Specifications of the EMSC testimony's Service

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Summary

I. Aim of the document

The aim of this document is to describe the specifications of all functionalities the EMSC will develop in order to give access to intensities of individual testimonies of seismic events collected by the EMSC. This includes the interactive access through the Seismic Portal website and the web service integrated into the EPOS Thematic Core Service.

The second section describes the data we receive at the EMSC and the parameters chosen to characterize testimony data.

The third section gives specifications of the new functionalities of the Seismic Portal allowing users to access the intensities of testimonies through a web service and an interactive web search.

Note about "testimony data" and "macroseismic information"

In this document, testimony data refers to the intensities collected as felt reports with the web and mobile site and with the Lastquake application. These data may be used to infer macroseismic information of seismic events. However, since they don't contain vulnerability information of infrastructures, the intensities of testimonies provided by this service can't be labeled as "macroseismic".

The Seismic Portal

The Seismic Portal has been developed within the NERIES FP7 project. This web site is operational and is a single point of access to explore and download earthquake information. It's available at the url www.seismicportal.eu. Future development of EPOS services will be integrated into the Seismic Portal.

II. Description of testimony intensity collected by eyewitnesses

This section describes the overview of the EMSC system that collects testimonies of felt earthquakes, it describes the restriction on the provided data (”this is not a real-time service”) and the parameters that define testimonies.

1. The collect of testimonies

One of the main activities at the EMSC is the collection of testimonies from earthquake eyewitnesses. Bossu et al. 2016[1] gives a complete description of this collection system. In July 2014, the EMSC launched a new smartphone application named LastQuake (Android and iOS platforms) that replaces the traditional online questionnaire with a thumbnail-based questionnaire (Bossu, et al., 2015a). This change was implemented simultaneously on its dedicated website for mobile devices –hereafter named mobile website- (m.emsc.eu last accessed May 2016).

The new questionnaire is based on 12 thumbnail-sized images conceptualized by a professional cartoonist that aim to be culturally neutral and to depict each level of the EMS-98 macroseismic scale (see Table 1). Each testimony has an individual geographical location, when the user has accepted to share it, it is the location provided by the mobile device (for testimonies collected from the app and the mobile website), otherwise the user is invited to provide his/her postal address which is then converted to a point location through an online service. Testimonies are collected from all the continents, with the majority of them coming from Europe, Continental Asia and North America.

Table 1: Subset of the thumbnails used to collect felt intensity

Not Felt	Intensity 3	Intensity 5
		
Intensity 7	Intensity 9	Intensity 11
		

[1] Thumbnail-Based Questionnaires for the Rapid and Efficient Collection of Macroseismic Data from Global Earthquakes, Rémy Bossu, Matthieu Landès, Fréderic Roussel, Robert Steed, Gilles Mazet-Roux, Stacey S. Martin, and Susan Hough. *Seismological Research Letter*. Oct 2016. doi: 10.1785/0220160120

1. Data quality

This collection system developed at the EMSC associates testimonies to seismic events. This association is mainly done automatically by the user. The process is automatic and is not systematically revised by seismologist. So it's possible that some testimonies are associated to wrong event and create testimonies at unrealistic combination of Intensity and Epicentral distance (for a given magnitude). However, these testimonies are regularly used in study and this dataset is continuously improved. More details are available in the Annex V.

2. Raw and corrected intensities

This service proposes two intensities for each testimony, the raw and a corrected intensity.

- The **raw intensity** is the value directly collected by our system. All values are keeped as is with no filtering, no clipping and no correction.
- **Corrected intensities** are calculated from raw intensities with the correction defined in Bossu et al. 2016[1]. As described in the article, some testimonies with a raw intensity larger than 10 are not included.

3. Data access restriction

a. It's not a real time service!

When an earthquake occurs, we collect testimonies in real time and this service is built to give access to this data. However this testimony service is not intended to be updated in real time. After a significant event, the data will be available after a delay not yet defined.

b. Authentication procedure

Moreover, we plan to implement an authentication procedure in a second step of the development. The solution is not yet defined. It could be online registration, subscription by mails, IP adresse filtering. This choice is purely technical and is intended to avoid an overload of our servers when users download large volume of data in an uncontrolled way. This will help us to identify the user, contact him and find an alternate solution.

4. Parameters describing intensities of testimonies

To describe intensities collected, we associate testimonies with the corresponding earthquake through the UNID parameter.

Event information			
UNID			UNified ID used at the EMSC to identify events

The following parameters describe all intensities collected for one felt earthquake. Note that these data contain an array of location and intensities for each individual testimony.

intensity data point information			
nvalues		integer	Nunber of points
array data		Array	Array of nvalues points
longitude latitude intensity corrected intensity	degree degree [1..12] [1..12]	float float float float or 'nan'	Point longitude Point latitude Raw intensity of one point Corrected intensity of one point
lastUpdate	UTC	datetime	date and time of the last update of the data
thumbnailInfo		string	version of the thumbnails
correctionInfo		string	description of the correction

Remark on the value of the corrected intensity: if the value of the raw intensity is larger than 10, then we discard this testimony and we don't provide a corrected intensity.

III. Interactive access and Intensity data point service

The different ways to access testimony data will be developed as extensions of the existing Seismic Portal with an interactive access and a web service. Three new functionalities are identified:

1. Update of the event page (called the "eventdetails" page) of the Seismic Portal to display testimony's information of EMSC events;
2. Give access to data available at the EMSC via a web service;
3. Add an interactive query search on the Seismic Portal for the associated web service.

1. Testimony's information on the event page of the Seismic Portal

The idea is to add testimony information for felt earthquake into the "eventdetails" page of the Seismic Portal. This functionality is a new section like the existing "origins" and "arrivals" sections and like other new data developed within EPOS (e.g. Moment tensors). This section will be called "Testimony".

This section will display the following information:

- The number of testimonies collected for this event;
- A table of location (longitude, latitude) and raw and corrected intensities for all testimonies;
- The date and time of the last update;
- The version of the thumbnails.

Moreover, the user should have the possibility to download these information using the output format described in the web service.

2. Testimonies web service

This service is a part of the EPOS Thematic Core Service. It aims to give access to the intensities of felts reports collected at the EMSC via a web service that is integrated into the Seismic Portal. This service is independent of existing EMSC web services and the specifications follows as closely those of FDSN-event.

As for the FDSN-event, this service gathers data for a given request, which can be based on:

- a search by region, or
- a search by time period, or
- a search for a specific event defined by an ID.

The user may choose to add other filtering rules on the magnitude of seismic events and on the number of reports associated events.

The output of the available data for a given request may be a zip archive of csv files (see Annex IV). The option of a quakeML format will be implemented with the incoming quakeML 2.0 version that includes the description of macroseismic data.

Specifications of this service are very similar to the FDSN-event specifications. The description of all available parameters is listed below in the Table 2 (page 9). The specification column refers to:

- FDSN indicates that the parameter behaves the same way as for FDSN-event specification;
- 1 - "from starttime" time constraint allows querying all focal mechanisms with the event time between "starttime" and "dayafter" days.
- 2 – The specification of the zip format is described in the Annex IV. The quakeml format will be implemented when the version 2.0 will be available. This version should allow the description of macroseismic data.
- 3 – Constrains minvalues and maxvalues allow to select events according to their number of reports.

3. Interactive search

Like other web services, the interactive search is a web interface that should give the user the possibility to request testimony data with all filtering options defined in the web service specifications.

Table 2: Description of parameters used in the web service

	parameter	abbreviation	min	max	type	Units	Specification
time constraints							
date range							
	starttime	start			time	UTC	FDSN
	endtime	end			time	UTC	FDSN
from starttime							
	starttime	start			time	UTC	1
	dayafter		1			integer	1
geographic constraints							
area-rectangle							
	minlatitude	minlat			float	degrees	FDSN
	maxlatitude	maxlat			float	degrees	FDSN
	minlongitude	minlon			float	degrees	FDSN
	maxlongitude	maxlon			float	degrees	FDSN
area-circle							
	latitude	lat			float	degrees	FDSN
	longitude	lon			float	degrees	FDSN
	minradius		0	180	float	degrees	FDSN
	maxradius		0	180	float	degrees	FDSN
specific event							
	eventid				string		FDSN
output control							
	format		json, zip, (quakeml)		string		2
	nodata				string		FDSN
filtering constraints							
	minvalues				integer		3
	maxvalues				integer		3
	minmagnitude	minmag			float		FDSN
	maxmagnitude	maxmag			float		FDSN

IV. Annex: description of the zip format

The zip format is a single ZIP file that contains one csv file per requested events.

Each csv file is divided in two parts:

1. A header of 4 commented lines containing the unid of the event, the thumbnail version, the description of the applied correction and the parameter of each column;
2. the csv data of 4 columns formed by the longitude, latitude, the raw intensity and the corrected intensity.

V. Annex: EMSC Activity Report

Extract of the EMSC activity report of 2018 that describes the data collected ant its statistics.

I INTRODUCTION

The European Mediterranean Seismological Centre (EMSC), hosted by the LDG (*Laboratoire de Détection et de Géophysique*, Bruyères-le-Châtel, France), is a non-profit and non-governmental scientific international organization which provides rapid earthquake information in coordination with the national seismological institutes in the Euro-Mediterranean region. 81 seismological institutes are members from 56 countries covering the whole Euro-Med region.

The main scientific activities of the EMSC are the real time information services which are presented in this report. These services are operated thanks to the operational and technical support of the LDG and of the IGN (Madrid, Spain) by compiling the real time parametric data provided by 96 seismological agencies, in the Euro-Med region but also worldwide.

The real time catalogue is available on various media: websites, smartphone App, Twitter, Browser add-ons, FDSN webservice etc.

In addition to seismological data, the EMSC collects rapid in-situ data thanks to the eyewitnesses who provide felt reports, comments and/or geo-located pictures of earthquake effects. Seismic data along with in-situ data allow the EMSC to quickly detect felt and potentially damaging earthquakes and to rapidly publish information on these significant earthquakes through various media: websites, email services, Twitter, smartphone App, etc.

The different earthquake information services and the publication media are presented in this report as well as their performance's evolution over the last few years. The report also presents recent developments carried out by the EMSC.

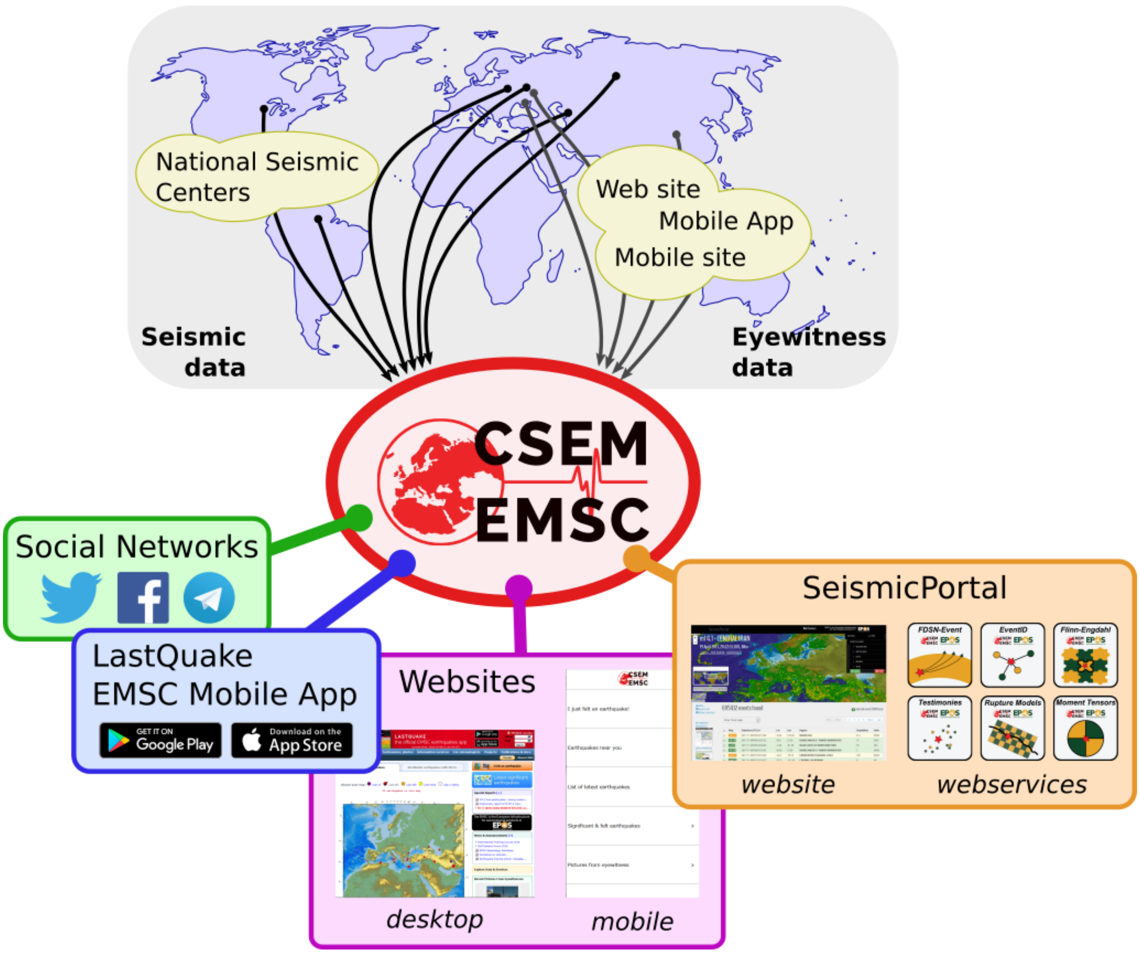

Figure 1 : Overview of the EMSC and its main services for the general public and for seismologists (www.seismicportal.com)

II STATUS AND PERFORMANCE OF THE REAL TIME SERVICES

Each year, we assess the status and the performance of the EMSC real time services using the following metrics:

- Status and performance of the email Earthquake Notification Service
- Seismological data received and number of earthquakes published
- In-situ data provided by the eyewitnesses (felt reports, comments, pictures)
- Who uses EMSC real time services and how?

II.1 EARTHQUAKE NOTIFICATION SERVICE (ENS)

II.1.1 PRESENTATION

The EMSC operates an email Earthquake Notification Service (ENS), thanks to the technical and operational support of the **LDG** (Bruyères-le-Châtel, France), and of the **IGN** (Madrid, Spain). The ENS is a free public service[1] which consists of quickly disseminating (within 10-20 minutes after earthquake occurrence) an email notification to its users for potentially damaging earthquakes (i.e. M5+ in Europe; M6+ for continental Asia; M7+ worldwide). The earthquake location and dissemination is performed by a seismologist on call. On average, 100-150 messages are disseminated each year via the ENS.

In the framework of the ENS, the seismologist on call is also in charge of relocating, when necessary, the earthquakes published on the EMSC website during the week-end. This task allows the seismologist on call to remain aware of the recent seismicity and to quickly detect any technical problems.

II.1.2 ROLE OF THE LDG

The Laboratoire de Détection de de Géophysique (LDG) is the EMSC's host institute. The LDG is part of the Commissariat à l'Energie Atomique (CEA) and is located in Bruyères-le-Châtel, France.

The LDG covers EMSC's overheads (premises, phone lines, …) as well as the computer infrastructure. All servers and computer are the property of the CEA. The CEA provides facilities to the EMSC to insure that it remains operational 24/7 thanks to people on call: seismologists, IT's, technicians. A dedicated vehicle, a laptop and a cell phone are at the disposal of the seismologist on call so that he/she can easily and securely connect to the EMSC from his/her home and therefore quickly disseminate messagesto the ENS users.

II.1.3 ROLE OF THE IGN

The **Instituto Geografico Nacional** (IGN), in Madrid, Spain, operates a back-up of the Earthquake Notification Service (ENS) when the EMSC is not able to operate it for maintenance reasons for example. When the EMSC website is offline, the real time seismicity is available on IGN website:

http://www.01.ign.es/ign/resources/sismologia/www/csem/csem.htm

It's important to notice that due to an hardware update, this backup system provided by the IGN is no longer operational. However, with our effort to update the data collection core system (see IV.3), it's now one of our main objectives and plan to install this system at IGN as soon as possible.

[1] http://www.emsc-csem.org/service/register.php

II.1.4 ENS USERS

The number of users registered to the Earthquake Notification Service is rather stable since 2013, with a total of 12,020 users on 01/01/2019 (Table 1). With the soar in smartphones devices and the release of numerous smartphone applications for earthquakes information, classical email-based services have become less interesting to the general public.

The database of ENS users is regularly cleaned and the email addresses that are not valid anymore are removed from the database.

II.1.5 ENS PERFORMANCE

We present here the evolution, over the last few years, of the response time performance of the ENS. Only Euro-Med earthquakes are considered because this is the region on which the ENS is focused. For each earthquake that has been processed via the ENS, we consider separately:

- **The Preliminary information time**

The preliminary information is the very first source parameters published on the EMSC website for a given earthquake (generally an automatic location).

The time delay between earthquake occurrence and publication of the preliminary information has continually decreased since 2006 to 2017 with a median value of 4.0 minutes. In 2018 this value increased to 5.5 minutes for Euro-Med earthquakes (Table 1 and Figure 3).

- **The Alert triggering time**

The Alert triggering time is the time elapsed between the earthquake occurrence and the time when the seismologist on call is automatically called, when the magnitude of an earthquake exceeds the local threshold[2] (Figure 2). The regular decrease of the Alert triggering time since 2004 is mainly due to the improvements in the performance of the individual seismological agencies in detecting and locating earthquakes more rapidly.

In 2018, the median Alert triggering time was 3.2 minutes (Table 1 and Figure 3).

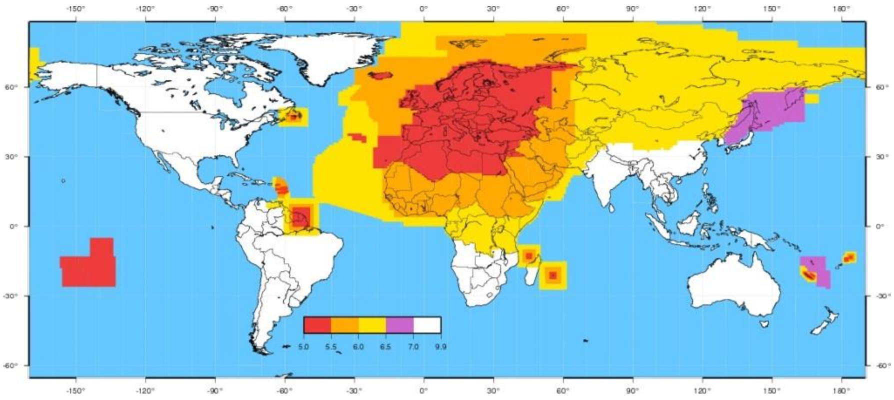

Figure 2: Map of magnitude thresholds for the alert triggering

2 http://www.emsc-csem.org/Images/threshold.jpg

- **The Alert dissemination time**

The Alert dissemination time is the time elapsed between the earthquake occurrence and the time when the seismologist on call disseminates the alert message to the ENS users. After slightly increasing in 2016 due to the arrival of 3 new seismologists in the on-call team, who needed some training, the alert dissemination time decrease in 2017 to 15.4 min and stayed stable in 2018 (Table 1 and Figure 3).

Earthquake Notification Service												
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Number of users	6,570	7,541	8,644	9,667	10,862	11,461	11,628	11,888	11,881	11862	12020	+1.3%
Number of disseminated earthquake notifications	157	135	122	137	152	156	208	119	131	151	170	+12.6%
Median preliminary information publication time for Euro-Med earthquakes	9.9	9.5	9.1	7.6	7	7	6	4.2	4.3	4	5.5	+37.5%
Median Alert triggerring time for Euro-Med earthquakes	7	7	7.5	7	7	6	6	3.5	3.7	2.6	3.2	+23.1%
Median Alert dissemination time for Euro-Med earthquakes	22	20	18	18	17	16	16	14.5	18.1	15.4	15.4	+0.0%

Table 1: Change in the response time performance of the Earthquake Notification Service over the last 10 years for Euro-Med earthquakes

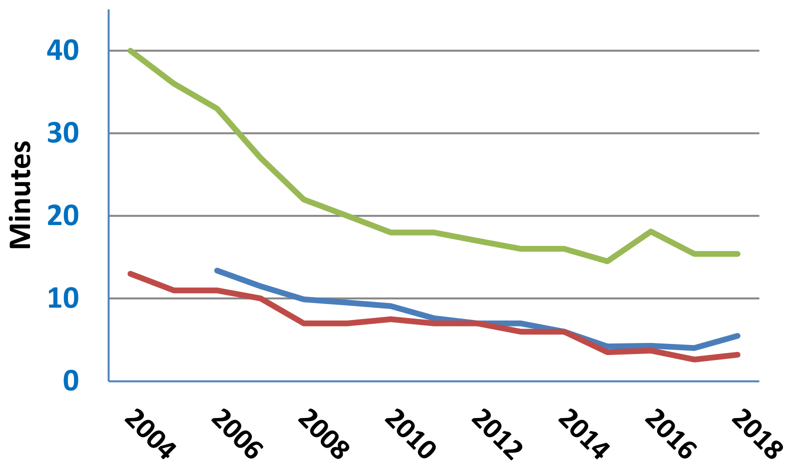

Figure 3: Earthquake Notification Service: improvement of the median values of the alert triggering time (in red), the preliminary information publication time (in blue) and the dissemination time (in green) since 2004 for Euro-Med earthquakes.

- **Location and magnitude accuracy**

Until 2013, we used to assess each year the location and magnitude accuracy of the information published or disseminated in the framework of the ENS. To perform this, we used to consider the location provided by the Euro-Med Bulletin (EMB; Godey et al.; 2007) as a reference location. However, the EMSC 2014 General Assembly, held during the ESC 2014 in Istanbul, decided to stop the production of the EMB which prevented us from assessing these performance anymore. Nevertheless, we showed in the report on 2013 real time activities that these performance had been rather stable in recent years, with a median accuracy of the disseminated locations of 10-12km and a median magnitude accuracy of 0.1 for Euro-Med earthquakes.

The reasons why the EMB production stopped and the final status of the EMB are presented in the report on Euro-Med Bulletin activities in 2015 (Godey et al. 2015).

II.2 SEISMOLOGICAL DATA

II.2.1 DATA CONTRIBUTORS

In 2018, a total of 96 seismological agencies provided real time data to the EMSC. This count can be compared to the 86 contributors of 2017 and this change shows our efforts to have our contributor list as up-to-date as possible. We have 6 new contributors:

- INSN: Irish National Seismic Network
- BRGM: Bureau de Recherches Géologiques et Minières, France
- UASD: Universidad Autonoma de Santo Domingo
- KIS: Kyrgystan
- CNRM: Morocco
- VEN: Venezuela

And we have also 4 contributors that are reactivated:

- MLT: Malte
- NSC: Nepal
- PIVS: Philippines
- UPSL: University of Patras Seismological Laboratory

II.2.2 DATA COLLECTED

The amount of data contributions has regularly increased since 2004 (Figure 4). In 2018, the 96 agencies contributed to the EMSC:

- Source parameters and phase pickings (see VII.1):
  - 151,276 origins (Figure 4) or 4,660,688 arrival times from 7,260 seismic worldwide stations (Figure 4; Figure 5; Table 2)
- Moment tensors solutions (see VII.2):
  - 3,703 moment tensor solutions[3] (Table 2)

[3] List of moment tensors received: http://www.emsc-csem.org/Earthquake/tensors.php

Data received																
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Nb of origins received	13,992	18,030	31,537	35,644	43,151	50,789	60,628	78,756	81,828	84,060	92,421	89,954	103,495	122,702	151,276	+23.3%
Arrival times received	447,552	671,225	731,878	1,032,159	1,244,879	1,532,786	1,670,703	2,084,588	2,304,648	2,262,900	2,440,773	2,329,705	2,650,725	3,077,100	4,660,688	+51.5%
Nb of contributing Euro-Med stations	1,100	1,249	1,359	1,624	1,672	1,782	1,896	1,996	2,100	2,236	2,415	2,459	2,431	2,603	2,653	+1.9%
Moment Tensors solutions received	1,013	1,139	1,105	1,175	1,328	1,285	1,303	2,488	2,886	3,024	3,972	3,557	3,438	3,868	3,703	-4.3%
Earthquakes with Moment Tensor solutions	182	640	622	699	725	703	701	1,037	1,198	1,230	2,052	1,910	1,612	1,348	1,299	-3.6%
Data published																
Nb of worldwide earthquakes	*NA*	9,814	11,109	14,342	15,386	16,582	17,540	24,237	32,944	36,181	42,530	39,471	49,731	52,459	75,776	+44.4%
Nb of Euro-Med earthquakes	*NA*	6,228	6950	8,993	9,819	11,018	12,189	18,049	24,771	24,908	22,168	18,674	18,800	23,278	14,533	-37.6%
Proportion of Euro-Med [2]earthquakes	*NA*	63.5%	62.6%	62.7%	63.8%	66.4%	69.5%	74.5%	75.2%	68.8%	52.1%	47.3%	37.8%	44.4%	19.2%	-56.8%

Table 2: Trends in the amount of data received and the number of earthquakes published in EMSC real time catalogue since 2004. NA=Not applicable

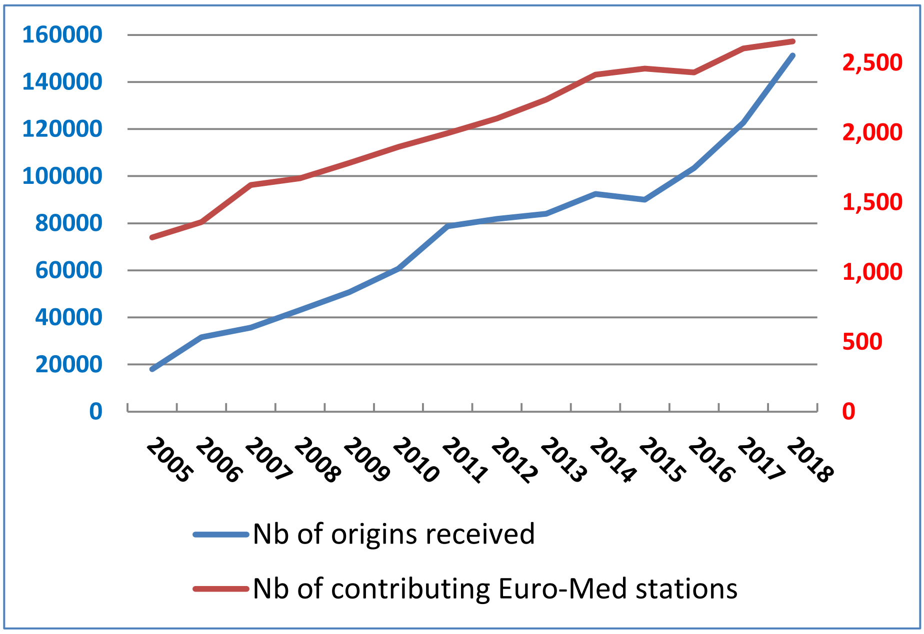

Figure 4: Growth in the number of origins received by the EMSC from the data contributors (in blue) and the number of Euro-Med stations that provided phase pickings (in red) in real time since 2004

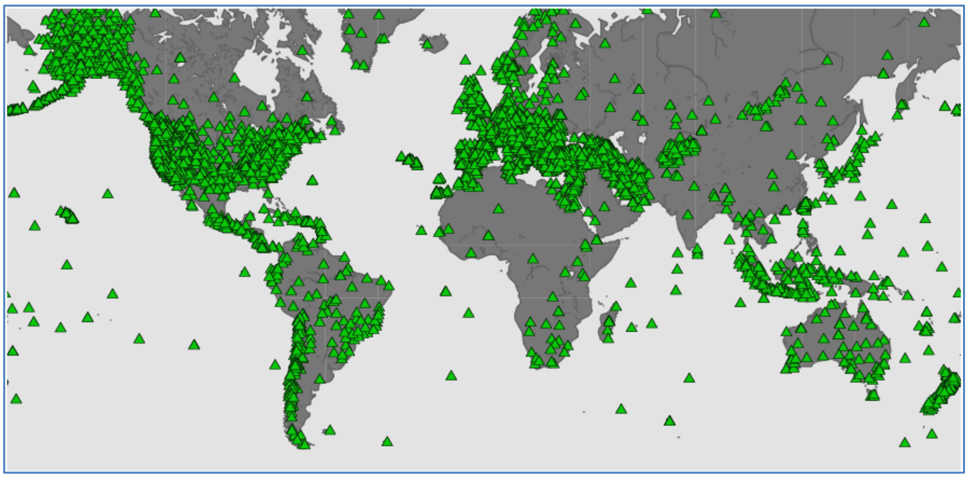

Figure 5 : Maps of the 7,260 contributing stations for 2018 referenced in the station book of ISC.

II.3 Real time catalogue

II.3.1 Number of earthquakes published

The number of worldwide earthquakes published each year by the EMSC in its real time catalogue has kept on increasing since 2004 and reached 75776 earthquakes in 2018 (Table 2, Figure 6 and Figure 7). The huge increase of seismic events (+44%) in 2018 is mostly due to a seismic crisis in Hawaii where we received a lot a small events (<M3).

The curve of daily distribution of earthquakes collected by EMSC is composed of different periods:

- In 2017, the number of earthquakes increased by 23.8 % compared to 2016 and this trend is probably linked to 3 main earthquake sequences: in Italy in January 2017, in Western Turkey in February 2017 and in Macedonia in July 2017.
- The regular increase observed between 2005 and 2012 is mostly due to the additional seismological stations available in real time (red curve on Figure 4) and the improvement of the detection capacities of the different seismological agencies which provide real time earthquake data to the EMSC. Concerning the Euro-Med earthquakes, their number did not increase since 2012. In this case, the year-to-year changes are mostly governed by the natural changes in the seismic activity.

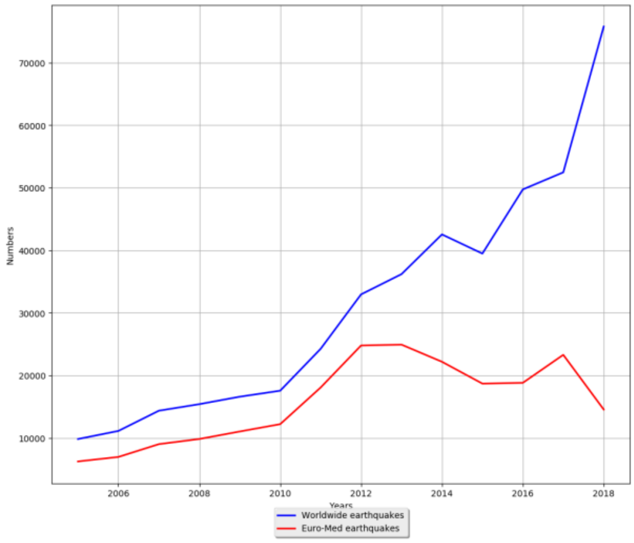

Figure 6: Change in the number of worldwide (in blue) and Euro-Med (in red) earthquakes published in EMSC real time catalogue per year since 2005

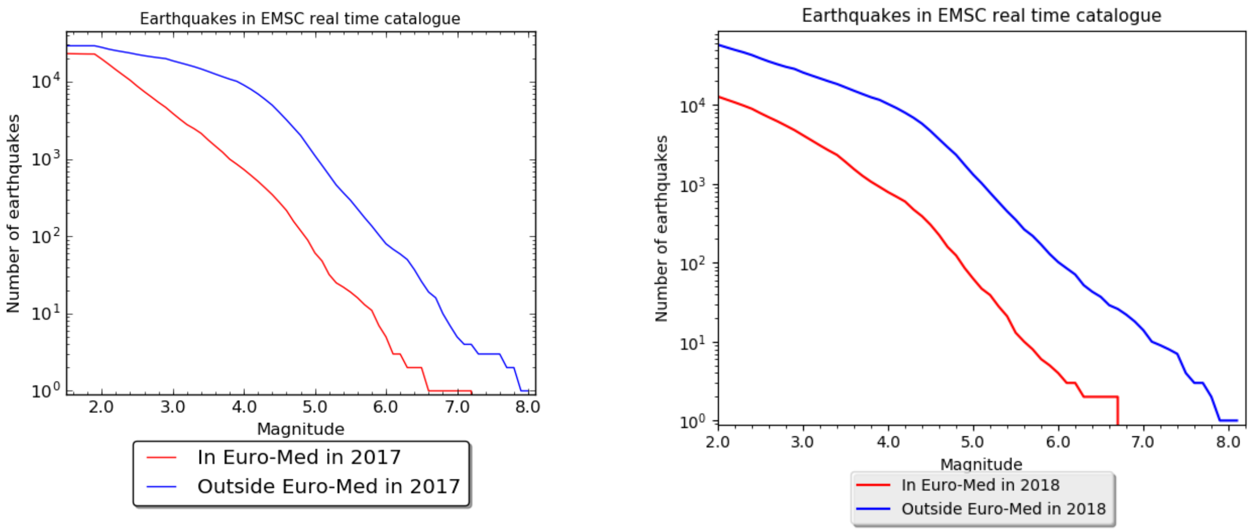

Figure 7: Comparisons of Gutenberg-Richter magnitude distribution of the earthquakes published in EMSC real time catalogue in 2017 (left) and in 2018 (right)

II.3.2 TYPES OF LOCATIONS

Among the tens of thousands of earthquakes in the EMSC real time catalogue, we distinguish four types of locations (Table 3):

- 1. Reported locations: earthquakes reported by only one contributor/agency which is the local agency but for which its location is not authoritative (Bossu et al.; 2011). The EMSC does not relocate them.
- 2. Authoritative locations: earthquakes for which at least one of the locations provided by the contributing agencies is authoritative (Bossu et al.; 2011). The EMSC does not relocate them.
- 3. Data Selected Locations (DSL): locations computed by the EMSC where no authoritative location is available but where a Ground Truth (GT) location (Engdahl et al.; 2001 and Bondar et al.; 2004) can be obtained by merging the data of the different agencies. DSL are accurate locations by definition.
- 4. EMSC locations: locations computed by the EMSC using all the pickings provided by the data contributors.

Table 3 clearly shows that the vast majority of the locations published in EMSC real time catalogue are not computed by the EMSC. In 2018, 87.3% of the worldwide seismic events (70.0% of the Euro-Med ones) diffused by the EMSC use a location directly provided by individual seismological agencies.

Type of locations	Worldwide	Euro-Med only	Computed by the EMSC
Reported locations	58.8%	49.9%	No
Authoritative locations	28.5%	20.1%	No
Data Selected Locations	0.1%	0.3%	Yes
Locations computed using all available stations	12.5%	29.8%	Yes
Locations not computed by the EMSC	*87.3%*	*70.0%*	-

Table 3: Distribution of the different types of locations published in EMSC real time catalogue in 2018

II.4 DATA COLLECTED FROM EYEWITNESSES

This section is dedicated to the information collected from the earthquake eyewitnesses in terms of felt reports, comments and pictures.

The EMSC collects eyewitnesses felt reports for several reasons:

- It provides a way to collect felt reports in countries where no online questionnaire is available.
- It supplies redundancy to macroseismic questionnaires provided by the local institutes.
- It is a way to collect and process felt reports over frontiers and in a homogenous way.

The EMSC collects felt reports:

- Either via the classic online questionnaire available on the EMSC desktop website[4] (i.e. for desktop)
- Or via the thumbnails describing each level of shaking (Figure 8) and made available on the mobile website[5] and LastQuake application.

In this report, the word “felt report” stands for both types.

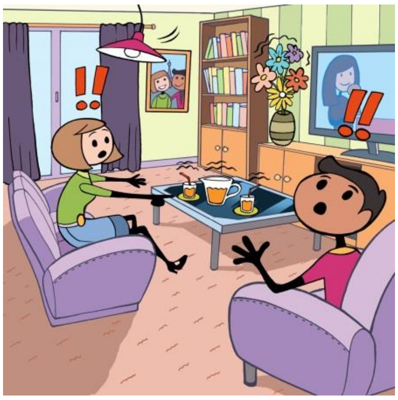

Figure 8: Example of thumbnails proposed to eyewitnesses to share their experience, corresponding to an intensity of 3.

II.4.1 FELT REPORTS

The number of felt reports collected by EMSC has continued to increase over these past 10 years and reached 120474 in 2018 (Figure 9, Figure 10, Figure 11 and Table 4).

Main observations:

- The number of felt reports collected has increased through all collection channels, the app, mobile website and desktop website; by 23% for LastQuake app and by 40% on the desktop.
- Compared to 2017, the coverage improved in Oceania and in particular in Indonesia (Figure 11) thanks to the Lombok sequence

Although the EMSC collection system is now well established, It’s interesting to note that the repartition between the collection channels depends strongly on the region and shows the complementarity of the global collection system (Figure 13).

[4] http://www.emsc-csem.org

[5] http://m.emsc.eu

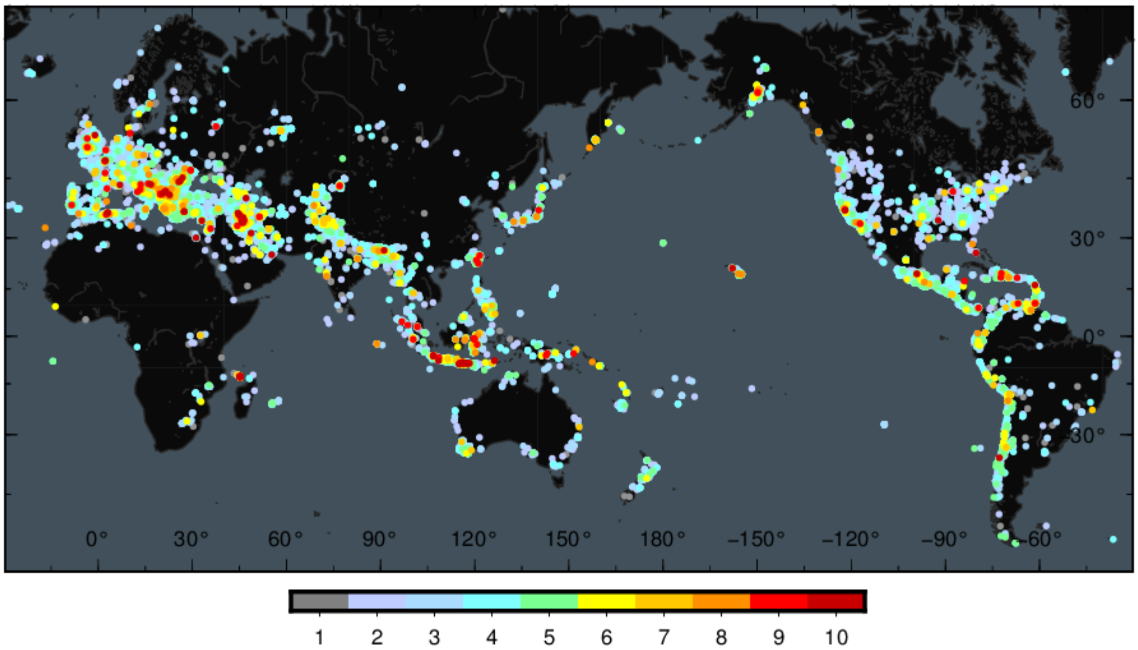

Figure 9: The 119,622 geolocated felt reports collected in 2018. On this map, higher intensity values overlay lower intensity ones.

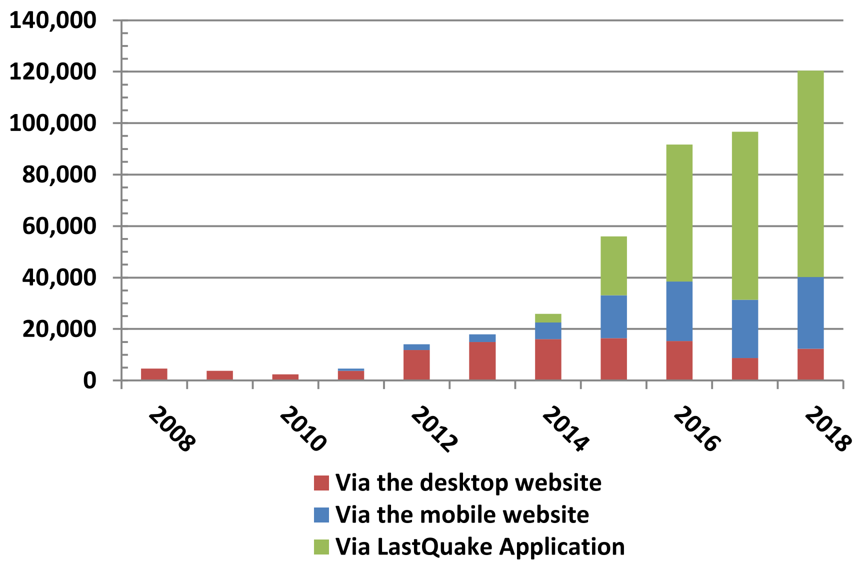

Figure 10: Yearly distribution of felt reports collected every year over the last 10 years.

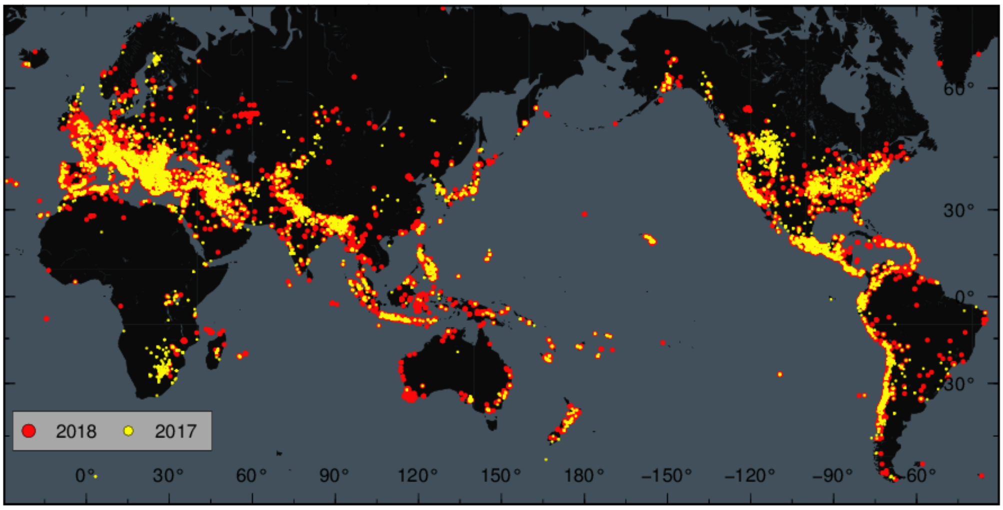

Figure 11: Comparison of the felt reports distribution in 2017 and 2018.

Felt reports collected from eyewitnesses												
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Via the desktop website	4,581	3,778	2,400	3,831	11,909	14,909	16,056	16,506	15,366	8,782	12,332	+40.4%
Via the mobile website	*NA*	*NA*	*NA*	783	2,235	2,991	6,491	16,581	23,134	22,562	27,818	+23.3%
Via *LastQuake* Application	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3,314	22,927	53,138	65,293	80,324	+23.0%
TOTAL	**4,581**	**3,778**	**2,400**	**4,614**	**14,144**	**17,900**	**25861**	**56014**	**91638**	**96637**	**120474**	+24.7%
Earthquakes with at least one testimony	686	795	693	841	1410	1526	2041	2705	3737	5152	4319	-16.2%

Table 4: The numbers of felt reports collected from eyewitnesses every year over the last 10 years

The "felt report" number gives a good indicator for evaluating the performances of all components of the collection system, that encompasses the hardware and the software as well as the overall popularity of EMSC. This year, there was no increase in collection speed. However, there were 12 events for which we collected more than 1000 reports and half of these had a magnitude less than M5. Of course these observations depend strongly on the seismic event distribution and so it is difficult to extract global trends. In 2018, the record set in 2016 was beaten twice. In 2016, we collected 4423 reports for an M5.6 event in Oklahoma on 2016/09/03. In 2018, we collected 4480 reports in Romania for a M5.5 on 2018/10/28 and the new "record" is 5407 reports for a M4.4 in the UK on 2018/02/17.

In term of performance, the Figure 12 shows that 60% of the felt reports collected in 2018 came within 15 minutes of earthquake occurrence for thumbnails and 25 minutes for questionnaires. Moreover thumbnails (felt reports from mobile and LastQuake) represent the majority of collected reports (90%). This shows the efficiency of the collection system enabled by the app and the cartoon thumbnails for choosing the felt intensity.

This optimal behavior is possible thanks to the effort made in 2016 to optimize some analysis, to upgrade our web servers and to upgrade our front-end servers (F5-Big-IP load balancers) which manage the traffic peaks generated by sudden visitor arrivals.

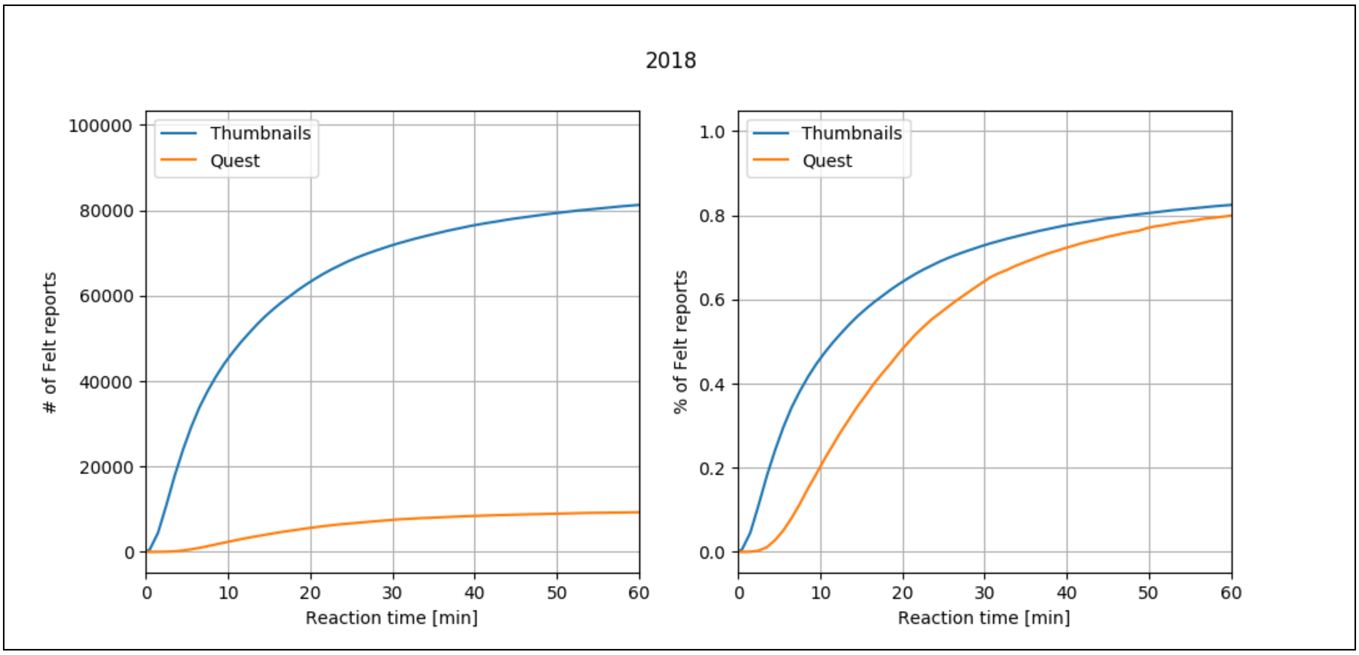

Figure 12: Number (left) and percentage (right) of all felt reports collected in 2018, with respect to time elapsed since earthquake occurrence, by thumbnails-based and online questionnaires.

M4.4 in San Francisco	M6.8 in Greece	M4.4 in England

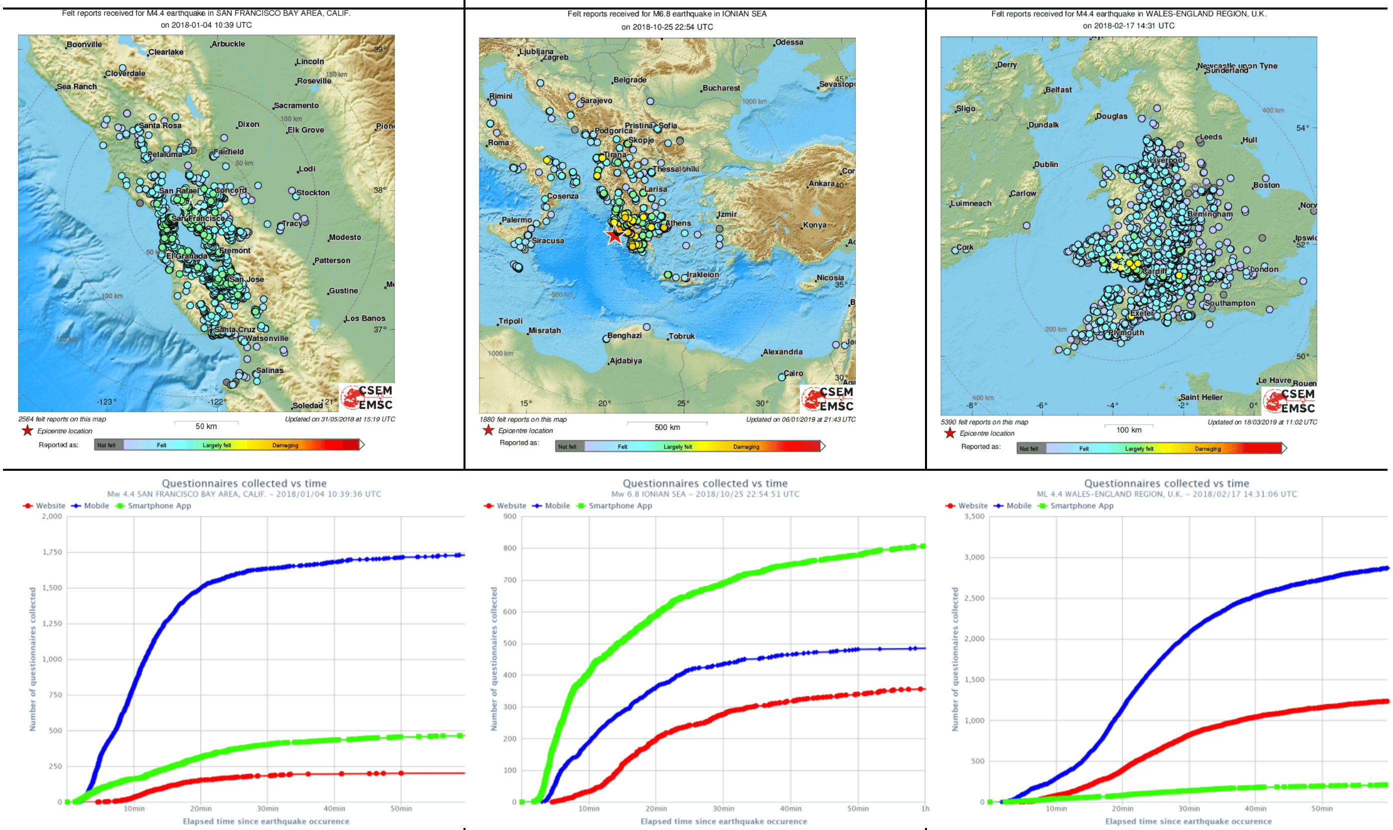

Figure 13: Examples of the three distinct collection mechanisms for three seismic events in 2018.