


Atmospheric electrical field
suppression in the time of the $M = 4.1$
Sousel earthquake (Portugal)



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Out-line

- Seismic precursors
- Seismo-electromagnetic Phenomena
- Our project
- Sousel Earthquake
- Atmospheric electric field
- Model
- AEF in Lisbon (future work)
- Conclusions



Seismic precursors

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Predicting the unpredictable; evidence of pre-seismic anticipatory behaviour in the common toad

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GEOPHYSICAL RESEARCH LETTERS, VOL. 29, NO. 17, 1824, doi:10.1029/2002GL015116, 2002

Coseismic hydrological changes associated with dislocation of the September 21, 1999 Chichi earthquake, Taiwan

Survey, MOEA, Taiwan, R.O.C.



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Preseismic changes in atmospheric radon concentration and crustal strain

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GEOPHYSICAL RESEARCH LETTERS, VOL. 17, NO. 9, PAGES 1465-1468, AUGUST 1990

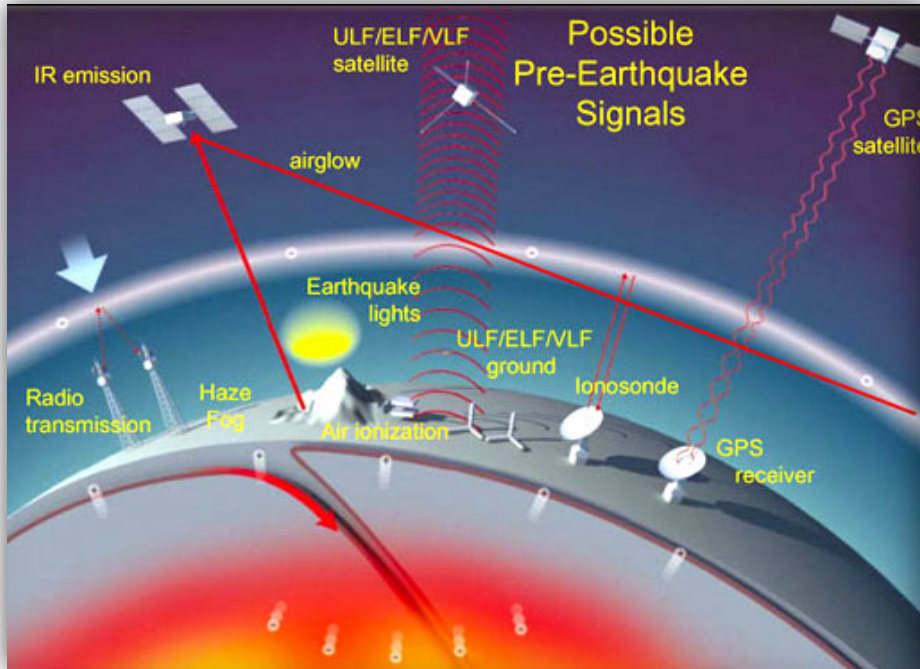
LOW-FREQUENCY MAGNETIC FIELD MEASUREMENTS NEAR THE EPICENTER OF THE M_S 7.1 LOMA PRIETA EARTHQUAKE

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M. E. Ladd, R. A. Helliwell, and O. G. Villard, Jr.

STAR Laboratory, Stanford University



SEM Phenomena



Extrated from <http://www.quakefinder.com/>

- Anomalous electrical signals,
- Abnormal ultra-low frequency EM emissions,
- Anomalies in very-low and low frequency radio transmissions,
- Variation of the total electron content in the ionosphere,
- Atypical IR emissions.

All these phenomena are correlated with the preparatory phase of earthquakes.



Our project

Atmospheric electric field sensor.



Radio receiver for very low and low frequencies.



Magnetometers for ultra-low frequencies (planned).



Meter of atmospheric Radon levels (in installation).



Our project

Seismo-electromagnetic phenomena in the western part of the Eurasia-Nubia plate boundary

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Nat. Hazards Earth Syst. Sci., 11, 241–248, 2011
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doi:10.5194/nhess-11-241-2011
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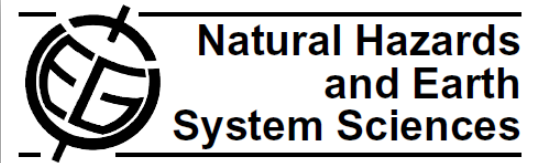
The European VLF/LF radio network to search for earthquake precursors: setting up and natural/man-made disturbances

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Nat. Hazards Earth Syst. Sci., 11, 987–991, 2011
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Atmospheric electrical field decrease during the $M = 4.1$ Sousel earthquake (Portugal)

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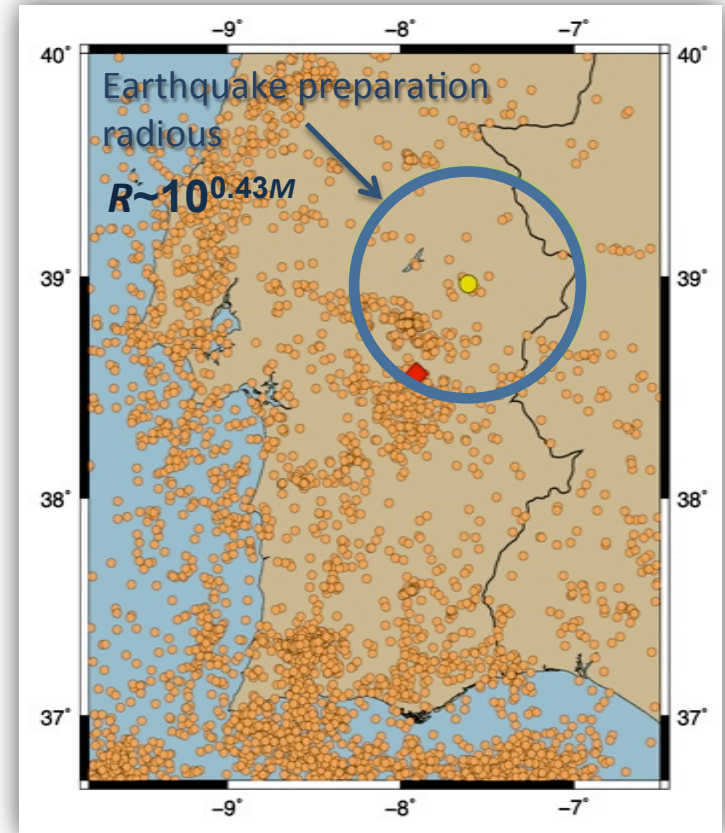
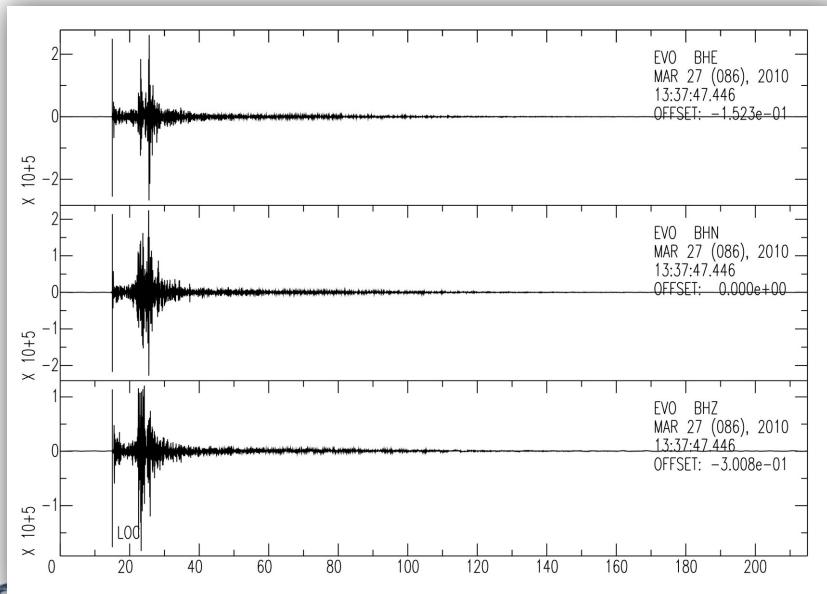


We Integrate the
European INFREP
network



Sousel Earthquake

The earthquake in the study occurred March 27, 2010 in Sousel (Alentejo, Portugal) with epicenter at $38^{\circ}58'12''\text{N}$, $7^{\circ}36'36''\text{W}$, at a depth of 15 km and with a magnitude of $M_L = 4.1$ (IM database).



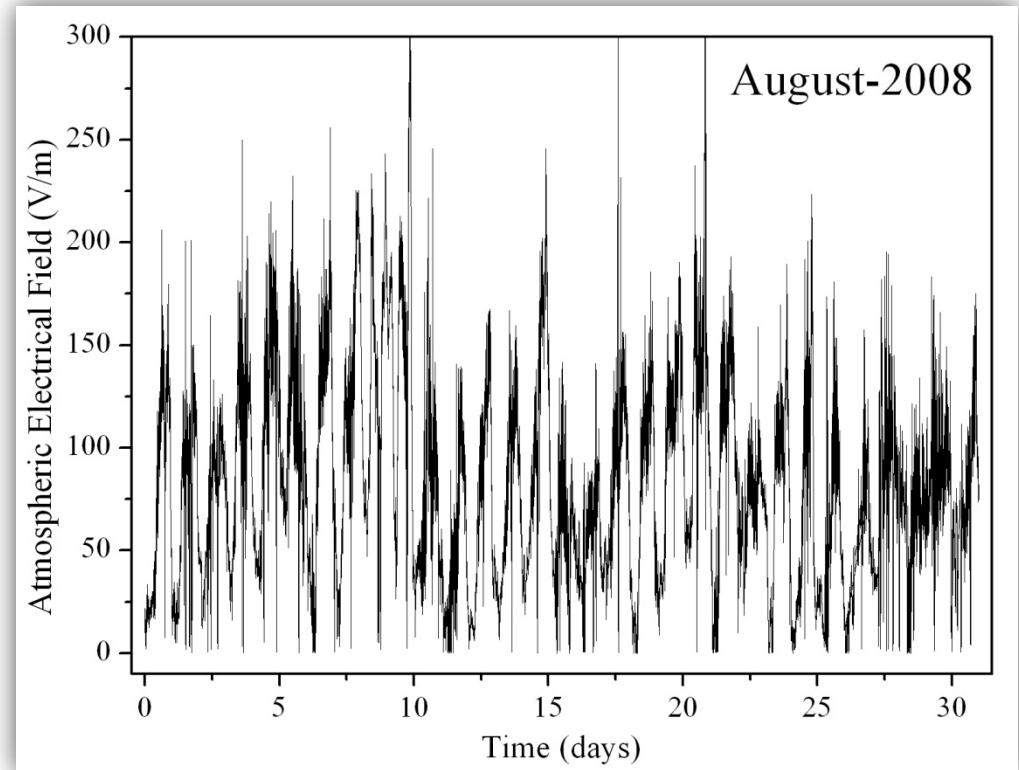
The electric field sensor was placed ~ 52 km from the epicentre of the earthquake and within the earthquake preparation zone.



Atmospheric electric field

The electric field sensor is a Keithley electrometer model of JCI 131 installed at the University of Évora. This equipment is in operation since February 2005 to date.

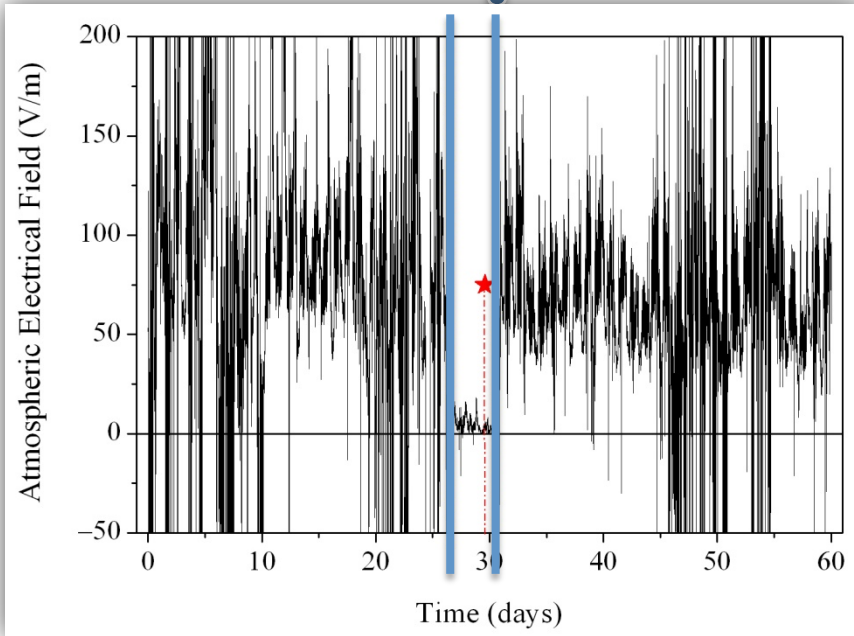
In this study we concentrate on the period from January 2007 until December 2010.



Usual atmospheric electric field.



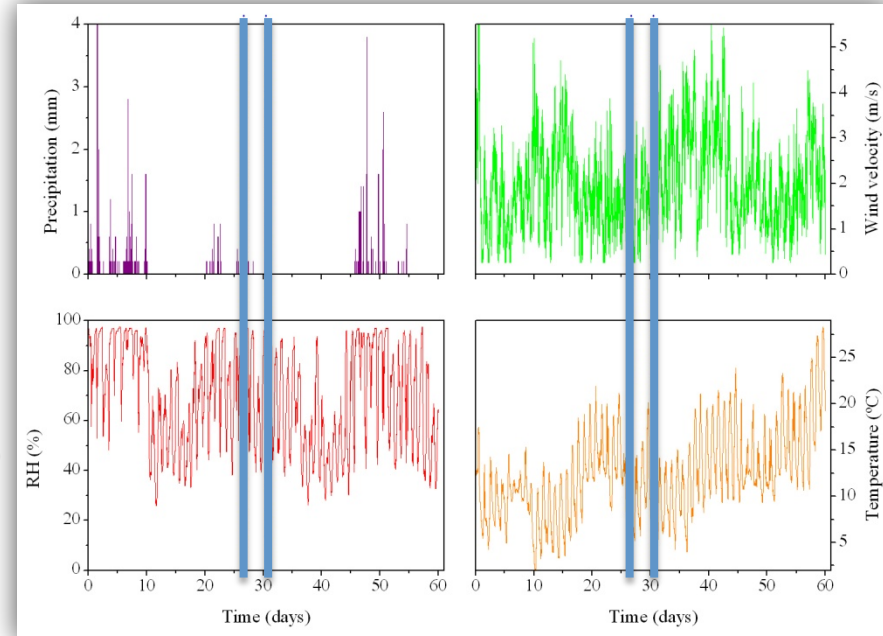
Atmospheric electric field



No human disturbance or malfunction of equipment were found.

Weather conditions during the two months that the earthquake occurred. The blue lines indicate the duration of the decrease of atmospheric electric field.

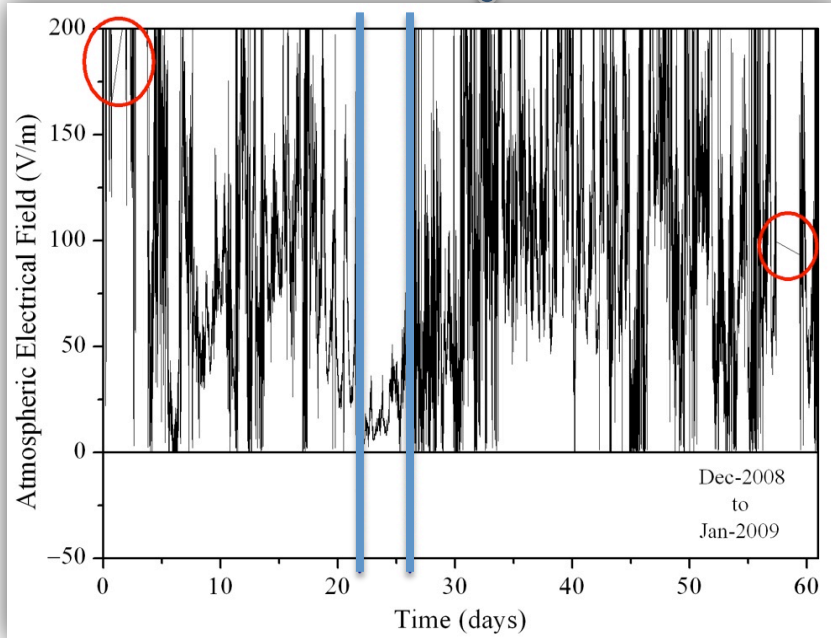
Atmospheric electric field from 27 to 27-February-April 2010. The earthquake is marked with a red star. The blue line indicates the duration of the reduction.



The weather conditions fit into "fair weather".



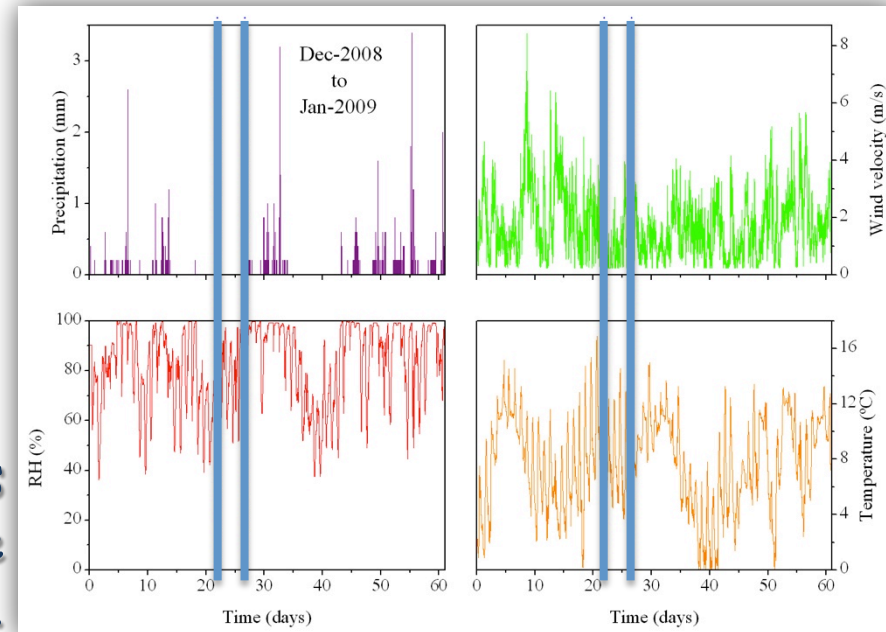
Atmospheric electric field



Atmospheric electric field from 01/12/2008 until 01/31/2009 in which there was a decrease in the atmospheric electric field. The red circles indicate malfunctions of the instrument.

For this event no significant seismic activity occurred in the region.

Weather conditions during the period from 01/12/2008 to 31/01/2009.



The weather conditions were similar to the Sousel earthquake.



Model

$$J_c = \sigma E$$



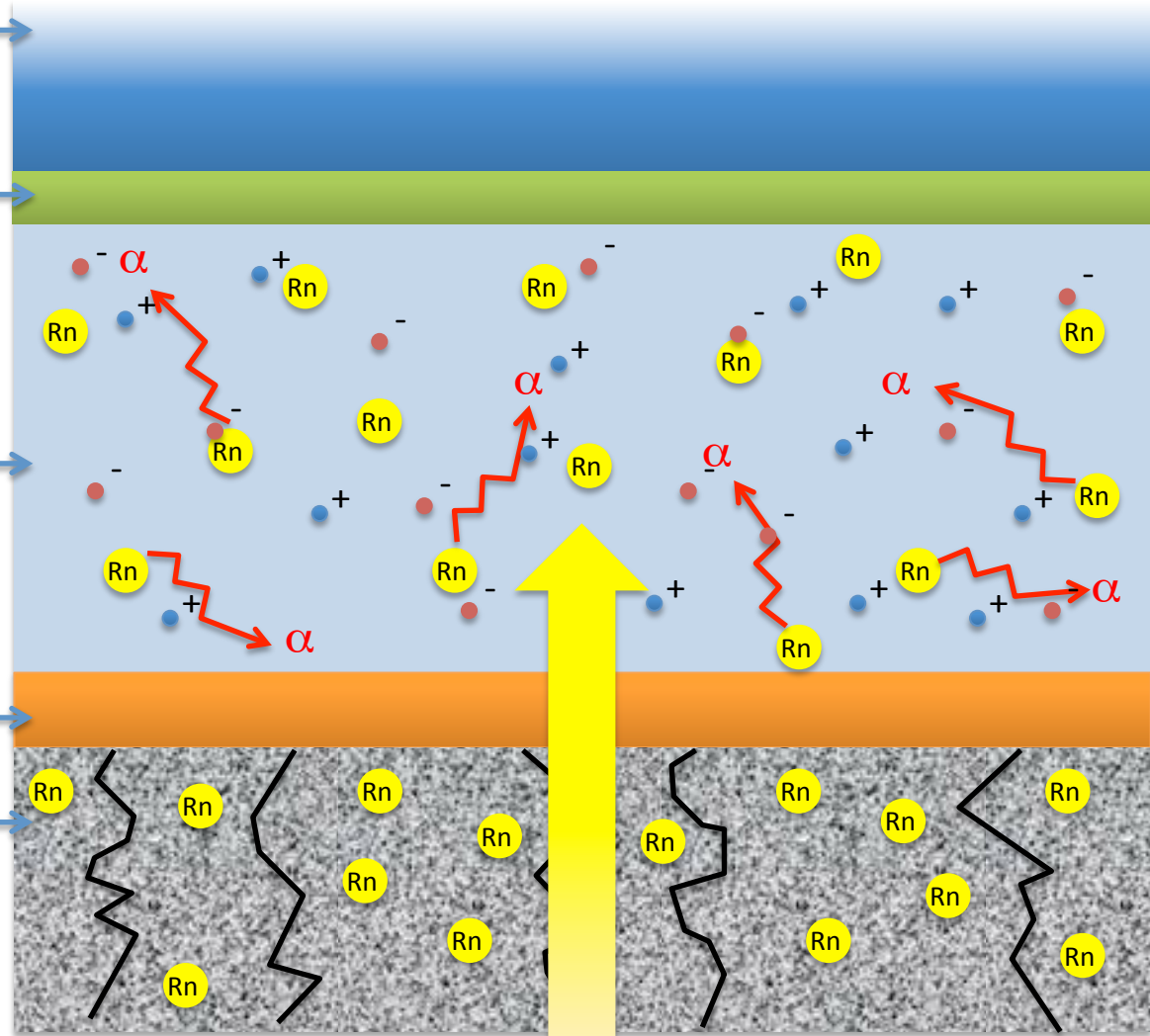
Ionosphere

Surface layer

Lower atmosphere

Permeable soil

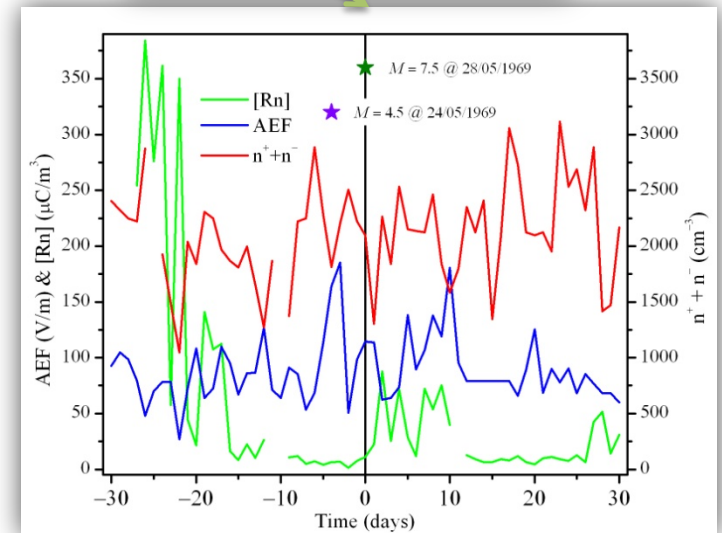
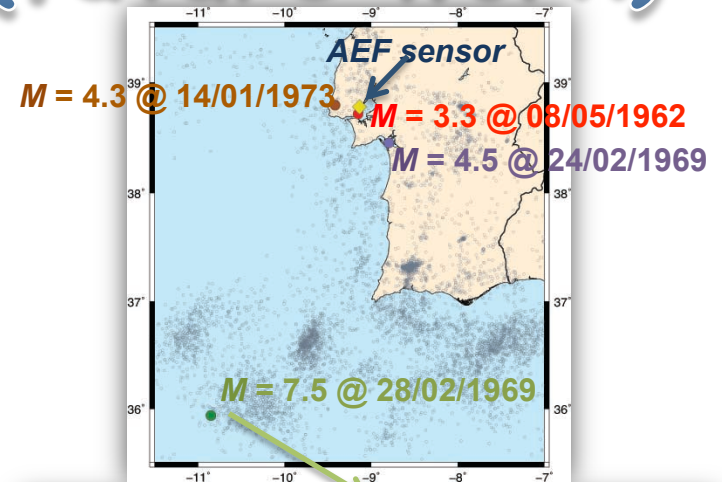
Lithosphere



AEF in Lisbon (future work)

We are also studying the AEF data from Lisbon station in the period of 1961 until 1991.

Day	Hour (days)	Depth (km)	Mag	R (km)	D (km)
08/05/1962	0.625	-	3.3	26.24	6.31
15/03/1964	0.938	10	6.2	463.45	319.06
31/03/1964	0.624	-	2.7	14.49	6.63
26/08/1966	0.248	10	4.6	95.06	87.70
24/02/1967	0.926	2	4.3	70.63	65.62
04/10/1967	0.104	13	4.3	70.63	56.34
24/02/1969	0.511	-	4.5	86.10	45.42
28/02/1969	0.111	10	7.5	1678.80	349.92
14/01/1973	0.853	2	4.3	70.63	25.08
29/06/1973	0.665	21	3.7	38.99	29.65
26/05/1975	0.383	10	8.1	3040.89	828.84
09/01/1987	0.025	9	2.0	7.24	4.31
22/05/1988	0.583	8	3.7	38.99	32.37



A significant increase of the Rn levels occur ~25 days before the $M = 7.5$ earthquake (that rapidly decays). The total ion concentration has a peak nearly 7 days before this EQ. The AEF sharply increases approximately 5 days before the seismic event.

Conclusions

- This study provides the first clear evidence of a significant reduction of the vertical component of atmospheric electric field in the preparatory phase of a seismic event.
- These observations support the idea that the radon emanations are the mechanism behind this decrease.
- Additional work is needed to confirm this hypothesis, in particular, the systematic measurement of radon levels is essential.
- The installation of new atmospheric electric field sensors, magnetometers, and radon detectors in seismic regions (evaluation of multiple parameters) is another step in the project.

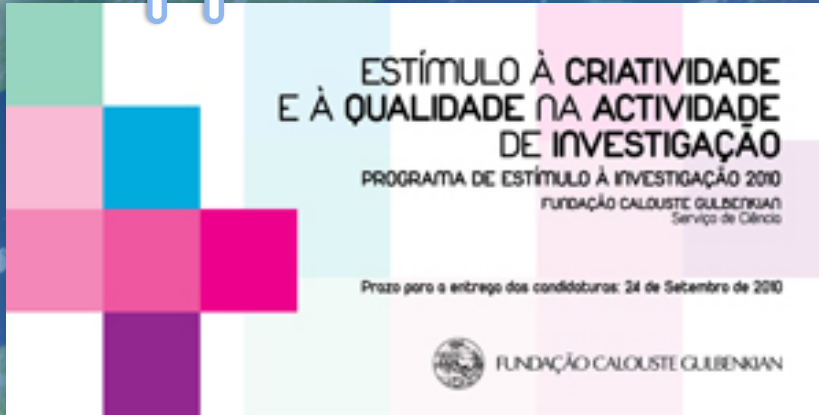


Acknowledgement

Team



Support



Colaborations



Thank you
very much
for your
attention!