ROMANIAN SEISMIC NETWORK

Anton Danet
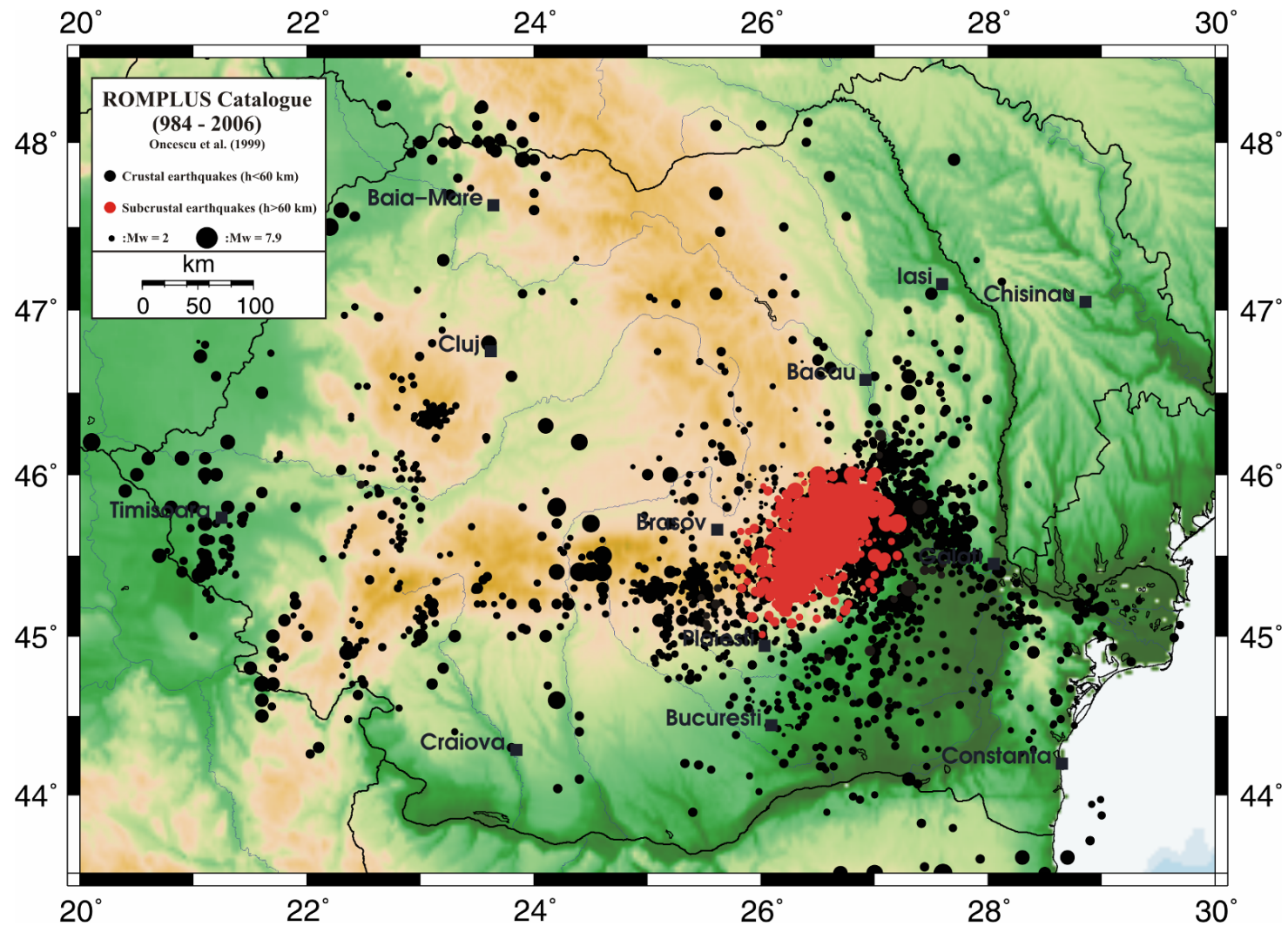
National Institute for Earth Physics, Bucharest

Euro-Mediteranean Quanterra and Antelope Users Group Meeting
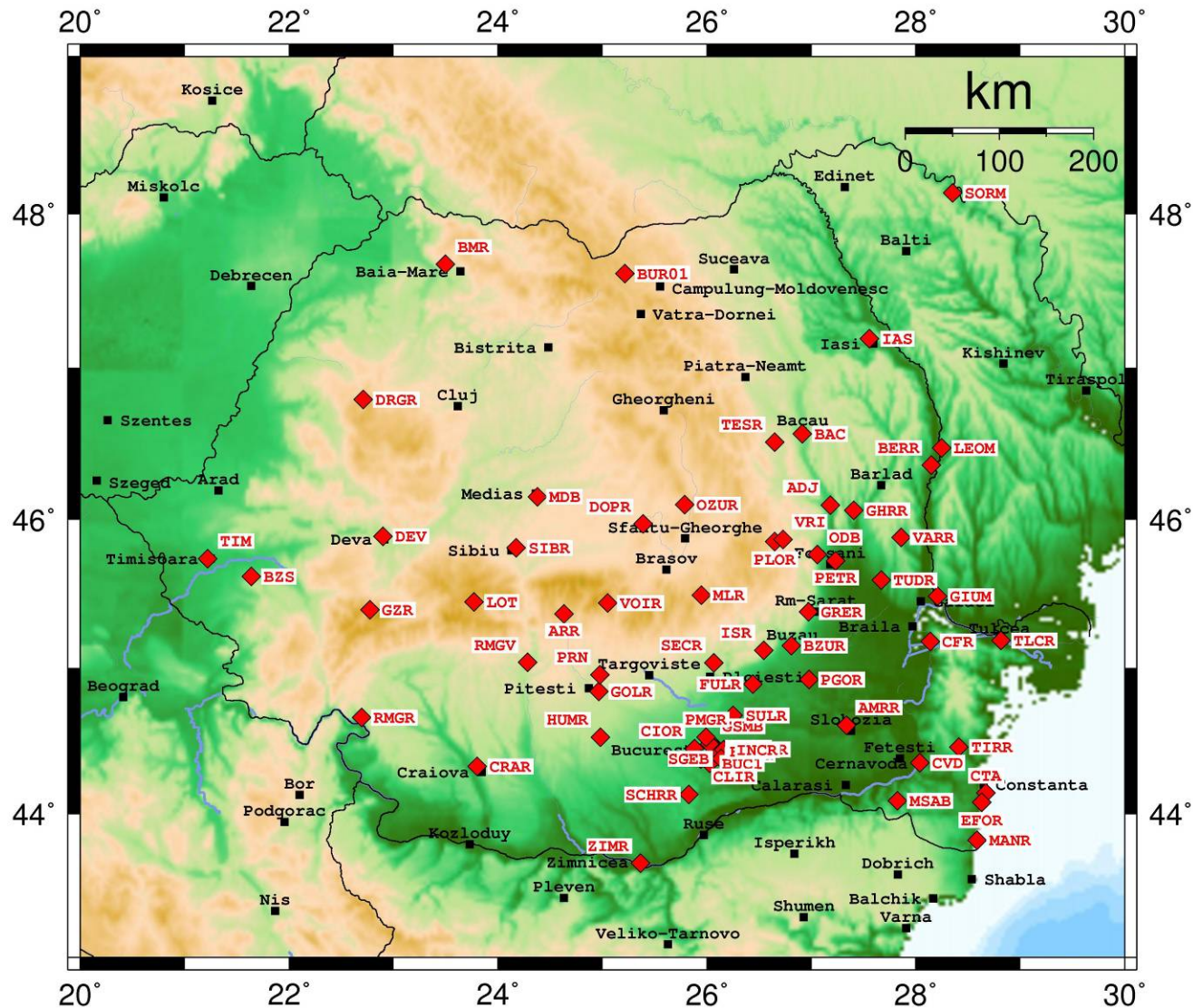Marrakech 11-13 March 2009

CONTENT

- General overview of the Romanian Seismic Network

- Linux SuSE 9.3 and Antelope 4.10

- How to get an early seismic bulletin

- Progress towards getting a near real time shakemap

Romania - seismic activity
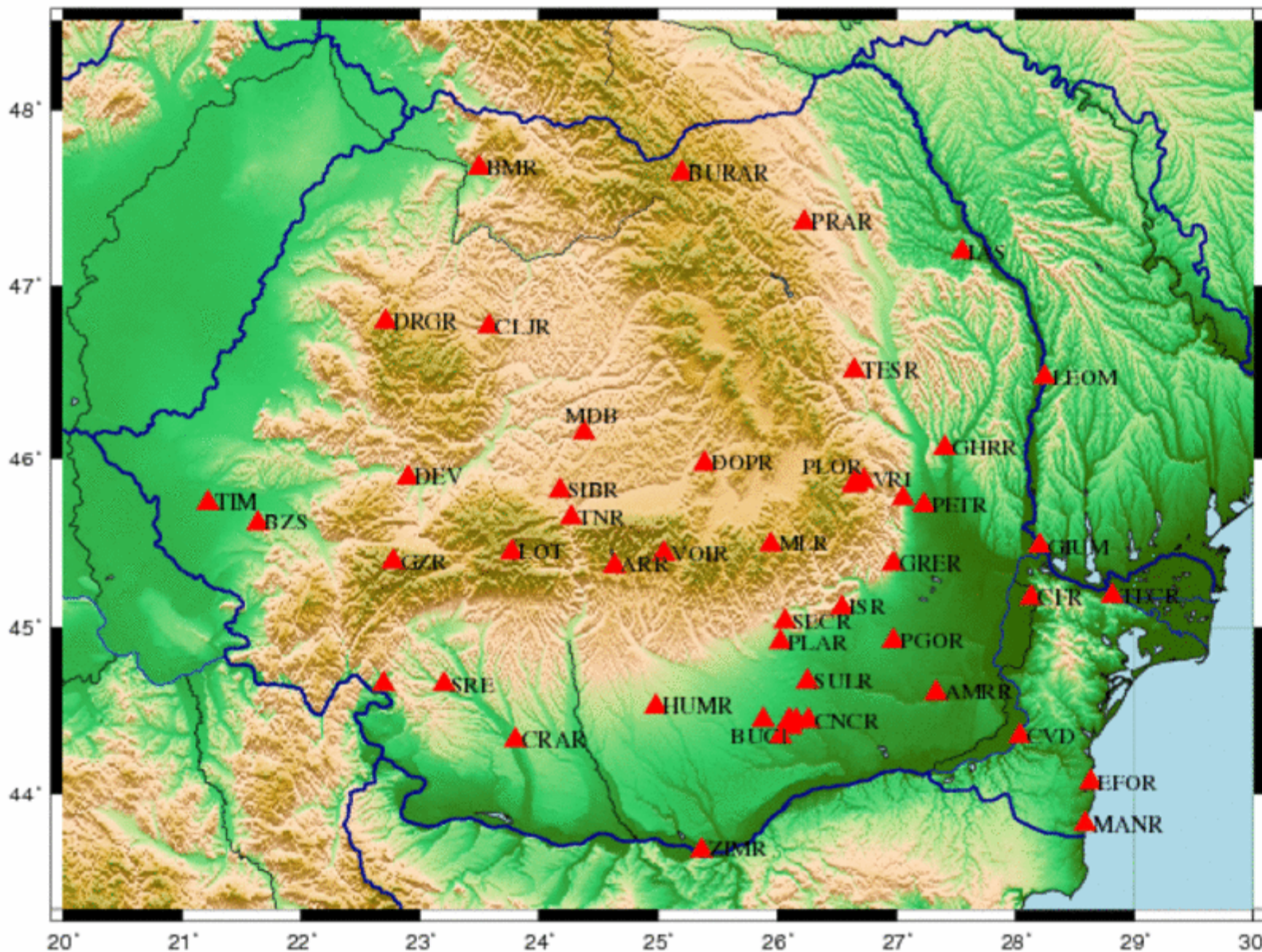
Real time seismic network

58 seismic stations
and 2 arrays,
BURAR and PLOR

Q330   - 49
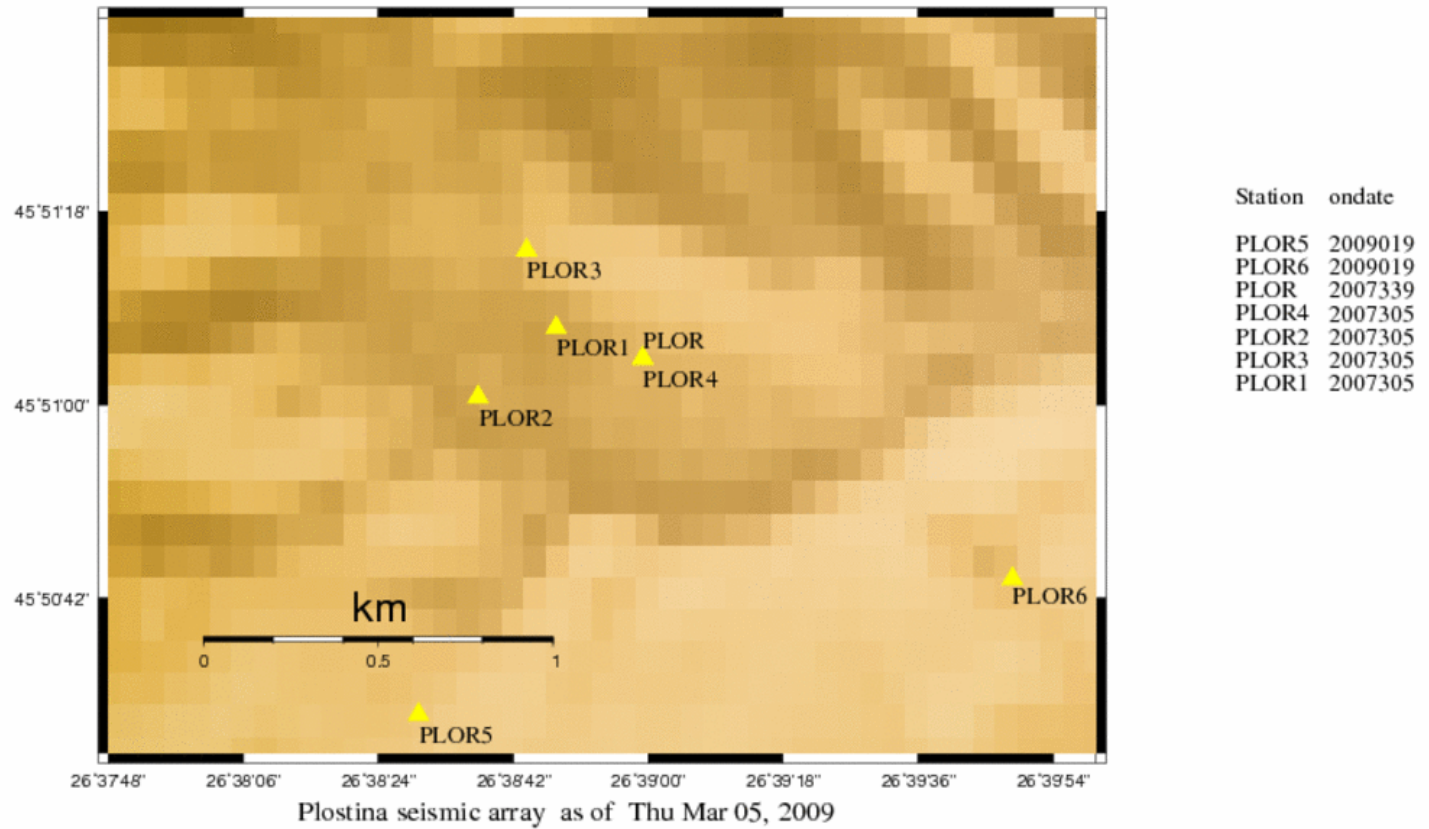K2   - 13
Marmot   - 21
Episensor   - 55

Dbmaster site table snapshot

RO stations in the Romanian Seismic Network as of Thu Mar 05, 2009

Station	ondate
SRE	2009044
ARR	2009034
PLOR5	2009019
PLSP4	2009019
PLOR6	2009019
CLJR	2009018
ODBI	2008347
PRAR	2008331
PLAR	2008324
EFOR	2008317
RMGR	2008308
HUMR	2008297
ISR	2008290
LOT	2008290
MANR	2008284
SECR	2008275
CNCR	2008256
BAPR	2008256
GHRR	2008249
BVCR	2008249
BSTR	2008234
CIOR	2008227
PGOR	2008199
BTMR	2008193
DOPR	2008193
SULR	2008157
GRER	2008149
TESR	2008149
AMRR	2008143
CFR	2008133
GIUM	2008098
LEOM	2008095
PETR	2008093
INCR	2008051
ZIMR	2008024
TNR	2007345
SIBR	2007345
PLOR	2007339
DEV	2007330
BUC	2007295
BMR	2007264
MDB	2007250

Plostina array

Plostina seismic array as of Thu Mar 05, 2009

SOH - Data streams latency

CLJR	761:40:10	INCR	41:41:01	MLR	39:09	DRGR	12:39
BUR01	8:09	ISR	7:54	GZR	6:59	BUR33	6:18
BUR32	5:54	BUR09	5:04	BUR05	4:58	MALT	4:56
VTS	4:47	PLSP4	4:28	MORC	4:24	VOIR	4:15
SRE	3:40	BUR02	3:39	BUR06	3:38	ARR	3:32
BZS	3:30	PLAR	3:25	BUR08	3:23	GRER	3:20
PRAR	2:52	BURAR	2:48	PLOR2	2:43	CFR	2:40
PKSM	2:32	BUR03	2:31	BUR04	2:29	BUR07	2:26
APE	2:25	VRI	2:25	TLCR	2:17	CRAR	2:10
TRPA	2:07	AMRR	2:06	PLOR6	2:05	BUC	1:59
PLOR4	1:57	PLOR	1:57	EFOR	1:51	KWP	1:43
HUMR	1:39	MDB	1:38	RMGR	1:35	PGOR	1:31
DEV	1:28	BVCR	1:28	AQU	1:24	ISP	1:23
LEOM	1:22	BUC1	1:17	PSZ	1:13	BSTR	1:13
PLOR5	1:02	CVD	1:01	CIOR	58	KIS	56
MANR	52	ODBI	52	SECR	49	TESR	48
PLOR3	45	BMR	45	BAPR	42	DOPR	40
ZIMR	39	TIRR	37	SULR	34	LOT	34
IAS	32	VRAC	31	BTMR	29	GHRR	20
SIBR	20	PLOR1	19	PETR	19	CNCR	18
TNR	16	TIM	15				

10:21:21

Main computer room

SOH - wfdisc table statistics

Session   Edit   View   Bookmarks   Settings   Help

```
scomp% /home/rt/bin/check_wfdisc -t -db ronet

            Records where endtime < time
sta      chan      time                    endtime                    nsamp              lddate


            Records number in ronet.wfdisc table is 558 (79 stations)
            from 2009/03/05 - 00:00:00.000   to  2009/03/05 - 06:40:12.648
            time interval = 0 days 6 hours 40 minutes

            The number of NULL calib fields is 0 and
            the number of NULL segtype fields is 0

RMGR    18       PLOR1   15      BTMR    15      CVD     15      PLOR2   11
KIS     9        ISR     9       ODBI    9       PETR    9       GHRR    9
TIRR    9        MLR     9       BMR     9       BVCR    9       TESR    9
MANR    9        VOIR    9       CFR     9       GZR     9       LEOM    9
ZIMR    9        GRER    9       BSTR    9       IAS     9       DOPR    9
PLAR    9        MDB     9       SECR    9       SULR    9       VRI     9
CIOR    9        BUC1    9       HUMR    9       PLOR4   9       DRGR    9
BZS     9        AMRR    9       ARR     9       TLCR    9       SRE     9
PGOR    9        PLOR    9       LOT     9       BUC     9       DEV     9
BAPR    9        EFOR    9       CRAR    9       PLOR3   7       BURO1   7
PLOR6   6        PLOR5   6       PRAR    5       BURO5   4       BURO9   4
SIBR    4        BUR32   3       AQU     3       PKSM    3       VTS     3
VRAC    3        PSZ     3       ISP     3       BUR33   3       BURAR   3
MORC    3        MALT    3       TRPA    3       CNCR    3       APE     3
KWP     3        PLSP4   2       TNR     1       BURO4   1       BURO3   1
BURO8   1        BURO7   1       BURO6   1       BURO2   1

sta    chan  nsamp     time                    endtime              calib      segtype
scomp%
```

Shell

orb2pf - ORB out of order packets - SuSE 9.3

```
danet@acteon2:~ - Shell - Konsole

Session   Edit   View   Bookmarks   Settings   Help

(SuSE 9.3 and  100MB ORB)
-------------------------------------------------------------------------
/pf/orbassoc        17811    1/15/2009    1:14:41.227
/pf/orbpftrigger    17812    1/15/2009    1:14:41.227
/pf/orb2dbt         17937    1/15/2009    1:14:42.598 association
/pf/orbmag          18045    1/15/2009    1:14:43.614
/pf/orb2dbt         19608    1/15/2009    1:15:05.013    magnitude

/pf/orbassoc        170445   1/16/2009   20:16:20.720
/pf/orbpftrigger    170446   1/16/2009   20:16:20.720
__/pf/orb2dbt       170558   1/15/2009    1:14:42.598 association
/pf/orb2dbt         170559   1/16/2009   11:25:09.199 association
/pf/orb2dbt         170566   1/16/2009   20:16:21.292 association
__/pf/orbmag        170679   1/15/2009    1:14:43.614
/pf/orbmag          170680   1/16/2009   20:16:22.835
/pf/orbmag          170697   1/16/2009   20:16:23.090

/pf/orbassoc        89482    1/16/2009   22:48:41.440
/pf/orbpftrigger    89483    1/16/2009   22:48:41.440
/pf/orb2dbt         89590    1/16/2009   22:48:42.051 association
/pf/orbmag          89881    1/16/2009   22:48:45.296

/pf/orbassoc        38609    1/17/2009    8:52:50.876
/pf/orbpftrigger    38610    1/17/2009    8:52:50.876
/pf/orb2dbt         38725    1/17/2009    8:52:51.371 association
/pf/orbmag          38752    1/17/2009    8:52:52.023
__/pf/orb2dbt       38903    1/15/2009    1:15:05.013    magnitude
++/pf/orb2dbt       38904    1/16/2009   22:48:48.960         magnitude
/pf/orb2dbt         38906    1/17/2009    8:52:53.863         magnitude
-------------------------------------------------------------------------
- magnitude - indicates a magnitude_update type /pf/orb2dbt packet (orbevproc produced),
- retransmitted packets are prefixed with __ , delayed packets with ++
- 170558 duplicates 17937,170679 duplicates 18045, 38903 duplicates 19608
- 38904 is a delayed packet, i.e. it was produced and written to ORB
on 1/16/2009  22:48:48 ( according to orbevproc log) but it appears later,
when a new event occured and /pf/ packets were generated (38609,38610,38725,..)
danet@acteon2:~> █

Shell
```

Estimation of processing times – SuSE 9.3

```
------------------------------------------------------------------------------
/pf/orbassoc          55650     2/25/2009     9:40:08.079  6        6.2      41.7       47.8
/pf/orbpftrigger      55651     2/25/2009     9:40:08.079
/pf/orb2dbt           55838     2/25/2009     9:40:08.863 association   0.784
/pf/orbmag            56145     2/25/2009     9:40:11.986

/pf/orbassoc          118107    2/25/2009    10:36:12.536  5       16.1     144.5      160.6
/pf/orbpftrigger      118110    2/25/2009    10:36:12.536
/pf/orb2dbt           118288    2/25/2009    10:36:13.539 association   1.003
/pf/orbmag            118398    2/25/2009    10:36:14.893
/pf/orb2dbt           118717    2/25/2009    10:36:19.135    magnitude   5.596

        Statistics for scomp - dbrex from 1/13/2009 12:33:09.854 to 2/25/2009 10:36:19.135
        - total pf packets: 336, nr of out of order packets: 3
        -total orb2dbt packets: 113, out of which there are 44 orbevproc produced
        -association computation time :    0.495/  6.044
        -magnitude computation time :    3.068/ 22.415
        -pick time span :    0.0/  66.7
        -last pick to orbassoc time :    31.2/ -
        -first pick to orbassoc time :    43.8/ -
danet@acteon2:~>
```

How to find out when orbevproc has terminated its job ?

Shakemap status

- Antelope dbgme – 2-D ground motion estimation from a database of epicenters and measurements
- USGS ShakeMap - suite of processing modules

Characteristics:
- rely on a geological model and specific attenuation laws
  - -> not available yet
- assume a radial symmetry of the shake pattern
  - -> not suitable for the Vrancea region

New approach

❑ Approach based on the macroseismic attenuation law derived for Vrancea region (1) and instrumental intensity law (2)

The Mathilde Soerensen macroseismic attenuation law (1) has 6 parameters $(c_i, i = 1..6)$ and a site correction function (dl)

$$I = c_1 \cdot M_w + c_2 \cdot \log(h) + c_3 + c_4 \cdot \log \sqrt{\frac{R^2 + h^2}{h^2}} + c_5 \cdot (\sqrt{R^2 + h^2} - h) + c_6 + M_w \cdot dl \quad (1)$$

M_w, R, h are moment magnitude, epicentral distance and depth respectively

$$dl(\lambda,\theta) = \sum_{j}^{6} p_{6,j} \cdot \exp(-\left[p_{3,j} \cdot (\lambda - p_{1,j})^2 + 2 p_{5,j}(\lambda - p_{1,j})(\theta - p_{2,j}) + p_{4,j}(\theta - p_{2,j})^2 \right])$$

λ, θ are longitude, latitude

$p_{i,j}$ constants (6x6 table)

Validity range : $(6.4 \leq M_w \leq 7.7)$ $70km \leq h \leq 180km$

$II = 3{,}25 \cdot \log(PGA) - 0.18$ (Bonjer at al., 2001)   (2)

$$\Rightarrow PGA(II)$$

The relations (1) and (2) are implemented as subroutines (get_mmi and get_pga) inside grind (ShakeMap main module)

Oct 27 2004 20:34:36 M=6.0

NIEP Macroseismic Intensity Shakemap : ROMANIA
Wed Oct 27, 2004 20:34:36 GMT M 6.0 N45.78 E26.73 Depth: 98.6km ID:817
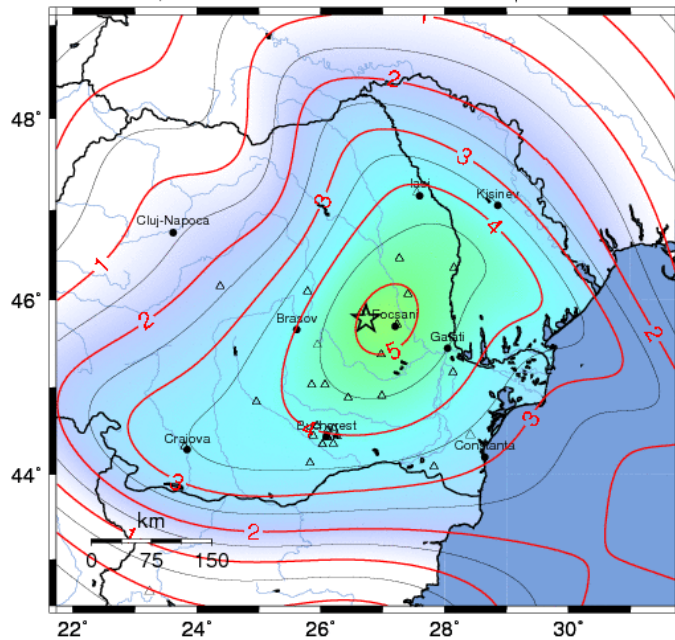
NIEP Peak Accel. Map (in %g) : ROMANIA
Wed Oct 27, 2004 20:34:36 GMT M 6.0 N45.78 E26.73 Depth: 98.6km ID:817

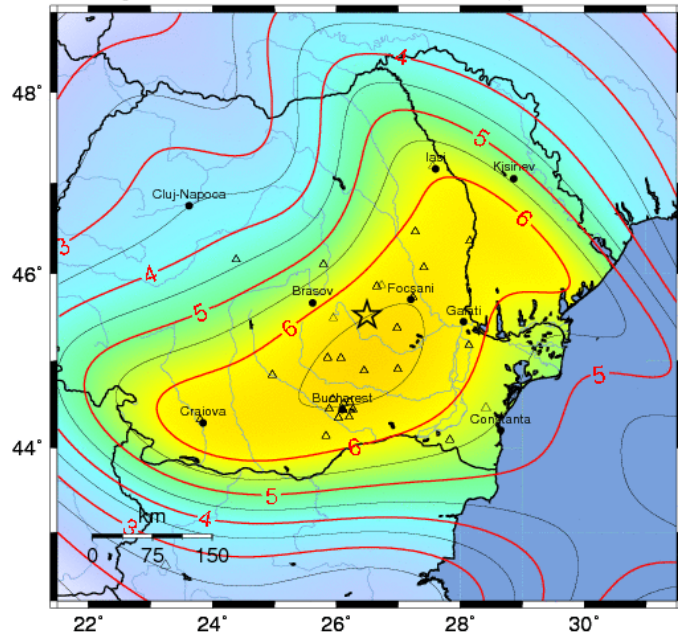| PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

May 31, 1990 00:17:47 GMT   M 6.4

May 30, 1990 10:40:06 GMT   M 6.9

NIEP Macroseismic Intensity Shakemap : ROMANIA
Thu May 31, 1990 00:17:47 GMT M 6.4 N45.85 E26.91 Depth: 86.9km ID:817

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
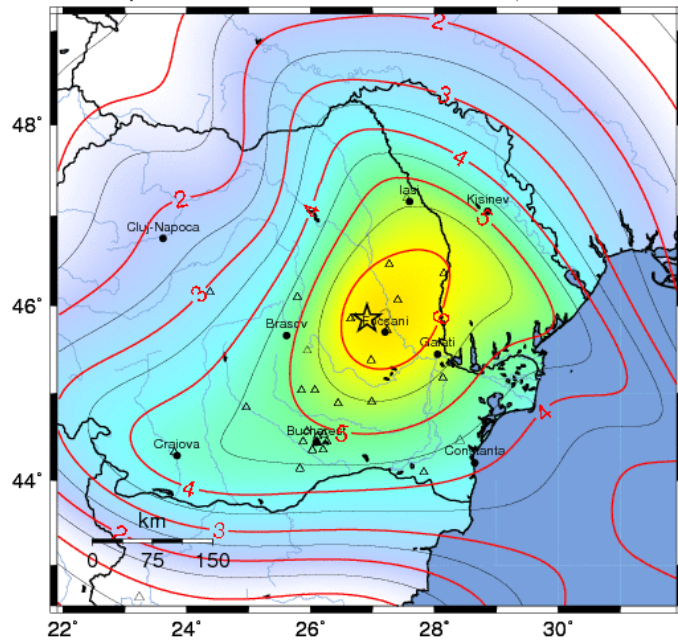
NIEP Macroseismic Intensity Shakemap : ROMANIA
Wed May 30, 1990 10:40:06 GMT M 6.9 N45.83 E26.89 Depth: 90.9km ID:817

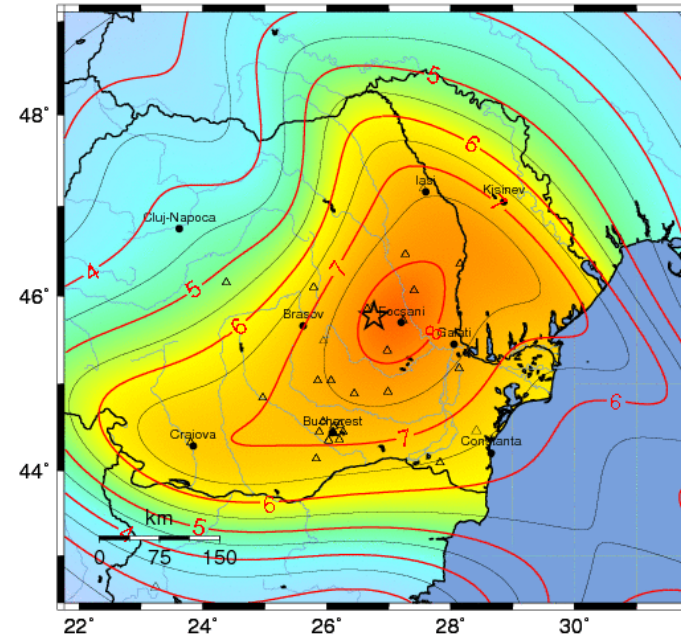| PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Aug 30, 1986 21:28:37 GMT   M 7.1

Mar 4, 1977 19:21:54 GMT   M 7.4

Some observations on the theoretical method:

- valid for a small range of earthquake magnitudes
- ignores site specific local conditions
- acceptable results mainly for intensities
- accelerations too high for magnitude greater than 6

❑   Approach based on observed data or

  observed data and computed values in between stations

- - computing the acceleration and velocity at every station

  (orbwfmeas, orbevproc, dbwfmeas)   then

  transfer the data to ShakeMap (db2shakemap_xml)

- - linear interpolation of data (GMT tools)

Observed site accelerations

Accelerations (mg) − max at LEOM 0.866335

Thu Jan 15, 2009 01:12:39 GMT Ml 2.78 N45.5050 E26.3282 Depth: 150.0 km Evid:3682
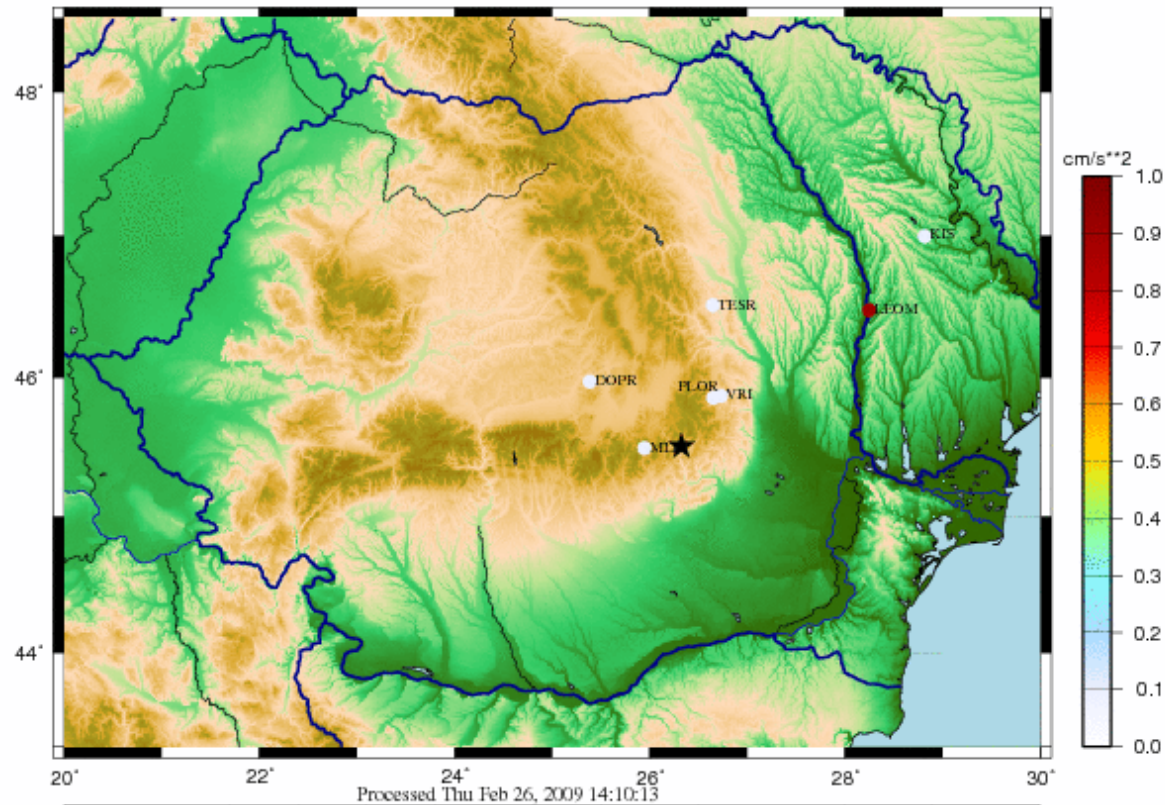
Processed Thu Feb 26, 2009 14:10:13

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate−Heavy	Heavy	Very Heavy
PEAK ACC (cm/s**2)	<1.7	1.7−14	14−39	39−92	92−180	180−340	340−650	650−1240	>1240
PEAK VEL (cm/sec)	<0.1	0.1−1.1	1.1−3.4	3.4−8.1	8.1−16	16−31	31−60	60−116	>116
INSTRUMENTAL INTENSITY	I	II−III	IV	V	VI	VII	VIII	IX	X

Thank you for your attention