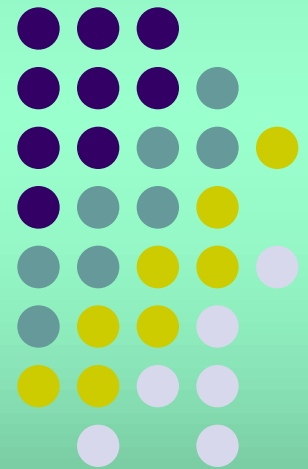


# ΕΜΒΙΟ- ΗΛΕΚΤΡΟΜΑΓΝΗΤΙΣΜΟΣ

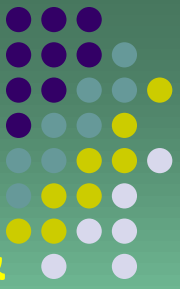
## Μάθημα 5<sup>ο</sup>

Ηλεκτρομαγνητισμός  
στον ανθρώπινο οργανισμό-

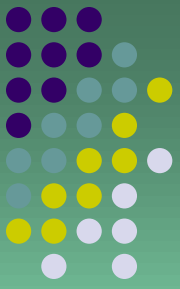
Σεισμοί και μεταβολές στην  
ψυχική υγεία



# Θέματα της Παρουσίασης



- **Εισαγωγή: Γιατί μελετούμε την συσχέτιση σεισμικότητας & ψυχικής υγείας; (Μικρή προ-ιστορία της έρευνας ΔΠΘ-ΠΚ / σύντομη βιβλιογραφία)**
- Διαφορετική επίδραση των **μεγάλων & μικρών** σεισμών
- Διαφορετική επίδραση της σεισμικότητας σε **διαφορετικές** ψυχικές ασθένειες / διαταραχές
- **Γεωγραφική** Σύγκριση Εισαγωγών – ομάδα ελέγχου
- Δορυφορική **Παρατηρησιακή** ένδειξη της επίδρασης της σεισμογενούς Η/Μ ULF (Ultra Low Frequency) ακτινοβολίας σε Ψ/Χ διαταραχές
- Ηλεκτρομαγνητική **προστασία**

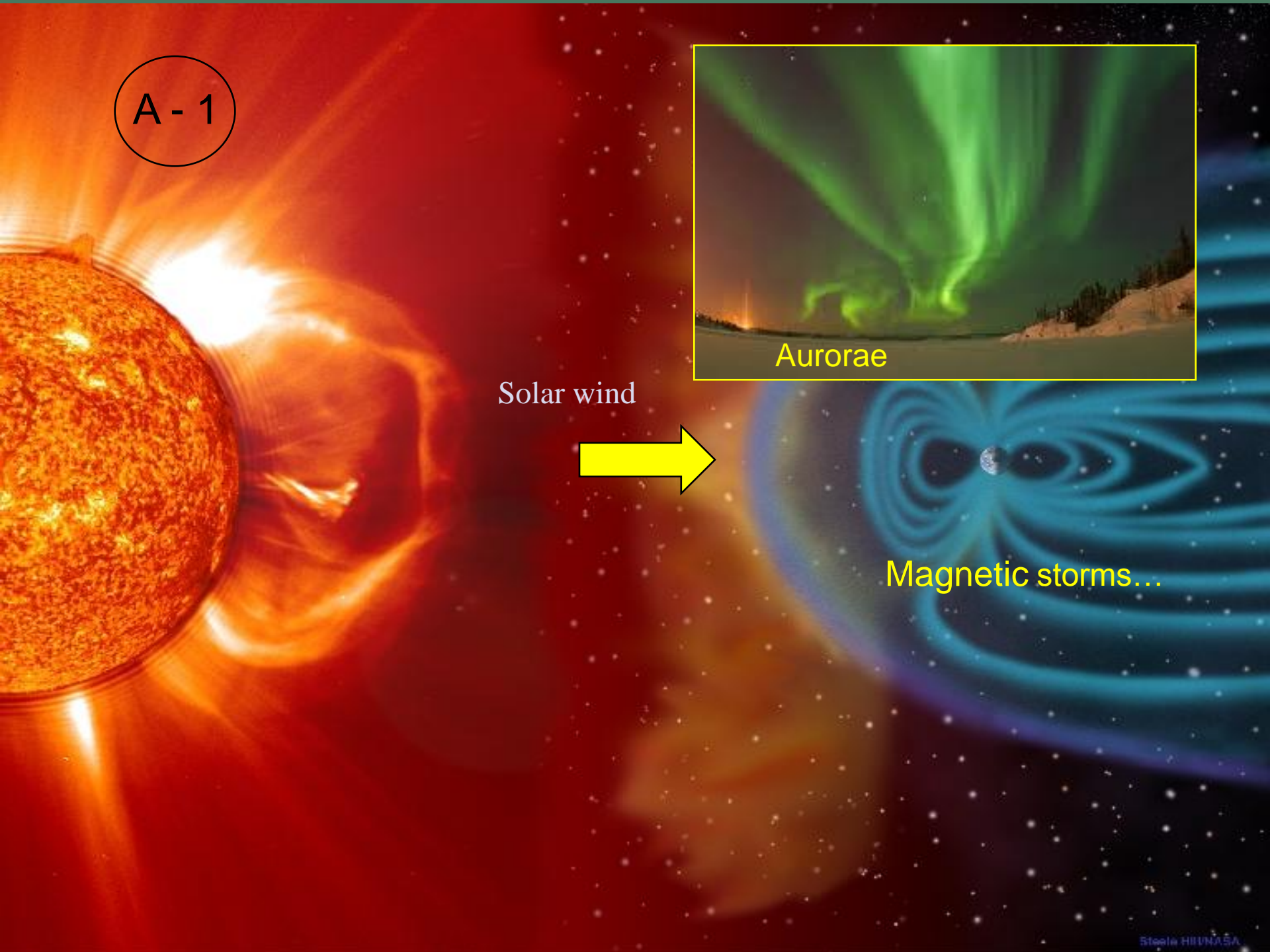


## **A. Εισαγωγή**

**Γιατί μελετούμε την συσχέτιση **σεισμικότητας & ψυχικής υγείας;****

***Μικρή ιστορία της πηγής έρευνας ΔΠΘ-ΠΚ***

A - 1



Solar wind

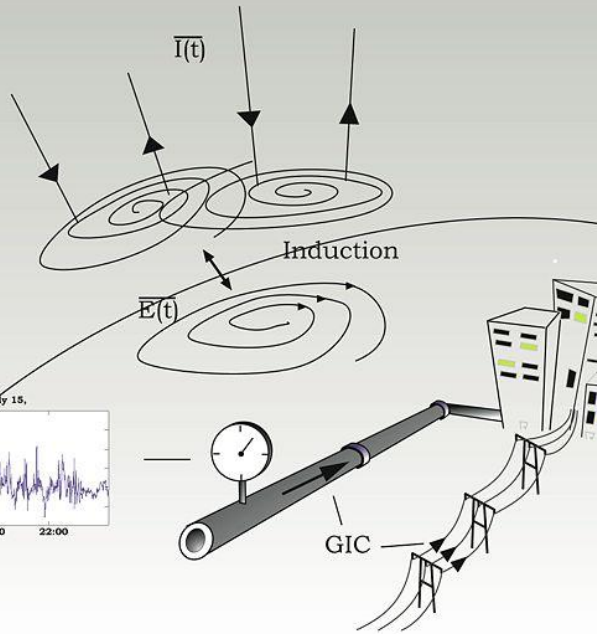
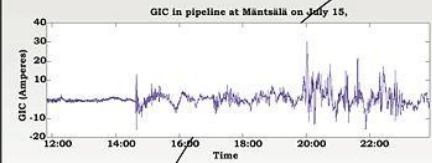


Aurorae

Magnetic storms...

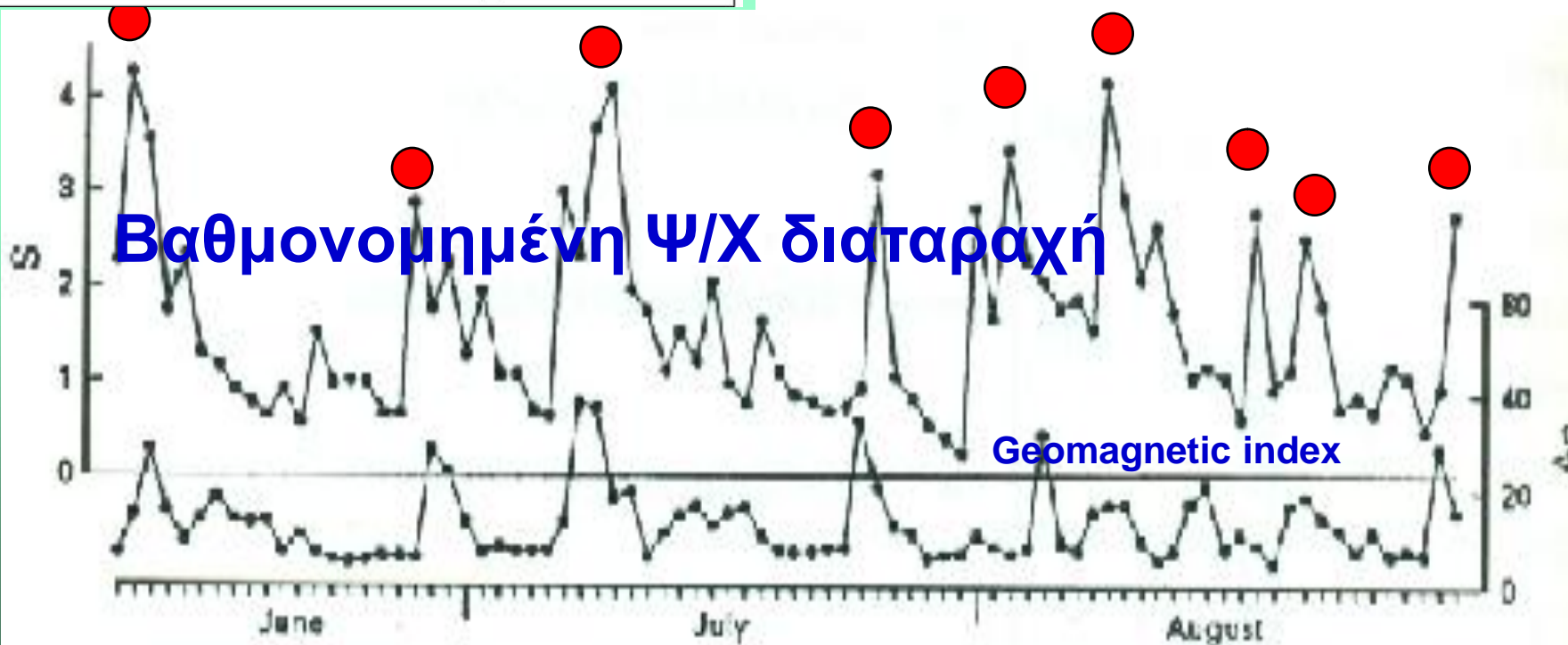
schizophrenia, bipolar disorders, multiple sclerosis (*Torrey et al. 1997*).

Parkinson's disease, mental-behavioral illnesses and probably human lifespan (*Cornelissen et al. 2002*).



Induced EMF

the area ( $\theta = 0$ ), then flux is high. Each turn in the coil ( $n$ ) adds more area.



A - 2



# E/M methods like Transcranial Magnetic Stimulation for depression therapy...

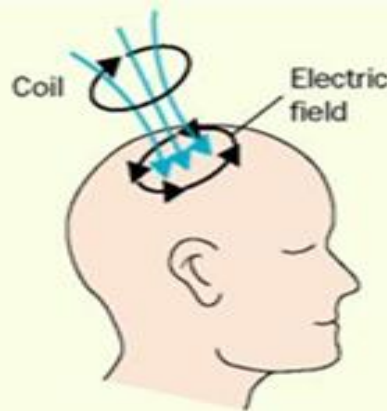
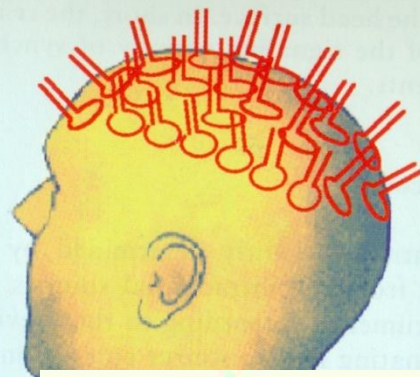


Fig. 17.

Motor response

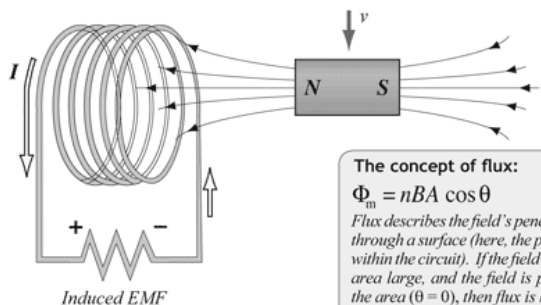


Physics • ELECTROMAGNETIC INDUCTION • XVIII.i • Faraday's and Lenz's Laws [379]

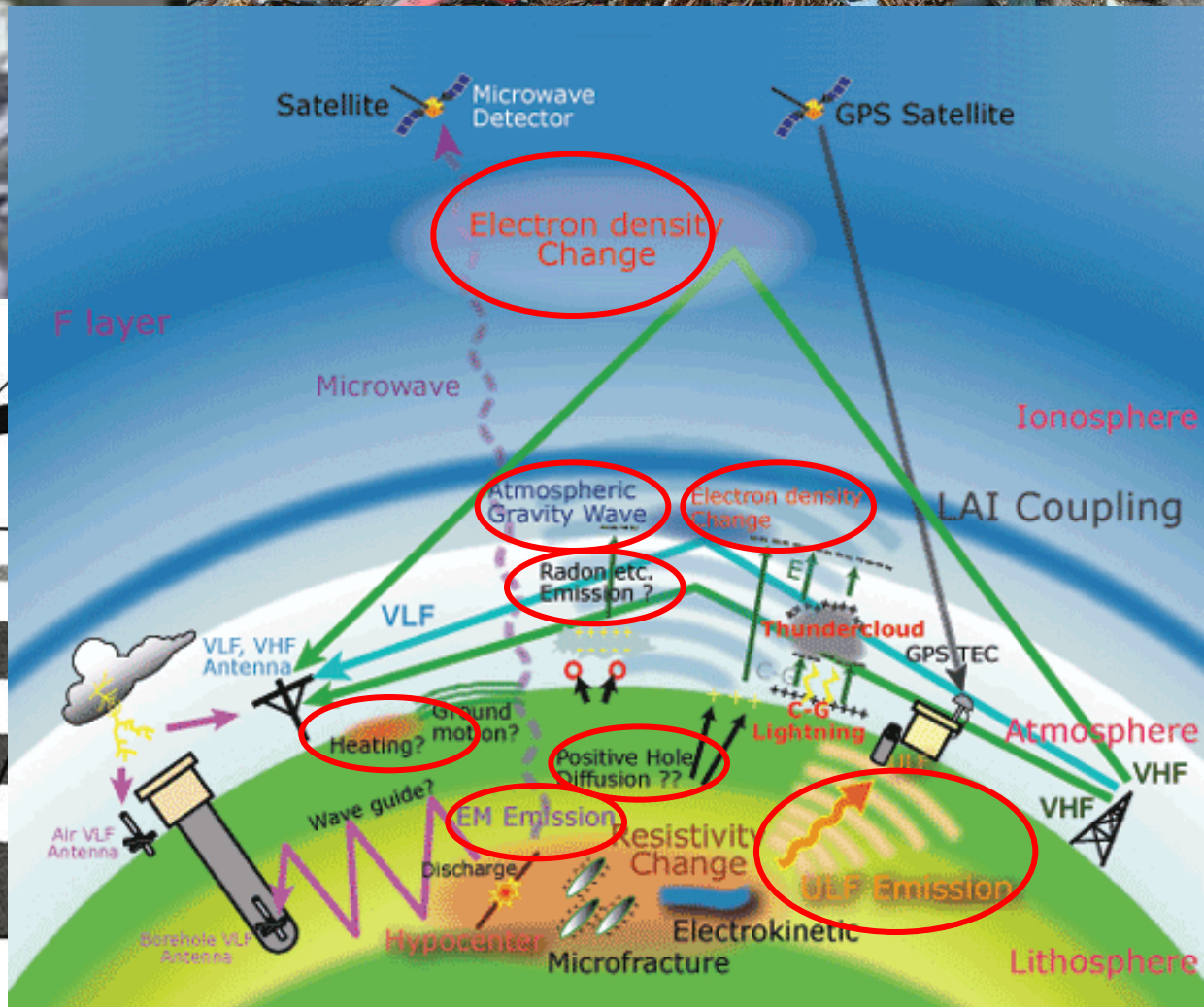
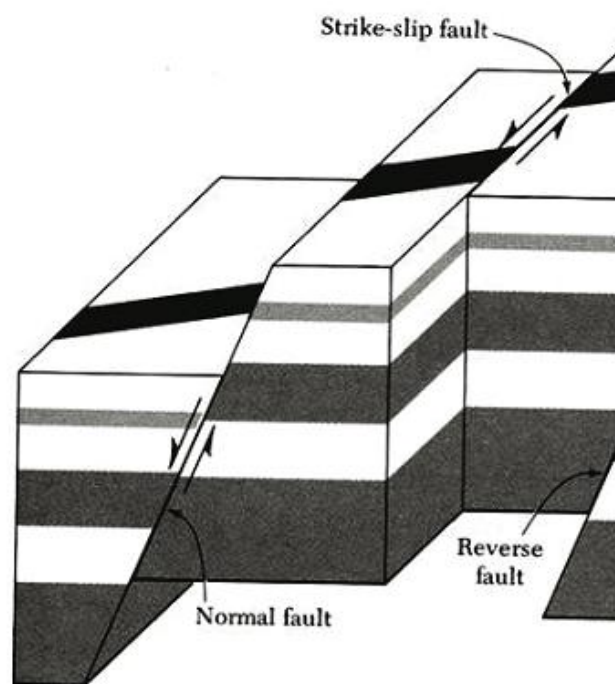
## Faraday's Law

$$\mathcal{E} = - \frac{\Delta\Phi_m}{\Delta t}$$

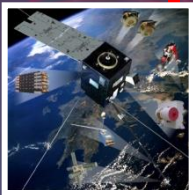
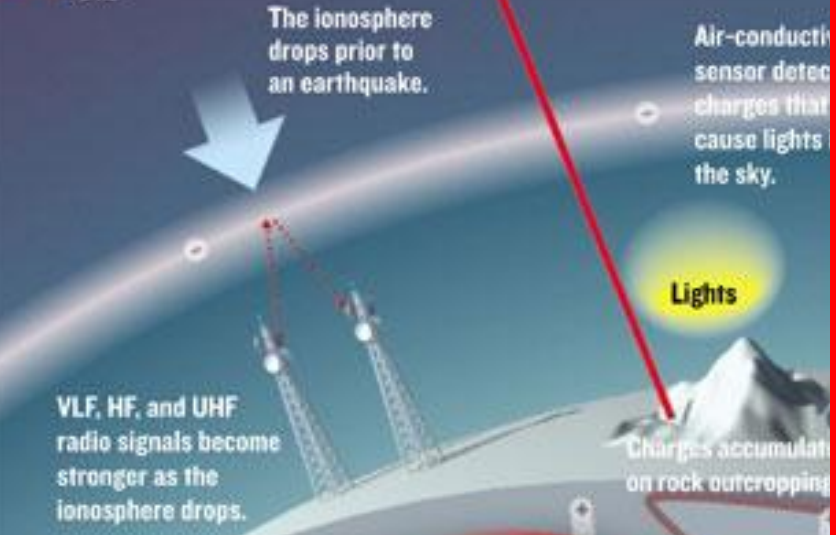
$\mathcal{E}$  = induced emf  
 $\frac{\Delta\Phi_m}{\Delta t}$  = rate of change of magnetic flux through the circuit



**The concept of flux:**  
 $\Phi_m = nBA \cos \theta$   
 Flux describes the field's penetration (or flow) through a surface (here, the plane of the loops within the circuit). If the field is strong and the area large, and the field is perpendicular to the area ( $\theta = 0$ ), then flux is high. Each turn in the coil ( $n$ ) adds more area.

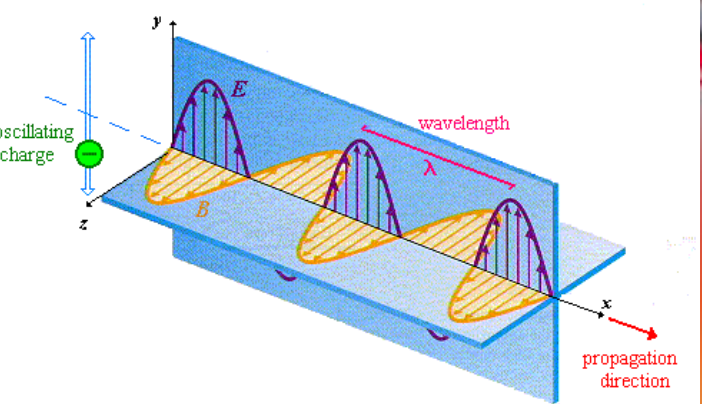
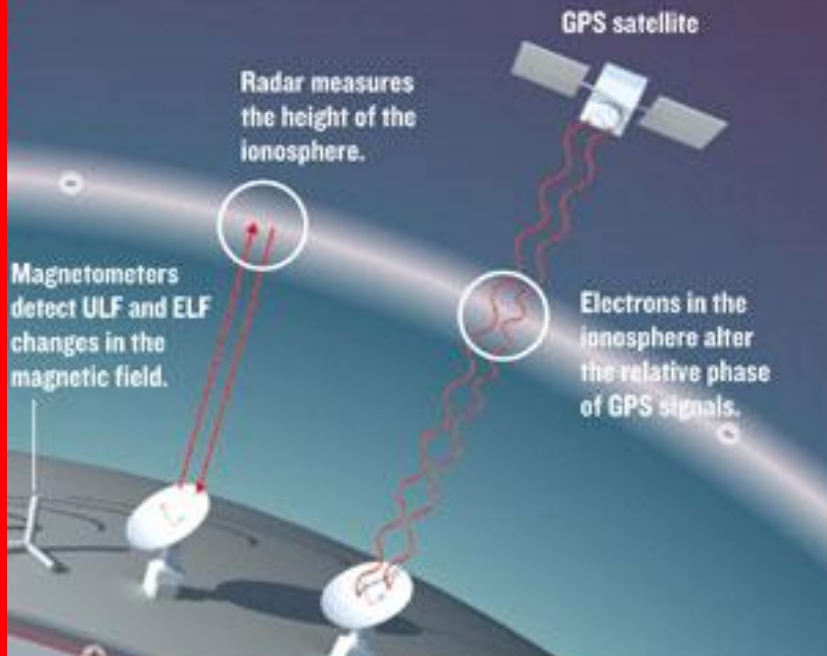


|     |         |
|-----|---------|
| UHF | 3 GHz   |
| VHF | 300 MHz |
| HF  | 30 MHz  |
| MF  | 3 MHz   |
| LF  | 300 kHz |
| VLF | 30 kHz  |
| VF  | 3 kHz   |
| ELF | 300 Hz  |
| ULF | 30 Hz   |
|     | 0 Hz    |



DEMETER, COSMOS 1809, and QuakeSat satellites sense ELF magnetic disturbances.

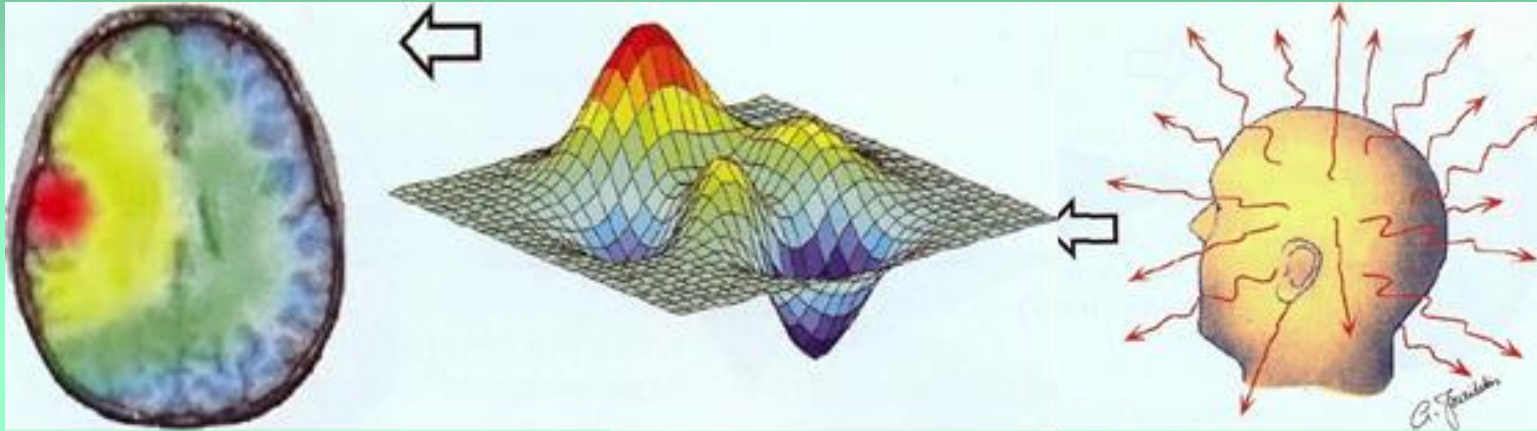
SIGNS OF QUAKES TO COME: Rocks cracking before earthquakes cause positive charge to flow up toward the surface. The flow of charge leads to electromagnetic disturbances that can be detected at the surface and even from space.



**ELF (30-300Hz)**  
**ULF (3-30 Hz)**  
 radiation from  
**EQ preparation region**



# The neural network radiates and receives signals in the ELF / ULF (<100 Hz)



- 0.1-5 Hz / affect the sympathetic nerves
- 0.1-10 Hz / muscle
- 10-150 Hz / parasympathetic nerves
- 10-15 Hz / motor nerves
- 90-110 Hz / sensory nerves,

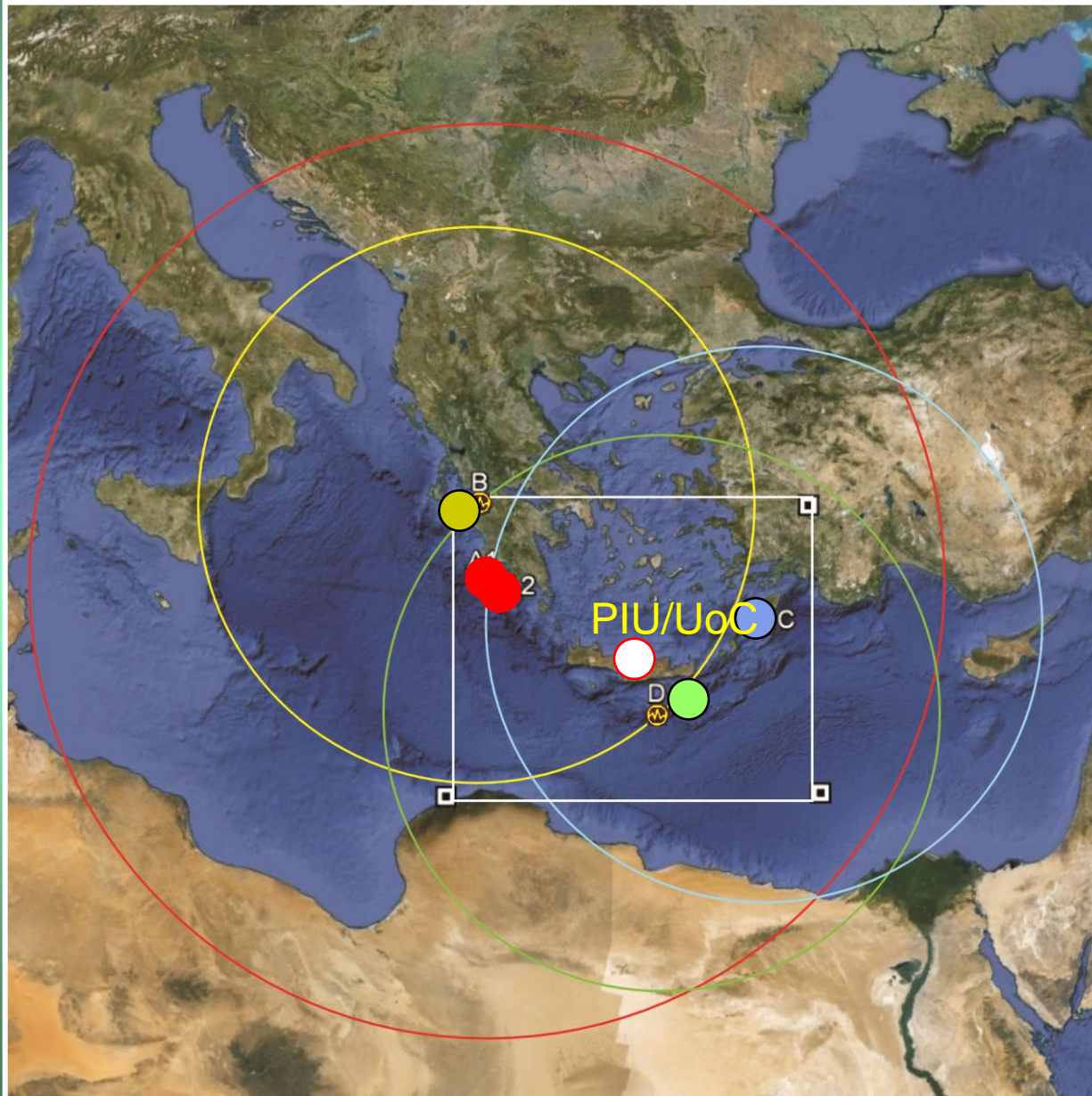
# B.



## Διαφορετική επίδραση των μεγάλων & μικρών σεισμών στην ψυχική υγεία




# Statistical Comparison of seismic activity in a geographical area window including the island of Crete to the admissions to the Psychiatric Inpatient Unit of the University of Crete (IPU/UoC)




Time interval  
2008-2010 (2012)

| EQ |   | Date       | M   |
|----|---|------------|-----|
| A1 | ● | 2008/02/14 | 6.9 |
| A2 | ● | 2008/02/14 | 6.5 |
| B  | ● | 2008/06/08 | 6.4 |
| C  | ● | 2008/07/15 | 6.4 |
| D  | ● | 2009/07/01 | 6.4 |

# A study of correlation between seismicity and mental health: Crete, 2008–2010

G.C. Anagnostopoulos , M. Basta, Z. Stefanakis, V.G. Vassiliadis, A.N. Vgontzas, A.G. Rigas, ...show all

Pages 45-75 | Received 15 Sep 2013, Accepted 21 Jun 2013, Published online: 08 Aug 2013

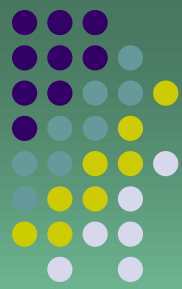
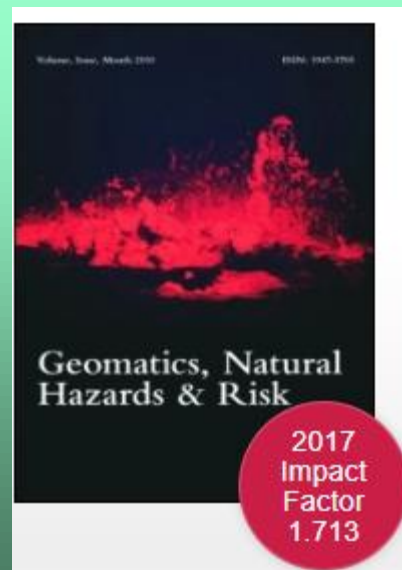
 Download citation  <https://doi.org/10.1080/19475705.2013.819385>



 Full Article  Figures & data  References  Citations  Metrics  Licensing  PDF

## Abstract

We compared the number of  $M > 2$  earthquakes in an area, including the island of Crete, Greece, to the number of admissions to the Psychiatric Inpatient Unit of the University of Crete (IPU/UoC), during the period 2008–2010. We found that when earthquakes with  $M$





# EOS

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

**IN THIS ISSUE:** Strategic Plan and Data Portal for Global Change Science, p. 426  
 Tracking Tephra Flux in Hawaii, p. 427  
 In Memoriam: Richard Honrath (1961–2009), p. 428  
 Meetings: Marine Ecosystems and Climate; Greenhouse Gas Information; Mediterranean Water Cycle, p. 429  
 About AGU: Council to Consider Three Position Statements; Nominations Open for William Kaula Award; MentorNet Helps Young Geoscientists, pp. 430–431  
 Book Review: The Environment in International Relations, p. 431

VOLUME 90 NUMBER 46 17 NOVEMBER 2009

## A Storm of Strong Earthquakes in Greece During 2008

An unusual cluster of four  $M_w > 6.2$  earthquakes ruptured the Hellenic Arc and Trench (HA-T) from 6 January to 15 July 2008 with a variety of focal depths and mechanisms (Figure 1 and Table 1). Common earthquake clusters incorporate a sequence of dependent events: a main shock, numerous aftershocks, and sometimes foreshocks preceding the main shock. Cluster members occur on the same fault or on a set of nearby faults. The four HA-T earthquakes, however, do not conform with this pattern because the faults are spatially isolated.

HA-T is a highly active seismotectonic system within the entire western Eurasia, but the occurrence of the 2008 cluster was still far beyond chance. Clusters of isolated earthquakes have been described in Greece since the 1950s, and more recently they were attributed to remote earthquake triggering [Papadopoulos, 1998, 2002]. Such triggering has traditionally been described through the popular Coulomb Failure Stress model, which explains aftershock occurrence or interaction between nearby strong earthquakes. This model predicts static stress

over a short time. The 2008 cluster seems to belong to that type of earthquake activity. It was initiated with a 6 January 2008 strike-slip earthquake of intermediate focal depth occurring at the descending slab in western HA-T. The largest earthquake in the cluster followed on 14 February and was an interplate low-angle thrust event, which, along with the two strong aftershocks (one on the same day and one 6 days later), again ruptured the western HA-T. The sequence continued on 8 June with a shallow, strike-slip event in the northwestern Peloponnese region. The time cluster concluded in eastern HA-T on 15 July with an interplate, oblique-slip earthquake.

Instrumental seismicity indicates that the rate of strong ( $M_w \geq 6.2$ ) HA-T earthquakes is about 1 event every 2.5 years. However, the occurrence of four main shocks in 6.5 months implies this frequency has now increased by a factor of 18. The rate increases by a factor of 27 if the two strong aftershocks following the largest main shock are also considered. The probability to observe by chance four main shocks in such



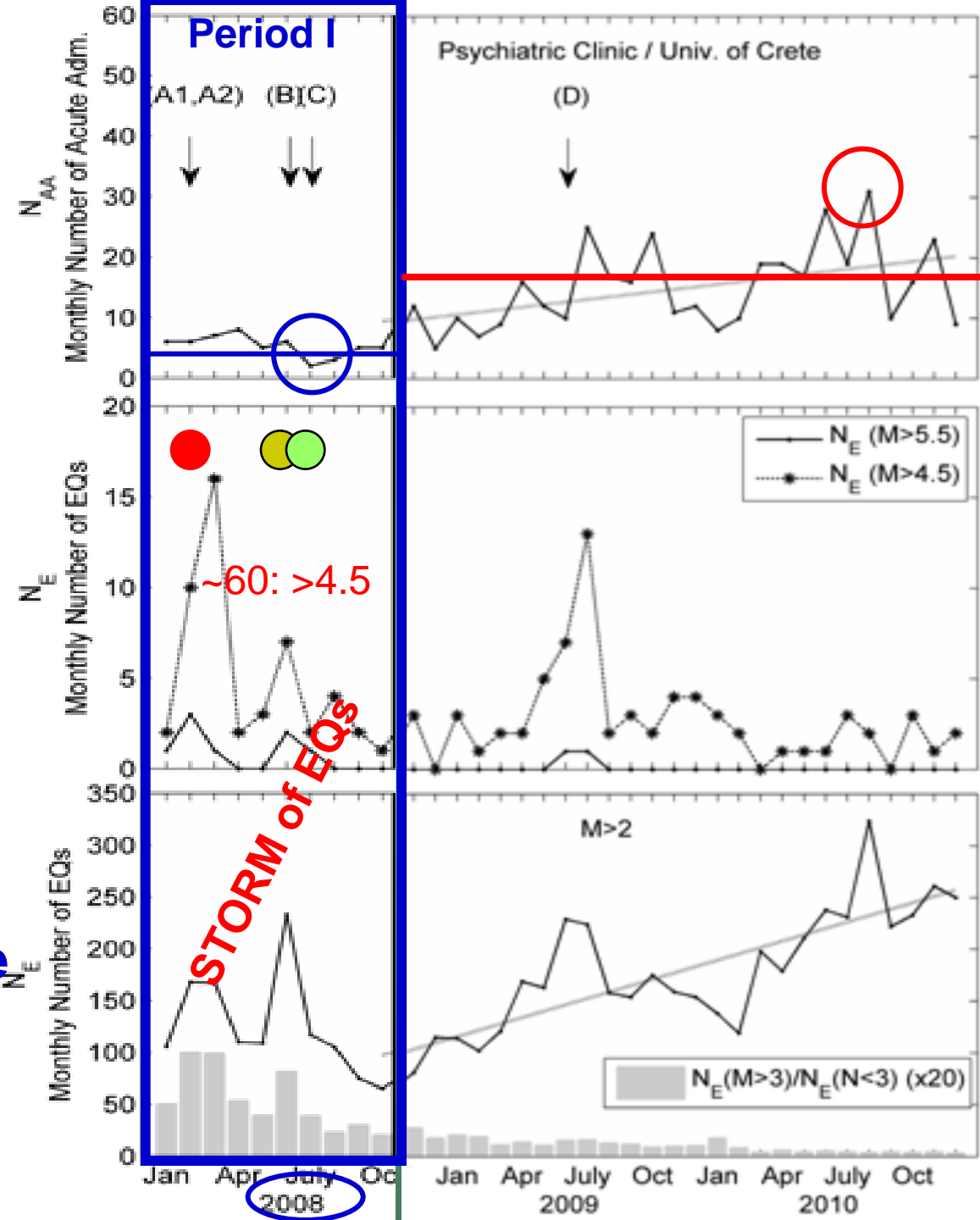
Fig. 1. Seismotectonic elements of the Hellenic Arc and Trench (HA-T) system. Dates, magnitudes, and focal mechanisms (beachball diagrams) of the earthquakes listed in Table 1 are shown (taken from the Harvard earthquake list, <http://www.globalcmt.org/CMTsearch.html>). Arrows represent the direction of plate motion, and triangles indicate volcanoes. The dashed line in the volcanic arc indicates the position of the earthquake epicenters at depth of 150 kilometers where magma is generated along the descending Mediterranean lithospheric plate. The box in the inset shows the location of the study area.

# Acute admissions

| EQ | Date       | M   |
|----|------------|-----|
| A1 | 2008/02/14 | 6.9 |
| A2 | 2008/02/14 | 6.5 |
| B  | 2008/06/08 | 6.4 |
| C  | 2008/07/15 | 6.4 |
| D  | 2009/07/01 | 6.4 |

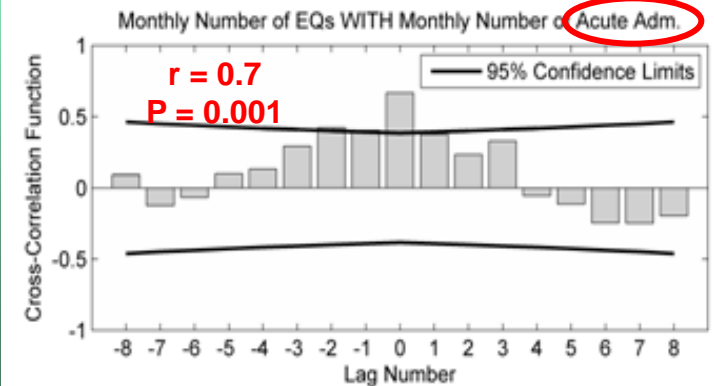
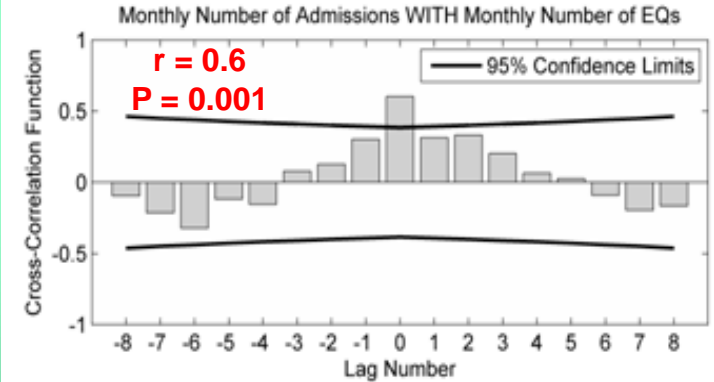
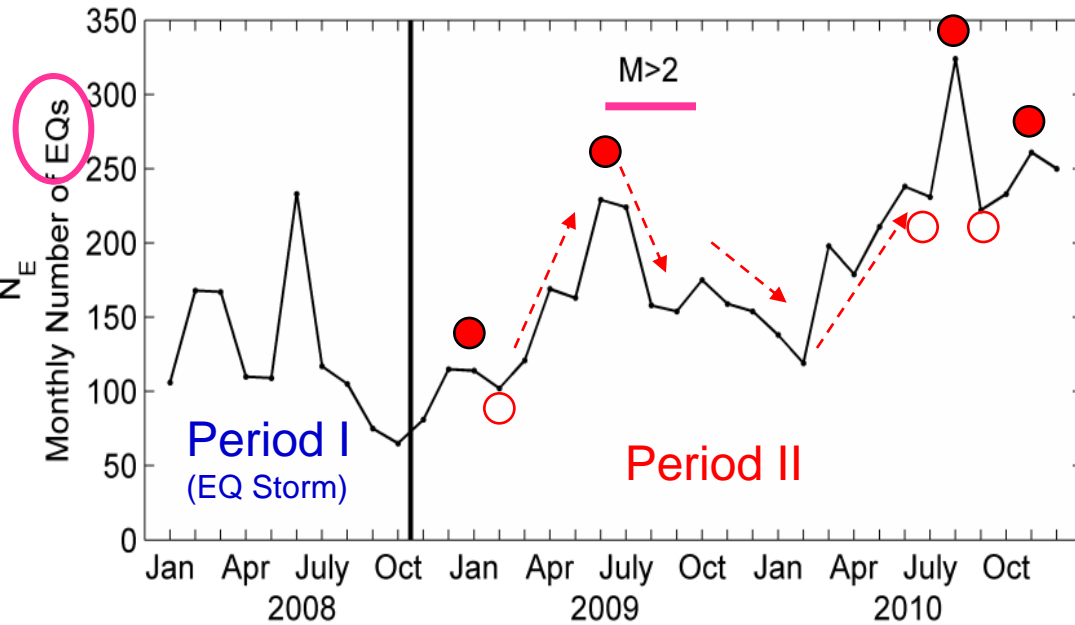
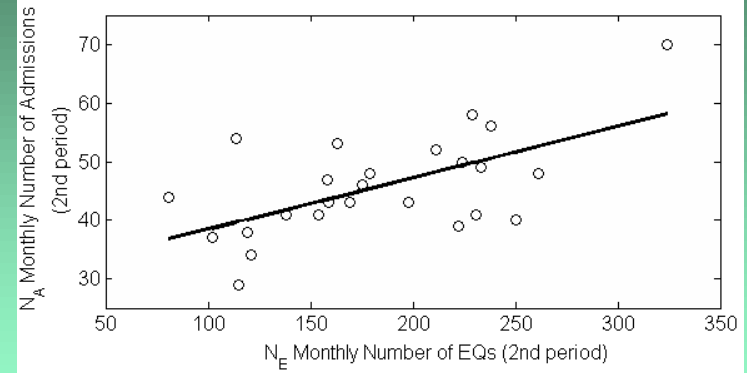
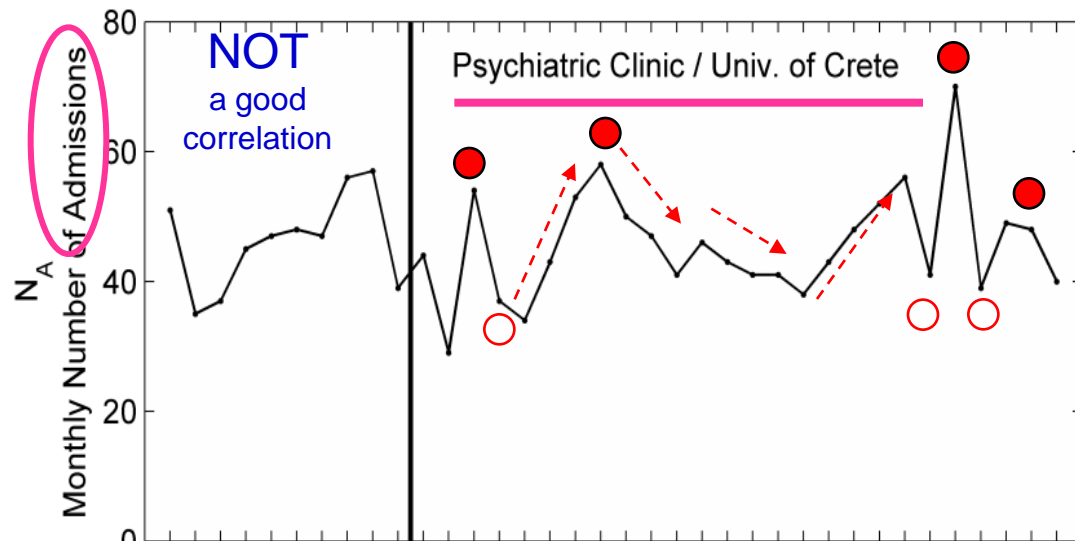


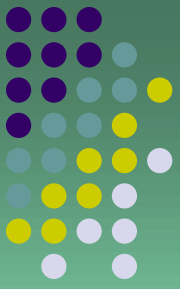
Very low admission Rate during P-I !!!



$P - I \neq P - II$

# Strong correlation between the number of admissions $N_A$ and the number of EQs $N_E$





# Διαφορετική επίδραση της σεισμικότητας σε διαφορετικές ψυχικές ασθένειες / διαταραχές



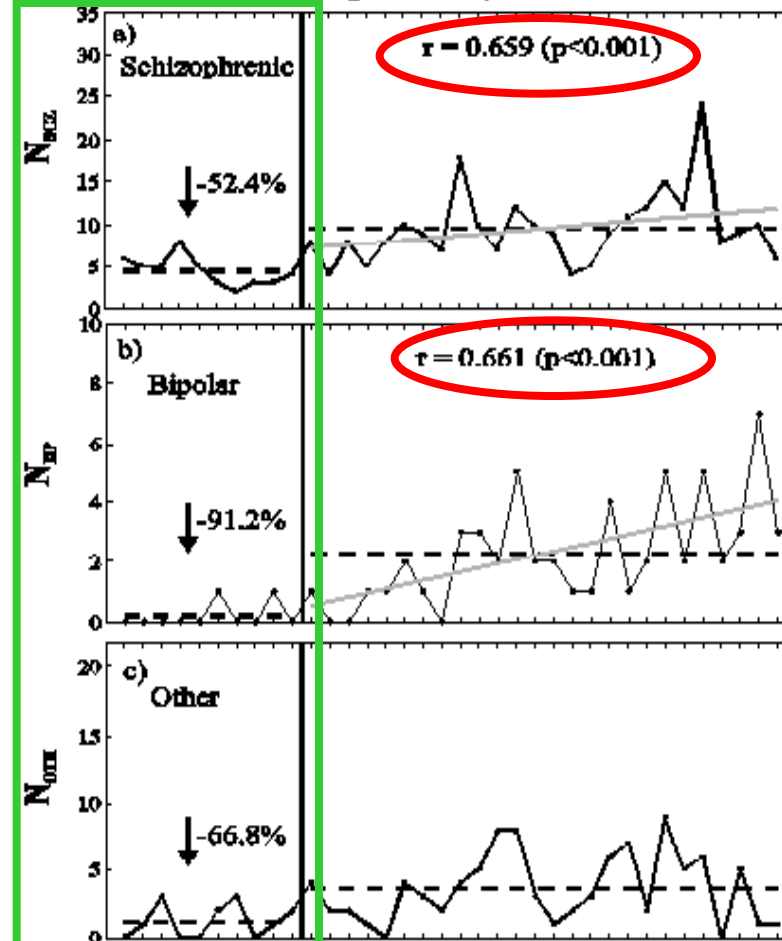
# ΟΞΕΑ

Περίοδος I  
(μεγάλοι σεισμοί)

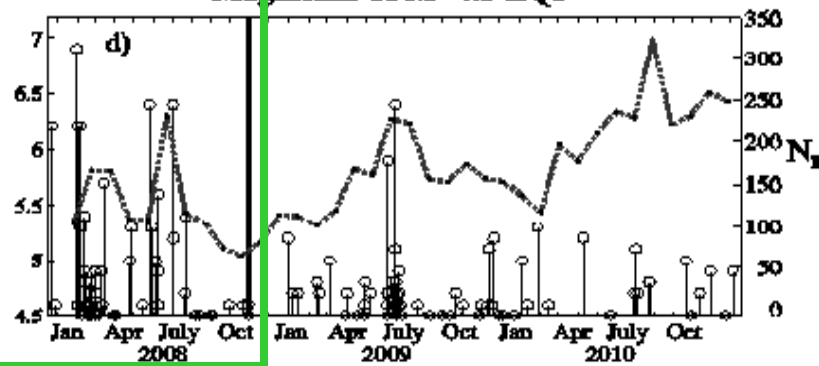
✓ **Λιγότερες Εισαγωγές**

✓ Μεγαλύτερη μείωση:  
**Διπολική Διαταραχή**  
(~90%)

Monthly Number of Admissions



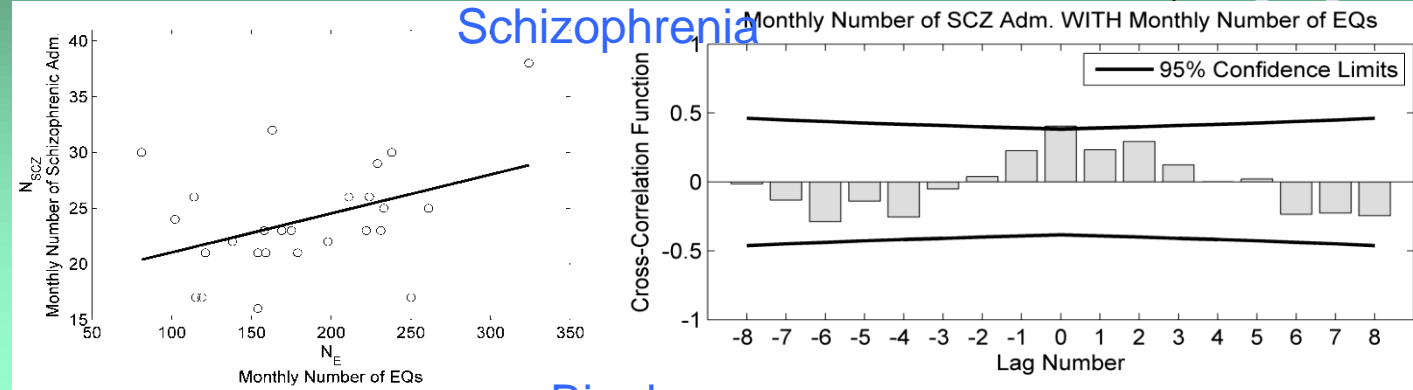
Magnitude of M>4.5 EQs



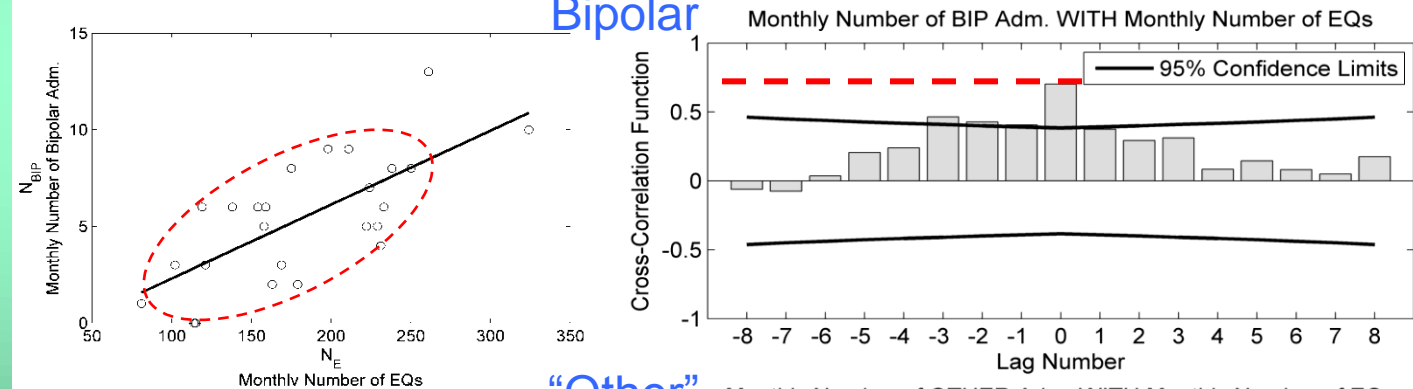
# The number of EQs $N_E$ is related in different ways for various types of Psychotic disorders (schizophrenia, bipolar, "other")



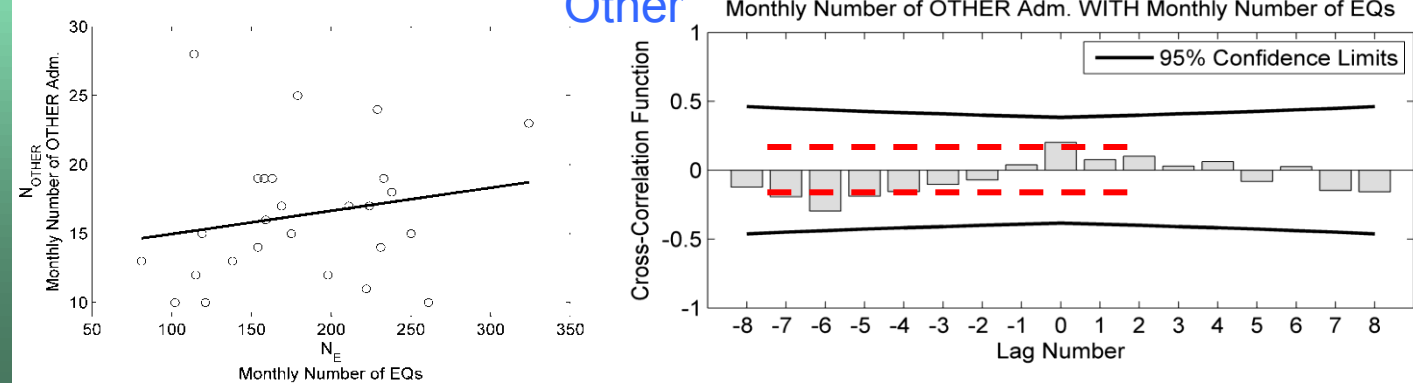
## Schizophrenia



## Bipolar



## "Other"



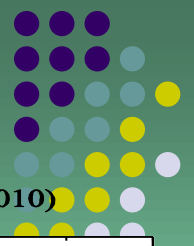
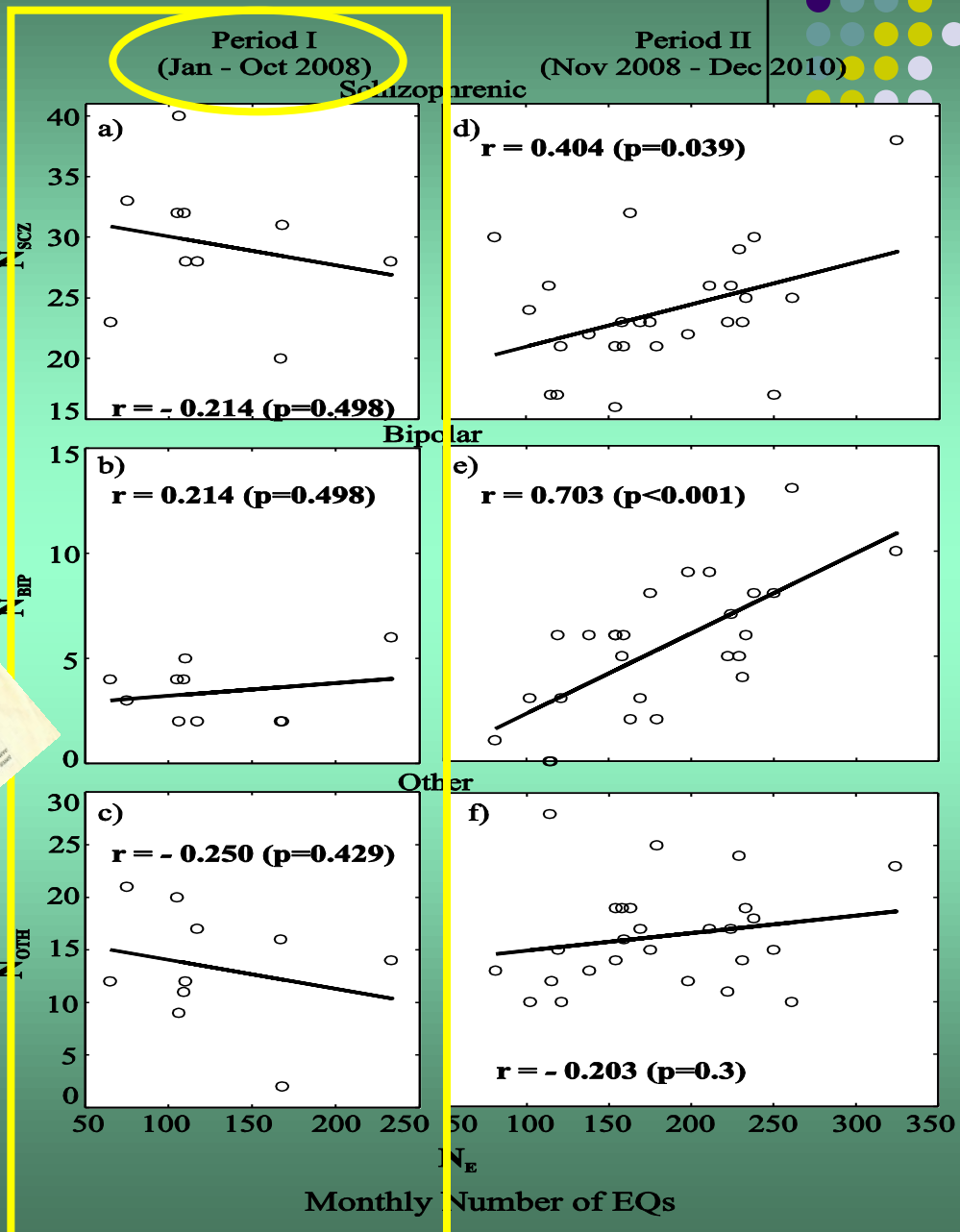
**Bipolar** disorders shows a strong ( $r=0.75$ ) correlation with  $N_E$  at  $P > 95\%$

"Other" disorders do **NOT** show any significant correlation with  $N_E$

Κατά την περίοδο I των μεγάλων σεισμών ο ρυθμός των Εισαγωγών ΔΕΝ σχετίζεται με το συνολικό πλήθος των σεισμών, που βλέπουμε στην περίοδο II.



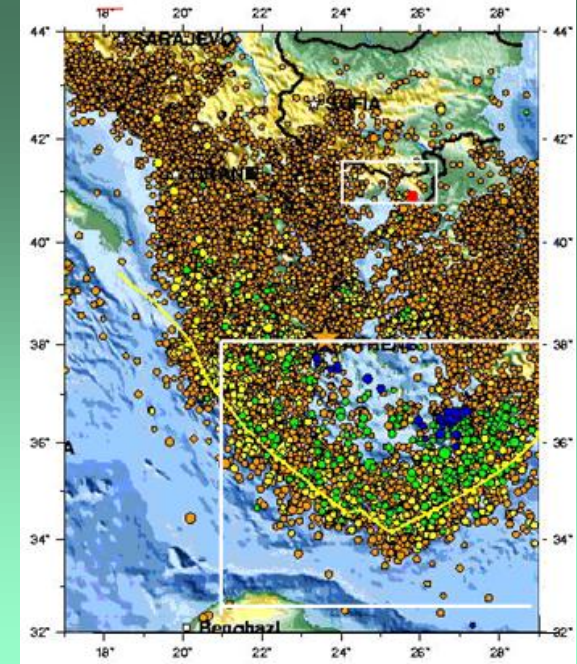
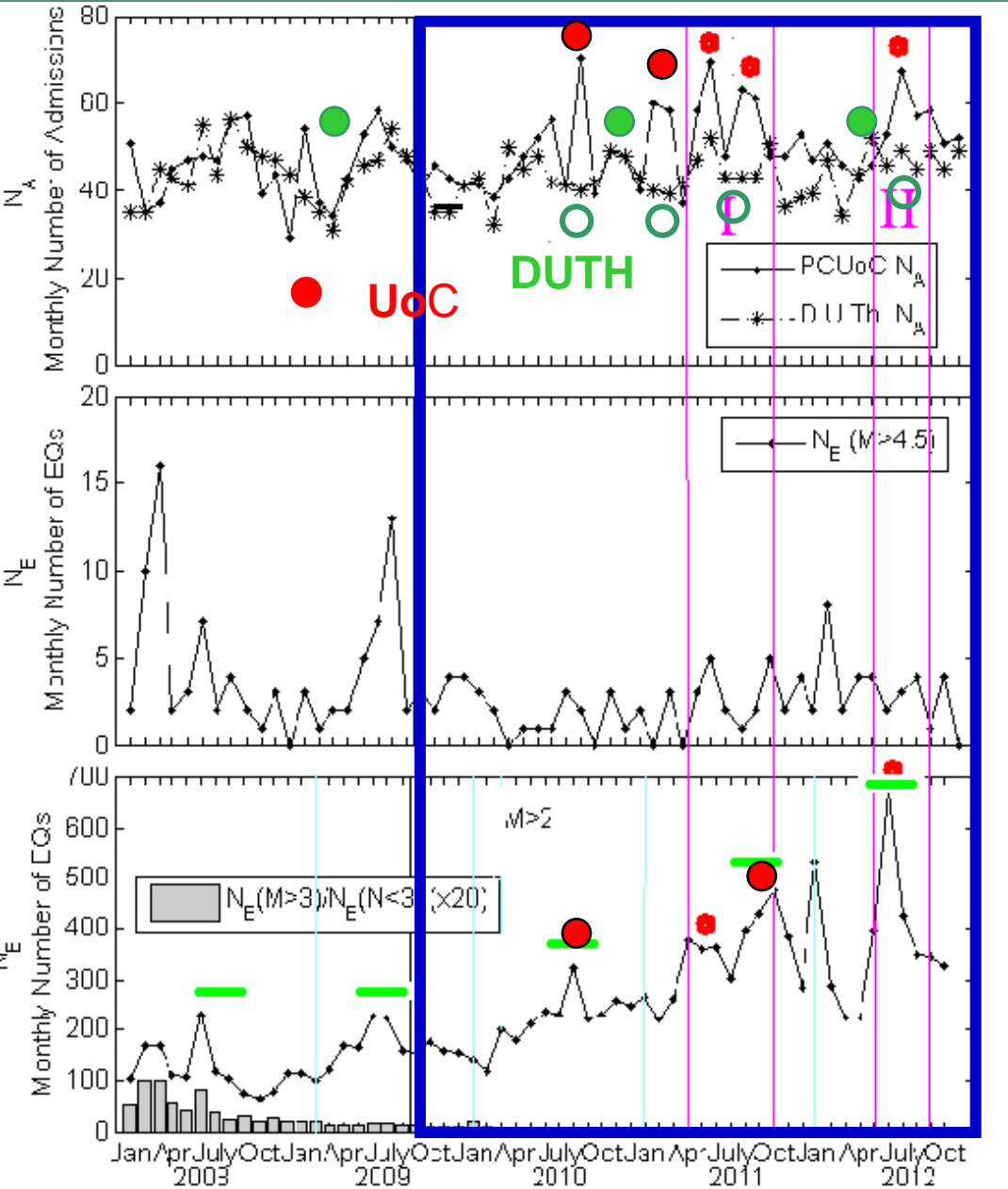
Number of Admissions



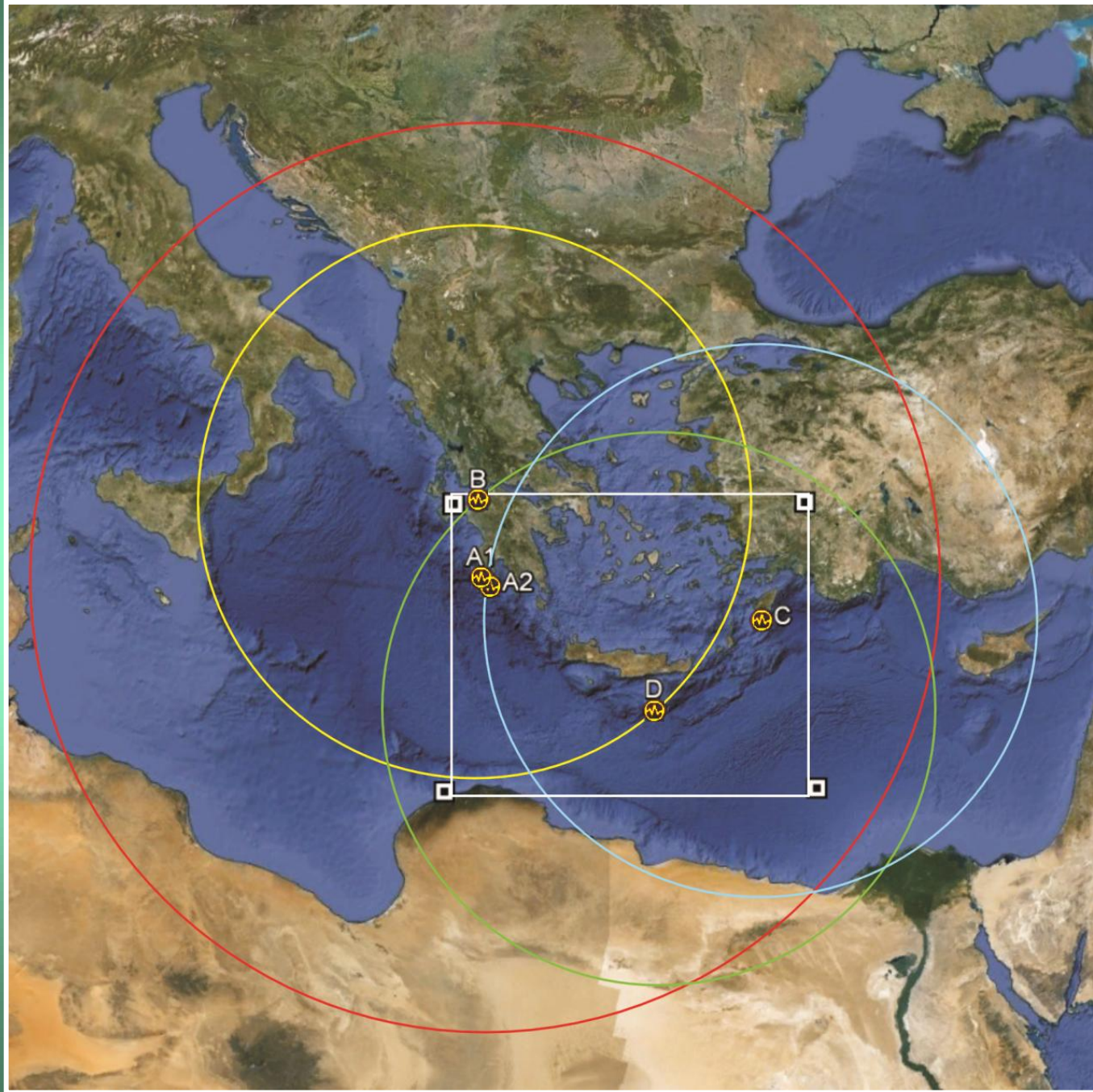


**Γεωγραφική Σύγκριση Εισαγωγών  
(Κρήτη, Αθήνα, Αλεξανδρούπολη) –  
ομάδα ελέγχου**

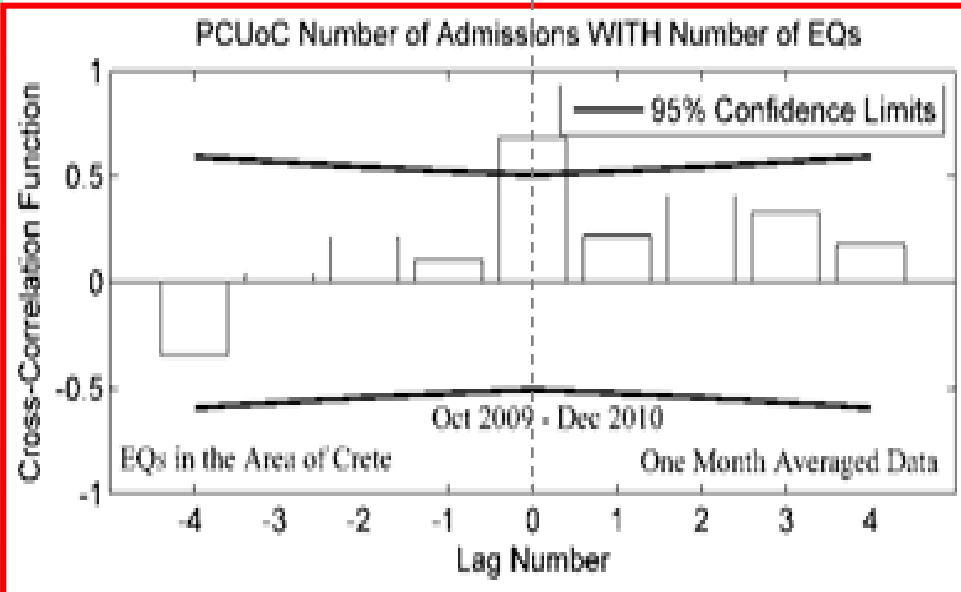
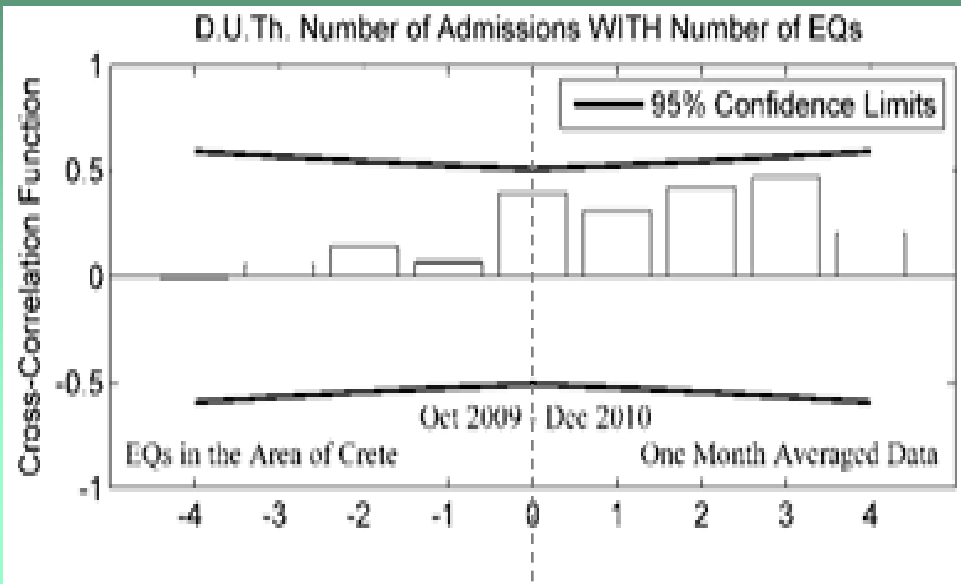
### 3. Γεωγραφική Σύγκριση Εισαγωγών – ομάδα ελέγχου

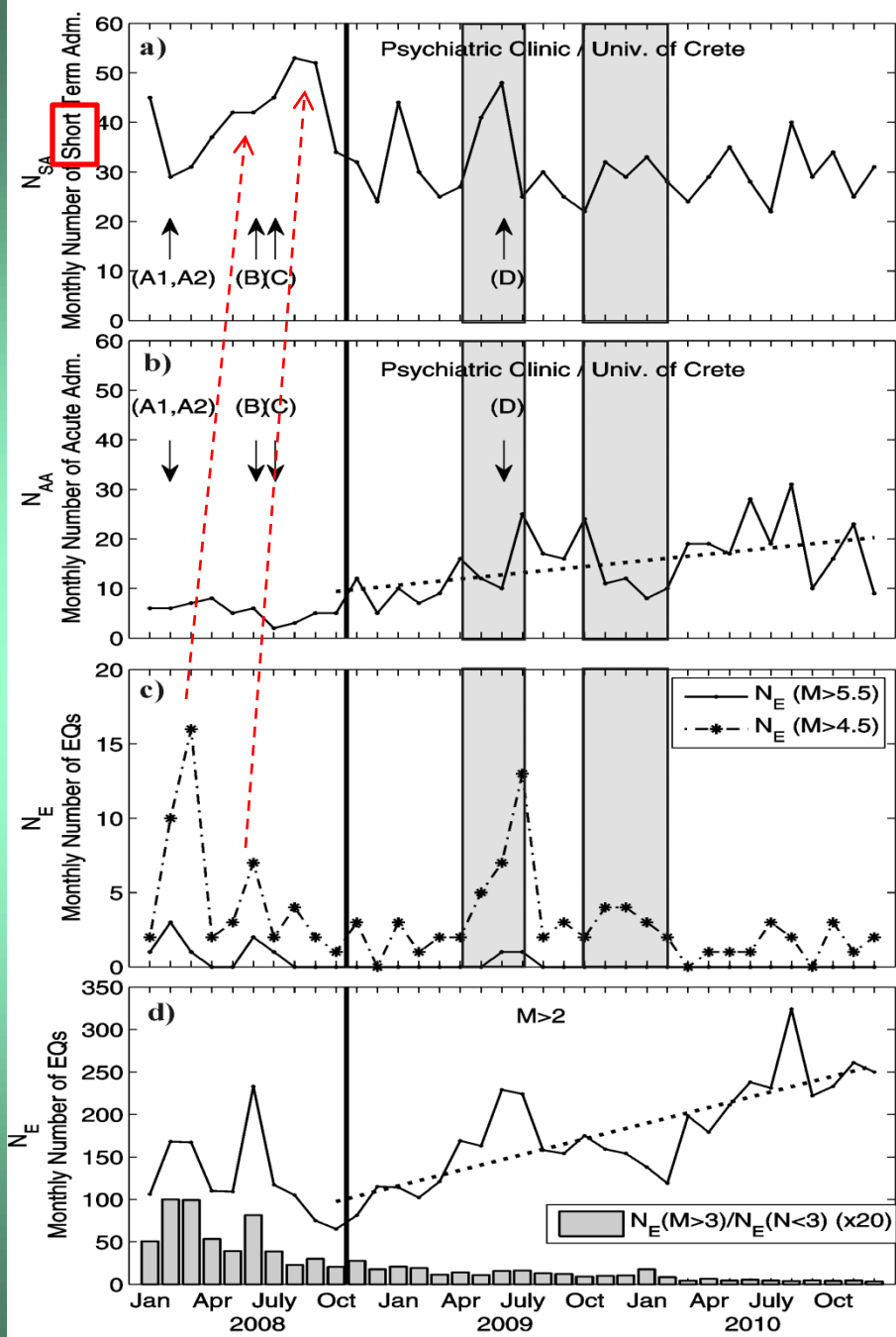


# Ευρεία περιοχή Ετοιμασίας Σεισμού



# (Μη) Σημαντική συσχέτιση πλήθους σεισμών με Εισαγωγές Στην Κρήτη ΠΑΓΝΗ (Θράκη/ DUTH)

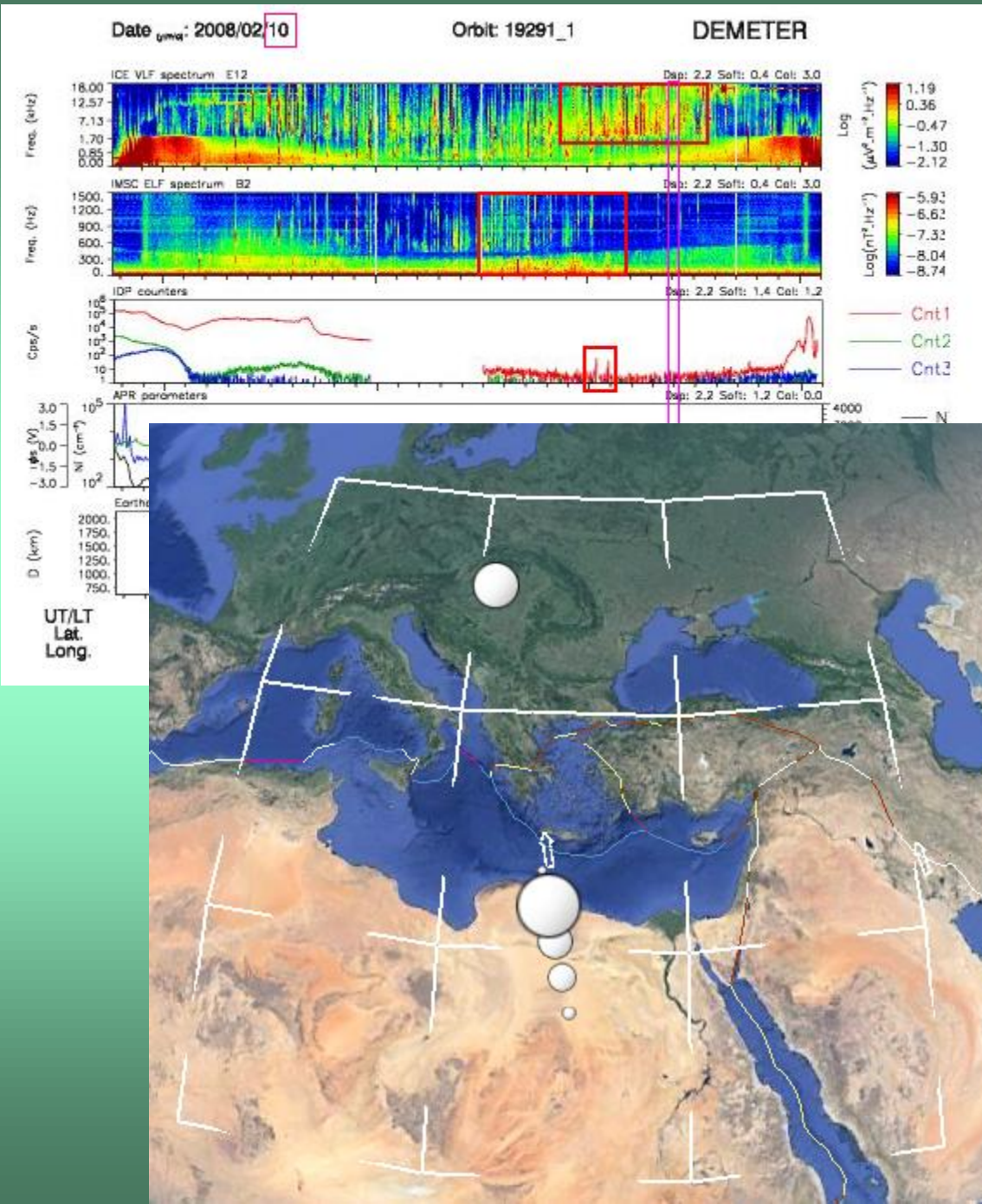




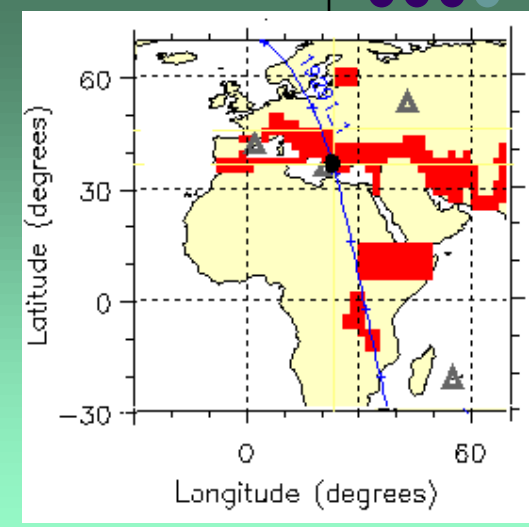




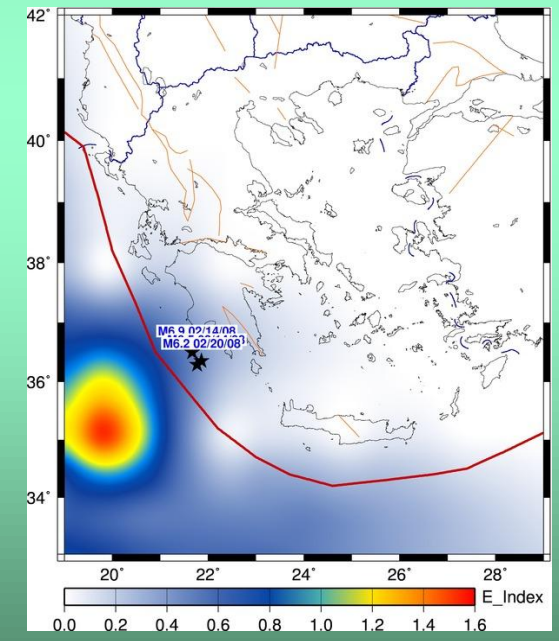
Δορυφορική Παρατηρησιακή ένδειξη της επίδρασης της σειсмоγενούς **H/M ULF** (Ultra Low Frequency) ακτινοβολίας σε Ψ/Χ διαταραχές –  
**Ημερήσια** ανάλυση δεδομένων

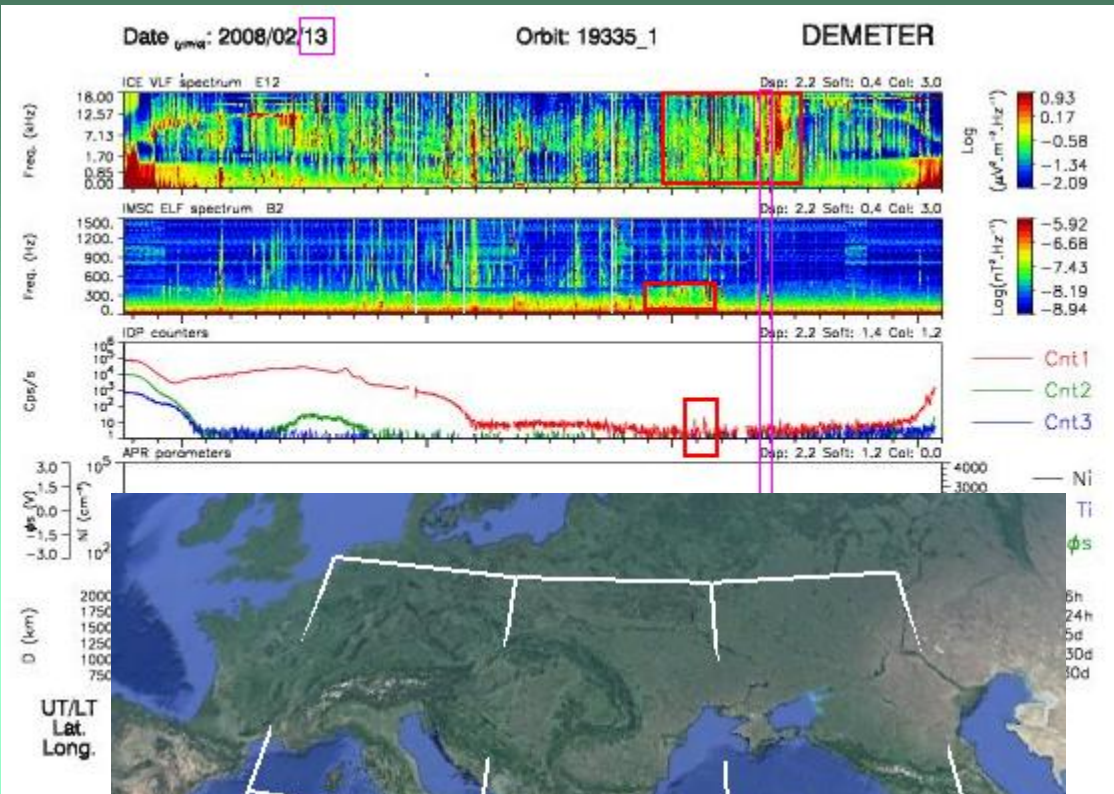


VLF  
ELF  
 $e^-$   
plasma

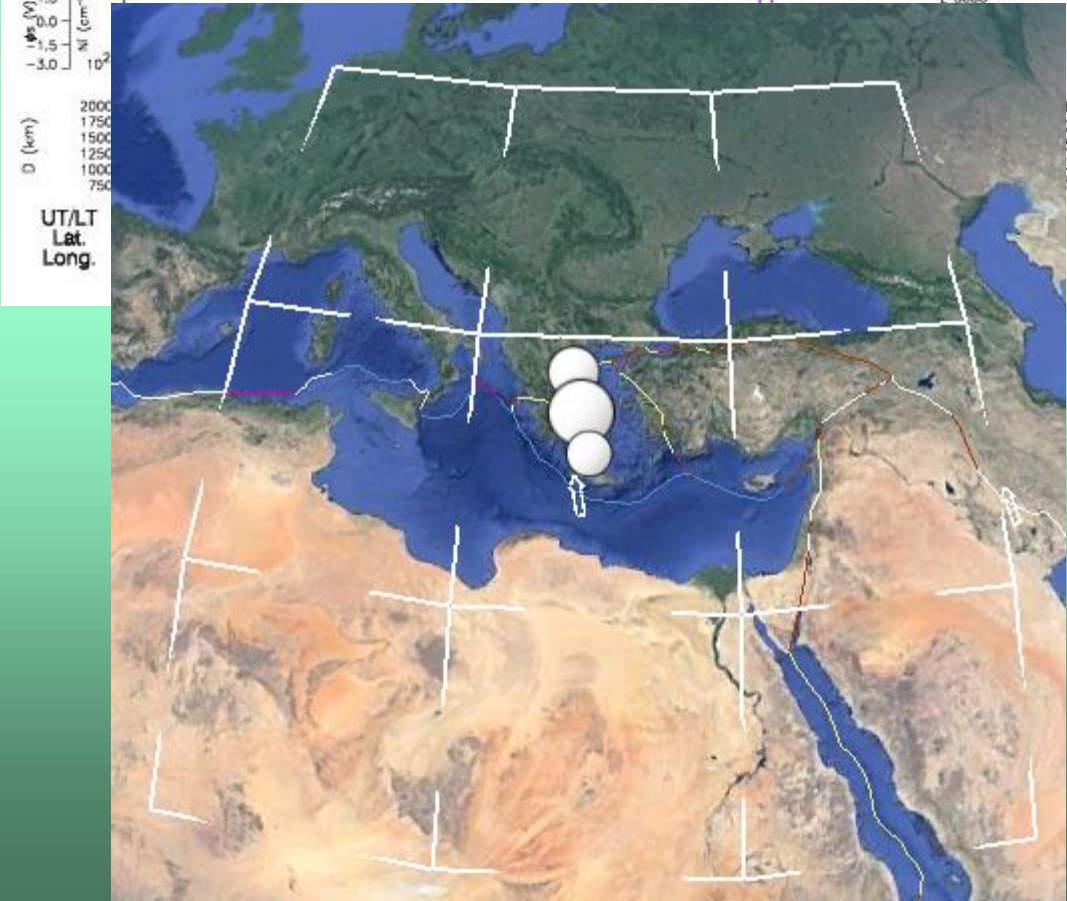
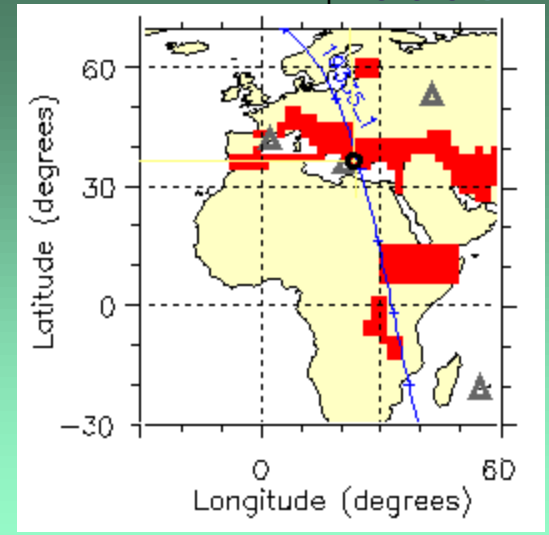


Demeter  
-EQ  
D (km)





VLF  
 ELF  
 $e^-$   
 plasma  
 Demeter  
 -EQ  
 D (km)





Dear Fr Georgios,

I am very happy to read your message to Guy Oullon. Wonderful to have you as an author.

Though I know of course your remarkable work on the possible correlation between seismic activity and clinical data in Crete, one of your papers that impressed me greatly was your 2014 study "The ultra low frequency electromagnetic radiation observed in the topside ionosphere above boundaries of tectonic plates".

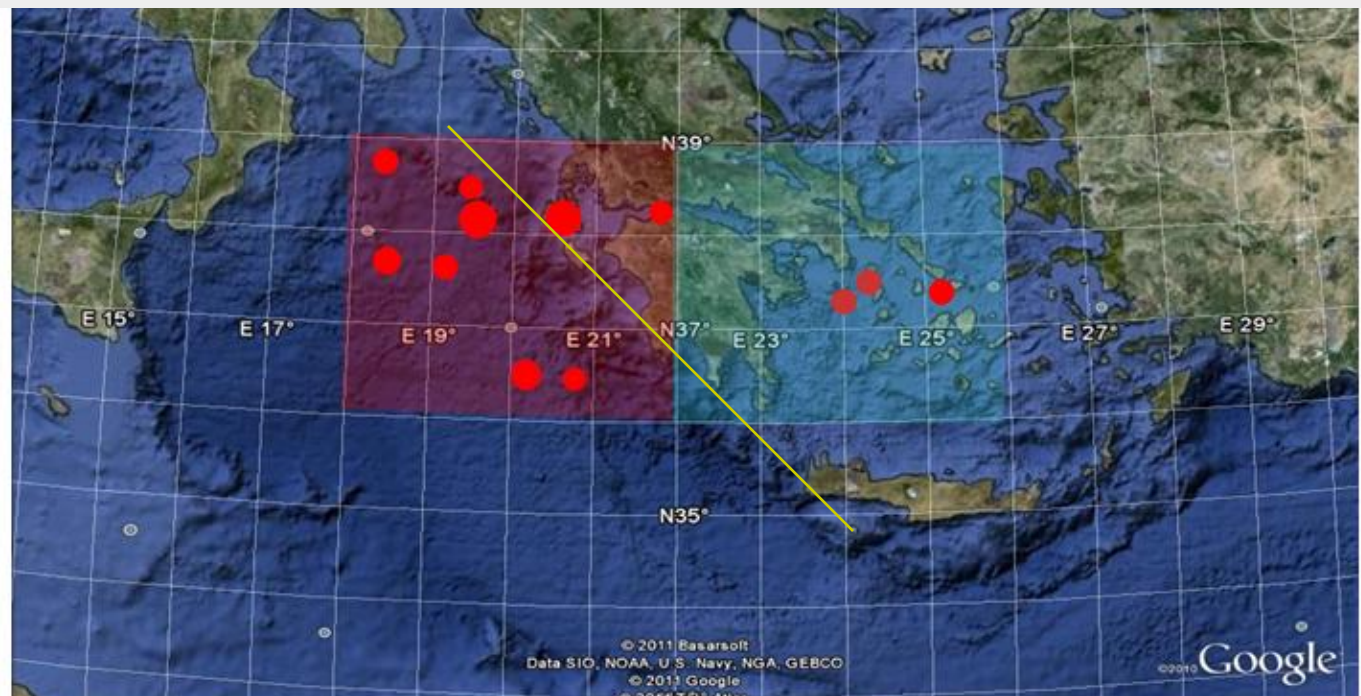
You demonstrated that DEMETER detected a distinct anomaly when crossing at a very oblique angle active marine plate boundaries. You report on one such boundary off the West coast of Greece.. I find this observation highly significant. It is consistent with my work. Most important is, I think, that you observe a + and - signal as DEMETER crosses the midline of the plate boundary. I would be superinterested in knowing more about this phenomenon for Mid-ocean Ridges such as southwest of Iceland and for subduction zones such as along the coast of Chile.

Maybe, for our European Physical Journal, you and your team could prepare a paper that would address this question.

With best regards,

Friedemann

Friedemann Freund

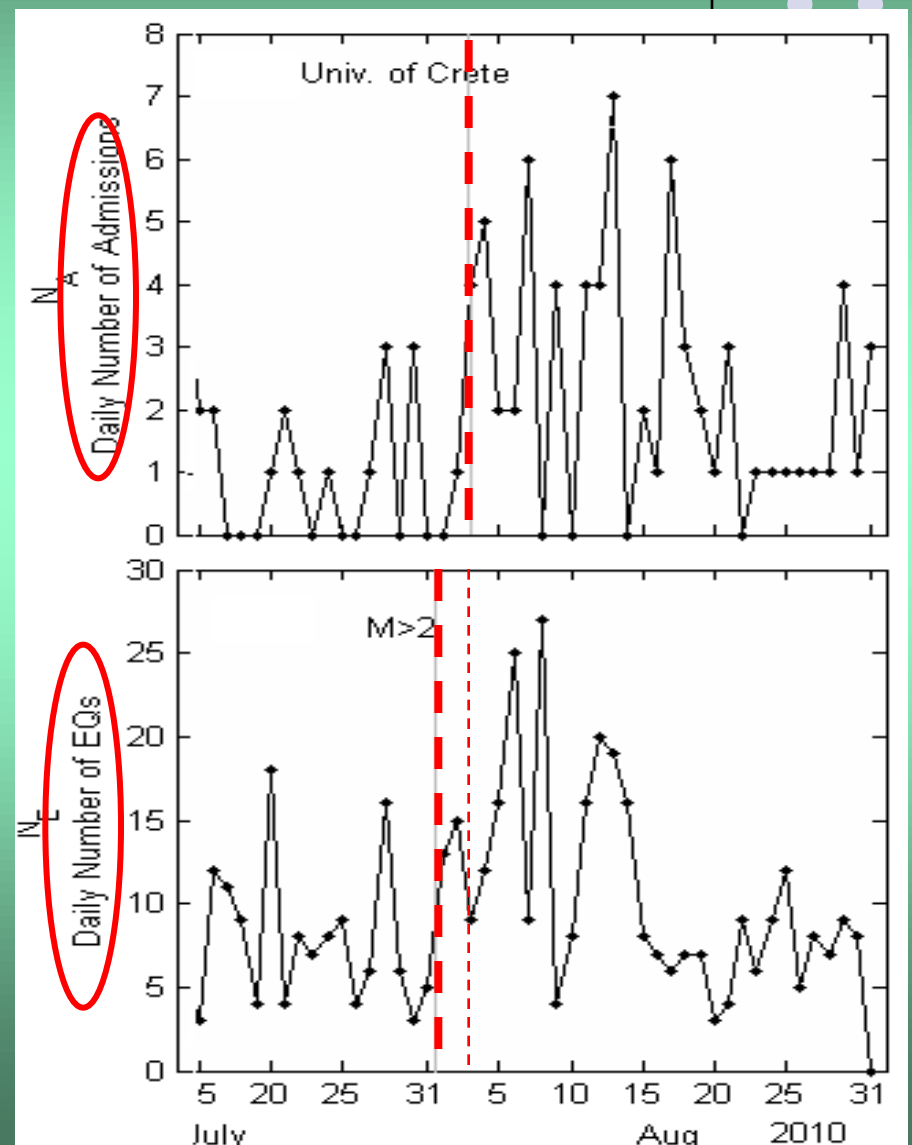
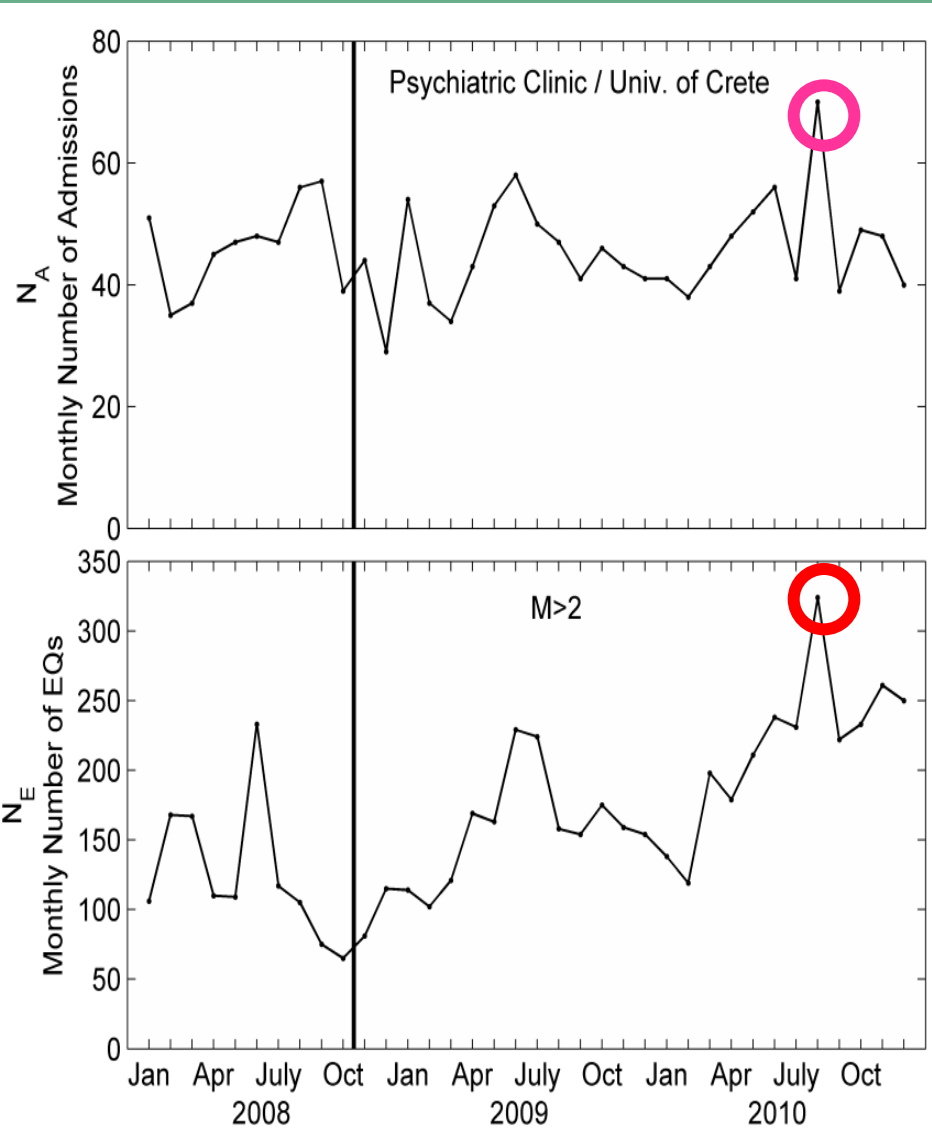




# Μέγιστος ρυθμός Εισαγωγών

# Ημερήσια ανάλυση

(Αύγουστος 2010)





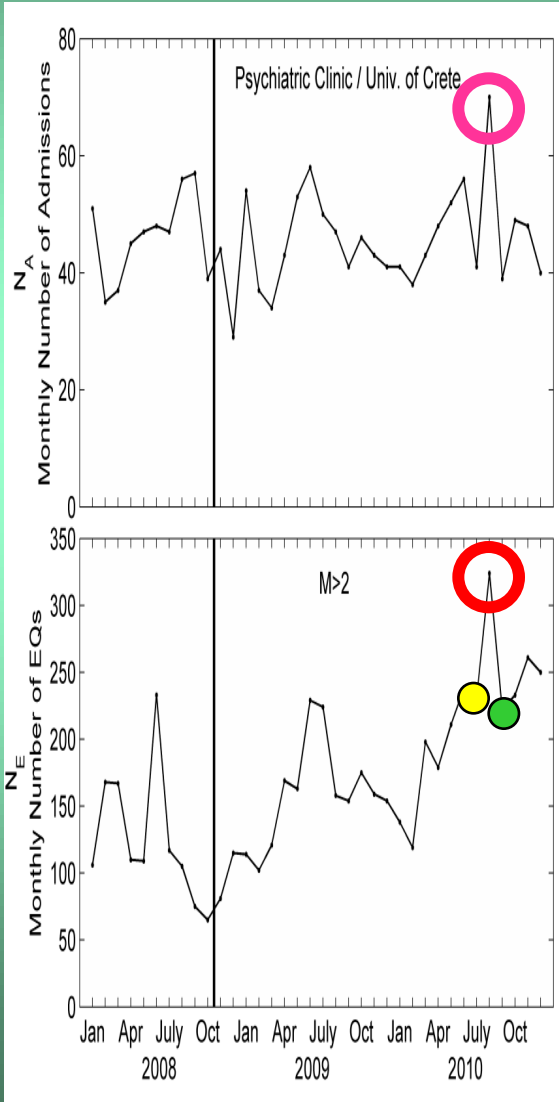
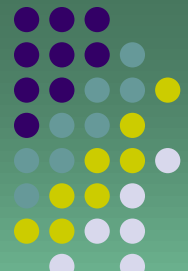
**ΙΟΥΛΙΟΣ 2010**



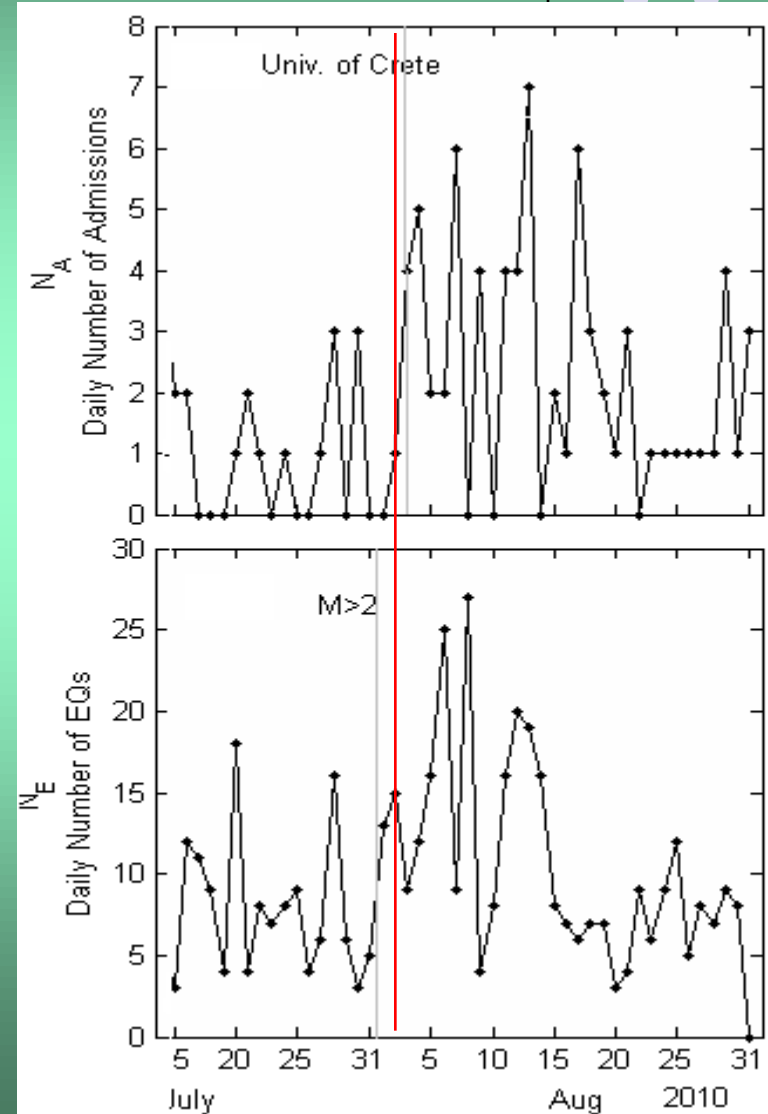
**ΑΥΓΟΥΣΤΟΣ 2010**



# Test the possible mediation of seismic-related ULF radiation to the admissions of August 2010



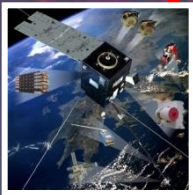
**ULF?**



|     |         |
|-----|---------|
| UHF | 3 GHz   |
| VHF | 300 MHz |
| HF  | 30 MHz  |
| MF  | 3 MHz   |
| LF  | 300 kHz |
| VLF | 30 kHz  |
| VF  | 3 kHz   |
| ELF | 300 Hz  |
| ULF | 30 Hz   |
|     | 0 Hz    |

3

GOES and Terra satellites sense infrared light from positive charges recombining with electrons in the atmosphere.



DEMETER, COSMOS 1809, and QuakeSat satellites sense ELF magnetic disturbances.

SIGNS OF QUAKES TO COME: Rocks cracking before earthquakes cause positive charge to flow up toward the surface. The flow of charge leads to electromagnetic disturbances that can be detected at the surface and even from space.

The ionosphere drops prior to an earthquake.

Air-conductivity sensor detects charges that can cause lights in the sky.

Lights

Charges accumulate on rock outcroppings.

2

Radar measures the height of the ionosphere.

Magnetometers detect ULF and ELF changes in the magnetic field.

GPS satellite

Electrons in the ionosphere after the relative phase of GPS signals.

VLF, HF, and UHF radio signals become scattered as the ionosphere drops.

ΗΜ Ακτινοβολία:

1. Υπόγεια ELF-ULF, 2.

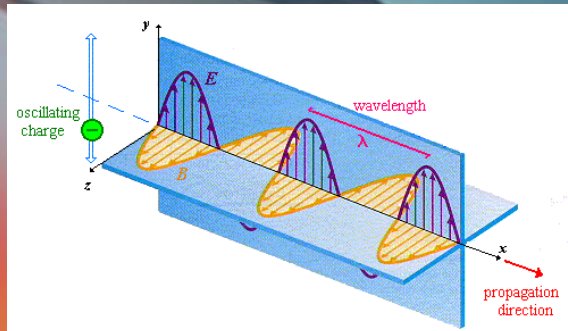
Ατμοσφαιρική TIR,

3.

Μαγνητοσφαιρική VLF

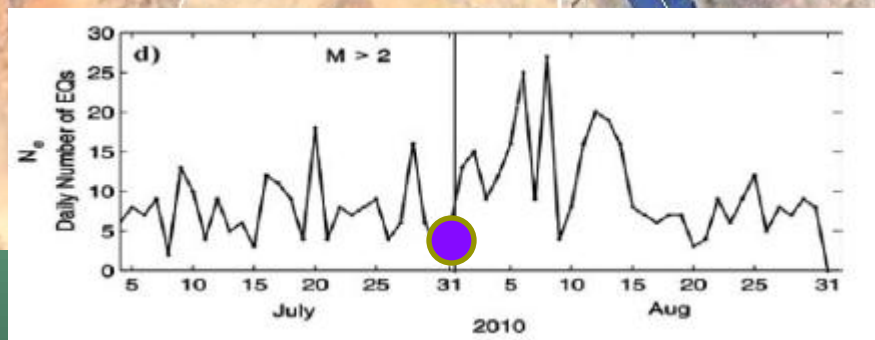
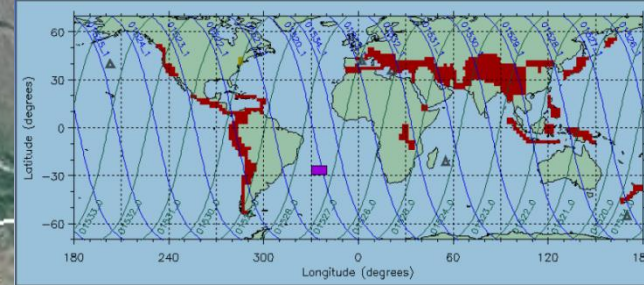
1

Stress on rock preceding earthquake causes flow of charge.



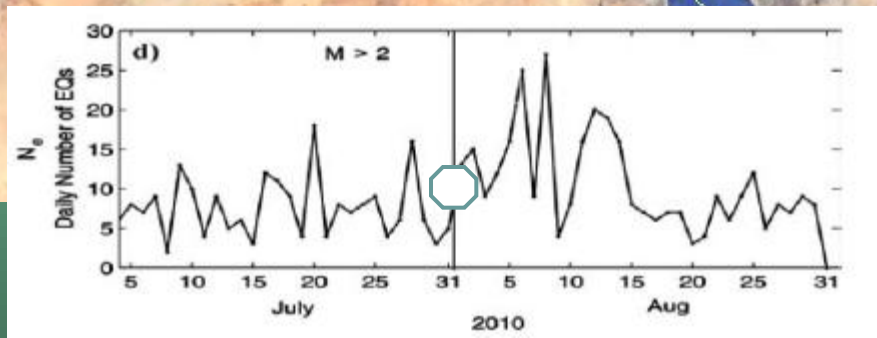
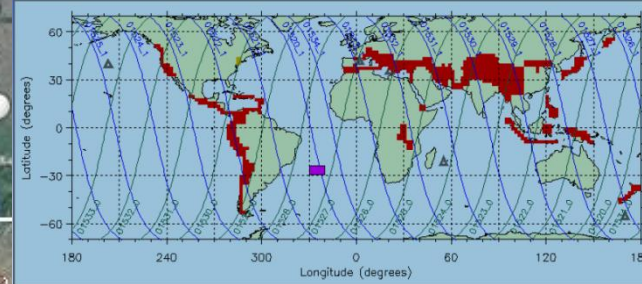
31.07.2010

**EMSC**



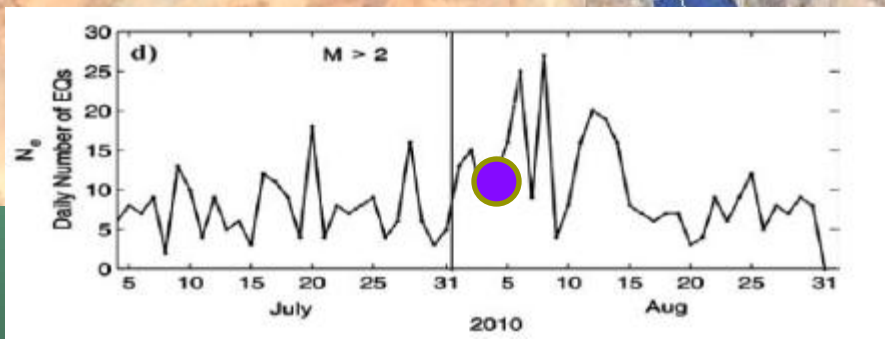
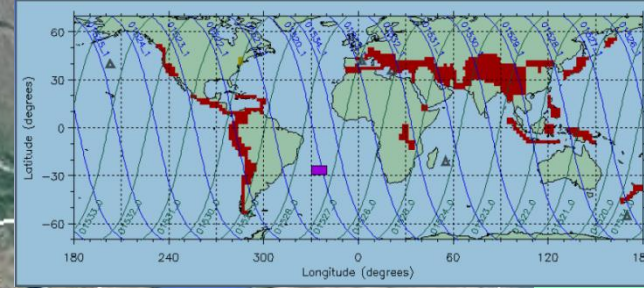
01.08.201

**EMSC**



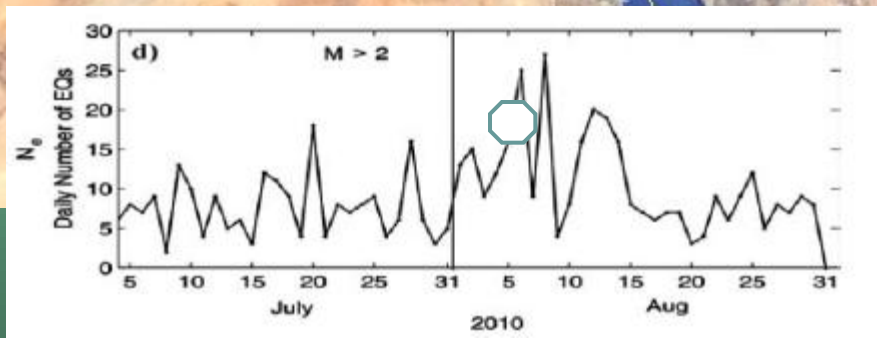
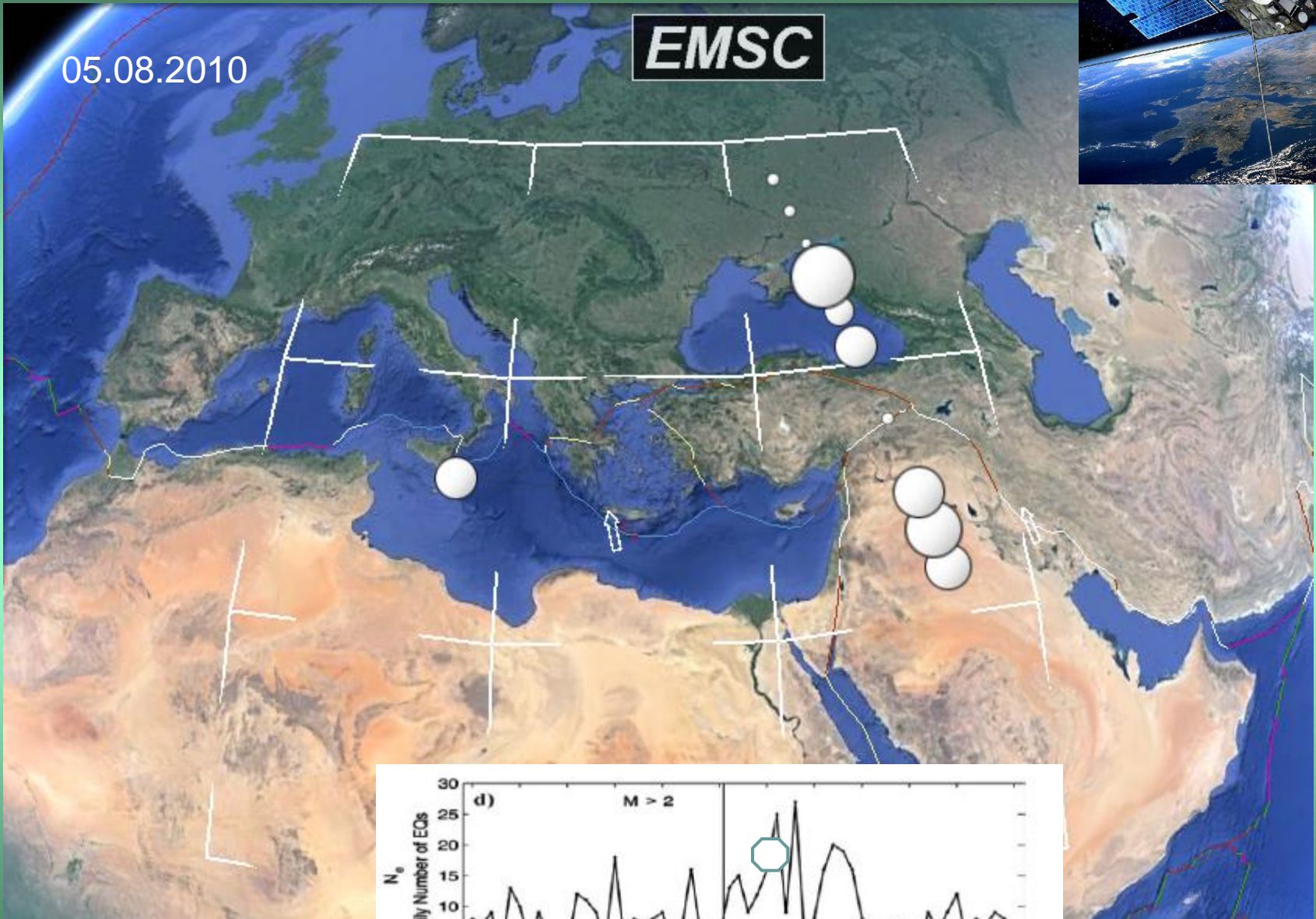
04.08.2010

**EMSC**



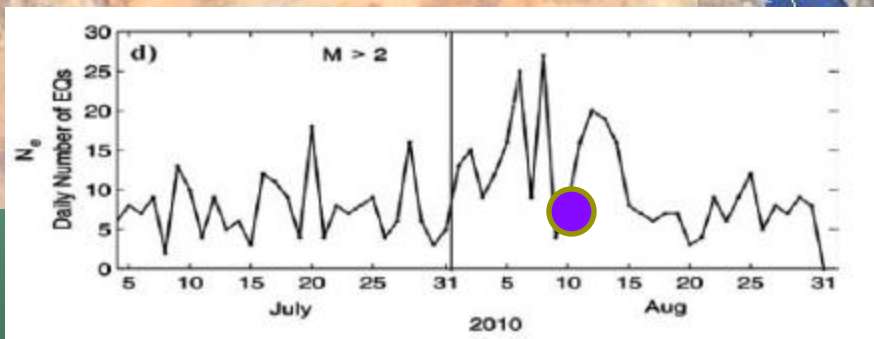
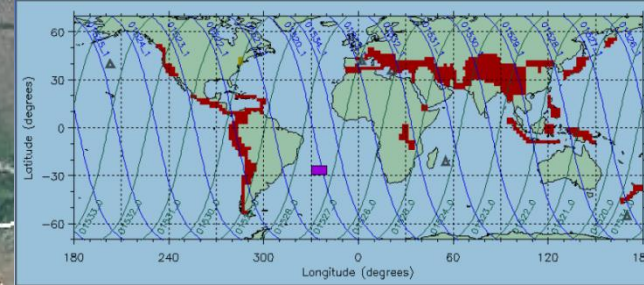
05.08.2010

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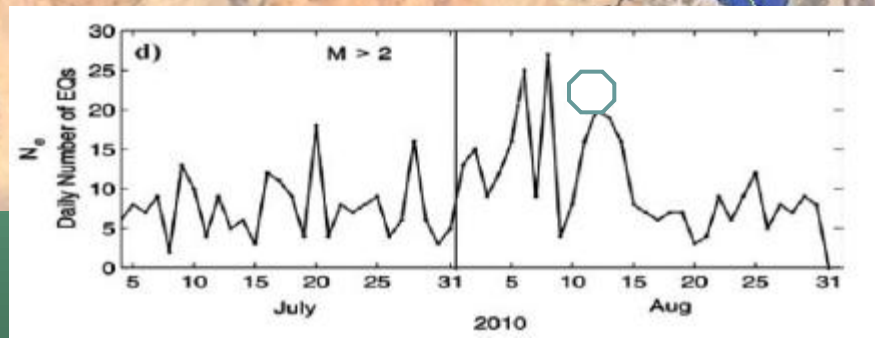
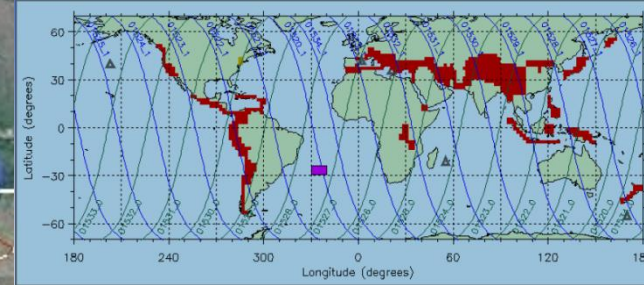
11.08.2010

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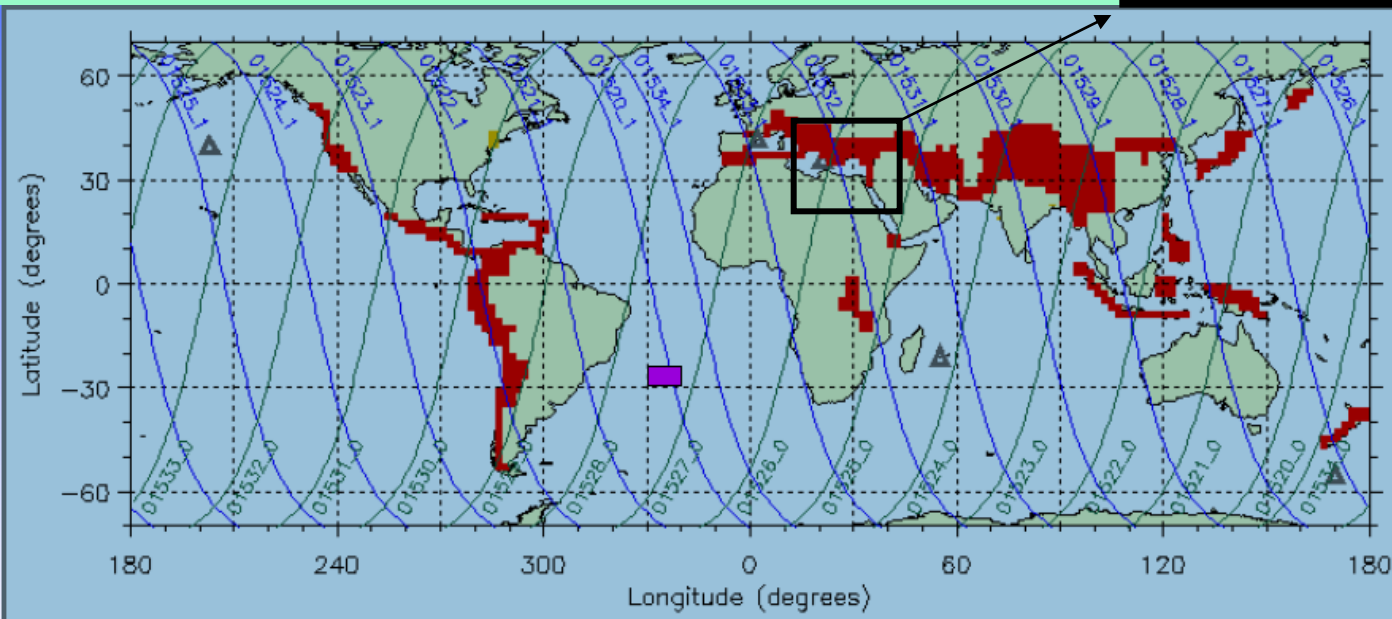
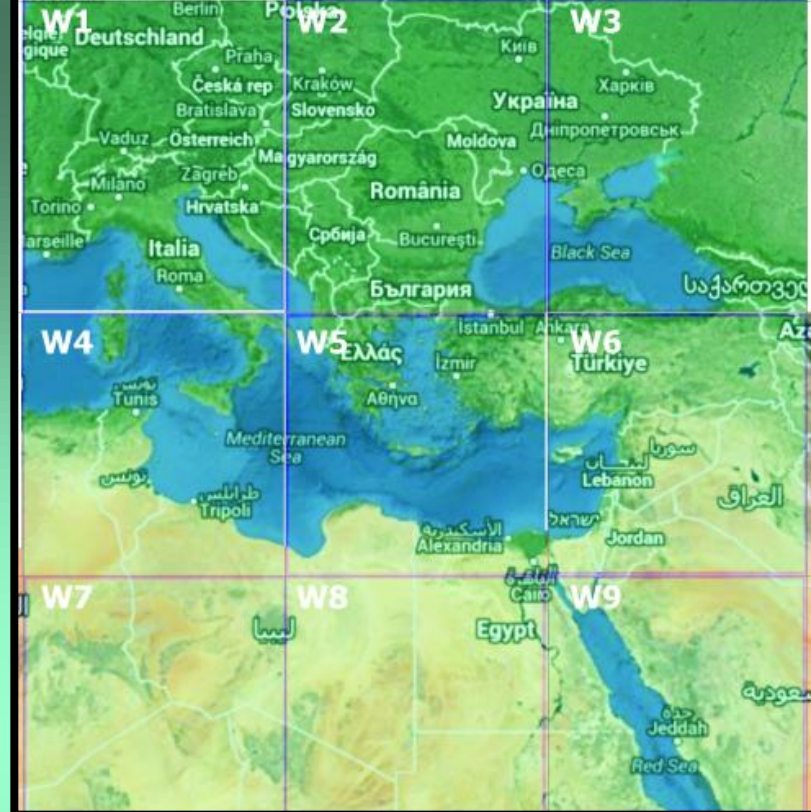


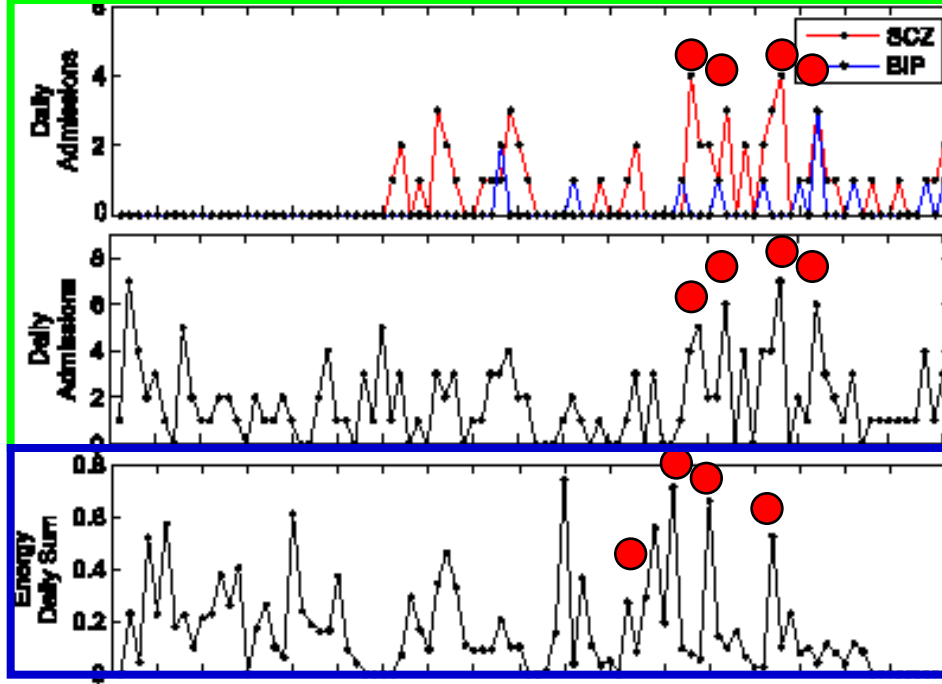
12.08.2010

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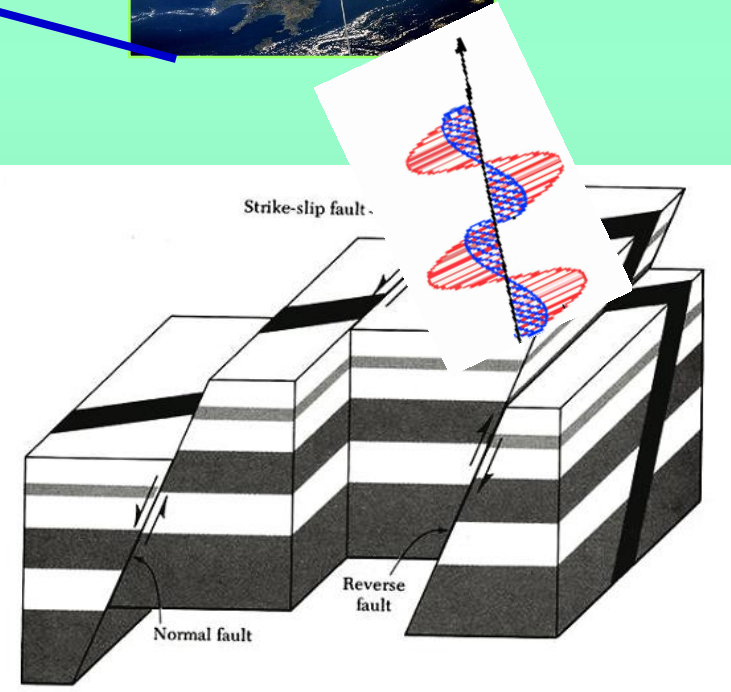
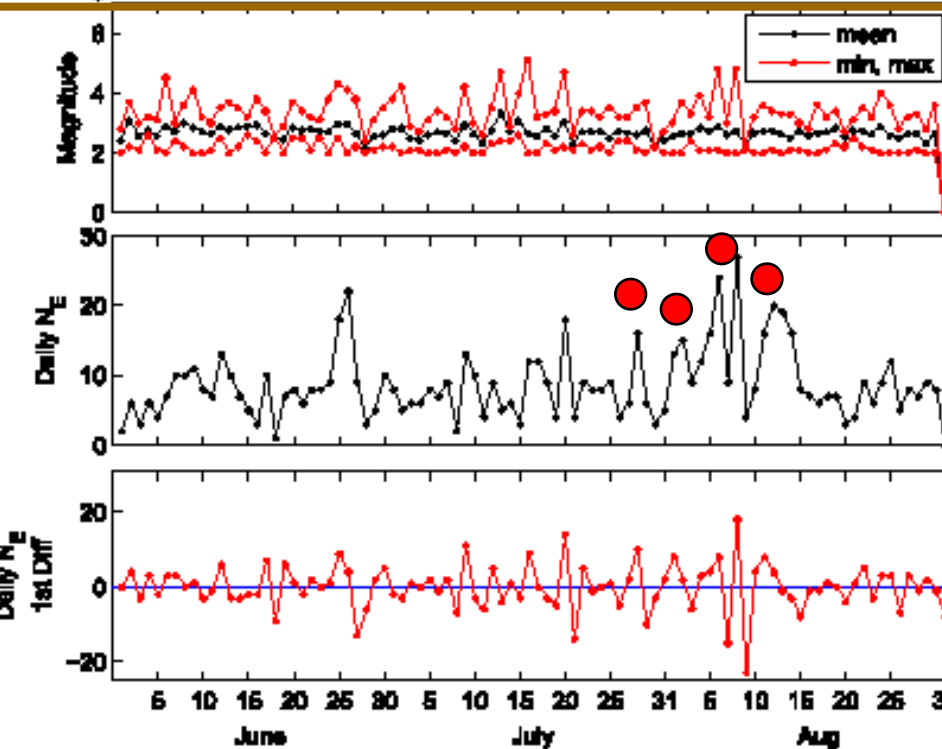


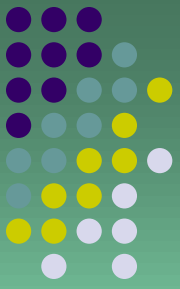




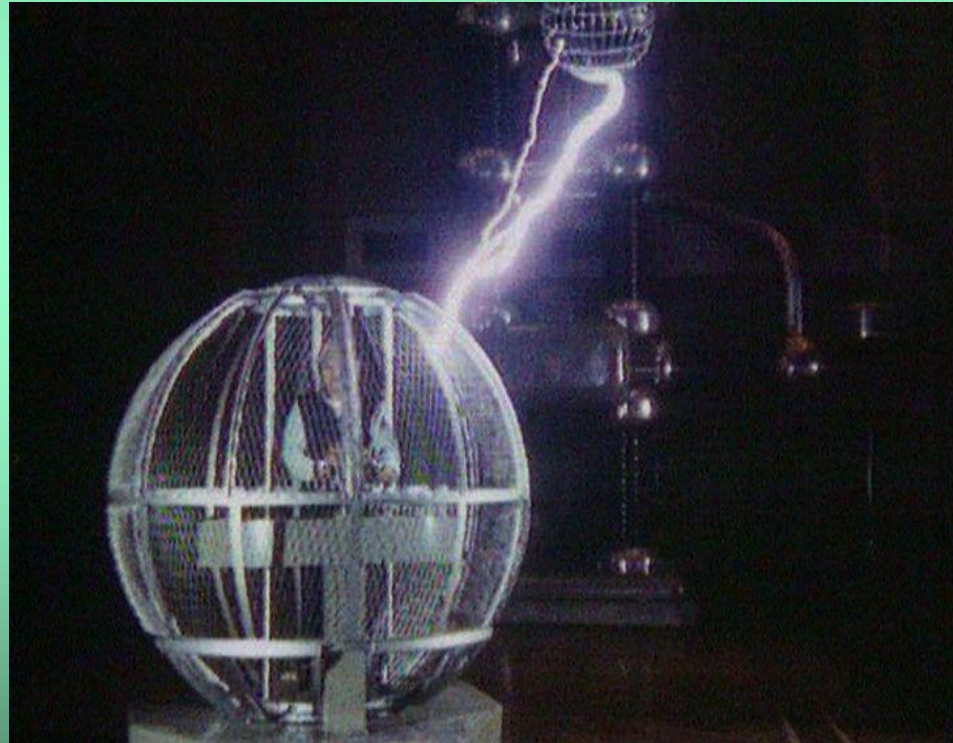


Πανεπιστήμιο Κρήτης  
ΤΜΗΜΑ ΙΑΤΡΙΚΗΣ



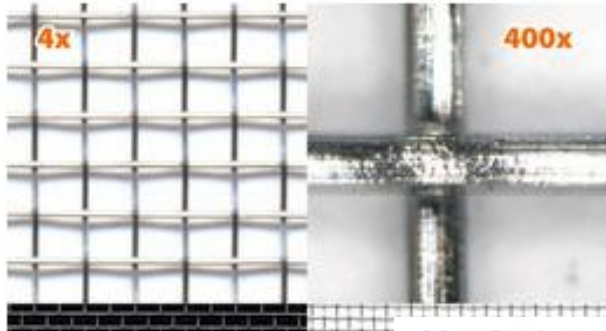


# Ηλεκτρομαγνητική προστασία



# ΗΜ ΠΡΟΣΤΑΣΙΑ (Κλωβός Faraday)

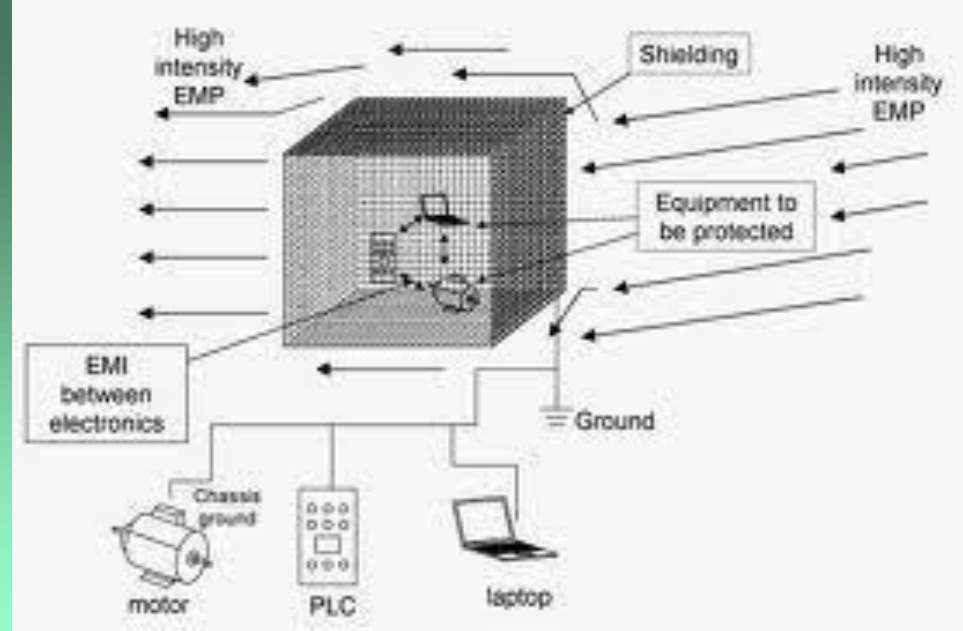
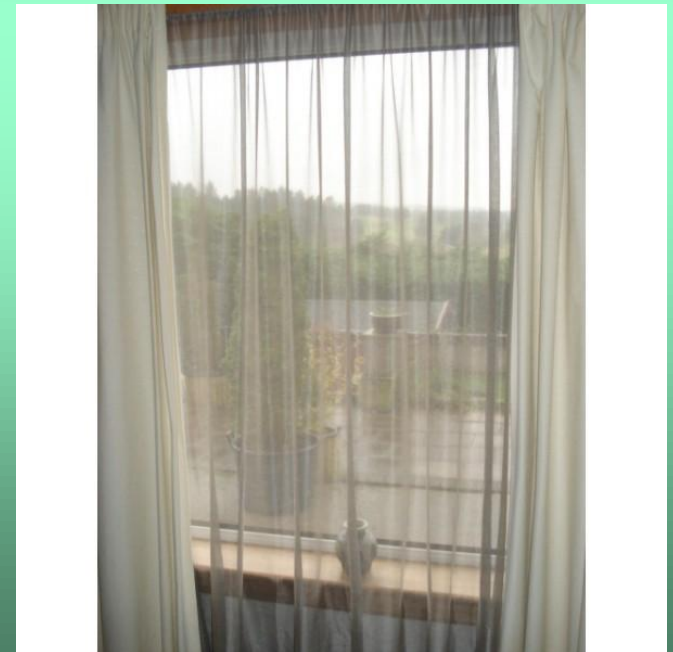
Πλέγμα ηλεκτρομαγνητικής  
θωράκισης



Μπογιά ηλεκτρομαγνητικής θωράκισης



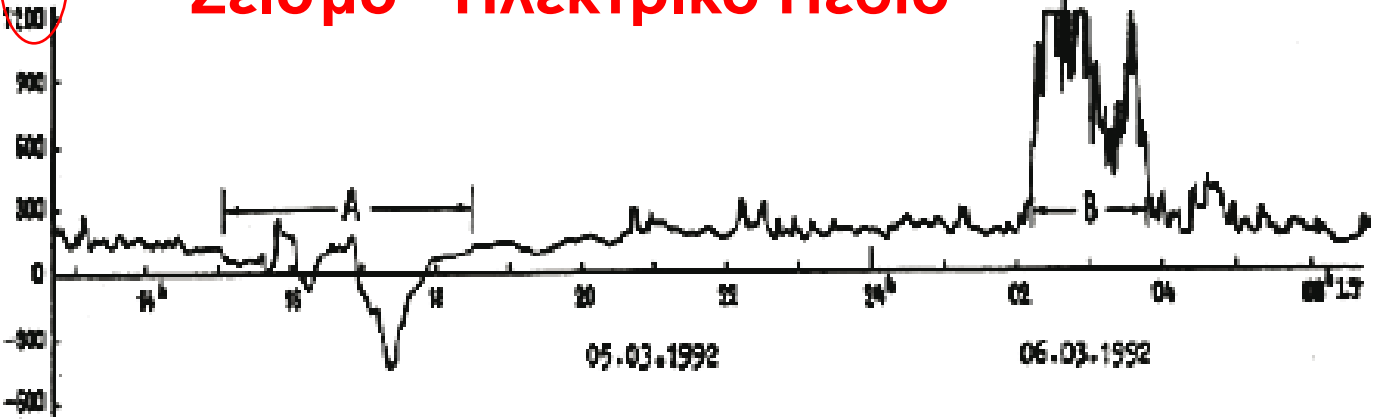
Μεμβράνη ηλεκτρομαγνητικής  
θωράκισης τζαμιών



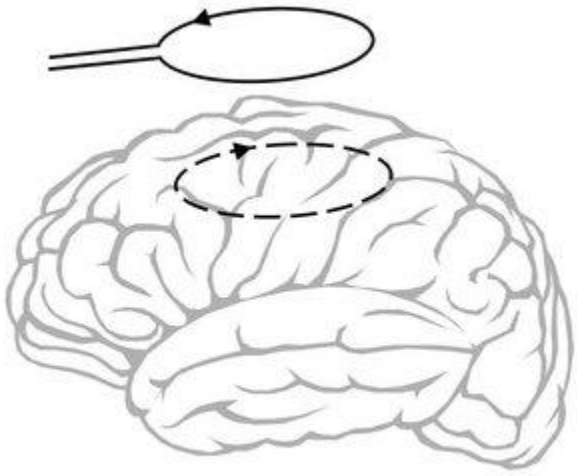
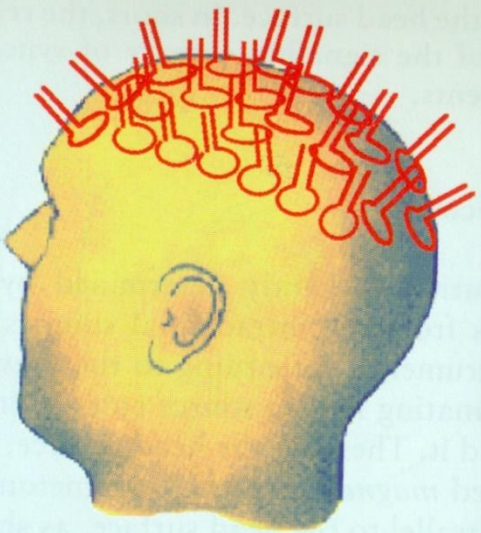
$E, \text{V/m}$

# Σεισμό - Ηλεκτρικό Πεδίο

$M = 6,1; \delta = 130 \text{ km}$



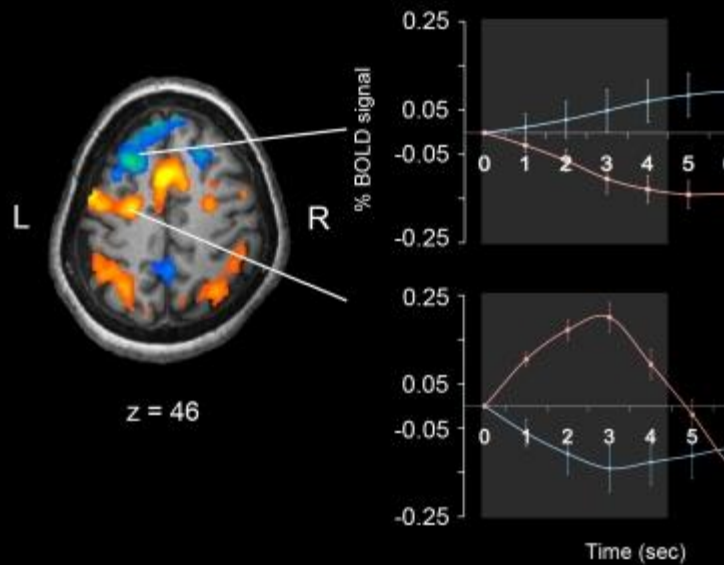
Vershinin et al. 1999



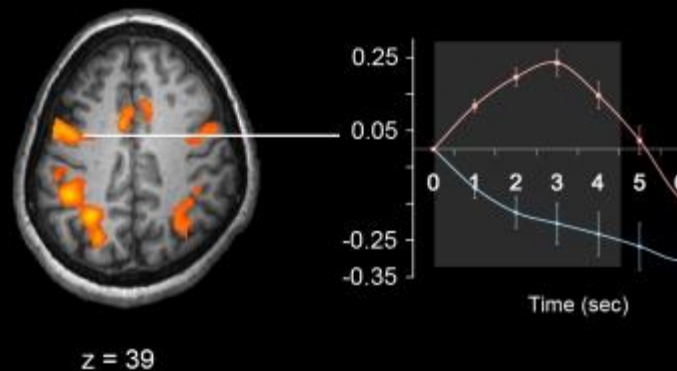
*A. Javidan*



### A. Healthy Controls



### B. Schizophrenia Patients



**An event-related fMRI study of phonological verbal working memory in schizophrenia.**

Kim J<sup>1</sup>, Matthews NL, Park S.

