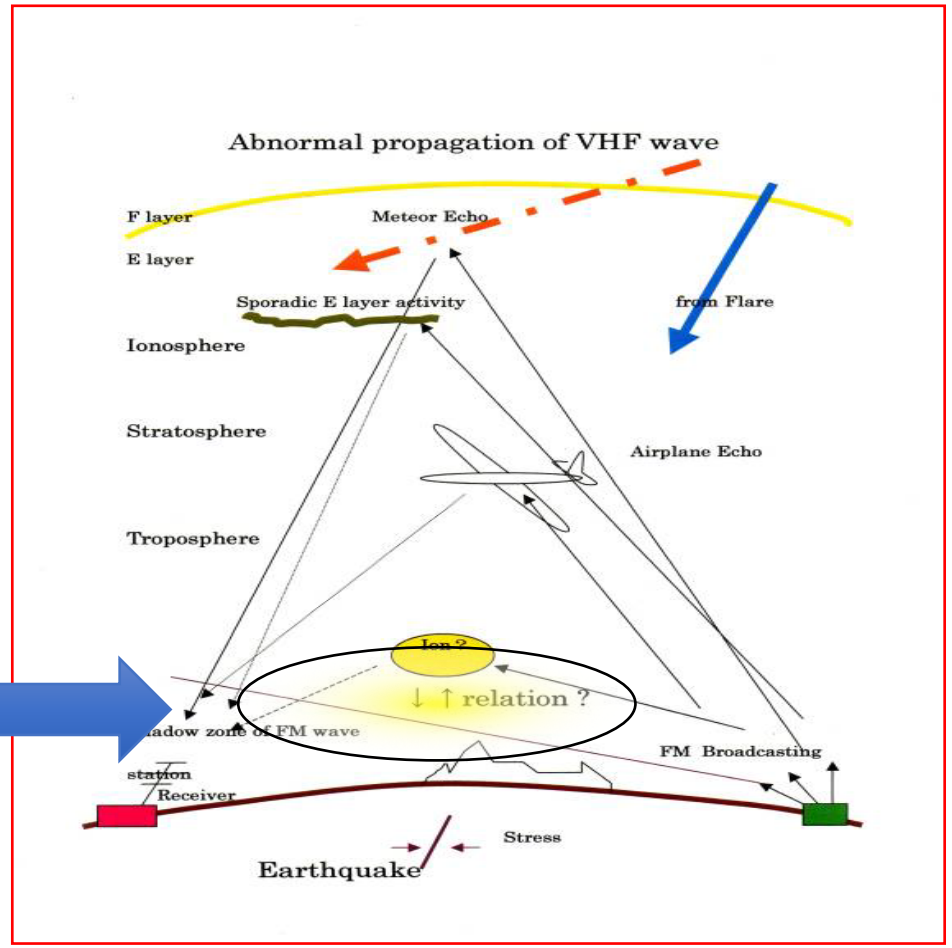


VHF observations

Creating an aerosol layer before major earthquakes

The concept of Lithosphere-Atmosphere-Ionosphere coupling (LAIC)

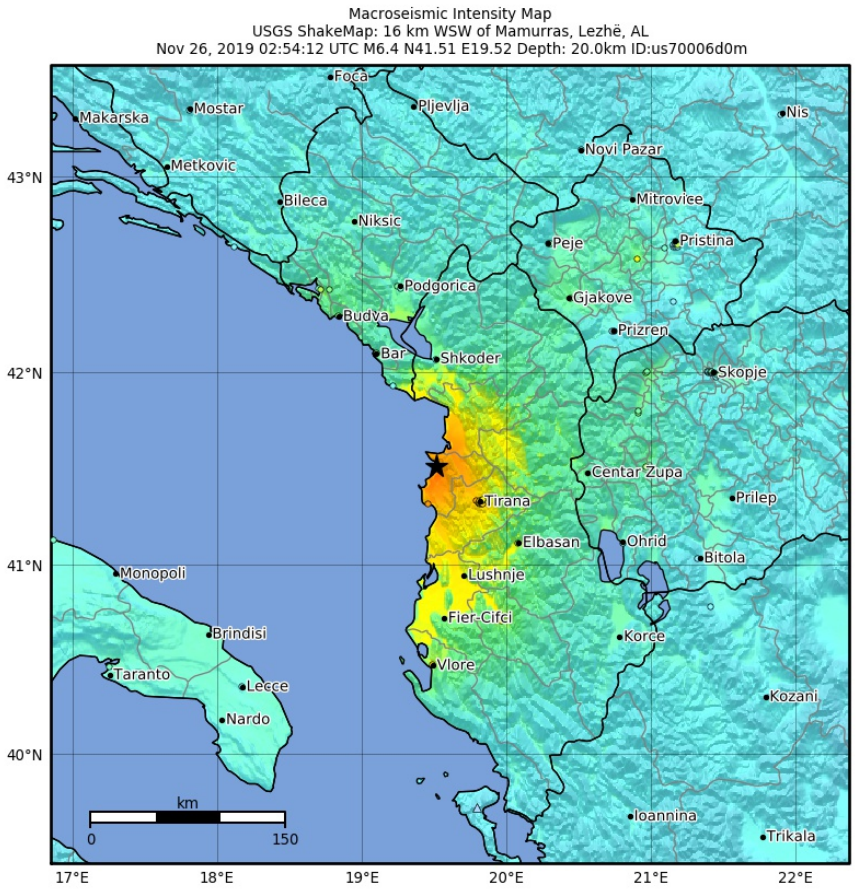




(after Liperovsky et al., 2005)

Shake map (USGS) after the M6.4 of Nov 26, 2019 (left)
Satellite Thermal anomaly (NOAA-18) on Nov 21, 2019 (right) .

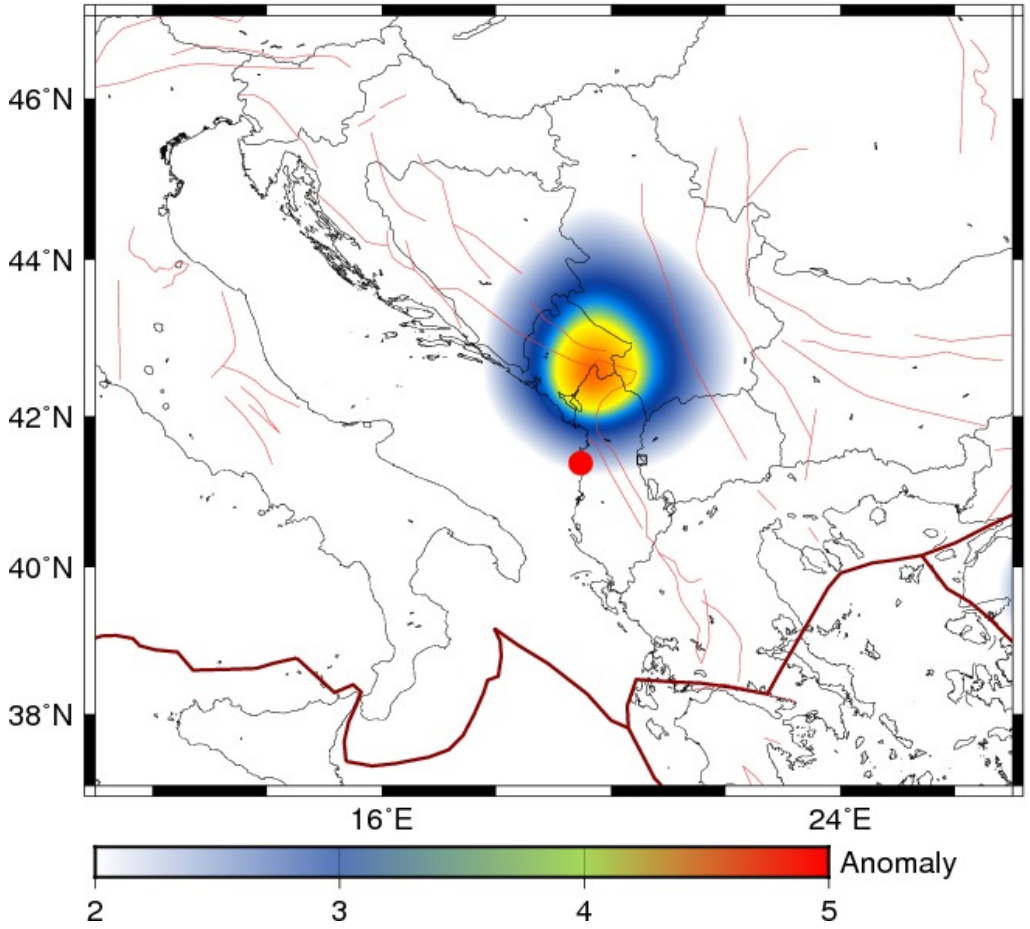
Nov 26, 2019



SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.05	0.3	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.02	0.13	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012) Version 6: Processed 2019-11-28T05:23:22Z
△ Seismic Instrument ○ Reported Intensity ★ Epicenter

Nov 21, 2019



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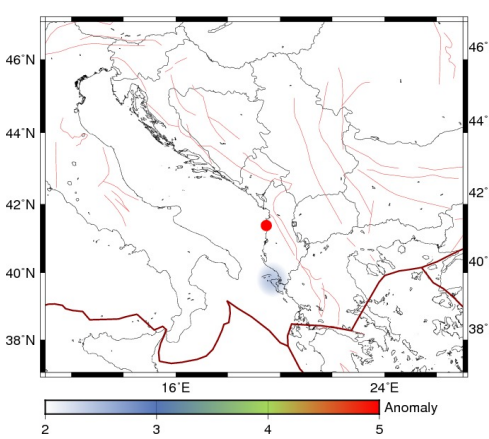
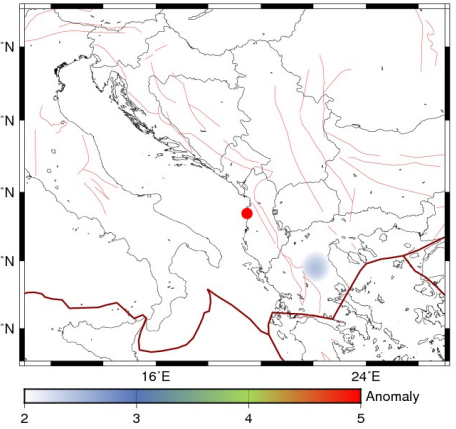
Satellite Thermal observation (NOAA-18) for Nov 18-27 .

An Anomaly was detected on Nov 21 and alarm was issued on Nov 22. M6.4 occurred on Nov 26. 2019

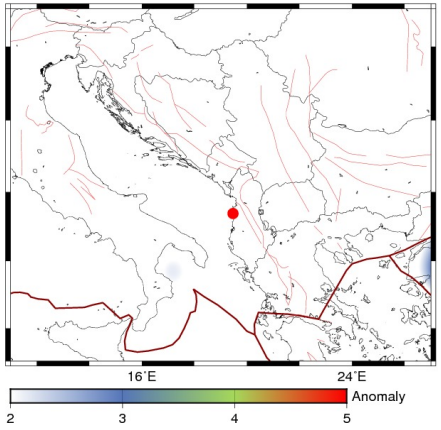
Nov 18, 2019



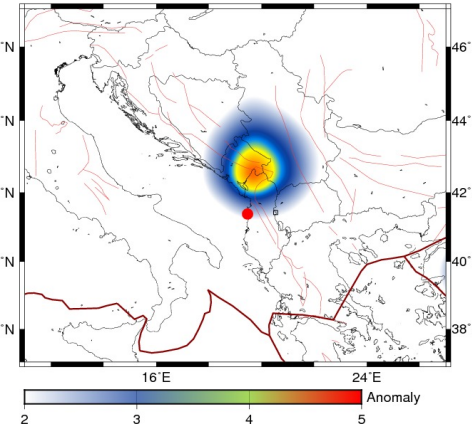
Nov 19, 2019



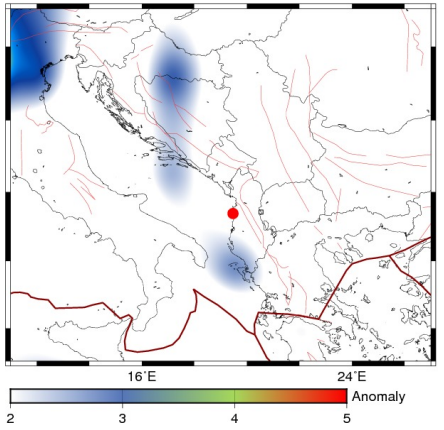
Nov 20, 2019



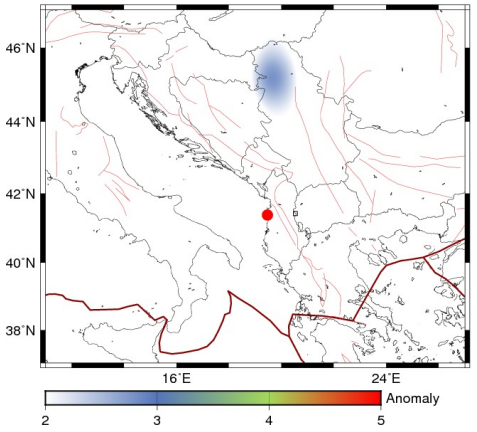
Nov 21, 2019



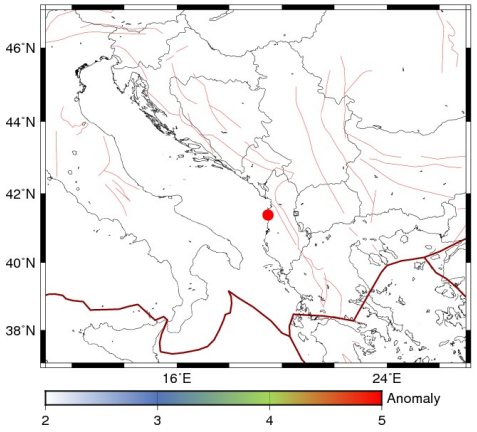
Nov 22, 2019



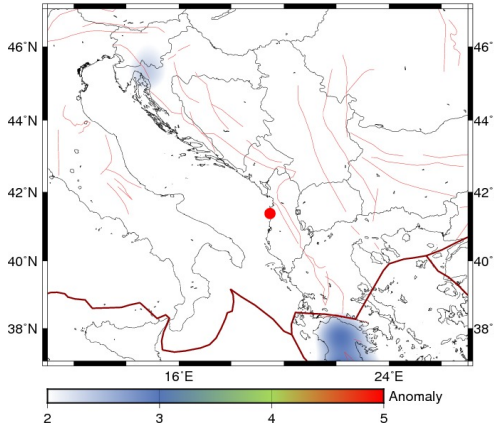
Nov 23, 2019



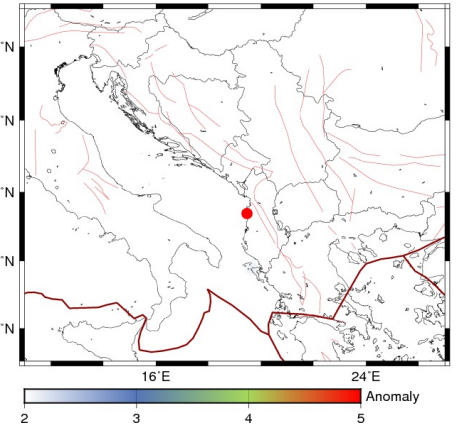
Nov 24, 2019



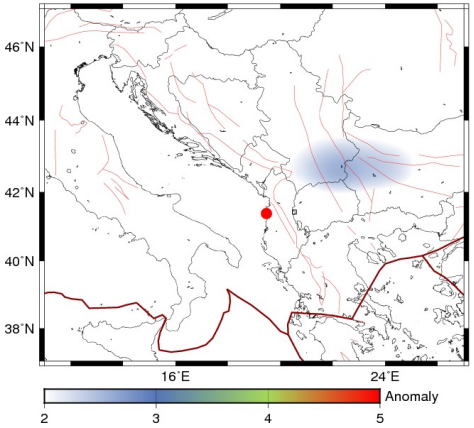
Nov 25, 2019



Nov 26, 2019



Nov 27, 2019



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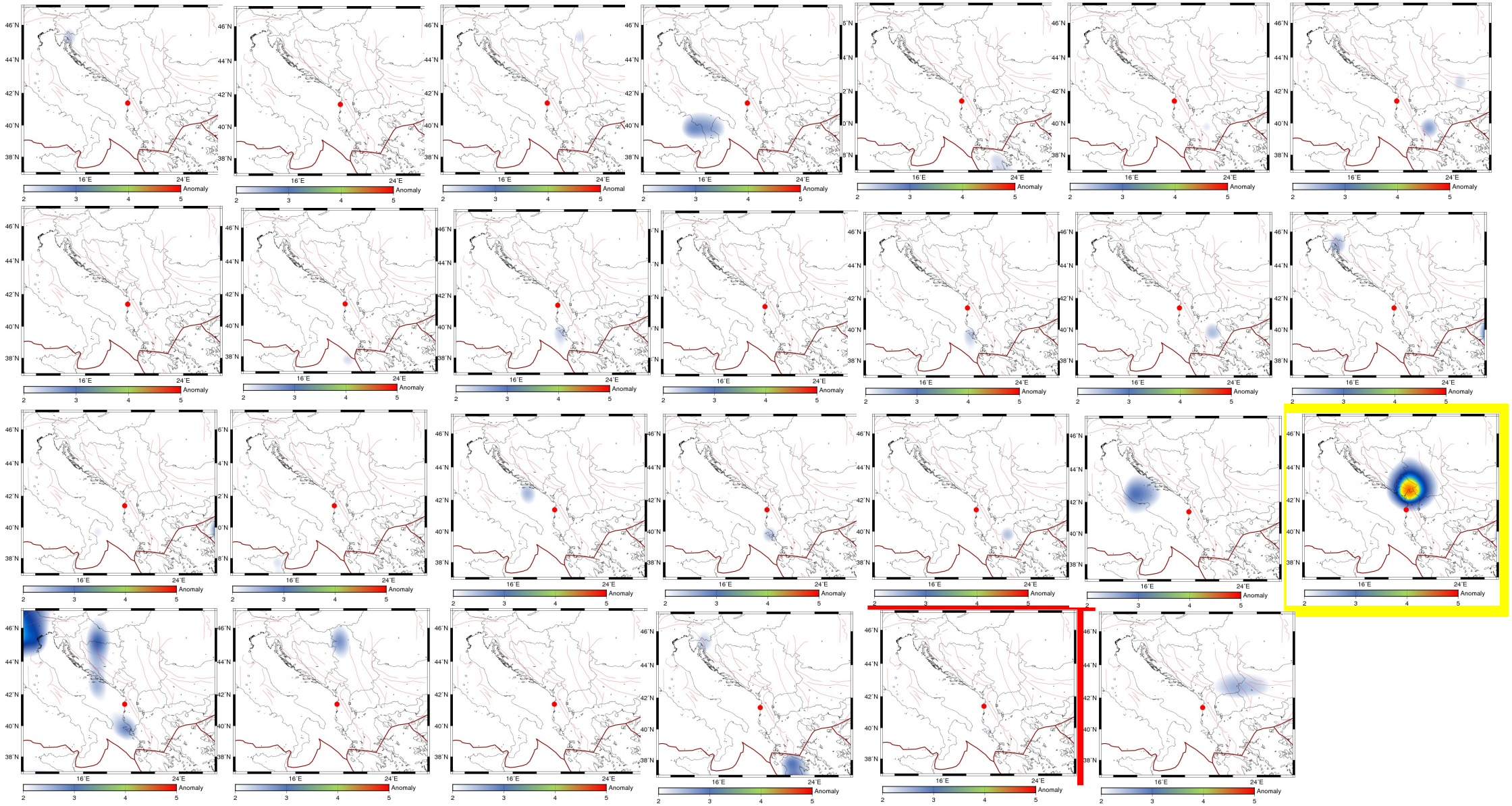
Satellite Thermal observation (NOAA-18) for Nov 1-27 .



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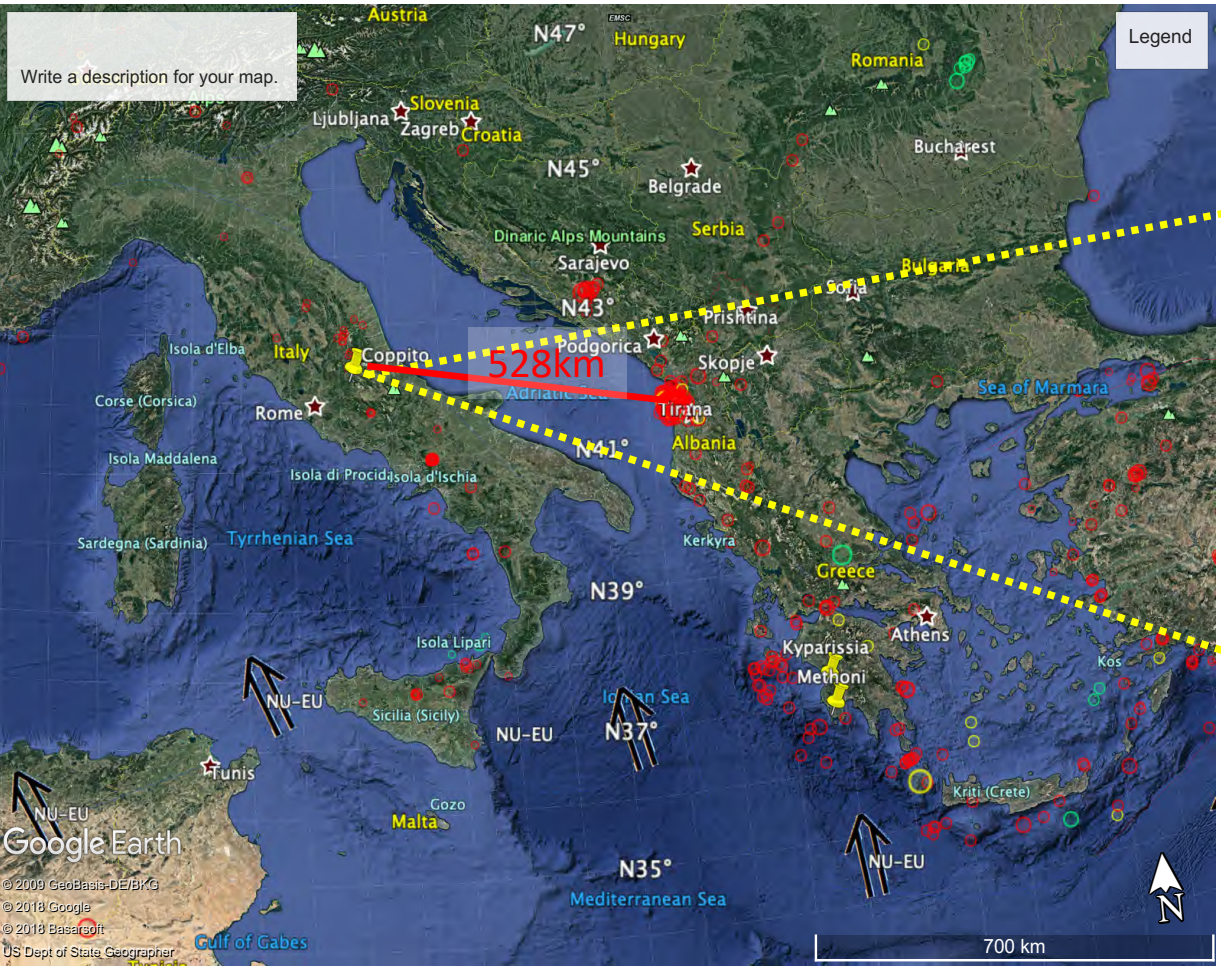
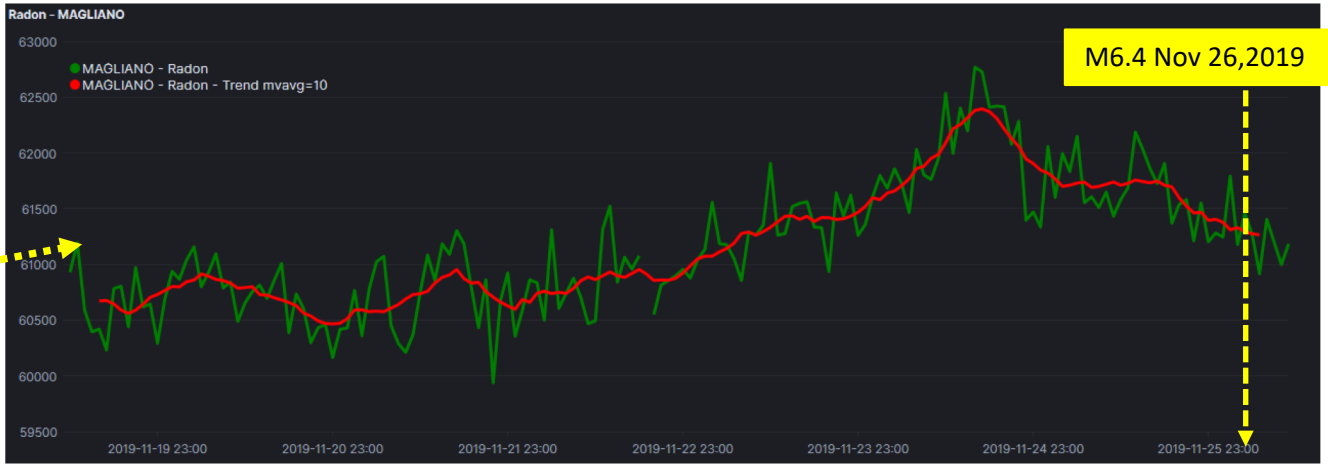
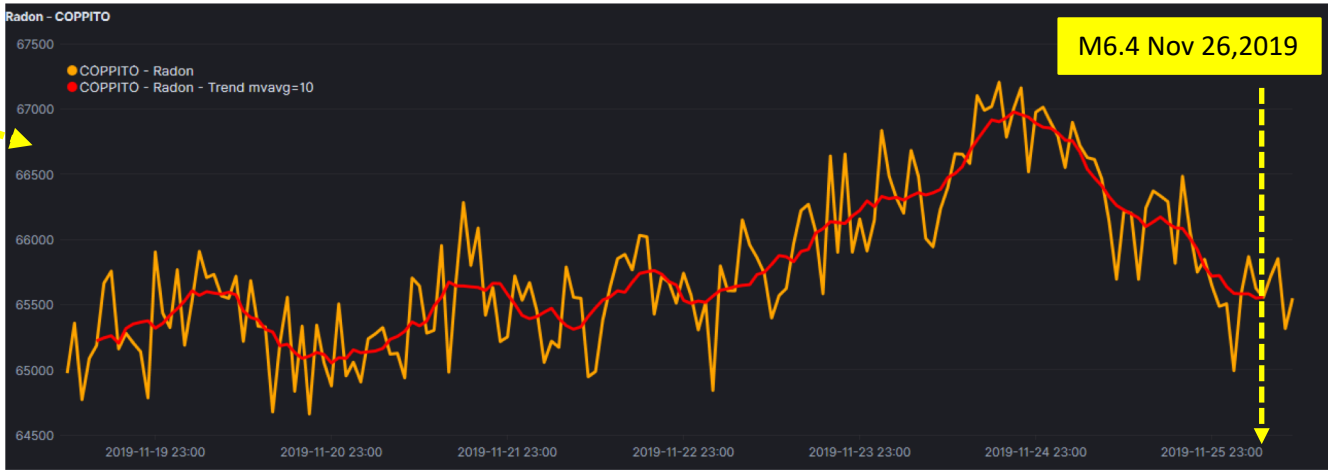
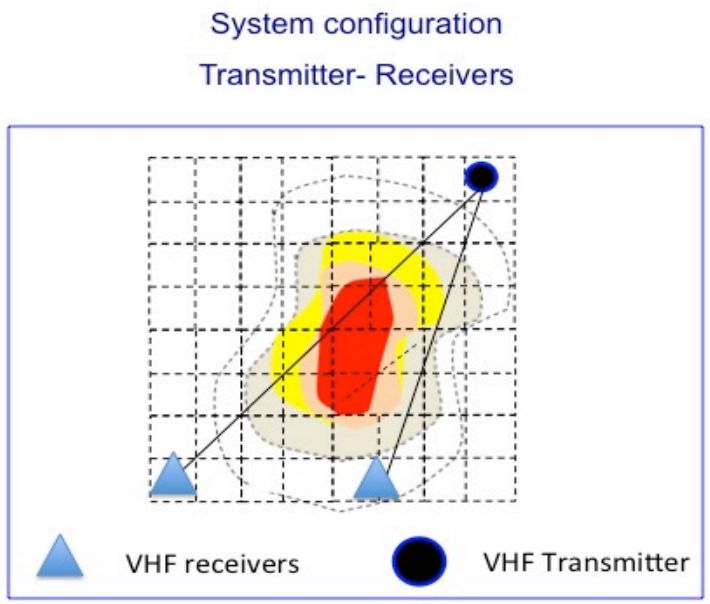
Radon raw data from 2 gamma sensor located in Central Italy at distance of 528 km from the M6.4 in Albania. Data show increase of radon on both stations (distance bwteen 45 km) from Nov 20 up to Nov 25. M6.4 occurred on Nov 26. 2019

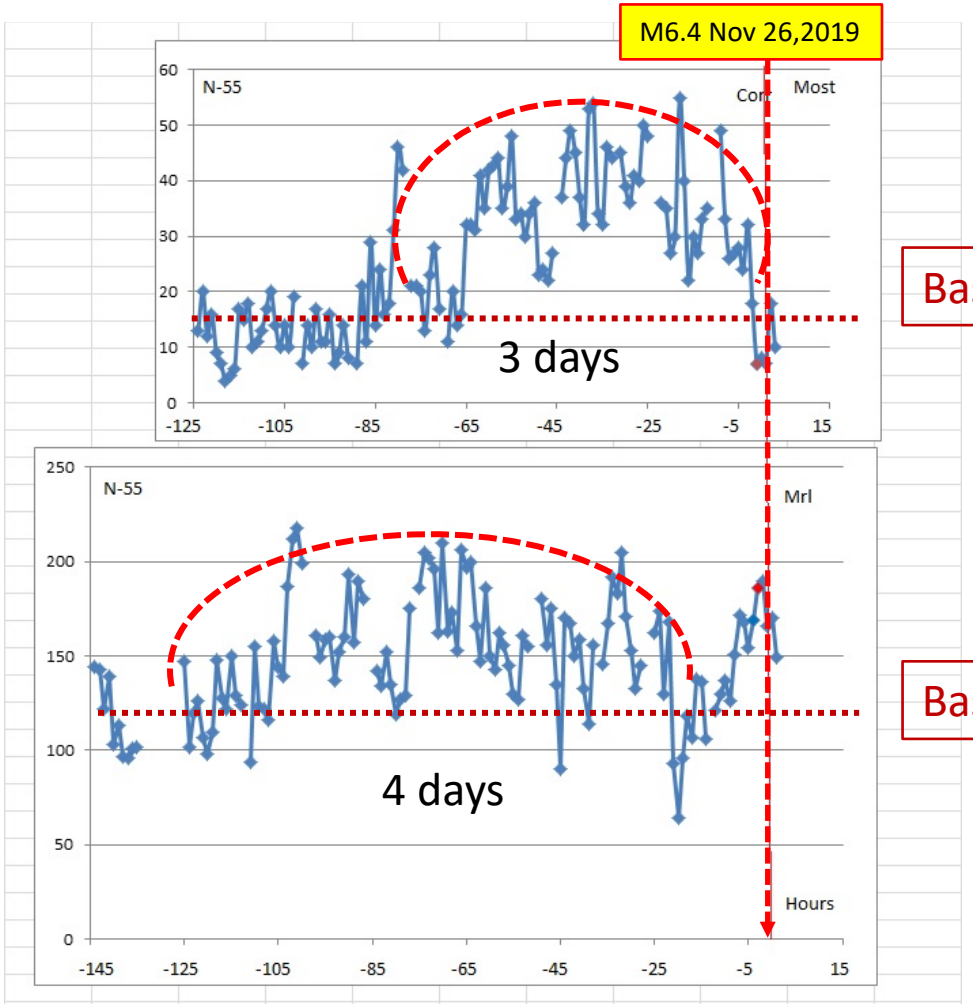






We study atmospheric variations in the intensity of broadband wireless signals propagation correlated with earthquake processes. We maintain observation in range of 1.8 -3.5GHz in two seismic SW Bulgaria. We working with EMC antennas with receiving range 10MHz - 6GHz and real-time processing RF Spectrum Analyzer with Displayed Average Noise Level DANL: -135dBm(1Hz).VHF





Hours before the main shock on 11.26.2019

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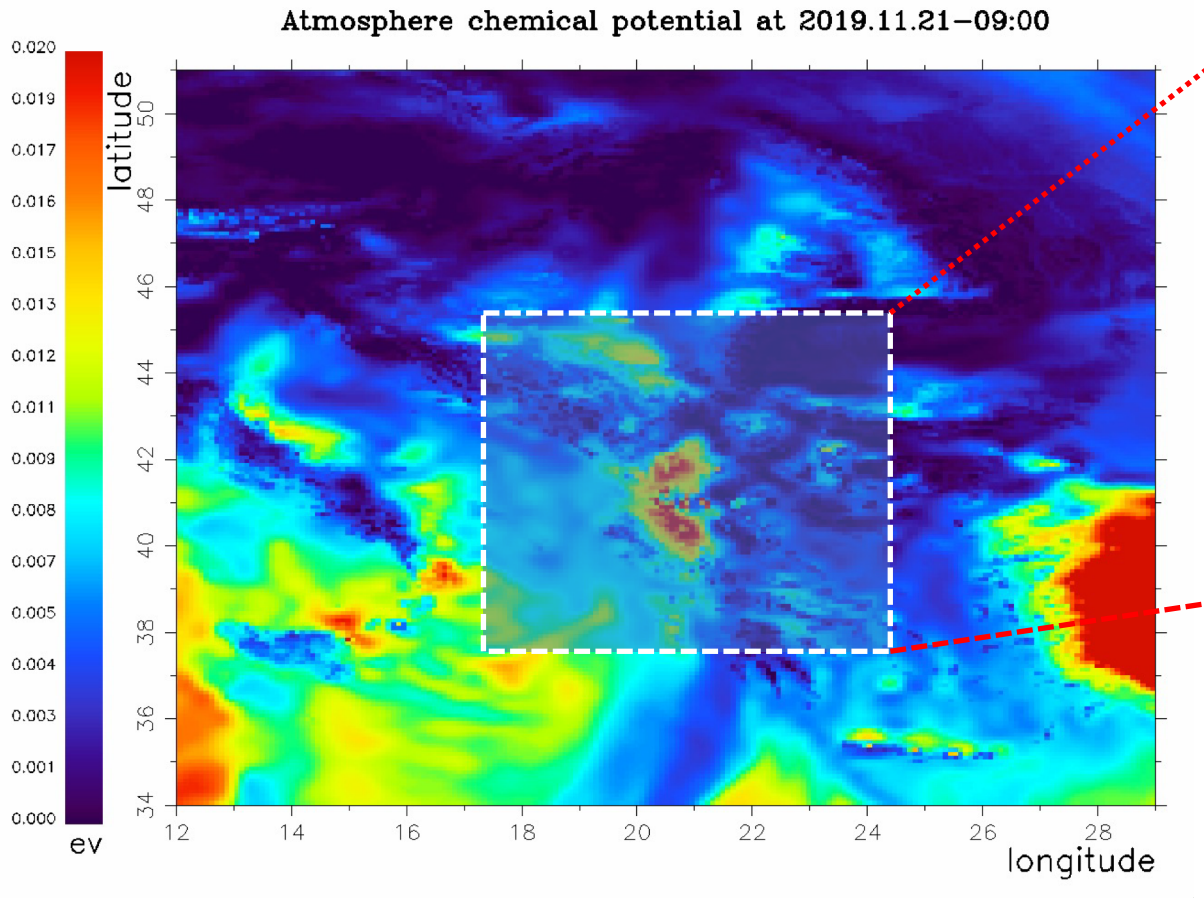
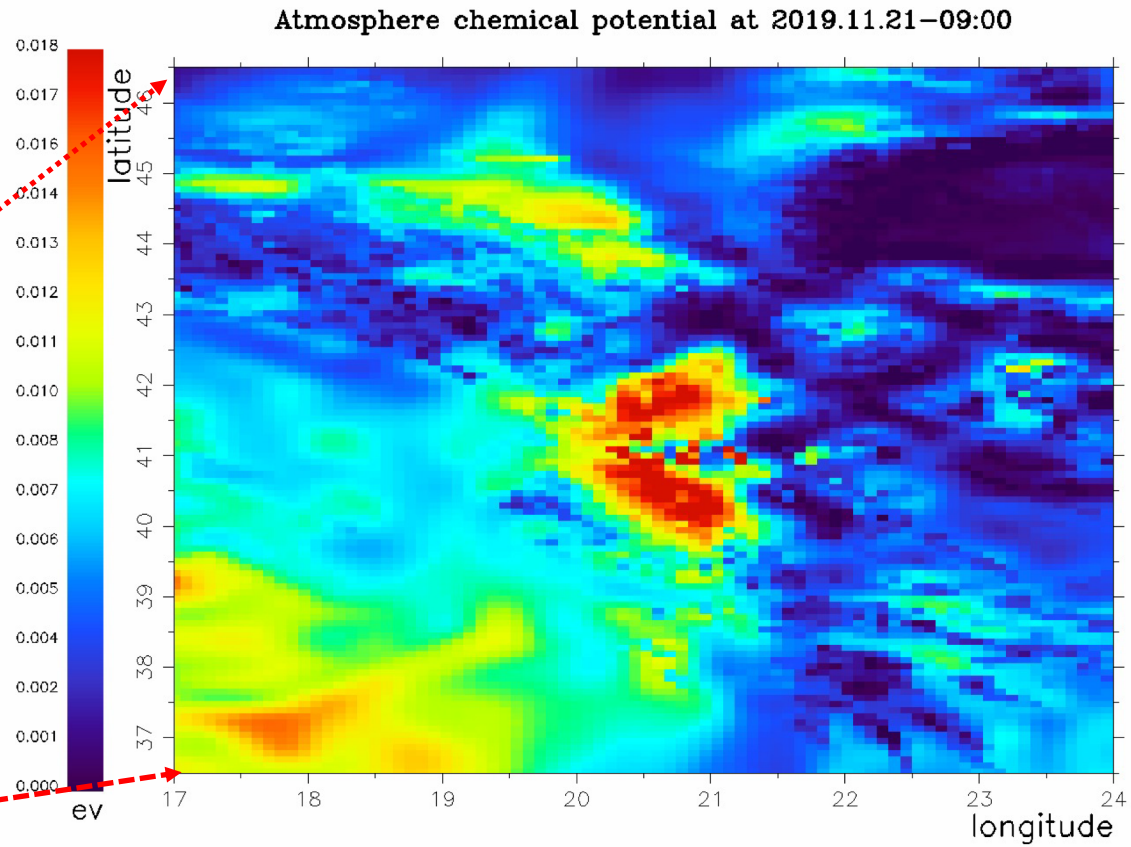
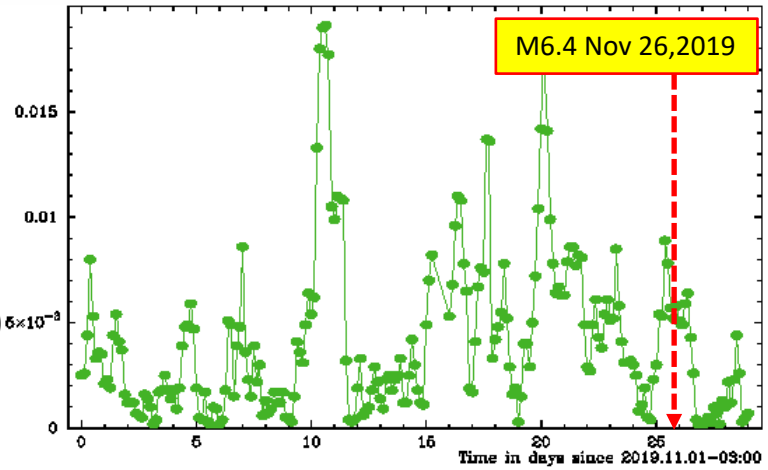
Atmospheric chemical potential map of Nov 21, 2019







Time series of the chemical potential map of for November 1-31-.2019
Over the epicentral area

Points to take home 1/2

- On Nov 21, 2019 our NOAA STA daily analysis over the Mediterranean detected a strong abnormal pattern between Italy and Albania. We estimated that a possible earthquake could occur in the Adriatic Sea between Italy and Albania with M5.5+ and start cross parameter validation with other observations. On Nov 26 an earthquake occurred near STA anomaly of Nov 21.
- The epicenter of the M6.4 earthquake in Albania is situated about 500 kilometers NE of the two-radon monitoring stations in Central Italy. Real-time hourly data show an increase in both sensors on Nov 20 (6 days before the M6.4 of Nov 26, 2019).
- From the satellite data these increases in radon coincide with an increase in the atmospheric chemical potential (on Nov 21), measured near the epicentral area.

Points to take home 2/2

- VHF data observed from two stations located 300 km from the epicenter in Southwest Bulgaria, indicated an intensity modulation about 90 hours (3.5 days) before the mainshock.
- We observed a synergetic abnormal response from ground and satellite data, although the ground data (radon and VHF) sensors were far from the epicenter (500 and 300 km, respectively). Starting six days before the M6.4 Nov 26 earthquake, the anomalous patterns were inside the Dobrovolsky-Bowman area of preparation.
- We examined the possible correlation between different pre-earthquake anomalies and the relationship between magnitude and the spatial size of the preparation zone in the framework of the Lithosphere -Atmosphere - Ionosphere Coupling (LAIC) concept.