European-Mediterranean Seismological Centre

http://www.emsc-csem.org

EMSC Real Time Earthquake

Information Services

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I. INTRODUCTION

The European Mediterranean Seismological Center (EMSC) is an international NGO which members are seismological institutes and observatories of the Euro-Med region (Appendix C) and hosted since 1992 by the LDG (Laboratoire de Détection et de Géophysique, France). Its main scientific activities are the Real Time Earthquake Information (RTEI) services and the production of the Euro-Med Bulletin (Godey et al.).

The RTEI services are operating thanks to the operational technical support of the LDG by compiling the real time parametric data provided, received by email and provided by 66 seismological networks. EMSC provides several services in the field of rapid information on the European-Mediterranean seismicity and significant earthquakes worldwide.

II. REAL TIME DATA AND REAL TIME EARTHQUAKE INFORMATION SERVICES

II.1. DATA DESCRIPTION AND PROCESSING

II.1.1. DATA DESCRIPTION

The Real Time Earthquake Information services are based on the reception, by email or via QWIDS (see §II.1.2), of parametric data (source parameters, phase pickings, amplitudes) provided by 66 data contributors (i.e. seismological networks) (Appendix A). Some data contributors send their data automatically and very shortly (few minutes) after the earthquake occurrence. For others, the data are sent by the person on duty. Some agencies provide data during working hours only.

The messages sent by the data contributors contain different types of data:

- Source parameters (origin time, epicenter location, focal depth, magnitude).
- Phase pickings (station code, arrival times, phase type, amplitudes and periods). Some messages only contain a group of phase pickings without any associated location.
- Moment tensors solutions, Focal mechanisms.

II.1.2. QWIDS: An actual real time communication system

In order to improve its performances and especially the speed and robustness of the reception of real time data, EMSC implemented a software named QWIDS (Quake Watch Information Distribution System) which has been developed by ISTI (Instrumental Software Technologies Inc.; http://www.isti.com/) and has been kindly provided by the U.S. Geological Survey. QWIDS provides a quick and robust data exchange system through permanent TCP connections. At the difference with emails that can sometimes be delayed or lost, QWIDS is an actual real time communication system that ensures the data delivery.

II.1.2.1. General features

QWIDS uses a server-client technology in which the information published by the server is immediately pushed (via CORBA methods), in xml format, to the connected clients. For this, a permanent TCP/IP connexion through 2 dedicated ports must be established between the server and the client.

Its performances show that it is able to push a single message to 1000 connected clients within 1.4 seconds.

QWIDS is a free (for non-commercial purposes) and open-source software developed in java and is therefore multi-platform. It also provides security features (user authorization + message authentication), a high level of configurability, a persistent archiving of messages, and a message recovery system which allows the client to catching up the missed messages during the period of time it has been down.

II.1.2.2. Configuration

QWIDS can be configured in a way to provide redundancy and scalability. In a typical configuration, several QWIDS Servers are permanently connected to the Data Providers (Figure 1). As soon as a Data Provider publishes new data, they are immediately pushed to the connected Servers. As a consequence the Servers that are connected to the same Data Providers receive the same data at the same time. Each Client is also permanently connected to both Servers (Figure 1) which provides redundancy in the collection and dissemination of data. Indeed, in such a configuration, in case of failure of Server 1, the client will receive automatically the data through Server 2.

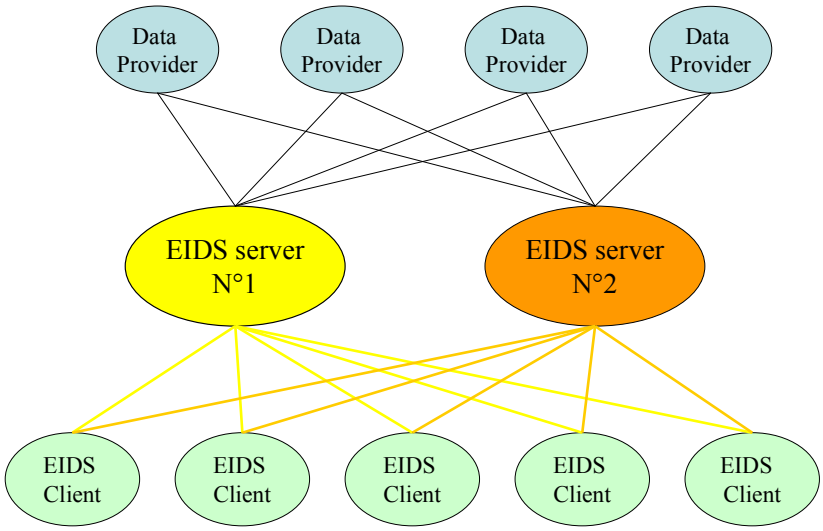

Figure 1: Typical architecture of QWIDS components

Other servers can also be added and even direct Server-Server connections can also be established to further improve the redundancy.

Currently, the NEIC and ORFEUS are both providing real time data to EMSC via QWIDS. Two QWIDS Relay servers are operated respectively at EMSC and ORFEUS.

II.1.2.3. Firewall issues

In a typical connection, a server and a client communicate through 2 dedicated ports: one for the data transfer and one for the notification service. For security reasons, these ports are generally chosen greater than 1024 (n° 38977 and 38988 by default). It is thus important to have in mind the difficulties that may be encountered on the server or client side while opening the ports through the different routers/firewalls that may be involved.

ISTI has also developed a client which runs through web services (port 80 (http) or 443 (https)) and therefore does not require any extra port opening however this solution does not provide the same quality of service.

II.1.3. MESSAGES PROCESSING

Hereafter is presented how the data are processed, how EMSC computes locations and the rules used to assign a location to an event. In this part, the word “message” refers to email messages that contain source parameters/phase pickings information.

The mailbox is checked every minute and every incoming message is processed following the same procedure:

- Identification of the network which provides the data.
- Conversion of the data into GSE2.0 format.
- Conversion of local station codes into international ones.
- Archiving into an Oracle database which makes the data available through an autoDRM (Figure 2).
- Discard events with magnitude lower than 2.0 for further processing. If no magnitude has been reported, the message is kept for further processing.
- Association to the group of messages previously received (i.e. from other networks) for the same event.

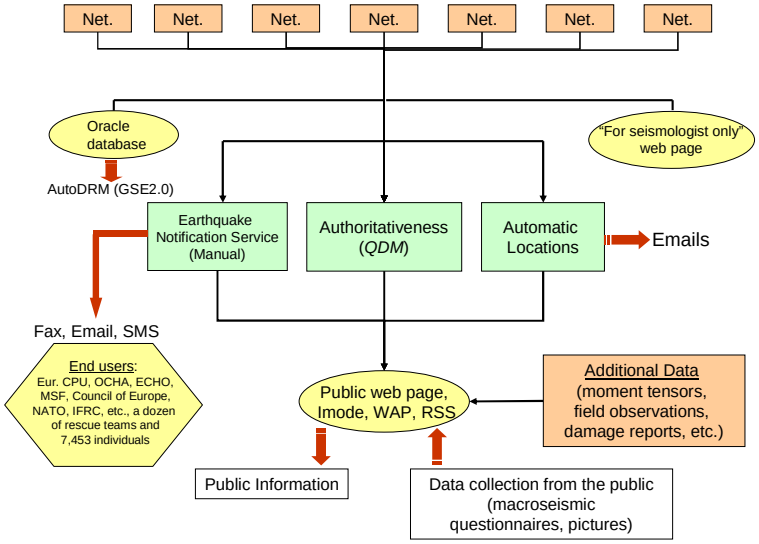

Figure 2: Data flow for the Real Time Earthquake Information services

II.1.4. STRATEGY TO ASSIGN A LOCATION TO AN EVENT

II.1.4.1. Event reported by one network

A geographical region defined as a polygon is associated to each network. An earthquake reported by this network and which location falls within this region is considered as reliable. One says the network is **authoritative** in the region. For example, the French national network is authoritative in France and border regions. A software named QDM (Quake Data Merge), provided by the U.S. Geological Survey (written by A. Jones and D. Oppenheimer) is plied to determine the authoritativeness of the network in the region of event occurrence.

When an event is reported by only one network, its location is assigned to the event only if this network is authoritative in the region of occurrence.

II.1.4.2. Event reported by several networks

When an event is reported by several networks, EMSC performs a location by merging and associating the phase pickings provided by the different networks. The location is assigned to this event. These locations can be either automatically or manually (by EMSC staff or the seismologist on call) computed.

II.1.4.2.1. Automatic locations

An automatic location is performed as soon as data from several networks are available for the same event. Then, when new data coming from another network is made available, the location is updated by integrating the new phase pickings.

Automatic locations are computed thanks to a program called ***Fusion*** provided by the LDG (EMSC host institute). The result of an automatic location is disseminated 65 minutes after the event occurrence to a list of seismological institutes. Some use them to trigger automatic moment tensors computations.

II.1.4.2.2. Manual locations

Afterwards, each automatic location is manually reviewed by a seismologist. For potentially damaging earthquake, the manual review is performed quickly after the event occurrence in the framework of the Earthquake Notification Service (Part II.2.1.) otherwise it is performed in the next hours or the next working day by EMSC staff or by the seismologist on call.

II.1.4.2.3. Case of redundant phases

Because of transnational data exchange and the development of virtual networks, the same seismic station recording may be used and reported by several networks but with different phase pickings. One has then to select one pick among the whole list during the location process. Therefore, in each location performed by EMSC, the following rules are applied:

- A manual pick replaces the automatic one (for the same station and same phase type) as long as its time residual is lower than the automatic pick.
- A pick to which an amplitude is associated replaces the one without amplitude (as it brings additional information) as long as its residual is lower than the one without amplitude.

II.2. REAL TIME EARTHQUAKE INFORMATION SERVICES

Thanks to the real time data received from the data contributors and the different successive processing, EMSC provides several real time services, among which information published on a web site or active dissemination of seismological information such as the Earthquake Notification Service or the autoDRM.

II.2.1. PUBLISHED INFORMATION

This part presents all the information available on the web site, the Imode and the WAP pages.

II.2.1.1. EMSC web site

The EMSC web site is accessible at the following URL: http://www.emsc-csem.org. It gathers several real time services described below.

II.2.1.1.1. "For Seismologist only" and "Public" pages

II.2.1.1.1.1. The "For Seismologist Only" web page

This page is dedicated to the seismological community and displays groups of messages that refer to the same event (Figure 3). All the messages received from the data contributors and which magnitude exceeds 2.0 (as long as a magnitude is reported) are published on a web page called "***For Seismologist Only (FSO)***" page (http://www.emsc-csem.org/index.php?page=current&sub=msg).

II.2.1.1.1.2. The "Public" web page

Because the FSO page is more dedicated to the seismologist community and because it may be difficult to understand by the general public, the "***Public page***" has been developed late 2004 and in order to show a single set of source parameters per event. As a result, a list of latest earthquakes is available through the Public page (http://www.emsc-csem.org/index.php?page=current&sub=list). It is updated each minute and presents for each event its associated source parameters: origin time, epicenter coordinates, focal depth, magnitude type and value, region of occurrence and the time when the location of the event has been updated (Figure 4).

Date & Time UTC	Latitude degrees	Longitude degrees	Depth km	Mag.		A/M	Region name	Network
More recent start ◀◀ ◀ 81 - 82 - 83 - 84 - 85 - 86 - 87 - 88 - 89 - 90 ▶ ▶▶ Back in time								
2007-12-16 08:09:54.5	17.0 S	64.0 W	30	mb	5.6	A	SANTA CRUZ, BOLIVIA	ZAMG
2007-12-16 08:09:30.7	21.6 S	68.8 W	48	M	6.4	M	ANTOFAGASTA, CHILE	BGR
2007-12-16 08:09:18.0	22.8 S	70.0 W	60	MS	6.5	M	ANTOFAGASTA, CHILE	GSRC
2007-12-16 08:09:17.7	22.9 S	70.1 W	45f	M	6.7	M.	ANTOFAGASTA, CHILE	NEIR
2007-12-16 08:09:16.7	23.0 S	70.1 W	28	M	6.9	A.	ANTOFAGASTA, CHILE	GFZ
2007-12-16 08:09:16.5	22.8 S	69.9 W	50f	Mw	6.7	M+	ANTOFAGASTA, CHILE	INFO
2007-12-16 08:09:15.5		*Moment tensors*				M#	ANTOFAGASTA, CHILE	MT
2007-12-16 08:09:15.2	21.5 S	70.9 W		mb	5.4	M	OFFSHORE ANTOFAGASTA, CHILE	RNS
2007-12-16 08:09:13.5	22.8 S	70.3 W		mb	6.4	M	ANTOFAGASTA, CHILE	MAD
2007-12-16 08:09:00.0	22.0 S	70.0 W		Mw	6.7	M.	ANTOFAGASTA, CHILE	PPTm
2007-12-16 07:50:24.0	37.0 N	29.2 E		ML	3.2	A	WESTERN TURKEY	NOA
2007-12-16 07:50:21.1	37.0 N	29.3 E	10	ML	3.3	M+	WESTERN TURKEY	INFO
2007-12-16 07:50:21.0	37.0 N	29.2 E	21	ML	3.3	M	WESTERN TURKEY	DDA
2007-12-16 07:50:20.8	36.9 N	29.3 E	16	MD	3.5	M	WESTERN TURKEY	KAN
2007-12-16 06:32						A		INGV
2007-12-16 06:20:17.9	41.1 N	20.1 E		ML	3.2	M	ALBANIA	THE
2007-12-16 06:20:17.3	41.0 N	20.0 E		ML	2.8	M	ALBANIA	SKO
2007-12-16 06:20:17.0	41.1 N	20.0 E	11	ML	2.9	M	ALBANIA	MSO
2007-12-16 06:20:16.8	41.1 N	20.0 E	2	ML	3.0	M+	ALBANIA	INFO
2007-12-16 05:27						M		MCSM
2007-12-16 05:27						M		BUC
2007-12-16 05:15:56.0	41.0 N	145.1 E	70	mb	4.8	A	HOKKAIDO, JAPAN REGION	GFZ
2007-12-16 05:15:51.4	40.4 N	143.4 E	33	M	4.6	M	OFF EAST COAST OF HONSHU, JAPAN	BGR
2007-12-16 05:15:44.4	40.1 N	144.8 E	18	M	4.8	M	OFF EAST COAST OF HONSHU, JAPAN	NEIR
2007-12-16 05:15:43.9	40.1 N	144.9 E	33	mb	5.0	M	OFF EAST COAST OF HONSHU, JAPAN	GSRC
2007-12-16 05:15:42.3	39.5 N	143.9 E	25	mb	4.1	A	OFF EAST COAST OF HONSHU, JAPAN	NEWS
2007-12-16 05:15:42.2	40.1 N	144.8 E	19	mb	4.8	M+	OFF EAST COAST OF HONSHU, JAPAN	INFO
2007-12-16 05:15:41.3	39.5 N	144.5 E	25	mb	3.9	A	OFF EAST COAST OF HONSHU, JAPAN	NEWS
2007-12-16 05:15:27.0	38.2 N	148.5 E		mb	5.5	A	NORTH PACIFIC OCEAN	BRA
2007-12-16 05:03:51.3	34.7 N	32.8 E	8	MD	3.0	M	CYPRUS REGION	NCSS
2007-12-16 04:57:26.0	35.6 N	92.4 E		ML	3.2	A	SOUTHERN QINGHAI, CHINA	NNC
2007-12-16 04:31						M		BUC
2007-12-16 04:28:51.2	39.1 N	29.0 E	8	MD	3.0	M	WESTERN TURKEY	KAN
2007-12-16 04:27						A		ISN
2007-12-16 04:06:20.0	35.1 N	67.1 E		ML	3.4	A	CENTRAL AFGHANISTAN	NNC
2007-12-16 03:44:35.8	37.6 N	38.6 E	7	ML	3.0	M	EASTERN TURKEY	DDA
2007-12-16 03:44:33.1	37.5 N	38.6 E	13	MD	2.7	M	EASTERN TURKEY	KAN
2007-12-16 03:44:32.5	37.4 N	38.5 E	10	ML	2.9	M+	EASTERN TURKEY	INFO
2007-12-16 03:35:40.9	41.1 N	25.4 E	30			A	GREECE	BUC
2007-12-16 03:35:15.7	39.4 N	26.2 E	13	ML	4.1	M	NEAR THE COAST OF WESTERN TURKEY	THE
2007-12-16 03:35:14.9	39.5 N	26.3 E	7	ML	4.0	M	NEAR THE COAST OF WESTERN TURKEY	DDA
2007-12-16 03:35:14.5	39.4 N	26.2 E	10	Ms	4.2	M	NEAR THE COAST OF WESTERN TURKEY	BUC
2007-12-16 03:35:14.0	39.4 N	26.3 E		ML	3.2	A	NEAR THE COAST OF WESTERN TURKEY	NOA
2007-12-16 03:35:13.7	39.4 N	26.3 E	11	ML	3.7	M	NEAR THE COAST OF WESTERN TURKEY	KAN
2007-12-16 03:35:13.4	39.4 N	26.3 E	10	ML	4.0	M+	NEAR THE COAST OF WESTERN TURKEY	INFO
More recent start ◀◀ ◀ 81 - 82 - 83 - 84 - 85 - 86 - 87 - 88 - 89 - 90 ▶ ▶▶ Back in time								

Figure 3: Extract of the "For Seismologists Only" web page

Date & Time UTC	Latitude degrees	Longitude degrees	Depth km	Mag.		Region name	Last update
1 - 2 - 3 ▶ Back in time							
2007-12-16 23:40:08.8	35.82 N	61.00 E	21	ML	3.7	NORTHEASTERN IRAN	2007-12-17 00:00
2007-12-16 22:35:33.4	44.33 N	10.15 E	10	ML	2.7	NORTHERN ITALY	2007-12-17 07:03
2007-12-16 19:11:46.3	44.32 N	129.30 W	10G	M	4.7	OFF COAST OF OREGON	2007-12-16 19:28
2007-12-16 18:28:06.8	35.40 N	13.92 W	30f	ML	3.0	AZORES-CAPE ST. VINCENT RIDGE	2007-12-16 20:17
2007-12-16 17:16:32.7	53.47 N	159.98 E	70	mb	4.1	NEAR EAST COAST OF KAMCHATKA	2007-12-17 05:18
2007-12-16 15:22:12.4	25.95 S	177.58 W	172	mb	4.9	SOUTH OF FIJI ISLANDS	2007-12-16 20:15
2007-12-16 14:36:57.9	37.66 N	38.49 E	16	ML	3.0	EASTERN TURKEY	2007-12-16 14:51
2007-12-16 14:28:47.9	47.35 N	156.44 E	20	mb	4.2	EAST OF KURIL ISLANDS	2007-12-16 20:27
2007-12-16 11:06:08.6	14.61 N	91.81 W	100f	mb	4.6	GUATEMALA	2007-12-16 20:12
2007-12-16 10:05:06.9	71.86 N	0.84 E	10f	mb	4.3	NORWEGIAN SEA	2007-12-16 20:07
2007-12-16 09:14:09.3	3.42 S	100.59 E	164	mb	4.5	KEP. MENTAWAI REGION, INDONESIA	2007-12-16 20:10
2007-12-16 09:10:39.0	41.24 N	74.34 E		ML	3.5	KYRGYZSTAN	2007-12-16 10:23
2007-12-16 08:12:48.8	39.42 N	26.26 E	7	ML	3.0	NEAR THE COAST OF WESTERN TURKEY	2007-12-16 09:10
2007-12-16 08:09:16.5	22.83 S	69.92 W	50f	Mw	6.7	ANTOFAGASTA, CHILE	2007-12-16 08:57
2007-12-16 07:50:21.1	37.00 N	29.33 E	10	ML	3.3	WESTERN TURKEY	2007-12-16 09:20
2007-12-16 06:20:16.8	41.10 N	20.03 E	2	ML	3.0	ALBANIA	2007-12-16 20:05
2007-12-16 05:15:42.2	40.08 N	144.84 E	19	mb	4.8	OFF EAST COAST OF HONSHU, JAPAN	2007-12-16 09:18
2007-12-16 04:28:51.2	39.12 N	28.97 E	8	MD	3.0	WESTERN TURKEY	2007-12-16 05:01
2007-12-16 03:44:32.5	37.44 N	38.51 E	10	ML	2.9	EASTERN TURKEY	2007-12-16 09:16
2007-12-16 03:35:13.4	39.41 N	26.28 E	10	ML	4.0	NEAR THE COAST OF WESTERN TURKEY	2007-12-16 09:13
1 - 2 - 3 ▶ Back in time							

Figure 4: Extract of the public web page.

II.2.1.1.2. Information associated to each event

For each event reported on the public page, the following information is available:

- Source parameters: Origin time (in UTC), epicenter location, focal depth, magnitude and region of occurrence. Since mid-October 2006, the name of the geographical regions which appear on the public page are defined following the 3rd level of Flinn-Engdahl regionalization (J. B. Young et al.; 1996), defined by Bruce Presgrave (USGS). The main improvement from 2nd to the 3rd level of regionalization is that the latter fits the political border which is crucial to correctly assign a region to an epicenter.
- Distances from epicenter to nearby cities + local time in these cities when the event occurred (Figure 5).

Figure 5: Source parameters of the event. Distance to nearby cities and local time of occurrence of the event in these cities.

- Links to networks which provided data for this event and links to regional seismological institutes where more information on the event may be available.
- Three epicenter views at global, regional and local scales + a Satellite Google Map centered on the region (Figure 6).
- List of regional deadly earthquakes from 1500 to 2000 (Utsu; 2002) (Figure 7).
- Moment tensors solutions provided by the different institutes (Figure 8).
- Past focal mechanisms in the region (Figure 9). Source: EMMA database (Vanucci et al.; 2004).
- Maps of regional instrumental seismicity (Figure 10). Source: 1964-2001 ISC catalog.

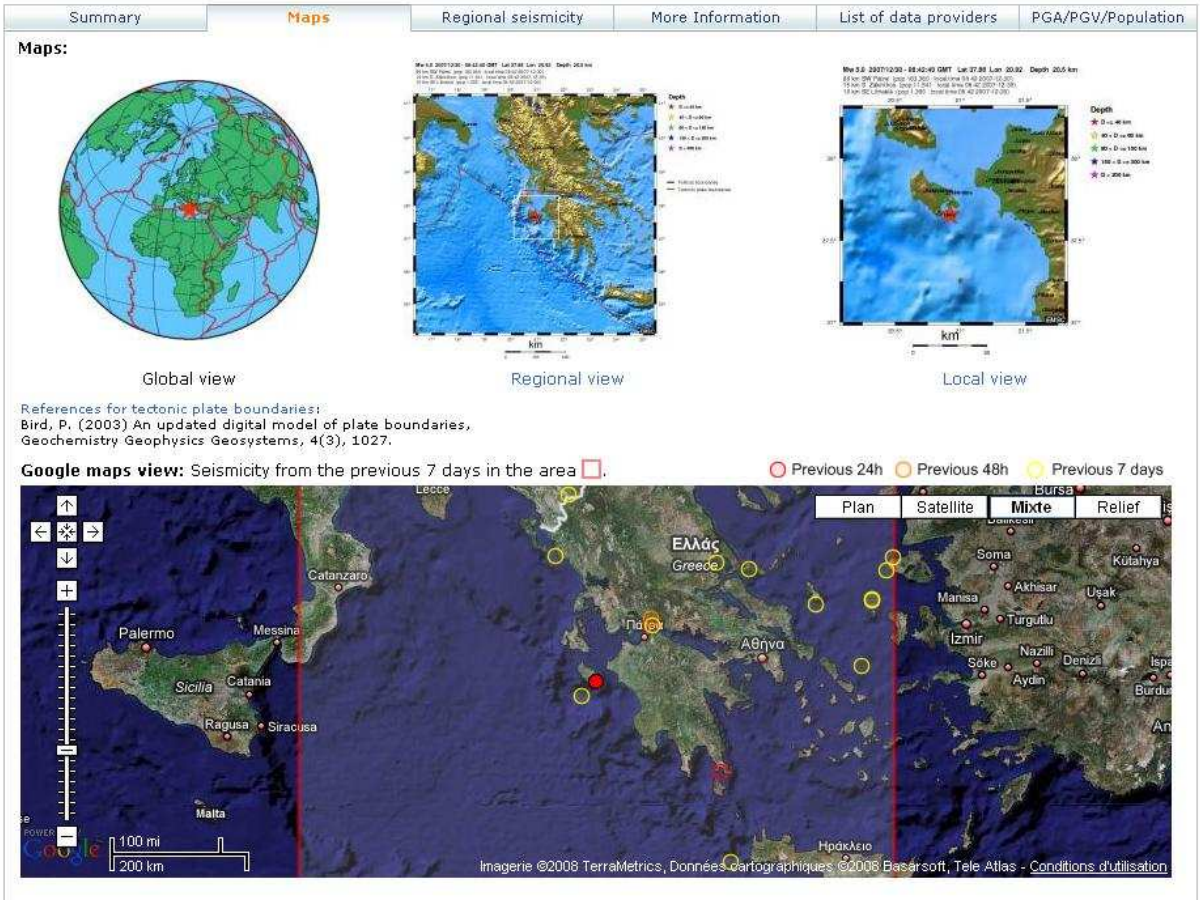

Figure 6: Snapshot of the different maps generated for each event reported on the public page

Regional deadly earthquakes from 1500 to 2000

Date	Long.	Lat.	Mag.	Death	Location
1514-04-16	21.0	37.7	6.5	many	SOUTHERN GREECE
1544-04-22	22.6	38.8	6.8	many	GREECE
1566-07-11	21.7	39.0	6.5	many	GREECE
1622-05-05	21.0	37.6	6.6	many	SOUTHERN GREECE
1630-07-22	20.9	38.3	6.9	many	GREECE
1633-11-05	21.0	37.6	6.9	many	SOUTHERN GREECE
1636-09-30	20.7	38.0	7.2	520	GREECE
1658-08-24	20.5	38.3	6.8	320	GREECE
1674-01-01	20.0	39.5	6.5	200	GREECE-ALBANIA BORDER REGION
1704-11-22	20.7	38.7	6.6	34	GREECE
1723-02-22	20.7	38.6	7.0	many	GREECE
1742-02-14	20.6	37.8	6.5	120	IONIAN SEA
1748-05-25	22.2	38.2	6.8	many	GREECE
1750-06-07	22.8	36.3	7.0	2000	SOUTHERN GREECE
1767-07-11	20.3	38.2	7.2	253	GREECE
1783-03-23	20.5	38.6	7.0	35	GREECE
1785-01-30	21.7	38.2	6.6	38	GREECE

Source: T. Utsu ; International Handbook of Earthquake and Engineering Seismology; vol. A; 691-718

Figure 7: List of regional deadly earthquakes since 1500

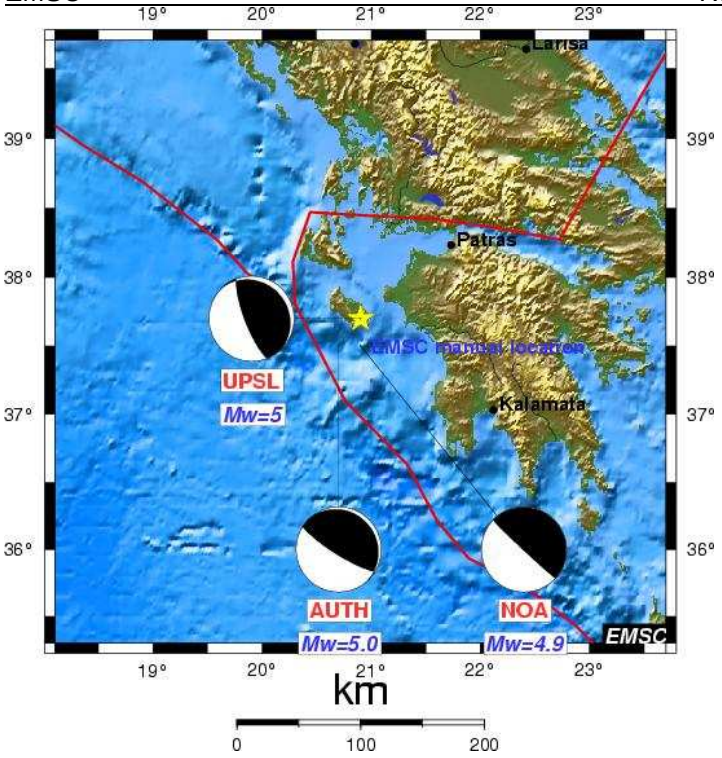

Figure 8: Moment tensors solutions provided by different institutes for the same event

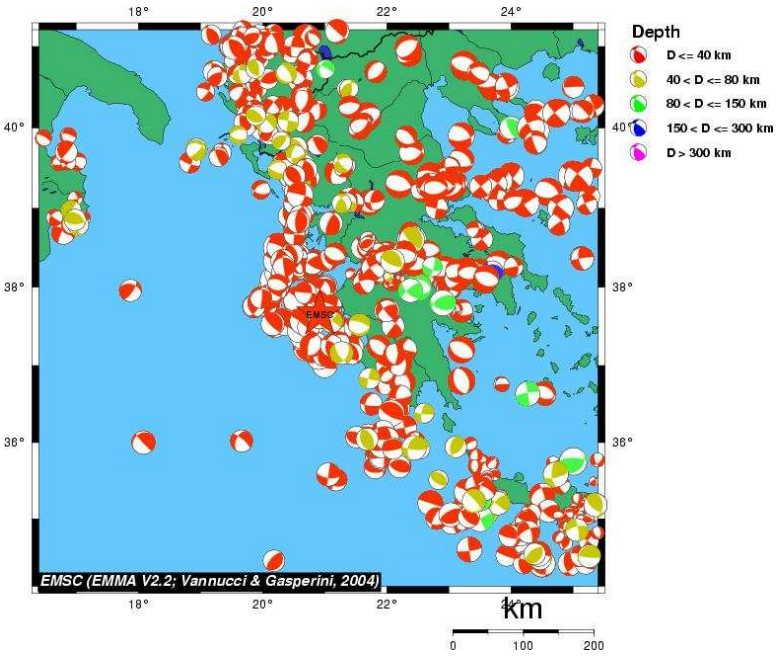

Figure 9: Map of past focal mechanisms

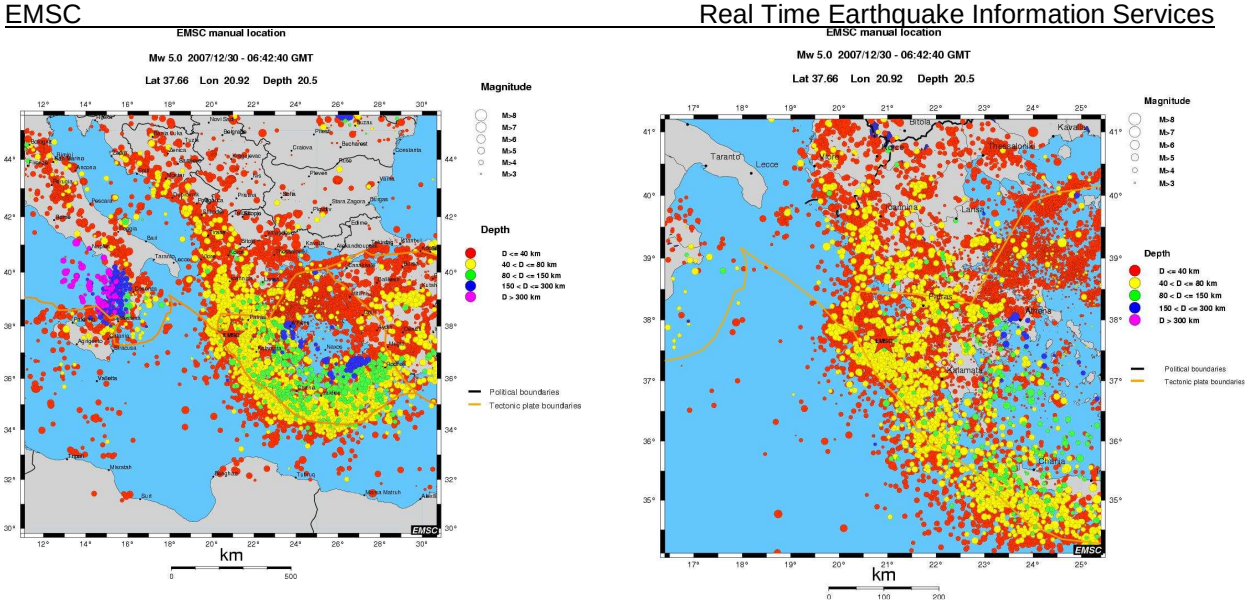

Figure 10: Regional instrumental seismicity maps (Source ISC catalog: 1964-2001)

II.2.1.1.3. Moment tensors solutions

EMSC receives moment tensors (MT) solutions from 12 institutes listed below. For each event, all the available MT solutions are plotted on the same map (Figure 8):

AUTH: Department of Geophysics, University of Thessaloniki, Thessaloniki, Greece
CPPT: Centre Polynésien de Prévention des Tsunamis, French Polynesia
ERD: Earthquake Research Department, Ankara, Turkey
ETH: Swiss Federal Institute of Technology, Zurich, Switzerland
HARVARD: Seismological group of Harvard University.
IGN: Instituto Geografico Nacional, Madrid, Spain
INGV: Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy
IPGP: Institut de Physique du Globe de Paris, Paris, France
KOERI: Kandilli Observatory and Earthquake Research Institute, Istanbul, Turkey
NOA: National Observatory of Athens, Geodynamic Institute, Athens, Greece
UPSL: University of Patras. Seismological Laboratory, Patras, Greece
USGS: U.S. Geological Survey, Denver, USA

A web page gathers all MT solutions received until now (i.e. for all events and from the different agencies): http://www.emsc-csem.org/index.php?page=current&sub=qmt

II.2.1.1.4. Quick Mw values provided by other institutes

EMSC also receives quick Mw values from three institutes which are extremely useful to quickly and reliably assess the magnitude of large events:

- Via the Tsunami Bulletin Board, EMSC receives the bulletins of the *Pacific Tsunami Warning Center* which contain rapid determinations of Mw magnitudes above 6.5, for events of the Pacific or Indian Oceans or in the Caribbean. These bulletins are quickly issued after earthquake occurrence and revised if necessary.
- The Japanese Meteorological Agency which provides quick Mw estimations for events in the Pacific Ocean.
- The Centre Polynésien de Prévention des Tsunamis in French Polynesia provides quick Mw estimations for events in the Pacific Ocean.

II.2.1.1.5. Special web pages

When an event raises a particular interest and/or causes significant damage (Indonesia (Sumatra) 26/12/2004, Pakistan 08/10/2005, Azores Cape Saint Vincent Ridge 12/02/2007, Chile (Antofagasta) 17/1/2007, etc.), EMSC publishes a special web page gathering additional information such as aftershocks distribution, field observations, damage reports, moment tensors solutions, macroseismic questionnaires results, preliminary source studies, etc.

II.2.1.1.6. Seismicity maps, Google tools

In order to represent the current seismic activity in different regions of the world, EMSC gives the possibility to display the seismic activity of the last 30 days in 6 different regions: Worldwide, Euro-Med region, North America, South America, Africa/Indian Ocean, Pacific Ocean. The seismicity can be animated day by day.

EMSC web site also allows to download a *kmz* file (to be viewed on GoogleEarth) which contains the last 2 weeks of seismic activity through the following link:

http://www.emsc-csem.org/index.php?page=current&sub=ge

II.2.1.1.7. Members section

In December 2006, a specific web page has been opened on EMSC web to provide specific information at the attention of EMSC members. Its access is restricted. It proposes services such as macroseismic questionnaire results, maps of expected Peak Ground Acceleration (PGA) and Peak Ground Velocity (PGV) (Akkar et al., 2007), number of inhabitants, a discussion forum, the list preliminary information[1] for events processed in the framework of the Earthquake Notification Service (Part II.2.) and the feltmaps[2].

II.2.1.2. Imode and WAP pages

The Real Time Seismicity is also available in Imode (http://www.emsc-csem.org/rts_imode.html) and WAP (http://www.emsc-csem.org/rts_wap.wml) for events with magnitude larger than 4.0. This permits viewing the current world seismic activity on a cell phone or on a PDA.

[1] The preliminary information is the first information published on the public page for a given seismic event. It may be either the location provided by the authoritative network or the EMSC automatic location depending which is available first.

[2] The felt maps are generated thanks to the increase of traffic on EMSC web site consecutive to events that have been felt by the population. By locating the additional visitors thanks to their IP in the first minutes following the earthquake occurrence, it is possible to map the area where the event has been felt. The way feltmaps are generated is not described in this report.

II.2.2. DISSEMINATED INFORMATION

Apart from the web-based services, EMSC operates seismic information dissemination services like the Earthquake Notification Service (for potentially damaging earthquakes), the RSS feed and the autoDRM.

II.2.2.1. Earthquake Notification Service

II.2.2.1.1. Principle

For potentially damaging earthquakes, EMSC operates an Earthquake Notification Service (ENS) which is operational 24/7. It consists in quickly notifying the end-users who subscribed to this service of the event occurrence, by fax (restricted to the operational organizations), email or SMS. The determination of the event source parameters and the dissemination of the message to the end-users are done manually by the seismologist on call for EMSC.

The subscription to this service can be done through the web site at: http://www.emsc-csem.org/index.php?page=receive&sub=email. The end-users of the ENS are ECHO (*Humanitarian Aid Agency of the EU*), OCHA (*Humanitarian Aid Agency of the UN), the* Council of Europe, the European Civil Protection Unit, the EADRCC (*Euro-Atlantic Disaster Reaction and Coordination Centre, NATO*), MSF (*Médecins sans Frontières*), IFRC (*International Federation of Red Cross and Red Crescent*) a dozen of rescue teams and several thousands of individuals.

II.2.2.1.2. Criteria to disseminate a notification

II.2.2.1.2.1. Definition of local magnitude thresholds

A set of magnitude thresholds has been defined for events which are processed in the framework of the Earthquake Notification Service (Figure 11). These magnitude thresholds are:

- 5.0 in Europe
- 5.2 in Northern Africa and Azores region
- 5.5 in Arabic Peninsula, Iran, Caucasus, Caspian region and a part of Northern Atlantic Ocean
- 6.0 in Russia and Continental Asia and Sub-Saharan Africa
- Spanning from 5.0 to 6.5 in areas around the French overseas territories.
- 7.0 in the rest of the world

II.2.2.1.2.2. Alert triggering

As soon as either the authoritative network or two non-authoritative networks report a magnitude that exceeds the local threshold for the same event, the seismologist on call is warned via phone calls. He immediately locates the event by merging all the available data, refines the location and disseminates the notification to the end-users.

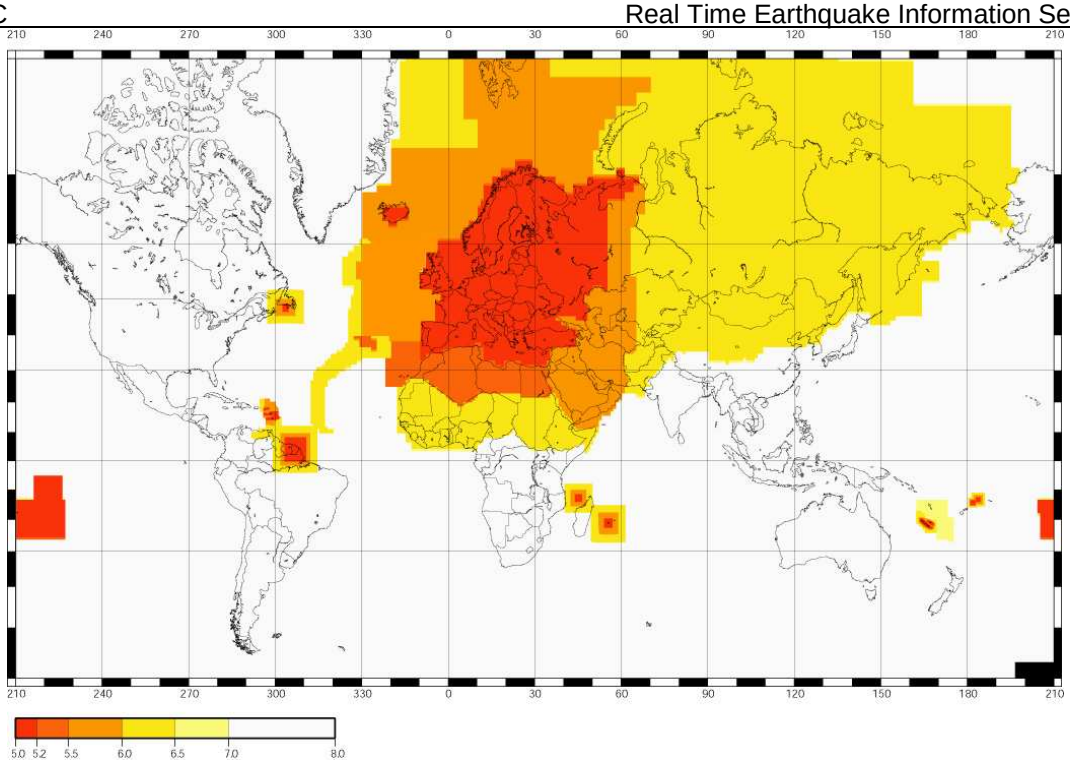

Figure 11: Local magnitude thresholds for the Earthquake Notification Service

II.2.2.1.3. Dissemination in alert mode

If the magnitude computed by the seismologist on call for the processed event exceeds the local magnitude threshold (Figure 11), the event is processed in alert mode. This means that the notification must be disseminated in less than 1 hour after the earthquake occurrence (generally in 20-40 minutes for Euro-Med events). The objectives of this rapid dissemination are:

- To give redundancy to alerts systems operated by national institutes.
- To ensure the information outside the affected country(ies).
- To provide reliable locations in border regions and off shore.
- To provide a unique source of information for European and International organizations.

II.2.2.1.4. Notification definitions and formats

While subscribing at the Earthquake Notification Service, the user can define up to two geographical regions for which he wants to receive the notifications. It is also possible to choose between four formats to receive the notifications defined as follows:

1. **SMS**
   This format is very concise and is adapted to the reception of messages on a cell phone or on a PDA. It contains the main characteristics of the event: origin time, epicenter location, focal depth and distance to a nearby city (Figure 12).

```
      28/06/2006 21:02
        Magnitude 5.7
        SOUTHERN IRAN
  Latitude    27.04 North
   Longitude   55.81 East
Depth        35 kilometers
 49 km SW Bandar-e 'Abbas
```

Figure 12: Example of message disseminated by EMSC in SMS format

2. **Standard**
   This format is dedicated to the general public and contains information such as distances to several nearby cities, population and local time at these cities when the event occurred and links to regional seismological institutes (Figure 13).

3. **Advanced**
   This format is mainly dedicated to the scientific community and contains additional seismological information (Figure 14).

4. **Pickings**
   This format is restricted to the seismological community. It adds to the Advanced format the phase pickings used in the location process.

```
        EMSC earthquake notification

        Magnitude 5.7 28/06/2006 21:02 SOUTHERN IRAN

        These parameters are preliminary and subject to revisions.
        For updates, please consult: http://www.emsc-csem.org


A magnitude 5.7 earthquake has occurred SOUTHERN IRAN at:
27.04N  55.81E Depth 35km 28/06/2006 at 21:02:12 (Universal Time)

Earthquake location with respect to nearby cities:
        49 km SW Bandar-e 'Abbas (pop 317946, local time 01:32)
        40 km W  Qeshm (pop 16691, local time 01:02)

Comments :

Manual location disseminated on 28/06/2006 21:35 (UTC)
EMSC cannot guarantee the receipt or timeliness of an e-mail after
sending.

For maps and additional data, please consult:
http://www.emsc-csem.org

Links to regional seismological observatories:
http://www.iiees.ac.ir/english/index_e.asp
http://irsc.ut.ac.ir
http://www.bhrc.ac.ir/

This location has been computed thanks to the data provided by the
following seismological institutes:
BEO BRA BUC GFZ INGV LDG LED LJU NEIA SED THR
See the full list of data providers at:
http://www.emsc-csem.org/index.php?page=current&sub=contrib


This EMSC service is jointly operated by the LDG (Laboratoire de
Détection et de Géophysique, Bruyères-le-Châtel, France) and the
IGN (Instituto Geografico Nacional, Madrid, Spain).


Subscribe/Unsubscribe/Modifications, please consult:
http://www.emsc-csem.org/index.php?page=receive&sub=email
```

Figure 13: Example of message disseminated by EMSC in Standard format

```
                Centre Sismologique Euro-Mediterraneen
              European-Mediterranean Seismological Centre

                Rapid Determination of Source Parameters
                operated at LDG (Paris) and IGN (Madrid)

**********************************************************************
**********************  ALERT  MESSAGE  **************************
**********************************************************************

WARNING : These parameters are preliminary and subject to revision.
Location and magnitude estimations may be revised if necessary in
an INFORMATION message.
_____________________________________________________________________



EARTHQUAKE on 28/06/2006 at 21:02 (UTC)
SOUTHERN IRAN                       7 km E  Pahel

MAGNITUDE: mb 5.7

Data provided by: BEO  BRA  BUC  GFZ  INGV LDG  LED  LJU  NEIC NEWS
                  NOR  SED  THR

Latitude    =  27.04 N
Longitude   =  55.81 E
Origin Time =  21:02:12.4 (UTC)
Depth       =  35 Km
RMS         =   1.14 sec
Gap         =  57 degrees
95% confidence ellipse: - Semi major = 7.5 Km
                        - Semi minor = 4.6 Km
                        - Azimuth of major axis =  10 degrees

Number of data used = 337

Preliminary location computed on Wed Jun 28 21:35:43 2006 (UTC)
Done by Julien VERGOZ

Comments :

Message number: 733

All magnitudes estimations :
mb5.6 (BEO)   mb5.7 (BRA)   Ms5.4 (BUC)   mb5.8 (GFZ)
mb5.4 (INGV)  mb5.7 (LDG)   mb5.3 (LED)   mb5.8 (NEIC)
mb4.8 (NEWS)  mb5.2 (NOR)   mb6.0 (SED)   ML5.4 (THR)
```

Figure 14: Example of message disseminated by EMSC in Advanced format

II.2.2.1.5. Evolution of the ENS early 2006

The Earthquake Notification Service has been upgraded on 11/01/2006 in order to give to the end-users the possibility to receive earthquake information for a specific geographic area and from a minimum magnitude. Before that, each manually reviewed location was sent to the whole list of end-users in the Advanced (Figure 14) or Pickings formats. Moreover, a distinction was made between the earthquakes for which the magnitude exceeds the local threshold and the others. Therefore, in the current service, the Advanced and Pickings formats still use this distinction:

- **Alert message:** if the magnitude of the event is higher than or equal to the local threshold.
- **Information message:** if the event raises a particular interest and/or if it is widely felt but its magnitude is lower than the local threshold.
- **Revision message:** sent as revisions of the initial messages (may be Alert or Information message) for significant variations of one of the source parameters (location, depth, or magnitude). Revisions messages are often used for large events for which the magnitude is generally difficult to estimate within the first hour. For minor revisions, the update is published on the web page only. The notion of Revision is also used for the Standard and SMS format.

II.2.2.1.6. Role of the IGN

When EMSC is not able to operate the Earthquake Notification Service, the IGN (Instituto Geografico Nacional, Madrid, Spain) is in charge of it. This occurs for example during maintenance intervention at or outside EMSC (internet service providers, electric backbone …) which may disturb the data processing although the real time services may remain on line during the intervention. However, the IGN operates this service in a degraded mode in which each earthquake notification is sent to all end-users.

II.2.2.1.7. A specific alert system: EUR-OPA agreement

EMSC also provides a specific alert system for the Council of Europe for events with magnitude larger than 6.0 in one of the countries which have signed the EUR-OPA (Open Partial Agreement on Major Hazards) agreement: Albania, Algeria, Armenia, Azerbaijan, Belgium, Bulgaria, Cyprus, Spain, France, Georgia, Greece, Italy, Lebanon, Luxembourg, FYR of Macedonia, Malta, Moldova, Morocco, Monaco, Portugal, San-Marino, Romania, Russia, Turkey, Ukraine.

II.2.2.2. RSS feed

RSS feeds are commonly used for frequently updated web pages. Users of RSS feeds use programs called feed readers or aggregators which can check the feeds to see if it has new content since the last time it checked. If so, it retrieves the content and presents it to the user.

A RSS feed for the real time seismic activity has been opened in December 2006 (http://www.emsc-csem.org/rss.php). As a difference with the public web page, the RSS feed does not display the EMSC automatic locations.

II.2.2.3. Widget for real time seismic information

In October 2007, EMSC developed a widget that allows viewing the last Euro-Med and worldwide events on a map that is updated automatically and that can be added to a personal web portal such as Google Desktop, Igoogle or Netvibes.

II.2.2.4. AutoDRM

As explained before, the messages received from the data contributors are all included into an Oracle database. The content of this database is available by autoDRM (Automatic Data Request Manager) to the users who subscribed to it (Subscription at http://www.emsc-csem.org/index.php?page=data&sub=register). The autoDRM sends data back to the user in GSE2.0 format.

There are 2 ways to use the autoDRM, either by filling a web form (http://www.emsc-csem.org/index.php?page=data&sub=request_rts&db=rts) or by sending a formatted email to EMSC which is automatically processed (Figure 15).

```
BEGIN GSE2.0
MSG_TYPE REQUEST
MSG_ID 00001
E-MAIL adress@domain.com
TIME 2006/12/19 10:00:00 TO 2006/12/19 12:00:00
LAT -90 TO 90
LONG -180 TO 180
DEPTH 0 TO 700
NETWORK *
ORIGIN GSE2.0
STOP
```

Figure 15: Example of autoDRM request

II.2.3. COLLECTION OF IN-SITU INFORMATION

In order to complement its services of rapid earthquake information, EMSC developed a number of tools to rapidly collect in-situ observations of the earthquake effects and better evaluate the reaction of the population. Here below is presented how peaks of web traffic are used to generate felt maps (Bossu at al, 2008), as well as a few examples of intensity maps and pictures received from the witnesses.

II.2.3.1. Felt maps: Area where the earthquake has potentially been felt

The felt map tool is an original EMSC development. It uses the observed surge of traffic on EMSC web site (Figure 16) to rapidly (within 5 to 10 minutes of the earthquake's occurrence) map the area where an earthquake has been felt and to determine whether there has been significant widespread damage. When an earthquake is felt, people rush to the Internet to find out the cause of the shaking, generating brutal surge of traffic on EMSC web site. The area where the earthquake was felt is determined by locating the IP addresses and identifying the localities which exhibit a significant increase of visitors (Figure 17) (Bossu at al, 2008).

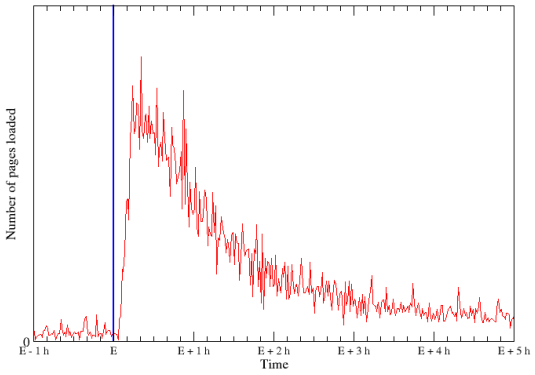

Figure 16: Typical surge of web traffic on EMSC web site after a felt earthquake

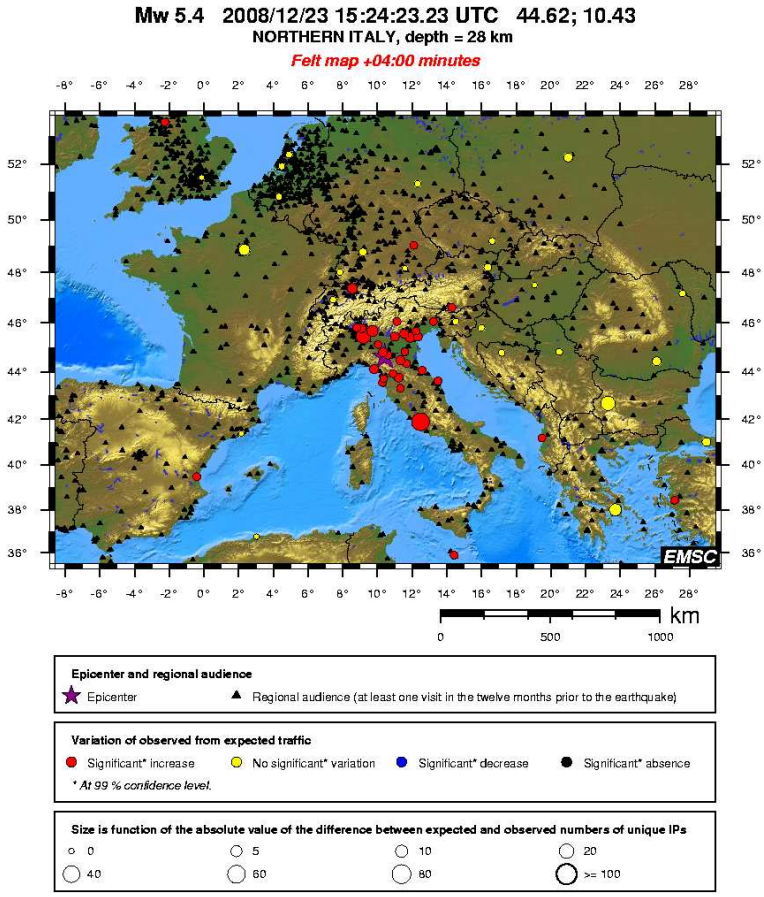

Figure 17: Felt map generated 4 minutes after the Mw 5.4 event in Northern Italy on 23/12/2008 at 15:24 UTC.

II.2.3.2. Online macroseismic questionnaire

Since July 2006, a macroseismic questionnaire is available on EMSC web site for people who wish to report their experience after an earthquake. The goal of collecting macroseismic questionnaires is first to characterize the effects of earthquakes on people, objects and structures. Eventually, the results of the questionnaires can be used to compute intensities and to plot macroseismic intensity maps (Figures 19 and 20).

The questionnaire was initially available in English but thanks to the help of EMSC members and data contributors, it has been translated in 20 languages (at the time of this report) and is now available in Albanian, Arabic, Armenian, Bulgarian, Croatian, Dutch, English, Farsi, French, German, Greek, Hungarian, Montenegrin, Polish, Portuguese, Romanian, Russian, Slovakian, Spanish and Turkish (Figure 18). The results of the questionnaires are available for EMSC members in the dedicated Members section of the web site.

Before filling the questionnaire, the visitor selects the event felt. An online help is provided to people who can not identify the event they have felt in the list of latest events. The visitor then determines the place (country + administrative subdivision + city) where the observation was made. This information is crucial in order to be able afterwards to associate a macroseismic intensity with an observation. For this, a database of 145,504 cities worldwide is used to help the observer to determine accurately the place of the observations. The exact postal address of the user is also collected (though optional) as it can be useful to the national institutes in charge of producing intensity maps to locate the observations with more accuracy.

The procedures to compute intensities have been developed at EMSC in collaboration with the BGS (British Geological Survey, Edinburgh, UK) and the ETHZ (Eidgenössische Technische Hochschule, Zürich, Switzerland).

Figure 18: Snapshot of the links proposed to the web users to access the macroseismic questionnaire

II.2.3.3. Intensity maps: A damage assessment using testimonies

Since April 2008, intensity maps are computed and updated automatically upon reception of new questionnaires. Intensities are expressed in EMS-98 scale. An intensity can be assigned to a location only if at least 5 questionnaires are available for this location (Colored dots on Figure 19-20). Otherwise a default intensity (*Felt*) is assigned (White dots on Figure 19-20).

Figure 19: Intensity map generated after the Mw6.4 event near Patras, Greece on 08/06/2008 at 12:25 UTC. Legends on Figure 21

Figure 20: Intensity map generated after the Mw 5.4 event in Northern Italy on 23/12/2008 at 15:24 UTC. Legends on Figure 21

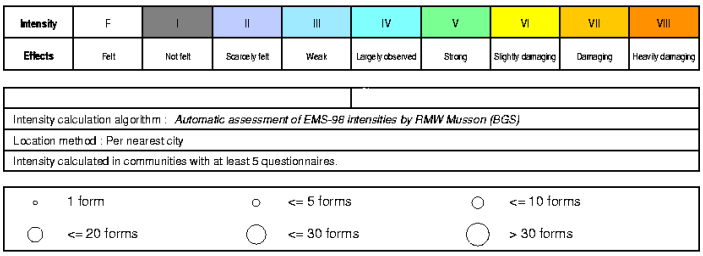

Figure 21: Legends for Intensity maps

II.2.3.4. Pictures: Actual damage caused by the earthquake

Witnesses have the opportunity to share their pictures of the damage. Once validated by a seismologist, they are published on EMSC web site. This proves valuable to provide local constraints on the actual damage but also to document the earthquake phenomenon. Rare pictures have already been collected as in Greece (Figure 22). Collected pictures are made available through the web site.

A tutorial available on the web site explains how to provide pictures (by email, by MMS or by direct file upload) and how to link the file to the right seismic event. However, so far no picture has been received via MMS.

Figure 22: Rock falls in Porto Katsiki, Lafkada Islands, Greece caused by the shake after the Mw6.4 event near Patras, Greece on 08/06/2008 at 12:25 UTC.

III. APPENDIX A: REAL TIME CONTRIBUTORS IN 2008

CODE	INSTITUTE	TYPE	COUNTRY
BEO	Seismological Survey of Serbia, Beograd	OP	Serbia
BER	University of Bergen, Bergen	OP	Norway
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover & Erlangen	OPA	Germany
BGS	British Geological Survey, Edinburgh	OPA	United-Kingdom
BGSG	British Geological Survey, Global network (*EarlyBird* system), Edinburgh	OP	United-Kingdom
BRA	Seismology Division, Slovak Academy of Sciences, Bratislava	OPA	Slovakia
BUC	National Institute for Earth Physics, Bucharest	OP	Romania
CNRM	Centre National de la Recherche Scientifique et Technique, Geophysics Laboratory, Rabat	OP	Morocco
CRAA	Centre de Recherche en Astronomie, Astrophysique et Géophysique, Algiers	OP	Algeria
CYP	Geological Survey Department, Nicosia	OP	Cyprus
DDA	Earthquake Research Department, Ministry of Public Works and Settlement, Ankara	OP	Turkey
DHMR	National Seismological Observatory Centre, Dhamar	OPA	Yemen
DJI	Observatoire Géophysique d'Arta, Arta	OP	Djibouti
GFU	Geophysical Institute of Academy of Sciences, Prague	OP	Czech Republic
GFZ	GeoForschungsZentrum (GEOFON), Potsdam	OPA	Germany
GII	Seismology Division, Geophysical Institute of Israel, Tel Aviv	OP	Israel
GRAL	National Center for Geophysical Research, Beirut	OP	Lebanon
GSRC	Geophysical Survey. Russian Academy of Sciences, Obninsk	OP	Russia
HSNC	Technological Educational Institute of Crete, Seismological Network of Crete	P	Greece
ICC	Instituto Cartografico de Catalunya, Barcelona	OP	Spain
IGUT	Institute of Geophysics, University of Tehran, Tehran	OPA	Iran
IMO	Department of Geophysics, Icelandic Meteorological Office, Reykjavik	OP	Iceland
IMP	Instituto de Meteorologia, Seismologia, Lisbon	OPA	Portugal
INGV	Italian National Seismic Network, Roma	OPA	Italy
INMT	Institut National de la Météorologie, Tunis	OP	Tunisia
IRSA	Romanian Institute for Applied Seismology, Bucharest	OP	Romania
ISN	Iraqi Meteorological Organization and Seismology, Bagdad	OP	Iraq
JSO	Jordan Seismological Observatory, Amman	OP	Jordan
KAN	Kandilli Observatory and Earthquake Research Institute, Istanbul	OP	Turkey
LDG	Laboratoire de Détection et de Géophysique, Bruyères-le-Châtel	OPA	France
LED	Landsamt für Geologie, Rohstoffe und Bergbau, Baden Württemberg	OP	Germany
LJU	Environmental Agency of the Republic of Slovenia, Seismological Office, Ljubljana	OP	Slovenia
LVV	Carpathian Seismological Dept., Ukraine Academy of Science, Lviv	P	Ukraine
MAD	Instituto Geografico Nacional, Madrid	OPA	Spain
MCSM	Ukrainian NDC, Main Center of Special Monitoring, Kiev	P	Ukraine
MOLD	Institute of Geophysics and Geology, Chisinau	P	Moldova
MON	Direction de l'Environnement, de l'Urbanisme et de la Construction	P	Monaco
MSO	Montenegro Seismological Observatory, Podgorica	OPA	Montenegro
NEIR	USGS/NEIC, Denver	OPA	USA
NEWS	Norwegian Seismic Array, Kjeller	OPA	Norway
NNC	Kazakhstan National Data Center, Institute of Geophysical Research, Almaty	OP	Kazakhstan
NOA	National Observatory of Athens, Geodynamic Institute, Athens	OPA	Greece
NOR	Norwegian Seismic Array, Kjeller	OPA	Norway
NRIA	National Research Institute of Astronomy and Geophysics, Cairo	OP	Egypt
NSSP	National Survey of Seismic Protection, Yerevan	OP	Armenia
ODC	Observatories and Research Facilities for EUropean Seismology, De Bilt	OP	The Netherlands
OGS	Osservatorio Geofisico Sperimentale, Trieste	OP	Italy
PDA	Instituto de Meteorologia, Azores University, Ponta Delgada, Azores	OP	Portugal
RNS	Réseau National de Surveillance Sismique, Strasbourg	OP	France
RSSC	Azerbaijan National Academy of Sciences, Baku	OP	Azerbaijan
SASN	South African Seismological Network, Pretoria	OP	South Africa
SED	Swiss Seismological Service, Zurich	OP	Switzerland
SGS	Saudi Geological Survey, Jeddah	OP	Saudi Arabia
SKO	Seismological Observatory of Skopje, Skopje	OPA	Macedonia
SOF	Bulgarian Academy of Science, Bulgarian Academy of Sciences, Sofia	OP	Bulgaria
SNSN	Swedish National Seismological Network, Uppsala	OP	Sweden
SPGM	Département de Physique du Globe, Rabat	OP	Morocco
THE	Department of Geophysics, University of Thessaloniki, Thessaloniki	OP	Greece

THR	International Institute of Earthquake Engineering and Seismology, Tehran	OP	Iran
TIF	Georgian National Survey of Seismic Defense, Tbilisi	OP	Georgia
TIR	Institute of Seismology, Academy of Sciences, Tirana	OP	Albania
UCC	Royal Observatory of Belgium, Brussels	OP	Belgium
UPSL	University of Patras, Seismological Laboratory, Patras	OP	Greece
WAR	Institute of Geophysics, Polish Academy of Sciences	OPA	Poland
ZAG	Seismological Survey, University of Zagreb, Zagreb	OP	Croatia
ZAMG	ZentralAnstalt für Meteorologie und Geodynamik, Vienna	OP	Austria

Appendix A: Seismological networks that have provided real time parametric data to EMSC in 2008 (in orange: new contribution). Legends: O: Source parameters; P: Phase pickings; A: Amplitudes.

IV. APPENDIX B: EMSC MEMBERS IN 2008

Key Nodal Members	Country	Contact
Laboratoire de Détection et de Géophysique (LDG)	France	Dr. B. FEIGNIER
GeoForschungsZentrum (GFZ)	Germany	Dr. W. HANKA
Istituto Nazionale di Geofisica e Vulcanologia (INGV)	Italy, Roma	Dr. M. OLIVIERI
Istituto Nazionale di Geofisica e Vulcanologia (INGV)	Italy, Milano	Dr. P. ALBINI
Instituto Geografico Nacional (IGN)	Spain	Dr. E. CARRENO HERRERO
Active Members		
Seismological Institute (ASN)	Albania	Dr. E. DUSHI
Centre de Recherche en Astronomie, Astrophysique et Géophysique (CRAAG)	Algeria	Dr. K. YELLES
National Seismological Center (NSC)	Armenia	Dr. A. Sh. ANTONYAN
Central Institute for Meteorology and Geodynamics (ZAMG)	Austria	Dr. W. LENHARDT
Republican Seismic Survey Center of Azerbaijan National Academy of Sciences (RSSC)	Azerbaijan	Dr. V. FARAJOV
Center of Geophysical Monitoring	Belarus	Dr. A. G. ARONOV
Observatoire Royal de Belgique (ORB)	Belgium	Dr. F. COLLIN
Republic Hydrometeorological Institute (RHI)	Bosnia-Herzegovina	Prof. D. TRKULJA
Federal Meteorological Institute (FMI)	Bosnia-Herzegovina	Dr. I. BRLEK
Bulgarian Academy of Sciences	Bulgaria	Dr. E. BOTEV
A. Mohorovicic Geophysical Institute and Croatian Seismological Survey (AMGI & CSS)	Croatia	Dr. M. HERAK
Geological Survey Department (GSD)	Cyprus	Dr. P. MICHAELIDES
Institute of Physics of the Earth, Brno (IPE)	Czech Republic	Dr. J. SVANCARA
Geophysical Institute of the Academy of Sciences (GFU)	Czech Republic	Dr. J. ZEDNIK
National Survey and Cadastre	Denmark	Dr. S. GREGERSEN
Observatoire Géophysique d'Arta (DJI)	Djibouti	M. K. MOHAMMED
National Research Institute of Astronomy and Geophysics (NRIAG)	Egypt	Prof. ABUO EL ELA AMIN
Institute of Seismology (ISF)	Finland	Dr. P. HEIKKINEN
Bureau Central de Sismologie Français (BCSF)	France	Dr. M. GRANET
Bureau de Recherches Géologiques et Minières (BRGM)	France	Dr. P. DOMINIQUE
Laboratoire Central des Ponts et Chaussées (LCPC)	France	Dr. P.-Y. BARD
Bureau of Seismic Risk Evaluation for the Safety of Nuclear Facilities (BERSSIN)	France	Dr. D. BEAUMONT
Laboratoire de Géophysique Interne et de Tectonophysique	France	Dr. F. COTTON
Institute of Geophysics (TIF)	Georgia	Prof. T. CHELIDZE
BGR Seismological Observatory Graefenberg (BGR)	Germany	Dr. K. KLINGE
National Observatory of Athens (NOA)	Greece	Dr. K. MAKROPOULOS
University of Thessaloniki (AUTH)	Greece	Dr. E. SCORDILIS
Institute of Engineering Seismology and Earthquake Engineering (ITSAK)	Greece	Dr. C. PAPAIOANNOU
Laboratory of Seismology, University of Patras (UPSL)	Greece	Prof. A. TSELENTIS
Icelandic Meteorological Office (IMO)	Iceland	Dr. S. JACOBSDOTTIR
Dublin Institute for Advanced Studies (DIAS)	Ireland	Prof. P. READMAN
Geophysical Institute of Israel (GII)	Israel	Dr. Y. GITTERMAN
National Data Center (NDC) of Israel, Soreq Nuclear Research Center	Israel	Dr. Y. BEN HORIN
Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS)	Italy	Dr. E. PRIOLO
Storia Geofisica Ambiente srl (SGA)	Italy	Dr. E. GUIDOBONI
Jordan Seismological Observatory (JSO)	Jordan	Dr. T. AL-YAZJEEN
Seismological Institute of Kosovo (SIK)	Kosovo	M. N. HASI
Geophysics Centre at Bhannes (SGB)	Lebanon	Dr. A. SURSOCK
Libyan Center for Remote Sensing and Space Science (LCRSSS)	Libya	Dr. H. GASHUT
European Center for Geodynamics and Seismology (ECGS)	Luxembourg	M. E. BUTTINI
Seismological Observatory	Macedonia	Dr. L. PEKEVSKI
Physics Department, University of Malta (PDUM)	Malta	Dr. P. GALEA
Academy of Sciences of Republic of Moldova	Moldova	Dr. V. ALCAZ
Direction Environnement Urbanisme et Construction (DEUC)	Monaco	Dr. P. MONDIELLI

Montenegro Seismological Observatory (MSO)	Montenegro	Dr. B. GLAVATOVIC
Centre National de la Recherche (CNR)	Morocco	Prof. A. I. IBRAHIM
Département de Physique du Globe	Morocco	Pr. B. A. TADILI
University of Bergen (BER)	Norway	Dr. J. HAVSKOV
Norwegian Seismic Array (NORSAR)	Norway	Dr. J. SCHWEITZER
Institute of Geophysics, Polish Academy of Sciences (IGPAS)	Poland	Dr. W. DEBSKI
Instituto de Meteorologia (IMP)	Portugal	Dr. F. CARRIHLO
Instituto Superior Tecnico (IST)	Portugal	Dr. J. FONSECA
Universidade de Evora	Portugal	Dr. M. BEZZEGHOUD
Universidade de Lisboa (UL)	Portugal	Dr. J. M. A. DE MIRANDA
National Institute for Earth Physics (NIEP)	Romania	Dr. G. MARMUREANU
Bucharest Seismic Alert Centre (BSAC)	Romania	M. A. AILENEI
Geological Survey of the Russian Academy of Sciences (GSRAS)	Russia	Dr. A. MALOVICHKO
Center of Geophysical Computer Data Studies (CGDS)	Russia	Dr. A. GVISHIANI
King Abdulaziz City for Sciences and Technology (KACST)	Saudi Arabia	Dr. T. AL-KHALIFAH
Seismological Survey of Serbia (SSS)	Serbia	Dr. S. RADOVANOVIC
Geophysical Institute, Department of Seismology	Slovakia	Dr. P. LABAK
Geophysical Survey of Slovenia (ARSO)	Slovenia	Dr. I. CECIC
Institut Geologic de Catalunya (IGC)	Spain	Dr. A. ROCA
Real Instituto y Observatorio de la Armada (ROA)	Spain	D. J. M. DAVILA
Universidad Politecnica de Madrid (UPM)	Spain	Dr. B. BENITO
Swedish National Seismic Network (SNSN)	Sweden	Dr. R. BODVARSSON
Schweizerischer Erdbebendienst (ETH)	Switzerland	Dr. F. HASLINGER
Royal Netherlands Meteorological Institute (KNMI)	The Netherlands	Dr. R. SLEEMAN
Institut National de la Météorologie (INMT)	Tunisia	Dr. M. RAJHI
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Kandilli Observatory and Earthquake Research Institute (KOERI)	Turkey	Prof. G. BARBAROSOGLU
Main Center for Special Monitoring (MCSM)	Ukraine	M. I. KACHALIN
Dubai Municipality	UAE	M. Y. A. ALMARZOOQI
British Geological Survey (BGS)	United Kingdom	Dr. B. BAPTIE
National Seismological Observatory Centre (NSOC)	Yemen	Dr. J. SHOLAN
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Observatories and Research Facilities for EUropean Seismology (ORFEUS)		Dr. B. DOST
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U.S. Geological Survey (USGS)		Dr. S. SIPKIN

Appendix C: List of 2007 EMSC members (in orange: new memberships in 2008)

V. REFERENCES

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