Centre Sismologique Euro-Méditerranéen
European-Mediterranean Seismological Centre

Newsletter

N° 11 JULY 1997

EDITORIAL

With this edition of the Newsletter, we look forward to our Assembly in Thessaloniki during the IASPEI Meeting. It will take place on Friday 22 August between 6pm and 9pm, in the "cool" of the evening. Members, particularly, are urged to come to participate in the review of our Centre, discuss the future programme and to vote on issues. All others are welcome to attend to hear about the EMSC and give us the benefit of your views. In return, we will, gently, suggest that your institution joins the membership (there is a small annual fee) and/or sends us data. At present, we have 33 members in 22 countries and have firm applications from 4 others whom we expect to welcome formally into the community at the Assembly.

The rapid determination of epicentres has continued to be the main focus of EMSC's activities with 180 names on the distribution list for alerts, of which 73% are issued by e-mail, 20% by fax and 7% by telex. Some 30 networks are now submitting data rapidly to the Centre which operates through its key nodal members in Bruyere-le-Chatel (LDG), Madrid (IGN) and Rome (ING). The last is, currently, becoming operational. As a result of the increasing data flow, the objective of despatching alerts within 1 to 2 hours of all earthquakes in the region with magnitudes 5.5, is being met in most cases. The award of an EU project, in 1996, to develop further this rapid warning system has achieved its first year objectives with the annual report submitted to Brussels. The ultimate goal of the 8 participating institutions, on behalf of the whole of the EMSC membership, is to be able to release, rapidly, accurate information for any earthquake of magnitude greater than 5.0 occurring in the European-Mediterranean area. In a two-stage process, basic parameter information will be sent immediately with detailed information on the source mechanism following. To achieve this, attention will be focused on extending the 30 SP and BB networks able to deliver data rapidly to the EMSC for inclusion in the solutions. In particular, stations will be added near the periphery of the existing network, in Scotland, the Canaries and Romania. Improved propagation models, location software and techniques for rapid moment tensor inversion are being developed. A project flier has been produced giving more details and copies may be obtained from Bruno Feignier or picked up at the Assembly in Thessaloniki.

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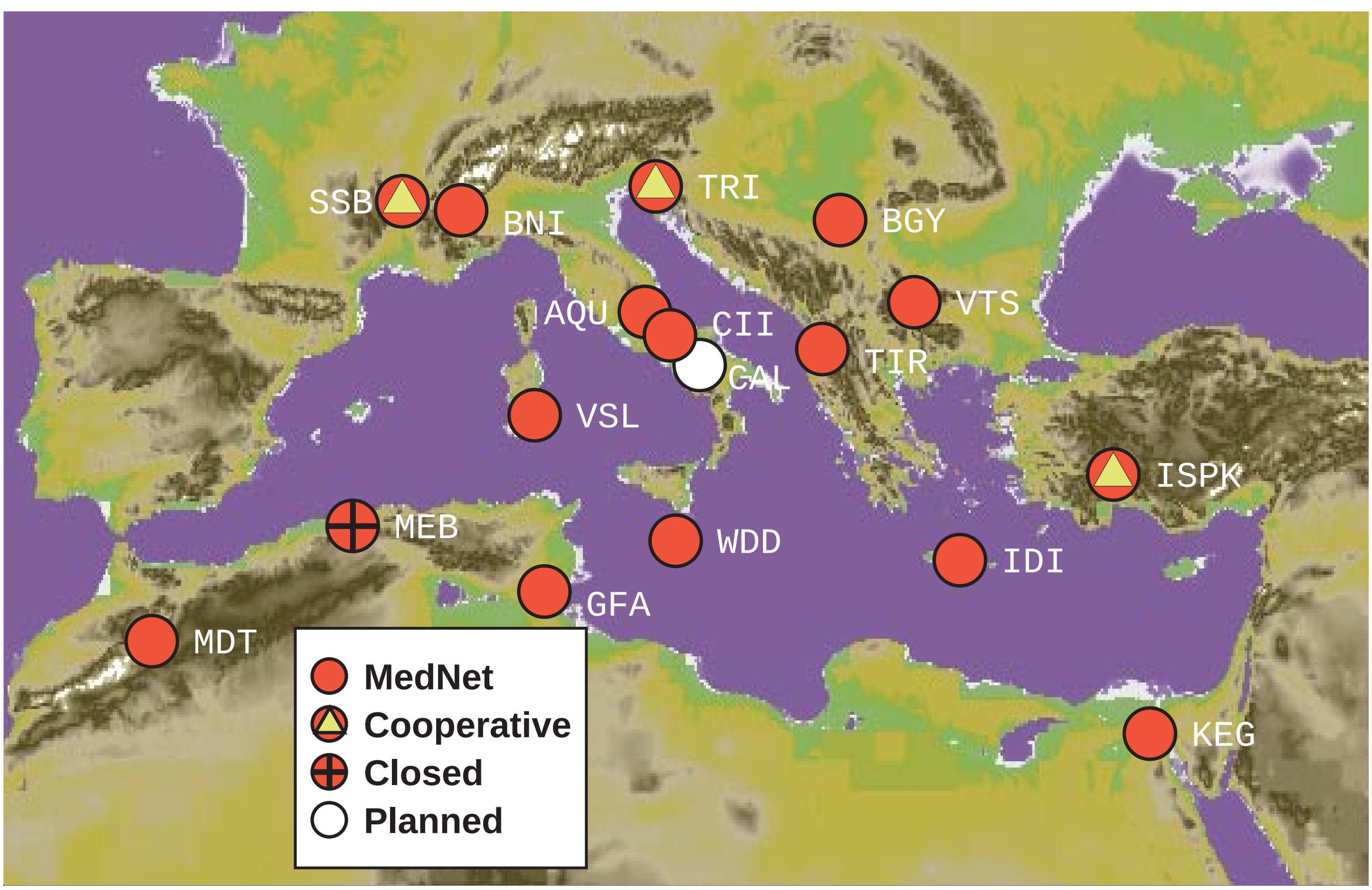

Status of the Mednet network (see text page 7)

AN AUTOMATED DATA PROCESSING METHOD FOR MINI-ARRAYS

by Y. Cansi and Y. Klinger,
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Introduction

Most of the seismic waves can be represented at a local scale by a set of plane waves using the well-known relation

$$f(\vec{r},t) = e^{i(\ \ t-\vec{k}\vec{r})}$$

where

$$\left\| \vec{k} \right\| = \frac{2\ \ f}{c}$$

is the wave vector associated to the frequency f and the phase velocity c, and

$$= 2\ \ f = \frac{2}{T}$$

is the angular frequency associated to the frequency f or the period T of the wave. The frequency content of a recorded seismic wave can easily be determined using a single station. At the opposite, a set of stations is needed to determine the propagation parameter $\vec{k}$. When the aperture of this set of sensors is roughly equivalent to one wavelength, this set is named a mini-array. At the opposite, when the aperture is far larger than the wavelength, it is named a network of sensors.

In the case of a network, the signal is often very different from one sensor to another and the measure of the propagation parameter can be only performed by the classical method proposed by Husebye which invert the set of arrival times. At the opposite. in a case of a mini-array, we can take advantage of the great similarity of the signals to compute arrival time differences using classical techniques of signal processing theory. This set of arrival time differences is used to compute the propagation parameters using a method derived from Husebye's method.
The most classical method for estimating these wave parameters in the case of a mini-array is a systematic search in a specific domain of wave vector using the signals recorded on the sensors. For exemple the disc defined by the relation

$$\left\| \vec{k} \right\| < \frac{2\ \ f}{V_{min}}$$

corresponds to all the waves with a frequency f, with any azimuth and with a velocity

$$V > V_{min}$$

For each discrete wave vector of this regularly discretized domain, the time delay of each sensor is calculated and the delayed signals are summed. When the signals are mainly composed of random background noise, the energy variation of the sum is small over the entire wave vector field. In contrast, if the signals are associated with a specified vector $\vec{k}_0$, the energy obtained for $\vec{k}_0$ will be much larger than for the other vectors. A lot of methods have been pro-

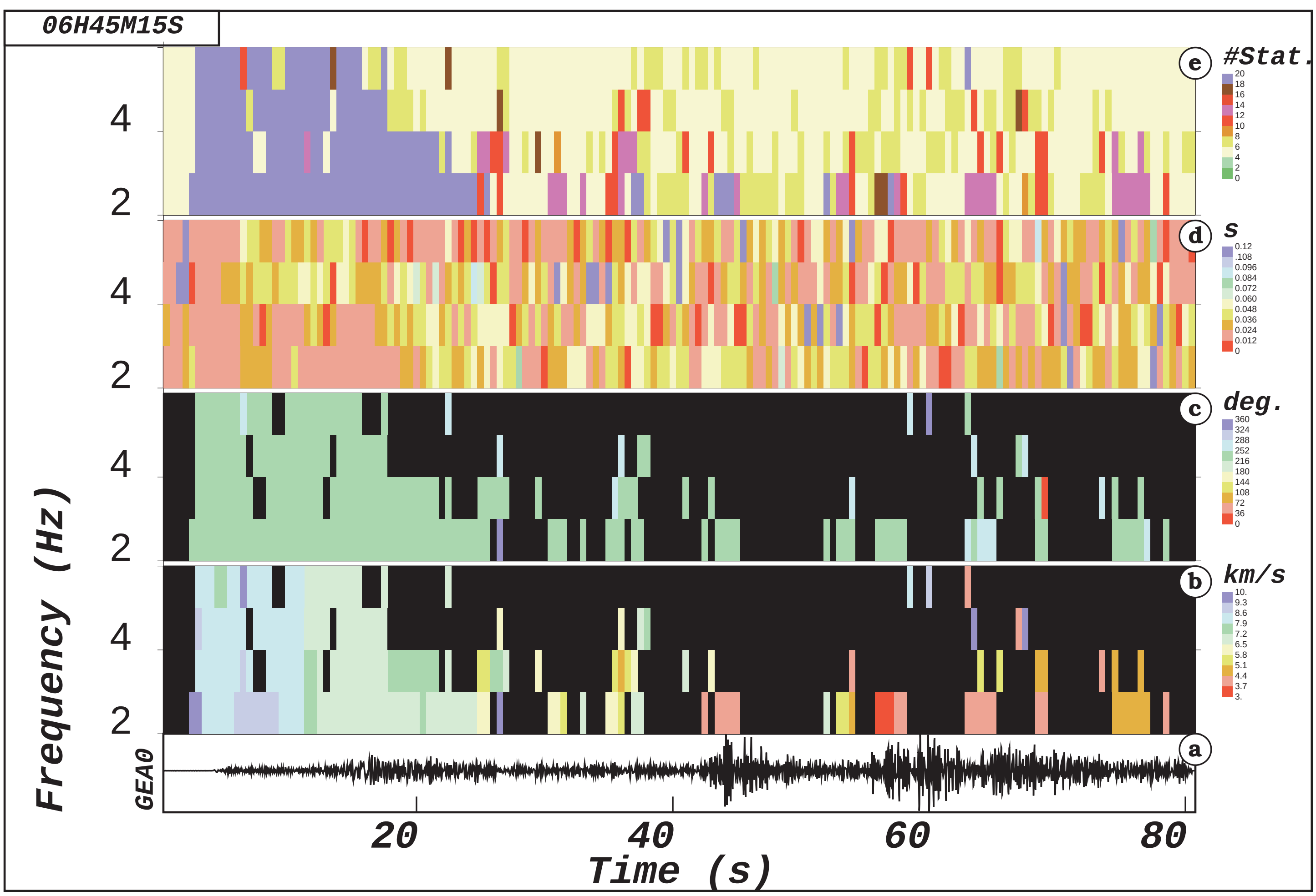

Figure 1 : Example of data processing on the GERESS mini-array

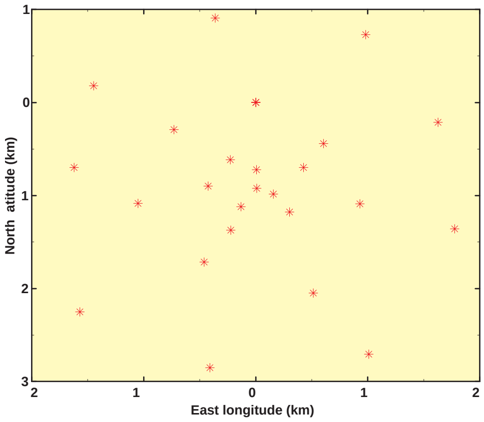

Figure 2 : Geometry of the GERESS array

posed by different authors to find the wave vector which produces the maximum of energy (see e.g. Capon, 1969). This is not a trivial problem because it is a discrete problem in the space domain (i.e. only few sensors are used). This implies that for each frequency, false results can be obtained due to correlated signals over one or more periods (ambiguity effect). To study these effects, Capon (1969) suggested to compute the array beam forming function :

$$B(\vec{k}) = \left| \sum_j e^{i\vec{k}\vec{r}_j} \right|$$

It represents the array response for a wave which arrives vertically under it, i.e. with a horizontal wave plane reaching all the sensors at the same time. The main hypothesis of this family of methods is the identification of a signal modelled by a plane wave recorded on all the sensors of the array. In practice, some of these assumptions are confirmed to various extents as diverse sources cause interference with these signals. That is why a more flexible method, less constraining with respect to the model, is proposed. It is based on conventional signal processing techniques to detect a stable signal on two or more records, partly by relaxing the plane wave model rigidity. We have named this method PMCC (Progressive Multi-Channel Correlation).

Basic tool : correlation

A temporal signal $s(t)$ can also be represented by its Fourier transfom $s(f)=A(f)e^{i\varphi(f)}$. The background noise is characterized by a rapid variation of $A(f)$ and $\varphi(f)$ from one sensor to another, even if they are closer than a wavelength. At the opposite, in case of signal propagating between the sensors, the following relations are available :

$$A_2(f) = A_1(f)$$
$$\varphi_2(f) = \varphi_1(f) - (\vec{r}_2 - \vec{r}_1)$$

($(\vec{r}_2 - \vec{r}_1) = \vec{k}(\vec{r}_2 - \vec{r}_1)$ in the case of a plane wave).

Based on these two observations, a signal processing tool can be used to detect a signal present on the records $s_i(t)$ and $s_j(t)$: the correlation function $Cor_{ij}(\tau)$. It is a measurement made in the time domain. This function has values ranging between [-1;1]. Taking into account all frequencies, it measures in a window W the similarity of the signals when shifted by a certain quantity τ. The maximum of the correlation function gives the time delay between the signals.

Detection by correlation : the PMCC method

Correlation is the basis of the PMCC method, which is used for fine detection and for measurement of the detected wave parameters.

The correlation function is used to measure the time delay Δt_{ij} between two signals $S_i(t)$and $S_j(t)$. In the case of a wave propagating without distortion (a fortiori in the case of a plane wave), this delay is the same for all the frequencies of the contributing signals :

$$t_{ij} = \frac{1}{2} (\varphi_j(f) - \varphi_i(f))$$

For each group of three sensors, a closure relation should then be obtained :

$$t_{ij} + t_{jk} + t_{ki} = 0$$

In contrast, in the presence of background noise, the phase is very unstable from one frequency to another. Therefore, the delays measured in this case are the result of random phase combinations. These delays, independent of the amplitude of each elementary wave, become random, and the closure relation given above is no longer valid.

A very powerful, self-contained detector can thus be obtained using the phases measured on the records by the correlation functions. This detector uses only the intrinsic information in the processed signals. This method enables a decision to be made on whether there is a signal in a set of simultaneous records, independently of any information on previous records.

The PMCC method is based on this principle to perform fine detection on short-duration recordings (a few signal periods). To avoid interference due to large random signals on certain sensors, and to avoid ambiguity problems when correlating the records made on sensors that are very far apart, the process is again progressive. The study is initialized on a sub-network R_n with n sensors. The consistency of the set of delays obtained using all the sensors of R_n is defined as the mean quadratic residual of the closure relations :

$$C_n = \sqrt{\frac{6}{n(n-1)(n-2)} \sum_{i>j>k} r_{ijk}^2} \quad i,j,k \in R_n$$
$$r_{ijk} = t_{ij} + t_{jk} + t_{ki}$$

If this consistency is below a certain thershold $C_{Threshold}$, a detection is observed on R_n. The attempts can be made to extend this detection to new stations. Again, to avoid ambiguity problems inherent in correlations of distant signals, the propagation information obtained on R_n is used to "direct" the search of other sensors. The delays measured on R_n can be used to estimate the propagation parameters of the detected wave, assuming it to be planar. Using these parameters, the value of the expected delay for a pair of sensors including one sensor of R_n and a new one outside R_n can be estimated. The new measured time delay corresponds to the relative maximum which is the closest to the computed value. The use of sensors increasingly far away, as long as the detection criterion is valid gives more and more precise parameters since the aperture of the network increases with each new sensor.

In the PMCC method, this processing is performed consecutively in several frequency bands and in adjacent time windows covering the whole signal. Each elementary detection is therefore defined by four parameters :

- the number of sensors in the final sub-network ;
- the associated consistency ;
- the detected wave velocity and azimuth.

In reality, a given wave can be represented by several elementary detections (corresponding, for example, to different frequency bands or to adjacent windows). Conversely, several waves with different parameters may

L.P. PERMANENT L.D.G. NETWORK

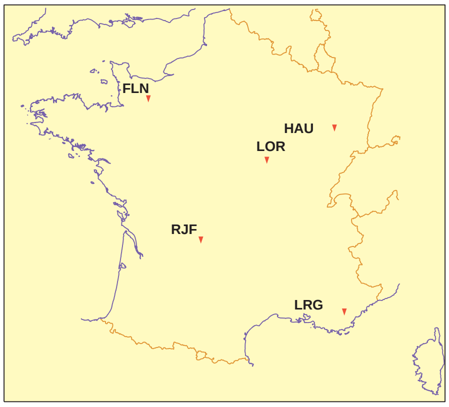

Figure 3 : Long-Period network operated by the LDG

coexist in the same time window but in different frequency bands. Each wave must be identified separately. To do this, a nearest-neighbour search method, which forms aggregates of elementary detections in the (t,f,V,θ) domain, is used. In this domain, a weighted distance is used to connect all the close-enough points :

$$d(p_1,p_2)=\sqrt{\left(\frac{t_2-t_1}{\sigma_t}\right)^2+\left(\frac{f_2-f_1}{\sigma_f}\right)^2+\left(\frac{V_2-V_1}{\sigma_V}\right)^2+\left(\frac{\theta_2-\theta_1}{\sigma_\theta}\right)^2}$$

Weights can be adapted to each parameter.

Examples of data processing

The first example shown in figure 1 has been recorded on the GERESS mini-array set up in Germany (see figure 2 for description). It represents the signals of a regional earthquake which occured at roughly 360 km from the array. The signals of station A of the array is shown at the bottom of figure 1 (diagram **a**). This signal has been processed in the frequency band *[2;6] Hz* using a time step of *3* s and a frequency step of *1 Hz*. Diagram **e** and **d** show the number of sensors and the consistency in the final sub-array as a function of time and frequency. Using the detection criteria on these two parameters, the corresponding propagation parameters are displayed on diagram **b** and **c** (velocity and azimuth respectively), only in case of detection. The automatic adaptation of the array to the recorded signals is clearly seen on this example : the *Pn* and *Pg* waves, which are very stable on the array are detected using a large number of sensors. At the opposite, the *Lg* wave train can be efficiently detected on a limited number of sensors, close enough to be undisturbed by local heterogeneities. It shows also that some discrepancies are measured in the azimuths of the *Pn* and *Pg* waves (about 8 degrees).

The second example has been recorded on the permanent long period network set up in France by the Laboratoire de Détection et de Géophysique (figure 3). It represents the signals of the large deep event which occured below Bolivia on June 6, 1994 (figure 4). Diagrams **b** and **c** represent the velocity and azimuth as a function of time and frequency. Direct body waves can be seen at the beginning of the records. In the coda of the Rayleigh wavetrain wave packets are detected with high phase velocities and opposite azimuth. These waves can be interpreted as the overtones of the R2 Rayleigh wavetrain. Despite the low signal-to-noise ratio due to the complexity of this part of a long period record, these waves can be automatically detected and analysed without ambiguity.

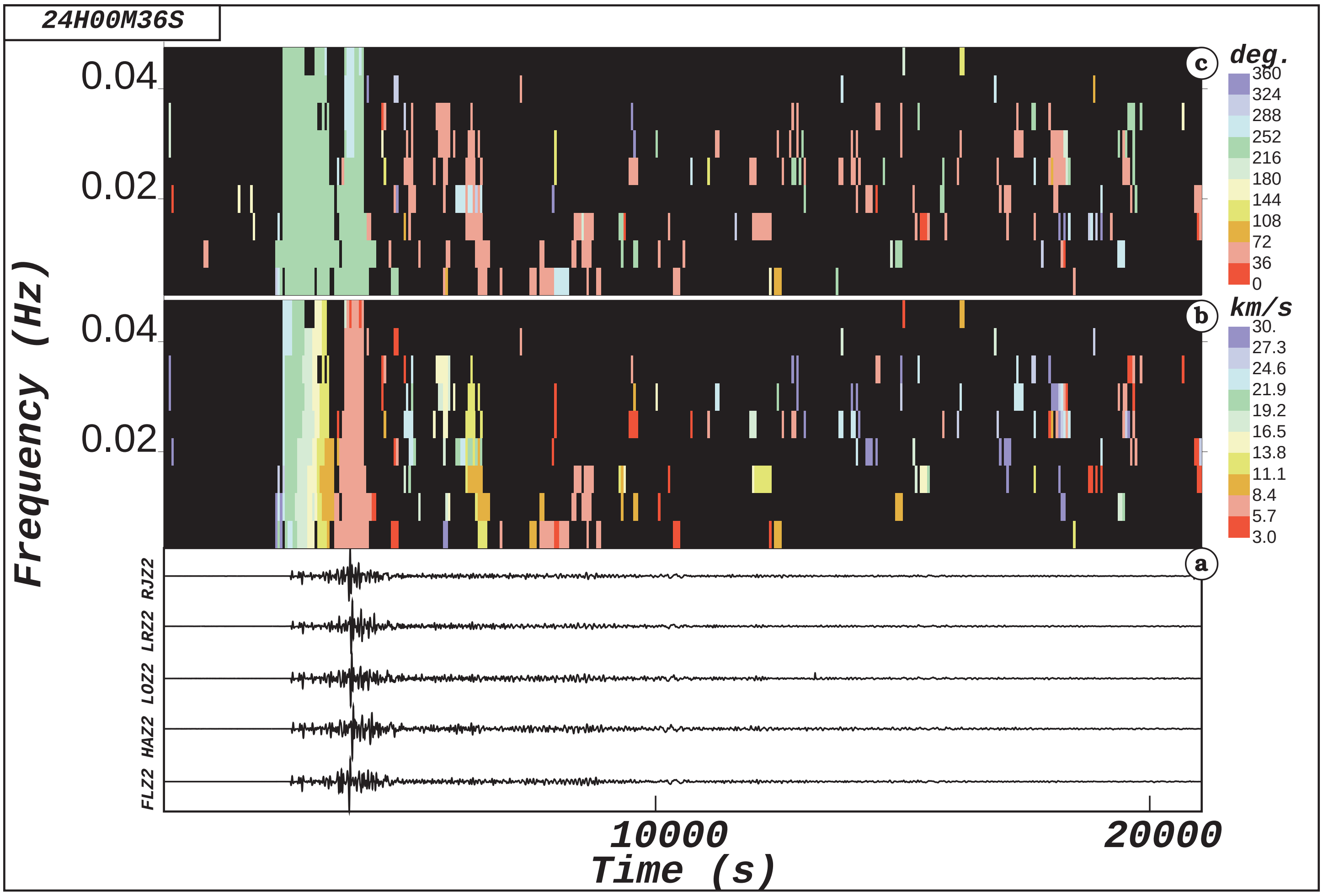

Figure 4 : Example of processing for the Bolivia event of June 6, 1994

ESMC STRONG MOTION DATABASE: WWW INTERFACE

Alexander Mikoyan, Alexei Burtsev, Alexei Gvishiani, Mikhail Zhizhin
GGDS UIPE RAS : http : // www.wdcb.rssi.ru/CGDS/.
P/O box 23, Moscow 109651, Russia

One of the major tasks for the Center of Geophysical Computer Data Studies (CGDS) of Joint Institute of Physics of the Earth RAS is the development of the world-wide Strong Motion Database (SMDB). At the 1994 EMSC General Assembly in Rome, the development of this database was also defined as the major activity of the CGDS in its capacity of EMSC key nodal member.

Structure and contents of the SMDB for 1994 were described in detail in ((1(). In 1995 the database was significantly extended and made accessible on-line. In 1996 , the CGDS devoted considerable efforts to study, implementation and development of new methodologies for database creation, maintenance and access. The technologies shall now follow client/server approach and that of the World-Wide Web.

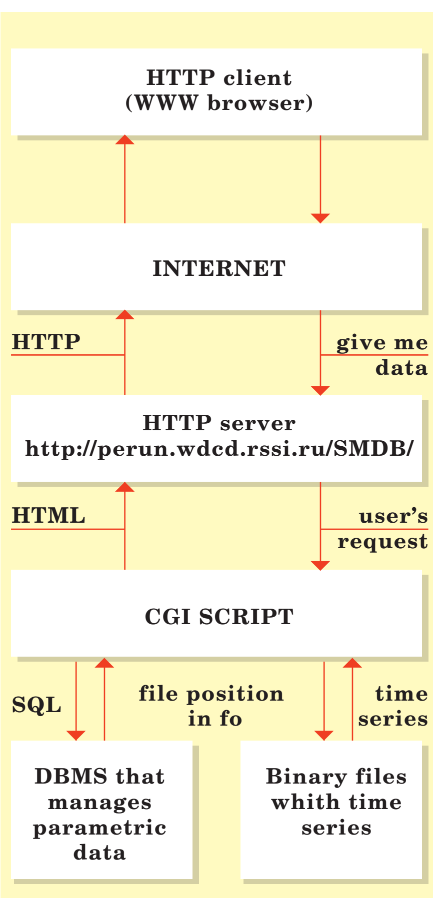

Figure 1 : SMDB data flow sketch

This will ensure the openness of that solution, upward compatibility with future improvements and computer platform independence, which are essential for data users. The preferable solution should be of low cost. It should also lead to the development of technology that can be easily adaptable to different tasks in database creation and management.

Here we describe such a solution that realises new interface to SMDB, which was built in 1996 using the above technologies.

Strong Motion Database : new interface, new features, new thinking.

The SMDB includes two types of data - parametric information on signals that for the database (waveforms, events, stations and recording instruments) and digital data for the time series themselves ((1(). The solution falls into three major parts (see Figure 1).

First, since the data transmission is conducted through HTTP (hyper-text transmission protocol) server, the client side only uses a WWW browser (or HTTP client), such as Netscape, Microsoft Internet Explorer or Mosaic. An essential requirement for such browser is that it should support HTML (hypertext mark-up language) tables.

The data transmission is done by HTTP server, of which there is a broad variety, also distributed free of charge over the internet. We used one of the most popular servers known as Apache ((2(). It supports the requiered CGI (Common Gateway Interface) standard for programming.

At the second stage the parametric data are managed by SQL (Structured Querry Language) compatible database management software (DBMS)- POSTGRES95

It is available together with all necessary libraries that can provide interfaces with different programming languages, such as C, C++, PERL, TCL/TK ((3(). The structure of the parametric data follows ((1(), when data are stored in several relations, which can be joined together by using unique keys in SQL statements.

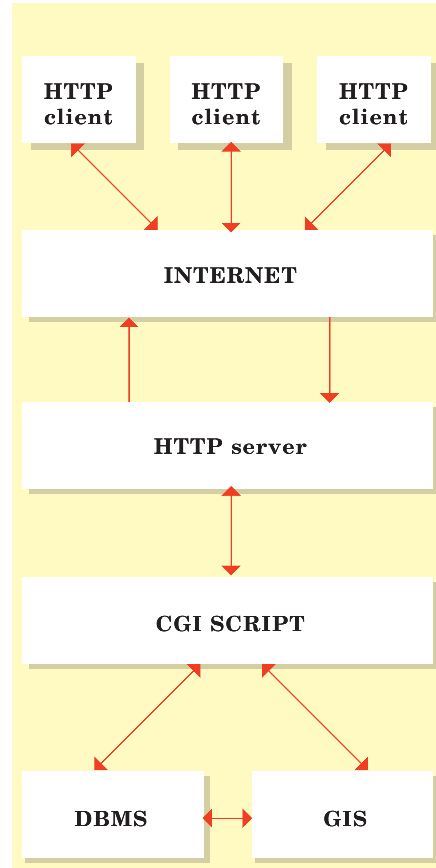

Figure 2 : Sketch of future information flow

The third major part consists of several CGI programmes (written in C, C++ and C shell) that interact between HTTP server, database management software and binary files with digital waveform data. These programmes make queries to the database, returning results in HTML format to be transmitted by HTTP server, dynamically create plots of the waveforms for the users preview, and make basic user authentication.

This scheme is invariant towards the software used, if it meets the above requirements. Should another DBMS be used, only a small part of CGI programmes has to be changed.

How to access the SMDB through WWW.

The Internet address for the SMDB is http://perun.wdcb.rssi.ru/SMDB
Users can query the database by filling the dynamically created HTML forms in their standard WWW browser and submitting them to the HTTP server. The latter passes these forms on to the CGI programme that creates the appropriate SQL statement. This statement is then forwarded to the DBMS. The results of the query are passed in the opposite direction.

Users from all over the Internet can employ different selection criteria, retrieve values for different fields, preview drawings of the waveforms with no restrictions. However, one can access the time series by logging with oneís password.
More CGI scripts will come to perform Fourier transform and sonogram calculation on request (4).

SMDB : future development

The next steps are planned to be made towards the usage of Java technology as a platform independent programming language and of Geographical Informational Systems (GIS) (see Figure 2).
The employment of Java technology will improve user interface, provide better opportunities for data processing, and facilitate handling of dynamic objects such as 2-3D simulation. GISs will allow users to deal also with spatial data, dynamically created vector and pixel maps while analysing strond ground motion information.

TABLE 1.

Region	Records/ components	On WWW	Events	Stations	M	R, km
Russia	610	+	56	36	3.1-7.2.	4-126
China	413	+	31	14	3.2-7.8	7-154
Japan	177	+	53	39	4.7-7.9	3-319
Peru	30	+	7	5	5.3-7.8	73-372
Nicaragua	24	+	6	3	4.0-5.6	5-32
Russia in progress	462	-	-	29	4.4-7.8	4-800
Greece in progress	267	-	70	44	3.5-6.7	3-69
United States	2024	-	89	232	3.0-7.7	2-223
Italy	1132	-	68	96	3.0-6.5	1-192
Mexico	281	-	6	32	up to 8.1	21-385
Total	**4900**	**1254**	**316**	**486**	**3.0-8.1**	**1-800**

M-range of magnitudes ; R - range of epicentral distances

Conclusions

New WWW interface to the Strong Motion Database, allows faster, more descriptive and efficient access to the data. The contents of the SMDB on October 1996 are represented in the Table 1. The new Russian and Greek data were included into the data base during 1996. Users can use software available in all computer platforms and they can access the database from anywhere in the world using global computer networks.

REFERENCES

1. **M. Zhizhin, A. Gvishiani, A. Mikoyan,** European-Mediterranean Seimological Centre, Newsletter, N°.6, December 1994.

2. Apache server source, binaries, and documentation are available at **http://www.apache.org/.**

3. The complete POSTGRES95 source, binaries, and documentation at **http://ftp.ki.net/postgres95/.**

4. **A.D.Gvishiani, M.N.Zhizhin, A.N.Miloyan, J. Bonnin & B. Mohammadioun** “Syntactic Analysis of waveforms from the world-wide strong motion database”, in proceedings of the fifth SECED conference “European Seismic Design Practice : Research & Application”, edited by A.S. Elnashai, 1995.

The ORFEUS page

NEW DEVELOPMENTS AT ORFEUS

ORFEUS and its Data Center are significantly improving its services. As of January 1, 1997 Torild van Eck left Utrecht University to join the ORFEUS staff as General Secretary, thus increasing the ORFEUS staff to three members.

Firstly, ORFEUS has new web pages (http://orfeus.knmi.nl). New developments will be announced on its pages 'What's New'. The present pages offer a number of new features:

1. improved on-line data access with:
   a. SPEED, an acronym for Selection Procedure for Extracting Earthquake Data. This allows on-line selection and downloading of SEED event volumes.
   b. AutoDRM selection form,
   c. Spyder(TM) data,

Please, let us know your criticism, comments, suggestions, etc on these extended services (dost@knmi.nl).

2. Web pages for three working Groups (see below).
3. ORFEUS seismology-links page. We would appreciate if you contact us (eckvan@knmi.nl) for errors or suggestions on improvement.

4. An ORFEUS software library is under construction. This is a new initiative in which we aim at gathering freely available software for seismologist and making it freely accessible through anonymous ftp. This will be done through maintaining mirrors and acquiring software. We would appreciate your ideas and suggestions on this initiative (eckvan@knmi.nl).

Secondly, ORFEUS started three new working groups, namely:

1. Broad-Band station siting with Jan Zednik at Charles University, Prague as coordinator. This working Group provides an inventory of the Broad-band stations in the European-Mediterranean Area. Please, check the inventory and contact Jan Zednik (jzd@ig.cas.cz) for corrections, etc.

2. Technical support group for broad-band seismometer users, which intends to gather and disseminate information on broad-band seismic equipment (hardware and software) installation advice and guidelines, maintenance and data handling. This group counts 7 members and is coordinated by Jeannot Trampert at the University of Utrecht and provides documentation and advice. Queries can be forwarded to this group through "orfeus.wg2-l@knmi.nl".

3. Mobile seismograph stations with Hanneke Paulssen (paulssen@geof.ruu.nl) as coordinator. This group intends to provide an actual inventory of mobile (broad-band) seismograph equipment. It also aims at gathering and making available information and publications about on-going, finalized and planned projects involving mobile equipment. We would appreciate your contribution (eckvan@knmi.nl).

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MEDITERRANEAN NETWORK: STATUS REPORT

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MEDNET is a network of very-broadband seismographic stations installed in Countries of the Mediterranean region (Boschi and Morelli, 1994). The project is coordinated and operated by ING, with strong cooperation ties with local seismological Institutions in other Countries and with other international programs. Financial contribution for all stations in developing Countries came from World Laboratory, Lausanne, a non-governmental organisation. Other stations are co-operated with University of Trieste (TRI, new location for the station TTE since may 1996), GEOFON (ISPK); station SSB belongs to the GEOSCOPE network but also hosts a MEDNET data logger. Station TNV (Antarctica) is funded by the National Antarctic Program (PNRA). Data processing software has been developed at USGS Albuquerque Seismological Laboratory. The network (see cover page) now lists 16 active stations, and one temporarily closed (MEB). Plans for the immediate future include installation of stations at Calitri (southern Italy). Stations accessible through telephone lines are automatically contacted daily for state-of-health controls, and to retrieve triggered data. Four stations (AQU, VSL, BGY, and the MEDNET channel at SSB) are also included in the Spyder system. All data flows to the FDSN and ORFEUS Archives where they can be automatically retrieved; requests for continuous data are also processed by our data center. Event data can be found on FDSN and ORFEUS CD-ROMs. More information on MEDNET can be accessed through the World Wide Web at: http://bounty.ingrm.it.

Station	Country	Code	Latitude	Longitude	Operator	Since
L'Aquila	Italy	AQU	42.35	13.40	MEDNET	AUG88
Beograd	Serbia	BGY	44.80	20.52	MEDNET	MAR91
Bardonecchia	Italy	BNI	45.05	6.68	MEDNET	APR95
Carovilli	Italy	CII	41.72	14.30	MEDNET	OCT94
Gafsa	Tunisia	GFA	34.34	9.73	MEDNET	JUN89
Anogia	Crete, Greece	IDI	35.28	24.89	MEDNET	JUL94
Isparta	Turkey	ISPK	37.80	30.50	GEOFON-MEDNET	OCT96
Kottamya	Egypt	KEG	29.93	31.83	MEDNET	DEC90
Midelt	Morocco	MDT	32.82	-4.61	MEDNET	NOV89
Medea	Algeria	MEB	36.30	2.73	MEDNET	MAY92-AUG94
S.Sauveur	France	SSB	45.28	4.54	GEOSCOPE-MEDNET	JUN91
Tirana	Albania	TIR	41.35	19.87	MEDNET	JUN94
Terra Nova Bay	Antarctica	TNV	-74.70	164.12	PNRA-MEDNET	JAN89
Trieste	Italy	TRI	45.71	13.76	UT/OGS/MEDNET	MAY96
Trieste	Italy	TTE	45.66	13.79	UT/OGS/MEDNET	JAN91-MAY96
Villasalto Suergiu	Italy	VSL	39.50	9.38	MEDNET	JUL89
Vitosha	Bulgaria	VTS	42.8	23.0	MEDNET	MAY96
Wield Dalam	Malta	WDD	35.8	14.5	MEDNET	JUL95
Calitri	Italy	?	40.9	15.4	MEDNET	Planned

Reference : Boschi, E., & A. Morelli, The MEDNET Program, Annali di Geofisica, 37, 1066-1070, 1994.

FORUM

CHANGES IN STAFF AT THE EMSC

Most of the EMSC Newsletter readers know Frédéric Ramon. Frédéric has been in charge of data exchange / database management at the EMSC over the last 2 years. He has recently moved on to a new job, working for a company specializing in computing and database management. We would like to thank him for his dedication and friendliness. Frédéric did a great job at answering requests for data and helping out in software development. We wish him good luck in his new position.
Yann Breton will replace him as of September. Yann, after graduating in geophysics from the Institut de Physique du Globe in Strasbourg, has recently completed a one-year degree from ENSIMAG, a computing shool in Grenoble. In the mean time, Régis Le Dren, a software engineer who was hired in the framework of the EC project "A Rapid Warning System for Eathquakes in the European-Mediterranean Region", has taken responsibility for data management at the EMSC.

WORKSHOP INFORMATION

SHALHEVEHT FREIER INTERNATIONAL WORKSHOP ON ADVANCED METHODS IN SEISMIC ANALYSIS

First Seminar: High precision hypocenter location and Seismic Tomography
Date : January 12-15, 1998
Venue: Dead Sea, Israel

The workshop will focus on advanced topics in seismic tomography and precise hypocenter location from local, regional, and teleseismic perspectives. Recent research developments will be presented along with applications in different parts of the world. Special emphasis will be placed on algorithmic aspects of hypocenter location and tomography and on applications to the Middle East.

The conference will take place in Israel at a hotel on the shore of the Dead Sea. The Dead Sea, the lowest place on the face of the earth, is a uniquely interesting geological site and is also active seismically. It is a quiet area, removed from the major population centers in Israel. However, it is easily accessible (about 40 km from Jerusalem) and can serve as a base for reaching many of Israel's fascinating historical and archaeological sites.

We will organize trips for participants, both before and after the workshop, subject to interest. We will also organize activities and trips for accompanying persons.

Keynote addresses will be made by Prof. Cliff Thurber (U. of Wisconsin), Prof. Edi Kissling (ETH Zurich), Dr. Wim Spakman (U. of Utrecht), Dr. Robert Engdahl (USGS), Dr. Harley Benz (USGS), Dr. Nitzan Rabinowitz (NDC, Israel), Dr. Abraham Hofstteter (GII, Israel), and several other invited lecturers. Discussions in general audience and in groups will play an essential role in this workshop. Contributions by young researchers are welcome.

Participants are invited to submit short presentations and/or to bring recent posters.

If participation in the workshop might interest you, please contact Dr. Nitzan Rabinowitz, head of the scientific program, as soon as possible at :
Dr. Nitzan Rabinowitz, National Data Center, SOREQ NRC, Yavne 81800, Israel
tel: +972-8-9434213 , fax: +972-8-9434171 email: workshop@ndc.soreq.gov.il

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