Investigating the possible relation of electromagnetic signals in the upper VHF and lower UHF bands to earthquakes in Greece

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ABSTRACT:

Various signals, which have been recorded prior to significant EQs, have been intensively investigated for their relation to these EQs, in a quest for the so-called precursors of general fracture. Among them, electromagnetic (EM) emissions, in a wide frequency range extending from lower than 1Hz (subHz, ITU band 0) to very high frequencies (VHF, ITU band 8).

In this work we investigate the possible relation of EM anomalies in the upper VHF, i.e. 142MHz to 230MHz, and the lower UHF (ultra high frequencies, ITU band 9), i.e. 320MHz to 415MHz, bands to significant earthquakes in Greece.

A number of significant surface EQs occurred recently, during 2008, in Greece, on land or near coastline. We try to locate EM anomalies within the recorded signals, which could be associated to specific seismic events. For this purpose, the correlations among the signals at different frequencies of the same station, the same frequency at different stations and their temporal and spatial placement relevant to the EQs are examined. Moreover, well established analysis methods are applied to reveal the meaningful part of the signals from the background noise and examine their possible origination from a subsequent catastrophic event.

Seismic Activity.
During the first two months of 2008, 9 EQs of M>4.5 occurred in S-SW Greece.
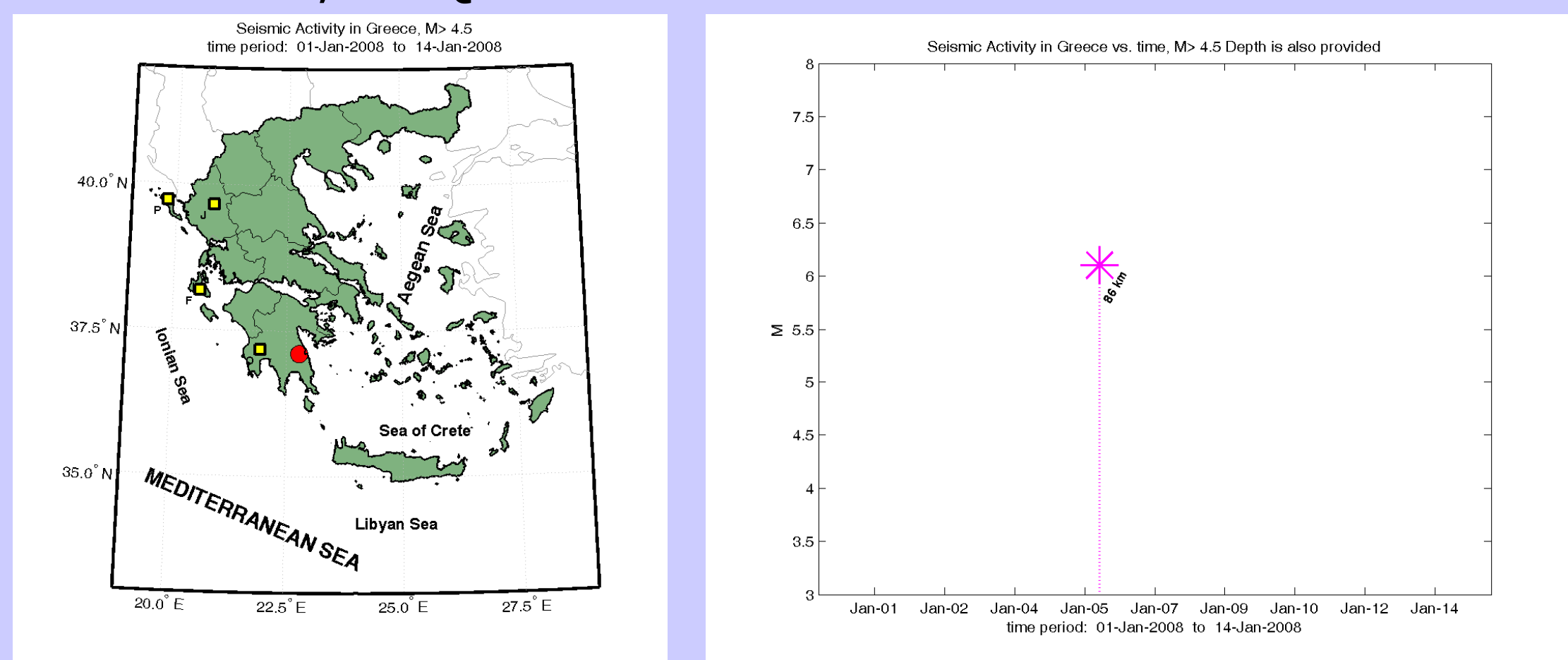
The first two weeks of January a strong EQ (M=6.1) occurred in Leonidion.
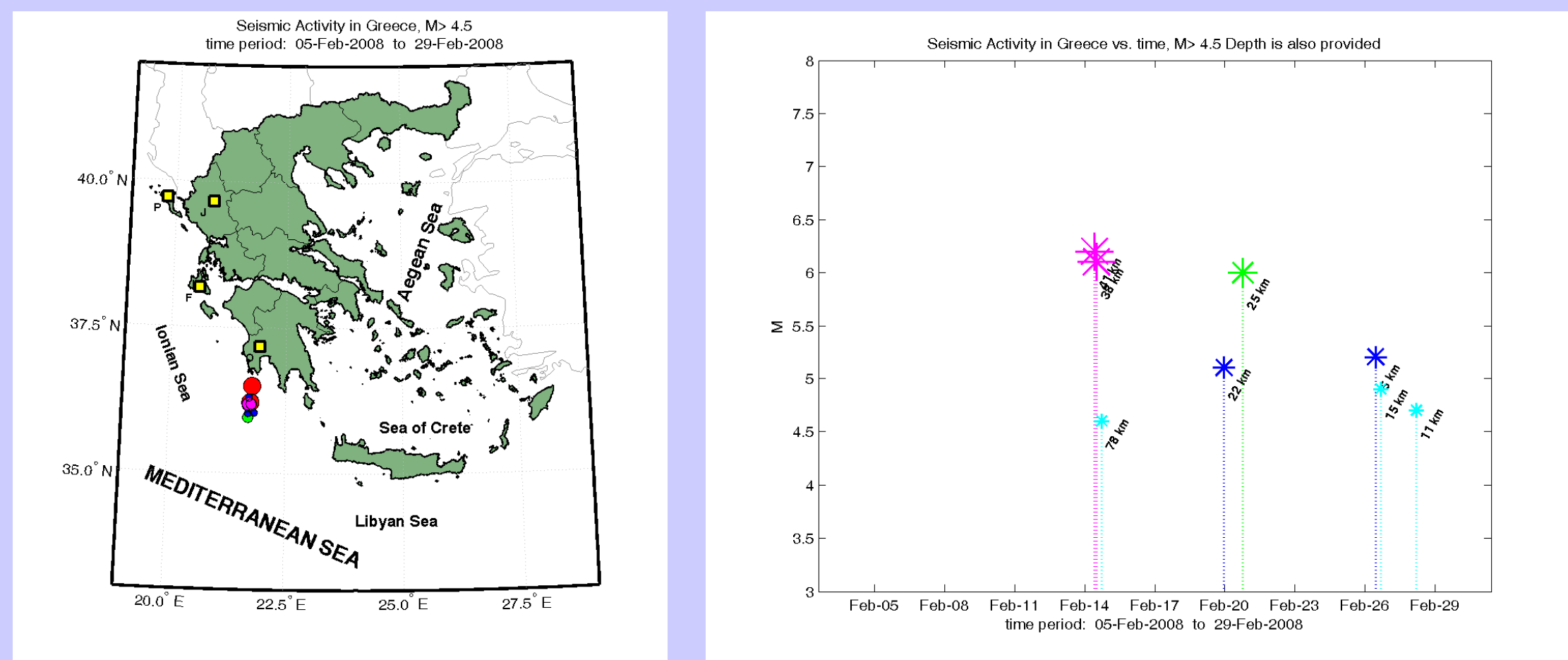
The last three weeks of February several EQs (4.5<M<6.3) occurred south of Methoni. Most of them were of small depth.

The measuring stations positions at Corfu (P), Ioannina (J), Kefalonia (F) and Ithomi (O) are marked in yellow.

Power Law

The power spectrum density (PSD), $S(f)$, is probably the most commonly used technique to provide useful information about the inherent memory of the system, to detect structure in time series. If the recorded time-series is a temporal fractal then a power law spectrum is expected:
$S(f) = \alpha \cdot f^{-\beta}$, where f is the frequency of the transform.

In a $\log S(f) - \log f$ representation the power spectrum is a straight line, with linear spectral slope β. The spectral amplification α quantifies the "power" of the spectral components following the power spectral density law. Applying the least square method, we calculated β, α, and the linear correlation coefficient r of the power law fit. The global wavelet spectrum is used in order to provide an unbiased and consistent estimation of the true power spectrum of the time-series .
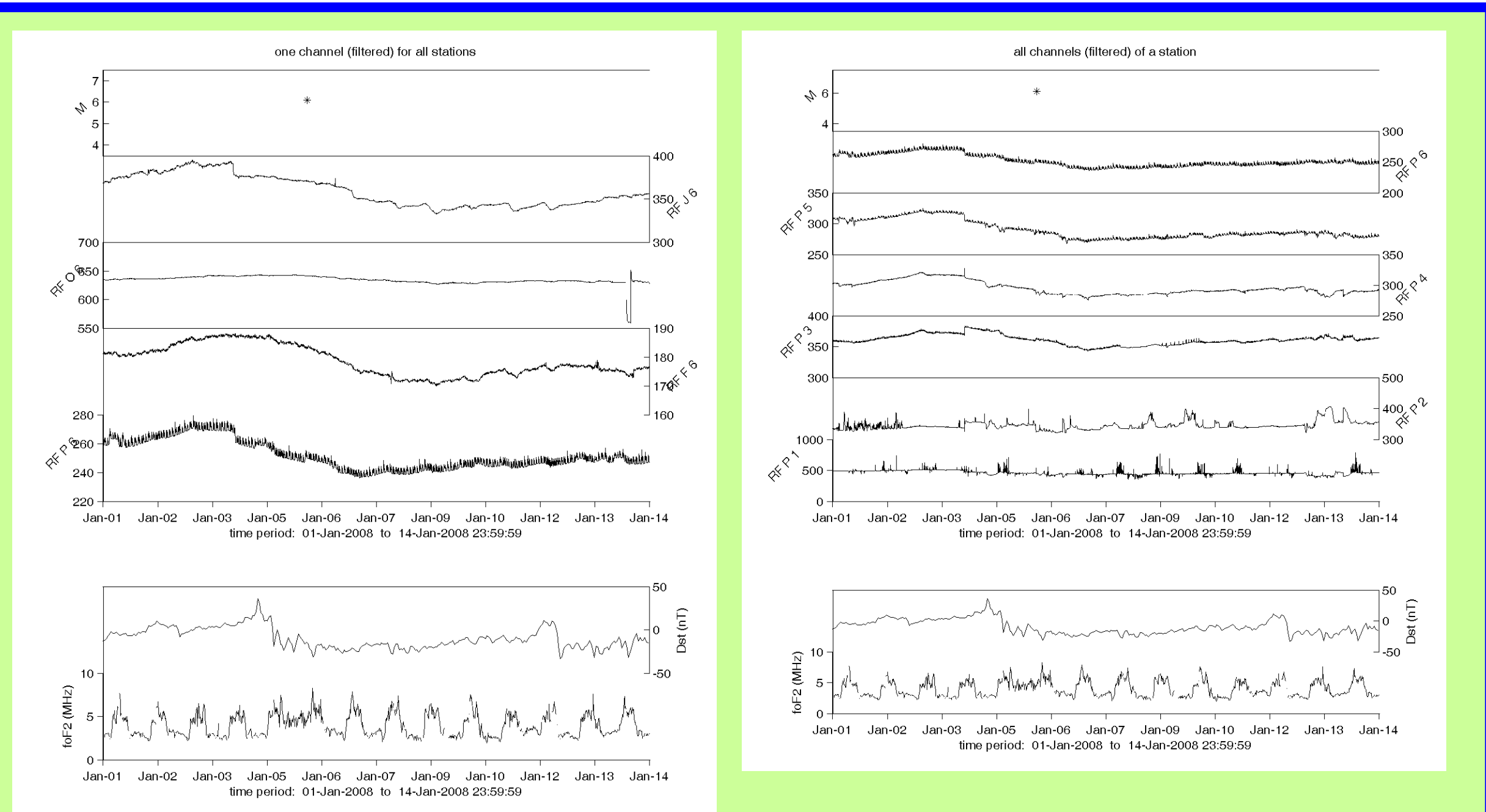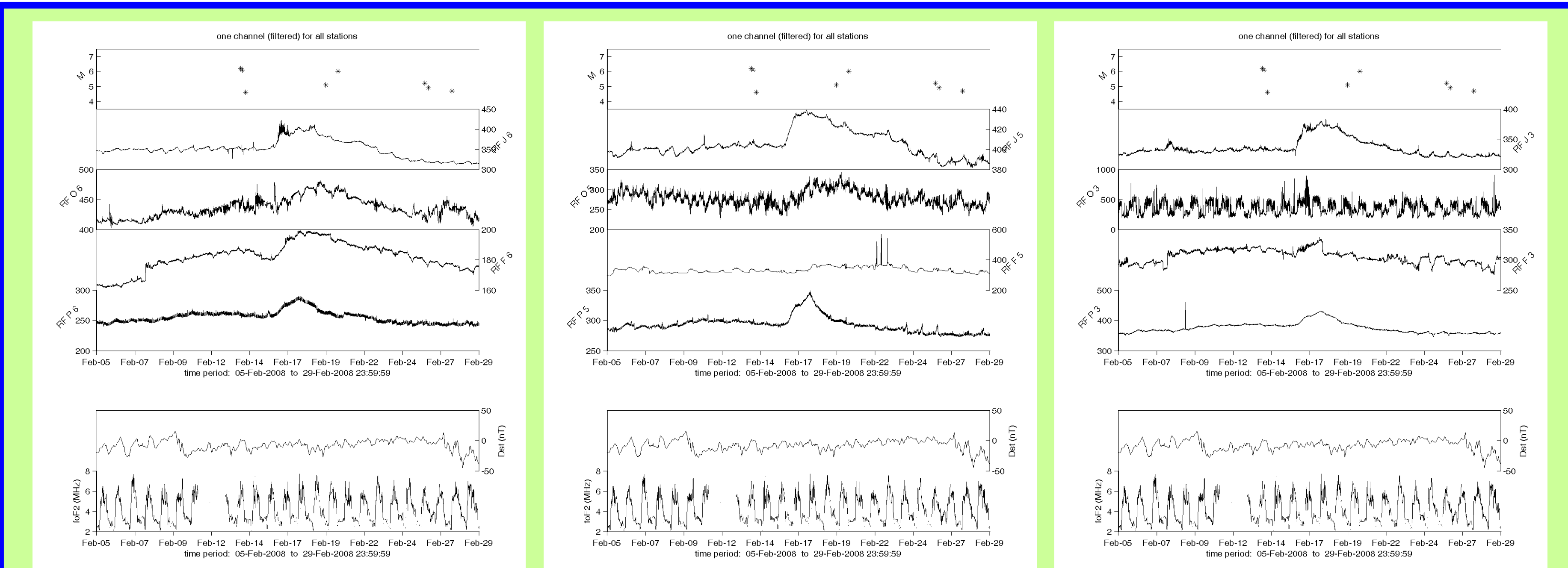

6th Channel (415MHz / UHF) for all stations
1-14 January 2008

All stations present a correlated change between 2 and 5 of January which don't seem to be related to ionosphere or magnetic changes.

All channels for station Corfu (P)

Likewise, most of the channels of station P present a slow evolving peak between 2 and 5 of January, just before the Leonidion EQ.
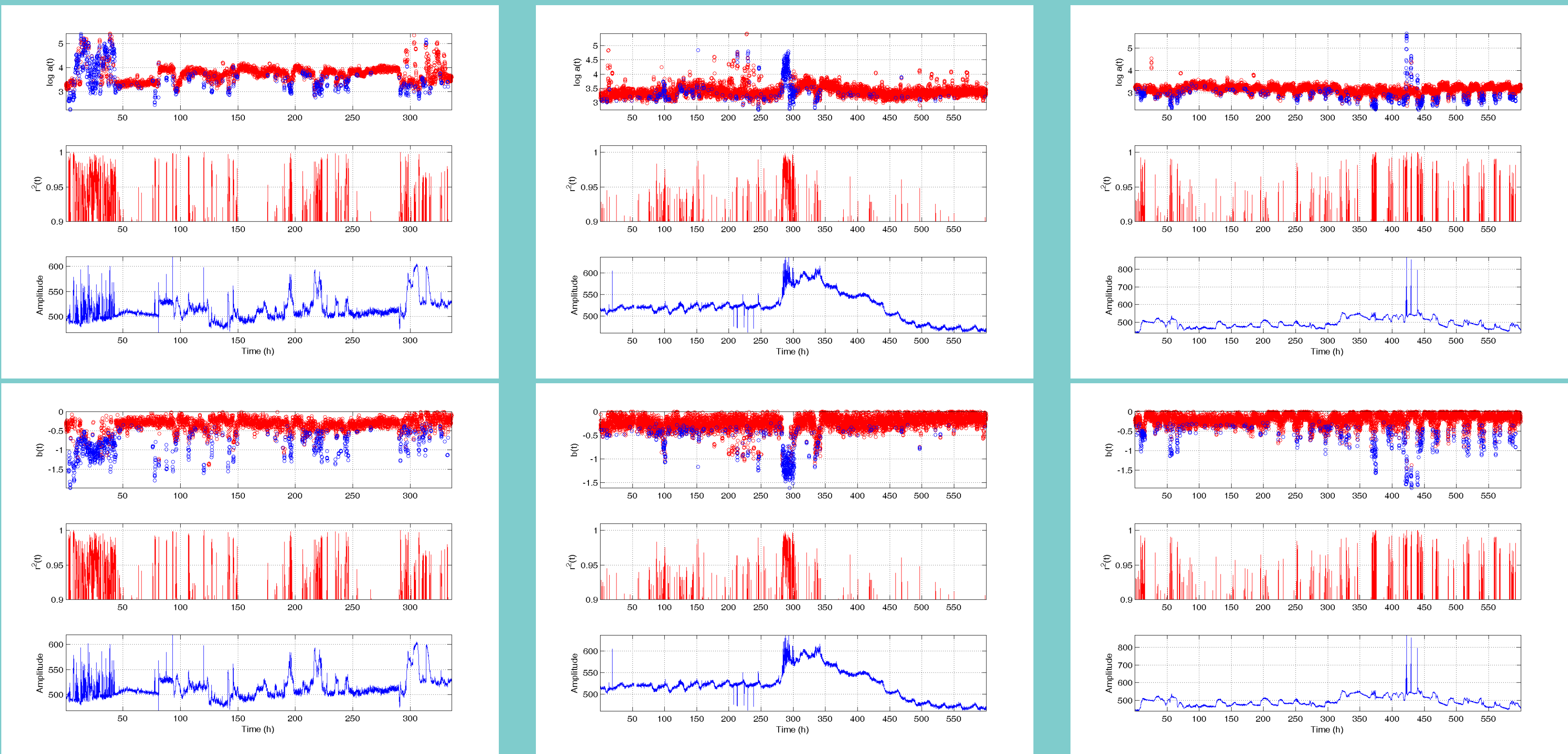

6th Channel (415MHz / UHF)   5th Channel (390MHz / UHF)   3rd Channel (230MHz / VHF)
5-29 February 2008 / the same channel for all stations

All stations present a correlated change between 15 and 20 of February, in all channels. This is just after the three (relatively deeper) EQs of 14/02/2008 and before the closer to surface EQs that follow. None of the recorded EM changes seems to be related to ionosphere or magnetic changes.

P / 2nd Channel (178MHz / VHF)   J / 6th Channel (415MHz / UHF)   F / 5th Channel (390MHz / UHF)
1-14 January 2008   **5-29 February**

Before the EQ in Leonidion β-values increase to (1, 1.5), while α-values increase to (4.5, 5.5)

Before the strong shallow EQs of 19 & 20 /02/2008 and 26 & 28 /02/2008 south of Methoni β-values increase to (1, 1.5), while α-values increase to (4.5, 5.5)

CONCLUSION:

EM signals presenting a slow evolving mean value increase before important EQs occurred in Greece (during the first two months of 2008) have been recorded in almost all monitored (upper VHF & lower UHF) frequencies, and all stations along the Hellenic arc. Moreover, anomalies of higher evolution rate have been identified at different frequencies/stations. None of the above seems to be related to ionosphere or magnetic anomalies. The observed increase of β-values with time in the anomalies indicates the gradual reduction of complexity in the underlying dynamics, while their range suggests anti-persistent behavior. However, more investigation has to be performed before these findings can be definitely characterized as pre-seismic.