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## *Citizen Seismology:*

# Harnessing the Collective Power of Citizens for Efficient Crisis Response

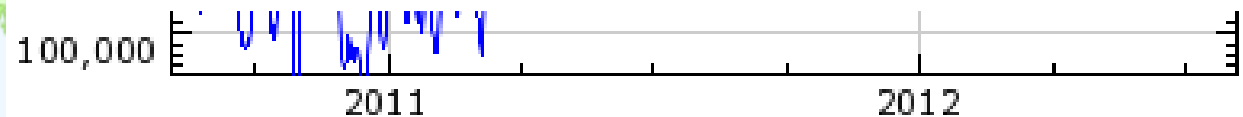
R. Bossu, S. Lefèvre, G. Mazet-Roux and F. Roussel

[www.emsc-csem.org](http://www.emsc-csem.org)

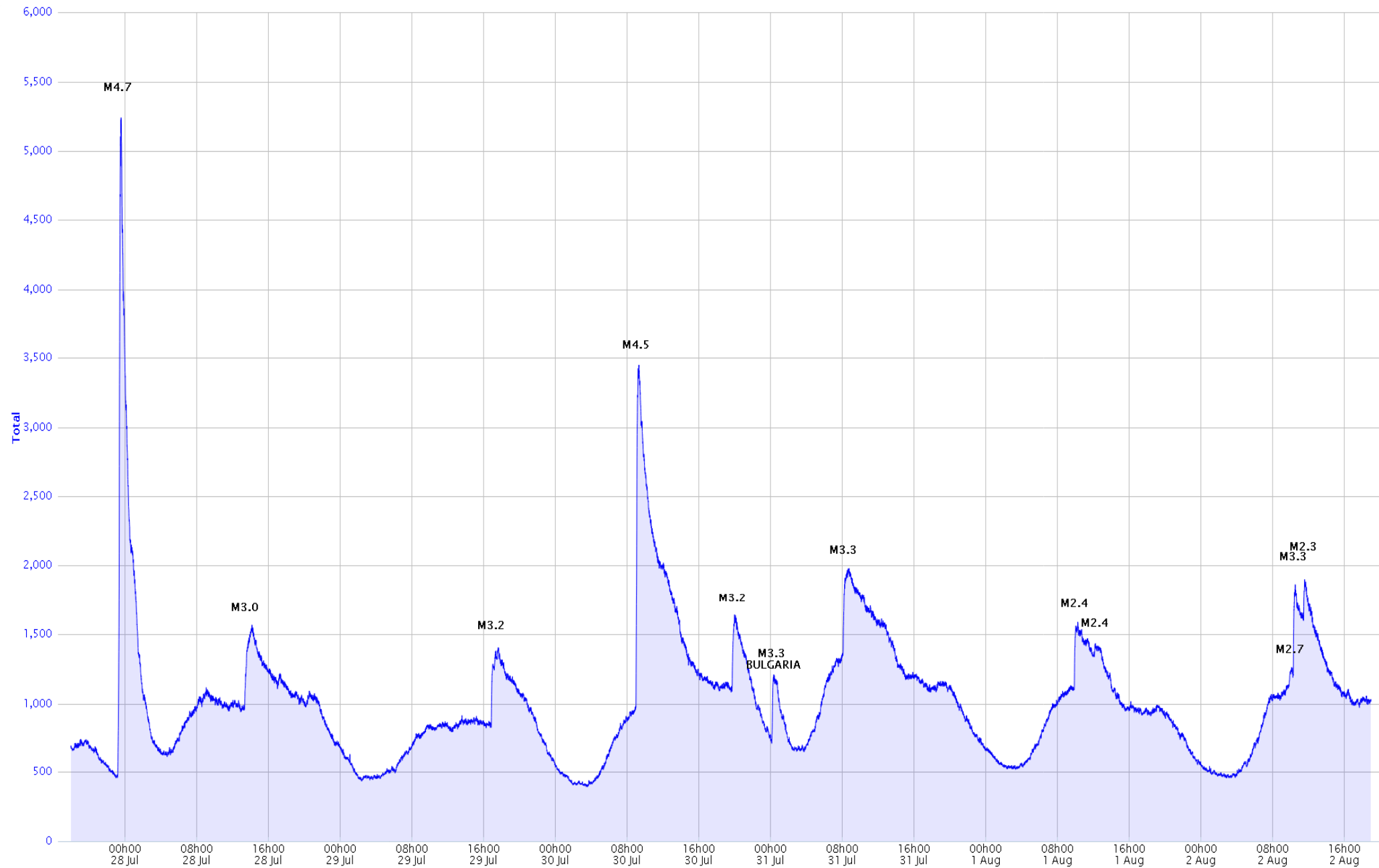
# EMSC Real Time Earthquake Information Services



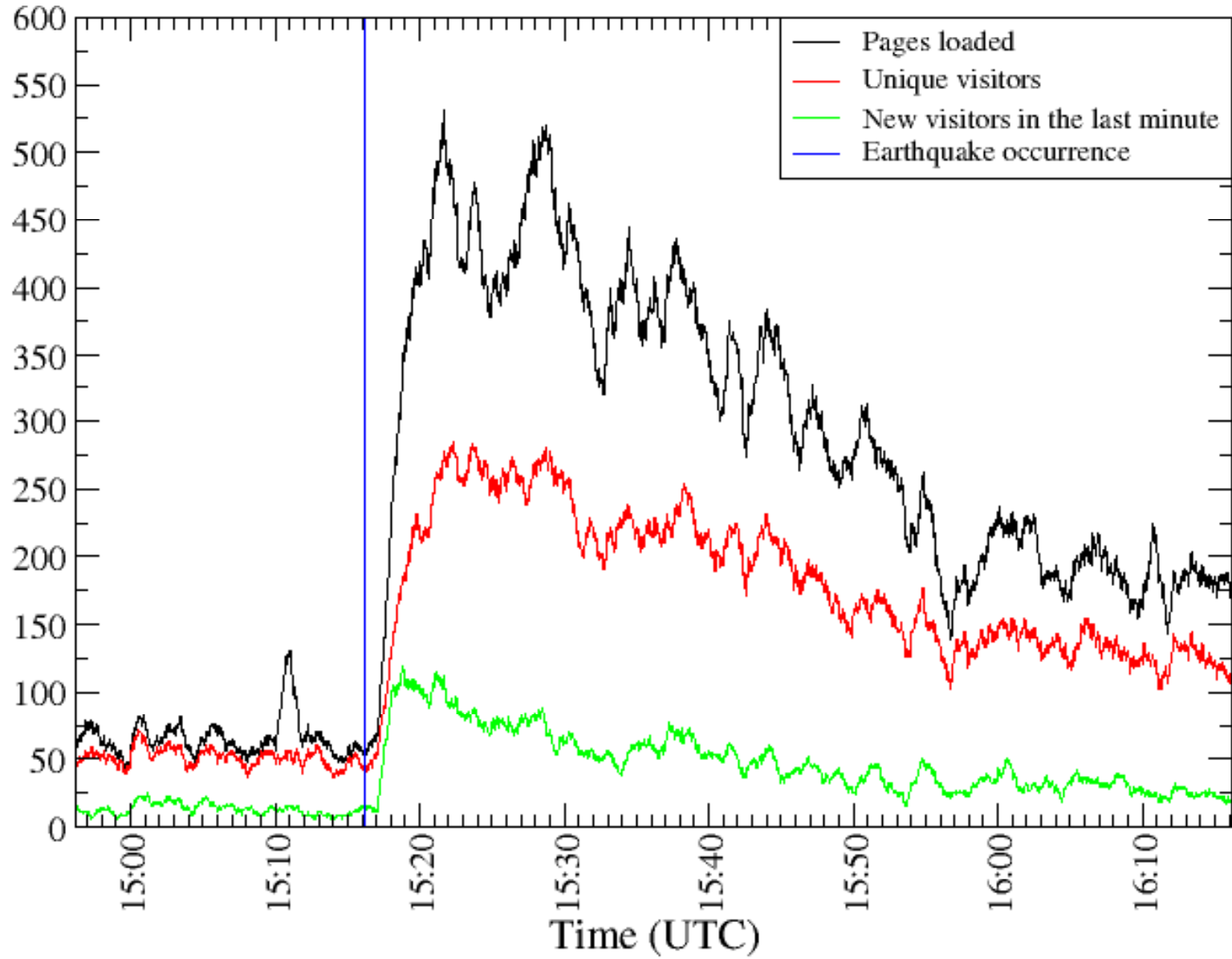
- Not for profit NGO: 84 institutes as members from 55 countries
- Second Global Earthquake Information Website
- RT Information Services by data collation from 70 networks
- Well identified website especially in the Euro-Med region:
  - Traffic rank: 20 000 - 40 000 (source [www.alexa.com](http://www.alexa.com))
  - 1.5 to 2 millions visits per month from 220 countries



# Seismic activity vs load of EMSC webserver



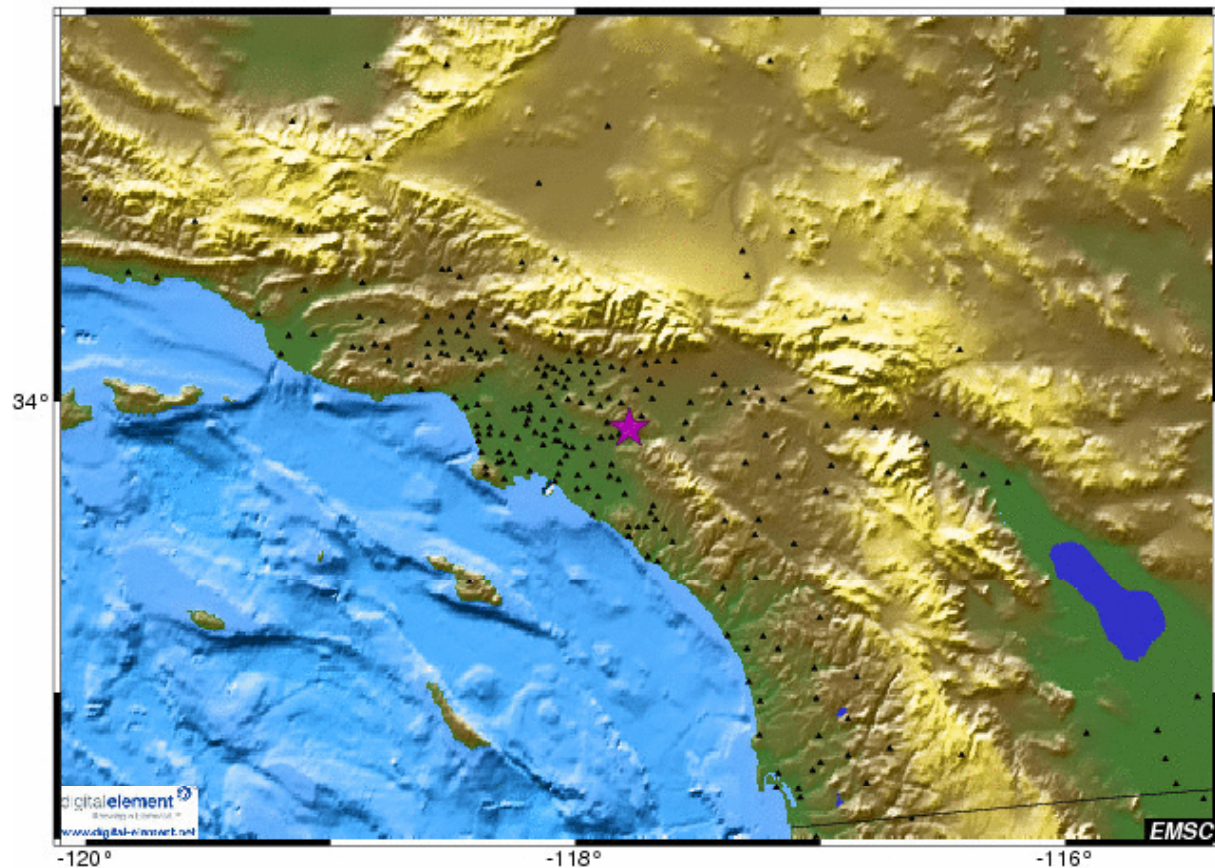
## Flashcrowd Caused by Felt Earthquakes



# Flashsourcing results



ML 4.4 GREATER LOS ANGELES AREA, CALIF.  
2012/08/08 06:23:34.3 UTC



**Before earthquake**

Variation of observed from expected traffic  
 ● Significant\* increase      ● No significant\* variation      ●/● Significant\* decrease/absence  
 ▲ Regional audience (at least one visit in the last 12 months)      \* At 99 % confidence level.

Difference between expected and observed numbers of unique IPs

○ 0      ○ 10      ○ 50      ○ ≥ 100

★ Epicenter

OECD

Updated on 2012/08/08 06:55:49 UTC

## EMSC Twitter Service

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Real Time Publication of Automatic Detection of Felt Quakes:

- Within 90 s of earthquake's occurrence (average)
- Faster than seismic networks for 90% of the earthquakes



**LastQuake** EMSC

NEW: Unconfirmed reports of a felt #earthquake in Western Turkey app. 2 min ago. <http://bit.ly/hgdCG9>

19 Mai ★ Annuler ↩ Répondre 🗑 Supprimer



**LastQuake** EMSC

NEW: Felt #earthquake M5.9 - Western Turkey - May 19, 2011, 20:15 UTC (7 min ago) <http://bit.ly/k6na0M>

19 Mai



## Another illustration (by Paul Earle, USGS)

Possible Twitter earthquake detection  
NOT AN OFFICIAL USGS ALERT  
NOT SEISMICALLY VERIFIED

Detection Time:  
2012/01/25 08:07:42

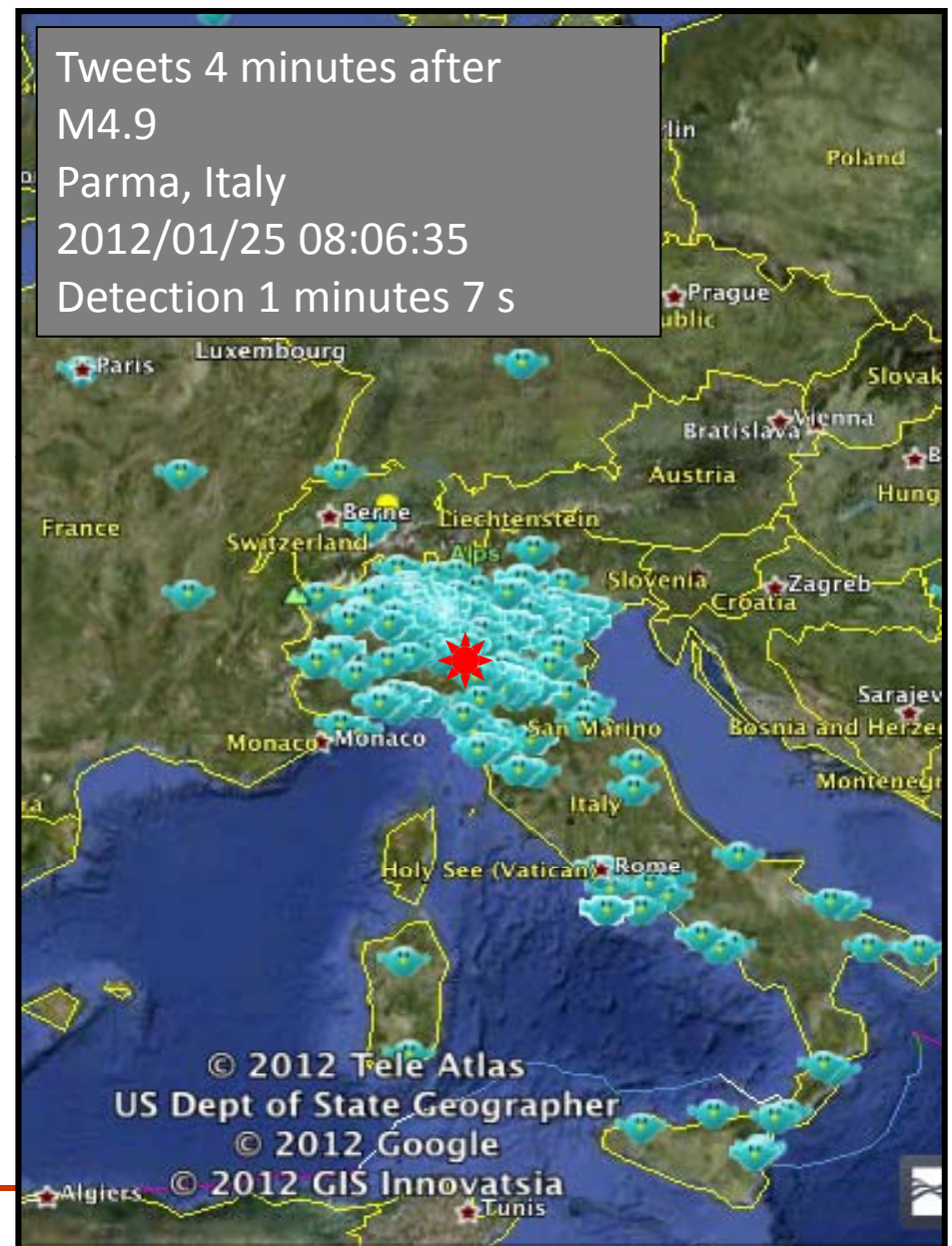
### Tweets:

2012/01/25 08:07:33  
Location: Padova - Italy  
GEO: 45.40 11.81 (A)  
terremoto!!! #padova

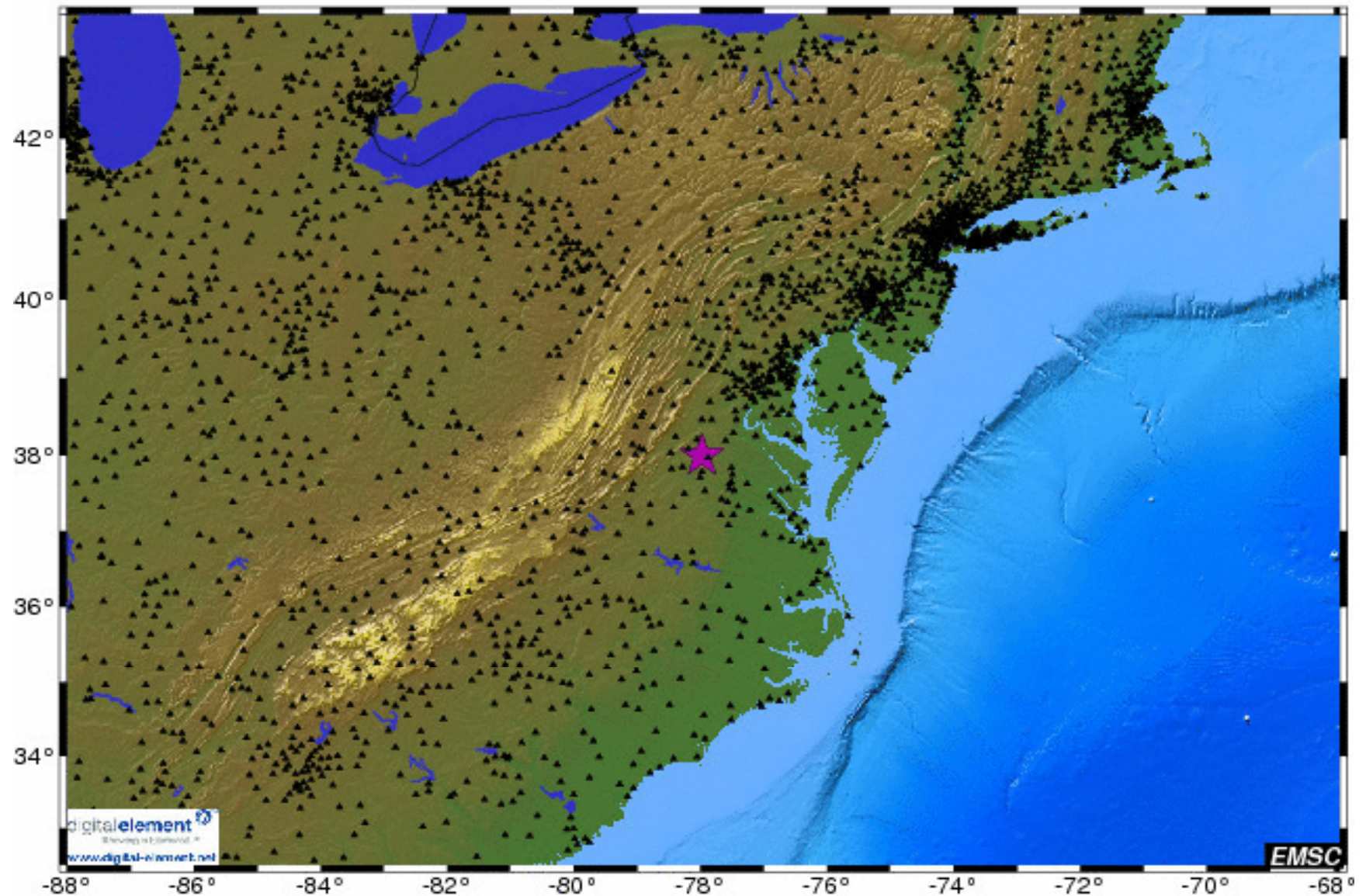
2012/01/25 08:07:33  
Location: Milan, Italy  
GEO: 45.46 9.12 (C)  
Mamma Mia..... Qua ballava tutto!!! #terremoto

2012/01/25 08:07:9  
Location: Cremona  
GEO: 45.02 10.12 (C)  
Terremoto pauroso.  
Porcaputtana.

2012/01/25 08:07:12  
UL: Parma // Valcamonica  
GEO: 5.42 11.82 (C)  
SCOSSA FORTISSIMA E LUNGA DI TERREMOTO



# Virginia, M5.8, 23 Aug. 2011

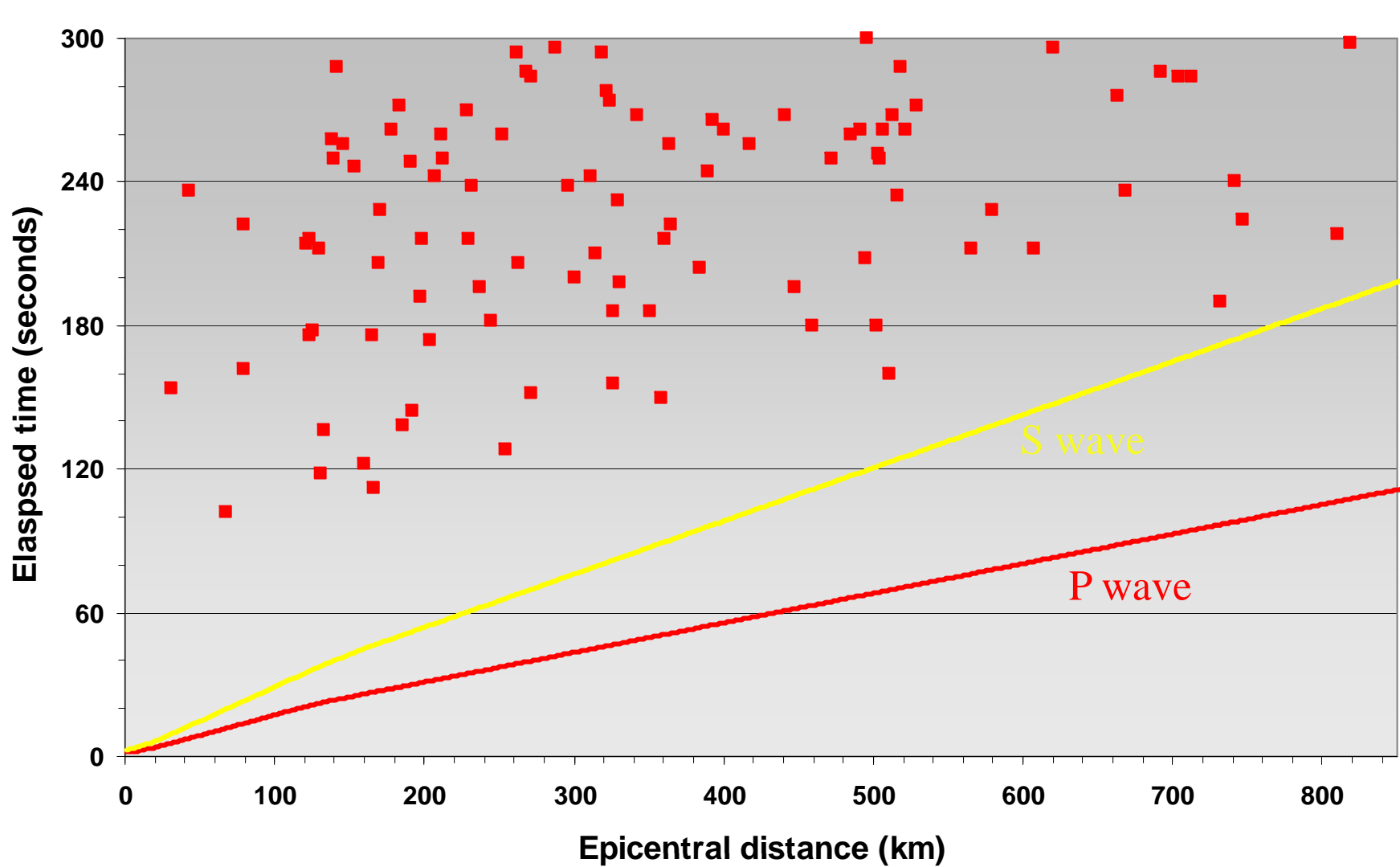


**Before earthquake**

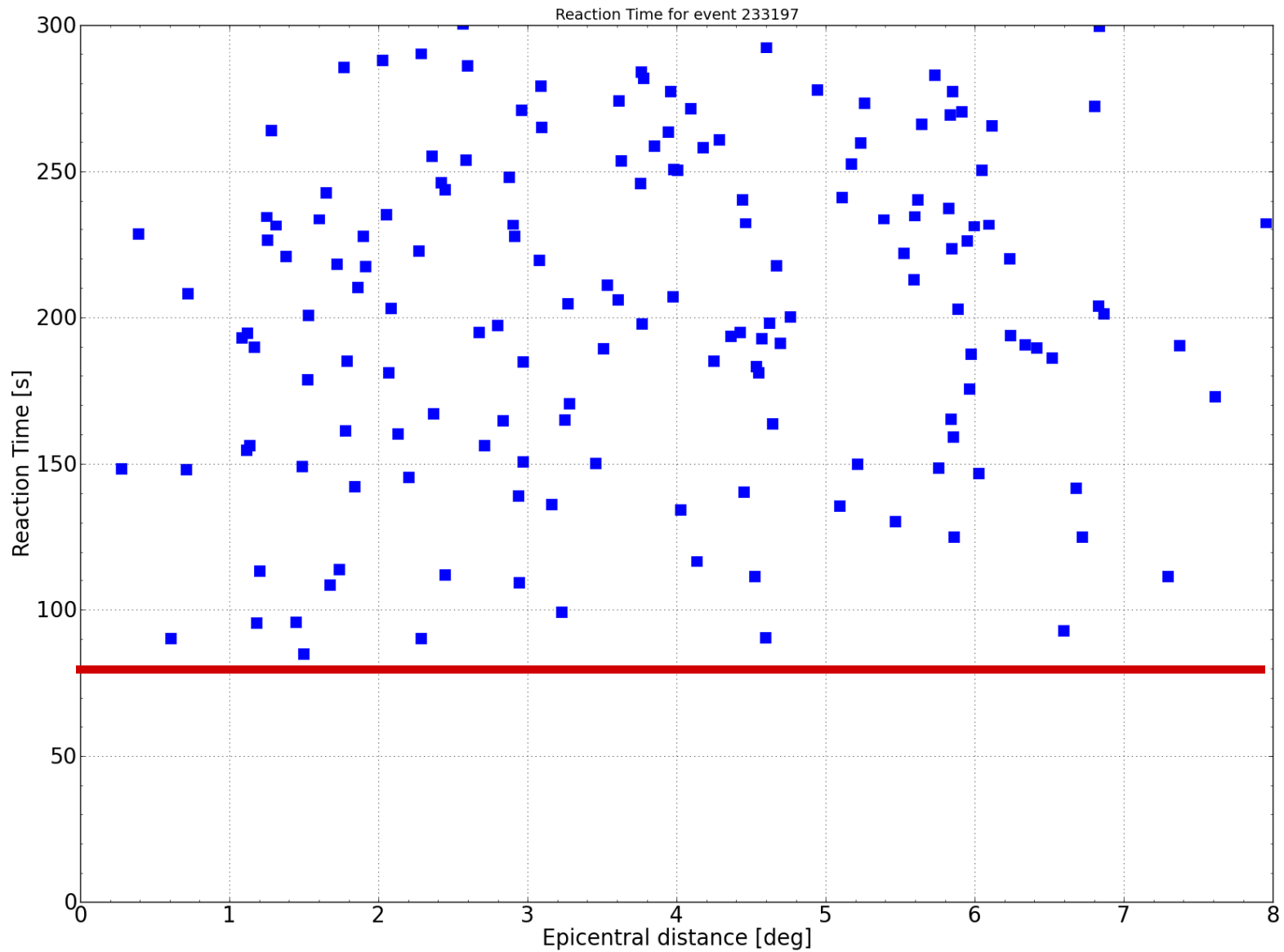
0 km 200 km 400 km



# Eyewitnesses Reacted to the P waves!

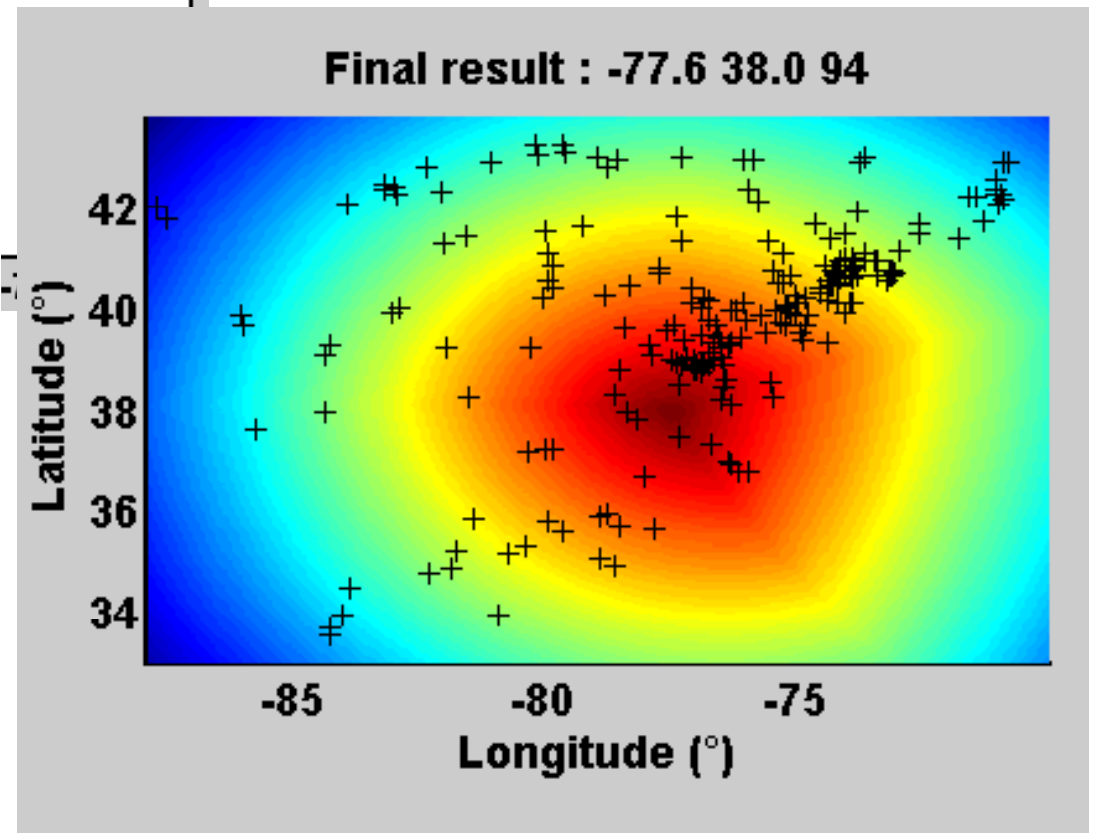
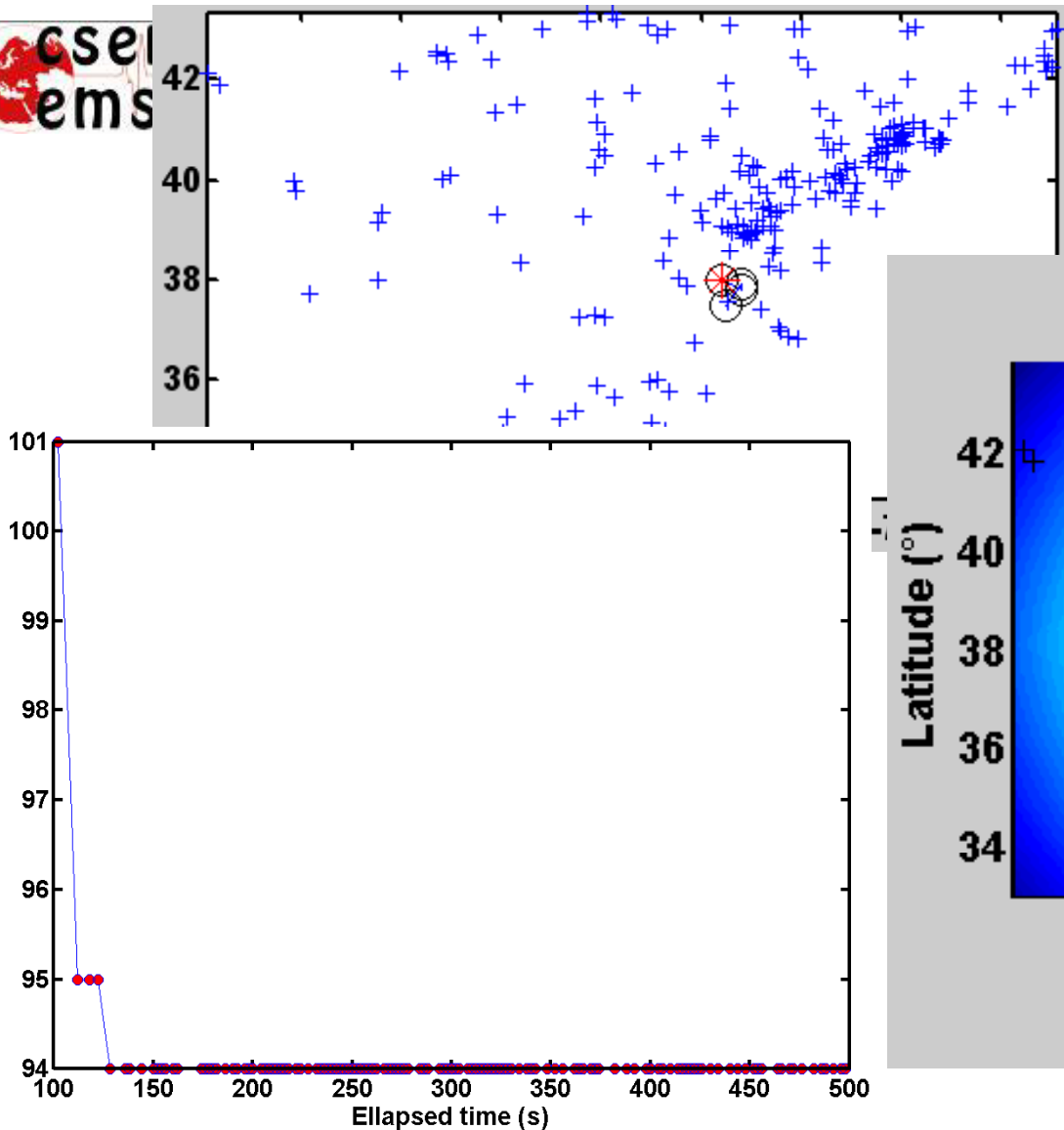


# Reaction Time: About 80s

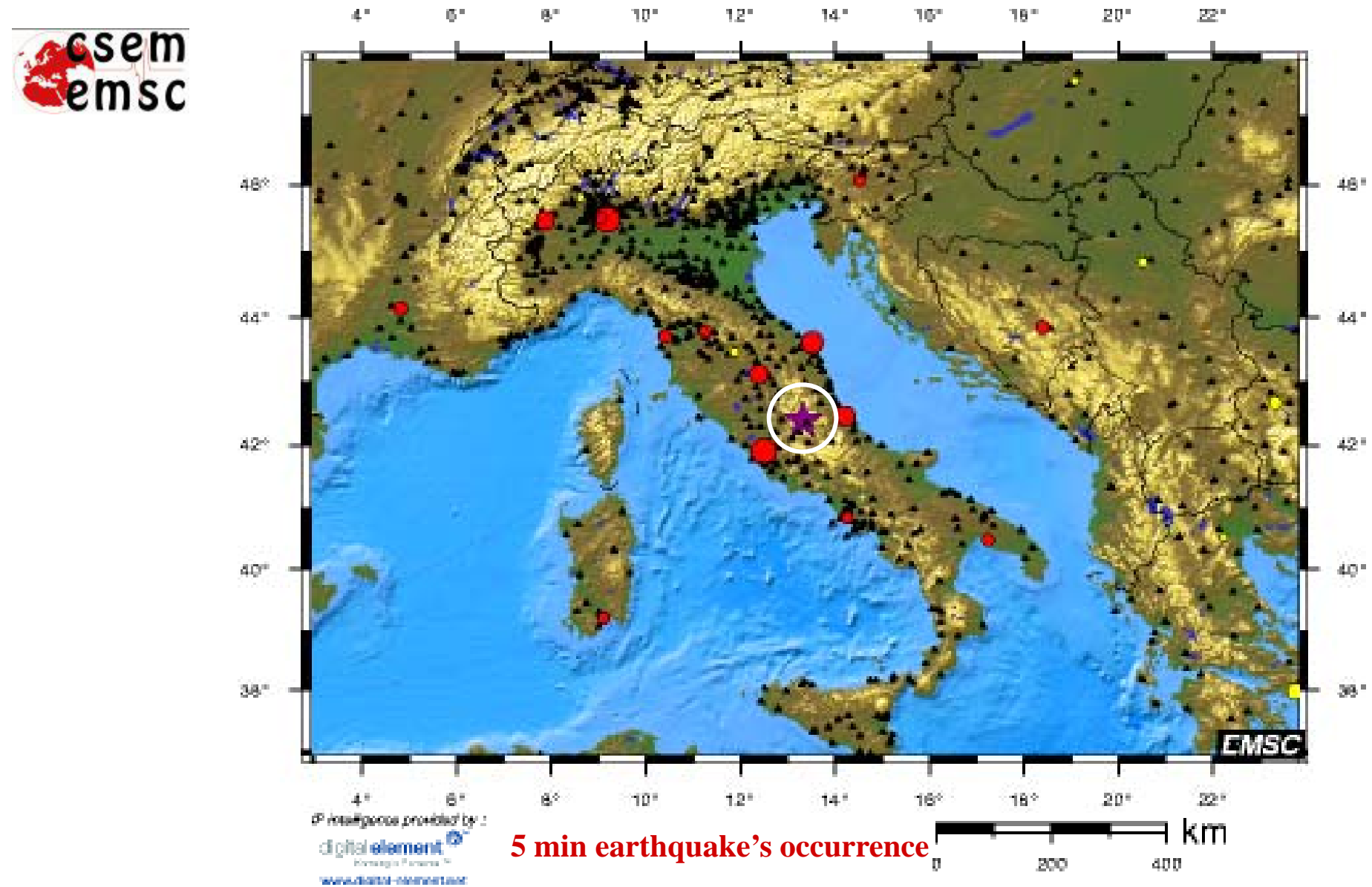


# Eyewitnesses as RT seismometers!

Earthquake Location  
in 120 sec, 30 km accuracy!

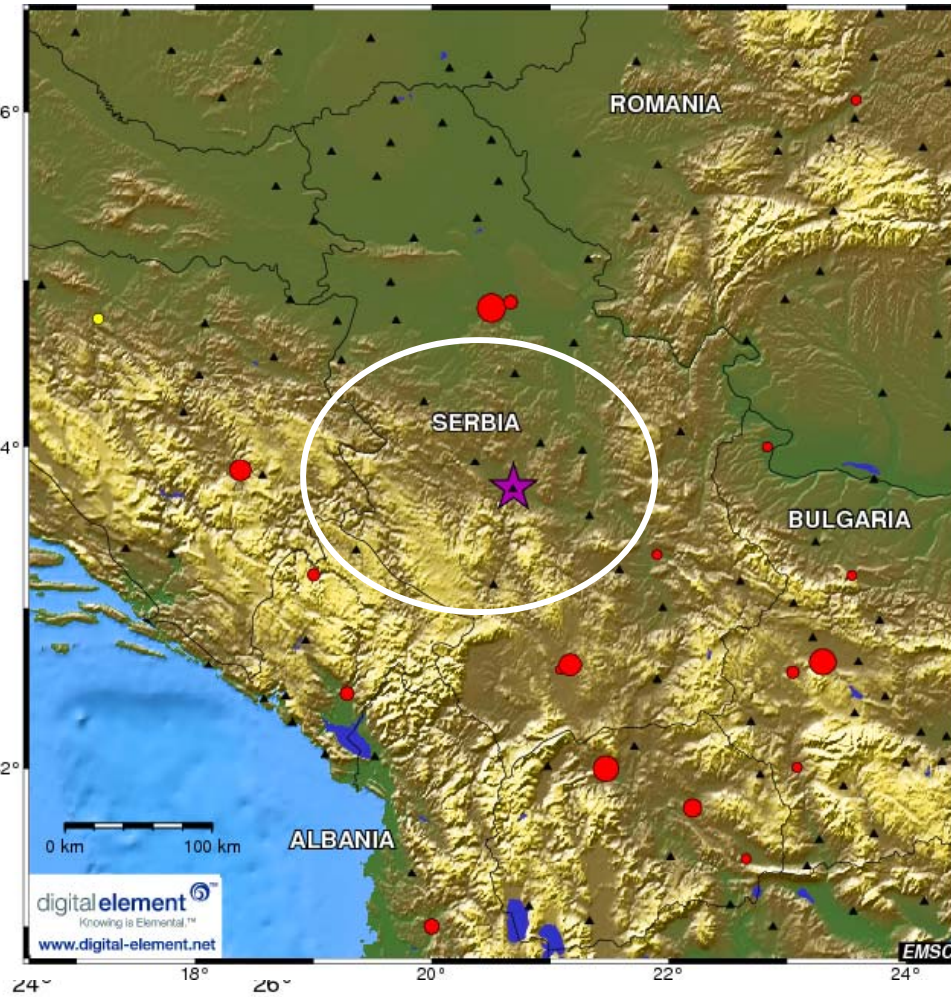


# Damage Detection and Mapping





# No Visitors from Damaged Areas: *Doughnut Shape*



★ Epicentre

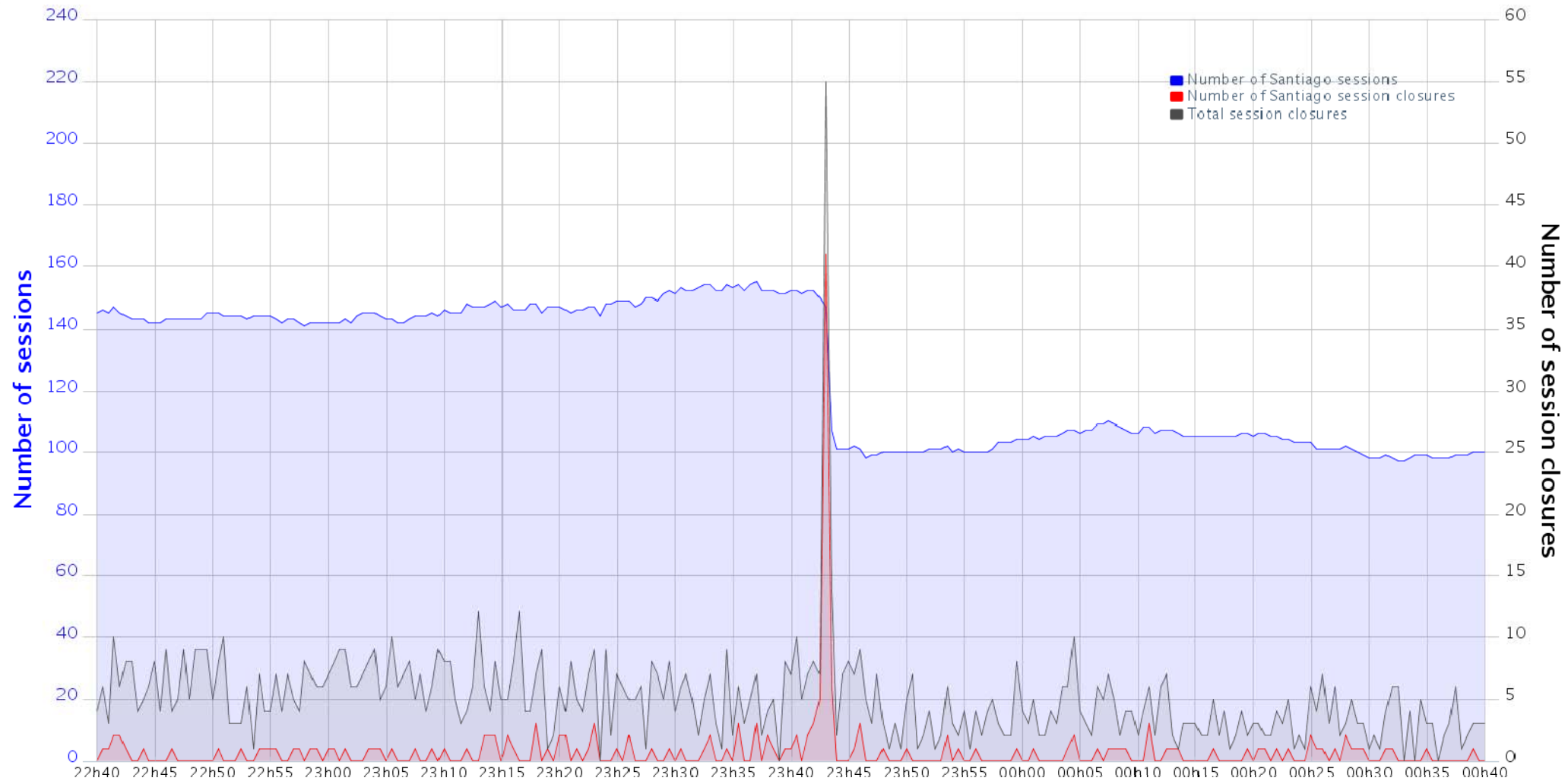
115 responses from 25 communities

0 km 100 km

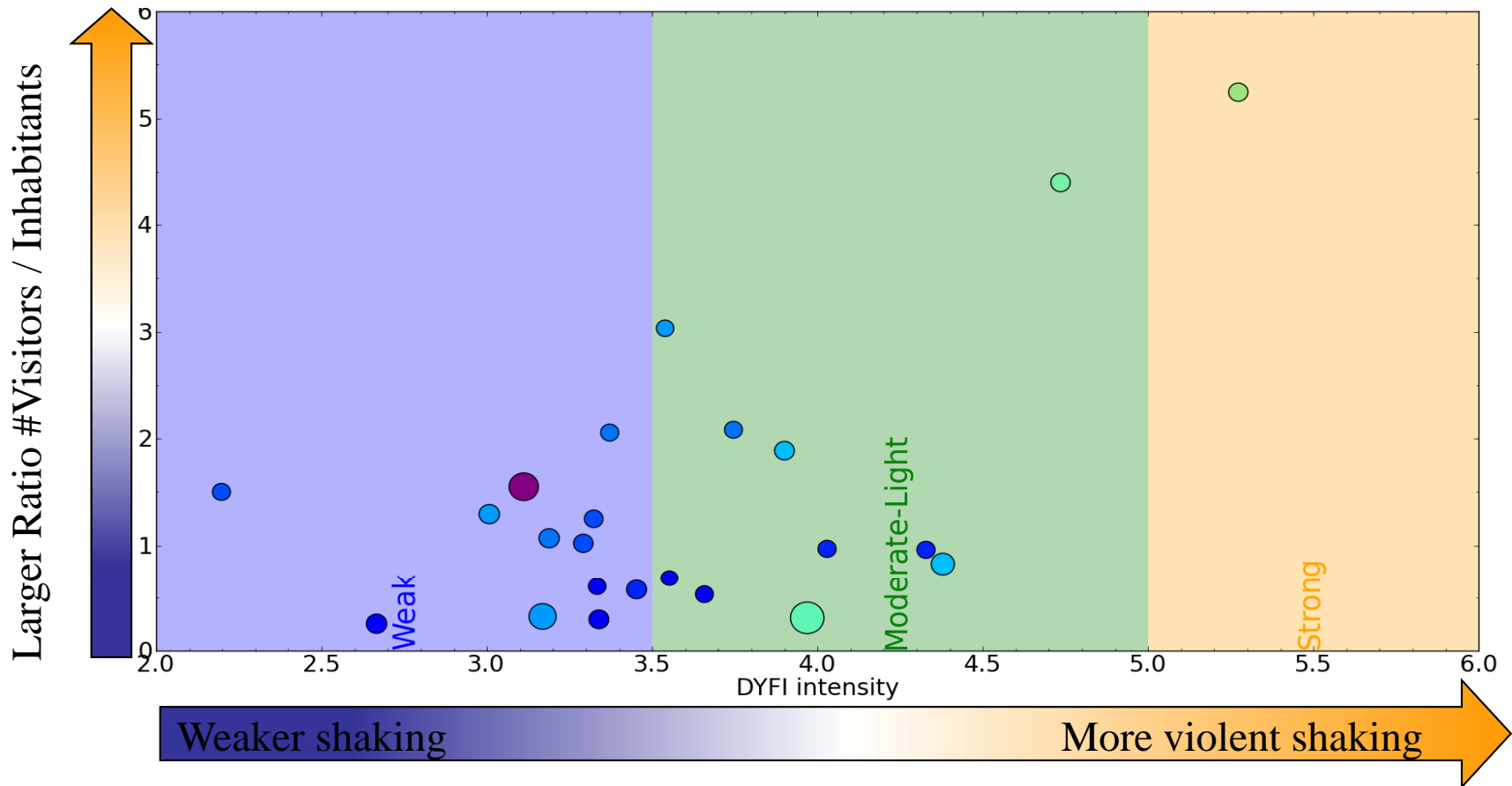
M5.4, Serbia, Nov. 2010

EMS-98	Intensity	F	I	II	III	IV	V	VI	VII	VIII
	Effects	Felt	Not felt	Scarcely felt	Weak	Largely observed	Strong	Slightly damaging	Damaging	Heavily damaging
	Nb forms:	○ 1 form	○ ≤ 5 forms	○ ≤ 20 forms	○ > 30 forms					

# Electricity Black out, Chile March 2010



## Evaluate the Level of Shaking?



And Map the Evacuated Areas ...?



## M6.4 Ajar (Iran): 44 geo-located pictures

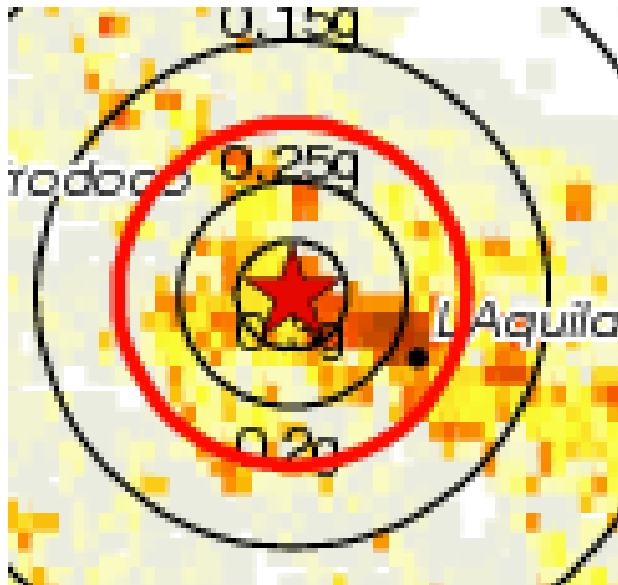




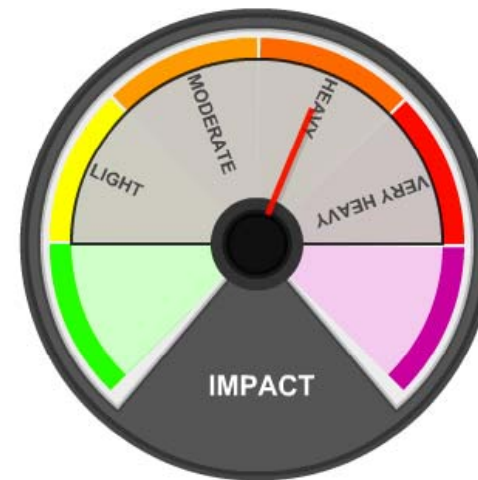
## Why in-situ Information are Essential?



- Intrinsic uncertainties in earthquake scenario
- Scenario for moderate quakes (M5.5-6.5), e.g. Athens, L'Aquila, highly sensitive to epicentral locations



Epicenter location uncertainties



IMPACT	NONE	LIGHT	MODERATE	HEAVY	VERY HEAVY	EXTREME
%	0.0	39.3	2.2	41.8	16.6	0.0

Impact assessment variability

⇒ In-situ information help to quickly reduce scenario uncertainties

## Conclusions

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- Citizen seismology provides rapid in-situ information on the effects of earthquakes within minutes of its occurrence:
  - Harness the collective power of eyewitnesses
- Fill the information gap in the first minutes after the earthquake
- Based on eye-witnesses (first informed – first concerned) who naturally converge on EMSC website
- Addresses the reliability issue:
  - Validation by statistical analysis
  - Check consistency between different types of information (website traffic analysis, online questionnaires, pictures and seismic info)
  - Focused on a short time window : difficult to trick !

## For More Information

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Thank you for your attention !

- Bossu, et al., *Flash-sourcing: Real Time Mapping of Earthquake Effects from Instantaneous Analysis of EMSC Website Traffic*. Annals of Geophysics 2011
- Bossu and Earle, *On the use of the Internet to collect earthquake information* Annals of Geophysics 2011
- Bossu et al., *Citizen Seismology or How to Involve the Public in Earthquake Response in Comparative Emergency Management: Examining Global and Regional Responses to Disasters*. Editors: M. Miller and J. Rivera. Auerbach/Taylor & Francis Publishers. 2011
- <http://www.youtube.com/watch?v=wunAHj1KztQ>



@LastQuake



facebook.com/EMSC.CSEM

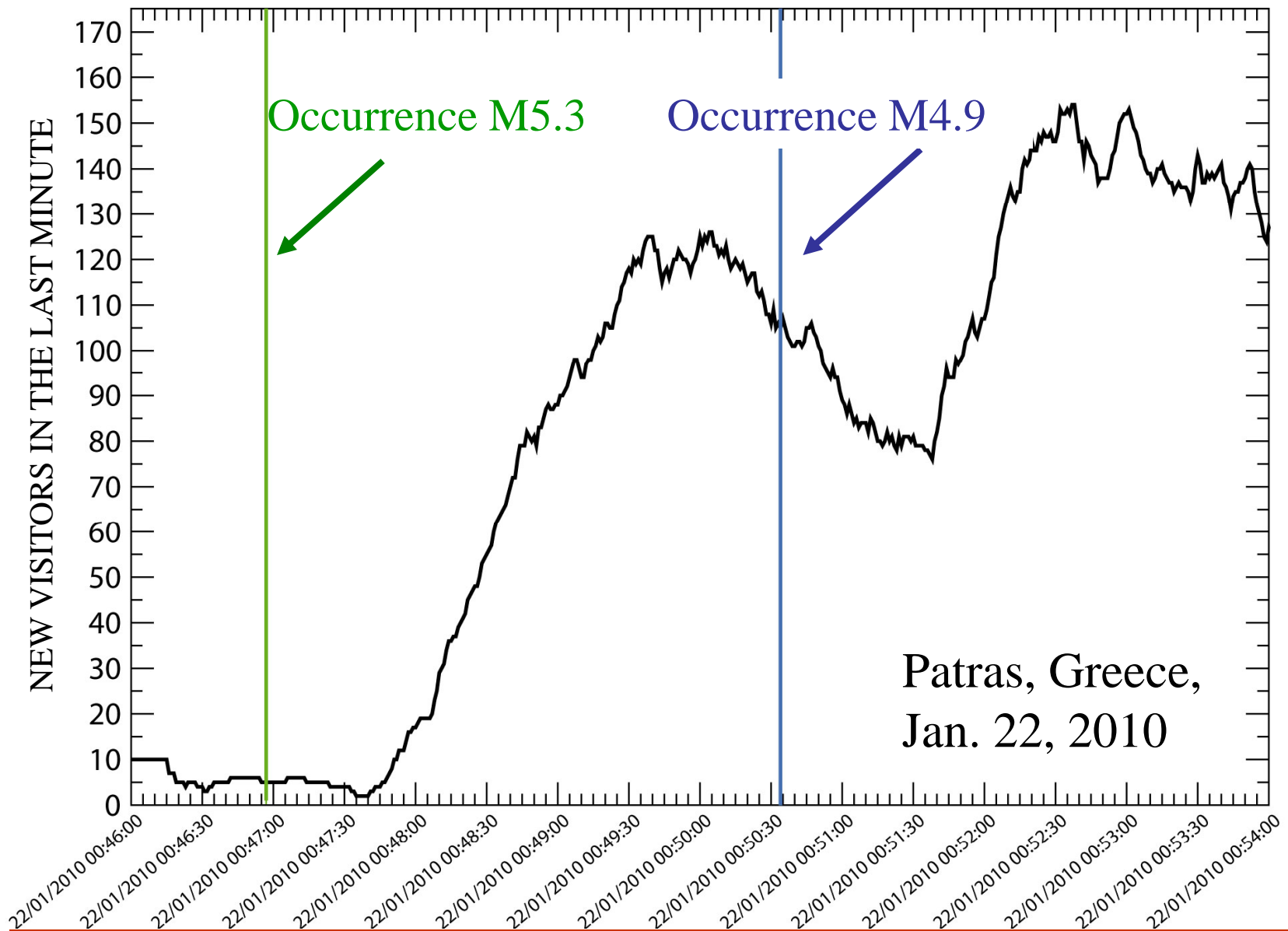


EuroMSC



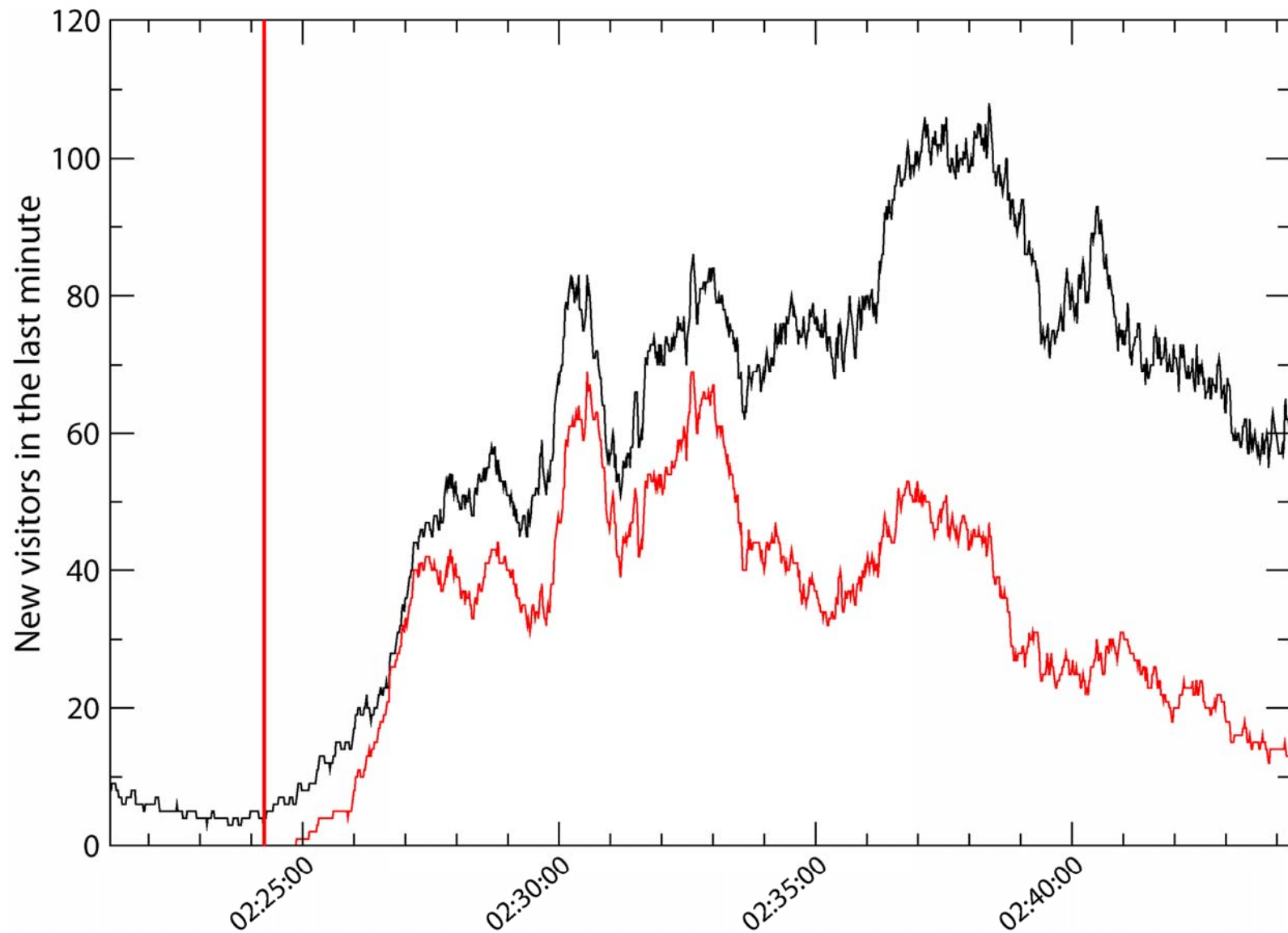
EMSC CSEM

# Identification of 2 Co-Located Earthquakes

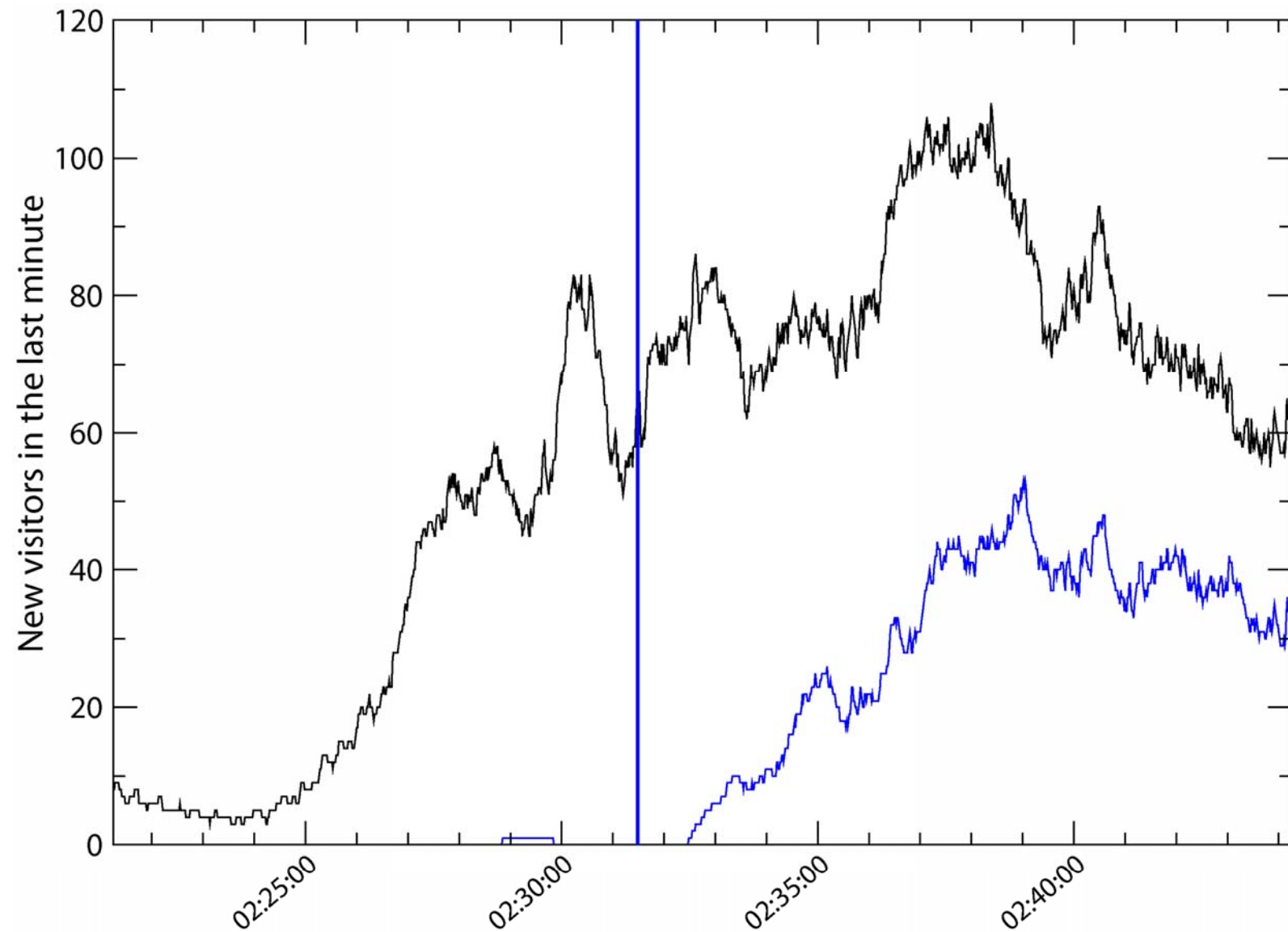




## M4.7 Romania 02:24



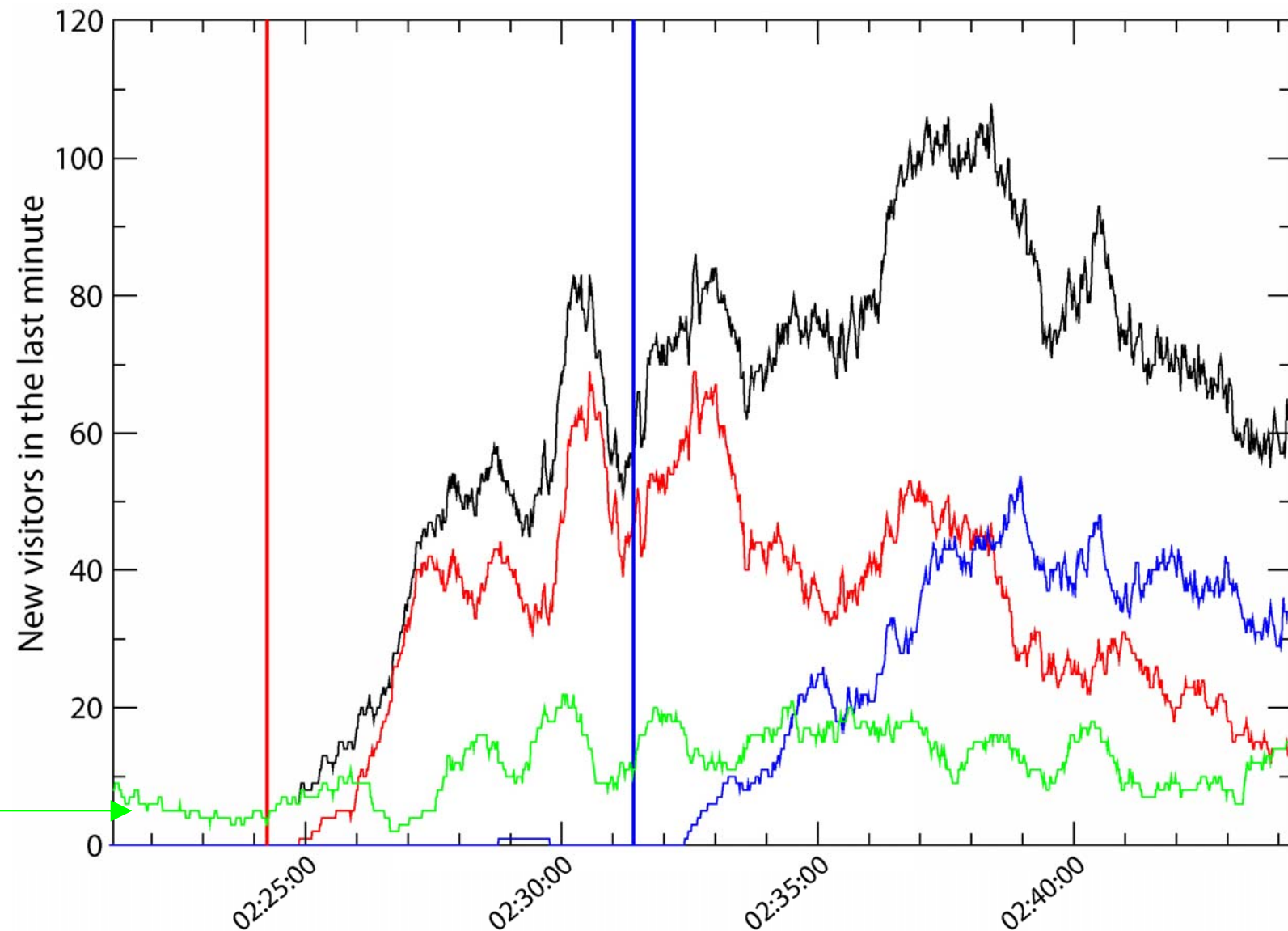
## M5.4 Eastern Kazakhstan 02:31



## 2 distinct events



Baseline  
traffic



## A False Trigger Caused by a Spanish TV program

