



SeisRaM

**University of Trieste
Department of Mathematics and Geosciences**

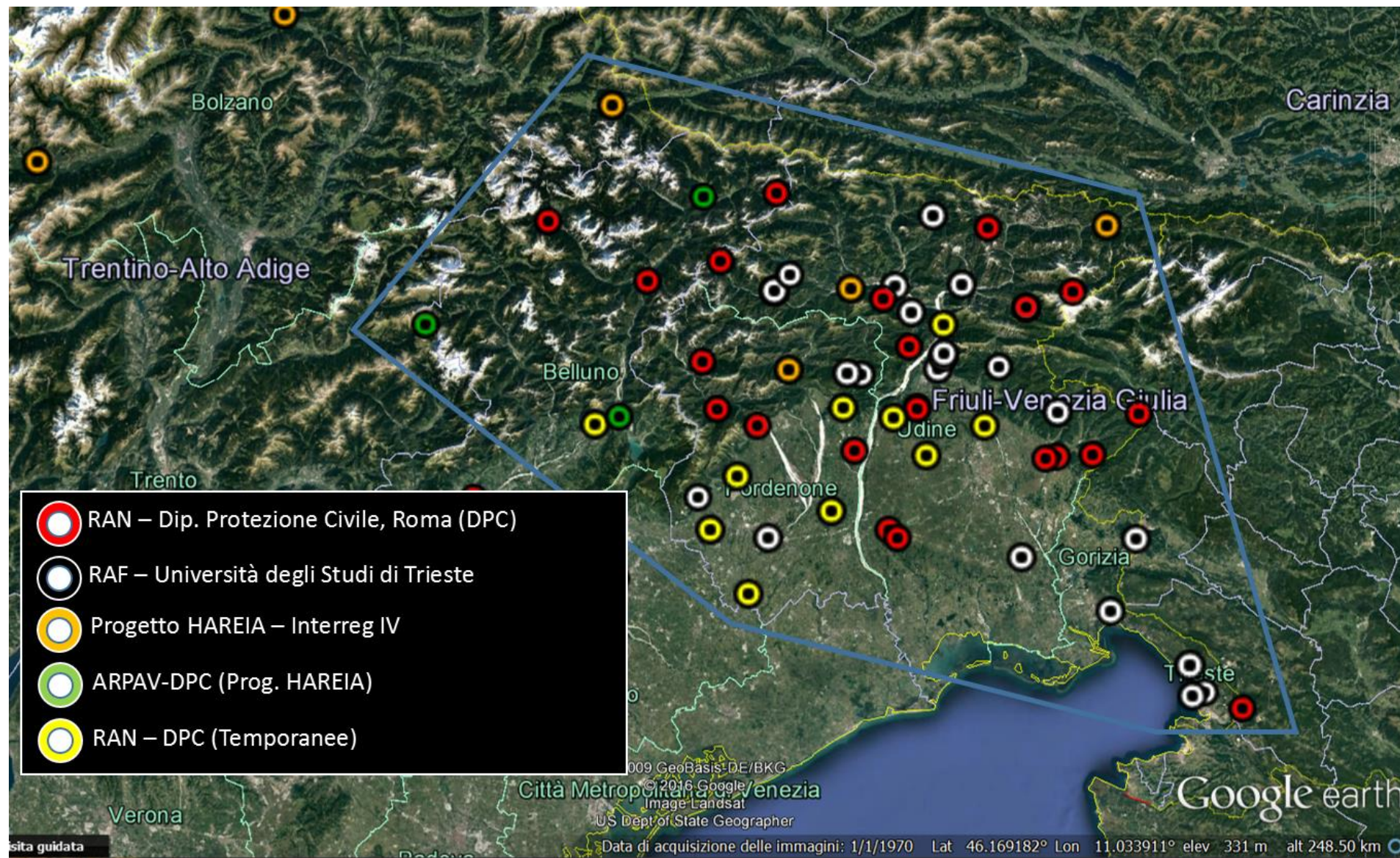
European Antelope User Group Meeting 2019

**May 28-30, 2019
Taormina, Italy**

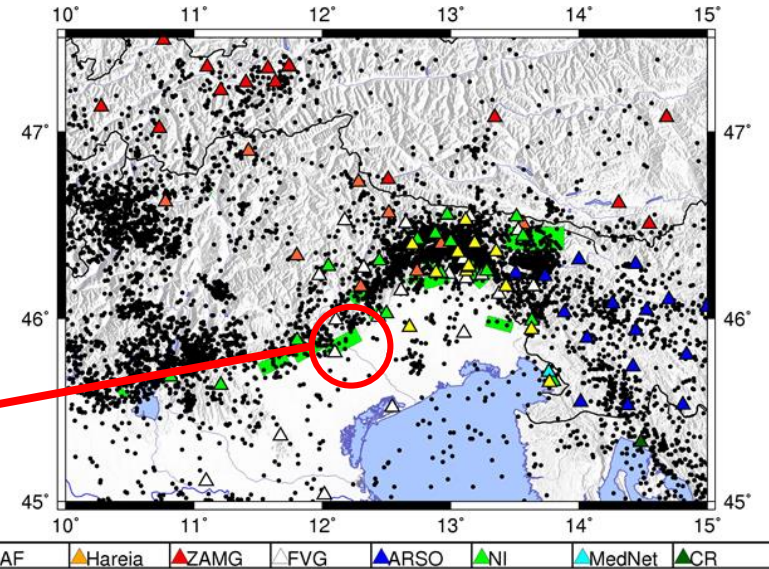
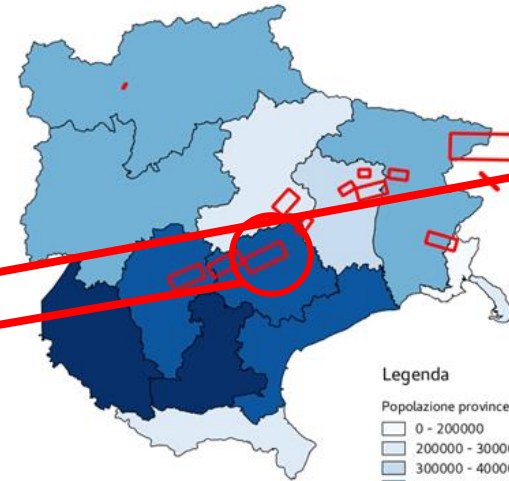
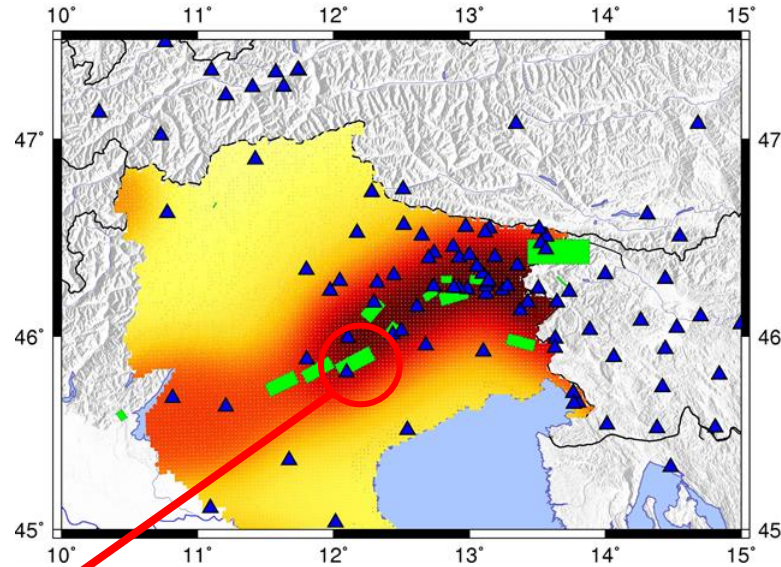
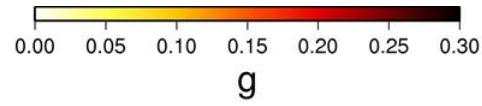
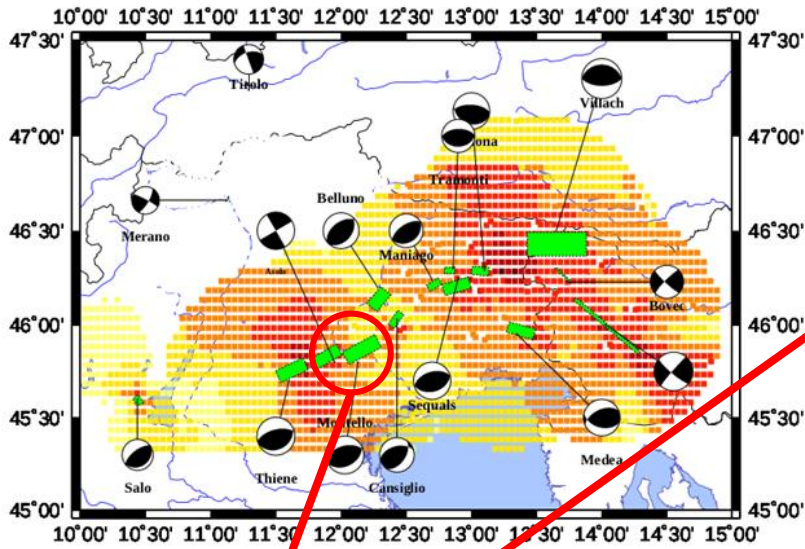
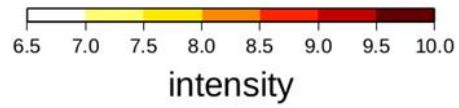
Ground motion data analysis in Antelope

SeisRaM group

Department of Mathematics and Geosciences – University of Trieste

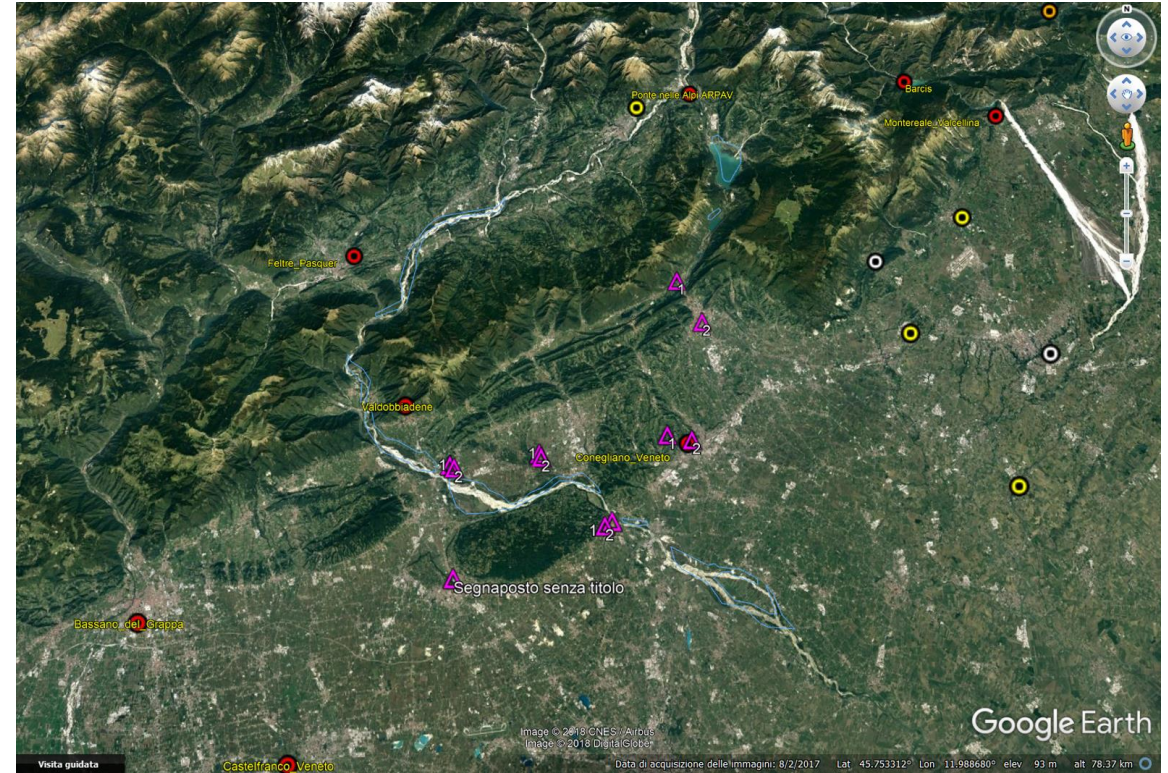
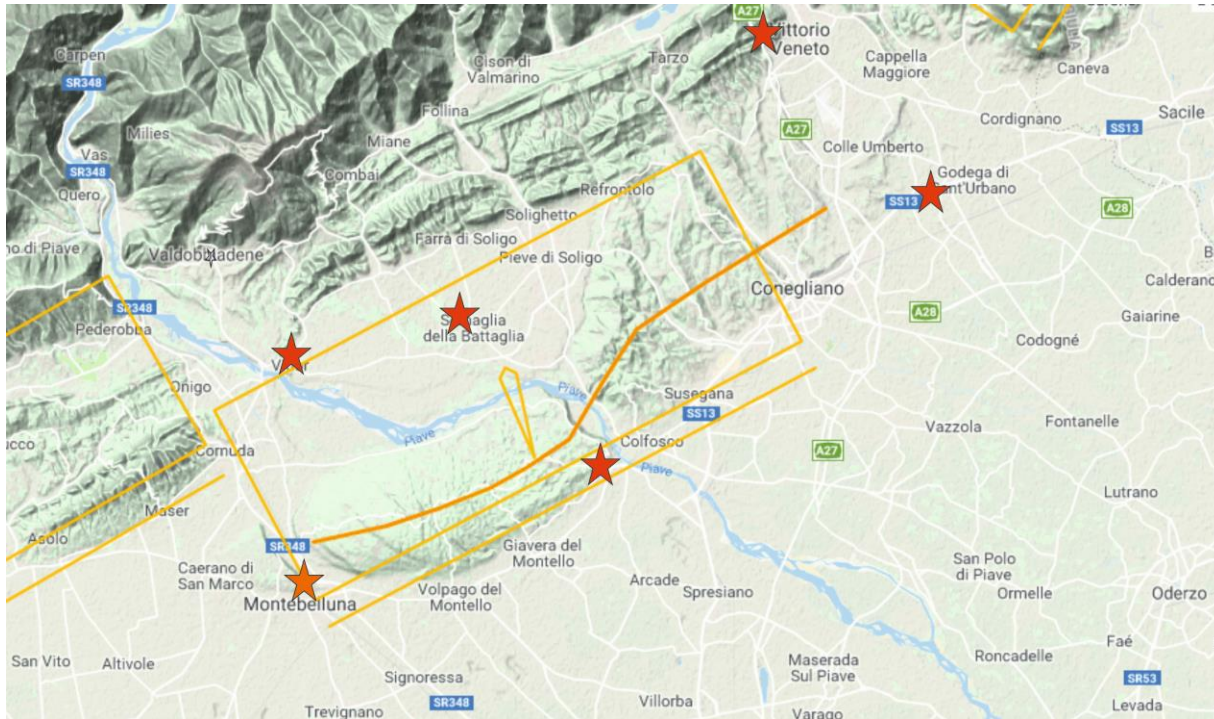


ARMONIA



Montello fault

ARMONIA





SeisRaM

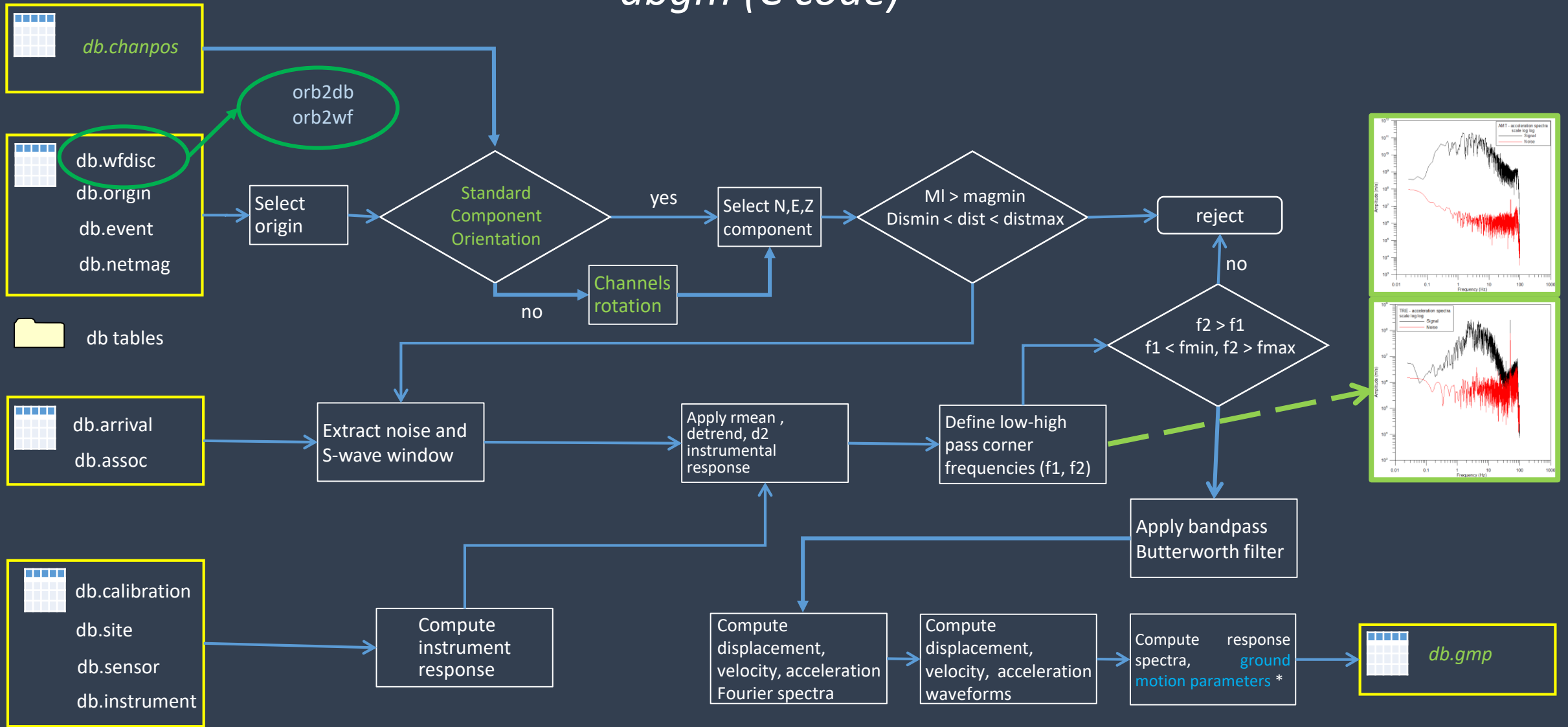




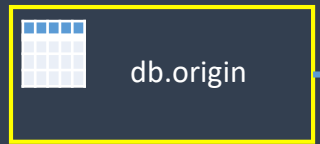
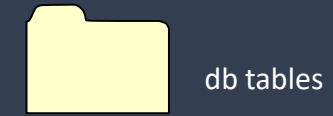
The SeisRaM group of Trieste University developed an automated routine in Antelope Software environment, that determines in near time seismic source parameters (Gallo et al. 2014, Costa et al. 2014) and strong motion parameters from recorded waveforms. These parameters are computed within *few minutes* after the earthquakes and rapidly revised.

This automatic routine, over time, has been optimized improving the quality of results and it is running at Italian Civil Department, at Italian strong motion network data center.

dbgm (C code)

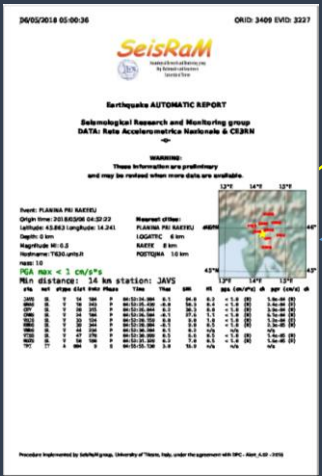


* PGA, PGV, PGD, EPA, PSA03, PSA10, PSA30, Housner, Arias, RMSA, duration, intensity of zero crossing, Saragoni index, damage factor,...



UTS.trigger

UTS.proc
 UTS.sms
 wfmax
 Alert
 dbgm
 dbgmw
 REPO
 db2shake.py
 db2GMPE
 db2kml
 db2json.py



python
 Alert

dbgmw

dbgm

python

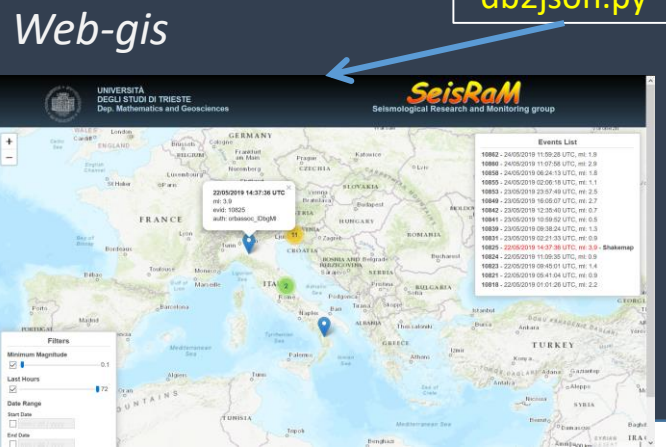
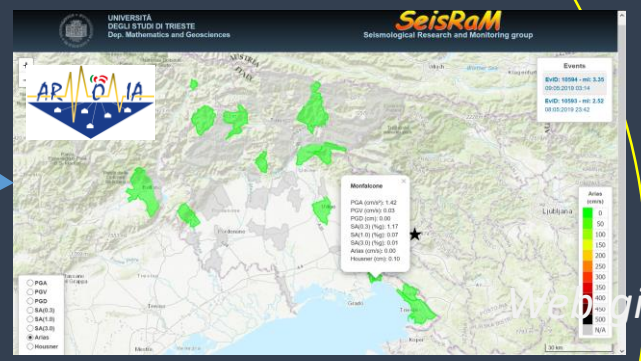
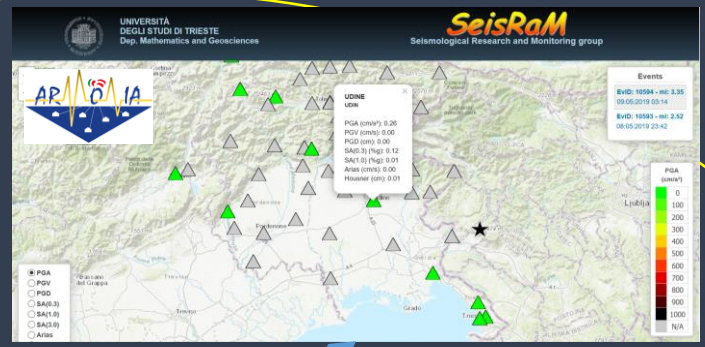
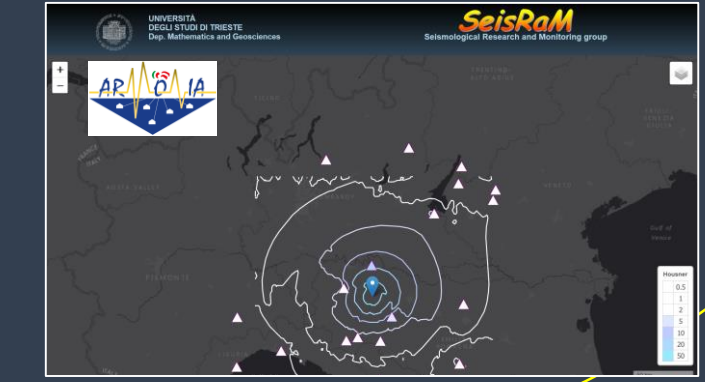
db2json

python-gmt

REPO

db2shake

python



Web-gis

Web-gis

Web-gis

Web-gis

Web-gis

geosite

chanpos



SeisRaM

gmp

| sta | staname | time | topc | morpho | Vs30 | EC8 | auth |
|-----|-----------|-----------------|----------------|--------|------|-----|-------|
| ACR | Acric | 7/19/2017 (200) | 9:51:46.00000 | T1 | | B* | ITACA |
| AGR | Argigento | 7/04/2017 (185) | 14:24:50.00000 | T1 | | R* | ITACA |

| sta | chan | loc | ondate | offdate | dnorth | deast | edepth | hang | vang | buildid | floor | level | descrip |
|------|------|-----|---------|---------|--------|-------|--------|-------|------|---------|-------|-------|---------|
| TOPP | HNN | 02 | 2016001 | | | | 0.0005 | 0.0 | 90.0 | | | | |
| TOPP | HNE | 02 | 2016001 | | | | 0.0005 | 90.0 | 90.0 | | | | |
| TOPP | HNZ | 04 | 2016001 | | | | 0.1500 | 0.0 | 0.0 | | | | |
| ANT | TOPP | HNN | 04 | 2016001 | | | 0.1500 | 0.0 | 90.0 | | | | |
| ANZ | TOPP | HNE | 04 | 2016001 | | | 0.1500 | 90.0 | 90.0 | | | | |
| AP00 | MIRB | HNZ | 02 | 2016001 | | | 0.0005 | 0.0 | 0.0 | | | | |
| APR | MIRB | HNN | 02 | 2016001 | | | 0.0005 | 0.0 | 90.0 | | | | |
| AQA | MIRB | HNE | 02 | 2016001 | | | 0.0005 | 90.0 | 90.0 | | | | |
| AQF | MIRB | HNZ | 06 | 2016001 | | | 0.1260 | 0.0 | 0.0 | | | | |
| AQG | MIRB | HNN | 06 | 2016001 | | | 0.1260 | 0.0 | 90.0 | | | | |
| AQH | MIRB | HNE | 06 | 2016001 | | | 0.1260 | 90.0 | 90.0 | | | | |
| AQM | MIRB | HNZ | 04 | 2016001 | | | 0.0310 | 0.0 | 0.0 | | | | |
| AQN | MIRB | HNN | 04 | 2016001 | | | 0.0310 | 0.0 | 90.0 | | | | |
| AQV | MIRB | HNE | 04 | 2016001 | | | 0.0310 | 90.0 | 90.0 | | | | |
| AR | CONA | HHZ | 15 | 2002155 | | | 0.0000 | 0.0 | 0.0 | | | | |
| ARE | CONA | HNN | 15 | 2002155 | | | 0.0000 | 0.0 | 90.0 | | | | |
| ARG | CONA | HNE | 15 | 2002155 | | | 0.0000 | 90.0 | 90.0 | | | | |
| ARL | CONA | BHZ | 15 | 2002155 | | | 0.0000 | 0.0 | 0.0 | | | | |
| ARL | CONA | BHN | 15 | 2002155 | | | 0.0000 | 0.0 | 90.0 | | | | |
| CONA | BHE | 15 | 2002155 | | | | 0.0000 | 90.0 | 90.0 | | | | |
| CONA | LHZ | 15 | 2002155 | | | | 0.0000 | 0.0 | 0.0 | | | | |
| CONA | LHN | 15 | 2002155 | | | | 0.0000 | 0.0 | 90.0 | | | | |
| CONA | LHE | 15 | 2002155 | | | | 0.0000 | 90.0 | 90.0 | | | | |
| CONA | HHZ | 51 | 2002155 | | | | 0.0000 | 0.0 | 0.0 | | | | |
| CONA | HNN | 51 | 2002155 | | | | 0.0000 | 0.0 | 90.0 | | | | |
| CONA | HNE | 51 | 2002155 | | | | 0.0000 | 90.0 | 90.0 | | | | |
| CONA | BHZ | 51 | 2002155 | | | | 0.0000 | 0.0 | 0.0 | | | | |
| CONA | BHN | 51 | 2002155 | | | | 0.0000 | 0.0 | 90.0 | | | | |
| CONA | BHE | 51 | 2002155 | | | | 0.0000 | 90.0 | 90.0 | | | | |
| CONA | LHZ | 51 | 2002155 | | | | 0.0000 | 0.0 | 0.0 | | | | |
| CONA | LHN | 51 | 2002155 | | | | 0.0000 | 0.0 | 90.0 | | | | |
| CONA | LHE | 51 | 2002155 | | | | 0.0000 | 90.0 | 90.0 | | | | |
| TOLM | HNN | 00 | 2016001 | | | | 0.0000 | 242.0 | 90.0 | | | | |
| TOLM | HNY | 00 | 2016001 | | | | 0.0000 | 152.0 | 90.0 | | | | |
| TOLM | HNZ | 00 | 2016001 | | | | 0.0000 | 0.0 | 0.0 | | | | |
| TOLM | HNX | 11 | 2016001 | | | | 0.0000 | 242.0 | 90.0 | | | | |

| sta | chan | orid | filter | time | dista | seaz | PGA | EPA | PGV | PGD | PSA03 | PSA10 | PSA30 | Arias | |
|-----|------|------|--------|----------|-----------------|----------------|------|--------|----------|----------|----------|----------|----------|----------|----------|
| CLF | HGE | 1918 | BW 0.5 | 6 48.2 6 | 3/14/2018 (073) | 17:56:24.85000 | 7.20 | 286.90 | 0.317937 | 0.088592 | 0.007868 | 0.000647 | 0.399687 | 0.095860 | 0.000058 |
| CLF | HGN | 1918 | BW 0.5 | 6 48.2 6 | 3/14/2018 (073) | 17:56:24.85000 | 7.20 | 286.90 | 0.398627 | 0.102073 | 0.009193 | 0.000651 | 0.624679 | 0.076573 | 0.000052 |
| CLF | HGZ | 1918 | BW 0.5 | 6 48.2 6 | 3/14/2018 (073) | 17:56:24.85000 | 7.20 | 286.90 | 0.312174 | 0.097469 | 0.007021 | 0.000388 | 0.493198 | 0.022828 | 0.000041 |

| sta | chan | Housner | duration | RMSA | Pd | v0 | Id | auth |
|------|------|----------|-----------|----------|----------|-----------|-----------|------|
| CLF | HGE | 0.029928 | 6.030000 | 0.077488 | | 28.026534 | 14.474735 | dbgm |
| CLF | HGN | 0.035860 | 5.790000 | 0.075000 | | 22.107081 | 8.887202 | dbgm |
| CLF | HGZ | 0.025675 | 6.170000 | 0.064307 | | 19.773096 | 11.641335 | dbgm |
| CNO | HGE | 0.012252 | 11.565000 | 0.024386 | | 15.737138 | 19.387602 | dbgm |
| CNO | HGN | 0.012945 | 10.965000 | 0.023854 | | 15.959872 | 13.330313 | dbgm |
| CNO | HGZ | 0.007512 | 41.295000 | 0.011067 | | 48.746822 | 23.880903 | dbgm |
| CNO | HGE | 0.005399 | 10.400000 | 0.011306 | | 18.401711 | 15.000000 | dbgm |
| CNO | HGN | 0.006403 | 10.140000 | 0.012677 | | 16.666667 | 10.816372 | dbgm |
| CNO | HGZ | 0.003726 | 12.770000 | 0.009496 | | 34.534064 | 21.912957 | dbgm |
| CLF | HGE | 0.016223 | 7.350000 | 0.055258 | | 43.673469 | 15.448053 | dbgm |
| CLF | HGN | 0.023717 | 7.830000 | 0.052471 | | 31.673052 | 11.685074 | dbgm |
| CLF | HGZ | 0.015869 | 7.340000 | 0.040228 | | 24.250661 | 17.361745 | dbgm |
| CNO | HGE | 0.013164 | 11.705000 | 0.023412 | | 15.378044 | 14.303143 | dbgm |
| CNO | HGN | 0.013455 | 13.145000 | 0.026081 | | 18.714340 | 15.507878 | dbgm |
| CNO | HGZ | 0.006553 | 46.180000 | 0.013430 | | 50.649632 | 38.806569 | dbgm |
| CLF | HGE | 0.016223 | 7.350000 | 0.055258 | | 43.673469 | 15.448053 | dbgm |
| CLF | HGN | 0.023717 | 7.830000 | 0.052471 | | 31.673052 | 11.685074 | dbgm |
| CLF | HGZ | 0.015869 | 7.340000 | 0.040228 | | 24.250661 | 17.361745 | dbgm |
| CNO | HGE | 0.013164 | 11.705000 | 0.023412 | | 15.378044 | 14.303143 | dbgm |
| CNO | HGN | 0.013455 | 13.145000 | 0.026081 | | 18.714340 | 15.507878 | dbgm |
| CNO | HGZ | 0.006553 | 46.180000 | 0.013430 | | 50.649632 | 38.806569 | dbgm |
| CNO | HGE | 0.006383 | 22.775000 | 0.006482 | | 23.670791 | 18.529089 | dbgm |
| CNO | HGN | 0.005202 | 25.015000 | 0.005521 | | 21.187288 | 19.502085 | dbgm |
| CNO | HGZ | 0.003018 | 32.445000 | 0.004304 | | 38.156881 | 28.009288 | dbgm |
| FOPC | HGE | 0.008562 | 15.820000 | 0.015049 | | 29.140329 | 15.019391 | dbgm |
| FOPC | HGN | 0.012354 | 10.930000 | 0.022957 | | 18.389753 | 13.887531 | dbgm |
| FOPC | HGZ | 0.005874 | 14.815000 | 0.017333 | | 33.977050 | 27.530165 | dbgm |
| TOD | HGE | 0.004389 | 26.685000 | 0.004326 | | 26.531759 | 19.267344 | dbgm |
| TOD | HGN | 0.003728 | 24.970000 | 0.004340 | | 21.305567 | 19.513768 | dbgm |
| TOD | HGZ | 0.002573 | 28.875000 | 0.003318 | | 35.255411 | 23.880533 | dbgm |
| TRE | HGE | 0.114697 | 4.635000 | 0.259441 | 0.000002 | 16.828479 | 8.206299 | dbgm |
| TRE | HGN | 0.086564 | 5.925000 | 0.209093 | 0.000002 | 13.502110 | 11.240533 | dbgm |
| TRE | HGZ | 0.063313 | 5.845000 | 0.172396 | | 19.674936 | 13.551568 | dbgm |

Automatic, real time report for Civil Defence



03/04/2014 12:05:11 ORID: 618 EVID: 389

Earthquake AUTOMATIC REPORT

Dipartimento della Protezione Civile - Rome - Italy
Rete Accelerometrica Nazionale RAN

WARNING:
 These information are preliminary
 and may be revised when more data are available.

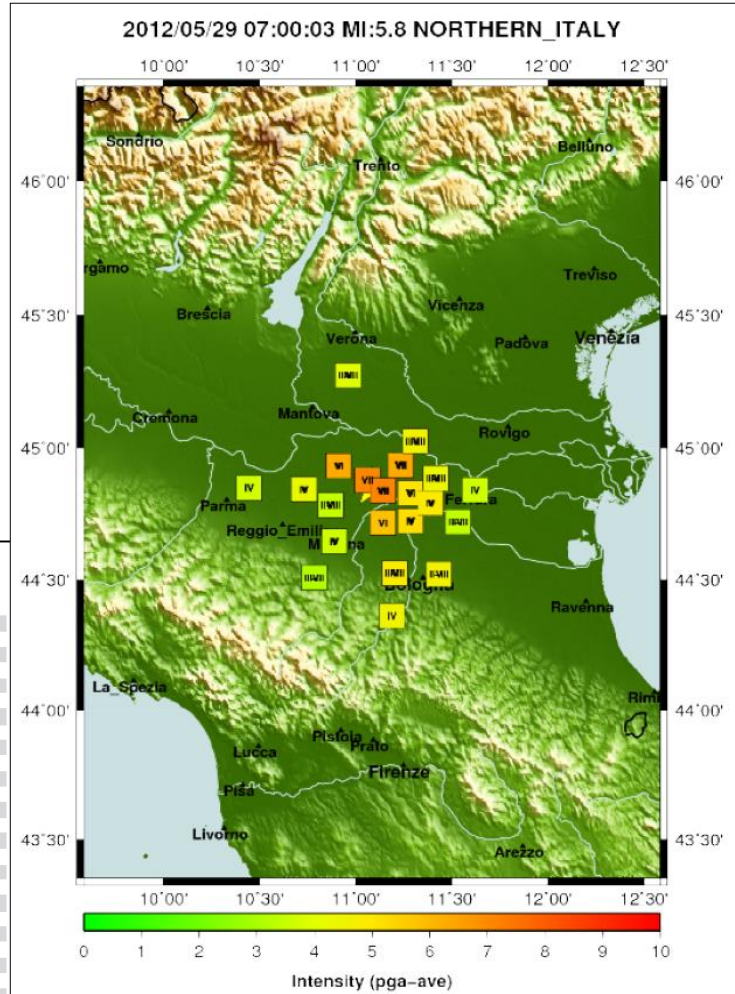
Event: NORTHERN ITALY
 Origin time: 2012/05/29 07:00:03
 Latitude: 44.851 Longitude: 11.086
 Magnitude MI: 5.8
 AGENCY: INGV

Seismic Moment: 1.13e+18 Nm
 Mw: 5.8
 AGENCY: UNITS

Records analyzed by procedure: 197
 Selected limits: max distance=150 km min PGA= 0.1 cm/s²
 min PGA to show response spectra= 0.1 cm/s²
 Records inside the selected limits: 185 response spectra inside the limits: 185

Nearest station: MRN distance: 3.81 km
 HGZ - PGA=895.78 cm/s², PGV=21.64 cm/s

Procedure implemented by SeisRaM group, University of Trieste, Italy - ver: SPT_1.24 - 2014 - costa@aquas.it

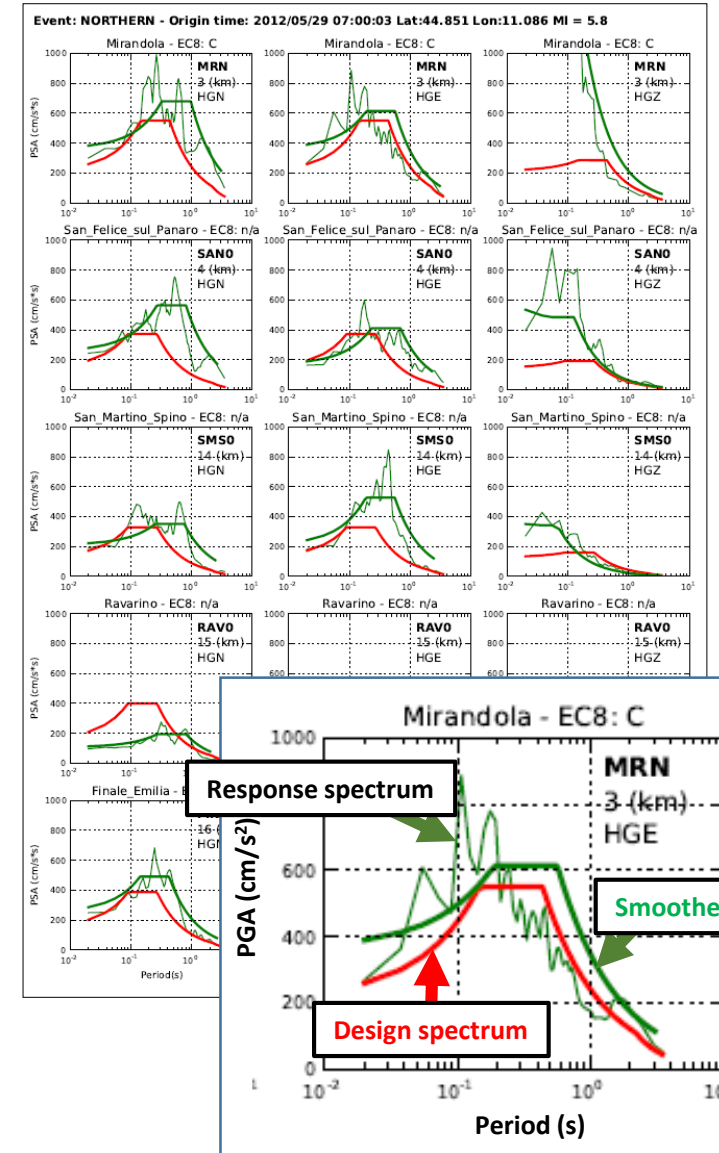


SeisRaM Event: KNEZAK - Origin time: 2014/04/22 08:58:27 Lat:45.633 Lon:14.258 MI = 4.7 Agency: UNITS
 Seismic moment: 2.670e+16 Nm - Mw = 4.5 Agency: UNITS

| sta | chan | dista | filter | Hz | PGA | EPA | PGV | PGD | PSA03 | PSA10 | PSA30 | EC8 | location |
|------|------|-------|----------|-------|-------------------|-------------------|------|-------|-------------------|-------------------|-------------------|----------------------|----------|
| | | km | | | cm/s ² | cm/s ² | cm/s | cm | cm/s ² | cm/s ² | cm/s ² | | |
| KNDS | HHN | 15 | 0.1-50.0 | 37.72 | 18.21 | 0.82 | 0.05 | 46.81 | 3.25 | 0.34 | na | Knezji Dol, SL | |
| KNDS | HHE | 15 | 0.1-50.0 | 23.92 | 13.69 | 0.69 | 0.06 | 27.62 | 3.59 | 0.28 | na | Knezji Dol, SL | |
| KNDS | HHZ | 15 | 0.1-50.0 | 17.14 | 6.61 | 0.33 | 0.02 | 15.04 | 0.78 | 0.11 | na | Knezji Dol, SL | |
| CEY | HHN | 17 | 0.1-50.0 | 47.72 | 10.45 | 0.75 | 0.05 | 17.87 | 3.40 | 0.32 | na | Cerknica, SL | |
| CEY | HHE | 17 | 0.1-50.0 | 30.33 | 9.38 | 0.70 | 0.04 | 11.35 | 1.94 | 0.22 | na | Cerknica, SL | |
| CEY | HHZ | 17 | 0.1-50.0 | 17.83 | 4.48 | 0.27 | 0.02 | 9.18 | 0.86 | 0.12 | na | Cerknica, SL | |
| SKDS | HGN | 21 | 0.1-50.0 | 30.76 | 9.61 | 0.62 | 0.04 | 15.55 | 2.15 | 0.20 | na | Skadanscina, SL | |
| SKDS | HGE | 21 | 0.1-50.0 | 19.71 | 7.32 | 0.44 | 0.03 | 14.50 | 1.60 | 0.14 | na | Skadanscina, SL | |
| SKDS | HGZ | 21 | 0.1-50.0 | 13.09 | 4.50 | 0.27 | 0.02 | 10.94 | 0.76 | 0.10 | na | Skadanscina, SL | |
| SKDS | HHN | 21 | 0.2-50.0 | 30.33 | 9.88 | 0.65 | 0.03 | 15.58 | 2.16 | 0.22 | na | Skadanscina, SL | |
| SKDS | HHE | 21 | 0.2-50.0 | 21.62 | 7.46 | 0.43 | 0.02 | 14.51 | 1.65 | 0.16 | na | Skadanscina, SL | |
| SKDS | HHZ | 21 | 0.1-50.0 | 13.35 | 4.49 | 0.27 | 0.02 | 10.97 | 0.77 | 0.10 | na | Skadanscina, SL | |
| SKDS | HHN | 33 | 0.1-50.0 | 6.33 | 2.86 | 0.14 | 0.02 | 4.66 | 0.80 | 0.15 | na | Javornik, SL | |
| JAVS | HHE | 33 | 0.1-50.0 | 11.36 | 6.15 | 0.31 | 0.03 | 10.40 | 1.63 | 0.20 | na | Javornik, SL | |
| JAVS | HHZ | 33 | 0.1-50.0 | 4.70 | 2.64 | 0.12 | 0.01 | 5.89 | 0.64 | 0.05 | na | Javornik, SL | |
| DST2 | HHN | 36 | 0.1-47.0 | 7.46 | 4.97 | 0.27 | 0.02 | 9.90 | 1.04 | 0.12 | A | DST-Trieste_station | |
| DST2 | HHE | 36 | 0.1-46.4 | 9.09 | 4.13 | 0.20 | 0.01 | 8.08 | 0.61 | 0.10 | A | DST-Trieste_station | |
| DST2 | HHZ | 36 | 0.1-47.8 | 4.49 | 2.65 | 0.12 | 0.01 | 5.70 | 0.47 | 0.05 | A | DST-Trieste_station | |
| GBAS | HHN | 37 | 0.1-50.0 | 3.23 | 1.26 | 0.07 | 0.02 | 2.35 | 0.33 | 0.05 | na | Gornja Brezovica, SL | |
| GBAS | HHE | 37 | 0.1-50.0 | 3.71 | 1.43 | 0.07 | 0.02 | 3.31 | 0.40 | 0.03 | na | Gornja Brezovica, SL | |
| GBAS | HHZ | 37 | 0.1-50.0 | 2.43 | 0.96 | 0.06 | 0.02 | 1.56 | 0.38 | 0.03 | na | Gornja Brezovica, SL | |
| TRI | HHN | 39 | 0.1-47.3 | 12.38 | 1.97 | 0.15 | 0.02 | 2.33 | 0.46 | 0.05 | A | TRI-Trieste_station | |
| TRI | HHE | 39 | 0.1-45.6 | 13.66 | 3.69 | 0.19 | 0.02 | 4.30 | 0.31 | 0.08 | A | TRI-Trieste_station | |
| TRI | HHZ | 39 | 0.1-47.5 | 31.18 | 4.24 | 0.34 | 0.02 | 5.12 | 0.30 | 0.08 | A | TRI-Trieste_station | |
| GBRS | HHN | 45 | 0.1-50.0 | 11.89 | 3.11 | 0.20 | 0.02 | 2.86 | 0.56 | 0.06 | na | Gornja Briga, SL | |
| GBRS | HHE | 45 | 0.1-50.0 | 15.31 | 3.81 | 0.25 | 0.02 | 4.30 | 0.46 | 0.07 | na | Gornja Briga, SL | |
| GBRS | HHZ | 45 | 0.1-50.0 | 4.42 | 1.12 | 0.07 | 0.02 | 1.75 | 0.47 | 0.06 | na | Gornja Briga, SL | |
| VISS | HHN | 49 | 0.1-50.0 | 3.78 | 2.32 | 0.13 | 0.01 | 4.22 | 1.16 | 0.09 | na | Visnje, SL | |
| VISS | HHE | 49 | 0.1-50.0 | 3.68 | 2.00 | 0.10 | 0.01 | 2.71 | 0.69 | 0.05 | na | Visnje, SL | |

dista = epicentral distance
 filter = automatic band pass butterworth filter
 EC8 = site classification (Eurocode from ITACA)

PGA,PGV,PGD = peak ground acceleration, velocity and displacement
 EPA = effective ground acceleration (Kramer, 1996)
 PSA03,PSA10,PSA30 = spectral acceleration (0.3, 1.0, 3.0 sec)





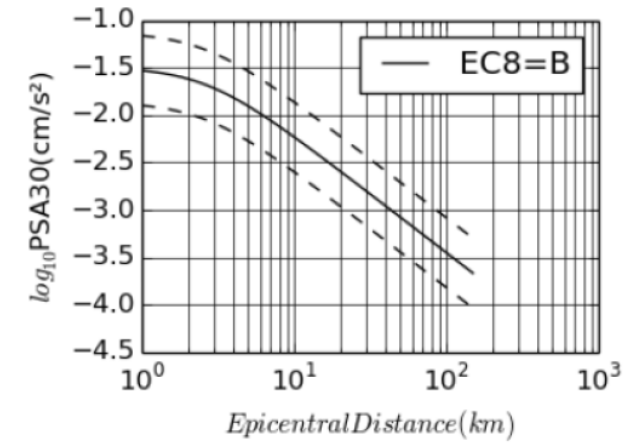
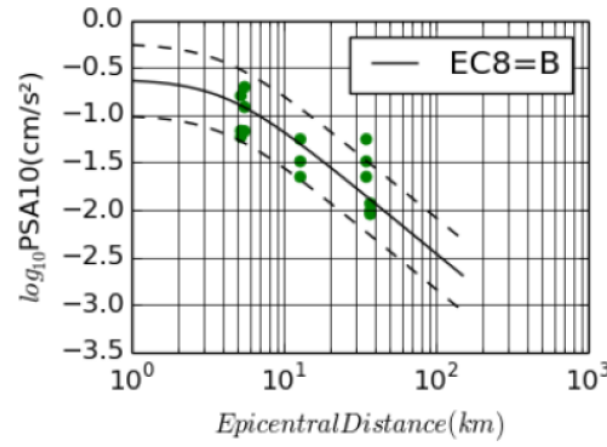
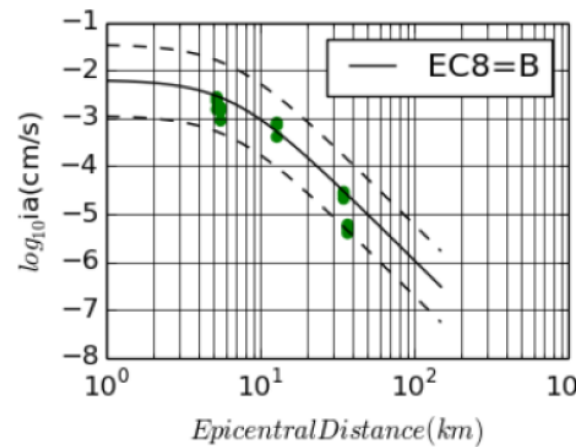
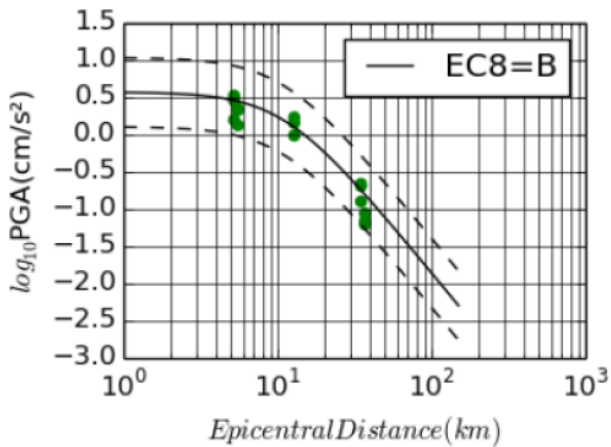
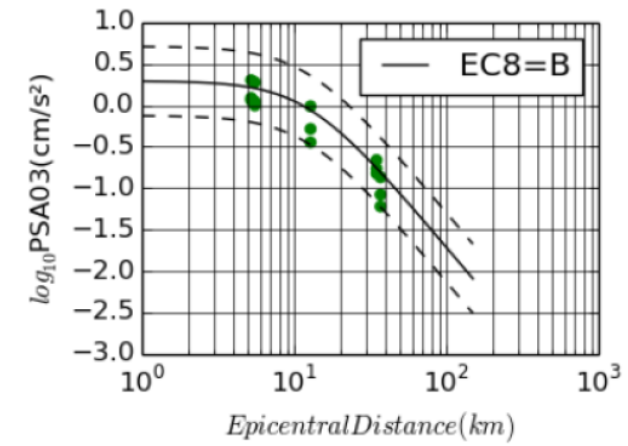
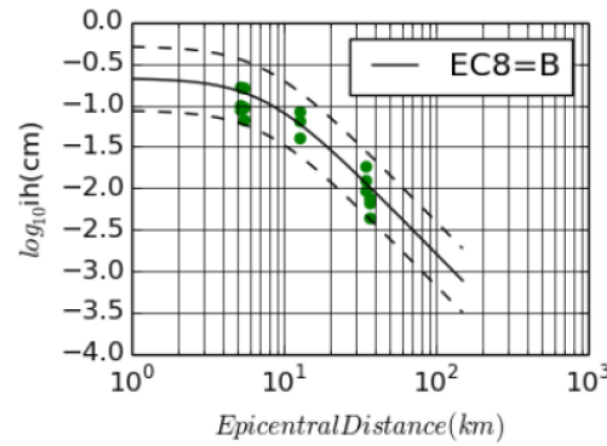
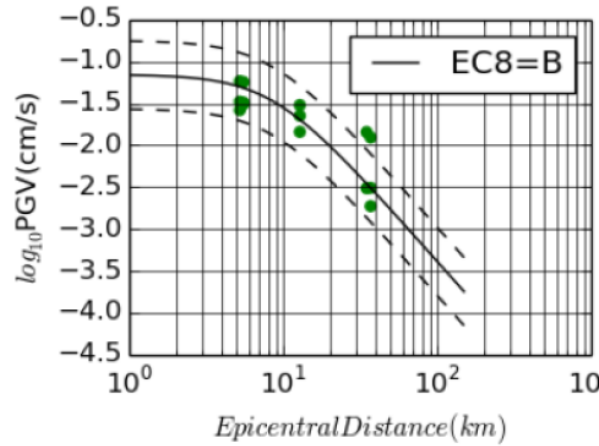
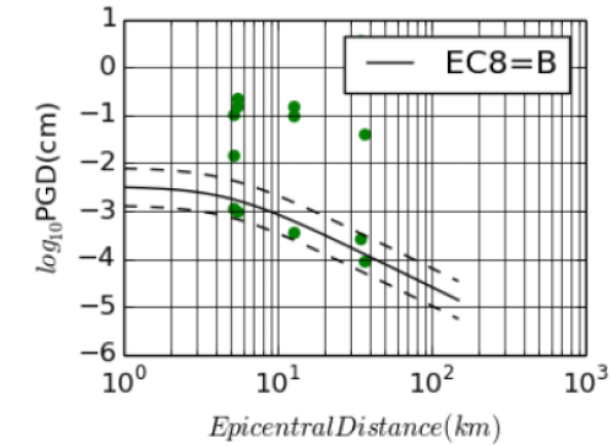
PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Automatic, real time report for Civil Defence

GMPE



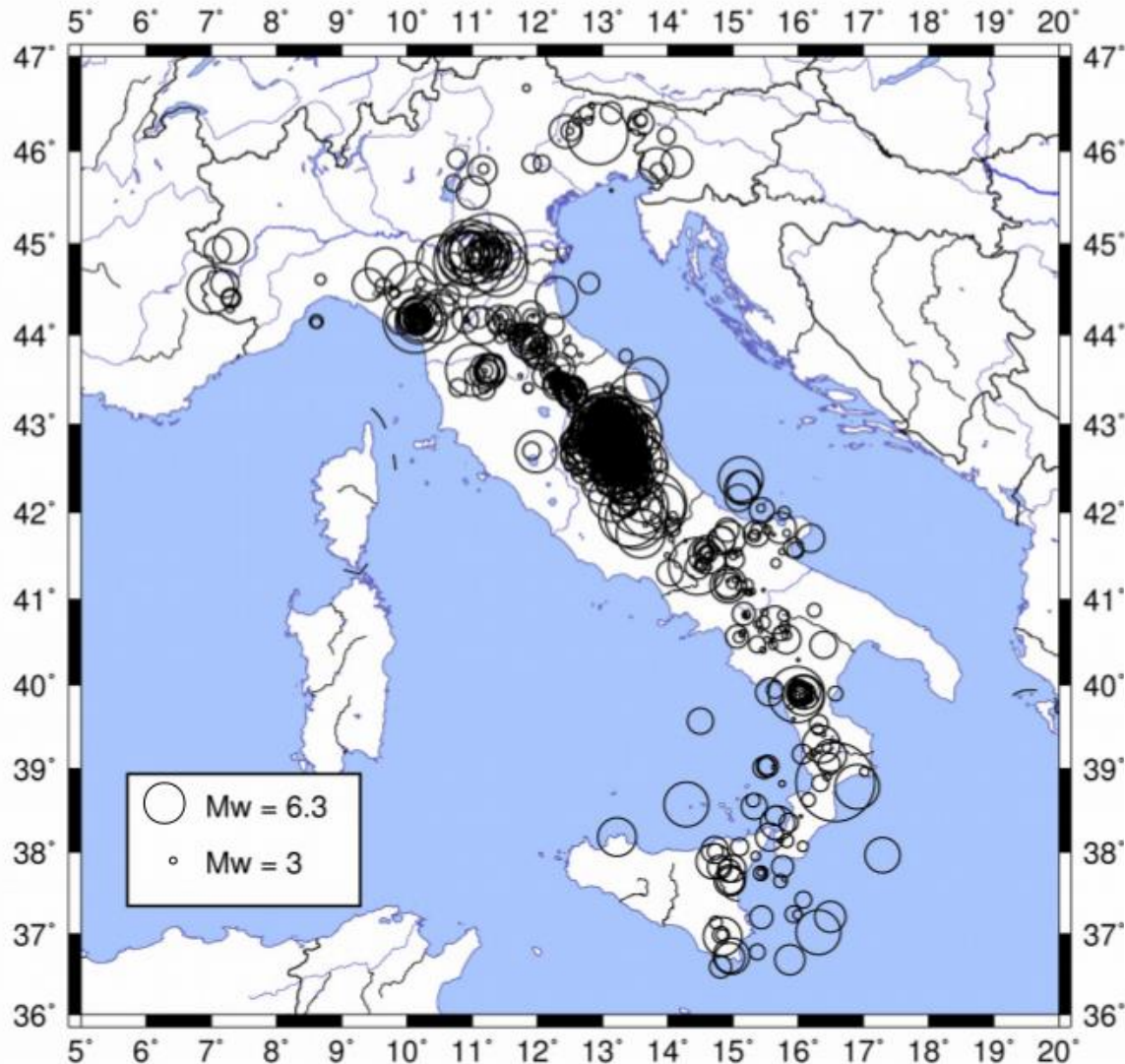
SeisRaM



Dataset Time-span : 2011-2017

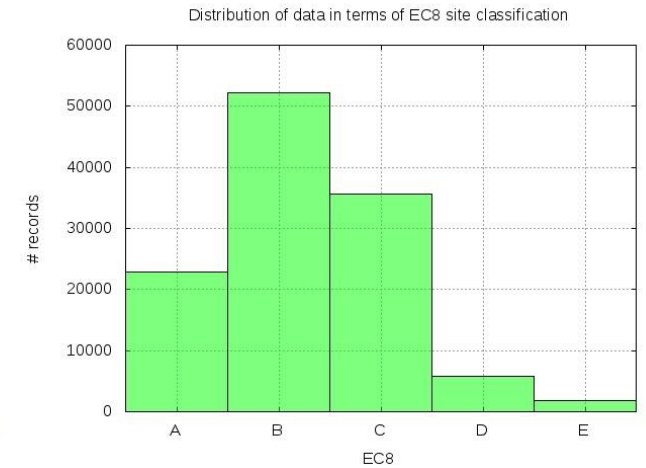
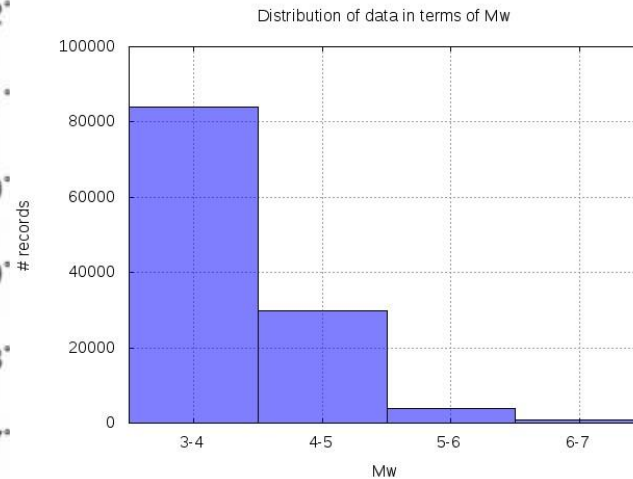


SeisRaM



The entire database counts **1985 earthquakes** with a moment magnitude between 3.0 and 6.4 of the strongest event of Amatrice sequence occurred the 30th of October, 2016.

The total number of **records** are **118021** up to 150 km.

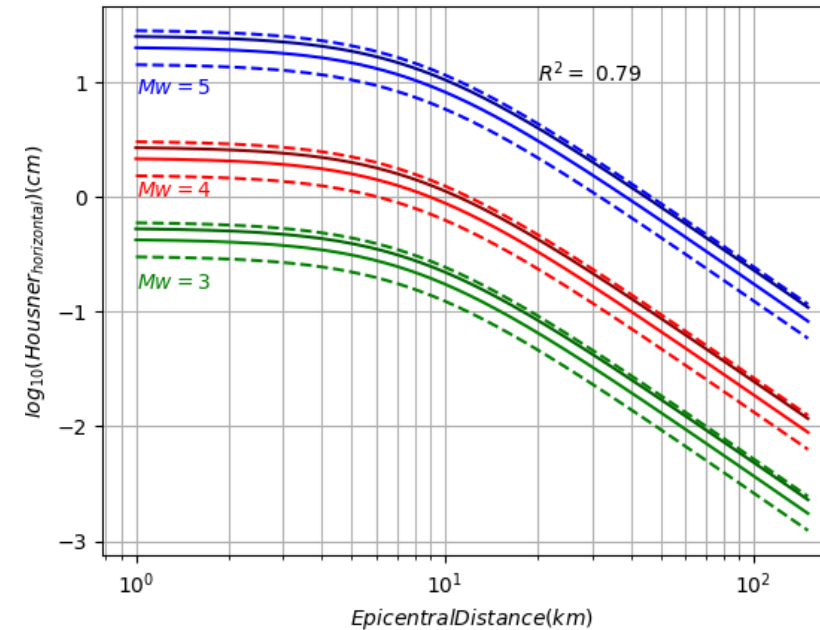
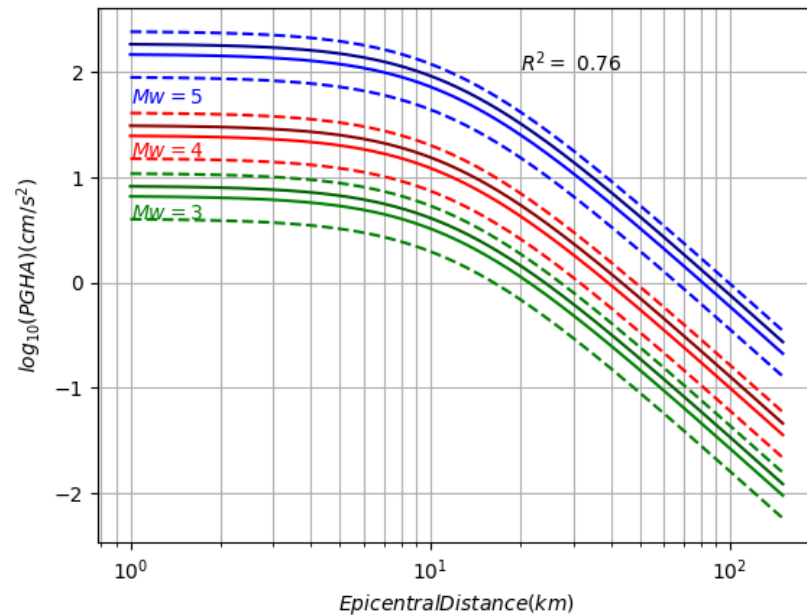


(Tiberi et al. 2018)

GMPE functional form:



$$\text{Log}_{10} Y = a + b Mw + c Mw^2 + c \log_{10}((R^2 + d^2)^{1/2}) + s1SA + s2SB + s3SC + s4SD + s5SE$$



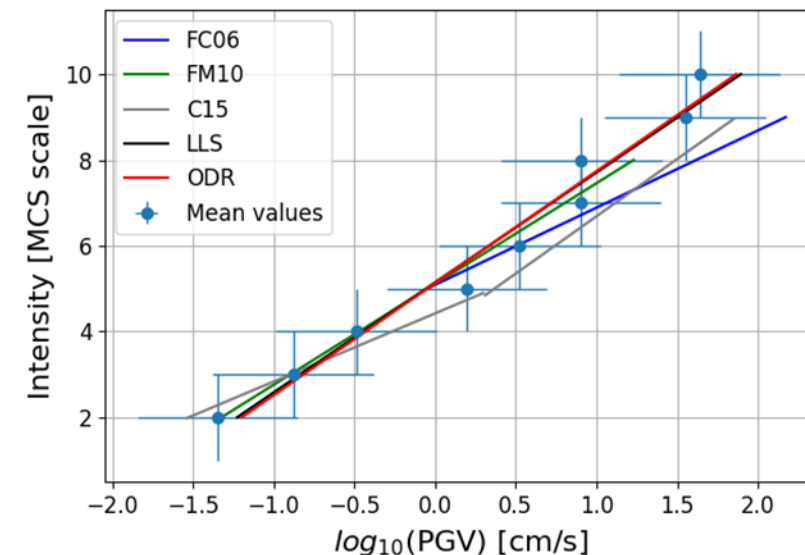
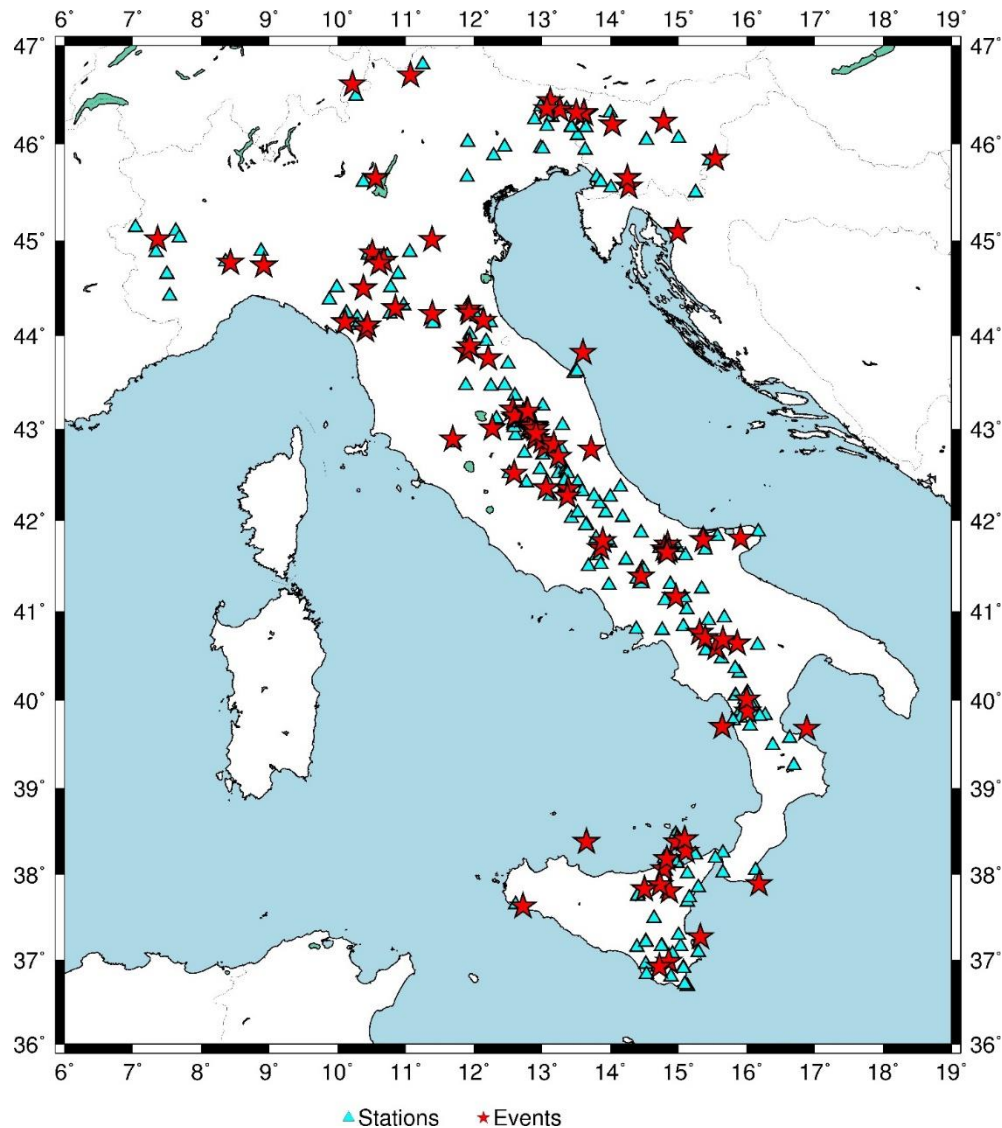
Ground motion parameters analyzed:

- PGA
- PGV
- PGD
- PSA03
- PSA10
- PSA30
- Arias Intensity
- Housner Intensity

A new estimation of MCS instrumental intensity for the Italian territory from high quality accelerometric data, using GMICEs and Gaussian Naïve Bayes Classifiers



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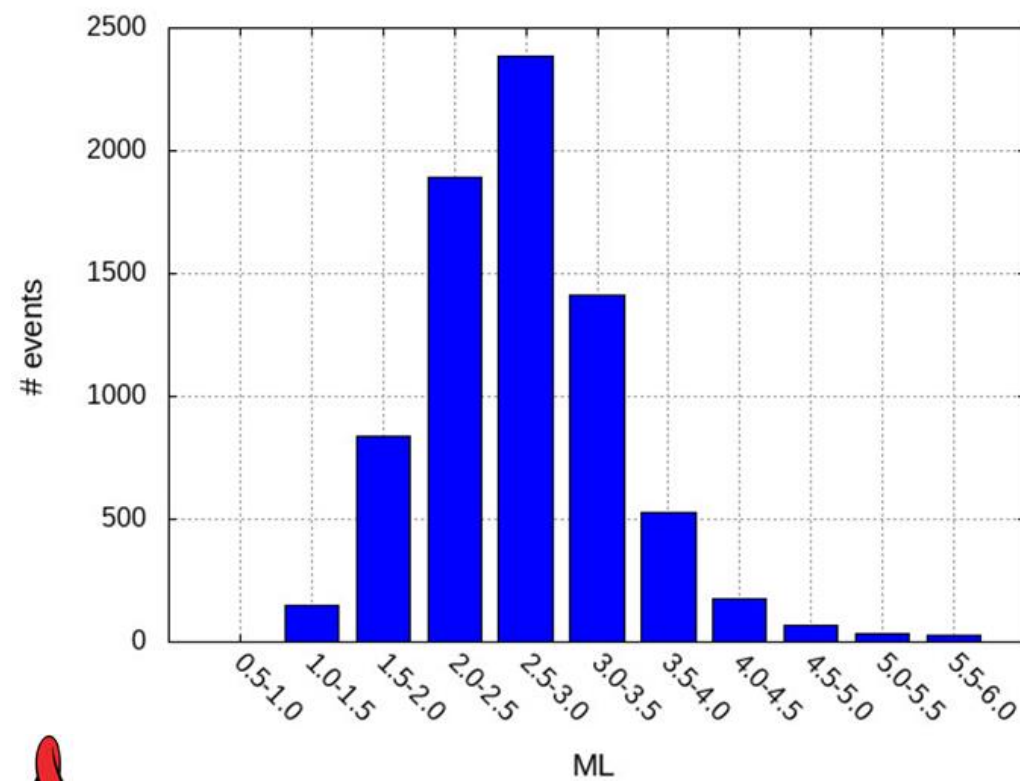
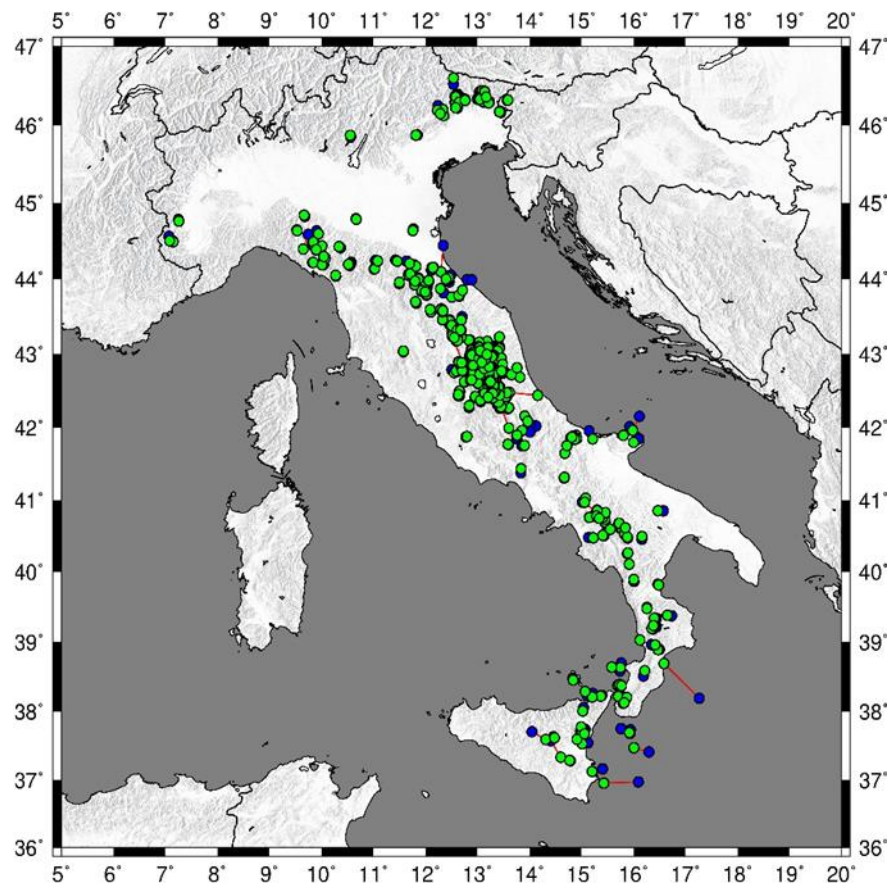


Comparison of the Intensity - PGV relationship obtained in this study with the two different algorithms (LLS, ODR) and three previous studies: Faenza and Michelini (2010), FM10; Faccioli and Cauzzi (2006), FC06; Caprio et al. (2015), C15. **(Bottom)** Comparison of the Intensity - PGA relationship obtained in this study with the two different algorithms (LLS, ODR) and the same previous three studies.

(Cataldi et al. 2019)



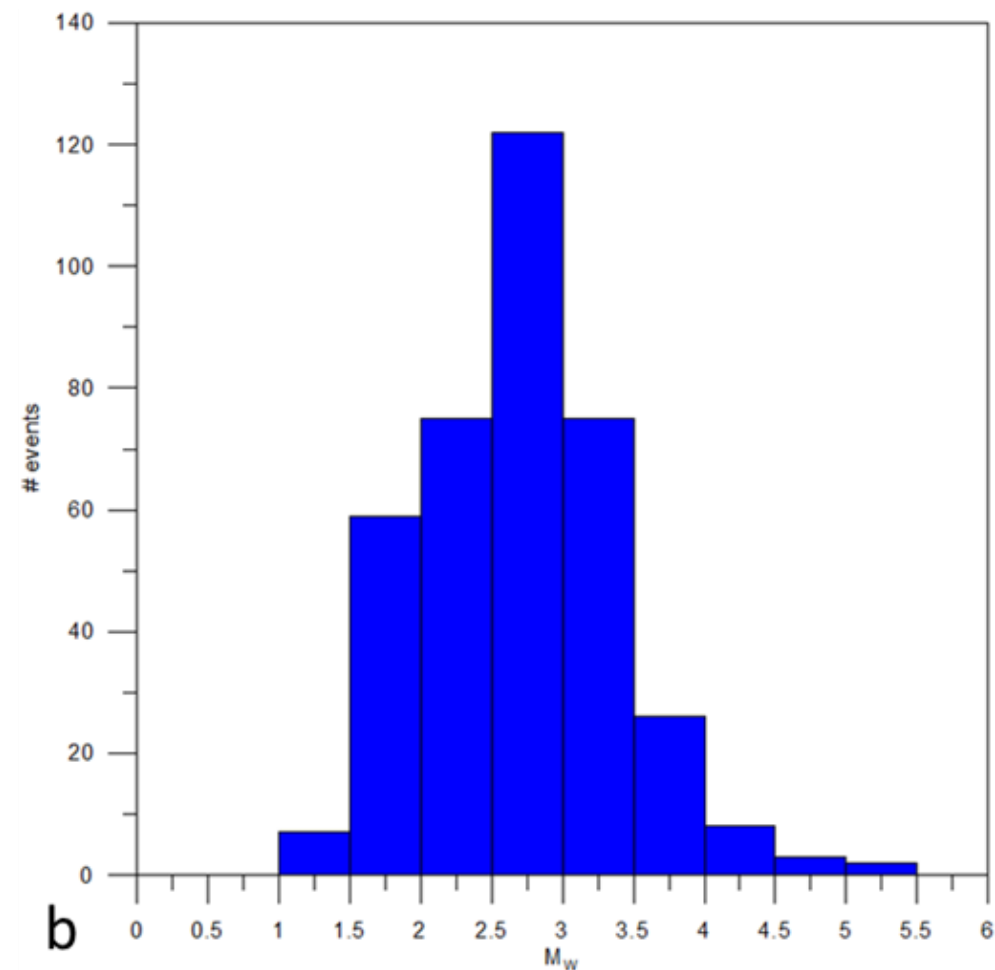
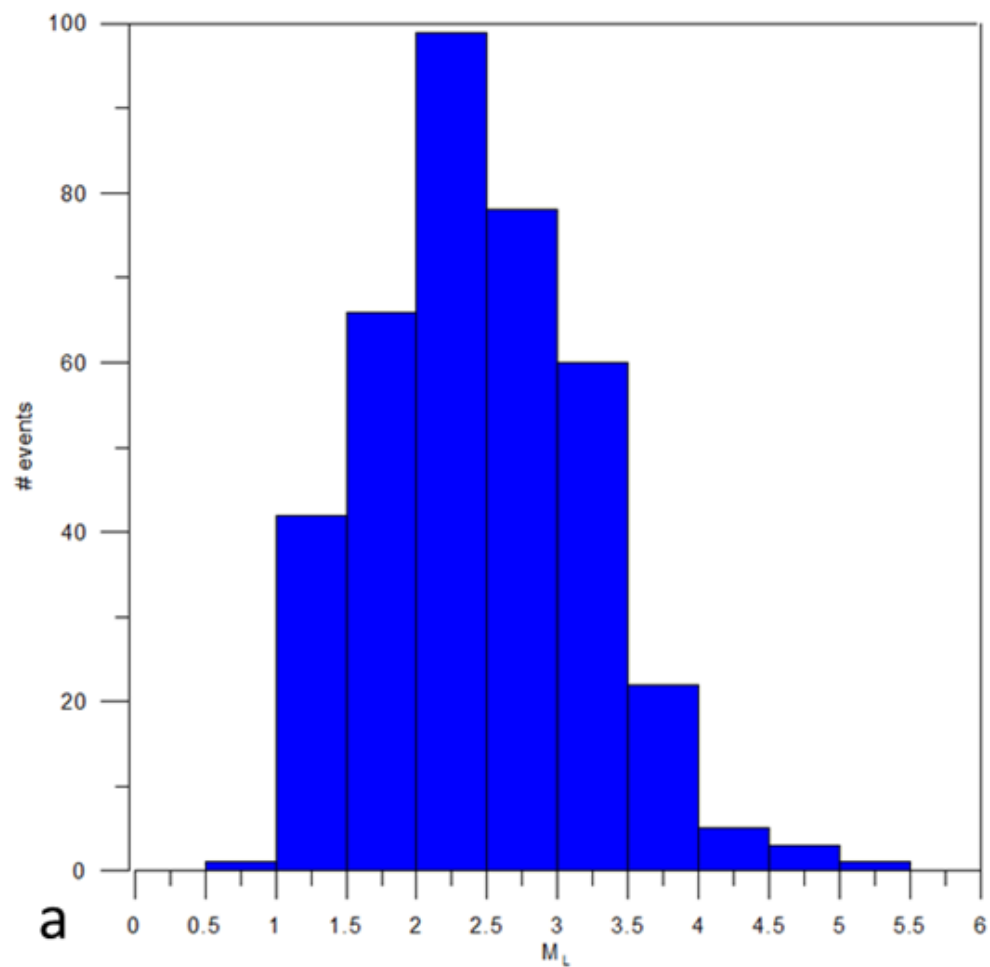
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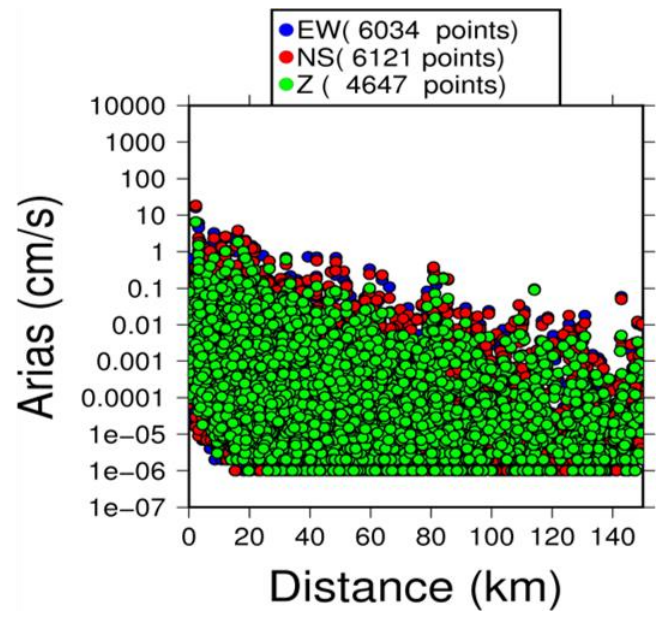
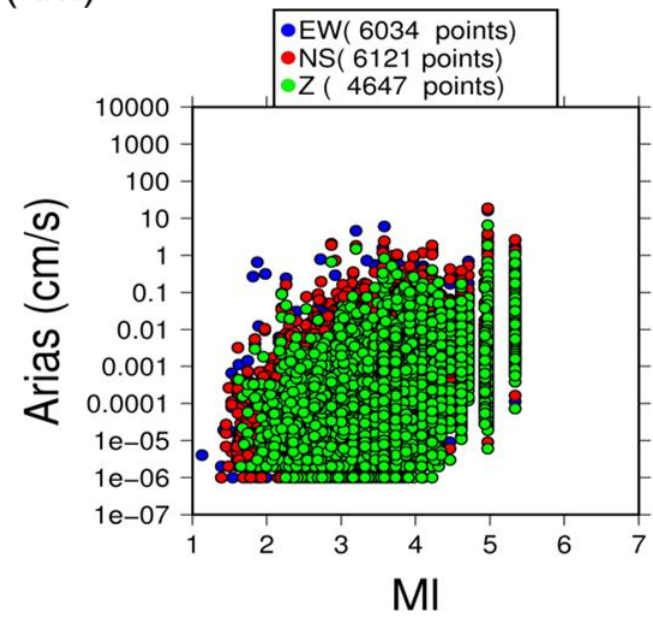
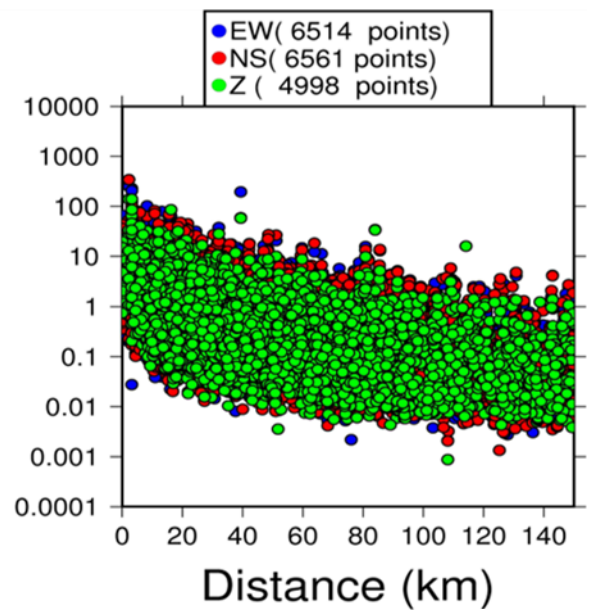
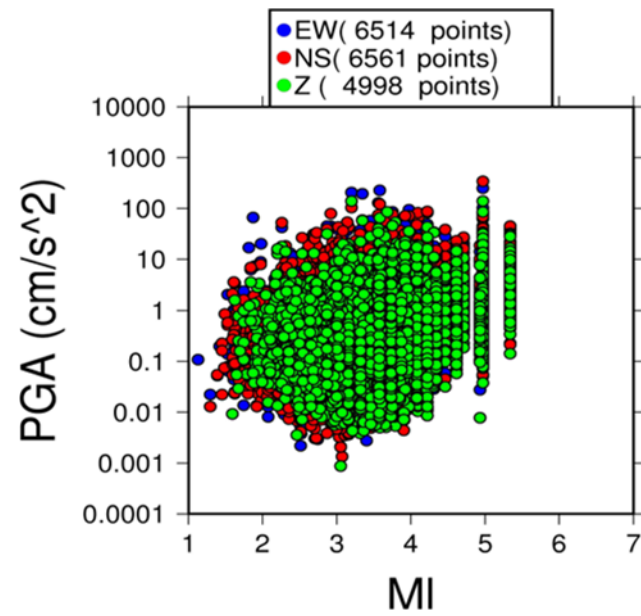
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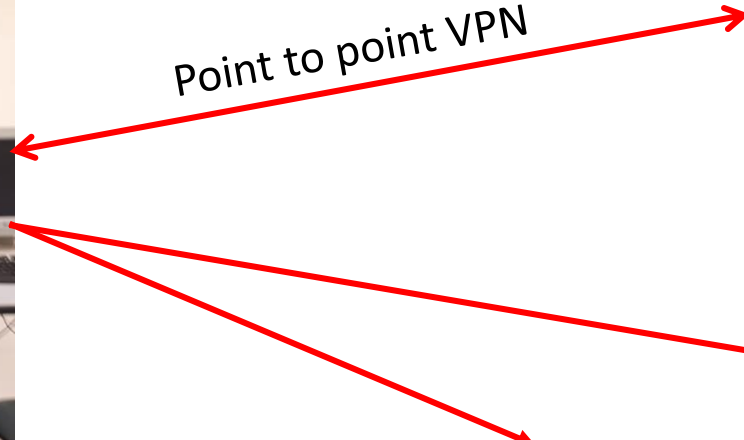


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Roma

Point to point VPN

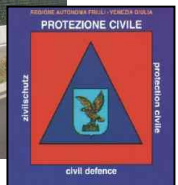


CE³RN

Central and Eastern European
Earthquake Research Network



Palmanova



HA Cluster