ROMANIAN ACADEMY

ROMANIAN NATIONAL COMMITTEE
OF GEODESY AND GEOPHYSICS

NATIONAL REPORT

ON GEODETIC AND GEOPHYSICAL ACTIVITIES IN ROMANIA

2003 – 2007

Prepared for the XXIVth IUGG General Assembly
PERUGIA - ITALY
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Bucharest
2007

FOREWORD

The National Report of the Romanian Committee of Geodesy and Geophysics (RNCGG) prepared for the XXIV-th General Assembly of IUGG aims at presenting the main directions and results of newly initiated and/or developed scientific researches of Romanian geoscientists, corresponding to the component associations, regarding the interdisciplinary study of the planet Earth.

In the framework of this volume, each section of the RNCGG has displayed, under the guidance of the national correspondents, the involvement of Romanian scientists and specialists in major national (especially in the frame of the National Programme of Research of Excellence - CEEX) and international research projects (especially in the frame of the FP 6 Programme), the organization of significant conferences and symposia, as well as the main topics discussed by the Romanian participants.

A selective bibliography is presented as an important part of every contribution within the National Report, allowing to those interested to continuously follow the development of the research projects as well as the involved working groups, in view of establishing contacts that we hope will prove to be mutually profitable in the next future.

This report, conceived as an ensemble that allows the interested reader to get an accurate image upon the activity in geodesy and geophysics in Romania, includes the interval 2003-2007, since the last IUGG General Assembly held in Sapporo, Japan.

The possibility of presenting a quite comprehensive volume is a consequence of the continuous improvements in the organizational policy of the RNCGG, by appointing a new national correspondent (IAMAS and IAHS) as well as new members and secretaries of the associations' committees. Significant efforts and dedicated work have been provided by Dr. Constantin Stefan Sava, RNCGG Secretary General and by all the associate editors. Their most important contribution is acknowledged and thanked.

The National Report represents also an homage to our dear professors and former presidents of the Romanian National Committee of Geodesy and Geophysics, founders of the Romanian school of geophysics, Acad. Sabba S. Stefanescu and Acad. Liviu Constantinescu.

Prof. Dr. Dorel ZUGRAVESCU
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* passed away during the 2003-2007 period!

International Association of Geodesy

I A G ACTIVITIES IN ROMANIA

2003 - 2007

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- Scientific Bulletin, Technical University of Civil Engineering Bucharest
- Journal of National Center for Geodesy, Cartography, Photogrammetry and Remote Sensing

Section I: Positioning and Reference Frames

1. Background

The economic and political situation in Romania for the time interval 2003-2006 influenced the developments in the geodetic and geophysics activities. Positive trend of the Romanian economy and the integration into the European Union are the most important events with benefit for the new start of research including geosciences.
The professional bodies were reorganized and for geodetic activities the Geodesists Order was created by Law 17/2006 for organizing the geodesists profession according to the Law 7/1996 – Cadastre and Real Estate law.
The National Office for Cadastre, Geodesy and Cartography was reorganized by Government decision no.1210/2004 into the National Agency for Cadastre and Land Registration (NACLR) including the land registration activities from the Ministry of Justice. National Agency for Cadastre and Land Registration it is a self financing public institution under Ministry of Administration and Interior. It includes the national mapping activities and 42 Cadastre and Land Registration Offices. As research and production institution the Institute for Cadastre, Geodesy, Cartography, Photogrammetry was reorganized as National Centre for Geodesy, Cartography, Photogrammetry and Remote Sensing under NACLR.

2. Global Navigation Satellite System (GNSS) Network

According to the global and European trends in the field of modern geodetic networks, Romania followed this trend by promoting and implementation of a new high accurate geodetic network in the time interval 2003-2007. The new geodetic network it is build as an active continuously operating network. As technological equipments the GNSS (GPS and GPS+GLONASS) receivers are included into the network.

Starting 1999, when it was installed the first GPS permanent station in Romania at the Faculty of Geodesy/ Technical University of Civil Engineering Bucharest (BUCU) in cooperation with Federal Agency for Cartography and Geodesy Frankfurt a.M. (Germany), the new methods of global satellite positioning were introduced also in Romania.

In 2001 the National Office for Cadastre, Geodesy and Cartography (reorganized in 2004 as National Agency for Cadastre and Land Registration) installed 5 GPS permanent stations in Braila, Suceava, Cluj, Sibiu, Timisoara (BRAI, SUCE, CLUJ, SIBI, TIMI) as a necessity for the precise geodetic measurements in the area.

Romania as a CERGOP (Central European Regional Geodynamic Project) country member installed two GPS permanent stations in Craiova and Constanta in 2004 (CRAI, COST).

In 2005 the continuously modernization of the National GPS Permanent Network consisted in the installation of 5 new GPS permanent stations in Bacau, Deva, Baia Mare, Oradea and Sfantu Gheorghe (BACA, DEVA, BAIA, ORAD, SFGH).

At the end of 2005 the Romanian GNSS permanent network included 12 GPS permanent stations installed by the National Agency for Cadastre and Land Registration (NACLR) and one GPS permanent station installed at the Faculty of Geodesy Bucharest. The EUREF(EPN) station BUCU was introduced into the IGS network since 2005.

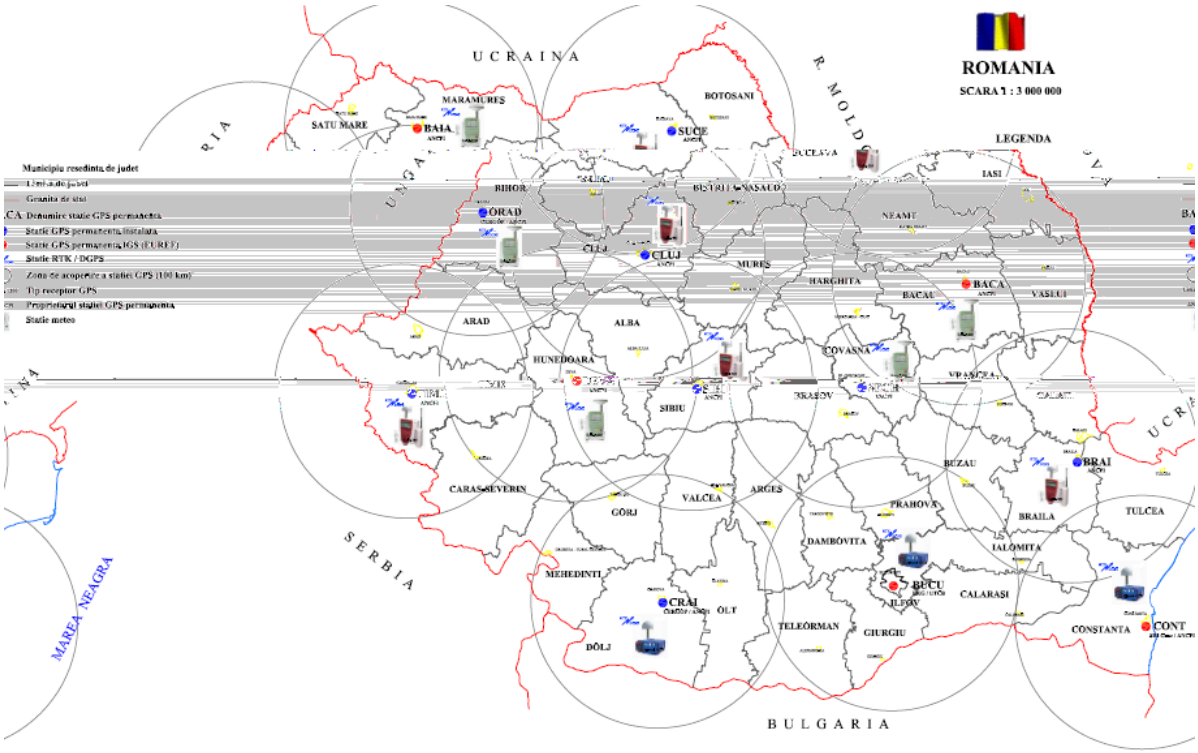

Figure 1. Romanian National GPS Permanent Network – 2005

In January 2006, the NACLR integrated in the EUREF-EPN (European Permanent Network) 4 new GPS permanent stations: BACA, BAIA, COST and DEVA as a contribution to the European reference frame maintenance and other special projects.

The EUREF-EPN GPS station in Constanta (COST) it is located near to a tide gauge and it is connected with this by precise levelling. It was proposed as ECGN (European Combined Geodetic Network) station.

The accuracy for the coordinates of the stations are better than +/- 1cm.

The next table presents the main national and international project with Romanian GNSS permanent stations participation.

PROJECT	**N^{O}**	**STATIONS**
IGS	1	BUCU
EUREF-EPN	4	BAIA, BACA, COST, DEVA
CERGOP (1,2)	3	BRAI, BUCU, CRAI, CLUJ, COST,ORAD, SIBI, TIMI
National Network	13+ 15 (installed 04.2007)	BUCU, BRAI, BAIA, BACA, CLUJ, COST, CRAI, DEVA, ORAD, SFGH, SUCE, SIBI, TIMI + ALEX, ARAD*, BIST, BUZA, CIUC, FOCS, IASI, MURE, PINT, RESI, SLOB, TARG, TJIU, TULC, VALC

* - to be installed in August 2007

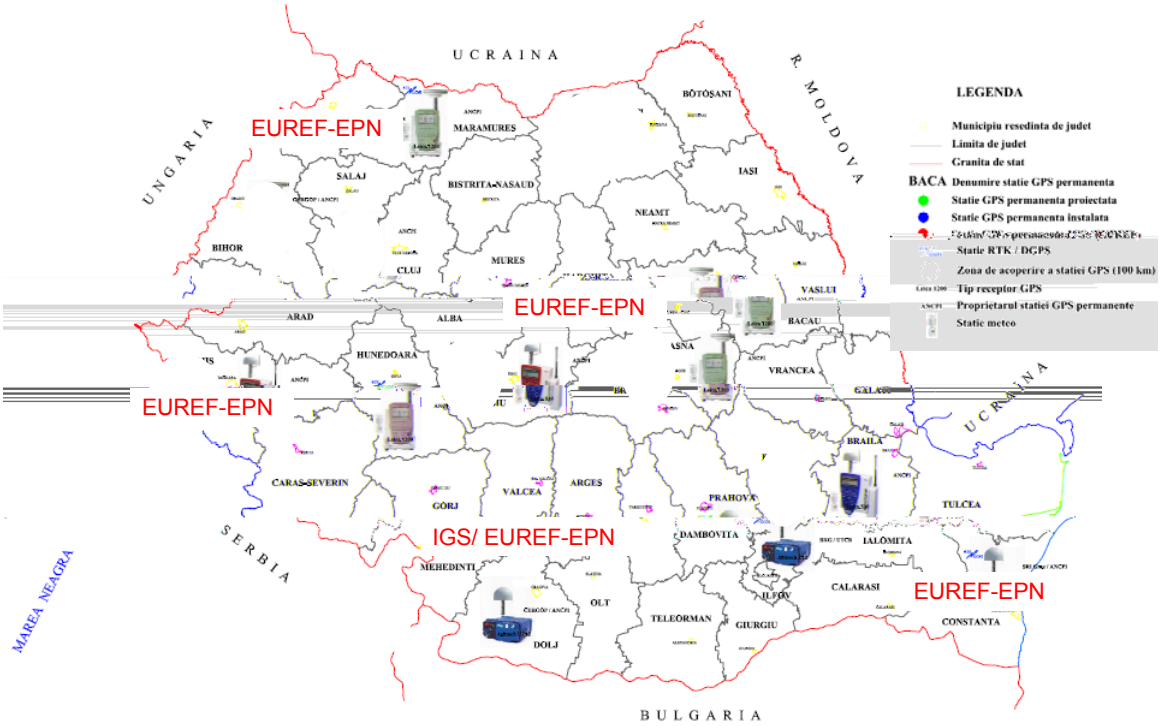

Figure 2. IGS and EUREF-EPN stations in Romania (Bucu, Baia, Baca, Cost, Deva)

The National (GNSS) Geodetic Network was proposed to be divided into “Classes” to be separated from the old triangulation network divided in “Orders”. The proposed classes and present status are presented in the next table.

	NO. OF STATIONS	CLASS TYPE	PRECISION	ELLIPSOIDAL HEIGHTS	NORMAL HEIGHTS
CERGOP points	8	AA	+/- 5mm	Yes	No
GPS permanent stations	28	A	+/- 1cm	Yes	Yes*
Ground points	306	B	+/- 2cm	Yes	Yes*

* partial

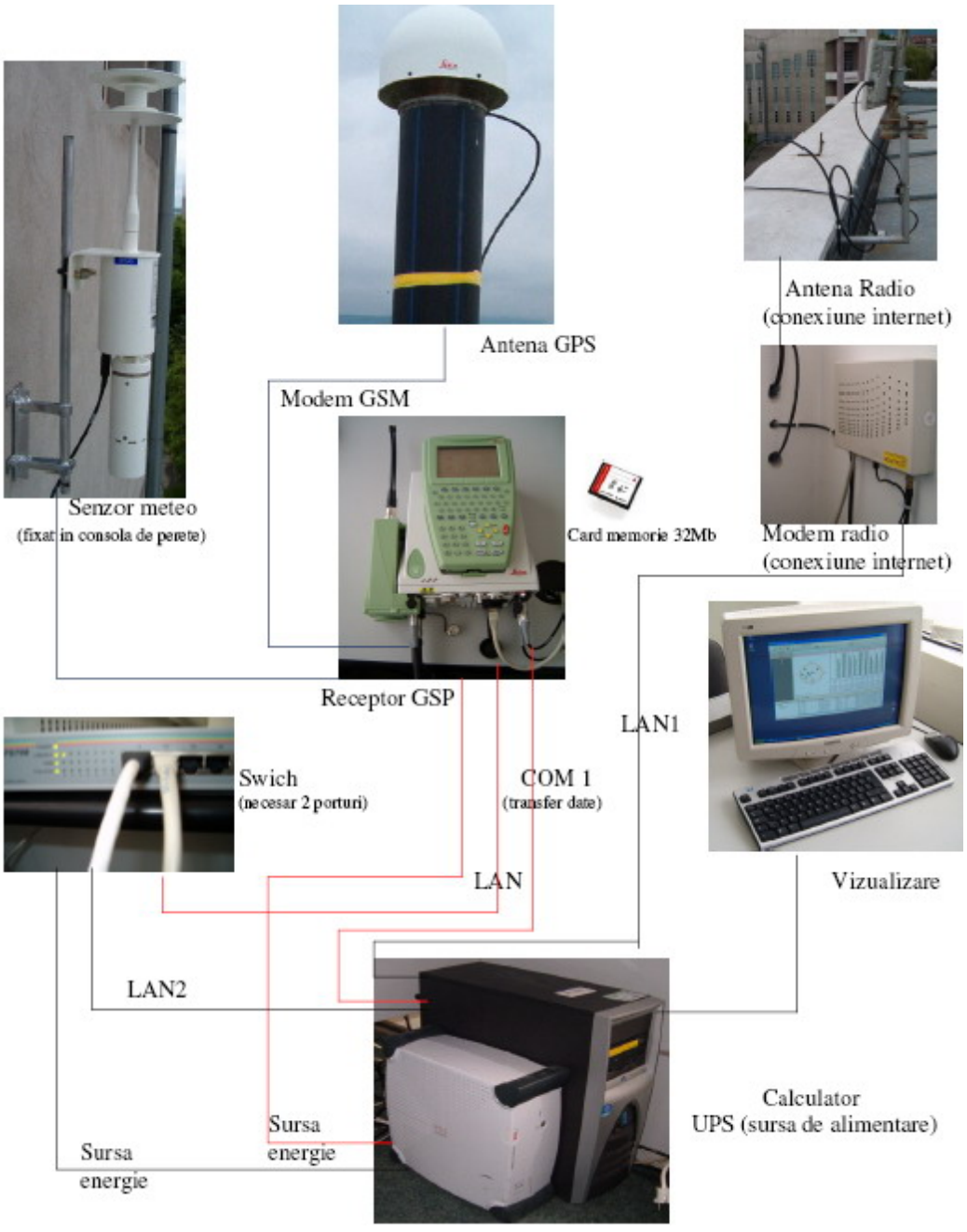

Figure 3. Typical GNSS permanent station equipments

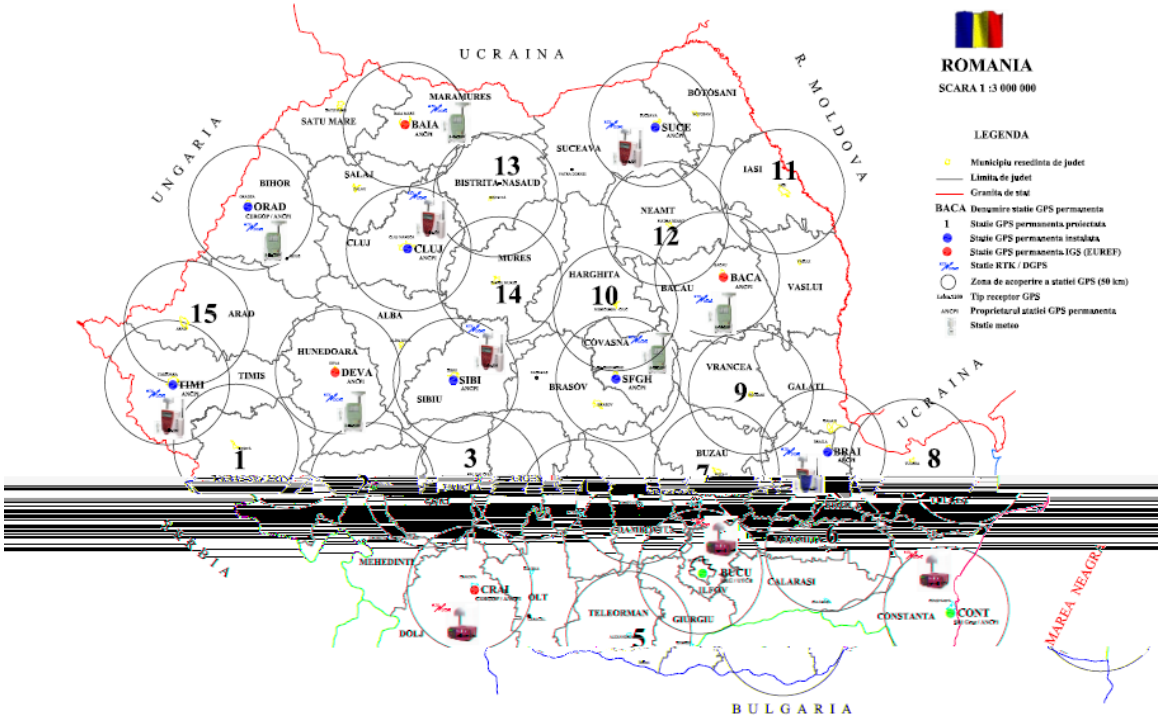

Figure 4. Romanian National GPS Permanent Network – 2007

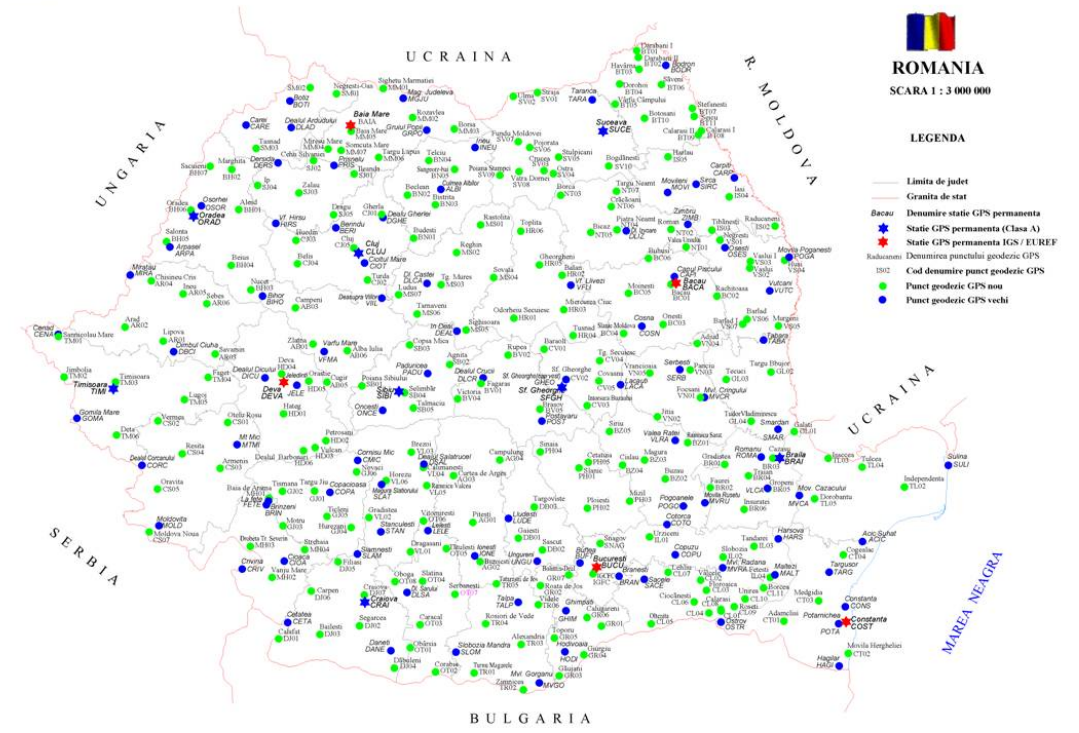

Figure 5. National Geodetic Network (GPS) – 306 points

Class B network was observed in 2003 and the results were included into national database in 2005. From the total number of stations about one third have geometric leveling. A number of 86 stations are old triangulation markers observed by GPS with coordinates in national geodetic reference system (Krasovski ellipsoid and Stereographic 1970 projection system). The Class B network was constrained on the Class A network. The precisions for the coordinates of these stations are about +/- 2cm.

GNSS technology for disaster management

In 2006 on the Danube the most significant floods in the last century damaged a the river surrounding areas including Romania. National Agency for Cadaster and Land Registration (NACLR) supported by GPS observations and leveling 3D positioning in the flooded area. Topographic and geodetic determination for flooded areas included mainly the accurate heights determination for the Danube level and surrounding areas. Rapid data transmission and data processing were necessary. Transformation from one reference system (ETRS89) to another (national reference system), plotting and interpretation together with other involved institutions and government bodies were necessary. The technology included GPS receivers, total stations (EDM), levels, laptops, staff, engineers, technicians, pilots, drivers etc. The main task of the geodetic services was the fast delivery of accurate and reliable results, especially heights. Special projects were performed in countys as Dolj, Calarasi, Giurgiu, Ialomita, Braila, Tulcea et. al. along the Danube. GNSS technology provided a great support in disaster management and underlined the significant potential of this technology. Further improvement by use of DGPS/RTK capabilities were proposed to be implemented for a better response on emergency and disaster situations.

Figure 6. Flooded area on the Danube at Tulcea (NACLR, 2006)

Leveling Network

The national geodetic reference system includes the normal heights in Black Sea 1975 datum.
The characteristics of the National Leveling Network are:

- The National Leveling Network is divided in 5 orders function of precision. The National Leveling Network of Ist order consists in a number of 19 polygons with a length of 6600 km and includes 6400 points and a density of 1 point / km.
- The connections with the neighbor countries includes 24 lines: 2 with Ukraine, 1 with Republic of Moldova, 6 with Bulgaria, 10 with Serbia and Montenegro and 5 with Hungary.
  This network was densified till 32 polygons with levelling networks of II-V order.

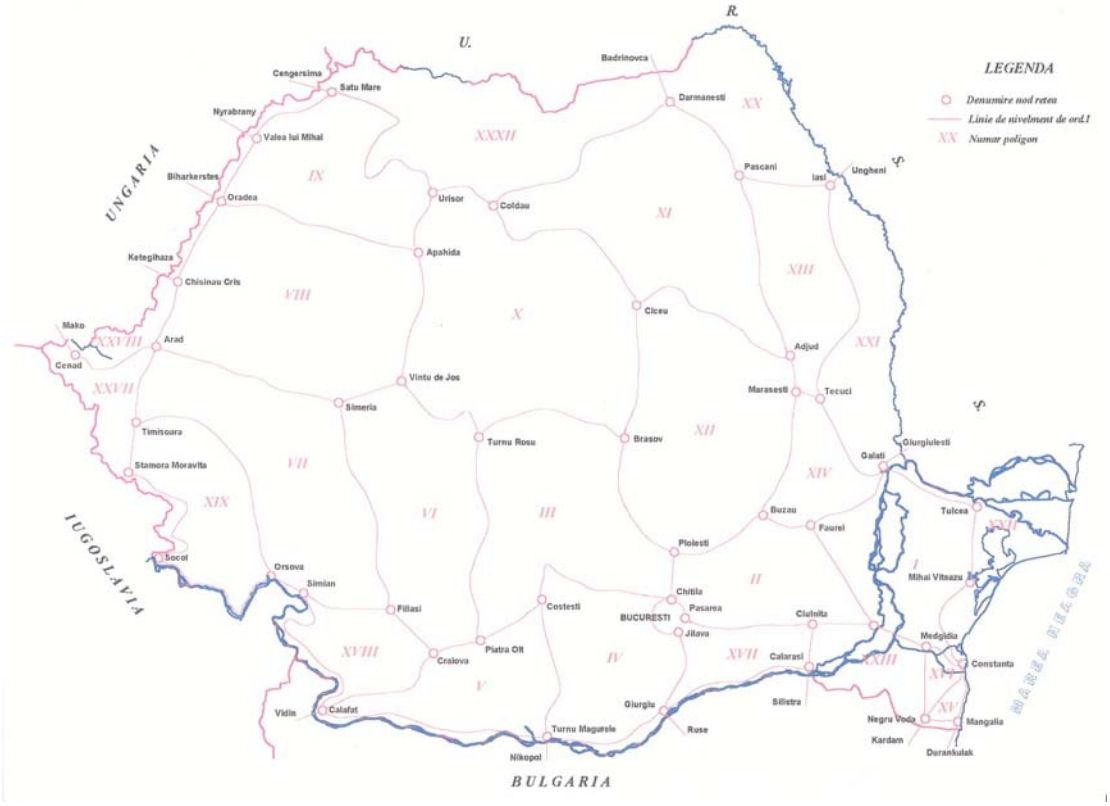

Figure 7. National Leveling Network

- The UELN network includes all the nodal points of the polygons of first order. For these points 89 observations and the normal heights in the national reference system for altitudes were transmitted to the UELN Data Centre.
- The EUVN Network contains 4 points from the Romanian leveling network : RO01 (Sirca-Iasi), RO02 (Constanta), RO03 (Timisoara) and RO04 (Tariverde – Height 0) points measured with GPS technology in 1997. For these points there are known the coordinates in ETRS89 and normal heights (precise leveling) in Black Sea 1975 datum.

Contents of the UELN/EVS - Data Base

Country	Number of Nodal Points	Number of Obser-vations	National Heights Available	Whole First Order Network	Epoch of Obser-vation	Epoch of each Meas. known	Year of Input in UELN	Kind of Obser-vations	Further Epochs
Romania	65	89	x	x	1974-1986	x	1999	ΔC, Δh	

- Other about 40 GPS Class B points were observed by geometric leveling at the beginning of 2007 and data was delivered to EUREF (EUVN_DA project) in order to strengthen the EGG97 model in Romania.

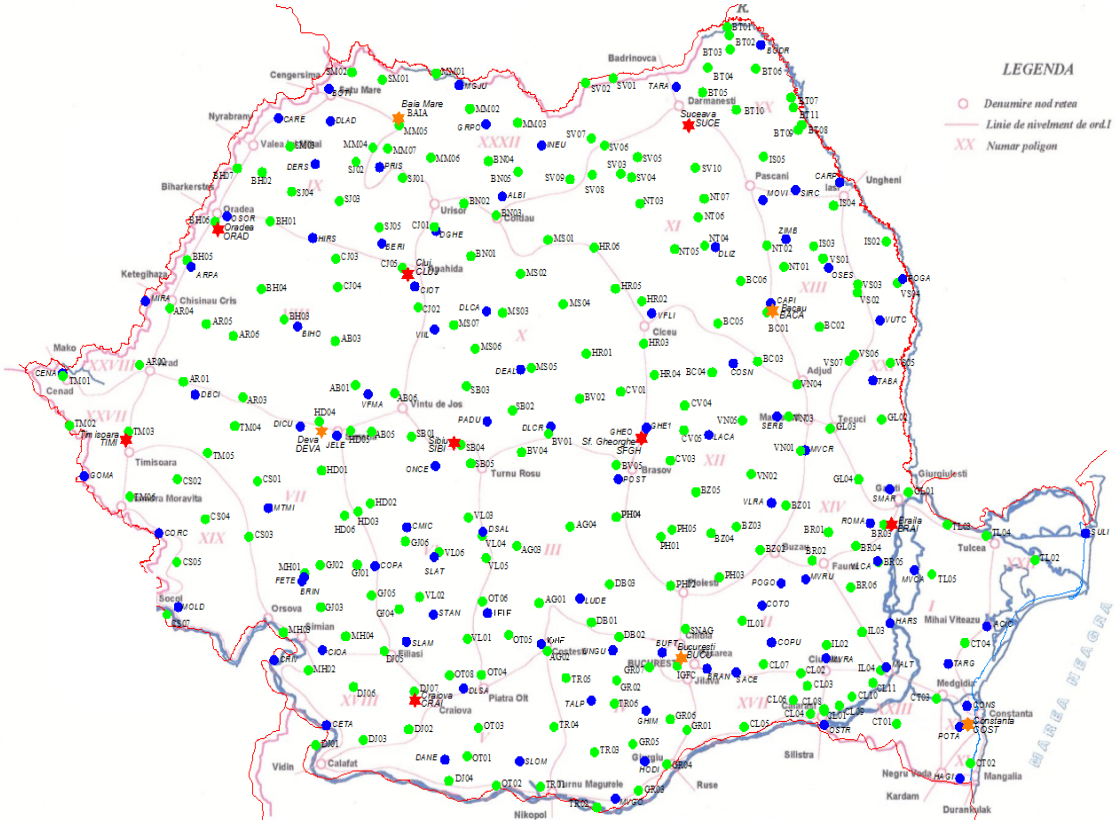

Figure 8. Class B Network including triangulation sites (in blue)

- This year the National Agency for Cadaster and Land Registration will introduce officially the results of a new adjustment of the leveling network performed by National Center for Geodesy, Cartography, Photogrammetry and Remote Sensing and Technical University of Civil Engineering as “Black Sea 1975 datum (Edition 1990)”.

- The EUREF-EPN permanent station in Constanta was connected in 2004 by precise geometric leveling with the two tide gauges close to the Black Sea – the old (analogue) and the new (digital) tide gauge maintained by the National Institute of Researches and Sea Developments “Grigore Antipa”.

- The GNSS permanent stations in Romania will be connected by leveling with the national leveling network. Around each station 3 stable ground control markers will be installed for all stations in order to monitor the movements of the GNSS antennas installed on the buildings.

CERGOP (Central European Regional Geodynamic Project)

The main objective of the project is to monitor the recent crust movements, detecting the borders of the tectonic plates and quantifying their three dimensional rates. The objective is achieved especially by the use of GPS technology and other significant data sources. Romania participate at this project since 1995 by Technical University of Civil Engineering and National Centre for Geodesy, Cartography, Photogrammetry and Remote Sensing Bucharest (former Institute for Cadaster, Geodesy, Photogrammetry and Cartography) to the Work Package 10. „Geodynamics of Central Europe“, WP.10.2. *Three Dimensional Plate Kinematics in Romania*. The main tasks of the project are:

- Romanian geodynamic research integration with Central European research;
- Establishment of reference geodetic network for geodynamic – CEGRN – Central European Geodynamic Regional Network, with less than 1cm accuracy;

- Tectonic plate velocity estimation on Romanian territory by geodetic methods (GPS);
- Realization of the monograph of Romanian geotectonic components;
- New technologies and methods for geodetic data processing;
- Close cooperation with similar institutions from participating countries;
- Dissemination of research results by different means (publications);
- New research projects proposals on geodynamic.

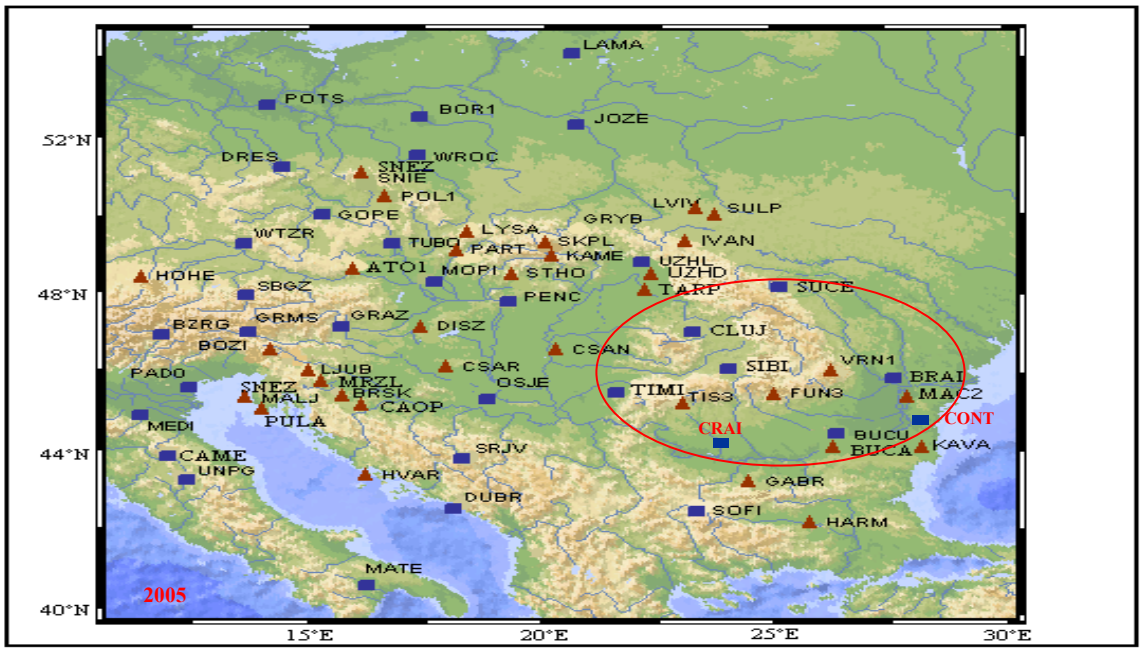

Figure 9. CEGRN network

- In the frame of the CERGOP a Central European Regional Geodynamic Network (CEGRN) was designed and realized including permanent and epoch stations observed by GPS technology. CEGRN was designed for geodynamic purposes (tectonic and geological position, markers, repeatability). The Coverage includes the Central Europe (CEI countries) and was observed yearly (1994-1997) and every two years after (1999 – 2005). CEGRN was continuously extended with new stations. The

CERGOP1	**(1994-1999)**			
Year	**Total no. of sites**	**No. of sites in Romania**	**GPS Observation interval**	**Epoch**
1994	30	-	2-6 May	1994.33
1995	41	8	29 May - 2 June	1995.41
1996	41	8	10-15 June	1996.45
1997	45	8	4-10 June	1997.43
1999	58	8+1*	14-19 June	1999.47
2001	55	2+1*	18-23 June	2001.49
CERGOP2	**(2002-2005)**			
2003	35+34*	5+5*+1**	16-21 June	2003.48
2005	> 70	5+7*+1**	20-25 June	2005.49
2007		*5+8*+5***	*June*	*2007.xx*

* EPN stations ** - non-EPN stations

- In the frame of CERGOP2 project the *„Monograph of geodynamics research in Romania – Vrancea region“* was elaborated and published by scientists from Geodynamic Institute of Romanian Academy, National Center for Geodesy, Cartography, Photogrammetry and Remote Sensing and Technical University of Civil Engineering. This monograph presents sub-regional geodynamical investigations in Romania.

The Collaborative Research Center (CRC) 461 “Strong Earthquakes - A Challenge for Geo-sciences and Civil Engineering”

The Collaborative Research Center (CRC) 461 “Strong Earthquakes - A Challenge for Geo-sciences and Civil Engineering” at the Universität Karlsruhe, Germany, and the “Romanian Group for Strong Vrancea Earthquakes”, Bucharest, collaborate since 1996 in a multidisciplinary attempt towards understanding Vrancea seismicity and mitigating seismic risk in Romania. The Collaborative Research Center (CRC) 461 is funded by the Deutsche Forschungsgemeinschaft (German Research Foundation) and supported by the State of Baden- Württemberg and the University of Karlsruhe. Collaborative Research Centers (**S**onder**F**orschungs**B**ereiche - **SFB**) aim at strategic research on issues that require intensive co-operation across various disciplines. CRCs form a framework for the development of these interactions and are expected to operate with a long-term (6 to 12 years) perspective. CRCs are peer-reviewed every 3 years. The CRC 461 has been established in July 1996. The CRC aims at strategic research in the field of strong earthquakes with regional focus on the Vrancea events in Romania. Key objectives of joint research activities are:

- Understanding of the tectonic processes that are responsible for the strong intermediate depth seismicity beneath Vrancea;
- Developing realistic models and predictions of ground motion;
- Prognosis of potential damage in case of a strong earthquake;
- Risk reduction by appropriate civil engineering concepts.

Specific goals for the period 2005 to 2007 are:

- Completion of methodology and data base for site-specific probabilistic hazard assessment and quantification of a geodynamic model of Vrancea earthquakes with thermo-mechanical numerical Finite Element modeling.
- Development of ground motion maps (Shakemaps) on urban and regional scale using neural net methods for the correlation of geological and seismological observations and considering liquefaction potential and other nonlinear soil behavior where applicable. Together with an improved Early Warning System key elements of an Earthquake Information System will be established.

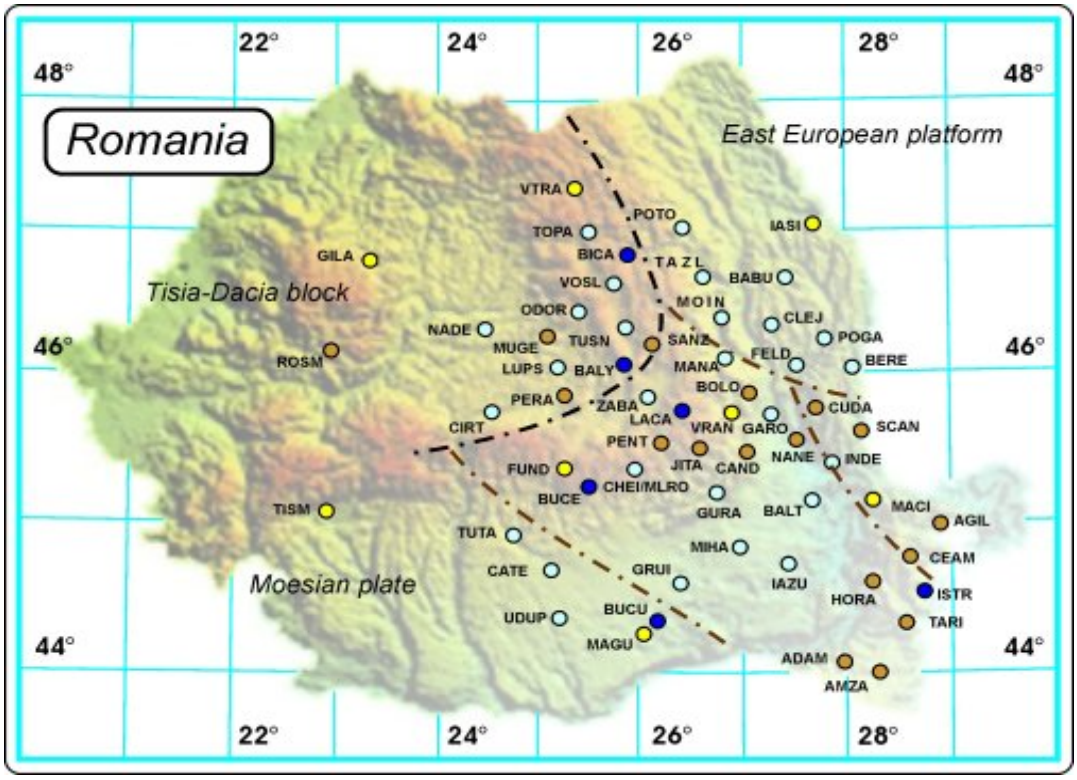

Figure 10. Map of the geodynamic network CRC 461

- Completion of the Disaster Management Tool (DMT) with additional modeling, decision support and communication components. It will become fully operational and will be tested in cooperation with the Romanian Civil Protection Command.

Specific efforts will be undertaken in order to ensure that results of the CRC will enter the Romanian earthquake mitigation effort. This requires an intense cooperation with Romanian colleagues and institutions. Documentation and dissemination of results, again as joint effort is a critical goal of the forthcoming years.

Section II: Advanced Space Geodesy

EUPOS (European Position Determination System)

Romania participate by National Agency for Cadaster and Land Registration at the EUPOS (European Position Determination System). The EUPOS initiative is an international expert group of public organizations coming from the field of geodesy, geodetic survey and satellite deployment. Partners from 15 CEE countries have come together with the aim to establish in their countries compatible spatial reference infrastructures by using the Global Navigation Satellite Systems (GNSS) GPS, GLONASS and as soon as available GALILEO by building up Differential GNSS *EUPOS* reference station services. The *EUPOS* services will allow a high accuracy and reliability for positioning and navigation and provide a wide range of geoinformation applications on this basis.

This fundamental infrastructure is based technically on a network of DGNSS reference stations and adequate communication lines. The data products can be used in many different applications requiring accuracy better than 3 m up to the 1 cm level in real-time and sub-centimetre

precision by post-processing. This “full scale accuracy” concept aiming all types of users from environmental protection, transport and public security, hydrography, maritime surveying, river and maritime traffic, fishing, machinery and vehicle control, to spatial data infrastructure developers and to geodesy. *EUPOS* is independent of private company solutions and uses only international and unlimited worldwide usable standards. In case international agreed standards do not exist, *EUPOS* is working on the standardization in the corresponding organizations like the Radio Commission on Maritime Services, Special Committee 104 (RTCM SC 104). *EUPOS* provides the GNSS observation data and real-time corrections for high precise positioning and navigation with guaranteed availability and quality.

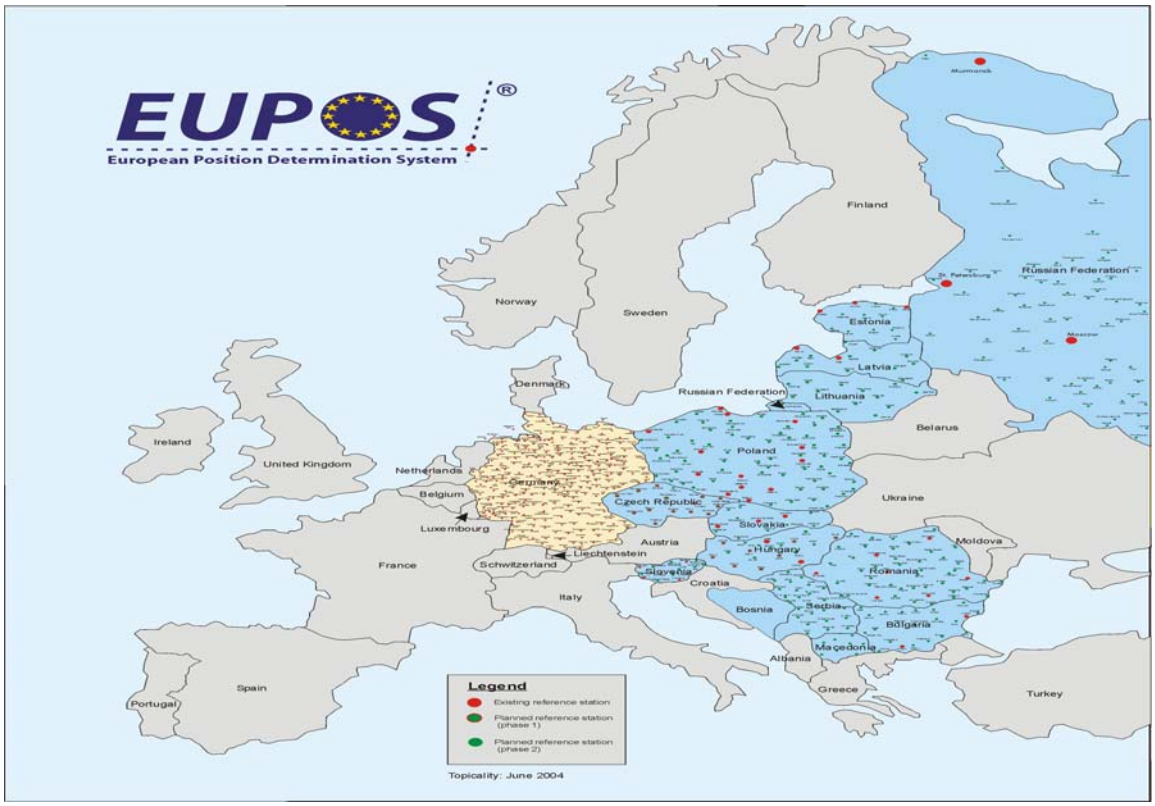

Figure 11. Distribution of EUPOS permanent stations (www.eupos.org)

The responsibility of developing and operating the *EUPOS* reference station network is distributed among participating organizations on national level, which give the characteristic flavor of the organization. The backbones of the developments are the International *EUPOS* Steering Committee (ISC) and the National Service Center (NSC) concept, that requires the establishment of a NSC in every participating country. The NSCs are responsible not only for network developments and operation, but they are the focal points of user information, quality and integrity assurance and international relations with other *EUPOS* countries. The International *EUPOS* Steering Committee decides and agrees the organisational and technical framework of *EUPOS*. The ISC Office (ISCO) at the Senate Department for Urban Development in Berlin/Germany is the central point of contact for interests of international importance.

With the creation of the European Terrestrial Reference System (ETRS 89) in 1989, a three-dimensional geodetic reference system became available for the whole Europe for the first time. Its spatial referencing connection is maintained up-to-date, notably through the EUREF Permanent Network (EPN), which contains the European stations of the International GPS Service (IGS). The ETRF base on the worldwide ITRF. *EUPOS* provides DGNSS correction data referred to ETRS.

Figure 12. ROMPOS Services

NACLR will implement in the next time the EUPOS services (ROMPOS) according to the EUPOS standards based on the improvement of the GNSS network up to 48 permanent stations with station spacing of about 70km.

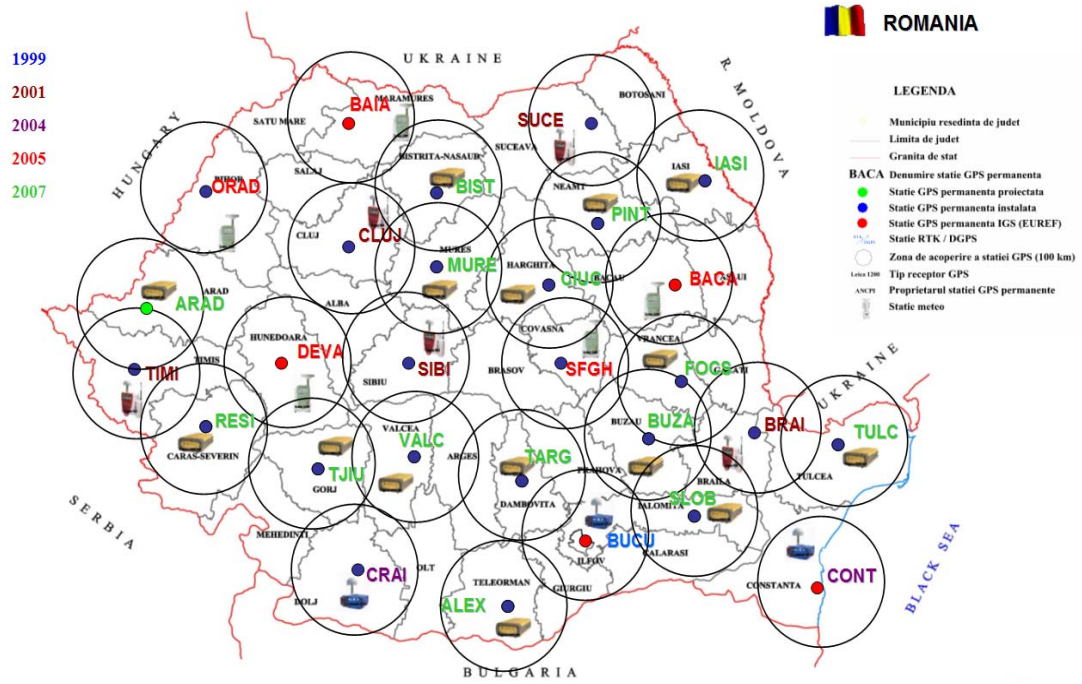

Figure 13. ROMPOS project status 2007 (28 stations; radius = 50Km)

GOCE (Gravity field and steady-state Ocean Circulation Explorer) mission

European Space Agency promote the GOCE (**G**ravity field and steady-state **O**cean **C**irculation **E**xplorer) mission dedicated to measuring the Earth's gravity field and modeling the geoid with

unprecedented accuracy and spatial resolution. This will be achieved by employing an Electrostatic Gravity Gradiometer (EGG), which consists of three pairs of identical ultra-sensitive accelerometers mounted on three mutually orthogonal 'gradiometer arms'.

Figure 14. GOCE satellite (ESA)

In addition, a GPS-based Satellite-to-Satellite Tracking System (SSTI) developed by Alcatel Alenia Space in Milan, has also been integrated into the satellite to provide accurate positioning of the satellite when in orbit. The last touch will be the completion of the Ion Propulsion Assembly integration and testing. The last touch will be the completion of the Ion Propulsion Assembly integration and testing. Additional testing will then be carried out prior to shipment of the satellite to ESA-ESTEC in the Netherlands in May - where the Gradiometer Core STM will be replaced by the Gradiometer Core PFM.

Unlike other spacecraft that act as a passive platform carrying various independent instruments, GOCE is unique because once the gradiometer and SSTI instruments are incorporated into the satellite, they becomes an intrinsic part of an integrated measurement and control system. With no moving devices, so that any 'false gravity readings' are avoided, the satellite and the system of sensors form one extraordinarily sensitive gravity-measuring device.

National Agency for Cadaster and Land Registration by Geodesy and Cartography Directorate under the EUPOS umbrella intends to participate starting with 2007 to the GOCE project. In April 2007, EUPOS consortium sent a research project proposal to ESA in order to support some experiments to validate and compare the new GOCE results with data field and to offer GNSS data for the accurate satellite positioning during the mission.

Section III: Determination of the Gravity Field

Gravimetric Network

The National Gravity Network of 1st and 2nd order (about 270 points) was observed by the Ministry of Defense – Topography and Cartography Directorate and there is not a public database available. Starting with 2006 year, gravity data are not classified information.

Gravity data at the present are not sufficient for the development of an geoid model with an accuracy of 10 cm or better. The EGG97 geoid model available from IAG was purchased by NACLR and tested in order to improve it locally by geometric method (local data and ellipsoidal heights from GPS).

Further efforts should be done for the modernization of the gravity network. The policy of the gravity network development needs to be clarified in the next time.

In 2004 for the EUREF-European Combined Geodetic Network (ECGN) project, The Federal Office of Metrology and Surveying (BEV – Bundesamt fuer Eich und Vermessungswesen) performed absolute gravity observations in Romania with an absolute gravimeter JILAg-6. The observations were made in Bucharest (Surlari), Iasi, Timisoara and Constanta.

Section V presents more detailed aspects of the gravity observations performed in Romania in the last time.

Section IV: General Theory and Methodology

The theoretical and practical aspects of the Geodesy as geoscience continued the evolution in 2003-2006 time interval. The uniform application of the new standards needed the elaboration of new methodologies for the success of the implementation. At the global level some standards organizations took the responsibility for the geosciences as **ISO (International Standards Organization).** In Romania the counterpart of the ISO it is **ASRO** (Romanian Standardization Association).

The International GNSS Service (IGS), formerly the International GPS Service, is a voluntary federation of more than 200 worldwide agencies that pool resources and permanent GPS & GLONASS station data to generate precise GPS & GLONASS products. The IGS is committed to providing the highest quality data and products as the standard for Global Navigation Satellite Systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. Currently the IGS includes two GNSS, GPS and the Russian GLONASS, and intends to incorporate future GNSS. You can think of the IGS as the highest-precision international civilian GPS community.

The IGS global system of satellite tracking stations, Data Centers, and Analysis Centers puts high-quality GPS data and data products on line in near real time to meet the objectives of a wide range of scientific and engineering applications and studies.

The IGS collects, archives, and distributes GPS observation data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentation. These data sets are used by the IGS to generate the data products mentioned above which are made available to interested users through the Internet. In particular, the accuracies of IGS products are sufficient for the improvement and extension of the International Terrestrial Reference Frame (ITRF), the monitoring of solid Earth deformations, the monitoring of Earth rotation and variations in the liquid Earth (sea level, ice-sheets, etc.), for scientific satellite orbit determinations, ionosphere monitoring, and recovery of precipitable water vapor measurements.

The primary mission of the International GPS Service, as stated in the organization's 2002-2007 Strategic Plan, “to provide the highest quality data and products as the standard for global navigation satellite systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. These activities aim to advance scientific understanding of the Earth system components and their interactions, as well as to facilitate other applications benefiting society."

The IGS Terms of Reference (comparable to the by-laws of the organization) describes in broad terms the goals and organization of the IGS. To accomplish its mission, the IGS has a number of components: an international network of over 350 continuously operating dual-frequency GPS stations, more than a dozen regional and operational data centers, three global data centers, seven analysis centers and a number of associate or regional analysis centers. The Central Bureau for the service is located at the Jet Propulsion Laboratory, which maintains the Central Bureau Information System (CBIS) and ensures access to IGS products and information. An international Governing Board oversees all aspects of the IGS.

The IGS is an approved service of the International Association of Geodesy since 1994 and is recognized as a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) since 1996.

EuroGeographics as the central-hub for Europe’s Geographic Information (GI) developments - a unique and diverse network working of all concerned with European GI; National Mapping and Cadastral Agencies (NMCAs), the European Commission and others. The websites contain information of national European Coordinate Reference Systems (CRS) and pan-European Coordinate Reference Systems for position and height. On the sites the following information can be found:

- Description of national Coordinate Reference Systems
- Description of pan-European Coordinate Reference Systems (ETRS89 / EVRF2000)
- Description of Transformation parameters from national Coordinate Reference Systems to pan-European Coordinate Reference Systems including
    - Qualitiy of transformation
    - Verification data of transformation
    - possibility for online conversion and transformation of single points for test and verification purposes (position)
- Links to the National Mapping Agencies of the European Countries

The Joint **Research Centre of the European Commission** jointly organized with Eurogeographics and EUREF two Workshops (Spatial Reference Workshop 1999 and the Cartographic Project Workshop 2000 in Marne-la-Vallee). These Workshops laid the foundations for the definition of uniform European coordinate reference systems in position and height for the unique georeferencing of data. The Information System contains the description of national and pan-European Coordinate Reference Systems (CRS) for position and height orientates on the international standard 19111. It contains also the descriptions of transformations of national Coordinate Reference Systems of European countries to pan-European CRS. In the future a service module will be enabled for the transformation and conversion of coordinates for test purposes.

CRS-EU is a extension and advancement of the former existing and now in this system integrated information system about European Coordinate Reference Systems CRS (http://crs.ifag.de)

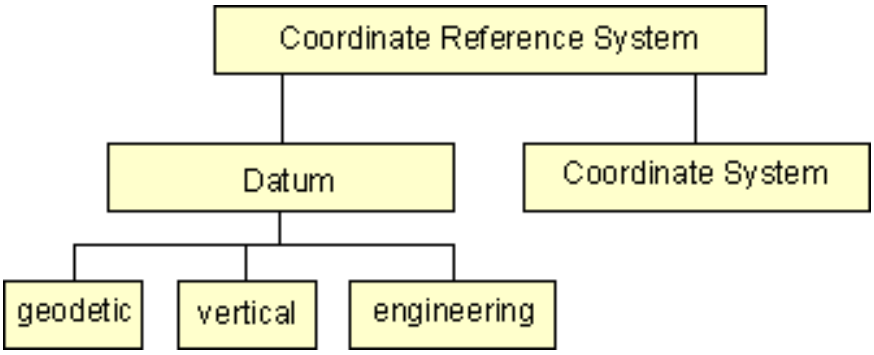

Figure 15 Structure of the Coordinate Reference System

The horizontal and vertical components of the description of a position in the space may sometimes come from different CRS. This shall be handled by a compound Coordinate Reference System (CCRS). The CCRS describes the position by two independent Coordinate Reference Systems. An European spatial reference system could be described as a CCRS. An example is shown in the figure.

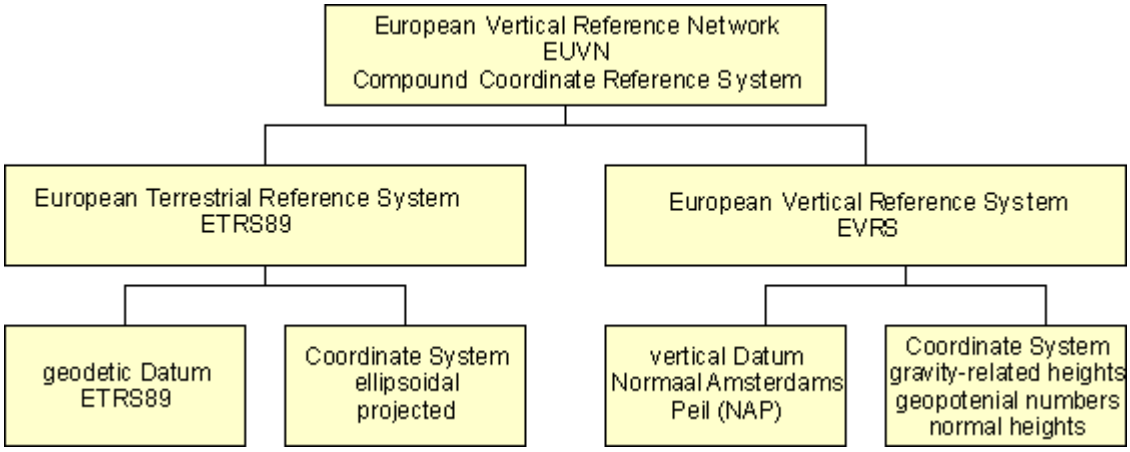

Figure 16 Structure of the Compound Coordinate Reference System (CCRS)

Transformation and Conversion - Change of CRS by Coordinate Operations

The change of coordinate from one Coordinate Reference System to another is a so called coordinate operation. There exist two kinds of operations - coordinate transformation and coordinate conversion.

Transformation

The change of coordinates from one CRS to another CRS based on different datum is only possible via a coordinate transformation. The transformation parameters could only be derived empirically by a set of points common to both coordinate reference systems it means by identical points. Choice, allocation, number and the quality of coordinates of the points affect extensive the results and the accuracy. Therefore different realisations for transformations from one datum to another exist.

Figure 17. Coordinate transformation

Generally the accuracy is for small transformation areas better, because the strains of the two CRS are for small areas lower. But you have for each area new transformation parameters. The derivation of transformation parameters for greater areas (e.g. whole country) deliver unique results, but the accuracy is worse. For 3-dimensional CRS in a 7-Parameter Helmert Transformation is used for coordinate transformations. The figure shows the formula, which is used in this information system.

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{(T)} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{(S)} + \begin{bmatrix} T_X \\ T_Y \\ T_Z \end{bmatrix} + \begin{bmatrix} 0 & -R_Z & R_Y \\ R_Z & 0 & -R_X \\ -R_Y & R_X & 0 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{(S)} + D \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{(S)}$$

(T)	Target Datum	
(S)	Source Datum	
T_X, T_Y, T_Z	geocentric X/Y/Z translations	[m]
R_X, R_Y, R_Z	rotations around X/Y/Z axis	[radian]
D	correction of scale	[ppm]

Remark: the rotations R_X, R_Y, R_Z must be small

Figure 18. Helmert 7 parameter transformation

Unfortunately there exists different versions of this formula with inverse definition of the signs of rotations and/or inverse sequence of the rotations. Inverse sequence means Rx = Rz, Ry = Ry, Rz = Rx. It should be considered for use of transformation parameters and software packages.

For 2-dimensional and for transformation of geo-topographical data also a grid-based transformation is usable. A grid-based transformation based on shift values of ellipsoidal coordinates. At first in a unique previous process the shifts were determined from identical points and stored in a regular grid. The shifts for the transformation of coordinates will be computed then by bilinear interpolation inside the grid meshes. All the complex mathematical processing was done during the creation of grid files, leaving the software to interpolate the required shifts and perform a simple addition to complete the transformation. In many cases of grid transformation the so called NTv2 -National Transformation version 2 - is in use (see http://www.geod.nrcan.gc.ca/pdf/ntv2_guide_e.pdf).

Conversion

The change from one Coordinate System to another based on the same datum is possible via a coordinate conversion. In this case mathematical rules (e.g. map projections) are necessary. Generally this conversions are unambiguous and can realised with high accuracy.

In case of gravity related heights the conversion (e.g. normal heights to orthometric heights) requires additional information about position and gravity of the points to be transformed.

Figure 19. Coordinate conversion

Change of CRS by Conversion and Transformation

The change of coordinates from one Coordinate Reference System to another Coordinate Reference System may result from a series of operations consisting of one or more transformations and / or one or more conversions. A concatenated operation records a change of coordinates through several transformations and / or conversions. There is no upper limit to the number of steps a concatenated operation may have. Each step is an operation described in the normal way. The figure shows as example for position the coordinate operations (conversions and transformations) for the changing of a CRS with a projected Coordinate System to another. This is in general the way for the change of a projected national CRS to an also projected pan-European CRS.

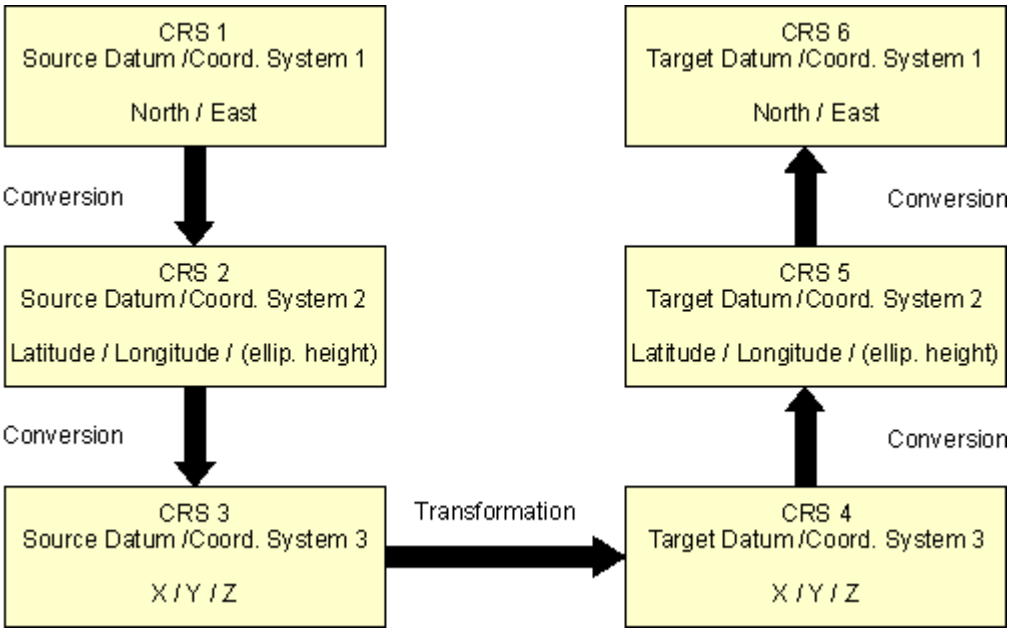

Figure 20. Change of CRS by conversion and transformation

Descriptions of pan-European Coordinate Reference Systems

Eurogeographics recommends to the European Mapping Agencies the implementation of the new standards including Coordinate Reference Systems as presented in the next table.

CRS Identifier	CRS Annotation	Description of CRS
Position		
ETRS89	pan-European CRS with Datum ETRS89 in ellipsoidal (geodetic) coordinates	◉
ETRS-LCC	pan-European CRS with Datum ETRS89 in European Lambert Conformal Conic Projection	○
ETRS89 / (X, Y, Z)	pan-European CRS with Datum ETRS89 in cartesian coordinates	○
ETRS-TMzn	pan-European CRS with Datum ETRS89 in European Tranverse Mercator Projection	○
ETRS-LAEA	pan-European CRS with Datum ETRS89 in European Azimuthal Equal Area Projection	○
Height		
EVRF_AMST / NH	normal heights of the UELN_95/98 in relation to the tide gauge Amsterdam (NAP) (also known as EVRF2000)	○
EVRF_AMST / CP	geopotential numbers of the UELN_95/98 in relation to the tide gauge Amsterdam (NAP)(also known as EVRF2000)	○

NACLR Methodology

National Agency for Cadaster and Land Registration (NACLR) is the main civil public institution involved in the realization of standards and methodologies for cadastre, geodesy, cartography and land registration. NACLR implements the recommendations of the ISO, IGS, EUREF, Eurogeographics.

Other Romanian institutions involved in the realization and implementation of geosciences standards are ASRO, INM (National Institute of Metrology).

Section V: Geodynamics

The Institute of Geodynamics of the Romanian Academy (IGRA) focuses mainly on research included in the priority program of the Romanian Academy “Complex geophysical research in geodynamically active areas with a special view to the Vrancea seismogenic area”. In the framework of this program, the Institute concentrated its efforts on (i) studying the space-time variations of several variables that are causally linked to the stress accumulation responsible for earthquake occurrence; and (ii) monitoring and analysing crustal deformations, i.e., relative displacement of tectonic blocks, as well as tectonic hazards. The Institute of Geodynamics runs a network of observatories of geodynamics, equipped with specific sensors. These and some of the results obtained between 2003-2007 are detailed in the following.

Geodynamic observatories network

The activity of the geodynamic observatories network of "Sabba S. Stefanescu" Institute of Geodynamics of the Romanian Academy is focused in three polygons: Căldăruşani-Tulnici geodynamic polygon, Crăciuneşti-Deva, Draica, Daniel, Ursoiu, Sarmizegetusa-Regia, Padeş-Gorj geodynamic polygon and Delta Dunării – Mangalia geodynamic polygons (Fig.21).

In the underground observatories : Crăciuneşti-Deva, Draica, Daniel, Ursoiu, Sarmizegetusa-Regia, Padeş-Gorj there were realized special arrangements for obtaining a thermal stability (maximum variations of +/- 0.5 Celsius degrees, throughout one year). So, functioning of the sensors in these underground observatories is very good because the thermal stability is a major factor in mitigation of the device drift and for the accuracy of the data. Quartz horizontal pendulums, water-tube tiltmeters, gravimeters, as well as systems for monitoring temperature and humidity.
A mobile laboratory of Geodynamics is used too, laboratory which has the target to realize some complex geodynamic, geophysical, electromagnetic, seismic, geochemical measurements, at precise measurement points in the active geodynamic zones which have a high potential for natural and anthropogenic risk. The laboratory is installed in a car specially designed for fieldwork.

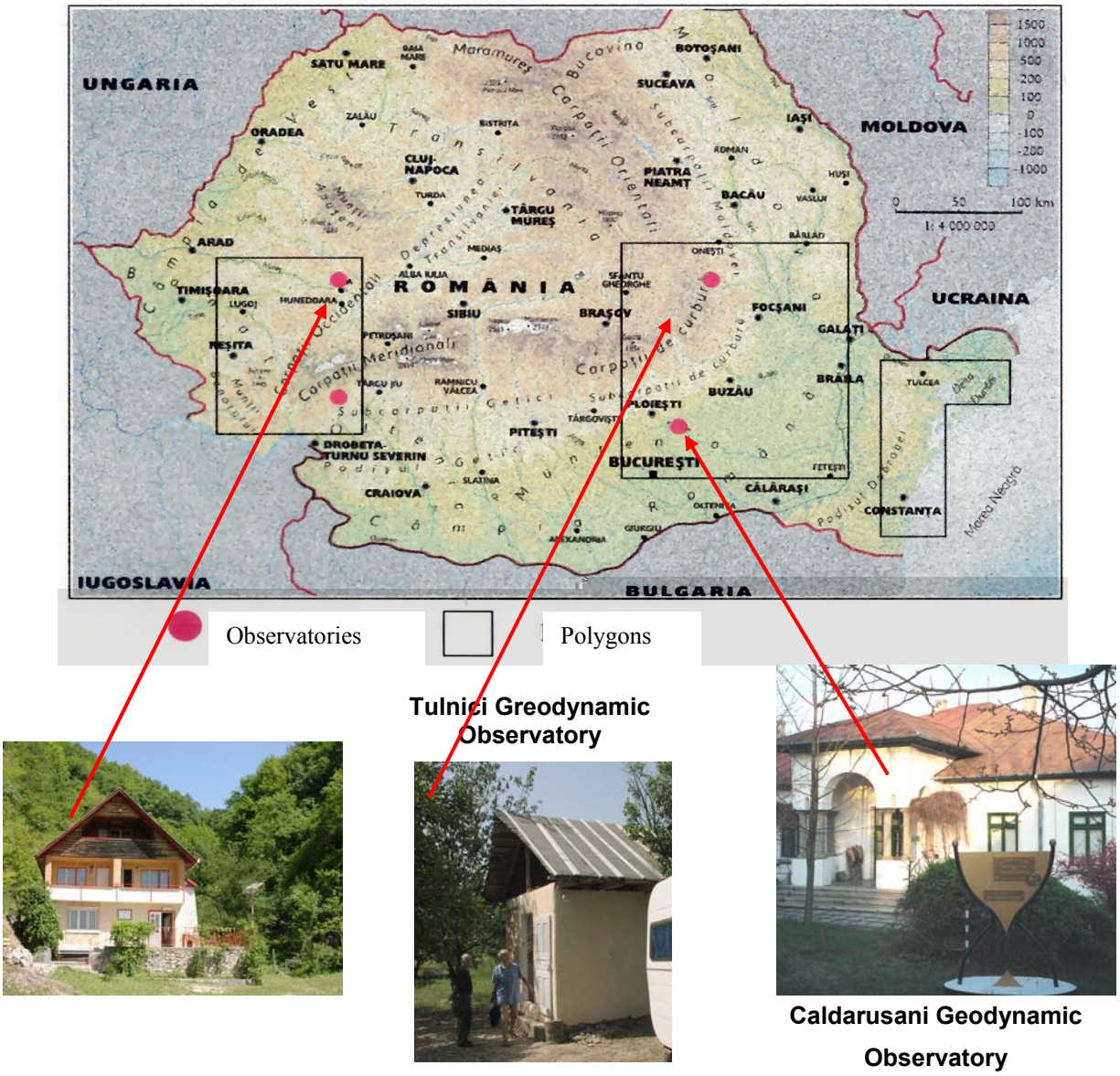

Figure 21. Geodynamic Polygons and Observatories in Romania

The existence of a laboratory for calibration and ageing of the geodynamic equipment (LERAG) was necessary in the framework of the activity of research for realizing performing sensors for geodynamics. We mention the tiltmeters with quartz horizontal pendulum which have the sensitivity of $0.5*10^{-9}$ radians but relatively large instrumental drift, which limits the use of the devices in recordings the terrestrial crust deformations for long intervals of time. This drift, produced by the stabilizing processes that appear in the quartz threads, is mitigated through the artificial ageing of the suspended quartz threads of the pendulum. This is possible assembling a LERAG in the underground of an old building situated in the centre of the capital where the anthropogenic vibrations are continuous and show high amplitudes. In LERAG there are realized calibrations of the geodynamic equipment, the analysis of natural and anthropogenic vibration spectra from urban centre, the study of the effects of temperature variations over geodynamic sensors, etc.

Geodynamic sensors for crust deformation measurements used for lithosphere structure understanding

Analysing the geodynamic phenomena by continuous recording of the crust deformations, indirect measurements were carried out, based on measurements of very small displacements of the sensitive

elements from the system measurements. These displacements are measured by the help of displacement sensors which give a variable tension versus monitored displacement. Except the base measurements there are necessary continuous measurements of the perturbation factors (temperature, atmospheric pressure, etc) for being able to eliminate them during the data processing.
Water-tube tiltmeters (Figs.22 and 23) have a base of tens or hundreds of meters. For the complete recording of the variations in horizontal plane two clinometers are necessary, perpendicular on each other.
Water-tube tiltmeters work in optimal conditions in a mining gallery where the temperature is constant. If the tiltmeters are situated in a location where the temperature has variations over $1^{o}C$, the measurement of the temperatures of the two terminals and the application of a temperature correction is necessary. The latter can be theoretically calculated, but it must be verified experimentally, especially in the case of tiltmeters that do not have identical environmental conditions at the two terminals.

Figure 22. Water-tube tiltmeter (single terminal)

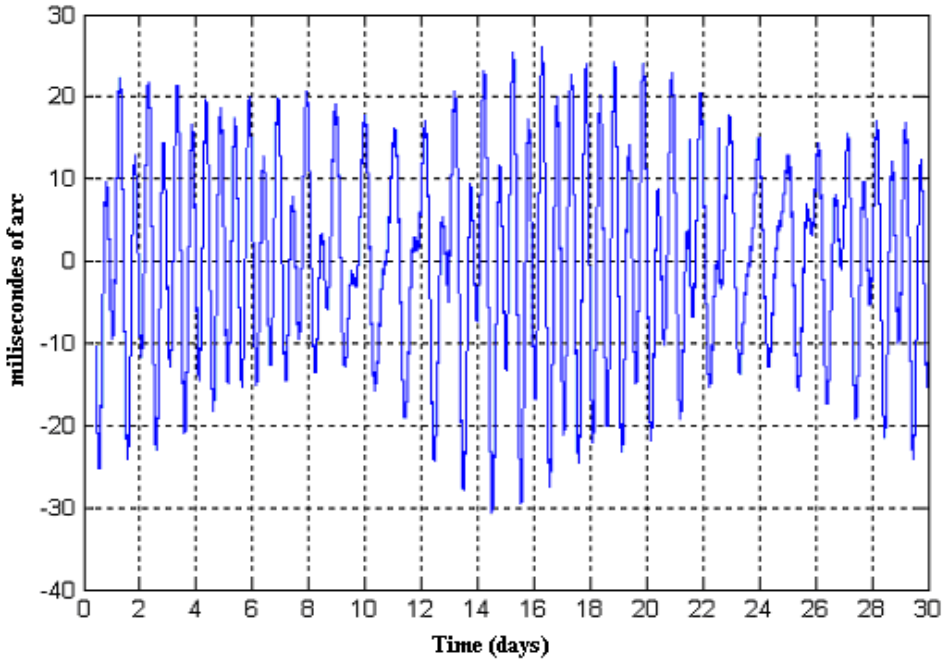

Figure 23. Tiltmeter recordings. URSOIU Geodynamical Underground Observatory 1.09.2005 – 30.09.2005

A parasite phenomenon that could cause an important noise in the recordings is the local variation on short time of the atmospheric pressure, like an effect of the turbulences induced by the wind. The variations of the pressure have a very broad band spectrum so that the electronic filtering and the averaging of the measured values are less effective.
Tiltmeters with vertical pendulum (Figs.4 and 5) show the direction of G vector through a normal or inverse pendulum. The length of the pendulum represents the measurement base and is limited from design reasons at values of meters or tens of meters, fact that imposes a high sensitivity of the

displacement sensors which are used. One pendulum can record the movement on two perpendicular directions in plane if it is equipped with displacement sensors.

Figure 24. Vertical pendulum

In normal conditions a simple pendulum has the length of approximate 1 m and it is used for recording the geodynamic phenomena of shallow depth like landslides, the stability of huge structures, etc, in which a high sensitivity is necessary. The damping of the pendulum is done by a stalk immersed in oil, disposed at the lower end of the pendulum. Pendulum mass is at order of tens or hundreds grams without soliciting too much the damping system.

For high sensitivities the length of the base for measurement was increased. In some specialized observatories in Romania there are optimal conditions (networks of galleries, boreholes, etc.) and technical equipment for the installation of long pendulum of about 17 m.

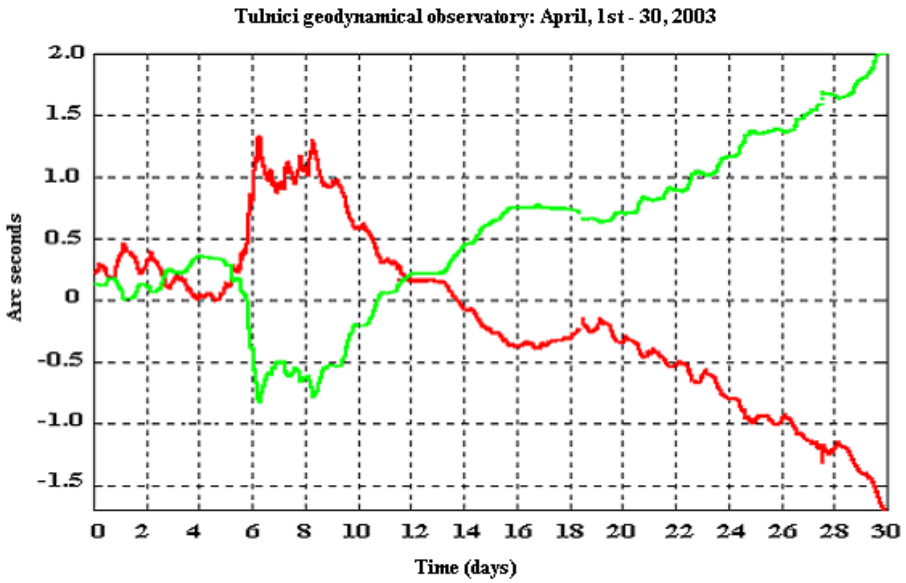

Figure 25. Recording with vertical tiltmeter on two directions: north-south and east-west

The recording gravimeters (Figs. 26 and 27) for observatory are ASKANIA GS11 type. This type of gravimeter was initially designated for the field measurements, using a direct reading, carried out by an operator. The instrument was modified and adapted for a continuous recording, replacing the

system for reading with a displacement sensor of high sensitivity. In this way there are carried out continuous recordings of the variations of the intensity of G vector, with a higher sensitivity than the original device. The stability of the recordings was raised, as well, by assembling the instrument in fix location, continuous electric supply and by its maintenance in chambers with small variations of temperature. Gravimeters will be assembled on a concrete pile, very deeply embedded in terrain. The setting in perfect horizontal position has to be done periodically to eliminate the possible modifications of this position meantime, fact that have a sensitive influence over the recordings.

Figure 26. Askania gravimeter

The temperature of the chamber, in which gravimeter is set, must be rather constant for improving the thermostat functioning. This demand will be the best-achieved in underground observatories in which the variation of the temperature is maximum +/- 0.5^0C during one year.

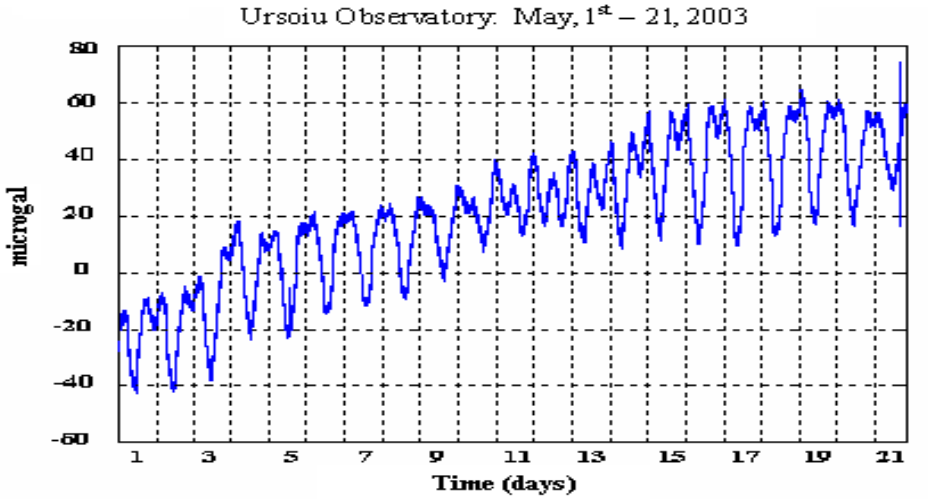

Figure 27. Gravimetric recordings. URSOIU Geodynamical Underground Observatory

At the other observatories the gravimeters are installed in special chambers, thermally insulated, situated in the underground, assuring a slow variation and small amplitude of temperature. In actual conditions the quasi-continuous recordings allow a good observation of the phenomenon of earth tides and allow noticing some anomalies, linked to the local conditions of surface or subsurface.

Acquisition systems

The electronic systems of acquisition of the data are different, from the professional ones of type National Instruments on 16 bites, with own software Lab View, to the systems on 8 bites (microDAS), 10 bites and 12 bites (GeoData), optimized for the special cases, simpler and easier to use. The magnetotelluric stations (Metronix), as well as the geomagnetic stations (Bartington) work on 24 bites.

New method of analysis in the problem of hazard and risk implied by the Vrancea seismogenic zone

A. Description of the HiCum stacking method of signal analysis, worked out in cooperation with the Royal Astronomical Observatory, Belgium

The analysis of any data bank representing a series of events fixed by time may prove the results to be random, non-random or a mixture of both. If the data is completely random no patterns will be found, but if any part of the data is non-random, then patterns can be detected either as a Gaussian distribution or, according to Fourier analysis, in a series of fundamental and harmonics of cosine waves. A common method of detecting these waves is to use Spectrum Analysis, which will detect the frequency and strength of all waves present, but it can be difficult to implement. However, in the situation where the detection of the presence or absence of a particular frequency is the primary objective, HiCum is a powerful tool.

HiCum is dependant on a large amount of data available and on the frequency of the wave to be detected. As each earth-tide component can be defined with a very high degree of accuracy, HiCum is a useful tool for determining whether earth-tides are influencing any of the parameters recorded in a series of timed events. ROMPLUS provides us a long series of timed events and is therefore suitable for analysis using HiCum. Using this method we are able to compare, for selected earth-tides component, the influence they may have on various parameters. In our case the parameters under consideration were occurrence, latitude, longitude, depth and magnitude.

The inspiration for HiCum came from the field of meteorology where stacking was first used in the late 19th century by Darwin. In general terms a signal has its time base divided into a series of selected constant length time periods *T*. For the detection of earth-tides signals this time period would be the time period of the earth-tide in question e.g. the Solar time clock, S1, or the lunar time clock, M1. This time period is then represented by 360°. The time base for each of these periods is then normalised as shown in Fig. 28. The occurrence of an event, E_i, at time t_i can then be represented by the phase α_i, which is the difference between the event E_i time and the time of the original event in the series, t_0, modulo T (except an integer number of periods T).

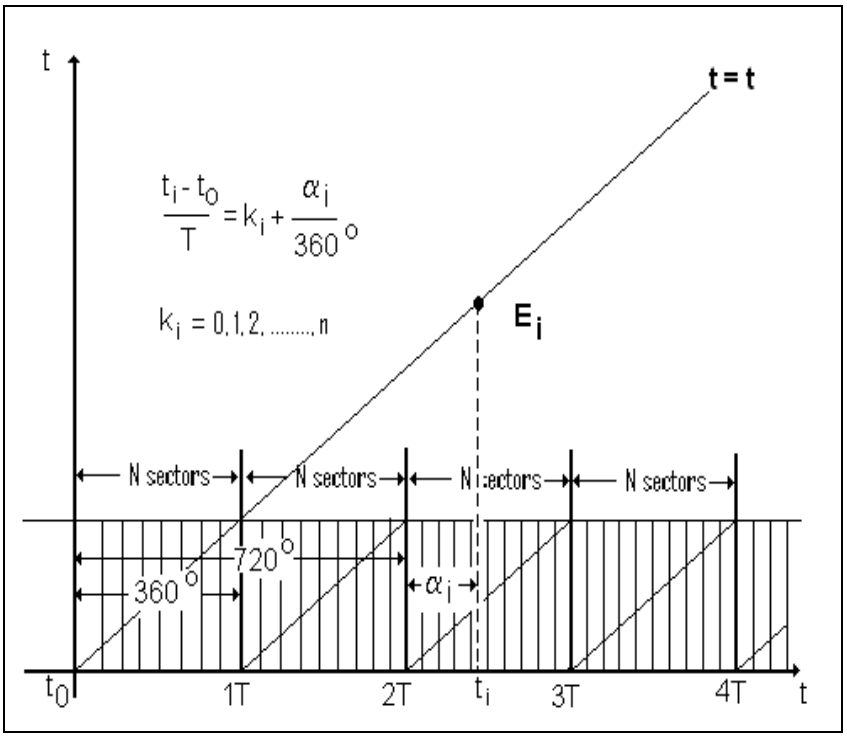

Figure 28. The time series partition into selected time period T. An event E_i occurring at time t_i will be α_i out of phase of the original event, t_0.

Each of these time periods are further divided into N sectors each of length 360°/N. The selection of an optimal number of sectors is done to find enough precision in phase and a significant number of events in each sector (even for small N).
For a parameter recorded at regular intervals, the data for each sector N (for example, in our case, the latitude, the longitude, the depth or the magnitude) is averaged and synchronised. These averages are then stacked producing a histogram bar representing the activity for this sector. This process is carried out for each sector until a complete histogram is produced for the time period under consideration (Fig.9). The histogram is then fitted, by nonlinear least square method, with the cosine function for that time period. The parameters of amplitude and phase are calculated. A graph can then be produced showing the link, in terms of phase and modulation, between the parameter under consideration and the chosen time period.

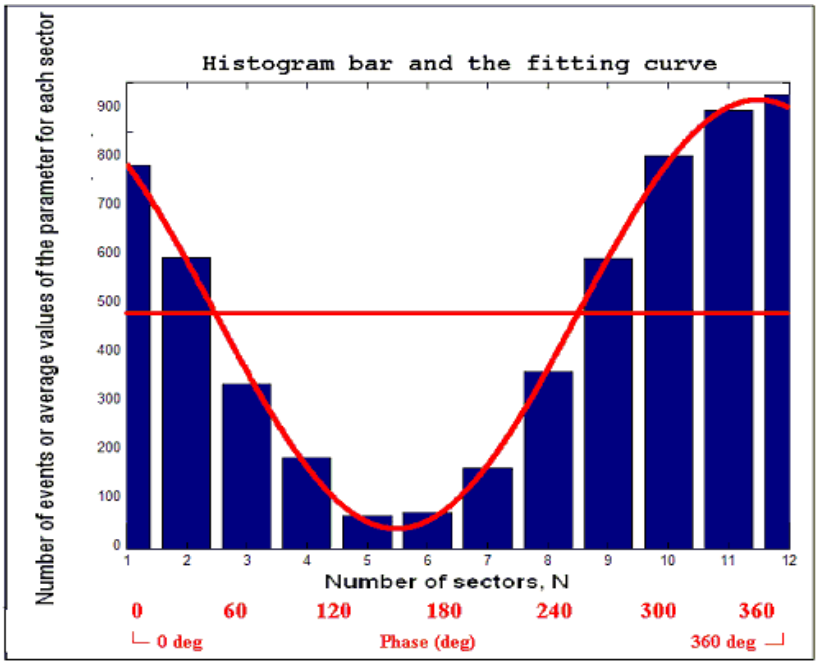

Figure 29. A histogram bar model, representing the distribution of the seismic activity or the average values of the parameter for each sector and a typical HiCum curve. The bars represent the results of the stacking of data, sector by sector (in this case N=12 sectors). The cosine signal represents the phase of the detected signal in relation to the earth-tides under analysis and the amplitude of the modulation of the detected signal

In the case of data recordings of discrete events, such earthquakes, the total number of all events recorded in each sector N is the value of the histogram bar for that sector. The remainder of the computation is then carried out in exactly the same fashion as for continuous recordings.

HiCum is embedded in a computer program which can take the data from ASCII files and display simultaneously the parameters of the above trigonometric function in a series of graphs. Thus the tendencies for various parameters can be expressed in terms of period, phase, amplitude and amplitude modulation. The input format for the HiCum software is based on the Doodson argument [Melchior, 1978)]. Figure 9 shows the characteristic features of a typical HiCum graph. The HiCum curve is a combination of the total output signal and the modulation of that signal by the selected earth-tides component, as detected by HiCum.

Using this method we are able to compare, for selected periodicities, influences on various parameters, in our case the parameters under consideration were occurrence, latitude, longitude, depth and magnitude. The selected time period will be that which is suspected to have an influence on the parameters in question e.g. the solar time clock S1. A time period is equivalent to an interval of width 360°. It is also necessary to select the optimal number of sectors for the HiCum computation.

B. HiCum Applied to the geodynamical data

We present a graphical example (Figs 10 and 11) of HiCum analysis of the water-tube tiltmeter data at Caldarusani Geodynamical Observatory. Figure shows the presence of the diurnal component in the tilmeter recordings from January to October 2006.
This method can be adapted too for the survey of the geodynamic sensors function and to find out the eventually damages.

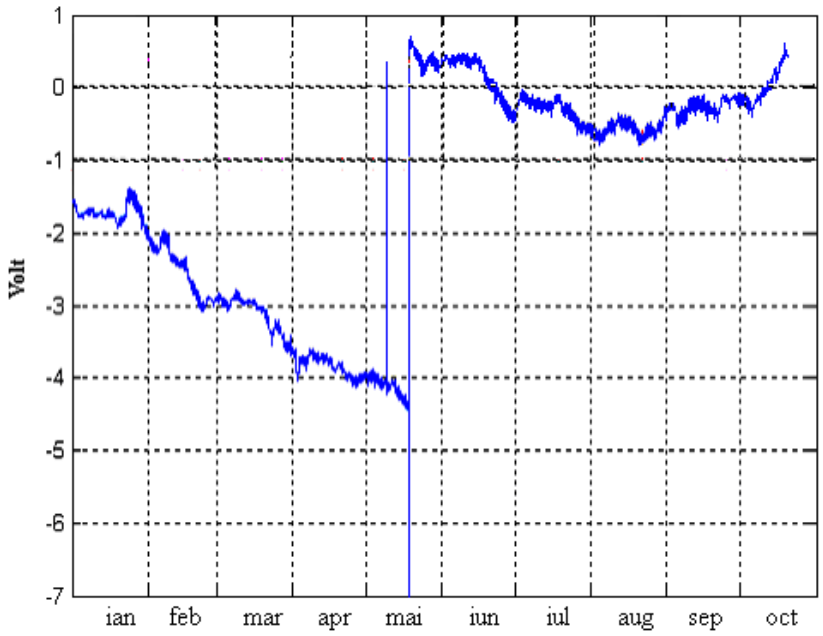

Figure 30. Water-tube tiltmeter data.
Caldarusani Geodynamical Observatory: 01.01.2006 – 31.10.2006

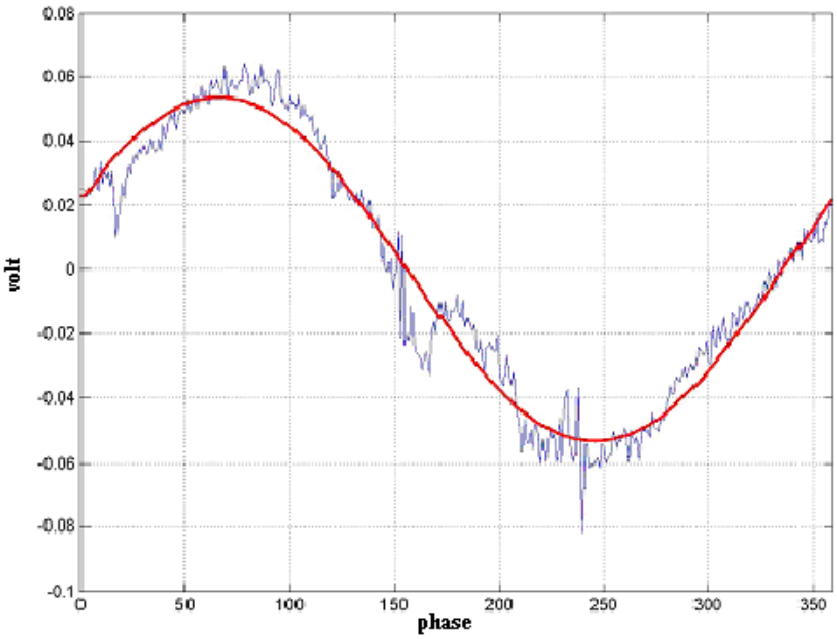

Figure 31. The diurnal component identified with HiCum method for the data from fig. 10.

C. HiCum Applied to the Vrancea Earthquake Data Base

Vrancea zone seismicity was tested for various periodicities related to the Sun and the Moon's motions. Firstly the solar semi-annual Ssa wave and solar annual Sa wave, which take into account the declination of the Earth with respect to the Sun. It is this declination that causes the seasons in Romania and in gravitational terms causes two maxima, one at the spring equinox (~March 21st) and the other at the autumn equinox (~September 21st). Next the lunar diurnal M1 wave and its first

harmonic M2 and the lunar declinational long period Md (lunar months in solar time) which are associated with gravitational changes are studied. Finally the solar diurnal S1 wave and its first harmonic S2, which are normally associated with climatic variations, are used in our analysis. A summary of the periodicities of these waves is given in Table 1. HiCum was applied for these Earth tides on the earthquake occurrences in the depth zone 100 – 200 km. Effects of these periodicities on the latitude, longitude, depth, magnitude and number of events were investigated.

Earth tide waves and their periodicities

Earth tide	Doodson argument	Angular frequency (°/h)	Ratio of periodicity with S1	Periodicity (h)
S1	164.555	15.000000	1.000000	24.000000
S2	273.555	30.000000	2.000000	12.000000
M1	155.555	14.496694	0.966446	24.833248
M2	255.555	28.984104	1.9322736	12.421000
Md	065.555	0.549016	0.0366011	655.717968
Ssa	057.555	0.082137	0.0054758	4382.921200
Sa	056.554	0.041067	0.0027378	8766.162610

Detailed analysis of the seismic activity of the Vrancea zone indicates that the most active zone is at a depth of 100-200 km [Bazacliu, Radulian-1999]. It was then decided to further sort the data. For this part of our studies, data on the three spatial dimensions of the location of a quake, namely the longitude, latitude and depth, were used for HiCum analysis along with the HiCum analysis of the frequency of earthquake occurrence, irrespective of its location within the Vrancea region.

The HiCum for Sa was then performed with the average value of latitude and longitude for each time sector and the results (Fig.12c,d) compared with the previous graphs (Fig.12b), to determine where the location of the earthquakes could be linked to Sa. From fig. 12 we can see that there is a tendency for the site of the earthquake to vary with Sa, the solar annual wave.

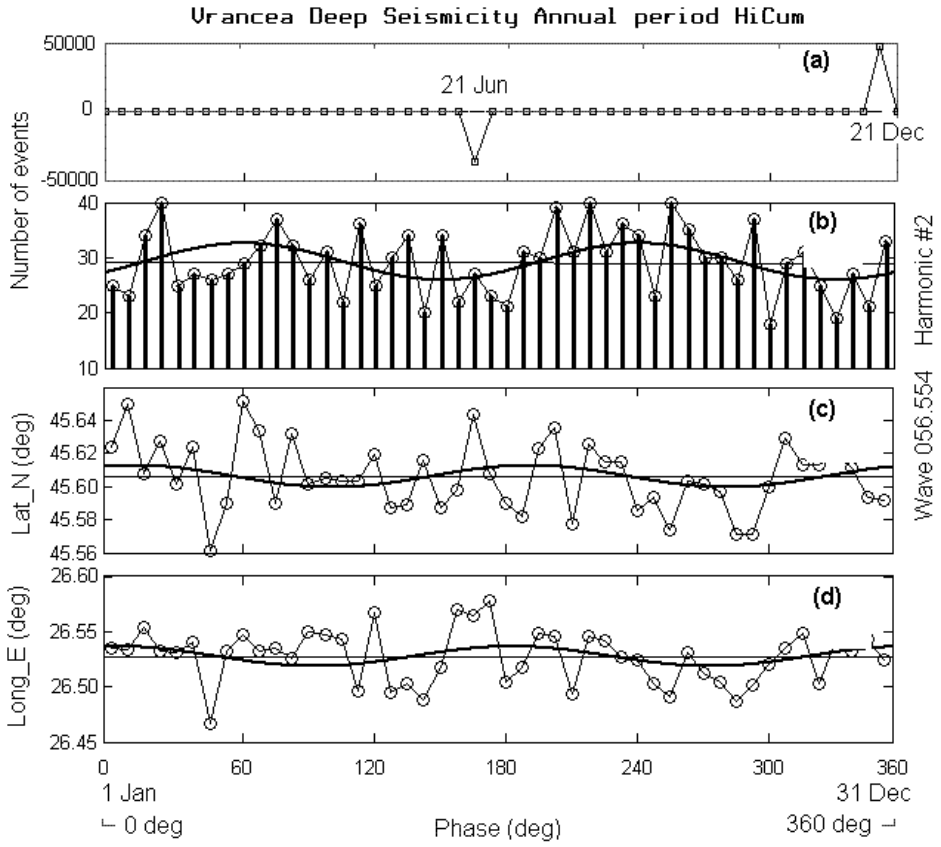

Figure 32. HiCum analysis on seismic activity (b), latitude (c) and longitude (d) relative to solstices moments (a) (Research on annual Time Clock Sa wave 056.554)

As the movement on the fault is likely to be affected by the change in direction of the gravitational field in relation to the fault [Enescu, 1999], this change in direction is defined by the derivative of Sa, Ssa.

Dissemination of results

The researchers of the "Sabba S. Stefanescu" Institute of Geodynamics of the Romanian Academy were present with a lot of scientific communications to prestigious national and international symposium, conferences and workshops. Their scientific activity is also reflected in many papers published in appreciated scientific revues.

International cooperation

In the report interval, several important international cooperation programs of the Institute of Geodynamics have continued, such as:

Complex geophysical studies in tectonically active areas (Vrancea - Romania, Piton de la Fournaise - France), with the Royal Belgian Observatory - Belgium, the Institute for Theoretical Geodesy of the University of Bonn - Germany, the Walferdange Observatory - Grand-duché de Luxemburg, the Institute of Earth Physics Paris - France.

Virtual International Laboratory of Geodynamics (2001-to present) - "Sabba S. Stefanescu" Institute of Geodynamics of the Romanian Academy in cooperation with the United Institute of Earth Physics "O. Yu. Schmidt" of the Russian Academy of Sciences and others have been established:

Unesco Chair in Geodynamics (2004-to present) - Agreement between the United National Educational, Scientific and Cultural Organization and "Sabba S. Stefanescu" Institute of Geodynamics of the Romanian Academy (Romania)

New images of the Earth's magnetic field in the South-East Europe (satellite data by Orsted and Champ) (program BRANCUSI) - (2003 - 2004) - Institut de Physique du Globe de Paris (France)

Extreme Events, Causes and Consequences (**E2C2)** Project (2005 – to present) E2-C2 is a Specific Targeted Research Project (STREP) within a Pathfinder Initiative aimed at Tackling Complexity in Science and initiated by the New and Emerging Science and Technology (NEST) Programme of the European Commission, as part of its Sixth Framework Programme (FP-6). E2-C2 is coordinated by Michael Ghil (ENS), with Pascal Yiou (LSCE) as Associate Coordinator.

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International Association of Seismology and Physics of the Earth's Interior

IASPEI ACTIVITIES IN ROMANIA

2003-2007

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GEOTEC S.A.

FOREWORD

The present report describes the activities carried out in Romania, under the supervision of the "Seismology and Physics of the Earth's" section of the National Romanian Committee of Geodesy and Geophysics, organized in four main domains: Seismology, Structure of the Lithosphere, Engineering Seismology and Heat Flow Studies.

Romania is characterized by moderate-to-high seismic activity, experiencing 3-4 destroying earthquakes per century, located at the Carpathian Arc Bend, in the Vrancea region, in a particularly confined focal volume at intermediate depths. The strong earthquakes generated here are significantly affecting extended areas in Europe. From time to time, earthquakes in the 5-6 magnitude range are generated in the crustal domain, as well, mostly in the regions of contact between platform and orogen zones.

Since Seismology is a data-driven science, special efforts were made in the last decade to develop and improve the data management, including acquisition, processing and rapid exchange of seismic information. The National Institute for Earth Physics is operating now a network of 21 seismic stations connected in real time to the National Data Centre in Bucharest. Part of the stations belongs to GEOFON network (one station), VEBSN network (6 stations) and AFTAC (one array) and is continuously exchanging data with other seismological centres. This network is designed first to monitor natural and induced seismicity, and to rapid disseminate high-level information in case of large earthquakes. At the same time, a strong motion network of 46 high quality digital accelerometers has been recently installed in the framework of the Romanian-German co-operation.

In the field of **Seismological Research**, important achievements were obtained during 2003-2006 period in the following domains:

- monitoring of seismicity;
- seismic source physics;
- wave propagation;
- seismotectonics;
- seismic hazard of Romania by probabilistic and deterministic approaches;
- earthquake prediction;
- engineering seismology;
- geotechnical investigations for site evaluation;

In the field of **Lithosphere Structure** the most significant results are referring to the deep structure of the lithosphere, determined from seismic data correlated with the available geological and geophysical data.

In the frame of **Heat Flow Studies**, the geothermal structure and evolution of the lithosphere in various tectonic units, as well as problems of borehole climatology, such as inversion of borehole temperature data and air-soil heat transfer, were tackled.

Prof. Dr. Dumitru ENESCU

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PART I: SEISMOLOGY

The National Institute for Earth Physics (NIEP, http://www.infp.ro) is the leading institution for seismology in Romania, responsible for the earthquake monitoring of the territory and basic and applied researches in seismology. It was established in 1977 as an organization for research and development in Earth sciences. Now is coordinated by the Romanian Ministry for Education and Research, being mainly financed by contracts from public sources. Structure of the NIEP is 6 departments, 34 researchers (18 PhD), 56 technical people and 16 PhD students. It has a wide background in earth sciences research, with focus on seismic source and seismotectonics, lithosphere structure and dynamics, seismic hazard assessment, site effects and microzonation, engineering seismology, assessment and mitigation of seismic risk.

The seismological research in Romania during the 2003-2006 time interval has been focused on seven main directions:

1) **monitoring of natural and induced seismicity**
2) **seismic source physics**
3) **wave propagation**
4) **seismotectonics**
5) **seismic hazard**
6) **earthquake prediction**
7) **engineering seismology**

Since Romania is an earthquake prone area, it is of crucial importance to obtain quantitative information needed for seismic risk mitigation and related public policies and seismic safety measures. The most damaging earthquakes in Romania concentrate in Vrancea region, located at the sharp bend of the Eastern Carpathians chain, in a well-confined focal volume at intermediate depths (60 to 200 km). The extremely peculiar seismotectonics and geodynamic processes in this area focused the attention of numerous seismologists. At the same time, taking into consideration the dramatic social and economical implications of the Vrancea earthquakes, major efforts have been made to seismic hazard assessment and seismic microzonation of the large urban areas affected by these earthquakes, and first of all of Bucharest, for long-term protection against earthquakes.

NIEP operates the national seismic network, consisting of 21 stations connected in real time and 46 free-field strong ground motion K2 seismic stations (Figure 1). Continuous digital acquisition of the seismological data has been carried out since 1991. The real-time seismic network has 9 stations equipped with short-period seismometers (one second natural period), 11 broadband stations, one seismic array of 5 km aperture with 10 stations. Nine stations are equipped with short-period (SP) vertical sensors (GS-21res) and one station is equipped with broad-band (BB) three component sensors (KS 54000) (Table 1). The data are collected and transmitted in real time to the National Data Center in Bucharest which is integrated in the European virtual network.

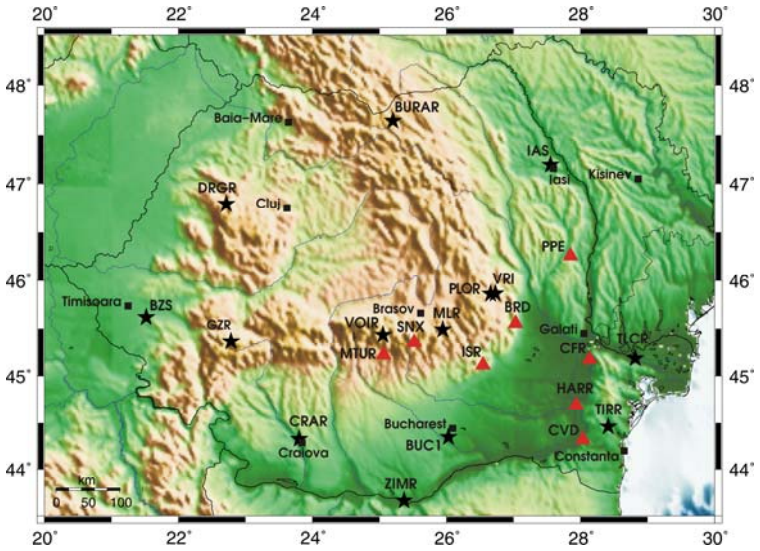

Figure 1. Romanian Seismic Network (red triangles - the Romanian telemetry network, black star – digital broad band).

Table 1. Real-time stations existing in Real-time stations existing in Romania

Net_Station Code	Latitude (N)	Longitude (E)	Elev. (m)	Station type	Sensor type	Digitisers Local data acquisition Sample rates	Data Transfer	Recording RO_NDC software data acquisition
GE_TIRR	44.4581	28.4128	77	3C BB	STS-2	EarthData SeisCOMP 50, 100 sps	RT Satellit	ANTELOPE
RO_BRD	45.3122	27.0373	250	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_BUC1	44.3479	26.0281	77	3C BB	CMG 40T	Altus K2 SeisCOMP 50, 100 sps	RT	ANTELOPE
RO_BURAR	47.6148	25.2168	1150	ARRAY SP 1C +3C BB	9xGS21 + KS54000	Science Horizons CD1 50, 100 sps	RT satellit	ANTELOPE
RO_BZS	45.6167	21.6167	260	3C BB	STS-2	Q330	RT	ANTELOPE

Net_Station Code	Latitude (N)	Longitude (E)	Elev. (m)	Station type	Sensor type	Digitisers Local data acquisition Sample rates	Data Transfer	Recording RO_NDC software data acquisition
						SeiscComP 50, 100 sps	radio	
RO_CFR	45.1780	28.1362	52	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_CRAR	44.32504	23.79990	125	3C BB	CMG 40T	Altus K2 SeisCOMP 50, 100 sps	Internet	ANTELOPE
RO_CVD	44.3145	28.0326	134	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_DRGR	46.7916	22.7111	921	3C BB	KS2000	Q330 SeisCOMP 50, 100 sps	RT satelit	ANTELOPE
RO_HARR	44.6900	27.9310	118	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_GZR	45.3933	22.7767	850	3C BB	CMG 40T	Q330 SeisCOMP 50, 100 sps	RT radio link	ANTELOPE
RO_IAS	47.1933	27.5617	160	3C	CMG 40T	Altus K2 SeisCOMP 50, 100 sps	Internet	ANTELOPE
RO_ISR	45.1188	26.5431	750	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_MLR	45.4909	25.9450	1360	3C BB	STS2	Q4120 Comserv 1, 40, 100 sps	Intranet	ANTELOPE
RO_MTUR	45.2261	25.0630	1018	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_PPE	46.2578	27.8503	267	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_PLOR	45.8512	26.6499	657	3C BB	CMG 40T	Q330 SeisCOMP 50, 100 sps	RT radio link	ANTELOPE
RO_SNX	45.3553	25.5155	1470	SP 1C	S13	DM16 SCREAM 100 sps	RT radio link	ANTELOPE
RO_TLCR	45.1861	28.8150	73	3C SP	Mark Product L4	Altus K2 SeisCOMP 50, 100 sps	Internet	ANTELOPE

Net_Station Code	Latitude (N)	Longitude (E)	Elev. (m)	Station type	Sensor type	Digitisers Local data acquisition Sample rates	Data Transfer	Recording RO_NDC software data acquisition
RO_VRI	45.8665	26.7276	472	3C BB	CMG 3ESP	Altus K2 SeisCOMP 50, 100 sps	RT satelit	ANTELOPE
RO_ZIMR	43.6221	25.3693	74	3C SP	S13 2xSH1	Altus K2 SeisCOMP 50, 100 sps	RT radio link	ANTELOPE

NIEP also operates a free-field strong motion network consisting of 46 K2 seismic stations for recording the strong and moderate Vrancea earthquakes. The K2-network has been installed starting with 1996 and continuously extended after, in the framework of the Romanian-German cooperation, within the project "Strong Earthquakes: A Challenge for Geosciences and Civil Engineering" of the University of Karlsruhe, Germany (Bonjer et al., 2000). The network is centered around the Vrancea seismic zone and covers an area with a diameter of up to 500 km. 16 of the K2 stations are installed in Bucharest and its surroundings.

The K2 stations are equipped with both accelerometer sensors (EpiSensor) and velocity sensors (broadband - KS2000, CMG3ESP and CMG40T or short period - MP, SH-1, S13). The K2 network works in trigger mode and uses 200 Hz sampling frequency. Twelve stations are available continuously in real - time.

Since July 2002 a new seismic monitoring station, the Bucovina Seismic Array, has become operational in the northern part of Romania, in a joint effort of the Air Force Technical Applications Centre, USA, and the NIEP. The new seismic monitoring system is continuously recording and transmitting data in real-time to the National Data Centres of USA, in Florida and of Romania, in Bucharest.

Romanian Data Centre in Bucharest, collects seismic data from all stations of the real-time national seismic network and from several stations in other countries: Bulgaria (VTS - MN), Czech Republic (MORC – GE, VRAC - CZ), Greece (APE - GE), Hungary (PSZ – GE, PKSM - HU), Italy (AQU - MN), Russia (KIV – IRIS/II) and Turkey (ANTO – IU, MALT – GE, ISP - GE) (Figure 2).

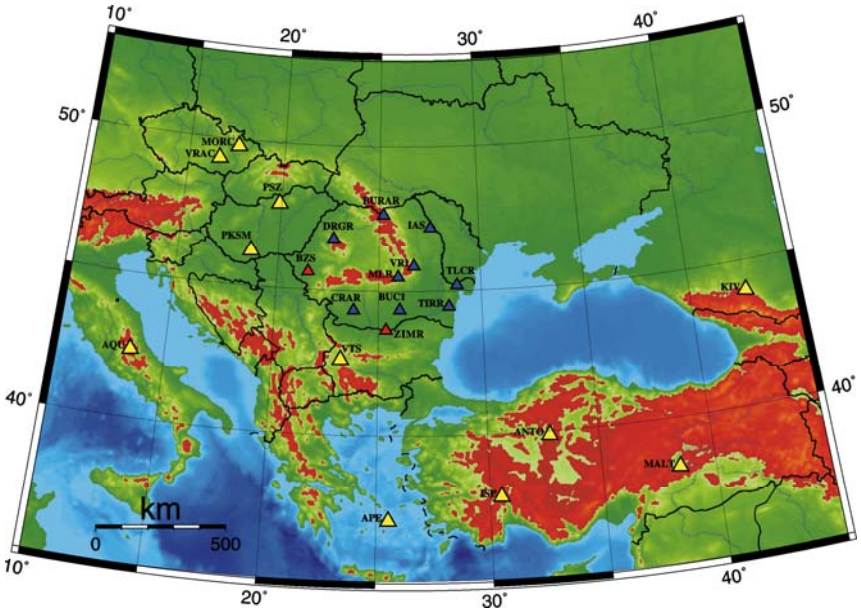

Figure 2. Seismic stations which are sending data in real-time to data center in Bucharest. Red triangles indicate future real-time stations of the national network.

Data from the national seismic network are collected in real-time using SeisComP/SeedLink and Antelope 4.8 software. The data are exchanged with all the institutions which supply data to the national data centre in Bucharest using SeedLink-SeedLink and ORB-ORB connections. Figure 3 shows the data flow between the data centre in Bucharest, seismic stations of the national networks and other institutions.

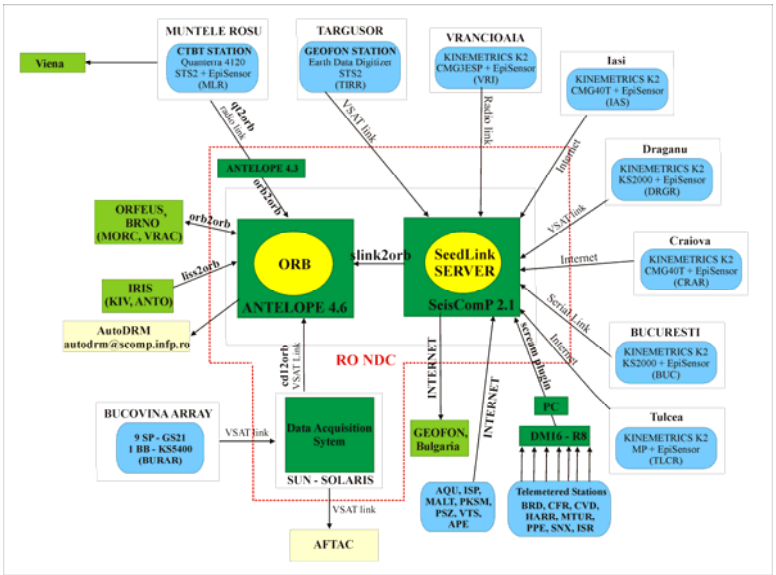

Figure 3. Data flow between the data centre in Bucharest, national seismic stations and other institutions.

NIEP has more than 25 years of experience in global seismological monitoring in support of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). It is participating to the international verification activities with the seismic station Muntele Rosu, which was included

in the auxiliary seismic network of the International Monitoring System, and with the operation of the Romania's National Data Centre (NDC). In order to ensure Romania's technical contribution to CTBT at the operational standards required by the Treaty, since 1999 an important upgrade has been under development both at the seismic station Muntele Roşu and at the NDC, involving both technical cooperation with the Government of Japan and technical assistance from the CTBT Organization. Hence, in the fall of 2001 a new seismic monitoring system was installed and is now fully operational, by recording continuous earth motion data at Muntele Rosu site and transmitting these data in real-time to the facilities in Bucharest, in the framework of the Japan International Cooperation Agency project „Technical Cooperation for Seismic Monitoring System in Romania".

Monitoring of natural and induced seismicity

Among the significant achievements in the past years we mention:

- A fully automated and networked system dedicated to digital acquisition and real-time processing of seismological data, as well as to rapid exchange of earthquake information has been implemented. At present, NIEP participates with 6 BB stations to the Virtual European Broadband Network and is ready to significantly increase its contribution to the objectives of the research infrastructures integrating activity, one of the main domain of the Structuring the European Research Area.
- The Romanian Earthquake catalogue (ROMPLUS) comprises updated, complete, user-friendly and rapidly accessible earthquake information. The catalog refers to earthquakes occurred on Romanian territory and in the neighbour boundaries since 984 up to present, including information related to locations and other source parameters, as well as links to waveforms of strong earthquakes. Seismicity analysis is continuously performed implying updating of the earthquake catalogue, spatial-temporal-magnitude patterns in different seismic regions of Romania, earthquake sequences [16]. Interpretation and reconsidering of historical data constitutes an important issue for the seismic hazard investigation.
- Field investigations of microearthquakes and earthquake sequences;
- Research on natural and induced seismicity.

Seismic source physics

Modelling the earthquake source is one of the main task with the long-term goal to construct a quantitative physical model for the entire earthquake process, including tectonic stress accumulation, nucleation of rupture, and the dynamics of the rupture propagation and cessation. Integration of the multiple aspects of the earthquake phenomena, from the small scale-scale (dynamic rupture) to large-scale (plate boundary tectonics) processes is becoming of increasing interest for many researchers.

The main contributions in the field of the seismic source deal with increasing the resolution of constraining the source parameters and determination of scaling relationships among these parameters over an extended size domain. The recent advance in both observations and computer simulations has strongly increased our performance in constraining the source parameters over a broad magnitude range. The investigations were focused on Vrancea intermediate-depth focus, where the most damaging earthquakes of Romania are generated. Inversion techniques and empirical Green's function deconvolution are applied to infer source characteristics. Standard procedures (first P-wave polarity and amplitude inversions, JHD) are applied as well on extended earthquake data sets in order to infer information on seismotectonics and stress field.

Another important issue is the physical interpretation of the spatial, temporal and size distributions of earthquakes, their clustering and scaling properties. Both crustal and intermediate-depth earthquake sequences have been considered. The relative deconvolution methods, like spectral ratios or empirical Green's function deconvolution were applied to retrieve the source parameters. The inversion of the waveforms recorded for small earthquakes ($M_L < 4$) has been applied to retrieve the seismic moment tensor and source time function. All the information obtained on source parameters and scaling has been used to characterize the main properties of the seismogenic zones of Romania as input data for seismic hazard deterministic computation.

Following one of the main targets of the NIEP, considerable amount of work has been carried out to model the influence of the seismic source on seismic hazard distribution and to simulate the strong ground motion characteristics in dense-populated areas of Romania, and first of all in Bucharest. Hybrid and analytical techniques in two-dimensional models were applied and proved encouraging when compared against observation accelerograms.. Partly the research is made in cooperation with the University of Trieste (Italy) (bilateral cooperation programme, NATO SfP project, UNESCO-IUGS-IGCP projects) and University of Karlsruhe (bilateral cooperation programme, NATO projects).

Numerical simulations of the earthquake process in the Vrancea zone were proposed, in a continuous attempt to integrate different scale processes in a unified seismogenic system. Concepts such as multi-asperity, percolation, phase transition models were adopted to this respect.

Seismotectonics

Several new models of the seismotectonics in the Vrancea seismic region were proposed in the last years. Other studies were focused on the correlation between seismotectonics, earthquake focal mechanism, structure of the deep crust in the seismic active zones of the Carpathians foredeep, Dobrudja and Southern part of the Transylvanian depression.

Focal mechanism solutions were analysed in order to determine the stress field and to correlate with the seismicity.

Implications of paleomagnetic research on seismotectonics in the Carpathians region were studied.

Wave propagation

The study of the wave propagation represents one of the main directions of research in the NIEP. The modal summation technique developed within the Department for Earth Sciences of Trieste is applied to compute complete synthetic waveforms for one-dimensional and two-dimensional structural models for different urban areas of the country.

Seismic tomography imaging for three-dimensional velocity structure of the Vrancea subducting zone using teleseismic and local body wave travel times was carried out using the data observed during the experiment of tomography CALIXTO'99. The experiment was achieved in the framework of the project "Strong Earthquakes: A Challenge for Geosciences and Civil Engineering" (CRC461 Programme of the University of Karlsruhe) with the participation of five countries (Romania, Germany, France, Swiss and Italy). A network of 120 (short-period and broad-band) instruments has been installed in 1999 over an area of about 140.000 km^2 around Vrancea region for a time interval of six months.

Significant results were obtained as concerns the strong lateral variation in the attenuation of the seismic waves generated in the Vrancea focus towards the back-arc region relative to the fore-are region. Systematic regional-scale variations in the dominant periods and amplitudes of the body waves indicate regional variations in attenuation (Q factor) in the upper mantle. The asymmetry in ground motion distribution around Vrancea seismic area may yield a strong test of slab detachment and continental lithosphere delamination hypotheses put forth to explain the unusual seismicity and volcanism of the Carpathian arc. Also has major impact on the seismic hazard distribution with typically unusually low values toward NW (Transylvanian Basin).

Seismic hazard

The seismic hazard assessment is a crucial step towards mitigation of urban earthquake risk and improvement of disaster prevention management. Vrancea earthquakes are documented for a millennium (since 984 a.c.) and represent very peculiar characteristics. They are a permanent threat for urban areas on the Romanian territory and extended areas in Europe. Bucharest is among the megacities mostly affected by destructive earthquakes. Extensive studies concentrate on the characterisation of the macroseismic field of Romanian earthquakes, such as Vrancea intermediate-depth events, Fagaras and Banat crustal earthquakes.

An essential step was the collecting of seismicity and geotechnical data, including information on historical seismology. A large amount of historical information has been re-evaluated. Different magnitude estimations were calibrated against observation data. An important parameter necessary to define the seismic hazard evaluation is the maximum magnitude. On the basis of these data, the seismic zoning map of the Romanian territory has been obtained. Finally, the seismic hazard was evaluated by probabilistic and deterministic approaches.

To apply the probabilistic approach, attenuation laws corresponding to Vrancea earthquakes were empirically determined in terms of macroseismic intensity and peak ground acceleration and a maximum magnitude value was prescribed.. In parallel, attenuation relationships for quarry blasts were studied.

Recent advances in computer technology make possible the use of the deterministic numerical synthesis of ground motion for seismic hazard calculations. The deterministic approach is completely different and complementary to the probabilistic approach. It addresses some issues largely overlooked in the probabilistic approach: (a) the effect of crustal properties on attenuation are not neglected; (b) the ground motion parameters are derived from synthetic time histories and not from overly simplified attenuation "functions"; (c) the resulting maps are in terms of design parameters directly, and do not require the adaptation of probabilistic maps to design ground motions; (d) such maps address the issue of the deterministic definition of ground motion in a way which permits the generalization to locations in which there is little seismic history.

Earthquake prediction

The failure in predicting the recent strong earthquakes of Northridge, California (1994), Kobe, Japan (1995) and Sahalin (1995) drew attention on the serious limitations of the standard earthquake prediction methods and at the same time provoked seismologists to look for new approaches of this extremely complex problem.

Vrancea seismogenic zone is a conspicuous active area in terms of its extraordinary seismotectonic features, outstanding persistent and highly recurrent seismicity displaying a

remarkable regularity in occurrence of large events and manifestation of a plethora of geophysical precursors and severe socio-economic impact with a huge felt area.

Extensive analyses in order to detect premonitory changes in seismicity patterns as possible precursors of the Vrancea strong shocks were performed for past and future earthquakes. Analysis and discussions of a variety of precursory seismicity patterns belonging to all temporal developmental stages of the preparatory geophysical process leading to the major Vrancea earthquake of August 30, 1986 were performed and documented, clearly proving that the earthquake would not has been unexpected .

Different algorithms, like CN and the geostatistical method were applied to predict the strong Vrancea earthquakes.. The CN algorithm (Keilis-Borok&Rotwain, 1990) has been initially created for the retrospective analysis of the seismicity patterns which precede the strong earthquakes within California-Nevada regions. The algorithm has been modified so that it can be applied, without any parameters adjustment, for all the seismic regions in the world. The method consists in analysis of a set of precursory phenomena reflected in the temporal evolution of the seismicity recorded in the earthquake catalogue. Although it was firstly conceived for crustal events, the CN algorithm can be also applied for prognosis of the intermediate earthquakes. The results are different depending on the seismic region which is under study. Thus, in case of Vrancea and Sicily regions where the paleosubduction is one of the possible interpretations, the results are positive (in case of Vrancea the strong earthquakes from 1977, 1986 and 1990 have been predicted), while for intermediate earthquakes within the regions where the subduction is still active, the algorithm can not be applied.

It has been recently experimented the electromagnetic and infrasonic methods to predict Vrancea intermediate-depth earthquakes and look for seismo-electromagnetic and infrasonic precursors.

Participation of the Romanian specialists in working groups involved in national and international projects or programmes

In the past four years the Romanian seismology has been actively contributing to:
(1) *world-wide interdisciplinary international research programs*, such as:

-Romania's technical participation in support of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The National Institute for Earth Physics hosts the Romania's National Data Centre (NDC), with operates the seismic station Cheia-Muntele Rosu (MLR) for its uninterrupted participation to the global monitoring network of the verification system, and co-operates with national and international organizations for upgrading and maintaining. NDC receives and analyzed the data coming from MLR station and from the International Monitoring System, as well the products of the International Data Centre (IDC) from Vienna, Austria.

- "International Lithosphere Program" (ICL) of the Inter-Union Commission for the Lithosphere.

- UNESCO-IGCP project 414 **"Realistic modelling of seismic input for megacities and large urban areas"**, comprises institutes from 12 countries (National Institute for Earth Physics - Bucharest, Romania, Department of Earth Sciences - Trieste, Italy, Central Laboratory for Seismic Mechanics and Earthquake Engineering - Sofia, Bulgaria, Geodetic & Geophysical Research Institute - Hungary, Geofiziki Zavod - Zagreb, Croatia, Institute of Geophysics - Beijing, China, Centro Nacional de Investigations Sismologicas - Cuba,

International Institute of Earthquake Prediction Theory and Mathematical Geophysics - Moscow, Russia). The project is deployed between 1997 and 2002 and Romania is one of the key participants. Bucharest was one of the selected megacities around the world as case study to develop seismic damage scenarios and measures to seismic risk mitigation.

- NATO project within Science for Peace Program **"Impact of Vrancea Earthquakes on the Security of Bucharest and other Adjacent Urban Areas"** (Project SfP 972266) (1999-2003), in collaboration with Italy and Russia.

The project provides decision-makers with key elements of seismological nature, necessary for the reduction of the damage from Vrancea earthquakes: (i) realistic modelling of seismic ground motion, providing the base for pre-disaster orientation; (ii) hazard prediction, risk assessment, and hazard mapping; (iii) intermediate-term earthquake prediction, providing the base for earthquake preparedness. The results of the project have been collected in two monographs, in nineteen scientific papers and presented at international scientific conferences, and to end-users: at the Workshop at ICTP in Trieste, 2001, at the Conference of Seismic Engineering in Bucharest, 2001, at the Symposium "25 Years of Research in Earth Physics and one Century of Seismology in Romania" in Bucharest, 2002, and at the Conference "Earthquake Loss Estimation and Risk Reduction", Bucharest, 2002.

-UNESCO-UVO-ROSTE 875.669.9: **"Seismic safety of urban areas: ground motion modelling and intermediate-term earthquake prediction"** - 1999-2004.

Project associated to the UNESCO IGCP 414 project and NATO SfP 972266 project, focused on the strong ground motion characterization in selected urban areas and intermediate-term prediction using CN, M8 and MSc algorithms.

-CERGOP: "The Central European Regional Geodynamics Project.

- European Commission Project, contract no. EVR1-CT-2000-40007: **"Mediterranean European Rapid Earthquakes Data Information and Archiving Network" (MEREDIAN) – 2004-2006**

(http://www.orfeus-eu.org/meredian/meredian.htm)

A large participation from The Netherlands, Bulgaria, Czech Republic, Estonia, France, Hungary, Italy, Malta, Poland, Romania, Russia, Slovakia, Spain was settled in order to integrate different seismological networks and set a common database procedures for archiving and processing earthquake data. The main goal of the project is to achieve a unitary system of communication and exchange of seismic data in real time was developed at European scale.

Objectives:

- Improving and securing data archives;
- Improving rapid cross-border data exchange;
- Developing European distributed seismological data base and software;
- Standardization of data exchange protocols.

- NATO Science for Peace Project 981882 (2006 - 2008): "**Site-effect analyses for the earthquake-endangered metropolis Bucharest, Romania"**

The main objective is earthquake risk mitigation and better seismic safety of Bucharest, the capital of Romania. As there is a major gap in knowledge concerning seismic and geotechnical parameters in the shallow (< 100 m), unconsolidated soil and sediment layers, we shall to drill 8 boreholes. By conducting seismic measurements at the boreholes and geotechnical analysis of the core samples, the dynamic parameters of soils and rocks will be determined. These dynamic parameters will be used as input for linear and non-linear waveform modelling to estimate the seismic amplitude amplification at specific sites in

Bucharest. These modelled waveforms will be compared and calibrated with observations from seismic stations in the city. The results from the site-effect analysis will be gathered in an updated seismic microzonation map of Bucharest which will be disseminated to the public and especially to the end-users who will introduce our results in the future city planning.

- European Commission Project, FP6-2005-GlOBAL-4, contract no. 036935: **"Seismic Early Warning for Europe"** (SAFER), 2006-2009.

The main goal of the project is to mitigate the seismic risk in Europe. The project puts Europe at the level of the non-European leading countries in this area.

Objectives:

- Development of improved algorithms for fast determination of earthquake source parameters (real time event detection and –location, real-time fault mapping as well as new approaches for fast magnitude/moment determinations based on strong motion data, modern seismic array technology or the concept of energy magnitude)
- Further elaboration of new concepts, including the virtual seismologist, for providing in an evolutionary process real-time alert maps and predicted shake maps within seconds and minutes as well as measured shake maps within a few minutes.
- Development of fast algorithms for damage scenario simulations and improvement of the existing methods for real-time simulation and prediction of earthquake triggered secondary landslides and related losses.
- Deployment of real-time structural control mechanisms for immediate protection of endangered structures and devices.
- Improvement of the reliability of assessments of the aftershock hazard in real-time.
- Applications to selected test cities (Istanbul, Bucharest, Atens, Napoli, Cairo)

-European Commission Project, FP6-2004-infrastructures-5, contract no. 026130 - **"Network of Research Infrastructures for European Seismology"** (NERIES), 2006-2009 (http://www.orfeus-eu.org/neries/neries.htm).

The project involves a consortium of 25 institutes form different countries of Europe.

Objectives:

- Foster the construction of a pan-European-Mediterranean cyber-infrastructure to serve the needs of the scientific seismological community and facilitate future research
- Network the main partners in seismology from the users and infrastructures communities to facilitate cross-disciplinary fertilizations and a wider sharing of knowledge
- Facilitate the expansion of the geographical availability of seismological data and the quality control of the data
- Develop synergies and complementary capabilities among operators of similar seismological infrastructures in order to offer an improved access to researchers
- Develop a single portal to provide remote access to all classes of seismological data to the wider research community, delivering a unified service to the whole community
- Enhance and facilitate the access to and utilization of key specialized seismological facilities
- Foster the development of the next generation of tools for future instrumental observations
- Reduce the fragmentation of the research community and foster an increase of the critical mass to work effectively on large-scale issues
- Network archives of data of high significance for seismic hazard assessment: historical instrumental records, earthquake damage intensity data, strong-ground motion recordings

- Invest in capacity building and technology transfer to ensure the access to modern technologies for infrastructures and the larger scientific community in the Euro-Med region
- Develop strategies and tools for long-term sustainable access to seismological infrastructures

(2) *regional projects*:

-COST 625 (1999-2005): **"3D monitoring of active tectonic structures"**

13 participating countries from Eastern and Central Europe are involved in the project.

(3) *national programs and projects*:

-National programmes for research and development: **CALIST**, **CERES**, **MENER**

(4) *bilateral cooperation:*

A long-term bilateral program on **"Strong Earthquakes: a Challenge for Geosciences and Civil Engineering"** with the Collaborative Research Center 461 of University of Karlsruhe (Germany) has been active since 1996 (Informaţii: http://www-sfb461.physik.uni-karlsruhe.de/).. The project implies extended interdisciplinary works focused on strong ground motion seismology and seismic hazard and risk due to Vrancea earthquakes. The seismology research objectives are approached within two subprojects: (1) Seismic Tomography of the Carpathian Arc and (2) Seismogenic Potential of the Vrancea Subduction Zone - Quantification of Source and Site Effects from Strong Earthquakes.

Several important subprojects were dealing with seismic hazard and microzonation subjects:

- Assessment resulting seismic hazard mapping of Romania using a probabilistic approach (Ardeleanu et al., 2005).
- Implementation of an early warning system in Bucharest for the Vrancea intermediate-depth earthquakes (Wenzel et al., 2001).
- Urban Seismology: A broad band experiment in the City of Bucharest, Romania. Monitoring of Bucharest City to get Shake Map/2003-2004 (Ritter et al., 2005).

The German partner has assisted the NIEP in installing and maintaining the digital accelerometer network on the Romanian territory. Romanian seismologists have been participating in research working groups as applied training or visiting scientists in several common working stages at the Institute of Geophysics of Karlsruhe for seismic profile data interpretation, tomography using local data, seismic source studies, early warning system, shakemap, hazard and microzonation.

The bilateral project on "Seismic microzoning of Bucharest" with the University of Trieste (Italy) has the goal to estimate the ground motion parameters due to waves coming from complex seismic sources and propagating in highly realistic structural models to mitigate the seismic risk in Bucharest metropolitan area.

During several stays as visiting scientists at ICTP and DES - University of Trieste, a group of researchers from NIEP worked within different NATO and EC projects focused on Vrancea earthquakes and their implications to the seismic hazard using the deterministic method developed at DES – Trieste. Complex research on microzonation, seismic source and earthquake prediction (CN method) was carried out on this occasion.

The scientific co-operation between Romania and Switzerland (project SCOPES nr. 7SUPJ062404, 2000-2003) **"CALIXTO - Seismic Tomography in the Vrancea Region, Romania"** was focused on seismic tomography studies using the data achieved during the CALIXTO'99 experiment in Romania.

The bilateral project with the National Science foundation (project EAR-0230336, 2004 – 2006) **"Seismic Attenuation and Anisotropy in the Carpathians and Adjacent Basins: Upper Mantle Role in the Last Stages of Tethyan Closure"** focused on the problem of inhomogeneous lithosphere structure beneath Vrancea region and its implications on seismotectonics, geodynamics and seismic waves attenuation.

A bilateral cooperation between the National Institute for Earth Physics (NIEP) and the Air Force Technical Applications Center (AFTAC) of the United States of America started in 1999 aiming at installing and operating a seismic array in the northern part of Romania (Bucovina array). The array consists of 9 short-period stations and 1 broadband station and started to be fully operational in July 2002. Another bilateral cooperation (NIEP and the Geoforschungszentrum Potsdam - GFZ) has been active since 1999 for the operation of the broad-band station Cheia - Muntele Rosu (belonging to the GEOPHON network). An important upgrade of the Cheia – Muntele Rosu station, as well as of the National Data Centre in Bucharest has been done since 1999, involving both technical cooperation with the Government of Japan and technical assistance from the CTBT Organization. Hence, in the fall of 2001 a new seismic monitoring system was installed and is now fully operational, by recording continuous earth motion data at Muntele Rosu site and transmitting these data in real-time to the facilities in Bucharest, in the framework of the Japan International Cooperation Agency project „Technical Cooperation for Seismic Monitoring System in Romania". Also, during 2001-2002, the CTBT Organization has supported the site preparation works at the seismic station Muntele Roşu and supplied equipment for establishing reliable data communications links between the seismic station, the NDC and the International Data Centre from Vienna.

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PART II: STRUCTURE OF THE LITHOSPHERE

Research activities regarding the lithosphere studies are carried out by the National Institute for Earth Physics, Institute of Geodynamics "Sabba Stefanescu", and the Faculty of Geology and Geophysics (University of Bucharest).

The interpretation of deep seismic data collected in some previous projects in several areas of Romania has been the main target of these studies. Mainly the final models and geological interpretation of the international VRANCEA 99 and VRANCEA 2001 projects were performed. Magnetotelluric research and heat flow and gravity modelling also contributed to this objective.

The two projects VRANCEA 99 and VRANCEA 2001 belong to the lithosphere program of the Collaborative Research Center (CRC) 461, University of Karlsruhe, Germany: **STRONG EARTHQUAKES: A CHALLENGE FOR GEOSCIENCES AND CIVIL ENGINEERING.**

VRANCEA 99 project:

German team: Dr. Franz Hauser, Dr. Claus Prodehl, Dr. Werner Fielitz
Romanian team: Dr. Victor Raileanu, Dr. Andrei Bala

A P-wave velocity model was performed in 2001 (Tectonophysics, 340, 233-256, 2001). Based on geometry of P-wave model and on the later arrivals of the S-waves, a S-wave velocity model and a density crustal model is carried out (Tectonophysics, 410, 251-272, 2005). The S-wave model show a increasing in depth of S wave velocities and a slighter variation on the horizontal direction. In sedimentary cover S-wave velocity increase from less 1.0 km/s at surface to Vs=3.25 km/s at its base located at 8-11 km depth. In the crystalline crust Vs increases from 3,40 km/s at the top of basement to 4.07 km/s at Moho. Poisson ratio's is variable in sedimentary layer, between 0.22-0.33 and in cristalline crust about 0.24-0.25. Density of sediments is increasing as well from 2.35 g/cm^3 at surface to 2.62 g/cm^3 at base. Cristalline rocks have 2.70 g/cm^3 in upper crust and 2.85 g/cm^3 in lower crust. Upper mantle has about 3.25 g/cm^3.. Composition of sedimenatry cover is variable from sands, sandstones and clays in upper part to limestones, sandstones, conglomerates and dolomites at base. Cristalline crust has some metasediments on the top of basement, granite, granodiorite, granite-gneiss and/or felsic amphibolite-gneiss for middle levels and gneiss and/or amphibolite for lower crust.

VRANCEA 2001 project:

German team: Dr. Franz Hauser, Dr. Claus Prodehl, Dr. Werner Fielitz, Dr. Michael Landes
Romanian team: Dr. Victor Raileanu, Dr. Andrei Bala

In order to study the lithospheric structure in Romania a 450 km long WNW – ESE trending seismic refraction project was carried out in August/September 2001. It runs from the Transylvanian Basin across the East Carpathian Orogen and the Vrancea seismic region to the foreland areas with the very deep Neogene Focsani Basin and the North Dobrogea Orogen on the Black Sea.

A total of ten shots with charge sizes 300 - 1500 kg were recorded by over 700 geophones. The data quality of the experiment was variable, depending primarily on charge size but also on local geological conditions. The data interpretation indicates a multi-layered structure with variable thicknesses and velocities. The sedimentary stack comprises up to 7 layers with seismic velocities of 2.0 - 5.9 km/s. It reaches a maximum thickness of about 22 km within the Focsani Basin area. The sedimentary succession is composed of (1) the Carpathian nappe pile, (2) the post-collisional Neogene Transylvanian Basin, which covers the local Late Cretaceous to Paleogene Tarnava Basin, (3) the Neogene Focsani Basin in the

foredeep area, which covers autochthonous Mesozoic and Palaeozoic sedimentary rocks as well as a probably Permo-Triassic graben structure of the Moesian Platform, and (4) the Palaeozoic and Mesozoic rocks of the North Dobrogea Orogen. The underlying crystalline crust shows considerable thickness variations in total as well as in its individual subdivisions, which correlate well with the Tisza-Dacia, Moesian and North Dobrogea crustal blocks. The lateral velocity structure of theses blocks along the seismic line remains constant with about 6.0 km/s along the basement top and 7.0 km/s above the Moho. The Tisza-Dacia block is about 33 to 37 km thick and shows low velocity zones in its uppermost 15 km, which are presumably due to basement thrusts imbricated with sedimentary successions related to the Carpathian Orogen. The crystalline crust of Moesia does not exceed 25 km and is covered by up to 22 km of sedimentary rocks. The North Dobrogea crust reaches a thickness of about 44 km and is probably composed of thick Eastern European crust overthrusted by a thin 1 - 2 km thick wedge of the North Dobrogea Orogen.

A crustal model based on P-wave arrivals is performed and then interpretated in structural terms (Tectonophysics, 430, 1-25, 2007).

PARTICIPATION IN INTERNATIONAL PROJECTS

The Collaborative Research Center 461: "Strong Earthquakes: A challenge for Geosciences and Civil Engineering", at the University of Karlsruhe, Germany, and the "Romanian Group for Strong Vrancea Earthquakes", Bucharest, collaborate since 1996 in a multidisciplinary attempt towards understanding Vrancea seismicity and mitigating seismic risk in Romania.

More details about projects within the Collaborative Research Center (CRC) 461 related to lithosphere study: http://www-sfb461.physik.uni-karlsruhe.de

SUBPROJECT A1:
DEEP SEISMIC SOUNDING OF THE VRANCEA ZONE

Project leaders: Dr. J.R.R. Ritter, dr. T. Forbriger, Geophysical Institute, Karlsruhe University.

Romanian partners: S. Balan, Gh. Marmureanu, V. Raileanu, A. Bala, National Institute for Earth Physics, Bucharest, Romania.

SUBPROJECT A2: SEISMIC TOMOGRAPHY OF THE CARPATHIAN ARC

Project leaders: Prof. Dr. Friedemann Wenzel, Geophysical Institute, Karlsruhe University.

Romanian partners: Dr. Mircea Radulian, National Institute for Earth Physics, Bucharest, Romania.

International Cooperation

Access to Research Infrastructure:

Dr. Andrei Bala have participated in the period 1 - 29 February and 21 Nov. - 19 Dec. 2004 in a research stage in NORSAR Seismological Centre, Oslo, Norway in the frame of Access to Research Infrastructure (ARI) Contract HPRI-CT-2002-00189. A paper was presented during this period: "H/V spectral ratio as a discriminant between shalow earthquakes and chemical explosions from quarries in Romania".

COST 625 Action: 3D Monitoring of active Tectonic areas (2001 - 2006).

In the years 2003 - 2006 continued the meetings in the COST 625 Action, with the participation of dr. Andrei Bala and dr. Aurelian Pantea from NIEP.

In 2004 the Romanian specialists organized the 8-th International Workshop in the frame of COST 625 action: 3D monitoring of Active Tectonic Areas, 23 – 25 September 2004, Bucharest, Romania. In this meeting took part 30 specialists participants in the COST 625 Action.
The scientific approach followed in COST Action 625 included integrated studies of tectonically active fault zones in different areas in Europe. The studies were mostly focused at understanding the kinematics behaviour of the different zones, at assessing their seismic potential, at identifying and characterizing the various fault segments making up the zones, and at establishing the appropriate instrumental devices for an efficient monitoring system.
Various areas in Europe were selected as test sites for such integrated monitoring methodologies, which were interesting for their relevance under geologic-tectonic aspects, seismic hazard, civil and engineering structures or cultural objects.
Dr. Andrei Bala took part in 2003 and 2005 in two Short Time Scientific Missions in the frame of COST Action 625 at the University of Thessaloniki, Greece. Specific subjects about the mechanism of the earthquakes in Romania were analyzed in these research missions.

PART III: ENGINEERING SEISMOLOGY

The evaluation and mitigation of the seismic risk is one of the permanent and urgent problems facing the Romanian society, equally implying work of seismologists, geologists and engineers. Significant efforts were made to predict the peak values and spectral characteristics of the strong motion in large urban areas, like Bucharest. At the same time, important efforts were made to determine the site effects and microzonation maps for the same city.

Every damaging earthquake demonstrates the importance of the local site effects and their worsening of the damage and economic losses. Another open problem is the correct definition of the local site effect and the possibility to control it to a certain degree. The experience gained of some recent earthquakes (Kobe, Loma Prieta, Mexico, etc.) shows the importance of quantifying the physical parameters of the local site and other local conditions which can affect the severity of ground shaking that a site may experience and the potential for locally induced effects, such as landslides, liquefaction, floods, fires, etc.

A number of studies have significantly contributed to the establishing of the response spectra to be used in connection with the large intermediate-depth earthquakes generated by the Vrancea region of Romania and the existing European Building Code Eurocode 8 was critically reviewed and improvements were suggested to orient it to the Carpatho-Balkan region.

The modal summation method and finite differences technique were applied to calculate the expected ground motion in Bucharest due to large intermediate-depth Vrancea earthquakes. The results outlined that the presence of alluvial sediments and the possible variation of the event scenario require the use of all three components of motion for a reliable determination of the seismic input.

Study of dynamic parameters of soils by using resonant columns and geophysical methods, realistic modelling of seismic input taking into account source, wave path propagation and local site effects have been permanent tasks for Romanian seismologists and

important outcomes for seismological engineers. Laboratory analyses were made also to determine the attenuation effects for surface layers and its dependence on the strain level induced by large earthquakes.

The role of the non-linear effects in the local site response has been the subject of several studies outlining their important contribution to the strong motion in Bucharest area. This will be a challenge for seismological research in the next years.

Examples of achievements related to microzonation, hazard and shake maps are given below:

NATIONAL PROJECTS

CEEX PROGRAM 2005-2008: Advanced studies on local seismic hazard (microzonation) for important cities located outside of the Carpathians Belt. Case studies for Iasi, Bacau, Buzau and Craiova .

Partners : University of Bucharest- Faculty of Geology and Geography, INCERC and Romanian Academy – Solid Mechanics Institute.

The objective of this project is knowledge accumulation on the competitive base at the European and international level, to obtain results and experience in the Earth physics and to transfer them to the economic and social activities from Romania. The proposal is correlated with the S/T thematic area, concerning natural hazards, observation and evaluation of the Earth and especially the earthquake research (deterministic and probabilistic analyses, linear and nonlinear wave propagation). Results of this project will consist of the local seismic hazard maps (microzonation) for the Iasi, Bacau, Buzau and Craiova cities and of data base for Romania SHAKE MAP performance. On the international level knowledge in this field were focused on the shallow earthquake which are numerous and notorious at the international scale. In case of our country the most important are the intermediate–depth Vrancea earthquakes which affect seriously the extra-Carpathian territory and partially neighbouring country (Bulgaria, Moldavia, and Ukraine). The main goal of this project is to mitigate the effects of these earthquakes. Edification of a culture of the prevention is not a facile work, the costs of prevention are made at the present, their benefits appear in the future (Kofi Anan).

Consortium formed by NIEP, Geological and Geophysics Faculty, INCERC and Institute of Solid Mechanics of Romanian Academy allows an optimal valorisation of the scientific potential from Romania and a real involvement in FP6 and FP7 European Projects and increases the Romanian capacity to supply experts for the international scientific and technical collaborative programs.

CEEX- 144/2006 – 2009: Earth Physics complex researches for final seismic Hazard map of Romania by probabilistic and deterministic approaches, linear and nonlinear methods/HHRO

Partners : University of Bucharest- Faculty of Geology and Geography, INCERC and Romanian Academy – Solid Mechanics Institute, University of Iassy – Faculty of Mathematics.

The seismicity of Romania comes from the released energy of **crustal** earthquakes, which have a depth not more than 60 km, and by the **intermediate** earthquakes coming from Vrancea region (the only European case) with a depth between 60 and 200 km. Vrancea earthquakes, the main ones in Romania, are belonging to the biggest calamities that take place around the world. **The objective** of this project is knowledge and experience gaining, at European and global level, in the field of fundamental research of Earth physics, in general, of seismology, in principal, based on competition, and transferring them to economic and social

environments of Romania, in order to increase its ability, national security, in order to protect the population against Romanian destructive earthquake. The proposal belongs to the thematic areas (code 6.1) regarding "natural disasters" generated by Romanian earthquakes from Vrancea, Banat or South Dobrogea areas, but because it is an Earth physics project, we used fundamental sciences (code 11) "like mathematics and physics" to solve the complex problem of evaluating the seismic hazard on Romanian territory, by using probabilistic and deterministic methods, linear and nonlinear analysis, and the wave propagation phenomena in viscoelastic nonlinear layers, on the path from focus-bedrock-free surface, of studied area. The result of this project is mainly the Romanian hazard seismic map. The consortium composed by INCDFP, Faculty of Geology and Geophysics, University of Bucharest, INCERC, Mathematics Faculty-Iasi University A.I.Cuza, Solid Mechanics Institute belonging to Romanian Academy allows an optimal valuation of the scientifically Romanian potential and a real commitment in the European project FP6 and FP7. The project belongs to the national politics in the field. In the HG 372/2004-"Seismic Risk National Management Programme", at page 5 the following objective is present: "Romanian seismic hazard map".

INERNATIONAL PROJECTS

NATO Science for Peace Project 981882 (2006 - 2008): "**Site-effect analyses for the earthquake-endangered metropolis Bucharest, Romania" in cooperation with Karlsruhe University, Germany.**
The main objective is earthquake risk mitigation and better seismic safety of Bucharest, the capital of Romania. As there is a major gap in knowledge concerning seismic and geotechnical parameters in the shallow (< 100 m), unconsolidated soil and sediment layers, we shall to drill 8 boreholes. By conducting seismic measurements in the boreholes and geotechnical analysis of the core samples, the dynamic parameters of soils and rocks will be determined. These dynamic parameters will be used as input for linear and non-linear waveform modelling to estimate the seismic amplitude amplification at specific sites in Bucharest. These modelled waveforms will be compared and calibrated with observations from seismic stations in the city. The results from the site-effect analysis will be gathered in an updated seismic microzonation map of Bucharest which will be disseminated to the public and especially to the end-users who will introduce our results in the future city planning.

The Collaborative Research Center 461: "Strong Earthquakes: A challenge for Geosciences and Civil Engineering", at the University of Karlsruhe, Germany, and the "Romanian Group for Strong Vrancea Earthquakes", Bucharest

SUBPROJECT B6: GEOTECHNICAL AND SEISMIC MICROZONATION OF BUCHAREST
Project leader: Prof. J. Rohn
Romanian partners: V. Ciugudean, METROUL S.A.;
M. Radulian, S. Balan, A. Bala, National Institute for Earth Physics, Bucharest, Romania.

Organization of national and international scientific conferences

- Workshop: General Assembly of Bucharest Geoscience Forum, Bucharest, April 10, 2003; in cooperation with Univ. Bucharest, Prospectiuni S.A., etc.

- Workshop on Geophysical Research Section – SFB 461, Univ. Karlsruhe, Project CRC 461, April 14-16, 2003; in cooperation with Univ. Karlsruhe, INCERC, GEOTEC S.A., Univ. Bucharest;
- Annual Session of the Faculty of Physics, Bucharest, May 30, 2003;
- The Stephan Muller Conference of the European Geosciences Union, Geodynamic and Tectonic Evolution on the Carpathian Arc and its Foreland: Environmental Tectonics and Continental Topography, Retezat Mountains, May 31-June 05, 2003; in cooperation with Univ. Bucharest;
- Workshop: The Romanian-German Cooperation, Vrancioaia, July 4-6, 2003: "The Vrancioaia-Ploştina early warning system and the shake /quake map"; in cooperation with Univ. Karlsruhe;
- Workshop on national network systems in the Balkan area, September 21 -28, 2003, Athens (MEREDIAN project); in cooperation with Univ. Athens;
- Workshop on Geophysical Research Section – SFB 461, Univ. Karlsruhe, Project CRC 461, November 22-24, 2003; in cooperation with Univ. Karlsruhe, INCERC, GEOTEC S.A., Univ. Bucharest;
- Workshop on Geophysical Research Section – SFB 461, Univ. Karlsruhe, Project CRC 461, January 16-20, 2004; in cooperation with Univ. Karlsruhe, INCERC, GEOTEC S.A., Univ. Bucharest;
- Annual Session of the Faculty of Physics, Bucharest, May 31, 2004;
- Fifth meeting of the Joint Scientific Commission – the Air Force Technical Application Center and the National Institute for Earth Physics, March 13-18, 2004, Patrick Air Force Base, Florida;
- Workshop: The ANTELOPE and the SHAKE MAP Programs to users; Bucharest, May 6-8, 2004; in cooperation with Kinemetrics and USGS (USA);
- 8-th International Workshop 3D Monitoring of Active Tectonic Areas, Bucharest, 22-26 September 2004
- 4th Congress of the Balkan Geophysical Society, Bucharest, 9-12 October 2005, "Bucharest 2005" - RSG-BGS / EAGE & SEG / EGU & AGU International Conference & Exposition of Applied Geophysics and Earth Physics
- Second International Conference "Science and Technologies for Safe Development of Lifeline Systems", Section Natural Risks: Earthquakes and co-seismic associated risks, neotectonics and seismic hazard assessment in the CEI area, 24-25 October 2005, Bratislava, Slovak Republic
- 3rd National Conference of Seismic Engineering, Bucharest, 9-10 December 2005
- Workshop „Contributions to the development of seismology amd earthquake engineering in Romania", 3 March 2006, Technical University for Constructions, Bucharest
- „Seiscomp Users Group Meeting" and „ORFEUS Observatory Coordination Meeting", 8 – 12 May 2006, Prague, Czech Rep.
- Annual Session of the Faculty of Physics, 26 May 2006, Bucharest
- Workshop „Geology and Geophysics, between Tradition and Change", 26-27 May 2006, University of Bucharest.
- Expozition of Romanian achievements in research „SALONUL CERCETĂRII – 2006", CERES Programme, 4-8 October 2006, Bucharest.

Participation of the Romanian specialists in the national and international symposiums and conferences

Many of the results obtained by the Romanian seismologists in the past four years have been presented at a series of national and international meetings. There were presented 57 papers in 2003, 41 papers in 2004, 45 papers in 2005 and 53 contributions in 2006, in national and international conferences, symposiums and workshops.

International Association of Seismology and Physics of the Earth's Interior (IASPEI) meetings:

IASPEI General Assembly, 2-8 October 2005, Santiago, Chile

12 contributions related to: Inversion of high-frequency local seismograms to obtain source moment tensor; Source parameters and scaling; Seismic waves attenuation; Seismic hazard of Romania: probabilistic approach; Site response using deterministic approach and spectral ratios.

European Geophysical Society (EGS) meetings:

EGS-AGU-EGU Join Assembly, Nice, April 6-11, 2003

Two contributions related to microzonation of Bucharest city and other large urban areas in the world using a deterministic approach;

The Fourth Stephan Muller Conference of EGU "Geodynamic and Tectonic Evolution on the Carpathian Arc and its Foreland: Environmental Tectonics and Continental Topography", Retezat Mountains, May 31-June 05 2003

14 contributions focused on Carpathians tectonics and geodynamics; Focal mechanism of Vrancea earthquakes; Delamination models for the Vrancea subcrustal source; Earthquake sequences; Seismic waves attenuation; 3D modelling of the lithosphere; Site effects in the Bucharest area; GPS measurements; Shakemaps;

1st General Assembly EGU, Nice, 25-30 April, 2004

4 presentations regarding intermediate-depth seismicity, lateral variation in the attenuation beneath Southeastern Carpathians, site effects for Bucharest case, broadband experiment in the city of Bucharest.

2nd General Assembly of EGU, Vienna, 24-29 April, 2005

7 contributions related to Vrancea source parameters; noise analysis for BURAR seismic array, Romania; site analysis; shear wave splitting; probabilistic seismic hazard

3rd General Assembly of EGU, 2 – 7 April 2006, Vienna, Austria

8 contributions related to source parameters and scaling; simulation using empirical Green's functions; local soil response; shakemaps; seismicity and seismotectonics; ambient noise measurements; seismic hazard

International Union of Geodesy and Geophysics (IUGG) meetings:

XXIII General Assembly of the IUGG, June 29 - July 11, 2003, Sapporo, Japan

8 contributions related to short period waveform modelling; seismic wave attenuation; non-linear seismology; multifractal and chaotic properties of seismicity; prediction; microzonation of Bucharest.

European Seismological Commission (ESC) meetings:

19th ESC General Assembly, Potsdam, Germany, September 12-17, 2004

7 presentations on signal detection, acquisition and analysis using arrays; real-time data acquisition and processing; seismotectonics; crustal structure;

Joint ESC/EAEE Conference, Geneva, 3-8 September 2006

21 presentations on seismicity patterns; site effects; probabilistic hazard assessment; attenuation; historical earthquakes; earthquake prediction; nonlinear seismology; early warning systems; earthquake risk.

American Geophysical Union meetings

AGU Fall Meeting, San Francisco, CA, Dec. 9, 2003

2 presentations on seismic wave attenuation and modelling of the continental lithospheric delamination.

AGU Joint Assembly, 23–27 mai 2005, New Orleans, USA

One contribution regarding aftershock activity study

AGU Fall Meeting, 5–9 December 2005, San Francisco, California, USA

2 presentations on neotectonics in the Southeast Carpathians foreland and aftershock relaxation modelling.

Central European Initiative meetings:

First International Conference 'Science and Technology for Safe Development of Lifeline Systems', 4 - 5 November 2003, Sofia, Bulgaria

4 presentations on seismic hazard, strong ground motion characteristics and elastic crustal parameters..

Second International Conference "Science and Technologies for Safe Development of Lifeline systems", 24-25 October 2005, Bratislava, Slovak Republic

5 presentations on seismic hazard, shakemap, strong ground motion, early warning systems..

Participation at workshops:

- International training workshop on "Seismic Hazard in Romania: a probabilistic approach", Bucharest, 19-20 June 2005

Two participations from NIEP on probabilistic hazard assessment.

- Workshops organised by the International Centre for Theoretical Physics in Trieste "Non-Linear Dynamics and Earthquake Prediction": three participants from NIEP in 2003 and 2005.
- Workshops organised by the International Centre for Theoretical Physics in Trieste "Three-Dimensional Modelling of Seismic Waves Generation Propagation and their Inversion": two participants from NIEP in 2004 and 2006.
- Symposium on seismic anisotropy and geodynamics of the lithosphere-asthenosphere system, Trest, Czech Rep., 14-21 June 2006 (two participants)

Other participations at workshops:

- 3-rd SAMCO (Structural Assessment Monitoring and Control) Workshop, Technical Univ. of Vienna, April 28-30, 2003: 4 contributions
- CRC 461 Meeting: Strong Earthquakes a Challenge for Earth Science an Civil Engineering, Vrancioaia, 4-6 July 2003 (10 contributions)
- 3-rd DPRI-IIASA (International Institute for Applied Systems Analysis) Symposium, Kyoto University, July 3-5, 2003, Japan (one participation)
- SE-40 EEE: Skopje Earthquake 40 Years of European Earthquake Engineering, August 26-29, 2003 Skopje-Ohrid, Macedonia (one participation)
- Workshop: Working Group on Active Tectonics Action "3-D Monitoring of Active Tectonic Structures"-Sofia, Bulgaria (17.09.2003-21.09.2003) – two contributions
- General Assembly of the German Geophysical Society, Berlin, 8-12 March 2004 (2 contributions)
- Fifth Meeting of the Joint Scientific Commission. AFTAC and NIEP, March 15-16, 2004, Patrick Air Force Base-Rockledge, Florida, USA (2 contributions)
- 5th International Symposium on Eastern Mediterranean Geology", Thessaloniki, Greece, 14-20 April 2004 (5 contributions)
- 7th International Workshop 3D Monitoring of Active Tectonic Areas, 12-16 May 2004, Granada, Spain (one contribution)
- The Third European Conference on Structural Control (3ECSC), Vienna, July 12-15, 2004, Univ. of Technology (one contribution)
- 32nd International Geological Congress (IGC), Florence, Italy, August 20-28, 2004 (7 contributions)
- Workshop: "Active Tectonics & Monitorning and Instrumentation", Bratislava - Slovakia, 25 – 29 May 2005 (one contribution)
- Second Workshop on Earthquake Engineering for Nuclear Facilities: Uncertainties in Seismic Hazard Assessment, Italy, Trieste (one contribution).
- Earthquake Early Warning Workshop, 13-15 July 2005, California Institute of Technology (two contributions)
- Workshop "Earthquake Hazards around the Pacific Rim -Prediction and Disaster Prevention ", University of Kyoto, 31 August – 2 September, 2005 (one contribution)
- Earthquake monitoring and seismic hazard mitigation in Balkan countries, NATO Advanced Research Workshop, 11-17 Sept. 2005, Borovetz, Bulgaria (two contributions)
- Workshop of the Institute for Rock and Soil Mechanics – University of Karlsruhe, Germany, 25 September 2005 (two contributions)
- NDC evaluation workshop on the First System-Wide Performance Test (SPT1), Italy, 17-21 October 2005 (one contribution)
- „Seiscomp Users Group Meeting" and „ORFEUS Observatory Coordination Meeting", 8 – 12 May 2006, Prague, Czech Rep. (one contribution)
- Workshop Neogene Magmatism of the Central Aegean and Adjacent Areas, Greece, 11-13 September, 2006 (two contributions)

Other meetings with Romanian participation are:

- Annual Scientific Conference of Faculty of Physics, Bucharest, 30 May 2003 (3 contributions); 20 May 2004 (3 contributions); 29 May 2005 (9 contributions); 26 May 2006 (7 contributions)

- WG COST, Action 625, Bucharest, 22-26 September 2004
- International exposition "Conceived in Romania – CONRO", 4-10 October 2004
- Annual Meeting of the German Society of Geophysics, February 2005, Graz, Austria
- Annual meeting of Seismological Society of Japan, May 2005
- Forth Balkan Geophysical Congress, Bucharest, 9 -12 October 2005
- Meeting of Japan Society of Seismology, Hokkaido, Japan, 19-21 October 2005
- Third National Conference of the Seismic Engineering, 9 – 10 December 2005
- Japan Geoscience Union Meeting, May 2006 (one contribution)
- Symposium "Contributions to the development of the seismology and earthquake engineering in Romania", 3 March 2006, Technical University for Constructions, Bucharest (one contribution)
- Symposium „Geology and Geophysics between Tradition and Change", University of Bucharest, 26-27 May 2006 (two contributions)
- Conference "20 Years of Nonlinear Dynamics in Geosciences", 11-16 June 2006, Rhodes, Greece (two contributions)
- Western Pacific Geophysics Meeting, 24-27 July 2006, Beijing, China (one contribution)
- Third International Symposium on the effects of Surface geology on Seismic Motion, Grenoble, France, 30 August - 1 September 2006 (one contribution)
- Exposition of Romanian achievements in research „SALONUL CERCETĂRII – 2006", CERES Programme, 4-8 October 2006, Bucharest (3 contributions)

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PART IV. HEAT FLOW STUDIES

The main heat flow research activities in Romania are carried out by the Institute of Geodynamics of the Romanian Academy and by the Geological Institute of Romania, in close correlation with programmes of the International Heat Flow Commission of IASPEI. The first Romanian member of this commission, Dr. Şerban Veliciu, was elected in 1995 on the occasion of the IUGG General Assembly, Boulder, USA.

In the report interval, Romanian scientists involved in geothermal research have had an active participation in international co-operations. Among these we mention the Romanian-German cooperation in the Geothermal study of the Eastern Carpathians bend foreland, financially supported by the Romanian Academy (Institute of Geodynamics, Bucharest) and Deutsche Forschungsgemeinschaft (Geophysical Institute, Karlsruhe).

The symposia and workshops with IASPEI or with IASPEI-interest topics, attended by Romanian scientists in geothermal research in the report interval are as follows:

- EGU - AGU - EUG Assembly, Nice, France, 2003
- IUGG General Assembly, Sapporo, Japan, 2003
- AGU General Assembly, Montreal, Canada, 2004
- International Workshop on New and Classical Applications of Heat Flow Studies, Aachen, Germany, 2004
- EGU General Assemblies: Nice, 2004, Vienna 2005 - 2006 - 2007
- International Workshgop on Heat Flow and the Structure of the Lithosphere, Prague, Cyech Republic, 2006

Main topics of research and results

Geothermal modeling

A rich geothermal information acquired during the previous IUGG interval, within the framework of cooperation with the Karlsruhe University (Geophysical Institute) Germany allowed extensive studies on the geothermal regime and on the Neogene tectonic evolution of the deepest sedimentary basin in Romania, namely the Focşani (FD) depression, to be undertaken. Detailed depth-temperature profiles, obtained by continuous temperature logging in the depth ranges from 0-700 m to 0-2400 m in eight thermally stabilized boreholes with thermometers of sensitivity in the mK range, have been combined with finite element modeling of the thermal budget of the lithosphere. The thermal effects of topography, palaeoclimate changes of the surface temperatures, fluid flow, sedimentation, crustal heat production and mantle heat flux have been assessed [1-3, 10-13, 23]. According to these studies, sedimentation, palaeoclimate, undercompaction and heat refraction effects, on one hand, and the heat generated in the upper crust, on the other, combine to explain the observed subsurface temperature field, and in particular the pronounced curvature of the vertical temperature profiles.

- Due to the interplay of thermal effects of high sedimentation rate episodes (13-12.5 Ma) and subsequent thermal relaxation and new sedimentation episodes, the overall effect of the Neogene-Quaternary sedimentation is rather uniform along the study profile – a deficit of about 12mWm^{-2}, in spite of the large lateral variation of the sedimentary pile thickness. This is contrary to the common belief that the surface heat flux distribution in this basin is shaped by the sedimentary pile thickness. The strongest depression of the surface heat

flux, of about 23 mW m^{-2}, occurred during the Sarmatian sedimentation (13-11 Ma) in the deepest part of the Focşani Depression on our profile (6 km in the last 13 Ma). It gradually recovered to the present day value.

- The palaeoclimate effect is responsible for most of the observed curvature of the vertical temperature profiles and for a surface heat flux depression of 7-8mWm^{-2}, uniform along the study profile. In young sedimentary basins such as the present case, both the thermal effects of rapid sedimentation and palaeoclimatic effects contribute to the temperature field in the upper part of the sedimentary section.
- With the depth of boreholes available, the two effects cannot be separated and inversion for palaeoclimate from measured borehole temperatures is not possible.
- The lateral variation of the palaeoclimatically corrected surface heat flux from the centre of the Focşani Depression (40 mW m^{-2}) to its margin and the foreland platform (70 mW m^{-2}) is mainly the result of the lateral variation of the heat produced in the upper crust, from ~15 mW m^{-2} in the deepest part of the depression (7 km of upper crust), to ~36 mW m^{-2} in the central part of the depression (17 km of upper crust) and to about 45 mW m^{-2} in the platform area (21 km of upper crust). A heat production of 2.3 □Wm^{-3} for the southeastern end of the profile and of 2.15 □Wm^{-3} for the rest of it has been modelled.
- The sedimentation process induces a significant time-dependency of the temperature field of the underlying lithosphere with repercussions on its thermal thickness, metamorphic state and rheological behaviour. Temperature variations as large as 70-100^{o}C occurred in the crystalline crust immediately under the sedimentary pile. Progressively smaller variations were present up to 40-50 km depth.
- As a direct consequence of the temperature increase in the upper crust caused by sedimentation, the upper and the lower crust in the central part of the foreland basin at the present have a higher degree of ductility in comparison with the corresponding crustal volumes in the southeastern end of the study profile (EET values are 26-28 and 39 km, respectively). This has consequences for the mechanical interactions between the foreland and the orogen that lead to the formation and evolution of the Focşani Basin.
- The modelling results indicate a thermally defined lithosphere thickness of about 160 km. The lithosphere has not reached yet the thermal steady-state, the present temperatures being about 80-90% of the equilibrium temperatures, depending on depth and on location along the study profile.

PAST CLIMATE CHANGES INFERRED FROM GEOTHERMAL MEASUREMENTS

Borehole temperature profiles contain information about ground surface temperature history which can be retrieved by appropriate means. This field has been also successfully approached in Romania under the aegis of the International Heat Flow Commission of the IASPEI. Several research directions have been followed:

a) Borehole climatology

A set of 15 vertical temperature profiles, measured in the 1980s for heat flow purposes, were analysed from the paleo-climatological point of view and ground temperature variations in the last 500 years were derived by inversion of temperature data [8] and by modelling the underground effect of surface temperature variations recorded in the last 150 years in comparison with measured temperatures in boreholes [6, 9].

To infer the long-term evolution of surface climate conditions (a boundary constraint on borehole temperatures), 150 years long time series of air temperature and precipitation recorded in Romania were studied in connection with solar and geomagnetic forcing [14-16].

b) Air-soil heat transfer

A set of daily averages of temperatures recorded above ground (2.5 m) and in soil (0, 5, 10, 20, 50, 100 cm) at 10 meteorological stations of the automated weather network of the National Meteorological Administration in 2003 and 2004 has been studied. Several aspects of the air-soil heat transfer were discussed [4, 5, 6, 7, 22]. A signal-frequency dependent transfer in the underground was found [6, 7].

The effects of land use changes of the subsurface temperature were also investigated [17-21], with an emphasis on de- and reforestation effects, in a cooperation with the STFX University, Antigonish, Canada.

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International Association of Volcanology and Chemistry of the Earth's Interior

IAVCEI ACTIVITIES IN ROMANIA 2003 - 2007

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PART I: INTRODUCTION AND ORGANIZATION

by Alexandru Szakács
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During the inter-IUGG General Assembly time period 2003 - 2007, the small volcanological community in Romania continued to cope with serious problems related to the economic and social transition of the country in the post-communist era. Romania Joined the European Union at January 1st, 2007, a new status which hopefully will improve significantly the availability of both National and EU funds for scientific research, volcanology included, in the near future. Both financial and institutional problems influenced IAVCEI-related activities in the mentioned period. Since most of the Romanian IAVCEI members were employees of the Geological Institute of Romania, the financial crisis this institution continued to cope with, had negatively influenced geological investigation in Romania including the domains of IAVCEI interest. Many researchers actively involved in volcanological and petrological/geochemical investigation had to find alternative jobs and part of them gave up with their former research work. The strong research nucleus active in

these fields within the Geological Institute of Romania has actually dispersed. A smaller group formed at the Institute of Geodynamics "Sabba S. Stefanescu" of the Romanian Academy, but its members also dispersed during the last few years. Other research groups, such as those related to former territorial state-own geological companies also waned.

In the same time, volcanological research effort and groups have been strengthened within Universities, such as Babes-Bolyai University and Sapientia University in Cluj-Napoca and North University in Baia Mare. The "Alexandru Ioan Cuza" University in Iasi is strongly specialized in geochemistry and IAVCEI-interest research, especially related to CEI topics, is increasingly undertaken here. Shift of volcanological research from research institutions to Universities seems to be a robust trend and is expected to continue in the future. However, only few researchers are actively involved in volcanological investigation at each university center, mostly on individual basis. At this time there is no any strong and internationally recognized research group in Romania specialized in IAVCEI topics.

IAVCEI membership was fluctuating during the time period considered. Very low wages (under US$ 2500/year in general), expensiveness of bank services and job instability precluded effectiveness of new membership recruitment, while a number of former IAVCEI members gave up their membership for similar reasons. The balance between newly recruited members and members renouncing to their memberships is clearly negative. The Romanian IAVCEI membership – a former "success story" (see Romanian IUGG Report, 1999) - is obviously shrinking, and this trend could only be reversed with the expected general economic-societal progress of the country related to the recent admission of Romania in EU.

In such circumstances, the Romanian National IAVCEI Section considers further membership recruitment as one of its major current tasks. Membership "erosion" from the Group is caused by objective and subjective factors, such as inability to pay the annual membership fee because financial shortage, frustration related to unrealistic expectations upon subscription, poor fit of changing professional duties and interests with IAVCEI activities and research topics, job instability, etc. Despite of "erosion", a few scientists with constant interest and dedication in IAVCEI-related science, forms the stable and active core of the Romanian National IAVCEI Section. They are active in research and publication and are willing to take part in IAVCEI-organized activities and events.

Despite the difficulties, scientific progress in IAVCEI-related research domains has been attempted to be kept at a steady-state pace. Individual efforts have also been made to maintain and develop connection of researchers with the international community by publication, attendance of scientific meetings and assemblies, and participations in international cooperation and correlation projects.

Members of the Romanian National IAVCEI Section Committee have tried to actively interact with IAVCEI officials and leaders of IAVCEI Commissions (especially CEV and CVS) by electronic correspondence and personal contacts during international meetings whenever attendance was possible.

Research centers in Romania where IAVCEI-related topics are being investigated

Active research in IAVCEI-related scientific domains, such as paleovolcanology, petrology of volcanic rocks, igneous rocks-related mineralogy, granite studies, metamorphic petrology, geochemistry, ore geology in volcanic areas and geophysics of volcanic areas, is conducted by groups of professionals at a number of institutions in Romania, from which IAVCEI members are recruited:

- Institute of Geodynamics „Sabba S. Stefănescu", Romanian Academy;
- The Geological Institute of Romania (Department of Mineralogy and Petrology; Department of Geophysics);
- Sapientia University, Cluj-Napoca (Department of Environmental Sciences)
- „Babeş-Bolyai" University, Cluj-Napoca (Department of Mineralogy);
- North University, Baia Mare (Department of Environmental Engineering);
- University of Bucharest (Department of Mineralogy and Petrology, Department of Geophysics);
- „Alexandru Ioan Cuza" University (Department of Geochemistry), Iasi
- S.C. Prospecţiuni S.A., Bucharest;

Membership: **currently listed in the IAVCEI membership Directory**

Dumitru Ioane	**Geological Institute of Romania**
Marian Munteanu	**National Agency of Mineral Resources, Bucharest**
Eugenia Niţoi	**Geological Institute of Romania, Bucharest**
Ioan Seghedi	**Institute of Geodynamics „Sabba S. Ştefănescu", Romanian Academy Bucharest**
Alexandru Szakács	**Institute of Geodynamics „Sabba S. Ştefănescu", Romanian Academy Bucharest**
Anna Paula Vinkler	**Babeş-Bolyai University, Cluj-Napoca**

PROFESSIONAL EVENTS

Participation to major IAVCEI events and to events including IAVCEI-interest topics

- The IUGG General Assembly in Sapporo (Japan) (2003) has not been attended by Romanian IAVCEI members, but abstracts have been published by Szakacs et al. and Seghedi et al. (2003) in the Abstract volume.
- The IAVCEI General Assembly in Pucon (Chile, Sptember 2004) has been attended by Alexandru Szakács who presented 2 posters on volcano response to edifice instability and on conceptual approaches to volcanic hazard.
- The 32nd International Geological Congress, Florence (Italy) (2004) with a strong volcanological component, has been attended by Corina Ionecu, Eugenia Nitoi, Akexandrina Fulop, Anna Paula Vinkler, Alexandru Szakacs presenting various IAVCEI-related contributions, both oral and poster
- The Second International Maar Conference, Lajosmizse (Hungary) (2004) was attended, and contributed to, by several Romanian researchers (Alexandrina Fulop, Ioan Seghedi, Alexandru Szakacs) and students (Ildiko Sos, Anna Paula Vinkler).
- The XVIth Congress of the Carpatho-Balkan Geological Association (CBGA) in Belgrade, Serbia (September, 2006) has been attended by Corina Ionescu who presented a number of oral and poster contributions; other colleagues, although not attending the event personally, presented posters and published their contributions in the Abstract volume

Involvement of Romanian IAVCEI members in international cooperation projects

- Members of the Romanian National IAVCEI Section are actively involved in a number of bilateral or multilateral co-operation projects, more or less related to IAVCEI-interest research topics, involving scientists who are or are not IAVCEI members.
- The sixth phase (2007-2012) of a long-term inter-Academic bilateral co-operation project involving scientists from Romania and Hungary is running. Its current topic is the "Comparative study of space and time and genetic relations of Neogene magmatism in the Oas-Gutii/Baia Mare volcanic region and Apuseni Mts., Romani ". The study profits of the K-Ar, and recently Ar-Ar, dating facilities of the Institute of Nuclear Research of the Hungarian Academy of Science (ATOMKI) in Debrecen. IAVCEI members Alexandru Szakács and Ioan Seghedi are involved.
- IGCP Project 455 ”Volcano-basement interaction and related natural hazard” (2003-2005): Alexandru Szakács was involved.

PART II: PROGRESS REPORT OF SCIENTIFIC RESEARCH IN RELEVANT IAVCEI-INTEREST DOMAINS IN ROMANIA

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Romanian researchers, whether IAVCEI members or not, achieved significant progress of knowledge in a number of research domains which are in the broader or tighter circle of interest of IAVCEI. The following report review the principal scientific achievements in the fields of volcanology, petrology of volcanic rocks, granite studies, metamorphic geochemistry and geophysical investigation of volcanic terrains in Romania and its broader environment, the Carpathian-Pannonian area.

STUDIES IN VOLCANOLOGY AND PETROLOGY OF VOLCANIC ROCKS

Although Romania does not host active volcanoes, yet it is the site of widespread and intense volcanic activity in the not too far geologic past. Morphologically well preserved volcanic edifices and features such as scoria cones, lava dome complexes, composite volcanoes and crater lakes can be investigated in the country.

Subduction-related, mostly andesitic volcanoes have developed in the Eastern Carpathians from Miocene (ca. 14 Ma) to Pleistocene (ca. 35-42 Ka). Volcanic edifices erosionally dissected to various degrees offer opportunities to examine the internal structure of andesitic stratovolcanoes as well as their degradation processes. Widespread volcaniclastic aprons surrounding the volcanic cones are deeply incised by valleys allowing studying their internal complexity and facies architecture. A wide range of pyroclastic, resedimented pyroclastic and epiclastic deposits is well exposed along major valleys. Late Pliocene and Quaternary alkali basaltic volcanoes dot two areas in the southern part of the Eastern Carpathians and in western Romania. Large volumes of Lower Miocene rhyolitic tephra have been emplaced in submarine environment in the Transylvanian Basin, then resedimented,

buried, diagenized, and partially exhumed. The Neogene volcanism in Romania offers practically unlimited research opportunities for volcanologists. Less investigated older than Neogene volcanic formations in Romania include Mesozoic ophiolites in the southern Apuseni Mts., Upper Cretaceous ignimbrites in the northern Apuseni Mts, Triassic bimodal rhyolitic-basaltic volcanism in Dobrogea, Permian rhyolitic volcanism in the northern Apuseni Mts.

Volcanological research has a long tradition in Romania. As perhaps not many volcanologists know, the type locality, from which the rock **dacite** has firstly been described, is found in Romania (Dacia being the ancient name of the region where Romania is located).

Relevant volcanological research in Romania focused in recent years especially on the Neogene volcanic areas. Investigations have been conducted in several main directions: (1) geochronology of volcanic processes, (2) relation between volcanism and tectonics (3) tuff studies (4) volcanic hazard and risk studies, (5) instability of volcanic edifices, etc. In addition, more theoretical and conceptual approaches to some basic problems of volcanology, especially related to volcanic hazard and risk have been undertaken. Research in the domain of petrology of Neogene volcanic rocks has, at this time interval, a pronounced synthetic character.

1. Volcanological studies

Geochronological investigation of Neogene/Quaternary volcanic rocks in Romania and its broader neighborhood, the Carpathian-Pannonian Region, based on K-Ar geochronology continued in cooperation with Hungarian colleagues in order to complete the time-space evolution story of volcanism. The time-space evolution of volcanic and intrusive activity in the Gurghiu Mts. and Calimani Mts. (East Carpathians) has been published (Seghedi et al, 2004, Seghedi et al., 2005).

Age constraints on the evolution of the East Carpathian Neogene "subvolanic zone" have been placed on the basis of K-Ar geochronology (Seghedi et al., 2004, Pecskay et al., 2006).

K-Ar geochronology in combination with paleomagnetic studies revealed two episodes of short-term alkali-basaltic volcanism in the Persani Mts. (East Carpathians, Romania) at ca. 1.2 and 0.65 Ma, respectively (Panaiotu et al., 2004).

Time-specific volcanic evolution is described for South Harghita Mts. in Romanian time (Szakacs & Seghedi, 2003) mostly based on radiometric datings.

A synthetic approach on the time-space evolution pattern and volcanological features in the Carpathian-Pannonian Region (Pecskay et al., 2006) pointed out that volcanism in the area show a number of evolutionary modes: (1) long-lasting (20 Ma – < 0.2 Ma) an focused activity in a back-arc area belonging to the northern Pannonian Basin and the Central Slovakian Volcanic Field, with a general succession from felsic calc-alkaline to intermediate calc-alkaline to alkaline compositions (2) an arc-type felsic to intermediate volcanism forming a max. 700 km long and slightly eastward-shifting volcanic front ranging from the Western Carpathians up to the Calimani Mts. in the Eastern Carpathians between 14-8 Ma, (3) a transient calc-alkaline to slightly alkaline (shoshonitic) and waning volcanism along the Calimani-Gurghiu-Harghita volcanic segment between 8-0.04 Ma, and (4) a dispersed back-arc-type areal volcanism unevenly distributed in the Pannonian Basin, Transylvanian basin and Apuseni Mts., including felsic to intermediate compositions followed by alkaline and even ultrapotassic associations.

Detailed geochronology of the volcanic evolution in the East Carpathians allowed for quantifying eruption dynamics in terms of migration of volcanic centers in time and space and an terms of magma output rates (Szakacs et al., 2004)

The relationship between volcanism and tectonic features has been investigated on regional scales (Fielitz & Seghedi, 2005, Szakács & Krezesek, 2006, Seghedi et al., 2006). A

plethora of unusual tectonic features in the Eastern Transylvanian Basin were generated by interaction between large composite volcanic edifices of the Gurghiu and Northern Harghita Mts. and their pre-volcanic basement enclosing ductile and brittle rocks sequences (Szakács & Krezsek, 2003, 2005, 2006).

Tuff studies include the detailed investigation of mineral chemistry in the Badenian "Dej Tuff Complex" (Translvanian Basin, Romania) addressed both primary magmatic minerals (Szakacs, 2003a) and accessory-phase minerals (Szakacs & Gal, 2006), allowing for the reconstruction of magma-chamber conditions (Szakacs, 2003b) prior to eruption. The presence of unusual foam-glass inclusions in the same "Dej tuff" crystaloclasts has been pointed out by Pintea (2005). The post-depositional diagenetic zeolitization of tuffs is treated in high detail in two books (Bulgariu, 2005, Bulgariu & Bulgariu, 2005) and a study paper (Bedelean et al., 2006).

Transport and deposition processes of ignimbrites and volcaniclastics in the Gutai Mts. sediments were inferred from volcanological and lithological studies (Fülöp, 2004)

Although there is no active volcano in the Carpathian-Pannonian Region, addressing the issue of **volcanic hazard** and risk in this area is not irrelevant as revealed once again by Szakács & Harangi (2005). There are at least two reasons to consider volcanic hazard in the area: (1) the most recent eruption occurred some 35-42 Ka ago at the Ciomadul volcano (South Harghita)(Szakacs et al., 2004) whose magma chamber is not completely solidified according to geophysical data, (2) hazard may originate from volcanic sources located outside the area (e.g. from large-scale eruptions of Central Italian volcanoes, as it happened in Upper Pleistocene).

Instability of volcanic edifices, as exemplified in the East Carpathians, besides world-class examples (e.g. in the Andes), remained an enduring subject of investigation throughout the 2003-2007 time period (Szakacs, 2003, 2004).

Paleogeographic reconstruction of the volcanic South Harghita Mts. and its adjacent areas is published by László (2005)

A **synthetic volcanological perspective** of the whole Carpathian-Pannonian Region in Neogene times is given by Szakacs (2003).

Attempts for **localizing hidden maar**-type volcanic centers in the Pleistocene Persani alkali-basaltic volcanic field have been undertaken by Soos et al. (2004). Phreatic breccias and hydrothermal breccia pipes were described and interpreted in the Apuseni Mts. (Tamas & Milesi, 2003)

Theoretical contributions to volcanology have been focused mostly on conceptual approaches to volcanic hazard and risk, including new assessment strategies (Szakacs, 2003c, d, 2004, 2006).

Romanian researchers contributed to the knowledge of the volcanology of the Neogene ultrapotassic province in Southern Spain (Seghedi et al., 2006).

2. Studies on petrology of Neogene volcanic rocks

The Neogene volcanic rocks in Romania and in the broader Carpathian-Pannonian Region continue to be a priority subject of IAVCEI-related investigation for Romanian researchers. Within the time period 2003-2007, besides studies focused on specific Neogene volcanic areas, such as the Apuseni Mts. (Rosu et al., 2004) and the Gutai Mts. (Kovacs & Fülöp, 2003), a number of synthetic works have been published addressing the issues of magma genesis and following petrogenetic processes on the scale of the whole Carpathian-Pannonian system. Part of those works aimed at understanding the complex relationships between magmagenetic processes and regional geodynamics (Seghedi et al., 2004) and the reflection of continental collision processes in the chemical features of igneous rocks

generated under various geodynamic settings (Seghedi et al., 2005). Another synthesis focused on the post-collisional alkali-mafic volcanism and its geodynamic connections in the area (Seghedi et al.2004).

Detailed petrologic studies have been performed on specific products of specific volcanoes in the area, such as the pumices in the ejecta of the most recent Ciomadul volcano (East Carpathians, Romania)(Vinkler et al., 2007), Badenain ignimbrites in the Gutai Mts. (Fülöp & Kovacs, 2003) or reaction coronas of quartz xenocrysts in basaltic andesites from Detunata (Apuseni Mountains)(Har, 2005).

Fluid-inclusion studies with strong petrogenetic relevance for the East Carpathaian Neogene volcanic range were presented by Pintea (2003, 2006) and Papp et al. (2003).

A number of studies addressed the petrology of magma-enclave interaction in Neogene volcanic rocks of the East Carpathians (Nitoi et al., 2003, 2004).

A special attention received the petrological study of the East Carpathian Neogene "subvolcanic zone"(Ureche et al., 2003, Papp et al., 2004, Nitoi et al., 2004).

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INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

The International Association of Geomagnetism and Aeronomy

REPORT OF THE ROMANIAN IAGA SECTION

2003 - 2007

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Revue Roumaine de Physique (Romanian Academy)

Studii si Cercetari de Geofizica (Romanian Academy)

Yearly Book – Geological Institute of Romania

Romania Journal of Geophysics – Geological Institute of Romania

Yearly Book – Surlari National Geomagnetic Observatory

MAIN DIRECTIONS OF SCIENTIFIC RESEARCHES

In this report there are mentioned activities developed in Romania during last four years (2003 – 2006) under the supervision of the national correspondent of the Association of Geomagnetism and Aeronomy of the National Committee of Geodesy and Geophysics.

Participation of the Romanian part was focused on researches from Division I, Working Group 2, 3 and 4 and Division V, Working Group 1, 2 and 8.

Working Group I – 2: Electromagnetic (EM) Studies

The aim of the EM contributions at the National Report prepared for the XXIV IUGG General Assembly , Perugia, Italy, 2007 consist in the implementation in the test sites of the specific geophysical measuring systems (SGMS) **destined for monitoring and diagnosis** in case of natural disasters imminence, due to:

- **earthquakes with a special concern for intermediate-depth seismicity in the Vrancea zone;**
- **active faults and associated landslides regarding the special areas with a high probability of occurrence of these phenomena;**
-

To perform in optimum conditions the EM studies the following specific activities have been developed:

- optimisation of the specific sensor structure, in laboratory and field conditions, for each type of natural risk monitored (earthquake, active faults and associated landslides);

- experiment and continuous improvement of the SGMS at the peculiar conditions of the monitored area for pattern recognition and hierarchy with value for warning and eventually alert;

- assessment of the short-term electromagnetic (EM) precursory parameters related to both the earthquakes (EQ) occurred at intermediate depth interval, characteristic to the seismic-active Vrancea zone, and the landslides associated, mainly, to the active faults developed in the Subcarpathian area, as sequence of the seismic activity;
- elaboration and managing of geophysical and geological data to produce several kind of hazard and risk maps, 2D geophysical models and 3D tomographic images as output support for the involved people;

- dissemination of the results.

The structure of the specific geophysical measuring systems (SGMS):
A. Specific sensors:

1. Specific sensors for Geo-Magnetic field measurements:

- **3 induction coils-Hx, Hy, Hz (MFS06- Metronix, Germany) –**Fig. 1
  Frequency range: 1/4096 Hz to 24 kHz, divided within two bands:

  HF (0.5kHz - 24 kHz); LF (1/4096 Hz - 1kHz)

- **Three-axis fluxgate (MAG-03 MC-Bartington, England)**
  - Fig. 2 Frequency range: 3Kh-DC

Fig. 2

2. Specific sensors for Geo-Electric field measurements:

- Two types: Pb-PbCl2 and Cu-CuSO4, very stabile in time (IG-RA, Romania) both having solution of kaolin gel –Fig . 3 a, b.

Fig.3, a. Electric sensor

Fig. 3, b. Electric sensor installed in field

Laboratory studies for :

(i) optimisation and time stability of the electric sensors – Fig. 4

Fig. 4

(ii) frequency response of the electric sensors (blue line) ~~at a~~ transmitted signal (red line) – Fig. 5

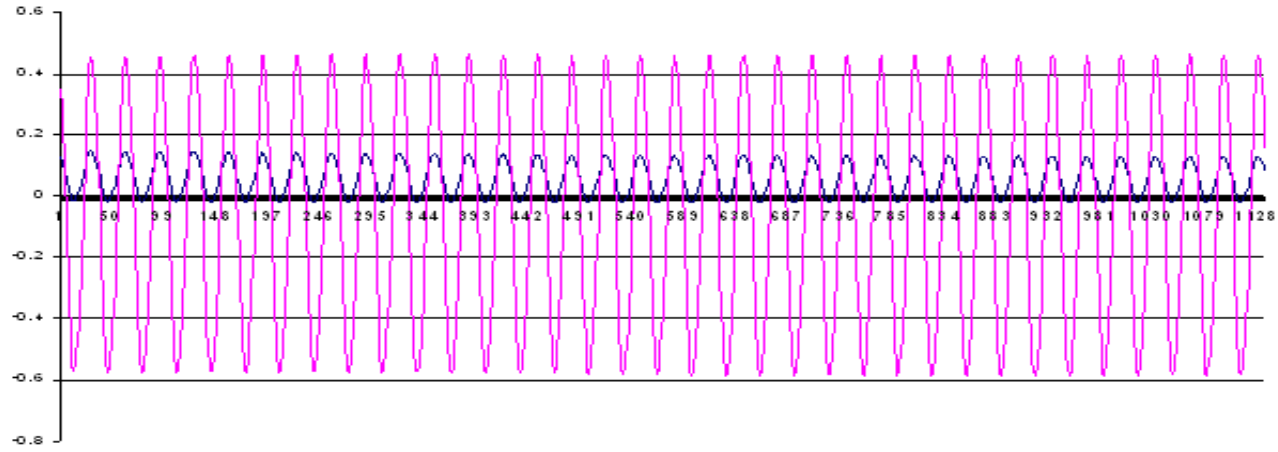

Fig. 5

B. Specific hardware (data acquisition modules)

- **Data acquisition module of the Geo-Electric field – Fig. 6**

Fig. 6. Resistivimeter (INTEL V3, Romania) is compact and self-contained thanks to an integrated receiver and DC-transmitter, with internal memory of 64 K, sampling rate of 0.2s, output power up to 200mA, communication trough serial interface enhanced by utility software for Windows

- **Data acquisition module of the electromagnetic field –Fig. 7**

Fig. 7. ADU 06 with 5 channel (2 electrics and 3 magnetics), GPS, flash memory, 24 bits resolution

- **Data acquisition module of the Geo-Magnetic field – Fig. 8**

Fig. 8. MAG-03DAM acquisition module with 6 channel, 24 bit resolution, sampling rate programmable, internal and external battery of 12 V

C. Software (MAPROS Packages)

The MAPROS software runs under Windows 95™ or Windows NT™ and the following basic tasks are performed:

- In-field system calibration and automatic offset compensation
- Real time data acquisition and processing
- Robust estimation of transfer functions
- Display of time series and all important E M-parameters
- Integrated data base for data storage and retrieval

PRECURSORY PARAMETERS

The most important parameters giving us useful information concerning the geoelectric changes of **deep** and **shallow structures**, generated by extreme events (earthquakes and landslides), are:

(i) the normalized function **Bzn = Bz/B⊥**, where Bz is the vertical component of the magnetic induction and B⊥ is the horizontal geomagnetic component perpendicular to the strike of the geological structure (this parameter is invariant in time for a 2D structure-Stanica et al, 2002, 2003, 2004, 2005);

(ii) normalized function **ρn** = $\rho_{\parallel}/\rho_z$, where $\rho_{\parallel}$ is resistivity parallel to the strike and ρ_z is vertical resistivity. As $|\mathbf{Bzn}| = (\rho_{\parallel}/\rho_z)^{1/2}$, the **ρn** parameter expresses the connection with the Bzn in terms of resistivity, namely the Bzn reflects the conductivity changes of the geoelectrical structure;

(iii) skew $= \left|\frac{|Zxx + Zyy|}{|Zxy - Zyx|}\right|$;

(iv) strike of the geoelectrical structure;

(v) electrical anisotropy factor : AF = $|\rho_{\perp}/\rho_{\parallel}|$, where $\rho_{\perp}$ and $\rho_{\parallel}$ are the resistivity perpendicular and parallel, respectively, to strike

As it was shown in the above relations, the normalized functions Bzn and ρn could be used as precursory parameters of seismic events, measuring the vertical component Bz (obtained directly from continuous monitoring of the geomagnetic field), B⊥, $\rho_{\parallel}$, ρ_z (all evaluated by using the magnetotelluric tensor impedance decomposition technique - MAPROS software packages).

To get to the precursory parameters of the seismic activity, first it is necessary to identify an optimum site for continuous monitoring of the electromagnetic field. It means the existence of a 2D structure what make possible the determination of the geoelectric pattern, in terms of non-seismic conditions, by means of the magnetotelluric tensor impedance decomposition procedure. On this way, three sites have been found out, the suitable one being the Geophysical Observatory Surlari, placed at 140 km far away from the epicenter of the seismic Vrancea zone. The applied methodology for precursory EM parameters was established according to the geotectonic features of the Vrancea zone and its surrounding areas (Fig. 9).

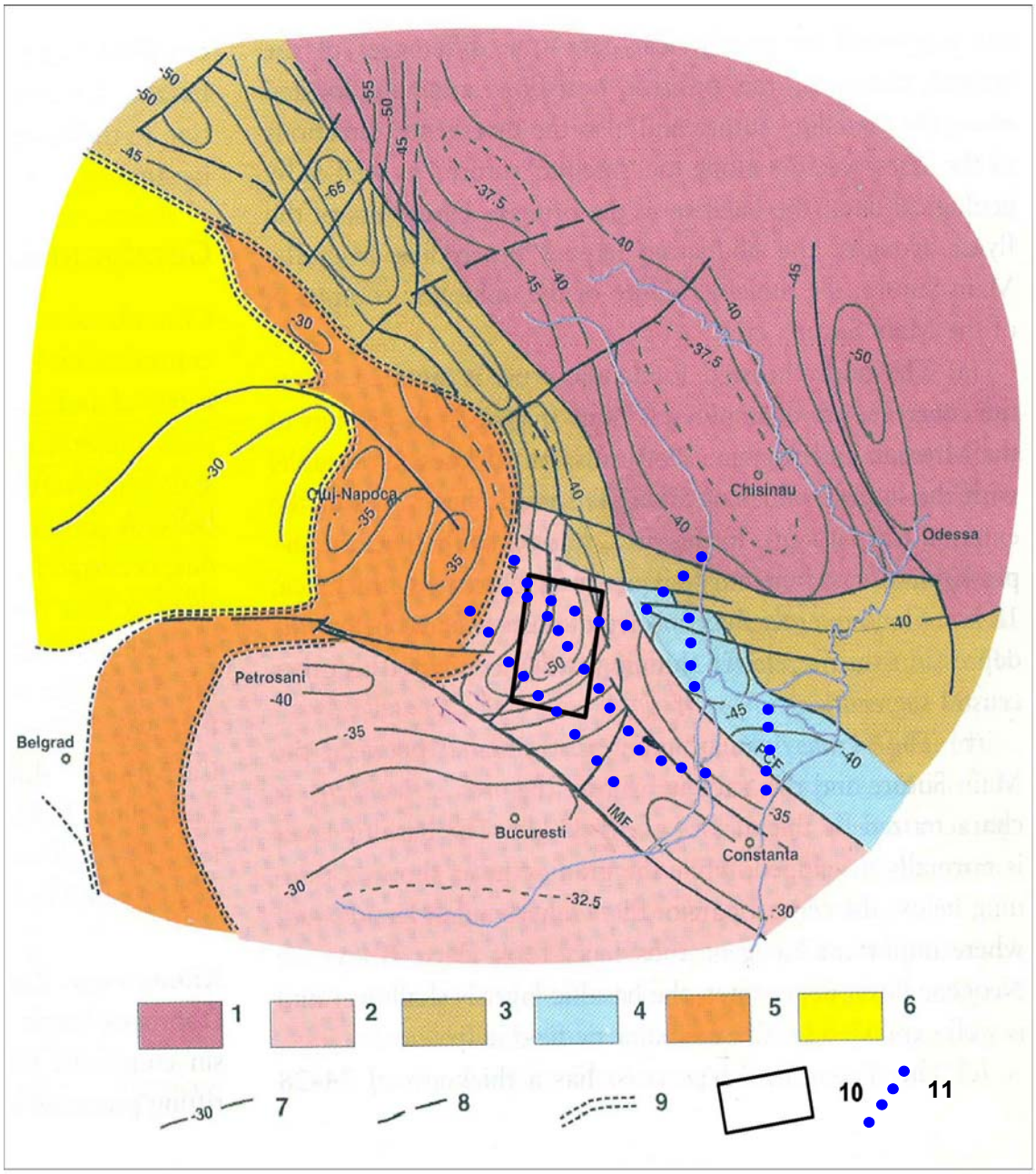

Fig.9. Seismic active Vrancea zone and magnetotelluric profiles on the crustal map (after Săndulescu and Visarion, 2000). (1) Precambrian East European Platform crust; (2) Precambrian Moesian crust; (3) Paleozoic Scythian crust; (4) Cimmerian North Dobrogea crust; (5) Transylvanian type crust; (6) Pannonian type crust; (7) depth to Moho; (8) main deep faults; (9) position of the suture zones at the Moho level; (10) the intermediate-depth seismic active Vrancea zone; (11) magnetotelluric profiles.

It is also necessary to mention that, according to the frequency range taken into consideration - corresponding to the subcrustal geodynamic processes- the processing and the analysis of the **Bzn** and **ρn** parameters were accomplished in such a manner that the anomalous fluctuations of the precursory parameters be correlated with the seismic events. To have a comprehensive view on the applied methodology, the daily average distribution of the parameters **Bzn** and **ρn** in correlation with Vrancea's deep seismic events occurred simultaneously is revealed in Figs 10 and 11.

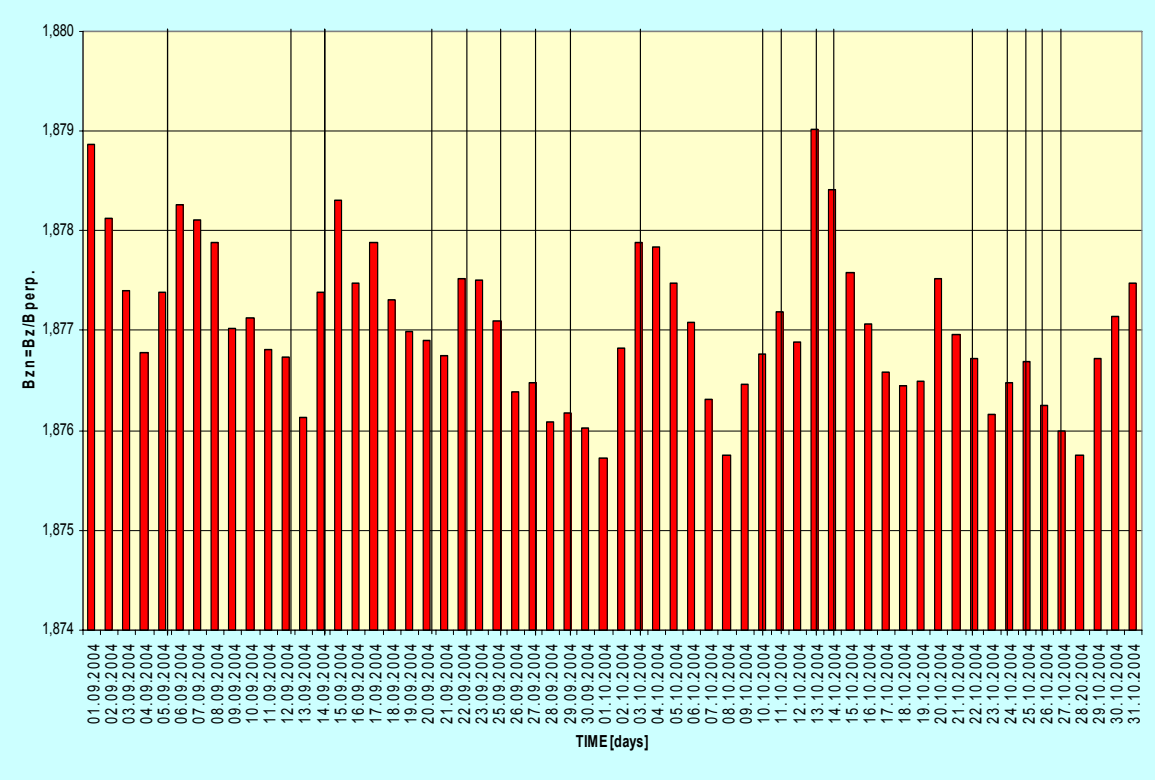

Fig.10. Daily average distribution of the parameter Bzn through 01.09.2004-31.10.2004 (vertical line indicates the triggering moment of the earthquake)

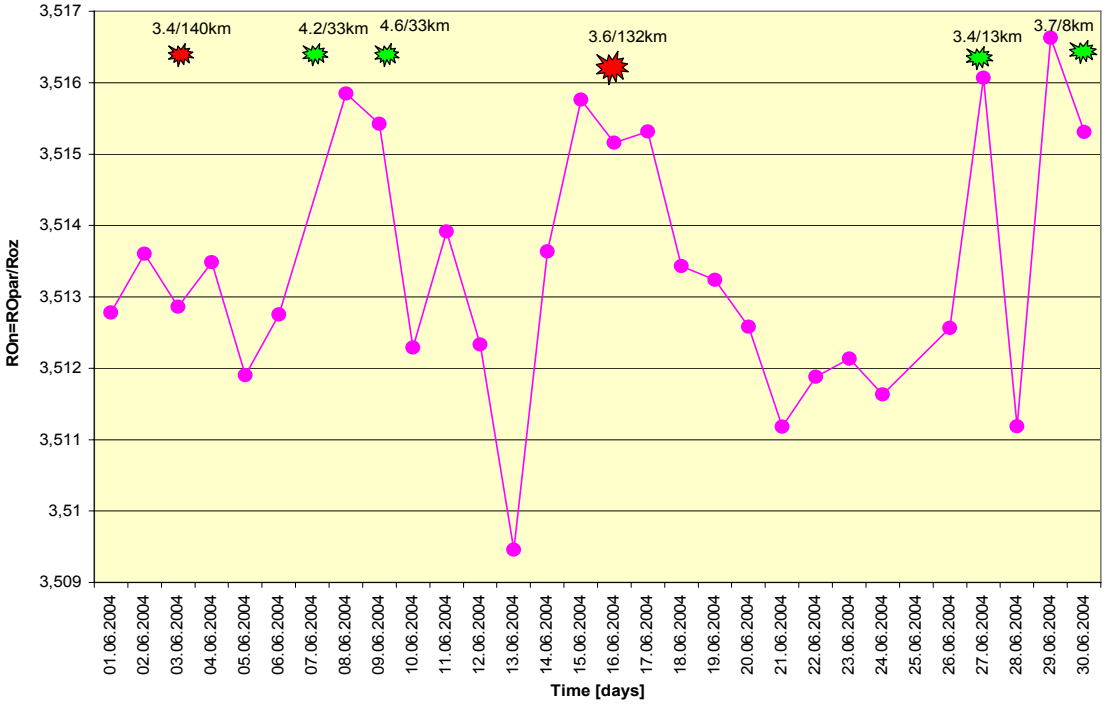

Fig.11. Daily average distribution of the parameter ρn (red star is intermediate earthquake and green star is crustal earthquake; 3.4/140km represents the magnitude/depth)

Finally, we have to conclude that some days before an EQ occurred, the daily variation of the normalized functions **Bzn** and **ρn** had had an anomalous behavior marked by a significant increase in respect with its standard deviation, as a result of the electrical conductivity changes that may be associated with the dehydration-induced faulting processes and fluid mitigation through cracks and faulting system developed inside the seismogenic volume (slab) and its neighboring zones Fig. 12.

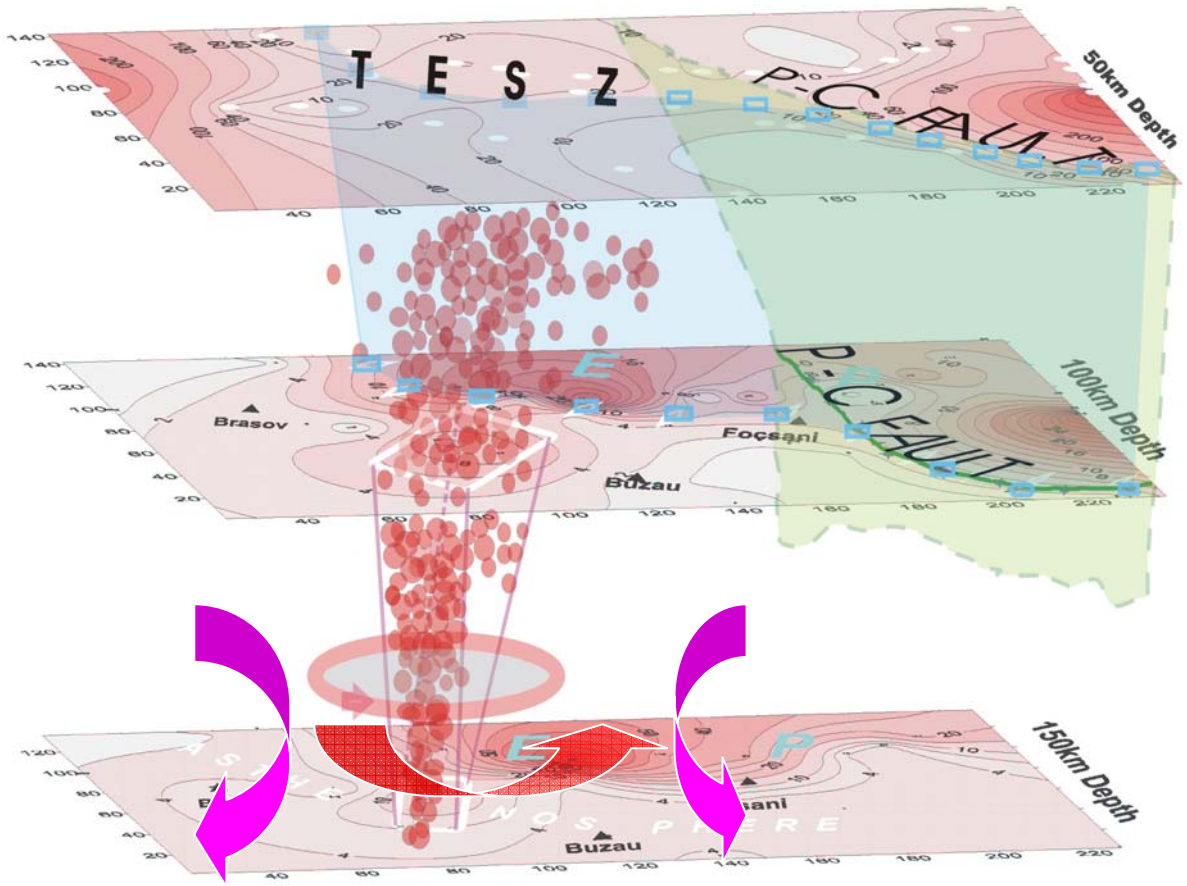

Fig.12. 3-D electromagnetic tomographic image for the Vrancea relic slab. Red circles are intermediate-depth foci; red arrow indicates the torsion direction of the relic slab; pink arrows indicate descending asthenospheric current occurred on the both sides of the "relic slab "

A similar methodology related to significant active faults connected with landslides area (Provita Valley, Prahova District) has been used, too.

In the last decades, the Alpine – Carpathian area was affected by a lot of natural hazards, as windstorms, flood and landslide, as primary consequence of the important climatic changes. In the Romanian segment of the Carpathian chain these natural hazards have endangered till now large human communities and also the environment.

The word "landslide" represents a descriptive and general term for many types of processes involving the downslide movement of soil and rock materials. Generally, the

landslides have many causes, most involve earth materials with low shear strength, ground-water saturation of materials, geodynamics, an interruption of the slope by natural causes or human activities, or a combination of these. In the Carpathian area the main causes for these phenomena are the nature of material (flyschoid deposits containing weak materials with low

mechanic properties), geodynamic context (the existence of Vrancea seismogenic active zone with earthquakes and active tectonics), weathering effects do to huge and irregular precipitation quantity, and anthropic activity.

The mass movement characteristics into the landslides depend by the relief energy and the geological composition and structure.

The Alpine architecture of Romanian territory is marked by the presence of Carpathian double arch, North Dobrogean domain and Apuseni Mountains and is made-up during Alpine orogenesis (Middle Cretaceous - Miocene).

The test area is located in the upper part of the Provita Valley (Prahova district) in which the landslides are developed in the flyschoid domain of the Carpathians. This landslide affects the Oligocene deposits of the Tarcău Nappe (Moldavides domain), which are characterised by the flyschoid deposits containing slate, sandstone (Fusaru sandstone) and marl. In the studied area the Upper Oligocene deposits occur. They are characterised by the presence of Slon beds a wildflysch formation which is discordant to the Vinetisu beds which is consist mainly by argilaceous marls an thin sandstone beds. This zone is tectonically very complicated by the presence of mesocretaceous and Miocene thrusts and Miocene and post-Miocene faults. The region is cross-cat by numerous active faults orientated NE-SW belonging to the seismic Vrancea zone.

Provita de Sus's landslide (Fig.13) has the following characteristics:

- altitude of the rear boundary of landslide deposits is at average 670 m
- altitude of the front boundary is at 410 m;
- relative height of landslide deposits is 260 m;
- average surface gradient of landslide deposits is 18°;
- average thickness of landslide deposits 35 – 40 m;
- angle of rupture surface 30° (rear average) – 10° (front);
- area of landslide deposits 1.25 km^2;
- average volume of landslide deposits 40 million m^3.

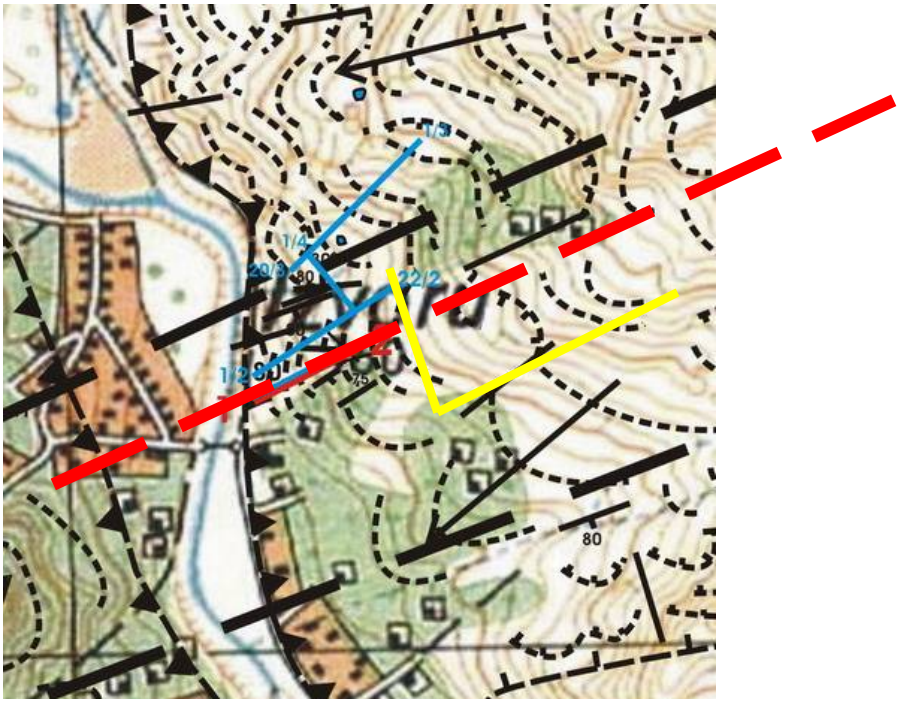

Fig. 13. Provita de Sus landslide map - test site

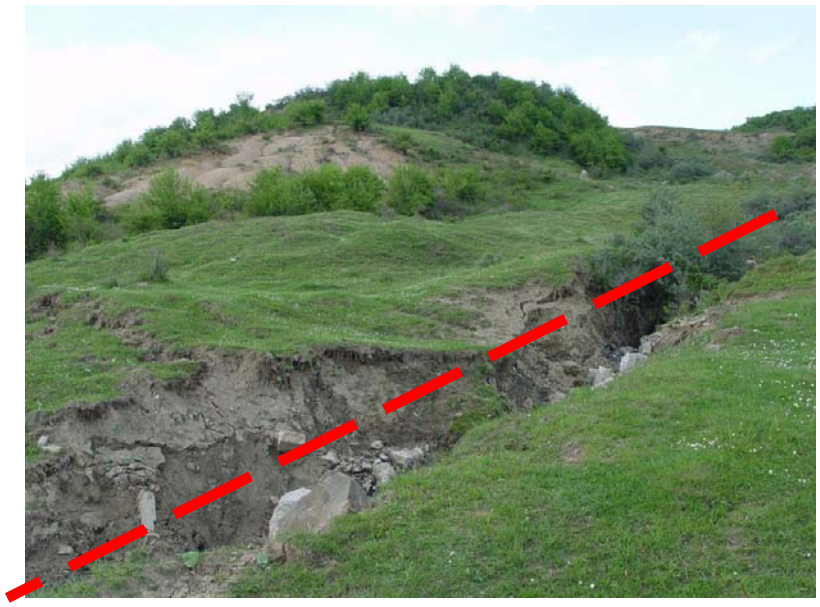

Fig. 13.a.

- blue and yellow lines are geoelectric (VES) and EM profiles;
- dashed red line is active fault-Fig. 13.a. (reactivated by seismic activity)

The regular monitoring of the geoelectric and electromagnetic parameters on the Provita test site (Fig. 13) allowed us to:

1. emphasize the specific pattern of the landslide in non geodynamic conditions;
2. outline the discontinuity between landslide material and bedrock (Fig.14);
3. identify the possible reactivation of active faults and sliding interfaces (Figs. 15 and 16);
4. obtain useful information about the thickness of the mobilized material and the main peculiarities of the sliding interfaces (Fig. 15 and 16)

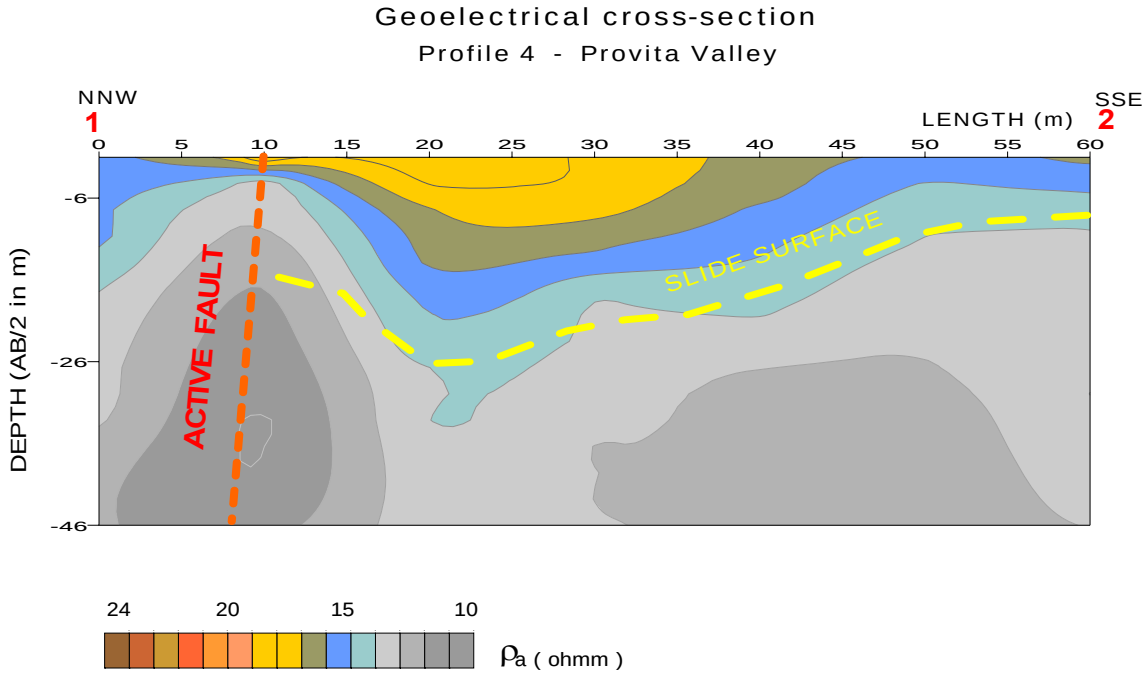

Fig. 14. Geoelectric cross-section (blue line) on the Provita de Sus - test site (the yellow dashed line represents the sliding surface and in red is one of the most active fault in the area)

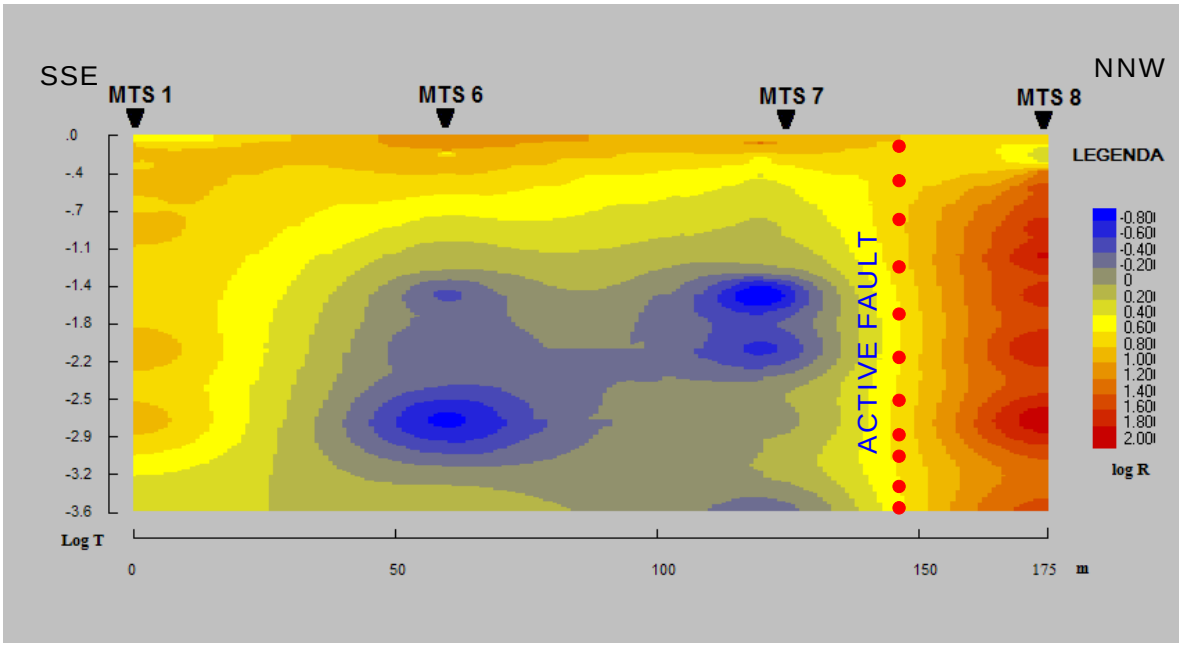

Fig. 15. EM tomographic image along the yelow profile crossing the active fault (dashed red line - Fig. 13)

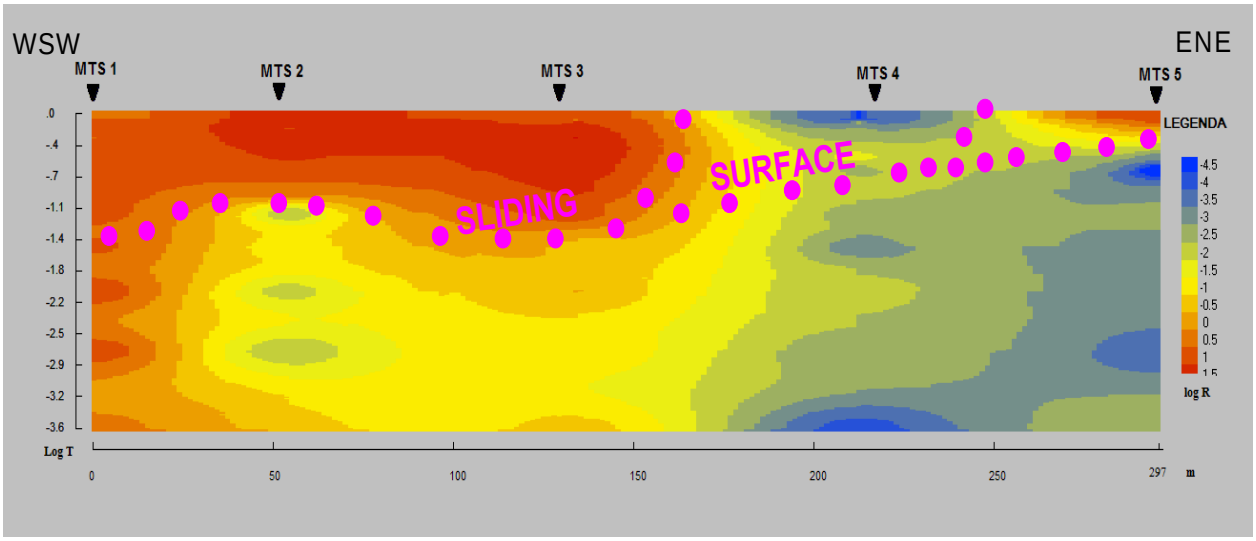

Fig. 16. EM tomographic image along the yelow profile parallel to the active fault (dashed red line - Fig. 13)

The SGMS which was used for real-time monitoring of precursory phenomena/parameters related to landslides is presented in Fig. 14

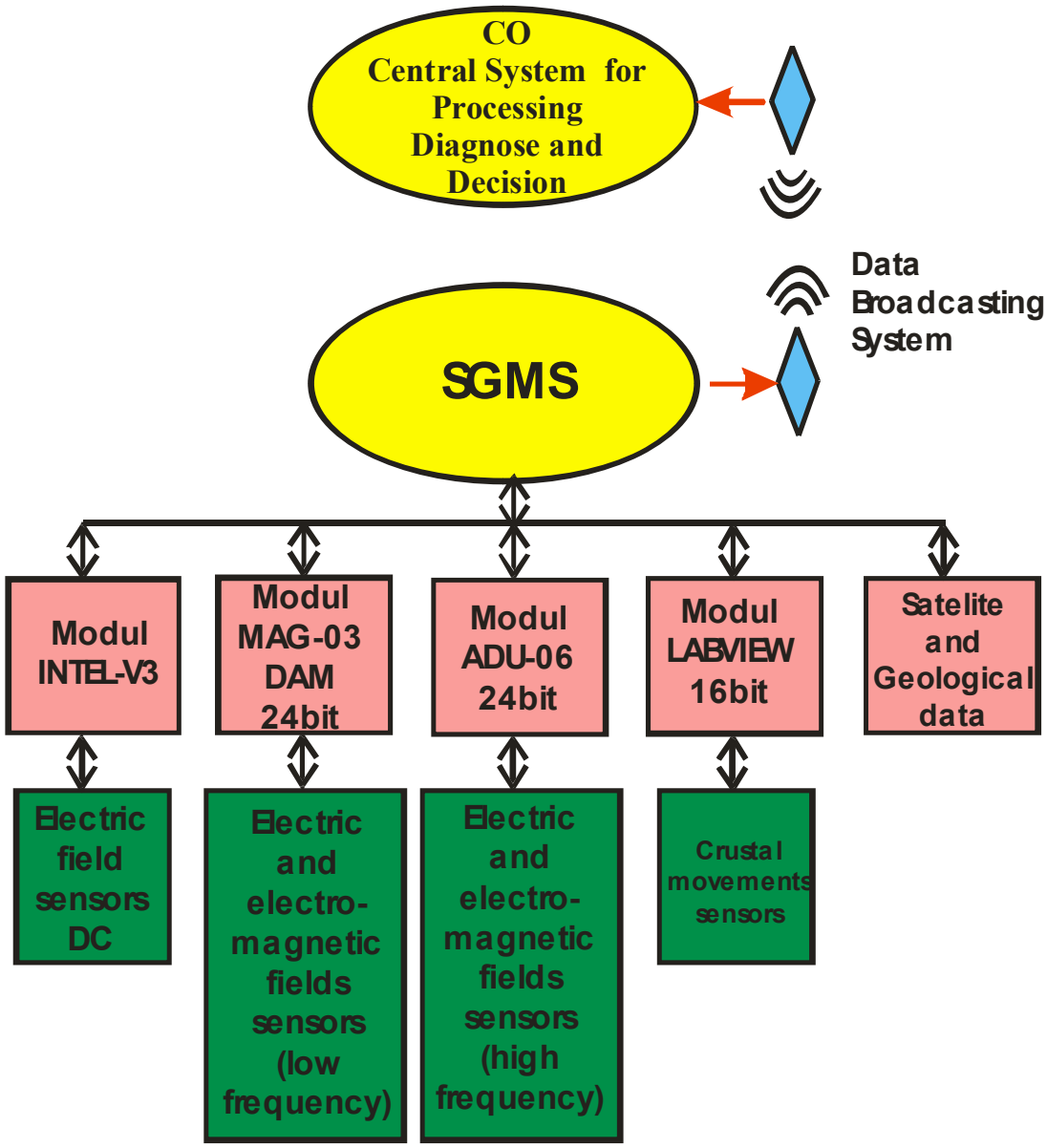

Fig. 14.

DISSEMINATION OF THE RESULTS

1. **D. Stănică, M. Stănică : G**eophysical methodologies used for real-time monitoring of the active tectonic structures, COST Action 625, 8th MC Meeting, 8th WGAT and 9th WGMI Meetings, Bucharest-Romania,22-26 September,2004, AbstractVolume
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7. **Dumitru STĂNICĂ:** Real-time electromagnetic monitoring of the active tectonic structure in the Southern Carpathians-Romania, International symposium and COST ACTION 625 meeting in Bratislava (Slovak Republic), May 25-29, 2005
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10. **Dumitru STĂNICĂ and Maria STANICA:** Real-time electromagnetic monitoring of the active tectonic structure in the Southern Carpathians-Romania, COST ACTION 625- Abstracts, Bratislava, Slovak Republic, May 25-29, 2005;
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13. **D. STANICA and M. STANICA :** Real-time monitoring systems of the geodynamic active structures in Romania, COST ACTION 625- Abstracts, 12-16 Oct.2005, Wroclaw, Poland ;
14. **Dumitru Stanica, Maria Stanica**, Extreme Events (Earthquakes and Landslides) Reflected by the Electromagnetic Parameters, EMSEV2005 Abstracts Notebook, 30 Oct.-04 Nov. 2005,19-20, Puerto Vallarta, Mexico.
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Working Group I-3: Paleomagnetism

Paleomagnetic constrains for the evolution of Neogene and Quaternary magmatism in Romania

New K-Ar ages combined with paleomagnetic data demonstrate that the basaltic volcanism in the Perşani Mountains occurred in two relatively short phases (Panaiotu et al., 2004). The first one lasted several tens of thousands of years around 1.2 Ma and it seems that the inception of the volcanic activity took place in two isolated places and reached the maximum extent during the Cobb Mountain Normal Polarity Subchron when larger areas were covered. The second phase started just before 600 ka and was restricted to the central area of the volcanic field. One lava flow of this phase recorded a short-lived reversed polarity event inside the Brunhes Normal Chron, probably the 15b reversal excursion. The duration of this phase was less than 200 kyr, which is the best estimate according to the available radiometric data.
Previous paleomagnetic results from Neogene magmatic rocks were used to constrain both the age of the volcanic activity (Pecskay et al., 2006) or the geodynamic settings, which have controlled this magmatism (Roşu et al., 2004; Seghedi et al., 2004, Panaiotu et al., 2006).

Geodynamic evolution of the Vrancea area

Complex studies of paleomagnetism, rockmagnetism and sedimentology, in cooperation with Fort Hoofddijk Paleomagnetic Laboratory from Utrecht University, imposed new constrains for the evolution of the Vrancea seismic area in terms of time (Vasiliev et al., 2004), evolution of the basin (Panaiotu et al., 2007) and tectonics (Dupont-Nivet et al., 2005).

Environmental magnetism

Two pilot rockmagnetic studies have shown that magnetic parameters can be used to identify polluted soils with heavy metals in two urban area from Romania: Bucharest and Baia Mare cities (Panaiotu et al., 2005a; Panaiotu et al., 2005b). The relation between rockmagnetic properties of sediments and climate was studied both loess and paleosol deposits from the southern part of Romania (Necula et al., 2005, Panaiotu et al., 2005c) and cave sediments from the Southern Carpathians (Petrea et al., 2006).

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Working Group I-4: Rock Magnetism

Working Group V-1: Geomagnetic Observatories, Instruments and Standards

The main objective is to obtain continuous long time series of geomagnetic elements in the fundamental national station of the Surlari Geophysical Observatory. These data

provided by standard absolute measurements and trivariational analogous and digital recordings are the most important information for some studies of the complex features of planetary magnetic field.

Two analogical recording systems and a Bartington digital system with three-axis fluxgate magnetic sensor are in function at Surlari Observatory . Absolute recording levels were also determined by a set of instruments: Mag-01H Flux Declinometer / Inclinometer, Elsec vectorial proton magnetometer for H and Z components and Varian proton magnetometer for total field component, F. By using personal computing programs in FORTRAN language files were created and included on a CD-ROM with the data of all INTERMAGNET observatories. All recorded daily data were transmitted to Paris GIN (Geomagnetic Information Nodes) and to World Data Centers almost in real time.All geomagnetic recorded data were summarized in the Yearbooks of Surlari Observatory.

Therefore, to access the final information , useful in many geoscience fields, has started in 2004-2006, an extended project to obtain homogenous transient and reference geomagnetic field data, covering over six solar activity cycles.

First of all, an inventory of analogical data bases was created , mostly on photographic support.

By detecting the periods when similar or different recording systems functioned simultaneously, it was able to achieve a comparative study of time series and also of continuity of the transient magnetic field record at high standards were carried out.

Function periods of recording systems at Surlari National Geomagnetic Observatory and number of daily recording.

System	Recording period	No of recording days
Askania& Eschenhagen	1943-2004	22,265
Mating & Wiesenberg	1959-1972	4,749
Bobrov	1971-2004	12,054
Bartington	1998-2006	2,792

System	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2004**	**2006**
Askania & Eschenhagen									
Mating & Wiesenberg									
Bobrov									
Bartington									

N.B. At first there were a few days without recordings, but these were not significant for terrestrial magnetic field data continuity. Since 1959, recording equipments functioned synchronic for a perfect continuity of the absolute measurements, with the exception of a couple of days in 1977, March 4 earthquake , when major damages were recorded to the both measuring and recording equipment at that time.

After having scanned old analogue measurements with a Bear Pau 4800, 100 dPi/cm^2 resolution - the process of analogue-to-digital conversion began, resulting in homogeneous numeric time series stored on digital support in TIF format, for an excellent preservation. The analogue-to-digital conversion was made with Excel and Surfer 8 software in two stages:

- digital conversion of the data in graphic mode and saving individual files of each D, H, Z geomagnetic fields components on the floppy disk or CD-Rom . The sampling rate was not constant but proportional to the number and amplitude of the existing fluctuations in component recordings thus creating image coordinate data files.

- creation of an algorithm for final data which provides conversion of image coordinate data into time data values of geomagnetic field components recorded, based on record data sensibilities and baseline corrections of field components.

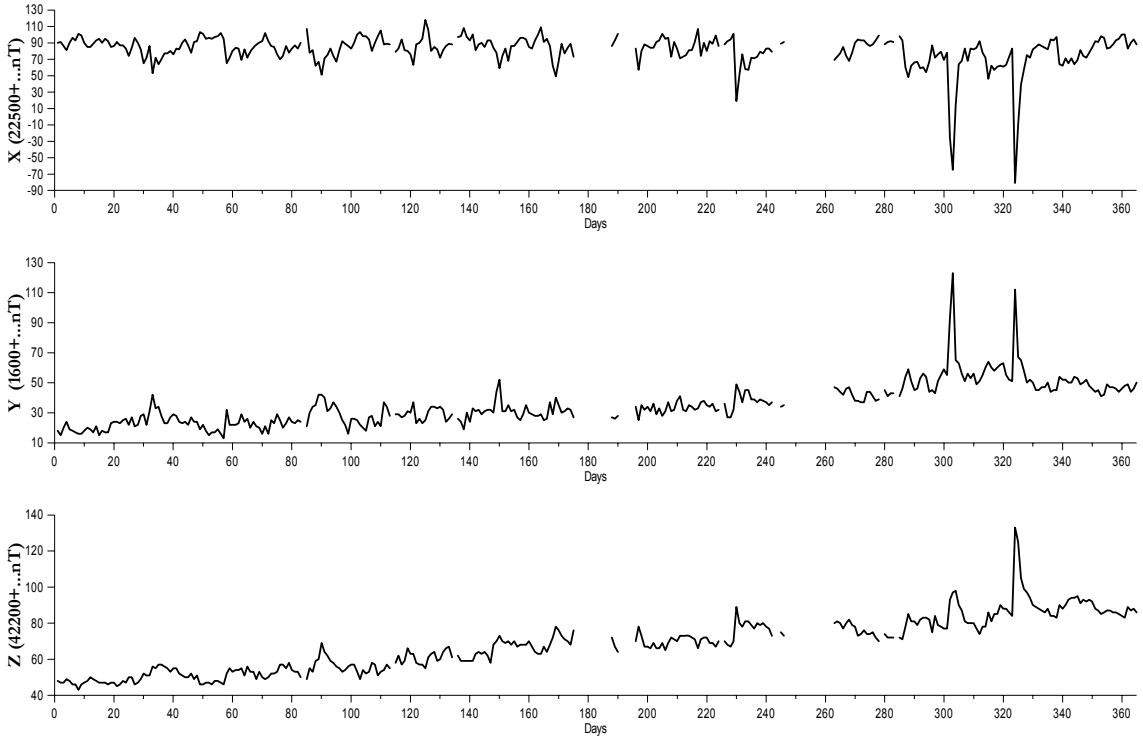
The main purpose of this project is to obtain a complex model for the spatial and temporal distribution of the main geomagnetic field, to render evident some peculiarities of its secular variation and to calculate the new coefficients for the national reference field on the Romanian territory. To realize this objective data on absolute values of the geomagnetic field in 1980 – 2000 period in the data banks of the National Geophysical Observatory Surlari and of the Institute of Geodynamics, were used.

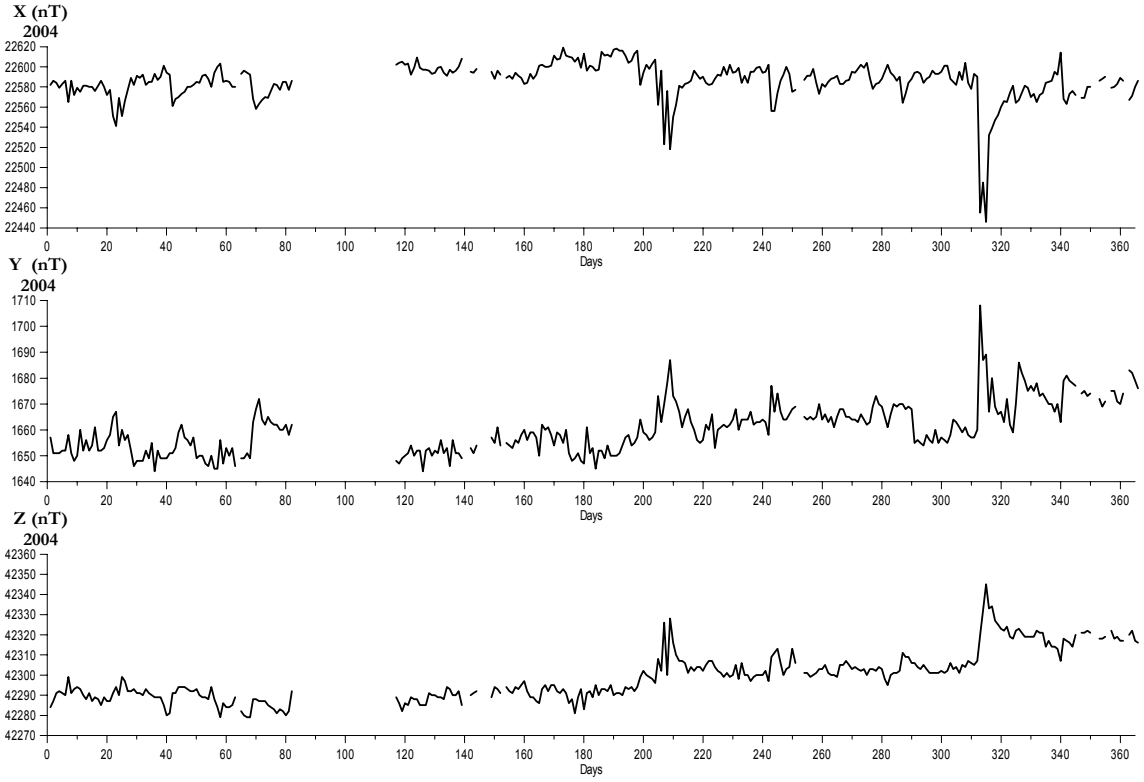
For the period 2003 – 2006 a lot of absolute measurements of D, I and F geomagnetic elements were carried out in some stations of the Romanian reference network. All these measurements were calibrated at the Surlari National Geophysical Observatory.

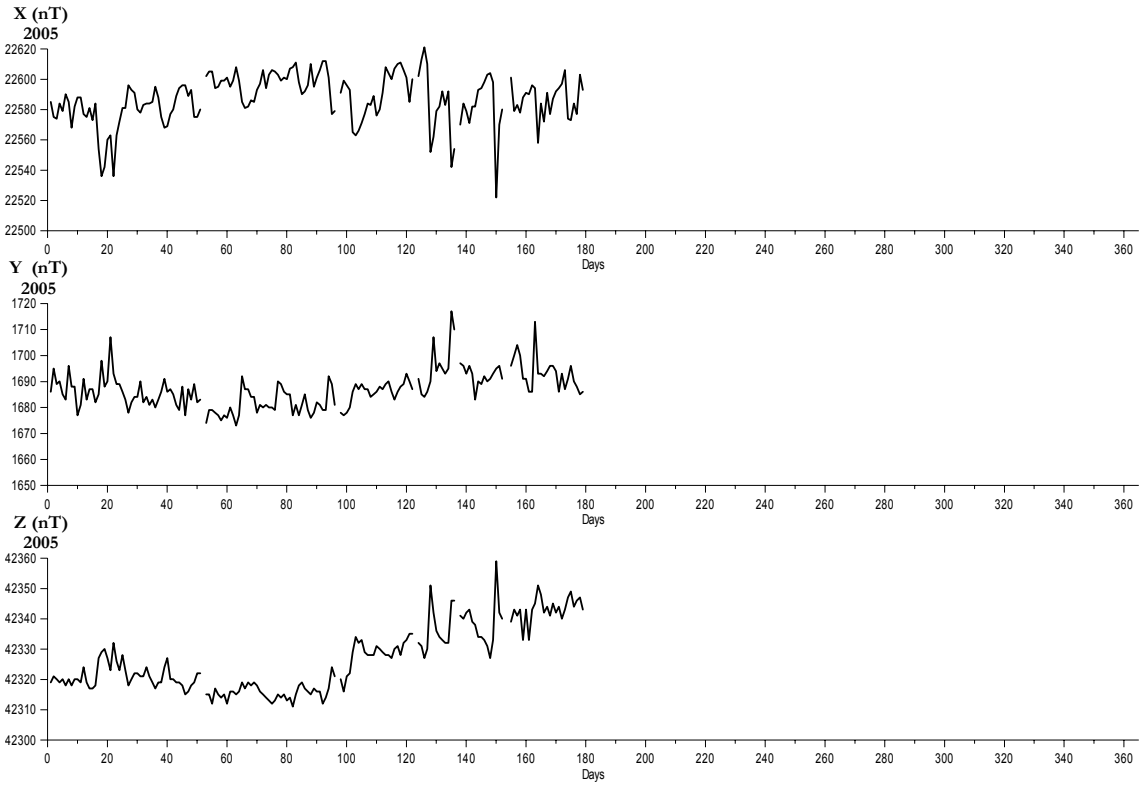
The preliminary processing of data series showed that secular variation of the geomagnetic field in Romania continues the trend in the previous period. Some results of existing data series processing are shown in the figure below.

Monitoring of the transient geomagnetic field, in general, and its secular variation, in particular, leads to important information used to elaborate models and theories on the mechanisms of producing and maintaining the geomagnetic field in studies on the electrical conductivity of the Earth. Also, such data are important in magnetic prospecting works (correction for daily and storm variations, measurement of e normal reference field, and correction for secular variation when panels of data obtained at different geomagnetic epochs are to be compared). In this way the access to final information, useful in many geoscience fields, can be directly and efficiently realized from the observatory data bank, and implicitly from the monitoring system of magnetic field at planetary scale.

In the attached figure daily mean values of geomagnetic elements X, Y, Z and evolution of geomagnetic field are presented at Surlari National Geophysical Observatory in 2003, 2004 and 2005.


X (22500+...nT)
Y (1600+...nT)
Z (42200+...nT)
Days


X (nT)
2004
Y (nT)
2004
Z (nT)
2004
Days



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Working Group V-2: Geomagnetic Data, Indices and Applications

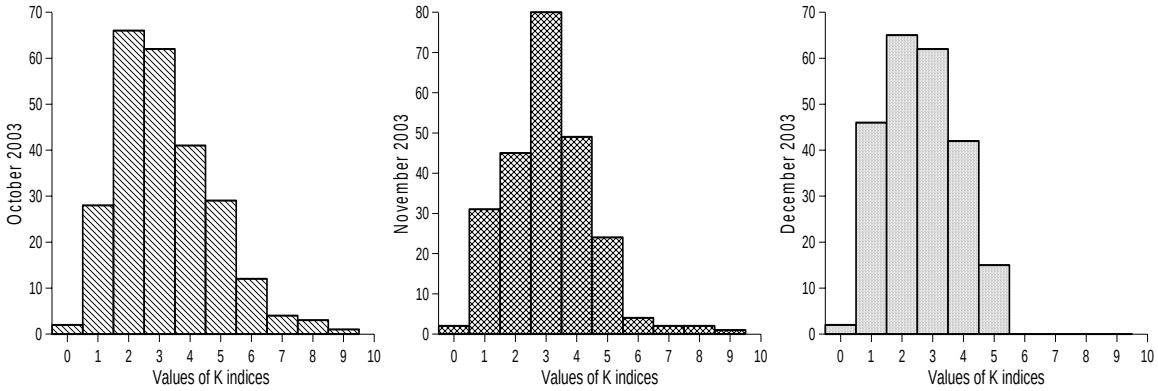
Continuous recordings of geomagnetic field variations at National Geophysical Observatory Surlari on long time series and the experience in their processing allowed a theoretical and experimental study on power systems influences .

A good opportunity of such applications was offered by a special phenomenon occurred during last years researches . Astronomical observatories announced, in the second part of October 2003, the occurence of a sunspot group with remarkable dimensions. In their West to East movement on solar disk , the most important spot, number 486, was in a favorable position that proton jet rejected in solar wind to cross terrestrial magnetosphere on 29th October, causing a magnetic storm of unusual intensity. To study this phenomenon there the Surlari National Geophysical Observatory recordings from the last three months of the

year 2003 where analyzed, having in view the time series of components X, Y, Z and of total field F and for a quantitative evaluation of geomagnetic disturbed degree, putting in evidence the K indices evolution.

This analysis confirms that the very intensive solar activity was the cause of the most important magnetic disturbances recorded by the Surlari Geophysical Observatory in the last 60 years. At the same time this permitted an evaluation of magnetic phenomena recurrence, according to the Sun rotation period and the persistency of these spots.

This figure presents the daily sum of K indices of geomagnetic activity in the last three months of 2003. In general the whole period is characterized by an increased magnetic activity because the values 5 and 6 of K indices are very rare. The presence of the value 9 of K indices is to be remarked (during the days of the 29th of October and of the 30th of November 2003), this level of magnetic activity has never been recorded before at the Surlari Geophysical Observatory.



We must mention that the occurrence of sun spot sets in October, generated X class sfe, with uncommon degree of intensity. To illustrate the importance of this phenomenon, some major sfe observed in the last fifteen years are shown in the Appendix, accompanied by their recorded manifestations as an amplitude of X, Y, Z components and total field F component at Surlari Geomagnetic Observatory. It is obvious that the amplitudes of 2003 October 29 phenomenon considerably excels the recorded rate of the previous major phenomena.

The main X (maximum x-rays effects) class sfe (chromospheric eruptions) and planetary magnetic effects (in Surlari National Geomagnetic Observatory magnetograms)

Nr. crt.	Data	X intensity class	ΔX(nT)	ΔY(nT)	ΔZ(nT)	ΔF(nT)
1	07.11.1978	X 15.0	+13.6	+18.9	-23.3	-15.75
2	06.06.1982	X 12.0	+40.6	+18.0	-17.9	+14.0
3	09.28.1989	X 9.8	-14.0	+27.0	-8.3	-15.75
4	10.19.1989	X 13.0	-	-39.6	-5.1	-4.5
5	06.15.1991	X 14.1	-14.56	-60.7	-12.7	-12.0
6	11.06.1997	X 12.0	-43.9	+39.5	-11.5	-10.0
7	04.15.2001	X 9.4	-24.4	-36.0	-12.9	-
8	10.29.2003	X 28.0	-740	-390	-30	-250
9	11.04.2003	X 10.0	-37.7	-38.0	-14.9	-

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Working Group V-8: Analysis of the Global and Regional Geomagnetic Field and Secular Variation

Secular variation studies

1. National Network of Repeat Stations

Since 1964 the secular variation of the main field has been monitored by measurements in a network of 21 repeat stations uniformly distributed over the Romanian territory. Annually repeat measurements are currently done within the project MagNetE, an initiative for repeat measurements at European scale launched in 2003. Partial results regarding the interval 1980 – 2004 have been presented (Demetrescu et al., 2003; 2005 a, b, c, d).

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2. Induction studies

Magnetic and electromagnetic effects in long period geomagnetic data were studied. Annual means of geomagnetic elements at European observatories and daily variation data from the Hokkaido (Japan) magnetometer array have been used to infer information on magnetic properties of the crustal rocks and on electric properties (inductance and resistance) of the mantle and crustal rocks under the arrays (Demetrescu et al., 2003, 2004; Dobrica et al., 2004, 2005).

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3. Recent secular variation. New insights from long time series of observatory data

100 – 150 years long time series of annual means from several geomagnetic observatories world wide were analyzed. Variations of 11, 22 and ~80 years, superimposed on a steady variation were rendered evident and their characteristics discussed in terms of the geomagnetic field vector and of equivalent centered dipoles. In terms of the analysis, the geomagnetic jerks are a result of the superposition of the 11-year solar-cycle-related variation on the 22-year and ~80-year variations, of internal origin. The way the three combine makes the difference in timing, magnitude and length of jerks as observed. The external contribution is decisive in establishing the very short time scale characterizing jerks, and, to some extent, also the amplitude and timing of the jerk (Demetrescu and Dobrică, 2003; 2004 a, b; 2005 a, b; Demetrescu et al., 2005).

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PALAEOMAGNETIC, ROCK MAGNETIC AND ENVIROMAGNETIC ACTIVITIES IN ROMANIA

GEOLOGICAL INSTITUTE OF ROMANIA (GIR)

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Since 2003, the research activity in the Laboratory of Palaeo-, Rock- and Environmental Magnetism *of the* Geological Institute of Romania *has focused mostly on the* **environmental magnetism**. *As regards the* **palaeo-** *and* **rock magnetism**, *is worth mentioning the contribution of our studies to the investigation of the state of the "magnetic recording medium", which is of fundamental importance in order to decipher correctly the Earth's magnetic field structure in the geological past. Besides, several papers (published before 2003) concerning magnetostratigraphic and/or petromagnetic results obtained in our laboratory were mentioned and/or analysed by other either Romanian or foreign authors, in publications issued in the 2003 – 2007 period. All these aspects are further approached.*

1. Environmental Magnetism.

*An original "Magnetic Susceptibility Scale" (**MSS** or "**k** Scale") has been conceived in order to characterise the sediments and to compare different deltaic, fluvial-deltaic and lagoonal aquatic environments (Rădan and Rădan, 2003A,B, 2003-O, 2004A,B, 2004-O, 2005a,b, 2005-P, 2006b,c, 2006b-P,c-P, 2006a-O, 2007a). The last version of the scale spans from **k** values lower than 10×10^{-6} SIu. (negative values included) to **k** values higher than 1000×10^{-6} Siu (Fig. 1). The **k** Scale was established using more than 2000 sediment samples collected from the* Danube Delta *(*DD*) and the* Razim (Razelm) - Sinoie Lagoonal Complex *(*RSLC*). Consequently, the **MS** Scale has a "genuine" lithological support. Five **MS** (**k**) categories related to specific lithological types of bottom sediments have been identified, which subsequently became "magnetic susceptibility classes"; the last one (that is, **V**th class) was subdivided into 4 sub-classes: **Va**, **Vb**, **Vc** and **Vd**. The correlation of the **k** Scale both to the "Geochemical Scale" (*i.e. *"Sediment Quality Scale"), which has previously been used within the Danube Delta water system, and to the "Scale with the normative definitions of the ecological status classification" (*i.e. *"Environment Quality Scale"; Fig. 2) were pointed out in several papers and reports (Rădan and Rădan, 2003A,B, 2004A,B, 2006a-O, 2006b-P,c-P, 2007a,b, Rădan, S.* et al.*, 2004, 2004-O).*

MAGNETIC SUSCEPTIBILITY SCALE (MS; k)	
k classes	k [SI u.]
Vd	$> 1000 \times 10^{-6}$
Vc	$675 \times 10^{-6} \div 1000 \times 10^{-6}$
Vb	$575 \times 10^{-6} \div 675 \times 10^{-6}$
Va	$275 \times 10^{-6} \div 575 \times 10^{-6}$
IV	$175 \times 10^{-6} \div 275 \times 10^{-6}$
III	$75 \times 10^{-6} \div 175 \times 10^{-6}$

***Fig. 1.** Magnetic Susceptibility Scale*

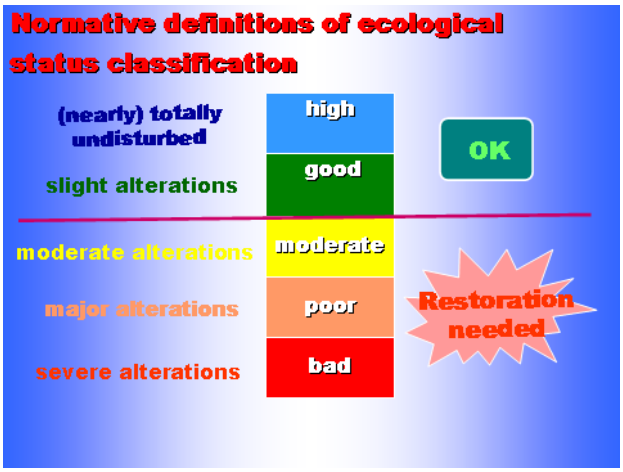


***Fig. 2** Environment Quality Scale.*

Based on the above mentioned original **MS** scale, the study of the capability of the magnetic susceptibility as a proxy parameter to differentiating proper deltaic sedimentary environments ("sed. env.") and fluvial-deltaic "sed. env." has been developed. The former are related to the ecosystems developed inside the *DD* interdistributary depressions (lakes and channels), while the latter are merged with the main *DD Branches* (Rădan and Rădan, 2003B, 2004B, 2005b, 2005-P, 2006a, 2006a-O, 2007, Rădan S.C. *et al*., 2004). Besides, the **MS** characterisation of the "sed. env" belonging to a particular unit, a lagoon system (*i.e*. the *CLRS*), isolated from the *Black Sea*, but linked with the *DD*, has been performed (Rădan and Rădan, 2004A,B, 2005a, 2006a, 2006a-O, 2007a). In addition, a case study concerning the sedimentary environments from the Danube Delta and the Black Sea was presented (Rădan and Rădan, 2003-O). The magnetic susceptibility technique – as a methodology of environmental magnetism – was used to characterise the sedimentary environments in a series of lakes from the *Matiţa – Merhei Depression* (Rădan and Rădan, 2003A, 2004B, 2004b, 2004-2005, 2007a, Rădan *et al.,* 2006A,B). These lakes are protected from the fluvial influx. Thus, they are not significantly affected by the *Danube River* supplies. The magnetic susceptibility characterisation of the bottom sediments sampled during a period of less than three decades (*i.e*. 1978 – 2006; Fig. 3) proved that the environmental and the geo-ecological conditions of this aquatic domain of the *Danube Delta* were nearly preserved (Rădan and Rădan, 2006a-O, 2007, Rădan *et al*., 2006A,B). Accordingly, since 1978, the natural and/or anthropogenic pressure exerted on the sedimentation environments in this area has not been significant. There have been slight alterations only.

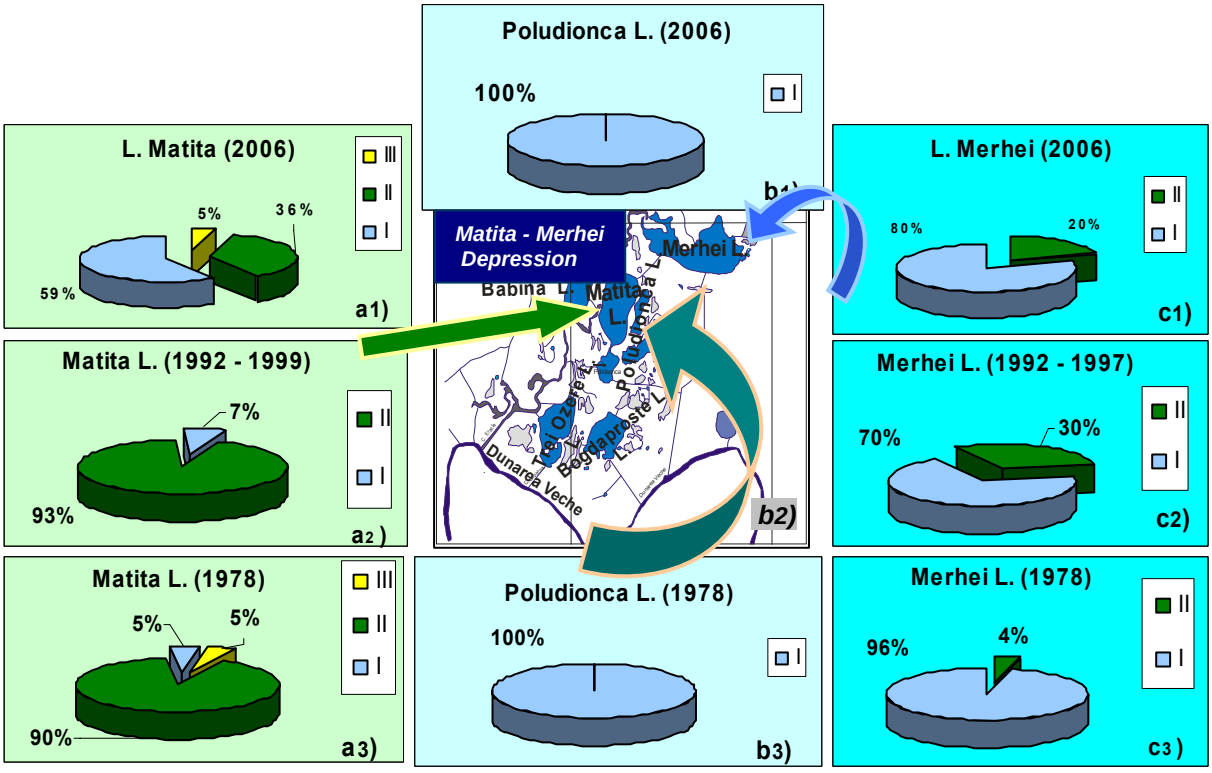


Fig. 3. Magnetic susceptibility of the sediments sampled in 3 lakes from the Matita – Merhei Depression (Danube Delta, Romania; 1978 - 2006).

A general feature is that the sediments of the *Danube Delta* lakes successively disposed along a main water way have modified in a natural manner – by transport and differentiated sedimentation – the lithological characters and the mineralogical and chemical composition, passing from a dynamic aquatic environment to a more or less stagnant

environment. These changes are always accompanied by a decrease in the **MS** values that are measured on bottom sediments. The correlation is as strong as the evaluation of the quality of the aquatic environments can be performed starting in a reverse order, from the information given by the **MS** levels. At a local scale, a similar differentiation was identified, this time along a short distance, for several "couples of lakes". There is a sharp change from one range of **MS** values to another, in some cases; this simulates the natural threshold existing between two lakes. There are also instances of a gradual passage, according to the slighter water transfer between the two lakes. A series of examples are analysed in several reports and pointed out in some papers (Rădan and Rădan, 2003B, 2004B, 2005, 2006a-O, Rădan *et al*., 2004).

On the other hand, some experiments were carried out in the *Danube Delta* relating to the magnetic susceptibility identification of the environmental impact of the anthropogenic activities on the aquatic ecosystems (Rădan and Rădan, 2003A, 2004B, 2004a, 2004c, 2005a,b, 2005-P, 2006a,b, 2006a-O,b-P, 2007a,b, Rădan S.C. *et al*., 2004). A case study was developed related to the lakes from the *western Mesteru – Fortuna Depression* (Fig. 4). The sedimentary environments existing in two lakes before the *Canal "Mila 36"* was dug (*i.e*. before 1982-1983) and afterwards were characterized by means of the **MS** measurements made on bottom sediments, and consequently differentiated. According to the environmental changes in the area caused by the digging of the *C. "Mila 36"*, the **MS** fingerprint suffered essential modifications (Rădan and Rădan, 2003A, 2004B, 2004a, 2004c, 2005, 2005a,b, 2005-P, 2006a, b, 2006a-O,b-P, 2007a,b, Rădan *et al*., 2006B).

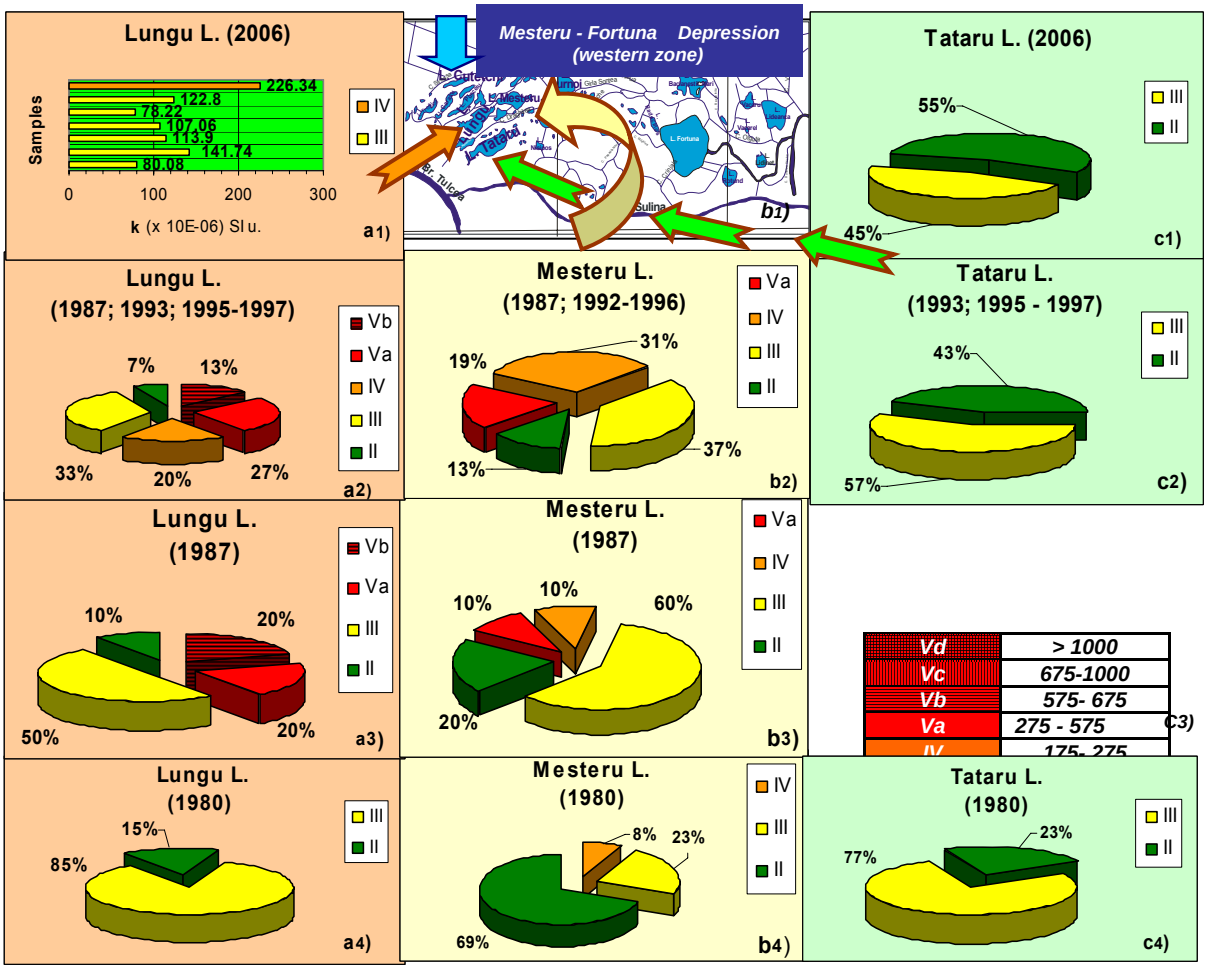


Fig. 4. Magnetic susceptibility of the sediments sampled in 3 lakes from the western Mesteru – Fortuna Depression (Danube Delta, Romania; 1980 - 2006).

Another investigated case was related to the human intervention of shortening a main *Danube Branch* (*i.e.* the *Sf. Gheorghe distributary*). That shortening resulted in a predominantly clayey or siltic-clayey sedimentation, along the cut meanders (mainly between km 85 and km 65). Consequently, the **MS** levels decreased 2–10 times. The process is natural, but it was caused by the human activities (Rădan and Rădan, 2003B, 2004B, 2005b, 2005-P, Rădan, S.C. *et al*., 2004).

An additional proof of the environmental capabilities of the "Magnetic Susceptibiliy Scale" that was applied to calibrating the sediments of the Danube Delta and of the Razim - Sinoie Lagoonal Complex was provided by comparing a Landsat image (recorded in 1991) with a set of magnetic susceptibility patterns, based on the colours that are characteristic for the **k** classes of the **MSS** (Rădan and Rădan, 2004B, 2005, 2005-P). These **MS** patterns were carried out for collections of samples taken either in the 1992–2006 time span or related to two time intervals (i.e. before and after the intervention of the anthropogenic work in the area) (Rădan and Rădan, 2004B, 2005, 2005-P, 2006A,B).

Undisturbed sediment cores up to 56 cm long, taken from three lakes of the Danube Delta, have recently been investigated for magnetic susceptibility (an example, in Fig. 5). The vertical distribution of the **MS** values along 4 sediment cores was analysed (Rădan et al., 2006B).

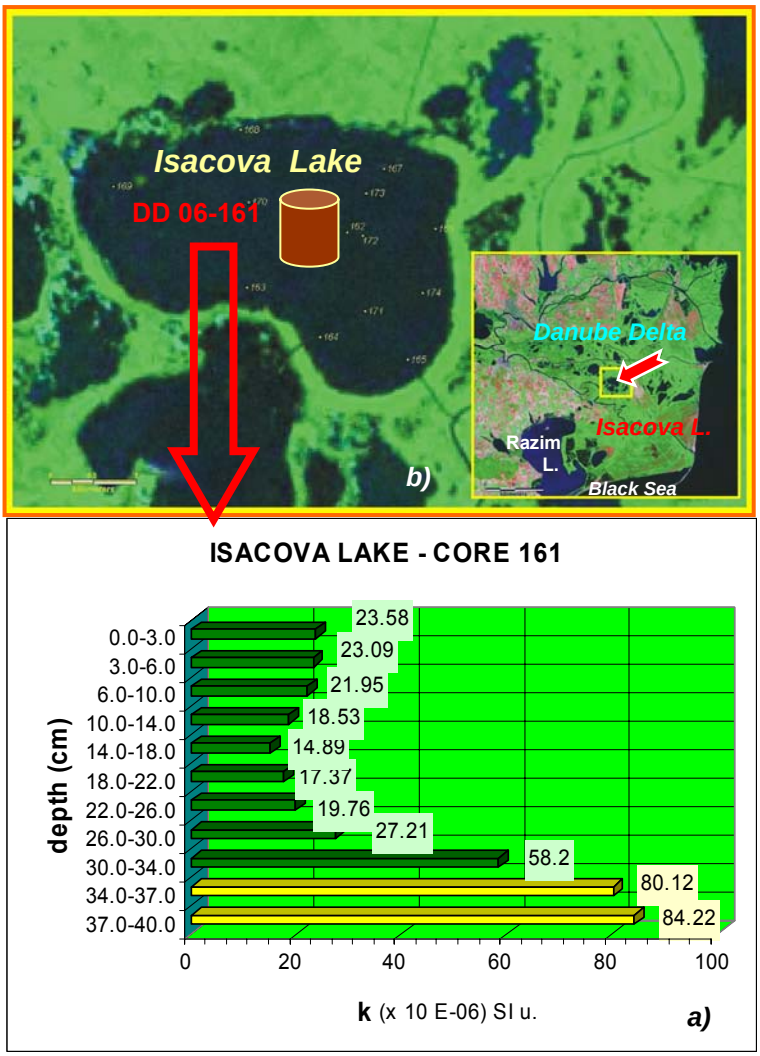


Fig. 5. Vertical distribution of the magnetic susceptibility for the sediment core DD 06-161, sampled in the Isacova Lake, in 2006 (Danube Delta, Romania).

One paper focused on the presentation of the "Magnetic Susceptibility Scale" originating in the lake sediments of the Danube Delta, and a review paper dealt with the synopsis of the 30 years of magnetic susceptibility measurements on the Danube Delta lake sediments (Romania, 1976-2006). Both of them were presented at the jubilee 10th Castle Meeting "New Trends in Geomagnetism – Palaeo, Rock and Environmental Magnetism", an outstanding Topic Symposium held at the Castle of Valtice (Czech Republic), on September 3 – 8, 2006 (Rădan and Rădan, 2006b, 2006b-P, 2006a, 2006a-O). In the first paper, several cases were selected to exemplify the way the elaborated and tested **k** Scale works; in this respect, an environmental and geoecological approach was used (Rădan and Rădan, 2006b-P, 2006b, 2007). This paper was also presented at the XVth International Symposium "Deltas and Wetlands 2006", held in Tulcea, at the "Danube Delta Gates", on September 20 – 24, 2006 (Rădan and Rădan, 2006c, 2006c-P). The second paper (Rădan and Rădan, 2006a, 2006a-O) describes a series of case-studies and/or history-cases, based on more than 2000 **MS** measurements carried out before (i.e. in the 1976-1982 period) and after (i.e. in the 1987-2006 period) the aggressive human intervention in the Danube Delta ecosystems. In the same time, the way from sedimentologic applications to Environmental Magnetism was run through. The paper also focused on a series of methodological, instrumental and conceptual problems related to the developing of the use of magnetic techniques in an aquatic area, particularly in the Danube Delta – Danube River – northwestern Black Sea geosystem (Fig. 6). An interactive schematic diagram illustrating these aspects was given (Rădan and Rădan, 2006a, 2006a-O).

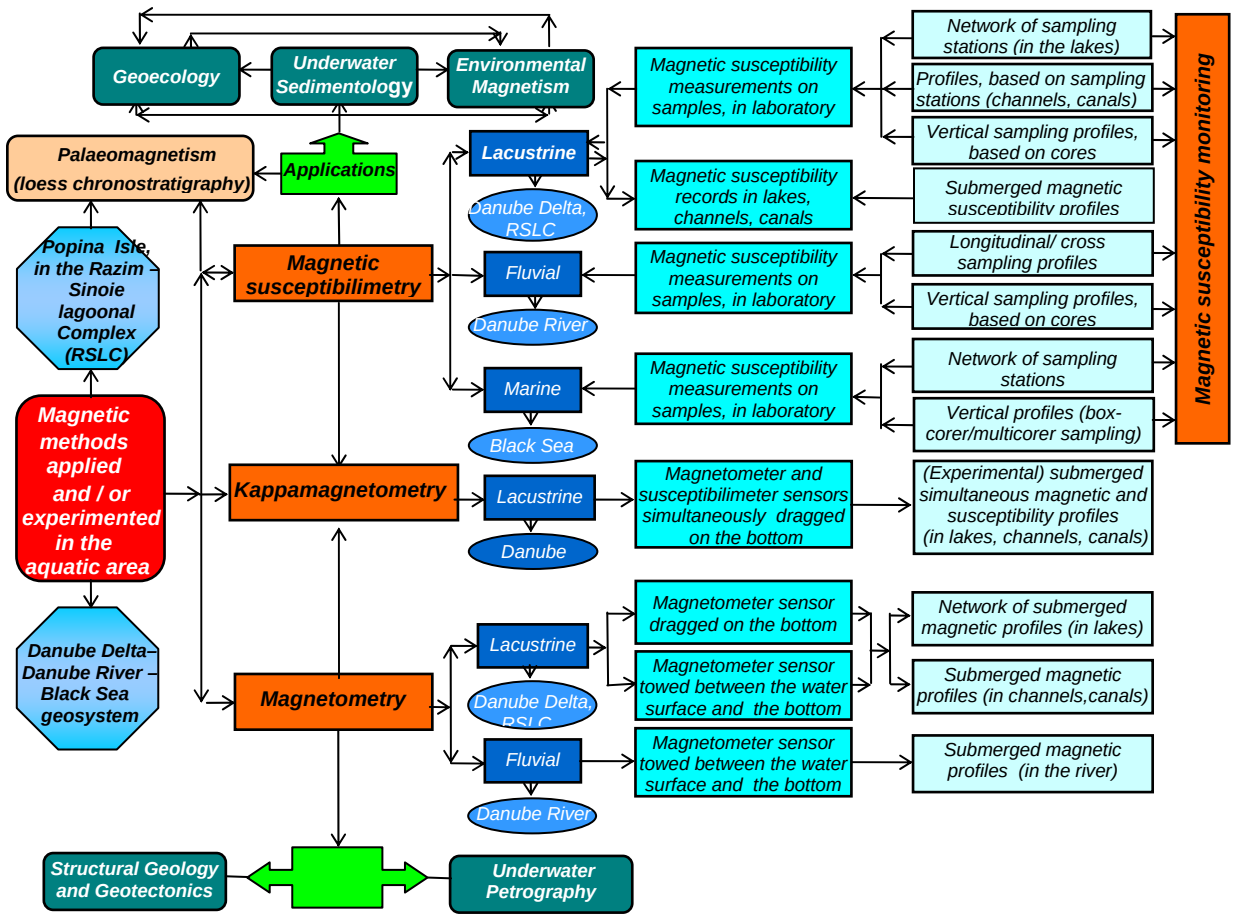


Fig. 6. Schematic diagram showing the magnetic methods applied and/or experimented in the aquatic area, particularly in the Danube Delta – Danube River – northwestern Black Sea geosystem.

The magnetic susceptibility proved a valuable proxy parameter for differentiating sedimentary environments, providing information on the quality of sediments, lithologic characteristics, evolution of sedimentogenetic processes and changes produced in the history of sediments under anthropogenic pressure. The excellent connection between the magnetic susceptibility values – correlated to the "Magnetic Susceptibility Scale" – with the lithological characteristics of the bottom sediments, the "Sediment Quality Scale" and the "Environment Quality Scale" demonstrated the potential of this modern environmental magnetism technique for sedimentological, environmental and geoecological interpretations.

Finally, it is worth emphasizing that the activity of Environmental Magnetism within the Laboratory of the Geological Institute of Romania (GIR) was developed during the 2003 – 2007 period in the framework of the following main National Research Projects: 1. "Elaboration of an enviromagnetic method for the characterisation of the sedimentary systems in areas covered by water. Experimentation in the Danube Delta and Razelm (Razim) – Sinoie Lagoonal Complex" (2002 – 2004), a Project financed by the "Fundamental, Social-Economic and Cultural" ("CERES") Programme (Rădan and Rădan, 2003A,B, 2004A,B); 2. Natural greenhouse gas emissions from wetlands in Romania, focus on the Danube Delta and the Black Sea littoral zone (GASERO) (2005 – 2008), a Project financed by the "Research of Excellence" ("CEEX") Programme (Rădan and Rădan, 2005, Rădan et al., 2006A,B,C). The first mentioned Project was fulfilled by GIR (as coordinator) in partnership with the National Institute of Marine Geology and Geo-Ecology (GeoEcoMar), while the second is ongoing (GeoEcoMar, as coordinator, in partnership with GIR and the University of Bucharest).

2. Palaeomagnetism and Rock Magnetism.

The analysis of the state of the magnetic recording medium (**m.r.m**.) is of fundamental importance in order to decipher correctly the Earth's magnetic field structure in the geological past. Thus, the case of the "medium" constituted by "coal bearing formations", located in two lignite quarries from the western Dacian Basin (Romania), has been approached (Rădan, 2003, 2007a).

The observation data, obtained in the Palaeomagnetic Laboratory of the Geological Institute of Romania, were based on a very large collection of specimens of both "fresh" (Fig. 7a) and "baked" clays (Fig. 7b). The comparison of their rock magnetic and palaeomagnetic parameters has resulted in a clear-cut differentiation of the characteristics of the two "states" of the magneto-recording medium.

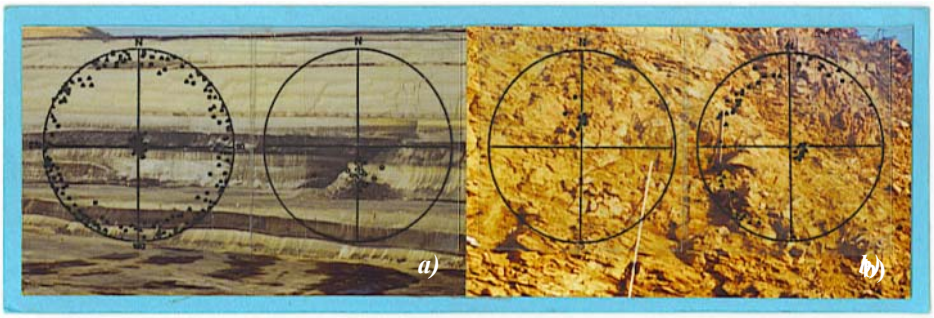


Fig. 7. Magnetic recording medium in an area with coal seams (western Dacian Basin, Romania).
a) Pliocene lignite-clay cycles in a quarry; **b)** baked clays (porcelanites) in a lignite quarry.

The rock magnetic signal – characteristic of the "original" (thermally-not affected) clays – was defined by low amplitude. The magnetic fabric is a (primary) depositional/sedimentary fabric. A strongly foliated (oblate) fabric was revealed. The magnetic anisotropy data obtained for the "fresh" clays could be calibrated to the theoretical depositional fabrics. These are mostly identified with the

pattern showing the case of the "horizontal depositional surface" and "quiet conditions". The total natural remanent magnetisation (**NRM**) showed low and very low intensity values (**In**). The **NRM** direction of the original ("fresh") clay samples, taken out at a similar level (i.e. coal bed X) with that at which effects of high temperatures (porcelanite formation) have been detected, was usually associated with a reversed polarity (Rădan, 2003, 2007a).

The rock magnetic signal, sent by the "baked clays", representing the thermally-disturbed **m.r.m**., is changed in comparison with the signal received from the "original" clays, which stand for the "initial"/"thermally non-affected" **m.r.m**. The $\mathbf{k_{in}}$ has considerably increased. High and very high **MS** amplitudes were recorded for porcelanites and porcelanite-like clays. The **MS** values of the "baked" clays are characterised by one to three magnitude orders higher than those measured on the "fresh"/"original" clays. With regard to the **AMS**, the enhancement of several magnetic anisotropy parameters (e.g. the magnetic foliation **F** and the anisotropy degree **P)** has been observed. The porcelanite-like clays and the porcelanites, newly formed at the expense of initial/original clays, acquired an important thermoremanent magnetisation (**TRM**). The remanent magnetisation recorded high and very high intensity values (**In**). The **NRM** direction has also been modified, usually showing a normal polarity, in a position that is close to the zone where the actual geomagnetic field direction is located (Rădan, 2003, 2007a).

The palaeomagnetic signal showed the essential modifications suffered by the **m.r.m.** due to the post-depositional perturbations; changes of the geomagnetic record that had been fixed in the "fresh"/"original" rocks were produced. So, the thermally non-affected clays, characterising the original ("initial") state of the **m.r.m.**, have recorded a reversed polarity, whereas the "porcelanites", characterising the modified ("subsequent") state of the **m.r.m.**, located in the vicinity of the "fresh" clays, have printed a normal polarity of the geomagnetic palaeofield (Rădan, 2003, 2007a). The former polarity zone was assigned to the Gilbert Chron, namely to the lower part of the C2Ar Subchron (**ATNTS-2004**; 4.187 – 3.596 Ma), whereas the latter was assigned to the Brunhes Chron (**ATNTS-2004**; 0.781 – 0.00 Ma).

A series of geomagnetic consequences were revealed, e.g. the significant magnetic anomalies produced by the porcelanite deposits (Rădan, 2003, 2007a) (Figs. 8 and 9).

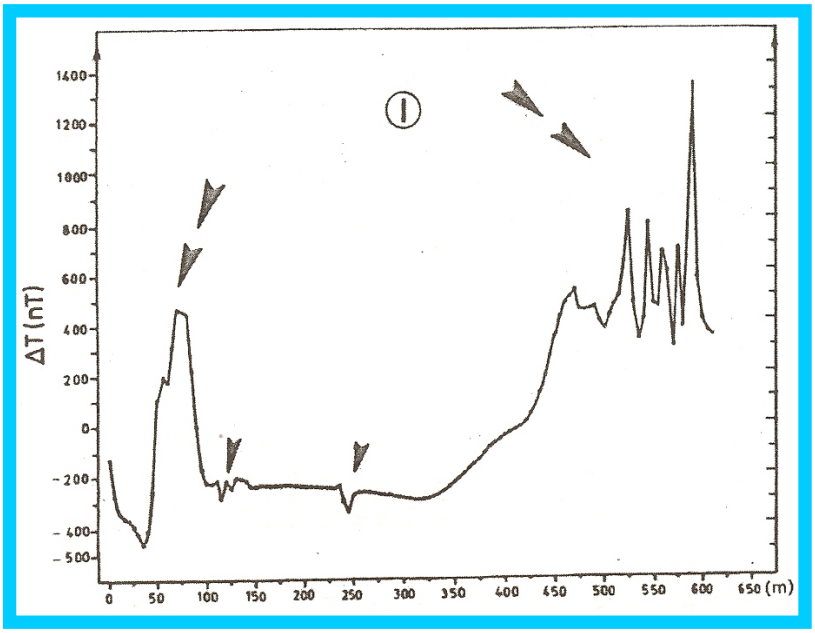


Fig. 8. Magnetic anomalies produced by changes of the magnetic recording medium (**m.r.m.**) in areas with coal seams (Lupoaia – Motru zone, western Dacian Basin). Note: big double arrows indicate "magnetic signals" produced by porcelanites; small single arrows indicate "magnetic noise" caused by surface sources not belonging to the **m.r.m**.

Besides, the role of a geothermometer played by the thermo-mineralogical characteristics detected for several groups of "baked clays" was emphasized (Rădan, 2003). This can be also used to control the remanent magnetisation transformation in the rocks

forming the **m.r.m.** affected by changes induced by temperature. Among the applications and implications of the study of the burnt rock deposits, the palaeoenvironmental impact and some economic consequences must not be neglected.

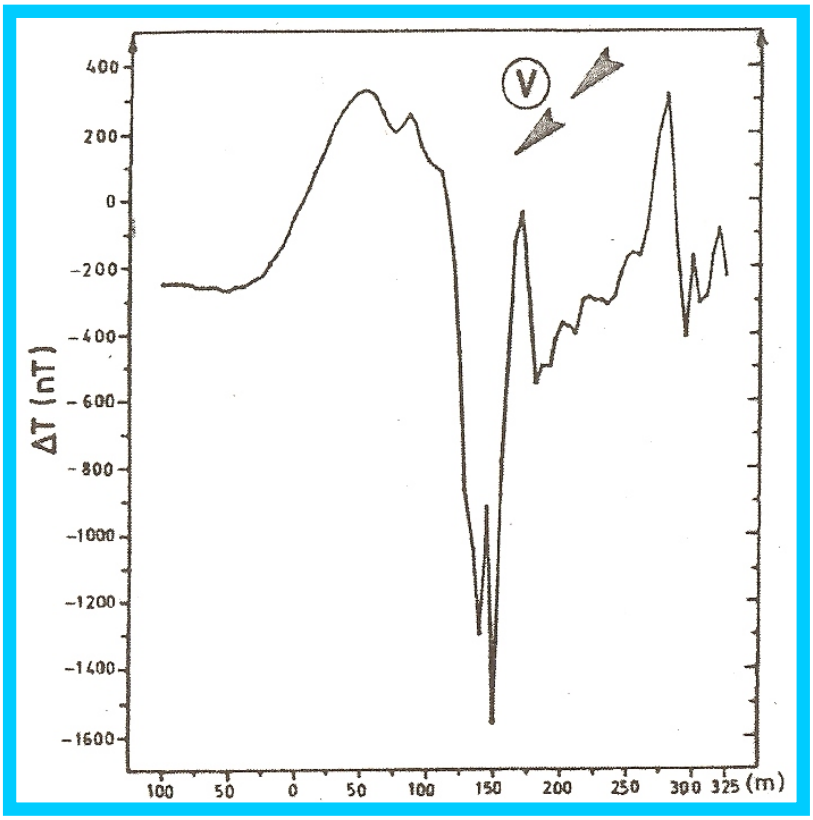


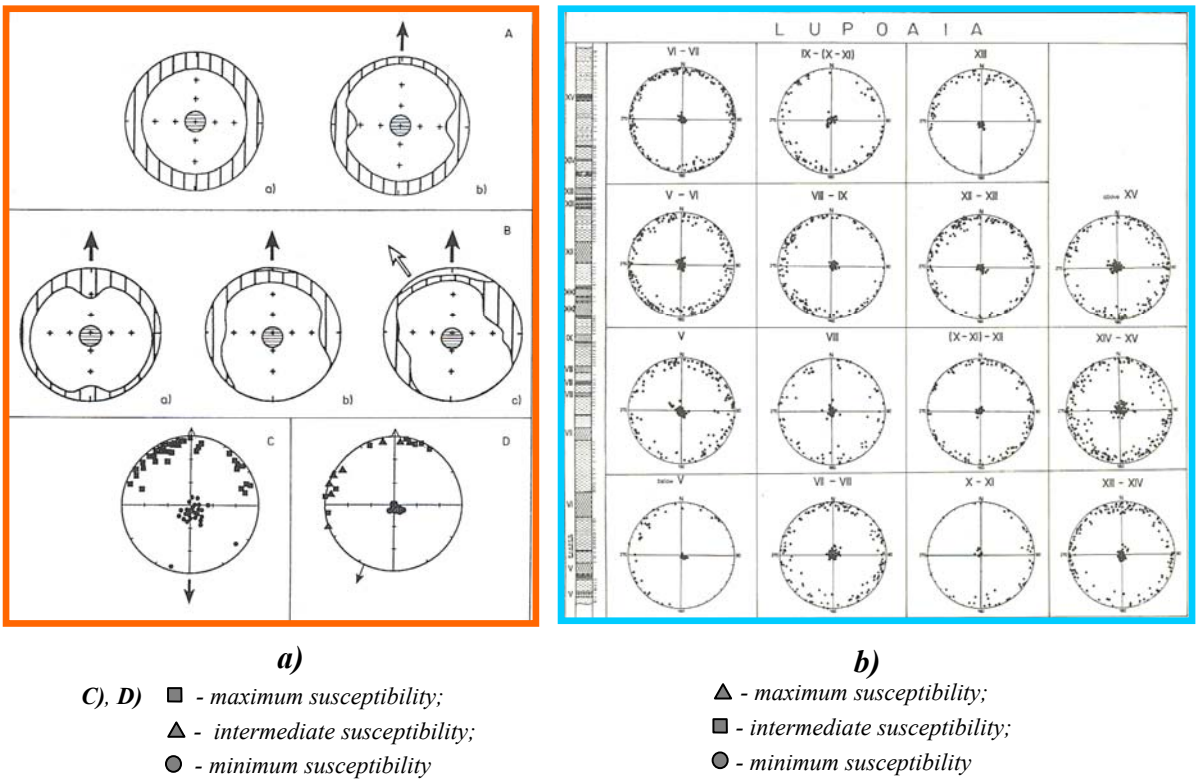
Fig. 9. Magnetic anomalies produced by changes of the magnetic recording medium in areas with coal seams (Lupoaia – Motru zone, western Dacian Basin). Note: big double arrows indicate "magnetic signals" produced by porcelanites.

In conclusion, all these (palaeo)magnetic signals received from porcelanites support a remagnetisation process, which evidences a natural thermal event occurring in the history of the lignite-clay sequences from the Dacian Basin (Romania) (Rădan, 2007a).

Another paper deals with a special, noteworthy topic (Rădan, 2007b). Starting from the geophysical concept – direct problem and inverse problem –, common for the methods based on the natural field measuring (e.g. magnetic and gravity methods), its transfer to Petromagnetology and Palaeomagnetology is attempted. Some terminology issues, as inferred from the rock magnetic and palaeomagnetic literature, are commented. The terms "petromagnetology" and "palaeomagnetology" might be an extension of those frequently met – "petromagnetism"/"rock magnetism" and "palaeomagnetism" respectively, the latter being able to be assigned to the corresponding investigated phenomena. Numerous and various examples offered by the rock magnetic and palaeomagnetic literature (contributions of the GIR Laboratory of Palaeomagnetism, Rock Magnetism and Enviromental Magnetism included) are given. These are systematised into two main groups: direct and indirect applications. They suggest and actually contain elements supporting the direct problem and the inverse problem, respectively, whose transfer to the two geoscience fields is attempted.

As regards the Petromagnetology, the determination of the characteristics of the remanent magnetisation-bearing minerals, of singledomain (SD) or multidomain (MD) states and of their transition, the knowledge of the physical mechanisms responsible for the stable remanence acquisition and preservation, and so on, could represent elements of the direct

problem in Petromagnetology/Rock Magnetism (Rădan, 2007b). The theoretical depositional fabrics established under laboratory conditions (when different hydrodynamic regimes are simulated) (Tarling, Hrouda, 1993; a compilation, after Radan, 1998, 2007b, in Fig. 10a) could be merged with the direct problem in Rock Magnetism. Their use to interpret magnetic fabrics in natural sediments represents an example of inverse problem of the Rock Magnetism/Petromagnetology. A concrete situation is illustrated by the interpretation of the magnetic fabrics determined in coal-generating areas, in the Western Dacian Basin (an example is given in Fig. 10b).



a)

C), D) ■ *- maximum susceptibility;*
▲ *- intermediate susceptibility;*
● *- minimum susceptibility*

b)

▲ *- maximum susceptibility;*
■ *- intermediate susceptibility;*
● *- minimum susceptibility*

Fig. 10. Magnetic fabrics for sediments and sedimentary rocks. **a)** Theoretical depositional fabrics (A, B); fabrics in sediments deposited under laboratory conditions (C); primary fabrics in natural sediments (D) (compilation after Tarling and Hrouda, 1993, in Rădan, 1998, 2007b); **b)** Primary magnetic fabrics in clays from the Lupoaia lignite quarry (Dacian Basin, Romania) (after Rădan 1998, 2007b).

Among the examples given in the paper as support elements of the direct problem in Palaeomagnetology, there are the study of the geomagnetic field behaviour in Phanerozoic, and particularly, the investigation of the palaeosecular variations, geomagnetic reversals, polarity transitions, geomagnetic excursions (Rădan, 2007b). If the Geomagnetic Polarity Time Scale (GPTS) elaboration is a produce resulted from the direct problem approach in Palaeomagnetology – a "palaeogeomagnetic pattern" actually –, its use as a dating and correlation tool for geological formations, extended to the palaeoclimatic and palaeoenviromental reconstructions – in a magneto(bio)stratigraphic, tephra-, chemo-, cyclo-stratigraphic and/or astrochronologic framework – could be assigned to the inverse problem of the Palaeomagnetology (cf. Fig. 11). This case is supported by a series of results obtained in Romania on various deposits, mostly concerning lignite-clay sequences (several references, in Rădan, 2007b).

Anyway, as the magnetisation of the rocks – integrated in the matrix of the geological medium – interferes with Magnetometry/Magnetology, Rock Magnetism/Petromagnetology, and equally with Palaeomagnetism/Palaeomagnetology, it is difficult, sometimes, to make a clear-cut distinction between what to assign to the direct problem and what to assign to the inverse problem.

Finally, it is worth mentioning that several papers concerning magnetostratigraphic and/or rock magnetic data obtained in the Laboratory of Palaeo-, Rock and Environmental Magnetism of the Geological Institute of Romania, published before the time interval to which this National IAGA Report refers, were mentioned and/or analysed in several papers, books and PhD Theses, published by other Romanian and foreign authors since 2003. Most of them mention and/or analyse our results concerning the study of the geomagnetic field structure in Tertiary in the context of magnetostratigraphic scale elaboration, focus on the Pliocene and Miocene (e.g. Gillet, 2004, Visarion, 2004, Suc et al., 2005, Vasiliev, 2006a,b, Popescu et al., 2006a,b, Snel et al., 2006). Our palaeo- and rock magnetic data, which were published in the papers to which the above mentioned authors refer, have mainly originated in the "coal bearing formations" from the western Dacian Basin (Romania), and a small part only from the Comăneşti Basin (Romania). Besides, Jipa et al. (2005) mention our results regarding the palaeomagnetic characteristics of the Quaternary loess – palaeosoil sequences investigated in South Dobrogea (Romania).

A very well-documented paper on the Late Miocene to Early Pliocene chronostratigraphic framework for the Dacian Basin (Romania), calibrated to the Astronomical Polarity Time Scale (**APTS**), facilitating the attempt to correlate the Paratethys stages with those of the Mediterranean, has recently been published by Snel et al. (2006). The authors present an "age model" illustrating the magneto- and biostratigraphic correlation of several Dacian Basin sections with the **APTS** and they compare with two interpretations of the magnetostratigraphy of the Kerch-Taman composite section. In the discussion on the Pontian, Dacian and Romanian stages, Snel et al. (2006) refer to Radan and Radan (1998), Radan (2000, 2002), among others. Moreover, in the "age model" from Fig. 11, the "option A" is after the magnetostratigraphic data of Radan and Radan (1998) and Van Vugt et al. (2001).

Some of the petromagnetic investigation tools, inferred from the magnetic susceptibility study of the epimetamorphic schists from the Poiana Ruscă Mountains, which was carried out in our Laboratory a long time ago, were referred and commented in a book concerning the "History of the Romanian Geophysics" (Visarion, 2004). Moreover, the book's author presented a series of considerations with regard to the palaeomagnetic and rock magnetic results obtained in the Palaeomagnetic Laboratory of the Geological Institute of Romania, pointing out the introducing of the magnetostratigraphy in Romania as an important technique of correlation of the coal beds, and, generally speaking, as a dating method for the geological formations (Visarion, 2004).

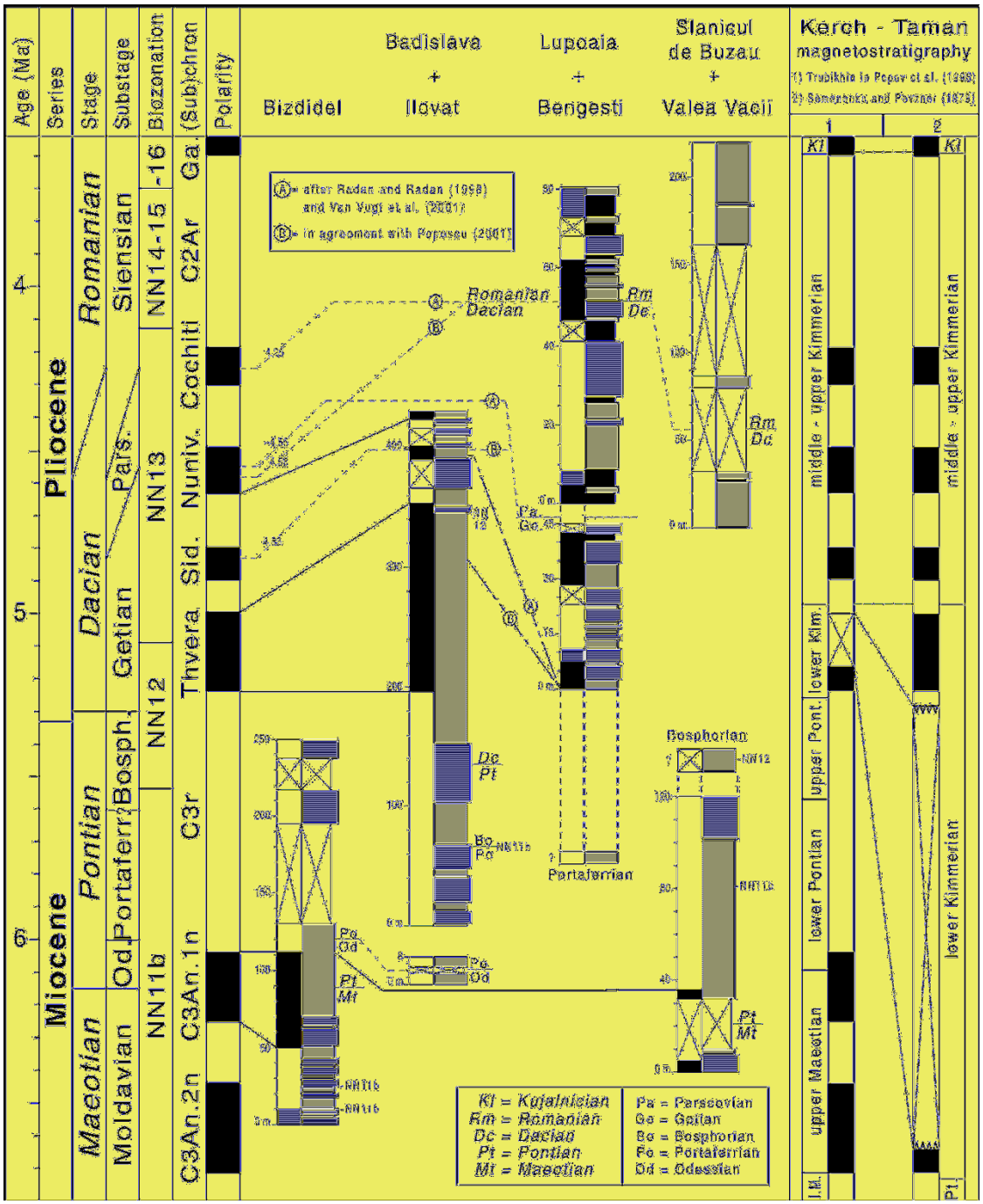


Fig. 11. Magneto- and biostratigraphic correlation of the Dacian Basin sections with the Astronomical Polarity Time Scale (APTS) and comparison with two interpretations of the magnetostratigraphy of the Kerch–Taman composite section (after Snel et al., 2006).

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II. Papers presented (Oral or Poster) at International Symposia, Workshops and Meetings

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Rădan, S., Ganciu, A., Strechie, C., Grosu, A., Bergheş, F., Rădan, S.C., Secrieru, D., Bălan, S., Grosu, D. (2004-O) Trends in pollutant inflow and dispersal in Danube Delta – Effects on aquatic ecosystem quality, International Symposium "The Pollutant Influxes into the Semi-enclosed Marine Basins – Comparison between the European River – Seas Systems of the Baltic Sea, the North Sea, the Mediterranean Sea and Black Sea", Bucharest, Romania, 22-24 April, 2004.

Rădan, S.C., Rădan, S. (2004-O) "Environmental Magnetism – Methodologies Applied in the Danube Delta and the Razelm-Sinoe Lagoon Complex: Sedimentogenetic Semnifications and Geoecological Implications", Euro–EcoGeoCentre – Specialised Course "Environmental Processes and Problems Focused Especially on Dynamics and Biogeochemistry of Water and Sediments in Rivers, Deltas and Coastal Seas", September 22 – 30, 2004, Uzlina (Danube Delta, Romania), Laboratory boat "Halmyris" and R/V "Istros".

Rădan, S.C., Rădan, S. (2005-P) Enviromagnetic fingerprints of the natural changes and anthropogenic pressure on Danube Delta ecosystems recovered from bottom sediments, XIVth International Symposium "Deltas and Wetlands 2005", Tulcea, Romania, 28 Sept. – 2 Oct. 2005.

Rădan, S.C., Rădan, S. (2006a-O) 30 years of magnetic susceptibility measurements on the Danube Delta lake sediments (Romania, 1976-2006). Sedimentologic applications to Environmental Magnetism, 10th Castle Meeting "New Trends in Geomagnetism – Palaeo, Rock and Environmental Magnetism", Castle of Valtice, Czech Republic, September 3 – 8, 2006.

Rădan, S.C., Rădan, S. (2006b-P) A magnetic susceptibility scale with a lithological support originated in the lake sediments from the Danube Delta and the Razim – Sinoie lagoonal Complex (Romania). An environmental and geoecological approach, 10th Castle Meeting "New Trends in Geomagnetism – Palaeo, Rock and Environmental Magnetism", Castle of Valtice, Czech Republic, September 3 – 8, 2006.

- **(2006c-P)**, presented, also, at the XVth International Symposium "Deltas and Wetlands 2006", Tulcea, Romania, 20 – 24 Sept. 2006.

III. SCIENTIFIC REPORTS (NATIONAL RESEARCH PROJECTS)

*(***unpublished works*;* GIR – GeoEcoMar Archives*)***

Rădan, S.C. *(*GIR*),* ***Rădan, S.*** *(*GeoEcoMar*)**(2003A)*** Elaboration of an enviromagnetic method for the characterisation of the sedimentary systems in areas covered by water. Experimentation in the Danube Delta and Razelm (Razim) - Sinoie Lagoonal Complex. *I.* Presentation of a case study regarding the environmental magnetism in the Fluvial Delta Plain (Danube Delta) *(in Romanian), 2002–044 CERES Project,* GIR–GeoEcoMar Archives*, Bucharest, 104 p. Text; 51 Figures and Tables.*

Rădan, S.C. *(*GIR*),* ***Rădan, S.*** *(*GeoEcoMar*) **(2003B)*** Elaboration of an enviromagnetic method for the characterisation of the sedimentary systems in areas covered by water. Experimentation in the Danube Delta and Razelm (Razim) - Sinoie Lagoonal Complex. *II.* Application of the compared analysis method of the magneto-susceptibility patterns (performed for repeated investigation phases, including a new cruise), in other ecosystems from the Fluvial Delta Plain, as well as from the Marine Delta Plain (Danube Delta*) (in Romanian), 2002–044 CERES Project,* GIR–GeoEcoMar Archives*, Bucharest, 54 p. Text; 57 Figures and Tables; Annex with 1 page Text.*

Rădan, S.C. *(*GIR*),* ***Rădan, S.*** *(*GeoEcoMar*) **(2004A)*** Elaboration of an enviromagnetic method for the characterisation of the sedimentary systems in areas covered by water. Experimentation in the Danube Delta and Razelm (Razim) – Sinoie Lagoonal Complex. *III.* Presentation of the case study regarding the environmental magnetism in the Razelm (Razim*)* – Sinoie lagoonal Complex *(in Romanian), 2002–044 CERES Project,* GIR–GeoEcoMar Archives*, Bucharest, 79 p. Text; 48 Figures and Tables; 2 Annexes with 11 pages Text and 2 Tables* .

Rădan, S.C. *(*GIR*),* ***Rădan, S.*** *(*GeoEcoMar*) **(2004B)*** Elaboration of an enviromagnetic method for the characterisation of the sedimentary systems in areas covered by water. Experimentation in the Danube Delta and Razelm (Razim) – Sinoie Lagoonal Complex. *IV.* Setting up and presentation of the enviromagnetic method characterising the sedimentary systems in the areas covered by water, with experimentation in the Danube Delta and the Razelm/Razim–Sinoie lagoonal Complex *(in Romanian), 2002–*

044 CERES Project, GIR–GeoEcoMar Archives*, Bucharest, 307p. Text, Figures and Tables; Annex with 7 pages Text.*

***Rădan, S.** (*GeoEcoMar*), **Rădan, S.C.** (*GIR*) **(2005)** Natural greenhouse gas emissions from wetlands in Romania, focus on the Danube Delta and the Black Sea littoral zone (GASERO). *I.* Summary of geological, hydrological, climate etc. data, which are relevant for establishing the strategy of research *(in Romanian)*, *2005-619 CEEX Project,* GeoEcoMar–GIR Archives, *Bucharest, 85 p. Text, Figures and Tables.*

***Rădan, S., Opreanu, P., Pavel, A., Jugaru, L., Bălan, S.** (*GeoEcoMar*), **Rădan, S.C.** (*GIR*), **Stoica, M., Milu, C.** (*University of Bucharest*) **(2006A)** Natural greenhouse gas emissions from wetlands in Romania, focus on the Danube Delta and the Black Sea littoral zone (GASERO). *II.* Measurement of the greenhouse gas flux and the investigation of water quality and sediment quality in characteristic ecosystems in the Danube Delta in periods of high waters, *2005-619 CEEX Project*, GeoEcoMar – GIR Archives*, Bucharest, 141 p. Text, Figures and Tables (in Romanian).*

***Rădan, S., Pavel, A., Jugaru, L., Bălan, S., Grosu, D.** (*GeoEcoMar*), **Rădan, S.C.** (*GIR*), **Milu, C.** (*University of Bucharest*) **(2006B)** Natural greenhouse gas emissions from wetlands in Romania, focus on the Danube Delta and the Black Sea littoral zone (*GASERO*). III.* Measurement of the greenhouse gas flux and the investigation of water quality and sediment quality in characteristic ecosystems in the Danube Delta in periods of low waters*, 2005-619 CEEX Project,* GeoEcoMar–GIR Archives*, Bucharest, 162 p. Text, Figures and Tables (in Romanian).*

***Rădan, S., Rădan, S.C., Pavel, A., Opreanu, P., Bălan, S., Jugaru, L., Stoica, M., Milu, C. (2006C)** Natural greenhouse gas emissions from wetlands in Romania, focus on the Danube Delta and the Black Sea littoral zone (*GASERO*) (Manuscript-Paper prepared for the Scientific Session "MENER 2006").*

IV. Books, PhD Theses and papers (by authors other than GIR *researchers), which refer to the results obtained in the Laboratory of Palaeo-, Rock and Environmental Magnetism of the Geological Institute of Romania*

***Gillet, H. (2004)** La stratigraphie tertiaire et la surface d'érosion messinienne sur les marges occidentals de la Mer Noire: stratigraphie sismique haute resolution*, Thèse, l'Université de Bretagne Occidentale, France, 260p.*

***Jipa, D.C., Dinu, I., Angheluţă, C. (2005) (Eds.)** Geo-ecological Assessment of Soil and Groundwater Hydrocarbon Contamination in the Oil terminal Area in Constanţa*, Romania*, Geo-Eco-Marina*, **7/8**, 2003-2004, Bucureşti-Constanţa,160p.*

***Popescu, S-M., Krijgsman, W., Suc, J-P., Clauzon, G., Mărunţeanu, M., Nica, T. (2006a)** Pollen record and integrated high-resolution chronology of the early Pliocene Dacic Basin (southwestern Romania), in Agusti, J., Oms, O., Meulenkamp, J.E. (Eds.), Late Miocene to early Pliocene environment and climate change in the Mediterranean area,* Palaeogeography, Palaeoclimatology, Palaeoecology*, **238**, 78-90.*

***Popescu, S.-M., Suc, J.-P., Loutre, M.-F. (2006b)** Early Pliocene vegetation changes forced by eccentricity–precession. Example from Southwestern Romania, in Agusti, J., Oms, O., Meulenkamp, J.E. (Eds.), Late Miocene to early Pliocene environment and climate change in the Mediterranean area,* Palaeogeography, Palaeoclimatology, Palaeoecology*, **238**, 340–348.*

***Snel, E., Mărunţeanu M., Macaleţ, R., Meulenkamp, J.E., van Vugt, N. (2006)** Late Miocene to Early Pliocene chronostratigraphic framework for the Dacic Basin, Romania,* Palaeogeography, Palaeoclimatology, Palaeoecology*, **238**, 107-124.*

Suc, J-P., Bakrac, K., Clauzon, G., Galovic, I., Jipa, D., Krijgsman, W., Mărunţeanu, M., Meulenkamp, J.E., Popescu, S-M., Snel, E. (2005) *Late Messinian – Early Zanclean Mediterranean-Paratethys connections with respect to Croatian and Romanian sections, 12th Congress R.C.M.N.S., 6-11 September 2005, Vienna, Post- Congress Excursion D, 12-17 September 2005, Programme and Abstracts.*

Vasiliev, I. (2006) A new chronology for the Dacian Basin (Romania). Consequences for the kinematic and paleoenvironmental evolution of the Paratethys region*, PhD Thesis, Mededelingen van de Faculteit Geowetenschappen, Universiteit Utrecht,* Geologica Ultraiectina*, **267**, The Netherlands, 193p.*

Vasiliev, I., Krijgsman, W., Langereis, C.G., Panaiotu, C.E., Maţenco, L., Bertotti, G. (2004) *Towards an astrochronological framework for the eastern Paratethys Mio-Pliocene sedimentary sequences of the Focşani basin (Romania),* Earth Planet. Sci. Letters*, **227**, 231-247.*

Visarion, M. (2004) The History of the Romanian Geophysics *(in Romanian), Ed. Vergiliu, Bucureşti, 517pp.*

IAMAS ACTIVITIES IN ROMANIA
2003-2007

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PART I: ORGANIZATION

The International Association of Meteorology and Atmospheric Sciences (IAMAS) Organization for Romania, a Section of the Romanian National International Union of Geodesy and Geophysics (IUGG) Committee, was constituted at the National Meteorological Administration (the former National Institute of Meteorology and Hydrology - Bucharest) in cooperation with the Faculty of Physics, Department of Atmosphere Physics of the University of Bucharest.

The National Meteorological Administration (NMA) represents the national service in the field of meteorology and the General Manager is the Permanent Representative of Romania with the World Meteorological Organization (WMO). The Scientific Manager is the co-president of IAMAS for Romania. The main activities developed within NMA are: *basic operational activity* (weather forecast, observation system, telecommunication, climatological database), *research activity* (numerical modelling, climate variability and climate change, physics of the atmosphere, air pollution, remote sensing and GIS, agrometeorology), *education and training and international cooperation.* At the Faculty of Physics, the Department of Atmosphere Physics, the students and the teachers work in the fields of Dynamic Meteorology, Physics of Climate, Thermodynamic and Radiation of the Atmosphere, Electricity of the Atmosphere and they collaborate with the researchers from NMA. Many research laboratories in the field of air and water pollution monitoring are present at the National Institute of Environment Research and Engineering (ICIM - Bucharest). Studies related to upper air are being performed especially at the Astronomical Institute (that IAMAS - Romania intends to attract within the association the next year) and ROMATSA. ROMATSA includes a National Center of Aeronautic Meteorology with 17 offices and airport meteorological stations, units corresponding to the OACI standards.

IAMAS has 10 commissions:

- International Commission on Atmospheric Chemistry and Global Pollution
- (ICACGP);
- International Commission on Atmospheric Electricity (ICAE);
- International Commission on Climate (ICCL);
- International Commission on Clouds and Precipitation (ICCP);

- International Commission on Dynamical Meteorology (ICDM);
- International Commission on the Middle Atmosphere (ICMA);
- International Ozone Commission (IOC);
- International Commission on Planetary Atmospheres and their Evolution (ICPAE);
- International Commission on Polar Meteorology (ICPM);
- International Radiation Commission (IRC).

The general objectives of IAMAS (to promote the study of the science of the atmosphere, to initiate, facilitate and coordinate international cooperation, to stimulate discussion, presentation and publication of scientific results, to promote education and public awareness) are also the objectives of the organization in Romania, although the activities related to these sections are different, some sections, such as: dynamic meteorology, climatology or air pollution enjoying more interest as against upper air or polar meteorology. In this view, we should mention the significant participation of the Romanian researchers in the international programs, especially the European ones, such as ALADIN, ETEX, and CLIVAR.

The Romanian Meteorological Society also supports the IAMAS activities for Romania.

Romanian IAMAS Activities

- **Dynamic Meteorology**
- **Climate**
- **Atmospheric Physics:**
  - Ozone and Radiation
  - Atmospheric Chemistry and Global Pollution
  - Atmospheric Electricity
- **Agrometeorology**
- **Remote sensing and GIS**
- **Nowcasting**

Professional Organizations

- **Romanian Meteorological Society**

Institutions

- **National Meteorological Administration (NMA)**
- **Institute of Environment Research and Engineering (ICIM)**
- **Romanian Civil Authority for Aeronautics (ROMATSA)**
- **University of Bucharest:**
  - Faculty of Physics
  - Faculty of Geography

National Conferences

- **Annual Scientific Session of the National Meteorological Administration**
- **Annual Scientific Session of the Faculty of Physics, University of Bucharest**
- **Annual Conference of Physics**

Publications

- **Romanian Journal of Meteorology**
- **Romanian Reports in Physics**

PART II: PROFESSIONAL ACTIVITY

DYNAMIC METEOROLOGY

1. Research orientation

The research activity in meteorology developed the main activity domains: numerical atmospheric modelling and modelling of the pollutant transport, climatic modelling and studies (climate variability, climate change and climatic forecasting), studies on the physics of the atmosphere and of the ozone layer, studies based on satellite techniques, remote sensing and GIS, as well as studies of the climatic conditions impact on crops.

The results of the research activity were presented at internal and international scientific meetings and were published in specialized Romanian and international journals.

1.1. Numerical modelling

The scientific research in the field of the numerical modelling of the atmosphere consisted in improving the current modelling techniques, in order to enhance fine-scale forecasting skills.

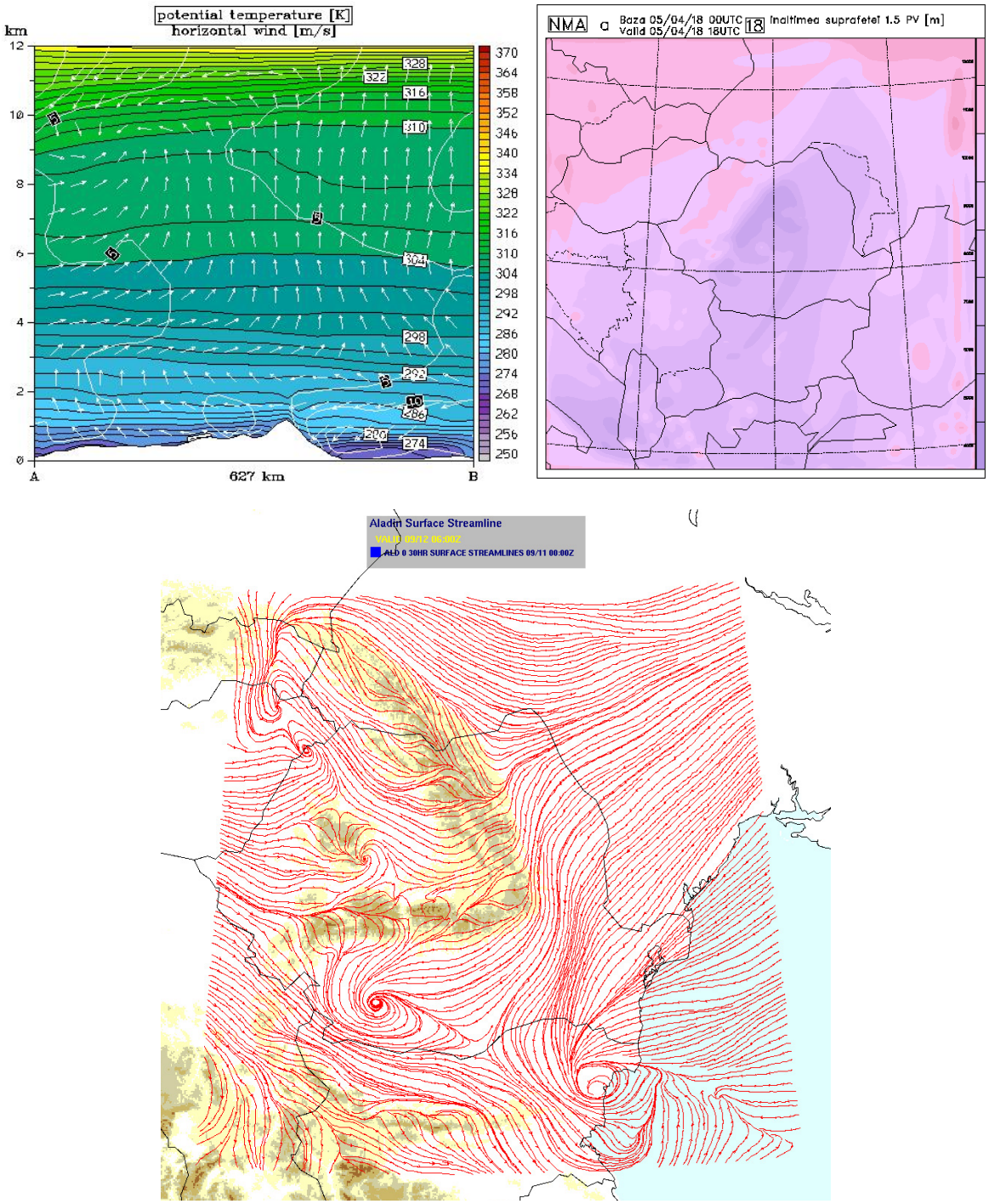
Numerical modelling of regional climate over south-eastern Europe has known an enhanced development as research activity this year. Systematic simulations of the regional climate have started using the coupled system: RegCM3/ECMWF forecast models for a domain covering Romania and the Black Sea. Two time ranges were covered by the ensemble forecast: 10 days and one month respectively, and stored as a database for research.

a) The ALADIN model

Since 1997, the mesoscale limited area model ALADIN is operationally integrated at NMA and used in the national weather forecasting system. The operational suite has been continuously improved. The ALADIN integration domain was enlarged from 100 x 100 points to 144 x 144 points, while keeping the 10 km horizontal resolution, with a positive impact on the precipitation forecast. Currently, the model is integrated four times per day for a forecast range up to 78 hrs. (the 00 UTC integration), 66 hrs. (the 12 UTC integration) and 48 hrs. (06 and 18 UTC integrations). Version 28T3 of the model, which gathers the newest developments achieved within the ALADIN project in the field of numerical modelling, especially in the domain of physical parameterizations and variational assimilation of the meteorological data, is operationally used. New products dedicated to the forecasters (for example, meteograms, total, low, medium and high cloudiness, 1.5PV geopotential, 12 and 24 hrs. cumulated precipitation, thickness of 1000 -500 hPa layer) have been developed.

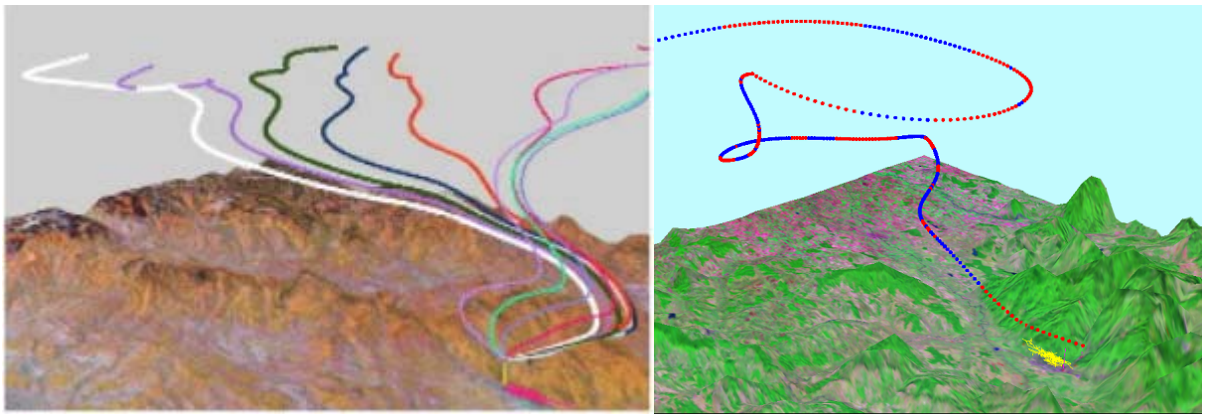
A diagnostic package of the ALADIN model, developed within the ALADIN project frame, has been implemented in the operational activity. The diagnostic fields are obtained by using all available meteorological SYNOP data over Romania (surface pressure, 2m temperature and humidity, 10m wind, mean sea level pressure) through the optimal interpolation method. These are the basis of further different diagnostics computations (CAPE, MOCON, stability indices), mainly used by the nowcasting department.

High-resolution dynamic adaptation (2.5 km resolution) for the surface wind forecast has been studied and operationally used, for both hydrostatic and non-hydrostatic versions of the ALADIN model. The dynamic adaptation of the forecast for wind field at kilometric scale is applied for two domains of touristic interest: one covering a mountain region, and the other one the Romanian Black Sea coast.



Examples of ALADIN products: vertical cross-section representing potential temperature and horizontal wind (top left), height of 1.5 potential vorticity surface (top right) and surface streamlines (bottom).

The daily ALADIN outputs are currently used for downstream applications (wave models, sea circulation models, hydrological models and pollutant transport models) as well.

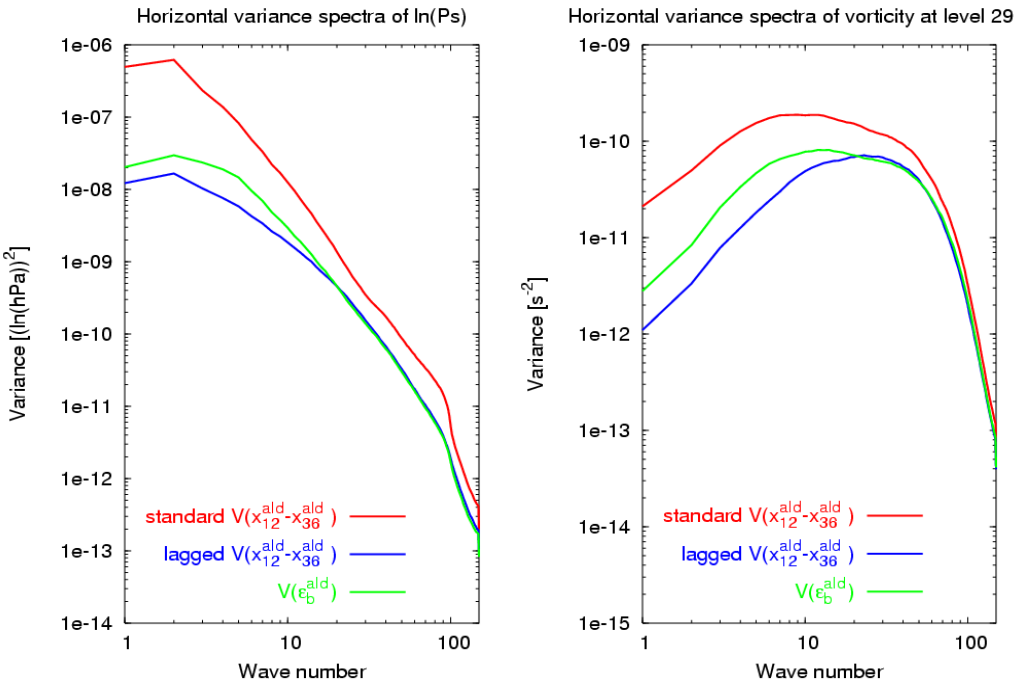


Pollutant trajectories for ALADIN forecast: hourly (left),
24hours evolution - succesive hours indicated by different colours (right).

The ALADIN research-development activities (part of them achieved in cooperation with other ALADIN teams) were focused on the following topics: spectral coupling, data assimilation, physical parameterization and high-resolution simulations (including comparison between ALADIN-NH and AROME) mainly for flood events studies.

Sensitivity studies in numerical weather prediction with respect to the initial conditions using ALADIN model and its adjoint have been performed.

The estimation of background error statistics for ALADIN three-dimensional variational assimilation (3D-Var) has been studied. An ensemble method was used and the results were compared with the NMC background error statistics. The ensemble approach appeared to be a good framework for the evaluation of the error statistics that are involved in the formulation of the ALADIN 3D-Var. It was shown that the influences of the analysis equation, of the implied initial and lateral uncertainties, and of the involved short ranges, are represented in a more accurate way than in the NMC method. Experiments related to the estimation of flow-dependent background error statistics are undergoing.



ALADIN 3D-Var background error horizontal variance spectra for logarithm of surface pressure (left) and vorticity at model level 29 (right) computed through three methods: standard NMC (red lines), lagged NMC (blue lines) and ensemble method (green lines).

Studies related to development of a scientific strategy for the implementation of a 3D-Var data

assimilation scheme for a double-nested limited-area model have been carried out. The applicability of the system to a limited area model has been investigated in order to obtain a better description of the fine scales by using high-density meteorological observations, together with the estimation of the best choice for the first guess, initialization method and background error statistics.

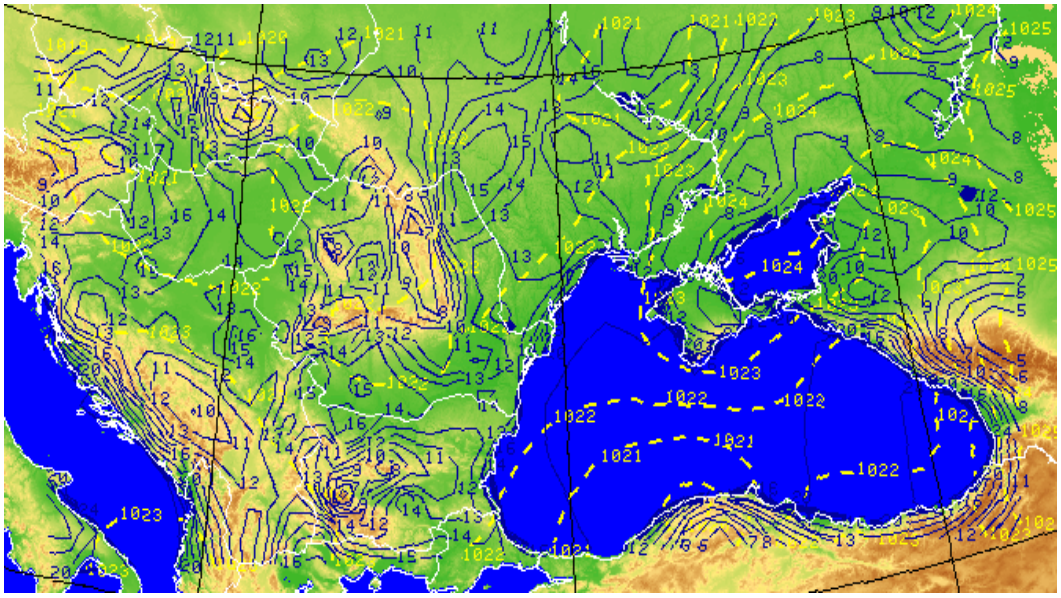
Studies for the optimization of the mesoscale ALADIN / large-scale coupling were performed. The performance of the ALADIN model in its hydrostatic and non-hydrostatic versions was investigated at both the fine and the operational resolutions, in case of using the spectral coupling method, for extreme weather phenomena. The large-scale processes involved in fine scale phenomena, the impact of the coupling schemes correlated to the non-hydrostatic dynamics, as well as the impact of the used resolutions were analyzed. In 2005, the spectral coupling method for ALADIN was validated on a daily database.

Regarding the physics field, our interest concerned the parameterization of moist processes in the ALADIN model (the deep convection scheme - formulation of the closure assumption and entrainment rate, the microphysics-transport approach, the scale dependency, the low stratus representation) and the study of the urban boundary layer using an extended database.

Case studies, especially for severe weather events over Romania are regularly carried out by using the hydrostatic version of the model at operational resolution and also the non-hydrostatic one at very high-resolution (2.5 Km).

b) The MM5 Model

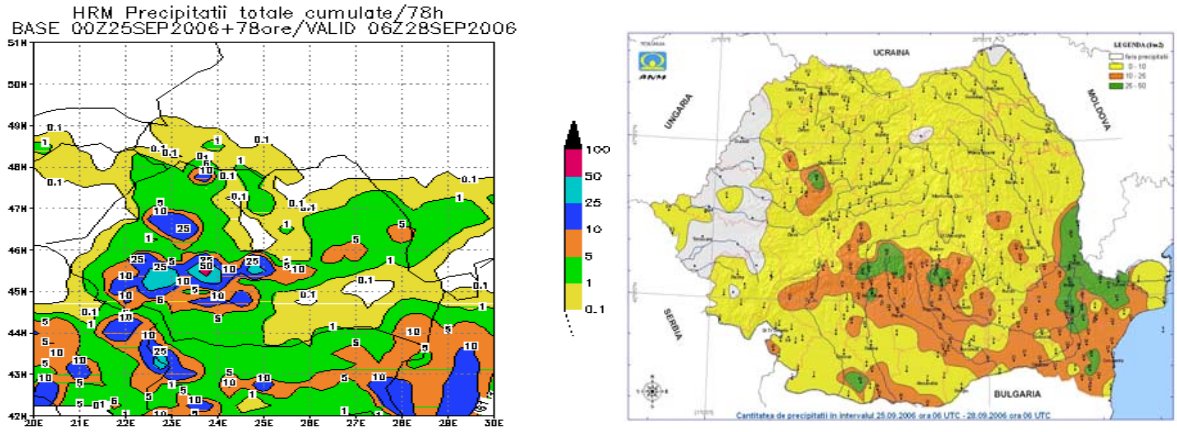
The implementation of the MM5 model on a Linux cluster, using an Intel 8.0 compiler, was tested, and experiments concerning the integration of the MM5 model at low resolution, using two overlapping domains for resolutions of 12 and 4 km respectively, were performed. Also, the impact of 4D data assimilation of surface and radiosounding data, on the MM5 forecast fields, was evaluated.



MM5: MSL pressure and 2m temperature forecast (at 15 km operational resolution).

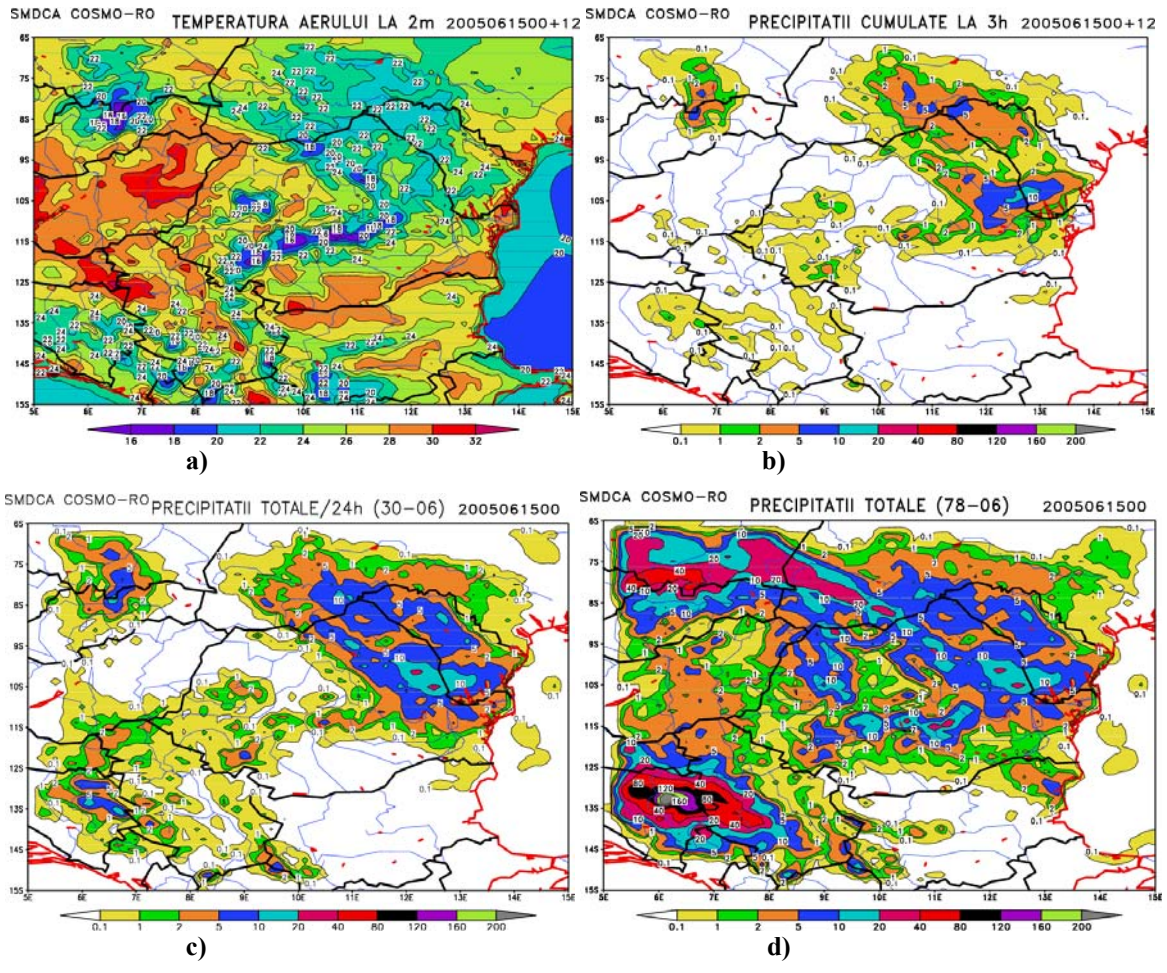
c) The High resolution Regional Model (HRM) and the COSMO Model (Lokall Model)

HRM is operationally integrated at NMA twice a day, at a spatial resolution of 28 km, the forecast anticipation being 78 h. The outputs of HRM are used to perform the weather forecasts for both NMA and ROMATSA.



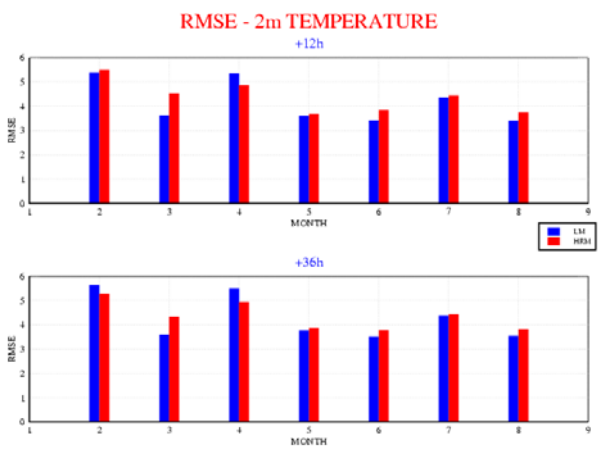
HRM domain: 78 hour cumulated precipitations forecast (left)
and 78 hour cumulated observed precipitations (right).

During January – August 2005 period, automatic running procedures were performed for the COSMO model, at a 14 km spatial resolution (73x81 grid points), over a domain covering the Romanian territory, and also for the post-processing of the results.
COSMO model forecast products (24 hours cumulated precipitation for the first two forecast days, 3 hour cumulated precipitation, convective and large-scale precipitation, 10 m wind, total cloudiness, geopotential at three levels, mean sea level pressure, 2 m temperature, relative humidity) are available at this time on the intranet server.

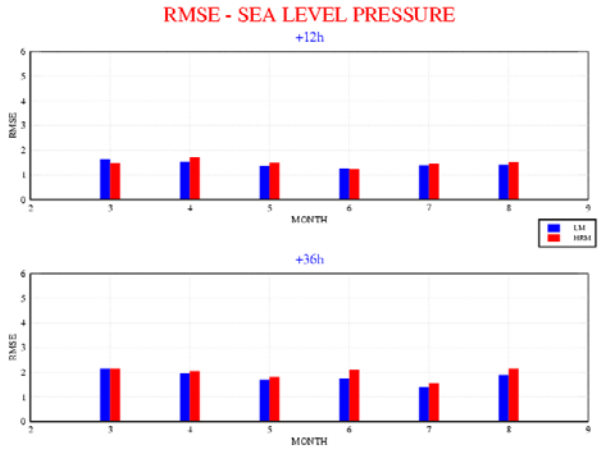


a) 2m temperature, 15.06.2005, 00 UTC +12h; b) 3 hour cumulated precipitation, 15.06.2005, 00 UTC + 12h;
c) 24 hour cumulated precipitation, 15.06.2005, 00 UTC; d) 72 hour cumulated precipitation.

Starting from January 2005, the non-hydrostatic limited–area model COSMO (Doms et al., 2004, Doms and Schattler, 2002), developed at DWD, Germany, has been implemented on a Linux Cluster and run in operational regime at NMA. In order to use it in the operational forecast activity, a thorough analysis of model's results was necessary, by means of statistical scores and case studies.
The performances of the COSMO model for an integration domain covering the Romanian territory was evaluated through objective and subjective verification measures for the period of February-August 2005, corresponding to the first pre-operational model integrations at NMA. A comparison between COSMO model results, the results of operational model HRM and surface observations from 160 meteorological stations on the Romanian territory is done for four parameters (2 m temperature, mean sea level pressure, 10 m wind speed and 6 h cumulated precipitation) using statistical scores. Some special weather situations (strong atmospheric instability, observed heavy precipitation) were investigated using the COSMO model.



a)



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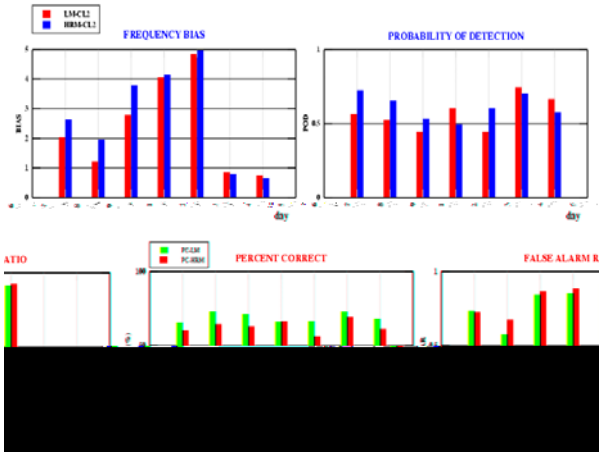
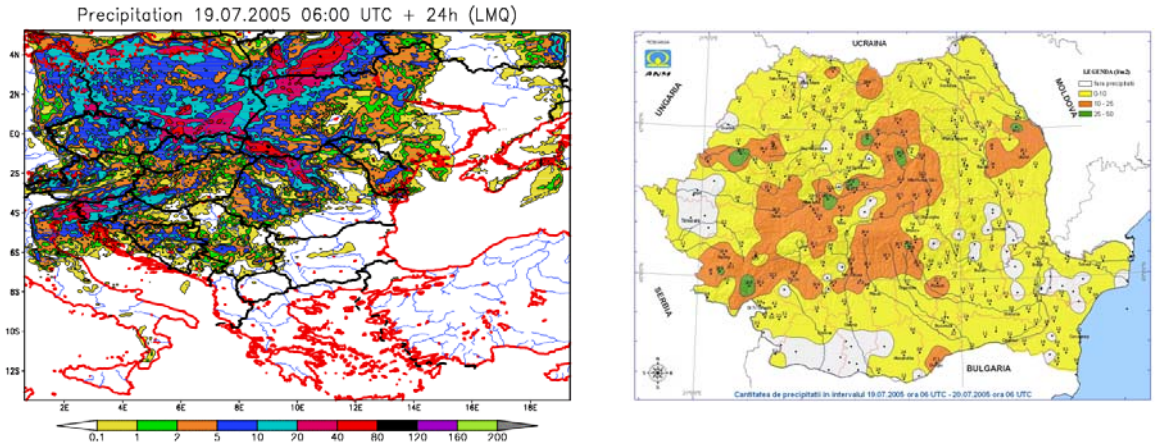


c) d)

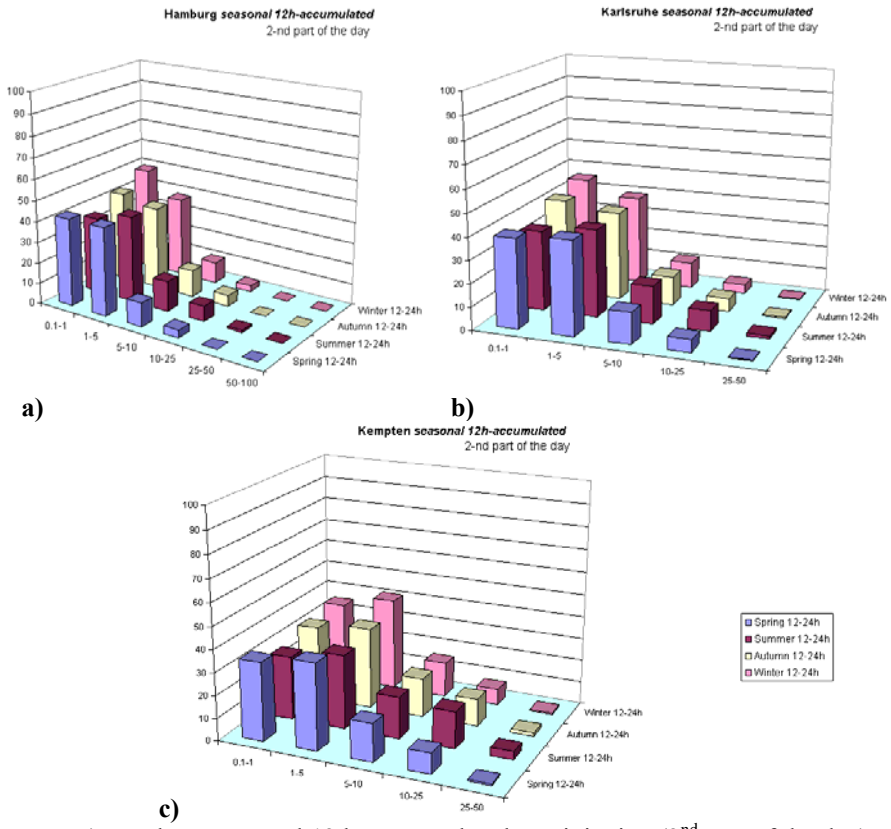
a) RMSE-2m temperature; b) RMSE-sea level pressure; c) RMSE-10m wind speed;
d) precipitation scores: frequency BIAS, probability of detection, percent correct and false alarm ratio.

Beginning with the spring of 2006, a new COSMO model version at a 7 km resolution has been implemented at NMA. A lot of tests regarding microphysical parameterizations, numerical methods, initial conditions and convection schemes, concerning quality precipitation forecast were performed. Two bigger domains were chosen, one for Romania (301x301 grid points) and another one for Italy (321x321 grid points).



a) 24 hour cumulated precipitation; b) 24 hour cumulated observed precipitation.

Another research activity was the study related to the non-gaussian distribution of the observed precipitation. It is an important preliminary stage and a real motivation at the same time for starting the development of a new prototype of data assimilation system for the convective scale, by means of a sequential Bayesian weighting and importance re-sampling filter (S.I.R.). The first step is to show that the supposition of gaussian distribution for the observed precipitation is not justified. Precipitation data were analyzed dates provided from three German stations and it was attempted to determine what is the behavior of the probability density function standing on the location, period of the year or of the day. According to all the statistical analyses that we have done here, it can be asserted that the precipitation data do not display a log-normal distribution.



a) Hamburg seasonal 12 hour cumulated precipitation (2nd part of the day);
b) Karlsruhe seasonal 12 hour cumulated precipitation (2nd part of the day);
c) Kempten seasonal 12 hour cumulated precipitation (2nd part of the day).

d) The regional climate model RegCM3

The research in the field of regional climate modeling has started in 2005 with the first numerical simulations on 10 day to one month periods, and then focusing on ensemble forecast simulations for the local-regional climate. The RegCM3 version of the regional climate model RegCM (Giorgi, 1993) has been coupled with ECMWF forecast in order to perform systematic simulations at mean-long term and to create and update a study database covering all seasons.

Extreme events' modelling was a main focus of the coupled models system verification. For the 2005 year, rich in extreme events in Romania, an analysis of the model's performance has been carried out with the main aim to asses the increase in accuracy by ensemble forecasts, and by resolution increase respectively versus the operational realization.

Ensembles of 10-day forecasts have been run with the RegCM3 model coupled with the ECMWF model (6h frequency). The model geometry was Lambert secant (30ºN, 60ºN), dx=10-50km; in the vertical: 18 sigma levels, with model top at 100hPa.

The numerical simulations of extreme floods in 2005 over south-eastern Europe and Romania were chosen: 1-3 June, 9-17 July and 17-24 September.

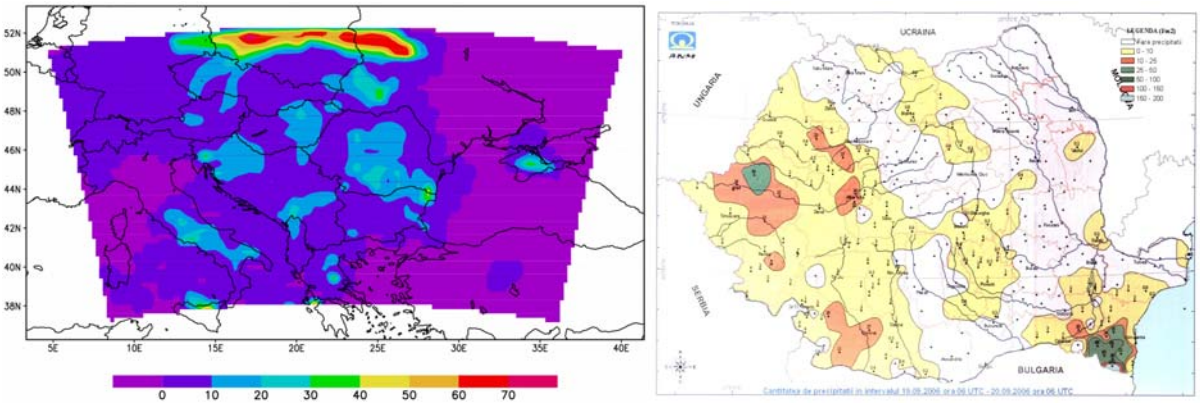
The EPS simulations at a 50 km horizontal resolution were conducted as:

- Perturbations (preliminary tests – 40 members) in: - initial conditions
  - lateral boundary conditions
  - physical parameterization
- Time-lagged ensemble (3 members)

The main objective of these studies was to analyze the EPS RegCM3 performance against:
- observations
- single realization (same and higher resolution)
- coupling model ECMWF forecast

The main conclusions of the results may be summarized as:
- EPS solution was better in all the tested cases;
- resolution increase versus initial/LBC EPS indicates here a large-scale stronger conditioning at a 10-days range (summer);

- RegCM/ECMWF coupling simulated qualitatively well severe weather concerning the process development, with better results at longer range;
- initial state EPS perturbation of most baroclinic sensitivity areas is important for such events.



A Black Sea cyclogenesis precipitation: forecasted by RegCM3 (10 days – left) and observed (right).

At present, the research in the field of regional climate modelling continues in the direction of ensemble forecasting systems use and verification for 10 days to one month range.
Two operational chains have been implemented, using the REGCM3 model (Giorgi, 1990) coupled with the ECMWF forecast: once a week a monthly ensemble (10 members) forecast and daily a 10-day forecast are performed. The ensembles are realized by using perturbed lateral boundary conditions from ECMWF forecast.
The REGCM3 latest model has been used in which aerosols forcing is represented both as background and also through anthropic and biomass emissions forcing.
The role of sea surface temperature specification has been investigated during parallel runs with one and two-way interactions, especially for the precipitation impact.
Other physical parameterizations have been analyzed in selected case studies of extreme events.

The ensemble RegCM behaviour versus global model ECMWF ensemble and versus observations has been analyzed and a systematic verification will be put to work.

1.2. The forecast of local scale meteorological parameters using statistical models

Statistical adaptations (MOS) of the ECMWF, ARPEGE and ALADIN numerical models are also used for the weather forecast elaboration.

These provide adapted forecast of 2-m temperature (three and six-hourly), extreme temperatures, wind direction and speed, cloudiness and precipitation (by three classes) at 168 weather stations in Romania, with anticipation of up to 180 hours. The statistical adaptation procedure runs operationally twice a day, with data from 00 and 12 UTC (ECMWF).

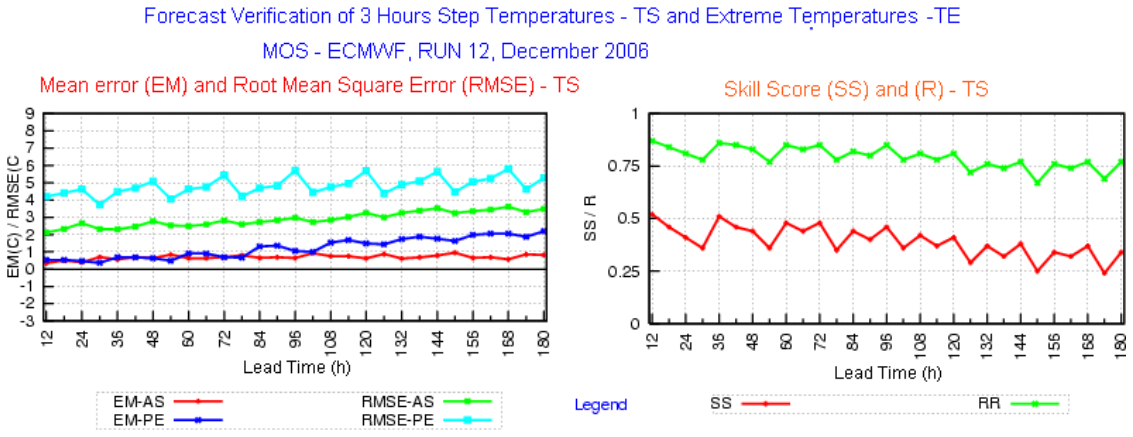
1.3. Weather forecasts verification

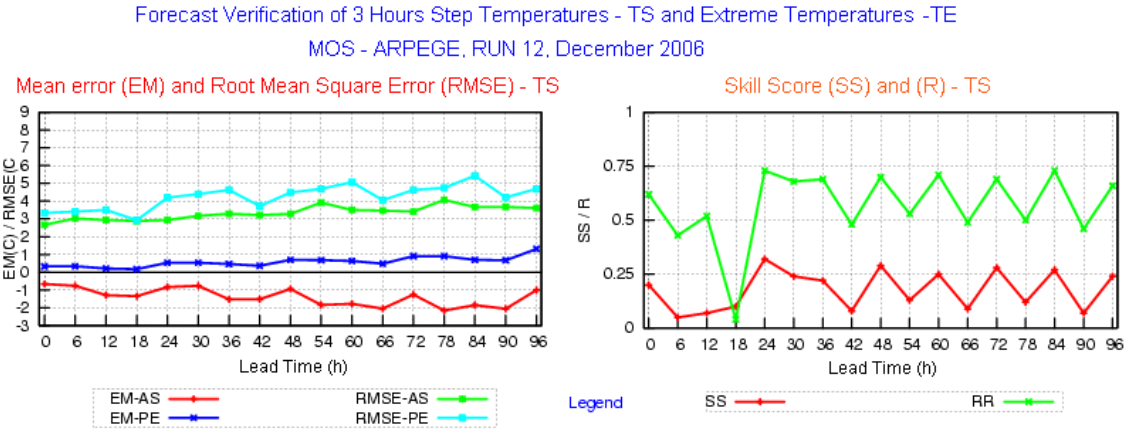
a) Verification of the statistical models (MOS) and of those issued by the forecaster within the National Weather Forecasting Center (NWFC)

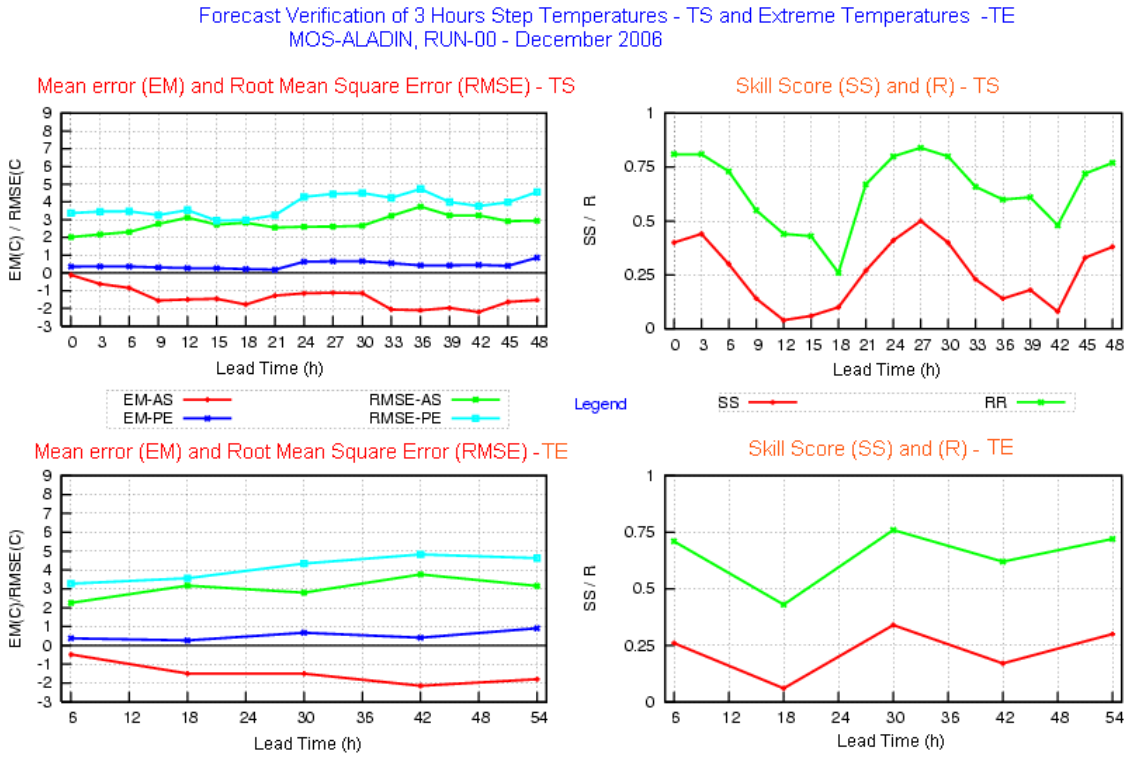
Verification of the weather forecast is operationally performed both for the one issued by numerical models and for those released daily by the forecaster at the NWFC.

Procedures for the monthly verification of the forecasts issued by the ECMWF-MOS, ARPEGE-MOS, ALADIN-MOS and ECMWF-DMO (direct model output) were achieved and implemented in the operational activity. The weather parameters subjected to verification are: 2-m temperature (three and six-hourly), extreme temperatures (minimum and maximum), total cloudiness

(by three classes), 6-h cumulated precipitation (by 3 classes), wind speed and direction.







Operational verification was performed for:

- the extreme temperatures forecasted by ALADIN-DMO, ALADIN-MOS, ARPEGE-MOS and ECMWF-MOS, compared to the one issued by the forecaster for 10 weather stations, representative for the Romanian territory, with 12 and 24 hrs. anticipation;
- the various forecast sets issued by NWFC for the country and Bucharest, with anticipation of 12 to 72 hrs., daily, monthly and annually. The specific parameters subjected to verification are: cloudiness, phenomena, precipitation (occurrence, form, distribution and intensity), wind direction and speed, special phenomena (fog, glazed frost, hail and hoarfrost) and extreme temperatures. The verification was also performed for the forecasts sent to the media (Antena 1 and Prima TV), issued within NWFC for nine representative cities of the country.

The verification procedures of the forecasts over multi-annual period for various sets of weather forecasts issued by NMA, with anticipations of 12 to 72 hrs. were finalized. The verification was performed for the forecasts issued for the country and Bucharest, for those issued by the NWFC for Bucharest, compared to the weather forecasts elaborated by four Internet sites, and also for the weather forecasts sent to the media (Antena 1), along with verification of the weather forecast issued by the forecaster in comparison with the forecast yielded by the numerical models.

Results of all weather forecast verification procedures are rendered graphically, available on the intranet site of the GVPAS group.

b) Verification of the long range ECMWF weather forecasting model for the Romanian area

The performance of global ocean-atmosphere models of ECMWF, Met Office and Météo-France has been assessed in the 2-m monthly mean temperature simulation, and as for the precipitation simulation - only those based on the ECMWF model. The ensemble monthly hindcasts obtained in DEMETER project have been utilized. The analyzed interval is 1958-2001. The simulated parameters are compared with the reanalysis from ERA40.

The global models have been verified on the Atlantic-European area, by evaluating the differences between the simulated monthly means and the observed ones for the 1958-2001 period.

The correlation coefficients have been calculated between the simulated and the re-analyzed fields of temperature and precipitation over Romania's territory.

The temporal variability of the models performance was also analyzed. Thus, the monthly

mean temperatures simulated and observed for consecutive years from 1958 to 2001 were represented in the nearest grid point to Bucharest (45ºN, 25ºE). For the monthly amounts of precipitation an annual global index was calculated, expressed by the spatial average of the differences between the hindcasts and the reanalysis over the interest domain for each year from 1958 to 2001.

2. Participation of the Romanian specialists in international projects or programs

- The international **ALADIN** project (**A**ire **L**imitée **A**daptation dynamique **D**éveloppement **I**nter**N**ational; http://www.cnrm.meteo.fr/aladin/)
- The international **ALATNET** project (**ALA**DIN **T**raining **NET**work; http://www.cnrm.meteo.fr/alatnet/)
- The international **RC-LACE** project (**R**egional **C**ooperation for **L**imited **A**rea modelling in **C**entral **E**urope; http://www.rclace.eu/)
- The European FP5 project **ARENA** (**A RE**gional Capacity Building and **N**etworking Programme to Upgrade Monitoring and Forecasting **A**ctivity in the Black Sea Basin; http://www.arena-blacksea.net/)
- The European FP6 project **ASCABOS** (**A S**upporting Programme for **CA**pacity **B**uilding in the Black Sea Region towards **O**perational **S**tatus of Oceanographic Services; http://www.ascabos.io-bas.bg/)

3. Organization of national and international scientific conferences

- Annual Scientific Session of NMA
- 8th COSMO General Meeting, 18-21 September 2006, Bucharest, Romania
- 1st AROME training course, 21-25 November 2005, Brasov, Romania

4. Participation of the Romanian specialists in the international symposiums and conferences

- Annual EWGLAM / SRNWP Meetings (2003-2006)
- Annual ALADIN Workshops (2003-2006)
- The 87th AMS Annual Meeting, 14-18 January 2007, San Antonio, USA
- COSMO CVS - Workshop, 20-21 November 2006, Rome, Italy
- The 7th International Workshop on Adjoint Applications in Dynamic Meteorology, 8-13 October 2006, Obergurgl, Tyrol, Austria
- 8th COSMO General Meeting, 18-21 September 2006, Bucharest, Romania
- St. Petersburg Summer School on non-hydrostatic dynamics and fine scale data assimilation, 11-17 June 2006, Sanatorium Dunes, Sestroretsk, Russian Federation
- International Training-Seminar Design, Product and Operational Use of the NWP Model-Chain of the DWD, 30 May-3 June 2006, Langen, Germany
- European Geosciences Union General Assembly, 2-7 April 2006, Vienna, Austria
- LM User Seminar at the Training and Conference Center of the DWD, 6-8 March 2006, Langen, Germany
- The 86th AMS Annual Meeting, 28 January – 3 February 2006, Atlanta, USA
- 1st AROME Training Course, 21-25 November 2005, Poiana Brasov, Romania
- Sixth International SRNWP Workshop on Non-hydrostatic Modelling, October 2005, Bad Orb, Germany
- Meeting on Effective Emission Indices, 26-27 September 2005, Prague, Czech Republic
- ECAM Conference, 12-16 September 2005, Utrecht, The Netherlands
- NATO Advanced Research Workshop “Transboundary Floods: Reducing risks and Enhancing Security through Improved Flood Management Planning”, 4-8 May 2005, Oradea (Baile Felix), Romania
- The 4th WMO International Symposium on Assimilation of Observations in Meteorology and Oceanography, 18-22 April 2005, Prague, Czech Republic
- The 85th AMS Annual Meeting, 9-13 January 2005, San Diego, USA
- 5th Annual Meeting of the European Meteorological Society, 2005
- Ateliers de modélisation de l’atmosphère, 29-30 November 2004, Météo-France, Toulouse, France
- The SRNWP/Met Office/HIRLAM Workshop “High resolution data assimilation: towards 1-4km

resolution", 15-17 November 2004, Met-Office, Exeter, United Kingdom
- The 8th International Workshop on Wave Hindcasting and Forecasting, 14-19 November 2004, North Shore, Oahu, Hawaii
- HRM Users Seminar, 5-9 September 2004, Rio de Janeiro, Brazil
- Second Workshop on the theory and use of regional climate models, ICTP, Trieste, Italy, 31May - 9 June 2004
- The 6th Workshop on Adjoint Applications in Dynamic Meteorology, 23-28 May 2004, Acquafredda di Maratea, Italy
- 2nd SRNWP Mesoscale Verification Workshop, 14–15 June 2004, De Bilt, The Netherlands
- International Workshop Black Sea Coastal Air-Sea Interaction / Phenomena and Related Impacts and Applications, 13-15 May 2004, Constanta, Romania
- 3rd International NCCR Summer School: Climate Variability - from observation to prediction, 2004, Monte Verita, Switzerland
- The 84th AMS Annual Meeting, 2004, Seattle, USA
- Workshop on Short-Range EPS, 2004, Bologna, Italy
- The 9th ECMWF Workshop on Meteorological Operational Systems, 10-14 November 2003, Reading, UK

6. Publications

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CLIMATE

The main climate research activities are developed at the National Meteorological Administration (NMA), the Department of Atmospheric Physics from the University of Bucharest, the Faculty of Physics, the Faculty of Geography, the Institute of Geography of the Romanian Academy, the Academy of Agricultural and Forestry Sciences.

1. The main research areas

The climate monitoring
Main objectives:

- data collection on national scale and data validation procedure;
- maintaining and developing the existing meteorological stations network;
- sustaining facilities to process and ensure the international data flux;
- quality control and homogenization of the climatological time series;
- compiling and editing the Climatic Yearbook of Romania.

Regional and large-scale climate variability
Main objectives:

- to study and understand the physical mechanisms and processes responsible for large-scale and regional-scale climate variability at various time scales; to analyze the characteristics of the main modes of large-scale variability (NAO, ENSO, circulation patterns) and their influence upon the regional climate;
- to study and understand the ocean-atmosphere interaction;
- to study and understand the cryosphere-atmosphere interaction.

Two out-of-phase relationships between the NAO and the Eurasian snow-cover extent are documented: a quasi-simultaneous connection (from January to March) and a lagged one (from April to October). The simultaneous correlation between positive (negative) NAO and negative (positive) snow cover extent anomalies is mostly due to the warm (cold) thermal advection over the continental area in mid and late winter.

Correlation analysis between the winter temperature in Romania (61 stations) and time series of some teleconnection patterns in the Atlantic-European area, revealed positive and significant correlation coefficients for the NAO (North Atlantic Oscillation), EA (East Atlantic), EAWR (East-Atlantic/Western Russia) and SCA (Scandinavian) patterns.

Climate change

Main objectives:

- to identify changes (trends and shifts) in the observed long term climatological time series and linkage with changes in the large-scale circulation;
- to identify changes in the frequency and intensity of extreme climate events (extreme precipitation and extreme temperature) and frequency of certain meteorological phenomena during the cold season (rime, snowstorm, hoarfrost and glazed frost);
- to develop statistical downscaling modelling in order to project global climate change scenarios on regional/local scale; linear models based on canonical correlation analysis (for seasonal mean and extreme temperature, seasonal precipitation amount) and conditional stochastic models (daily precipitation) were developed;

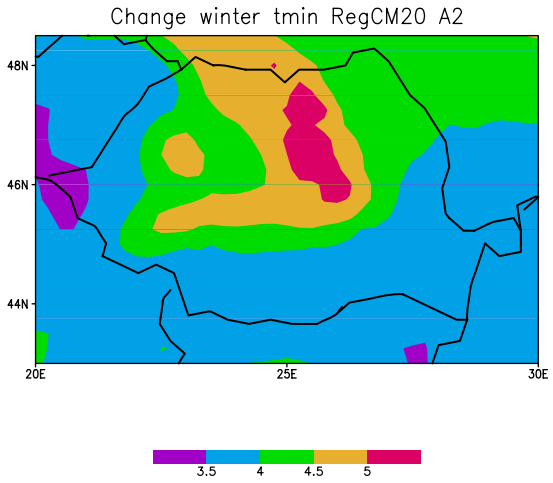
- to validate the global/regional climate models in reproducing the regional features and large-scale mechanisms controlling the regional climate variability; the global models HadCM3 and HadAM3H (elaborated by the Hadley Center) and regional climate model RegCM (elaborated by ICTP) were analyzed;
- to construct climate change scenarios for the Romanian area by applying the statistical downscaling models to the changes in the large-scale parameters derived from global climate change scenarios achieved with various general circulation models (GCM); comparison between statistical and dynamical downscaling result, application for seasonal precipitation.

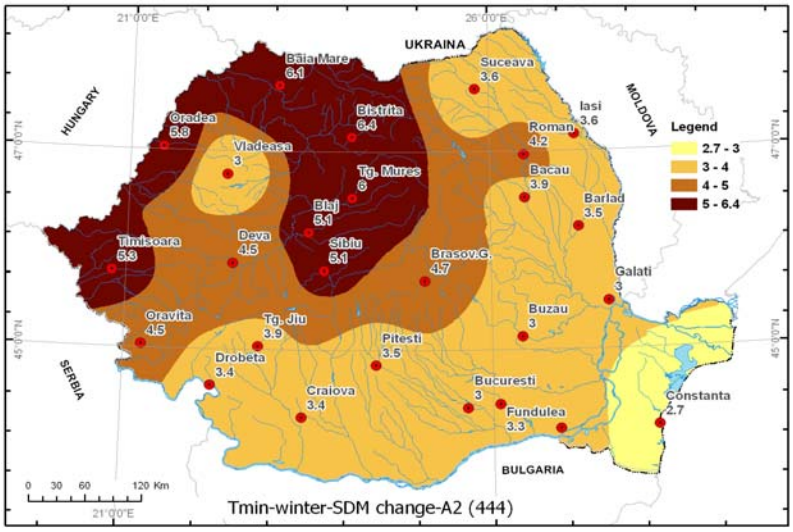
The trend analysis for various climate parameters over the Romanian territory carried out in the analyzed period concluded significant climate change signals for the period 1961-2000: the annual mean temperature increased over the entire country and, on a seasonal scale, the warming is more enhanced in winter and summer, while, in autumn, even cooling has been identified in the eastern part; the annual precipitation amount decreased, more enhanced in the southern half of the country, whereas in the north-west and north-east increasing trends were noticed; increase was noticed in the frequency of the winter weather phenomena such as: rime over the almost entire country (mainly due to an advance towards the spring of the occurrence date) and other phenomena (glazed frost, snowstorm) over certain regions.

The analysis of connection between the seasonal frequency of extreme precipitation events (daily precipitation amount exceeding the long term 90th percentile) at 36 Romanian stations and the pressure anomalies at European scale, revealed a strong linkage between extreme precipitation variability in Romania and large-scale atmospheric circulation variability. The signal is stronger for winter, when the decrease in the extreme precipitation frequency is associated with the decrease in the frequency of the south-westerly circulation.

Other results show that over Romania, like over many mid-latitude land areas in the Northern Hemisphere, the strongest warming during the snow season and the associated downward trend in snow depth are observed in mid-late winter (January to March). The analysis reveals that the diminishing snow depth over the Romanian territory is related to the tendency toward the positive phase of NAO. In mid-late winter, snow amounts exhibit significant downward trends in the western, north-eastern and some south-western Romanian regions. Thus the tendency of the prevailing zonal circulation in mid-late winter (JFM) over Central Europe can partially explain the snow reduction, especially for the regions situated at a low altitude, in extra-Carpathian areas.

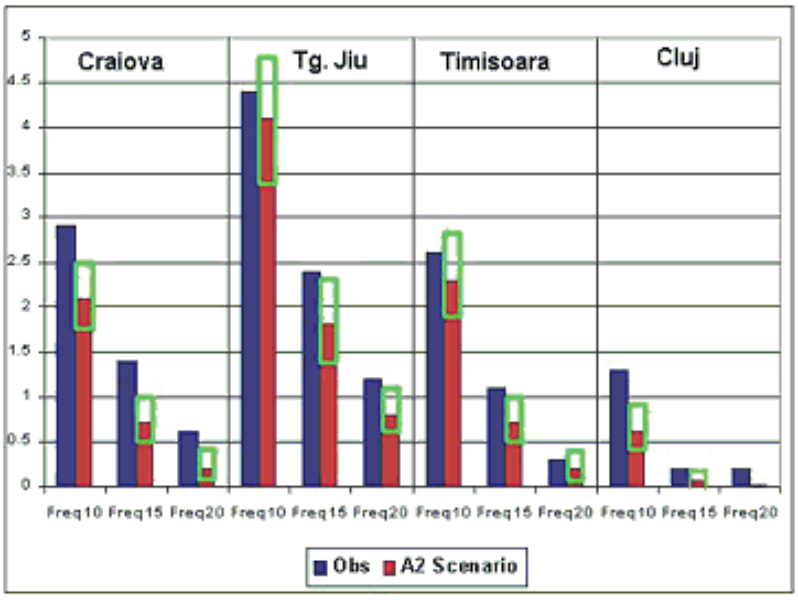
Statistical downscaling models (SDMs) based on canonical correlation analysis (CCA), developed for seasonal maximum and minimum temperature, using the air temperature at 850 mb as predictor compared to the sea level pressure from previous studies, were found with a significantly improved performance. Similar SDMs, developed for winter precipitation, were used to construct climate change scenarios for the period 2070-2099, using HadAM3H simulations as inputs and the results were compared to those obtained through a regional climate model (RegCM-elaborated by ICTP).





Changes in the winter mean minimum temperature over Romania for the period 2070-2099 against 1961-1990, derived directly from the RegCM-20 (top) and indirectly through a statistical downscaling model based on CCA (A2 scenario) (bottom).

Within the FP6 ENSEMBLES project, preliminary work was achieved for developing a conditional stochastic model for the generation of daily precipitation amount in order to construct probabilistic climate change scenarios, focusing on extreme events. The model was tested for 4 Romanian stations regarding its performance in reproducing several indices of extreme precipitation events (maximum duration of intervals with/without rain, maximum daily precipitation amount and frequency of extreme daily precipitation). Probabilistic climate change scenarios for these indices were obtained using as input the simulations of the HadCM3 model (elaborated by the Hadley Centre) under the A2 scenario.



Changes of the winter frequency of daily precipitation exceeding certain thresholds (10 mm, 15 mm, 20 mm) for 4 Romanian stations over the period 2070-2099 (compared to 1961-1990), derived through a conditional stochastic model applied to the sea level pressure changes on European scale, simulated by the HadCM3
model under A2 scenario.

Applied climatology
Main objectives:

- to establish the relationship between climate and socio-economic activities at regional and national scales (energy, food supply, water resources, agriculture, forestry, urbanism, health, etc.); the rainfall intensity over various intervals and various return periods were computed in order to be used in various urbane projects (design);
- to study the frequencies, duration and return periods for various extreme events (snow cover, glazed frost, fog, hoarfrost, etc) affecting the transports;
- studies on renewable energy resources in order to evaluate the wind and solar energy potential on the Romanian territory.

Climate predictability
Main objectives:

- to develop statistical techniques in order to obtain predictive information from the large-scale circulation patterns (NAO, geopotential heights and SST patterns);
- to develop statistical downscaling models, so as to obtain the detailed spatial scale information from the broad-scale climate prediction.

2. Participation of the Romanian specialists in international projects/ programs

FP6 Projects

- ENSEMBLES "ENSEMBLE-based Prediction of Climate Changes and their Impacts" (2004-2009)
- DYNAMITE "Understanding the Dynamics of the Coupled System" (2005-2008)
- IPY-CARE: "Elaboration of the scientific plan and of the implementation plan for the researches concerning the Arctic processes influencing the climatic predictability in Europe"
- CECILIA "Central and Eastern Europe Climate Change Impact and VulnerabiLIty Assessment" (2006-2009)

LIFE Projects

- AIR-AWARE "AIR Pollution ImpAct Surveillance and WArning System for URban Environment" (2006-2008)

Joint Research Projects

- Joint Research Project Italy-Romania "Changes in the characteristics of extreme climate events in southern and south-eastern Europe" (2006-2008)

COST Actions

- COST Action 718 "Meteorological applications for agriculture", WG2 Irrigation Modelling, 2000-2004
- COST Action 719 "The use of GIS in climatology and meteorology"
- COST Action 733 «Harmonization and Applications of Weather Types Classifications for European Regions (2005-2010)
- COST Action 730 «Towards a universal thermal climate index UTCI for assessing the thermal environment of the human being" (2005-2009)

Mobility for research and as visiting scientist

- Research stage on statistical downscaling issues at the ARPA Emilia Romagna (1 scientist in 2003, 2004) and at the Institut Non Lineare de Nice (INLN) – Sophia Antipolis, France (1 scientist in 2004) under the FP5 European project STARDEX (STAtistical and Regional Dynamical downscaling of Extremes for European regions)
- 1visiting scientist – pos-doctoral NATO fellowship at Universidad Complutense, Madrid (2004)
- Research visits at the ICTP (Trieste) for 4 scientists as regular, senior associates and young PhD student, respectively (2003-2006)
- Visiting (1) scientist at the University of Bremen, Faculty of Geoscience in the framework of the

project: "Multidisciplinary study based on upper Pleistocene and Holocene deposits in the Arges river lower basin for climate reconstruction in connection with Paleolithic and Neolithic chronology", under Human Potential Programme of the EU (2002-2003)

- Visiting scientist (1) at the University of the West Indies on statistical downscaling issues, Mona, Kingston, Jamaica, September 2005
- ENSEMBLES Training Programme -*Mobility Scholarship* ; 1 young researcher was trained at the *University of East England* (UEA), January-March, 2006
- Visiting scientist at the University of Bremen for Ph.D. studies, starting from August 2006

3. Organization of national and international scientific conferences

- Annual Scientific Session of the Faculty of Physics, University of Bucharest
- Annual Scientific Session of the National Meteorological Administration
- Workshop "Climatic change and impacts in Eastern and Central Europe", 13-15 September 2006, Poiana-Brasov, Romania
- RT2B ENSEMBLE Technical Workshop, 14-16 June 2006, Bucharest, Romania

4. International workshops, conferences and symposiums (selection)

- 10th Session of the IPCC WGI, Paris, France, 29 January-1 February 2007
- General ENSEMBLES meetings (Lund-2006, Athens-2005, Trieste-2004)
- First EUMETSAT Workshop on the Use of Satellite data for Climate Applications, Zagreb Croatia, 11-15 December 2006
- Alpine Snow Workshop, Munich, Germany, 5-6 October, 2006
- Workshop "Climatic change and impacts in Eastern and Central Europe", 13-15 September 2006, Poiana-Brasov, Romania
- 6th European Conference on Applied Climatology (ECAC) Ljubljana, Slovenia, 2-8 September, 2006
- WMO Conference "Living with Climate Variability and Change: Understanding the uncertainty and managing the risk", 17-21 July 2006, Dipoli, Espoo**,** Finland
- Final conference of COST 719 "The use of GIS in climatology and meteorology", Grenoble, France, 3-5 July 2006
- The Fourth Lead Author Meeting of the WGI IPCC AR4, Bergen, 26-29 June 2006
- RT2B ENSEMBLE Technical Workshop, 14-16 June 2006, Bucharest, Romania
- Third Workshop on the theory and use of regional climate models, ICTP, Trieste, Italy, 31May - 9 June 2006
- European Geosciences Union General Assembly, 2-7 April 2006, Vienna Austria
- The Third Lead Author Meeting of the WGI IPCC AR4, New Zealand, December 2005
- Workshop "Regional Climate Modelling and Mini-Symposium on Climate Change in Europe", 29 November-1 December 2005, Prague, Czech Republic
- Workshop on statistical downscaling issue, 3-4 October 2005, Oslo, Norway
- 5th Annual Meeting of the European Meteorological Society and 7th European Conference on Applications of Meteorology (ECAM), 12-16 September 2005, Utrecht, The Netherlands
- The Second Lead Author Meeting of the WGI IPCC AR4, Beijing, China, 10-12 May 2005
- European Geosciences Union General Assembly, 24-29 April 2005, Vienna Austria
- The Lead Author Meeting (Chapters 10,11) of the WGI IPCC AR4 and Workshop on Climate Model Analysis, Hawaii, 1March 2005
- The 22nd IPCC Session, 9-11 November 2004, New-Delhi, India
- The First Lead Author Meeting of the WGI IPCC AR4, Trieste, Italy, September, 2004
- Second Workshop on the theory and use of regional climate models, ICTP, Trieste, Italy, 31May - 9 June 2004
- Workshop "Describing Scientific Uncertainty in Climate Change to support Analysis of Risk and of Options", National University of Ireland, Maynooth, Ireland, 11-13 May 2004
- The EGU 1st General Assembly, Nice, France, 26-30 April 2004
- Workshop on climate variability in the 20th century, 19-30 April 2004, Trieste, Italy
- Escuela Internatcional de Climatologia Avanzada, Orense, 2004

- Workshop on "Potential climate changes and sustainable water management, 22-26 September 2003, Jachranka, Poland
- International Conference on Earth System Modelling, 15-19 September 2003, Hamburg
- 26th International Conference on Alpine Meteorology (ICAM) and MAP Meeting, 19-24 May 2003, Brig, Switzerland
- The 4th ECAC Conference, Brussels, 2003

5. Others

- 1 Member in the Expert Team on Observing Requirements and Standards for Climate of the Commission for Climatology (CCI-XV) – WMO
- 3 Associate members (1-regular, 2 Seniors) at the ICTP, Trieste, Italy
- 2 lead authors of the IPCC WG1 for elaboration of the Four Assessment Report (AR4)
- 3 expert reviewers for the IPC AR4
- 2 expert evaluators for the FP6 UE proposals
- 1 INTAS evaluator for NIS-INTAS projects
- 4 reviewers for the international peer reviewed journals (Tellus, International Journal of Climatology, Theoretical and Applied Climatology, Climate Research, Water Resources Research)
- Two Stefan Hepites Awards of Romanian Academy (2005)
- 1 Review Editor of the SYR AR4 – IPCC (2007)

6. Publications

Books

Busuioc, A, V. Cuculeanu, P. Tuinea, A. Geicu, C. Simota, A. Marica, A. Alexandrescu, N. Patrascanu, V.Al. Stanescu, P. Serban, I. Tecuci, M. Simota, C. Corbus, 2003: *Potential impact of climate change in Romania.* Ed. ARS DOCENDI, National Comity for Environmental Global Change of the Romanian Academy, Ed. Coord: V. Cuculeanu ISBN 973-558-125-6, Bucharest, Romania, 230 pp.

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Cheval, S., 2004: On the maximum daily temperatures in the South Dobroudja Plateau (Romania). *St. Cercet. Geogr.*, **XLVII-XLIII** (2000-2001), 209-216 (In Romanian).

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Dima, M., T. Felis and G. Lohmann, 2005: Distinct modes of bidecadal and multidecadal variability in a climate reconstruction of the last centuries from a South Pacific coral. *Climate Dynamics*, **25**, 329-336, DOI 10.1007/s00382-005-0043-2.

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7. Acknowledgements

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ATMOSPHERIC PHYSICS

Ozone and radiation

Ozone

1. Main activities

a) Monitoring of the ozone layer:

- long term monitoring is carried out in Bucharest since January 1980 and is performed with Dobson spectrophotometer No. 121;
- data processing and instrument maintenance.

b) The research activities were focused mainly, as follows:

- ozone climatology related with meteorological condition on locale scale;
- total ozone data analyzed with respect to changes in atmospheric circulation and natural variability;
- annual and seasonal stratospheric temperature trends and tropopause height variations;
- statistical analysis (trends) on local and regional scale;
- besides the specialized studies, there also has to be mentioned: various articles for general public aimed at correct explanation of the ozone depletion, mass-media information concerning the ozone layer, courses for students from the meteorological and environmental training system referring to the atmospheric ozone and its depletion.

2. Interaction with other programs and activities

Bucharest station is part of GAW (Global Atmospheric Watch) Ozone Network as "associated station".

3. International Projects

Romania is a permanent participant in the **WMO/GAW-GO3OS** and European Union Programs concerning the monitoring of the ozone layer.

4. Participation in the national and international scientific symposia

- International Day for the Preservation of the Ozone Layer (every year, in mid-September)
- Annual Scientific Session of National Meteorological Administration
- International Session of Dobson spectrophotometers Intercomparison
- International Workshop "The Black Sea Coastal Air-Sea Interaction/Phenomena and Related Impacts and Applications", Constanta, Romania, May 2004.

Radiation

1. Main activities

a) Measurements Programme

- The monitoring of global UV (A+B) radiation was being carried out at Bucharest, on an hourly-value basis, by means of a TUVR radiometer, until July 2004. The wavelength range was 295 – 385 nm.
- Hourly records of the total UV (A+B) radiation were taken at the Fundata GAW station, with the same TUVR sensor, from 2002 to 2005. The wavelength range was 295 – 385 nm.

b) Research programme

- The global (A+B) radiation data collected at Bucharest and Fundata GAW stations were analyzed with an emphasis on their climatological profile;

- The UV index was also computed using the Canadian calculation method;
- Turbidity data collected in earlier years were analyzed.

2. Participation in International Projects

Romania attended the IPC – X - Davos meeting held at the World Radiometric Center in Switzerland, 25 September – 14 October 2005.

3. Participation to domestic and international scientific conferences and symposia

- The Annual Scientific Session of the National Meteorological Administration (NMA) in 2003, 2004 and 2005
- The Applied Climatology Symposium, Ovidius University, Constanta, August 2003 and August 2005
- Annual Scientific Session of the Faculty of Physics, University of Bucharest, May 2006.

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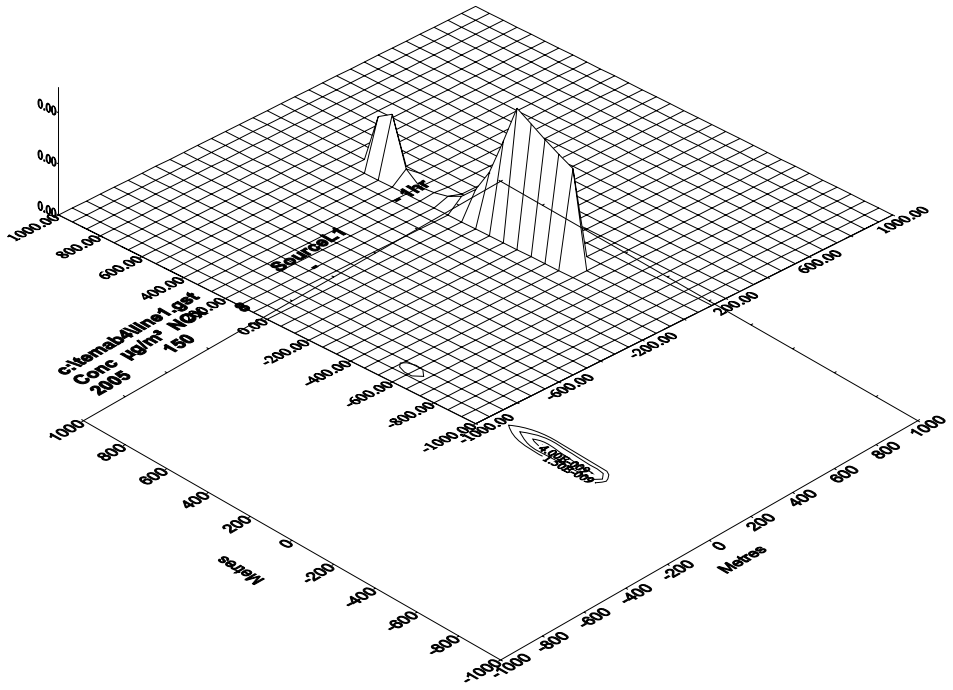
Atmospheric Chemistry and Global Pollution

1. Research orientation

The research activity in the pollution domain had two objectives:

- To improve the forecasting methods using the new generation dispersion models;
- To realize a local and regional air pollution forecasting system using different dispersion models: OML model, INPUFF model, ADMS model, MEDIA model, trajectory model.



NOx concentration field [ug/m3] (obtained from ADMS model) emitted by a linear source in a very stable atmosphere may exhibit multiple local maxima

OML model

- The automated transfer of the meteorological forecasted data from the numerical atmospheric model to the dispersion model: wind field (u, v), temperature - at ground level, relative humidity - at ground level, surface snow, surface precipitation, cloud cover, roughness length, temperature - in 20 layers, potential temperature - in 20 layers, pressure - in 20 layers;
- A preprocessor for evaluating the boundary layer parameters using the hourly meteorological forecasted data was developed;
- The following boundary layer parameters are computed by the Meteorological Preprocessor: friction velocity, Monin Obukhov length, convective scale velocity, surface heat flux, net radiation, mixing height;
- The dispersion model using the output of the atmospheric models and the information about the characteristics of air pollution sources run operationally and the results are integrated in GIS map for Baia Mare area**;**
- Using BOOT and RESIDUAL statistical evaluation models, some statistical comparisons between measured and computed SO_2 values (one year series data) were made with the OML and ADMS models. The result was the following: OML model overestimates the measured concentration values and ADMS model underestimates the values.

INPUFF model

The diffusion and transport model - INPUFF, coupled with the German atmospheric model HRM is also running at NMA in order to survey the accidental pollution of the air from different sources (for example, Kozlodui, Cernavoda, etc).

MEDIA model

The dispersion model MEDIA, which uses the output of the atmospheric model ALADIN and the information about the characteristics of air pollution sources, was run operationally at regional

scale; 48- hr. forecasted pollutant concentrations maps were obtained. The results of the same model, coupled with both the hydrostatic and the non-hydrostatic versions of the ALADIN model at local scale, consisted in forecasted pollutant concentrations integrated in a GIS map for Baia Mare area.

Trajectory model

A database with 48- hr. forecasted trajectories obtained for five pollutant sources was built up. The daily results of trajectory model for two pollutant sources in Baia Mare were analyzed in Open-GIS system.

2. Participation in international programs or projects

- **GAW (**Global Atmospheric Watch): a program for monitoring the chemical composition of the atmosphere, using data from the high altitude station Fundata.

- **LIFE AIRFORALL Project** (2001-2005): "Air Pollution Forecasting, Alert and Monitoring System on Short Time Scale, at local and regional scale, in unfavourable meteorological and topographic conditions (AIRFORALL)".

Financed by:

CCE – D.G XI – Environment. Program developed under Partnership at the National Meteorological Administration (former National Institute of Meteorology and Hydrology)

Project Partners:

Baia Mare City-Hall (CH BM)
Environmental Protection Agency- Baia Mare (EPA)
Météo-France, Toulouse

Project Manager: Constantin IONESCU – GIS expert from NMA

Project Contact Person: Dr. Mihaela CAIAN – ALADIN expert from NMA

Project Objectives:

- pointing out potential threats to urban and other air quality sensible areas with 24 to 48 hrs. anticipation;
- developing a GIS-hosted air quality database able to process air quality forecast on a geographically aware basis;
- promoting co-operation between the atmospheric forecasting authority, the central and local authorities and the polluters, in order to avoid dangerous air quality situations;
- monitoring ground gas leaks near polluter sites on pollution crisis, using a mobile crisis cell auto laboratory.

Project results: the system used in the project contains and is able to use deterministic models to forecast the air quality: digital terrain model, air pollution dispersion and transport models as well as pollutant direct trajectory models. The system incorporates six main modules for air pollution / air quality forecast. Assessment, transmission and dissemination, all interact through the OPEN-GIS integrator system. The AIRforALL system allows EPA Baia Mare and the City Hall Baia Mare to announce the polluters, so that they reduce their emissions, to alert the population and to monitor the situation of the air quality.

- ***INTERNATIONAL EXERCISE -CONVEX-3***

In May 2005, NMA participated in an international exercise – CONVEX3, held in Romania, at Cernavoda, coordinated by IACRNA, which include the Nuclear Energy Agency/Organization for Economic Co-operation and Development (NEA/OECD), the United Nations Office for the Co-ordination of Humanitarian Affairs (OCHA), the World Health Organization (WHO). During the exercise, NMA supplied: meteorological forecasts, forecasts of the pollutant dispersion using ALADIN/MEDIA and HRM/INPUFF models and the forecasted trajectories (ALADIN/trajectory model) of the pollutant released from Cernavoda.

3. Participation in the international symposiums and conferences

- ACCENT-CMAS Training Workshop on Air Quality Modelling, 30 July – 8 August 2006, Sofia, Bulgaria
- Air Pollution Management 2006, An Advanced International Training Programme in Norrköping, Sweden, 4 September - 6 October 2006
- The 5th Meeting of European Meteorological Society (EMS), September 2005, Utrecht, The Netherlands
- The 27th EWGLAM / 12th SRNWP Meeting, October 2005, Ljubljana, Slovenia.
- Second Workshop on Short Range EPS (Ensemble Prediction System), April 2005, Bologna, Italy
- Workshop on ENSEMBLES PROJECT, September 2005, Athens, Greece
- The Fourth WMO International Symposium on Assimilation of Observations in Meteorology and Oceanography, 18-22 April 2005, Prague, Czech Republic

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AGROMETEOROLOGY

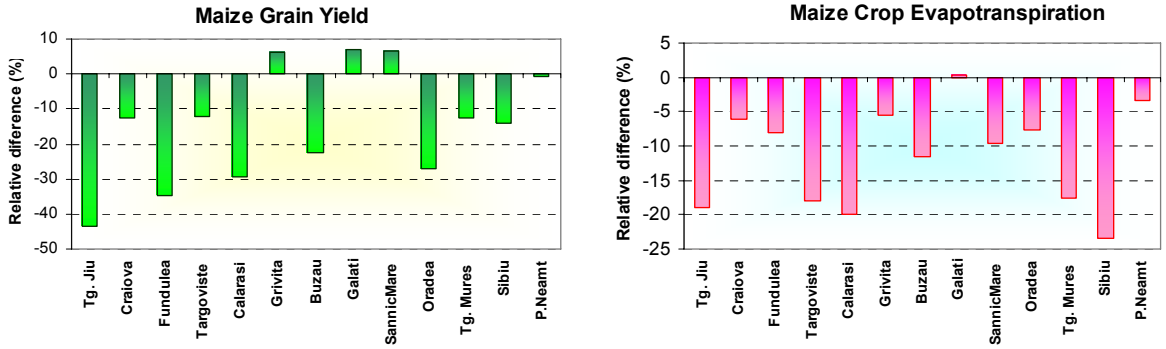
1. Main operational agrometeorological activities

- Assessment and near-real time monitoring of the risk agrometeorological factors (drought, heat, water excess/deficit in the soil, etc.) and their zoning over the country's agricultural territory, during the vegetation season of crops, in order to identify the agricultural areas the most vulnerable and the dissemination of the information to users for taking adequate measures (irrigation, fertilizing, agrotechnics to preserve the water in the soil, etc.);
- Evaluate and monitoring the soil moisture dynamics and soil water deficits at the rooting depth of the main agricultural crops, in order to provide information necessary in taking decisions on irrigation management;
- Elaborate/edit specialized information as agrometeorological bulletins containing diagnoses and forecasts, graph and cartographic products and timely warnings regarding the occurrence and

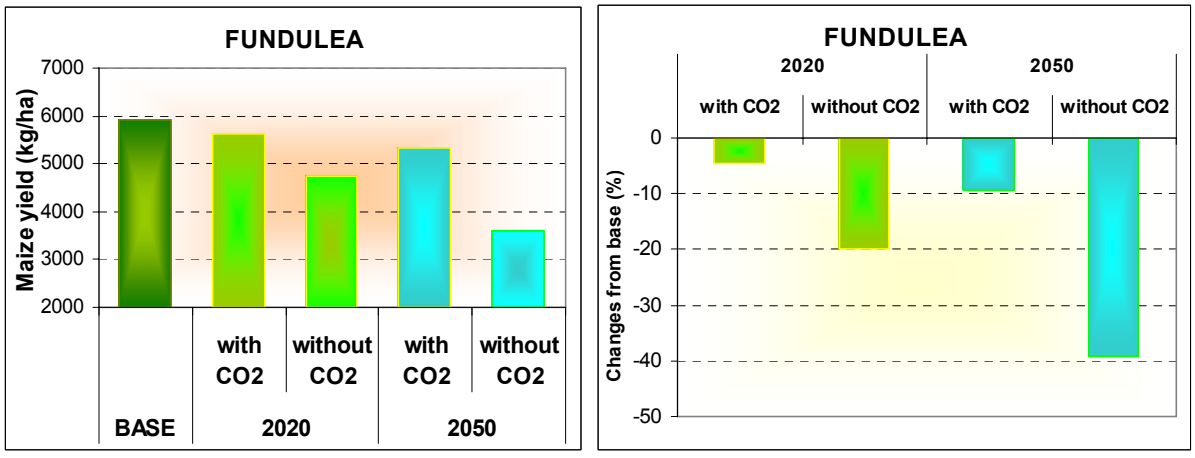
expansion of the drought-affected agricultural surfaces or other extreme events, and their dissemination to users, so as to take fast measures, in order to diminish the negative consequences.

2. Main research agrometeorological activities

- Applying seasonal climate forecasts combined with the simulation capabilities of the CROPWAT model to estimate and predict the soil moisture dynamics and soil water deficits during the crop growing seasons;
- Developing and improving agrometeorological applications through using remote sensing, GIS and modelling techniques coupled with decision support systems for agriculture;
- Quantifying the effects of climatic variability on the main components of the water balance (evapotranspiration, crop water demand, soil moisture deficit, effective rainfall) using the CROPWAT model;
- Assessing of climate change and climatic variability impacts on agricultural crops and the main water balance elements, including the effects of agriculturally significant climatic extremes by using modelling approaches;



Relative changes (%) in the grain yield and real evapotranspiration of maize crop simulated with CERES-Maize model in the baseline climate (1961-1990), using calculated dates by the regional climate model RegCM3 vs. observed one.

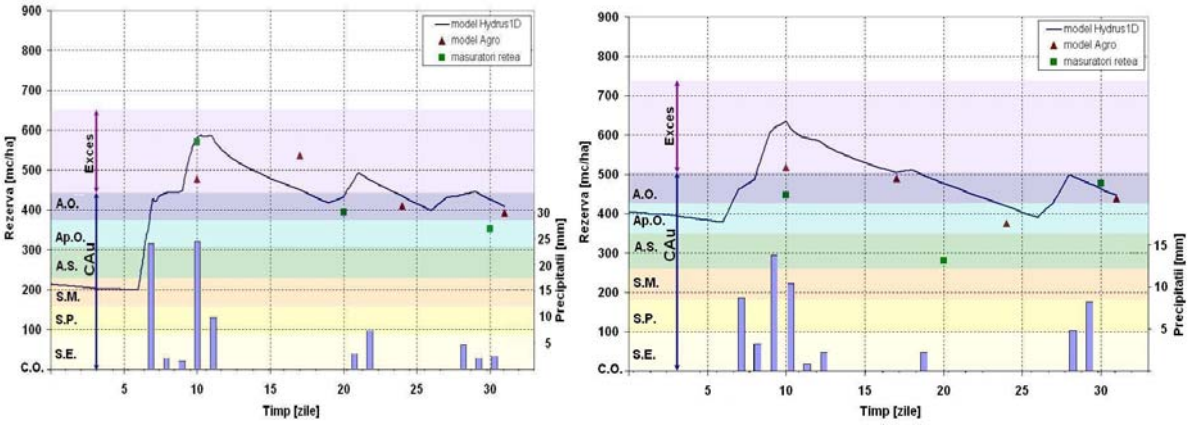


CERES-Maize model results on maize grain yield under HadCM3 climatic scenarios (decades 2020 and 2050, with and without CO_2 effect) as compared with the baseline period (1961-1990).

- Analyzing the possible use of satellite information as input for the CROPWAT model in order to compare the daily actual crop evapotranspiration, calculated by the model, with the estimated data from satellite images (NOAA-AVHRR data);
- Developing applications of new methods and technologies to provide additional improved

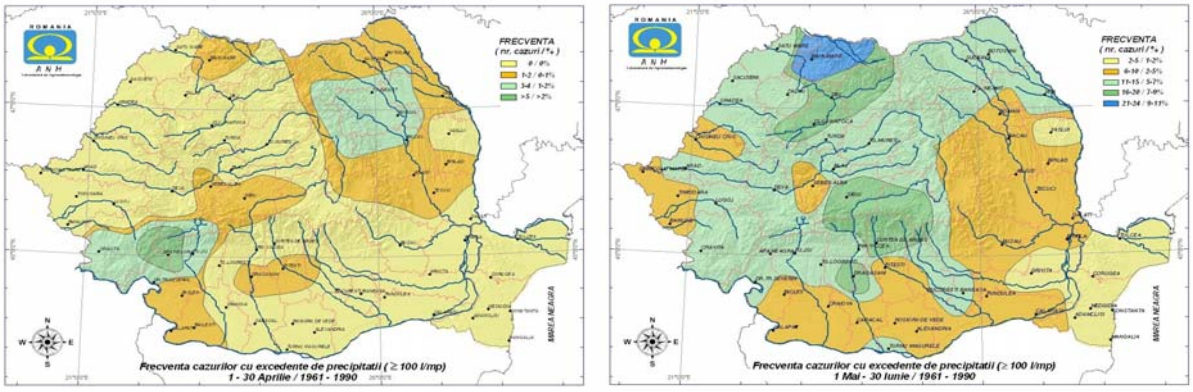
agrometeorological information for decision-makers and other users, based on a statistical analysis procedure, on historical series of soil moisture data to produce an agroclimatic classification;

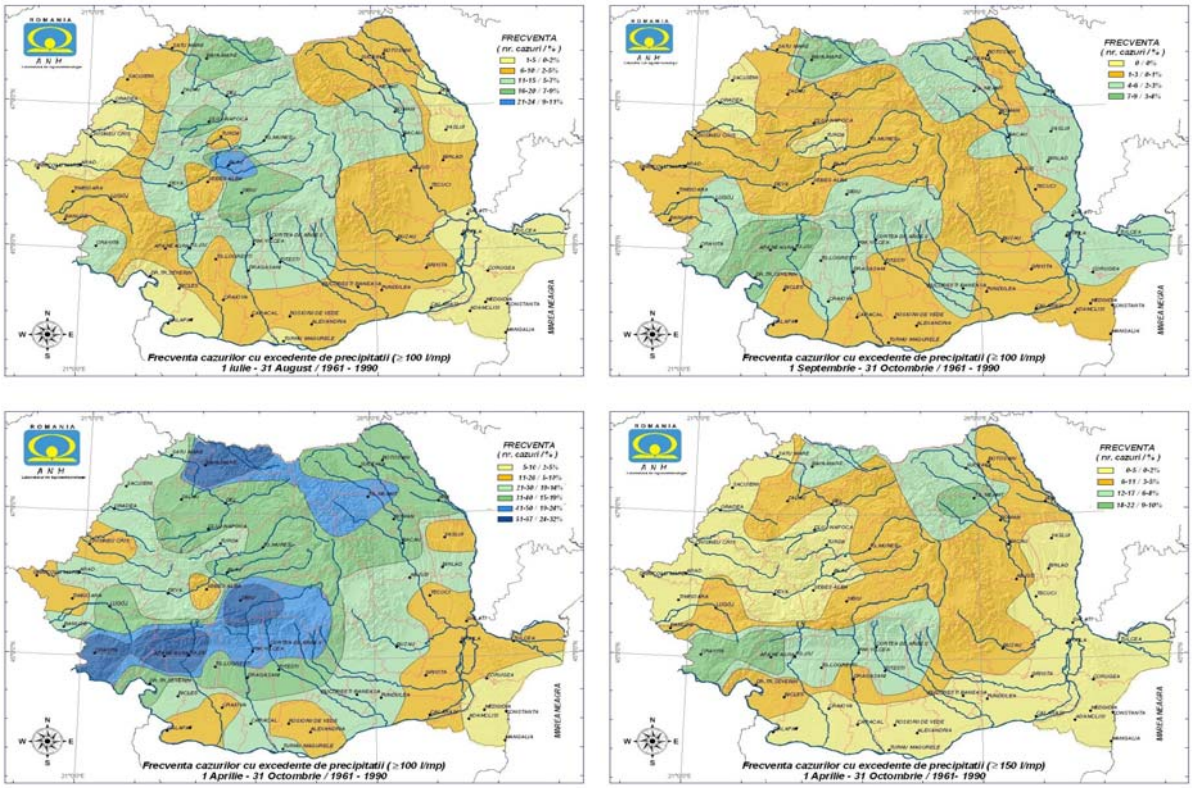
– Calibrating and testing the performance of Hydrus 1D model to simulate the soil moisture dynamic in different climate conditions and soil depths;



Hydrus 1D model results on maize available soil moisture dynamics at Buzau (left) and Calarasi (right) sites, for may 2006.

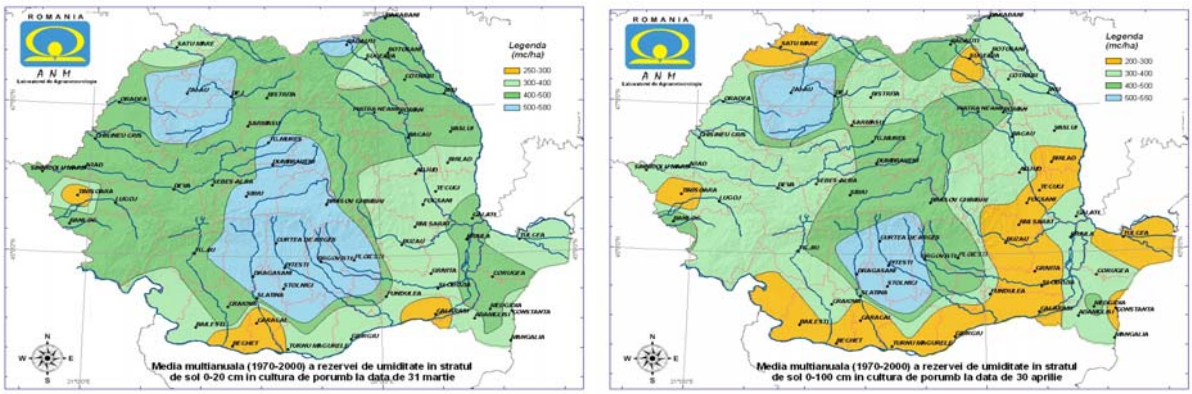
– Elaborate specialized studies regarding the agrometeorological risk generated by the heavy rain on the main agricultural crops at the whole agricultural territory of Romania;

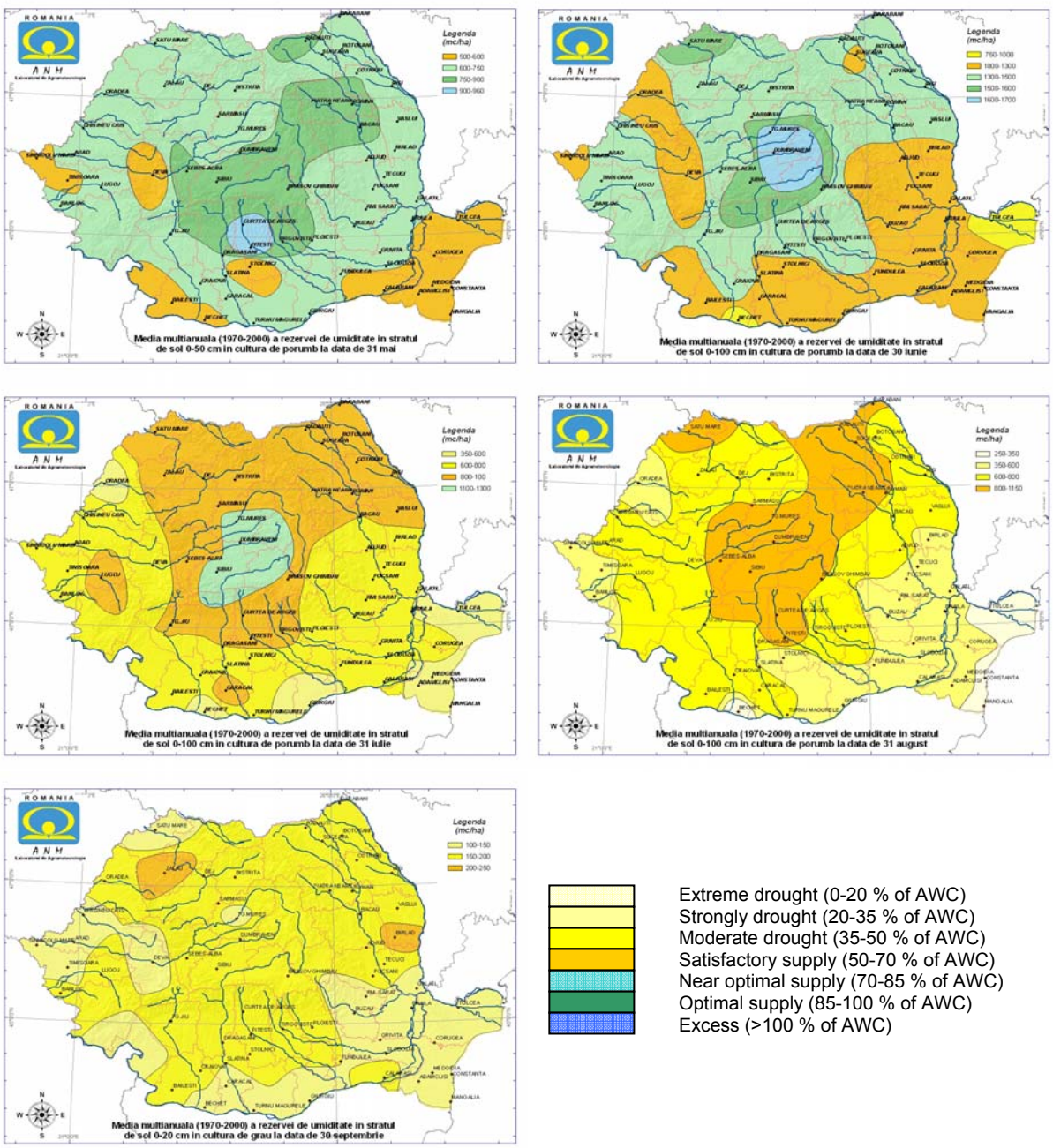




Frequency of the heavy rain cases in the period april, may-june, july-august and april-october (≥100 l/mp and ≥150 l/mp), the interval 1961-1990.

– Analyzing the spatial and temporal evolution of soil moisture dynamic over a 30-year period in order to identify the intervals and zones with high risk at the occurrence of extreme climatic events (droughts, excessive moisture, etc.);





Average maize available soil moisture for the interval 1970-2000, at different soil depths and specific calendar dates. *AWC: available water capacity.*

– Increasing scientific and technical research co-operation in the field of agrometeorology and establishing a very close collaboration with a series of International and European bodies such as: the Agrometeorological Division of WMO, FAO, WAMIS, etc.

3. International and national projects/programs

- 2002-2005: European Cooperation in the field of Scientific and Technical Research - COST Action 718: "*Meteorological Applications for the Agriculture*"
- 2002-2006: OPAG 1 on "*Agricultural Services for Agricultural Production*", Implementation/Coordination Team (ICT) for Agrometeorological Services – RA VI, WMO/ Commission for Agricultural Meteorology (CAgM)
- 2002-2006: OPAG 3 on Climate Change/Vulnerability and Natural Disasters in Agriculture: *"Impact of Climate Change/Variability on Medium-to Long-Range Predictions for Agriculture"*, WMO/CAgM

- 2004-2006: National Program for Research-Development and Innovation MENER:*"Monitoring system of climate change based on the integrated measurements of temperature in the forages – CLIMOSIS"*
- 2006: European Cooperation in the field of Scientific and Technical Research – COST Action 734: *"Impacts of Climate change and Variability on European Agriculture* –CLIVAGRI"

4. National and international conferences

- WMO, FAO & COST 718 Workshop on Climatic Analysis and Mapping for Agriculture, 14-17 June 2005, Bologna, Italy
- Expert Team Meeting on *Impact of Climate Change/Variability on Medium- to Long-Range Predictions for Agriculture*, 15-18 February 2005, Brisbane, Australia
- Workshop on *Weather, Climate and Farmers*, 15-18 November 2004, Geneva, Switzerland
- Meeting of the CAgM Implementation/Coordination Team for Agrometeorological Services, 29-31 March 2004, Manila, Philippines
- Inter-Regional Workshop on *Strengthening Operational Agrometeorological Services at the National Level,* 22-26 March 2004, Manila, Philippines
- Meeting of Regional Association VI, Working Group on *Agricultural Meteorology*, 17-19 December 2003, Braunschweig, Germany

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REMOTE SENSING AND GIS RELATED ACTIVITIES

1. Research orientation

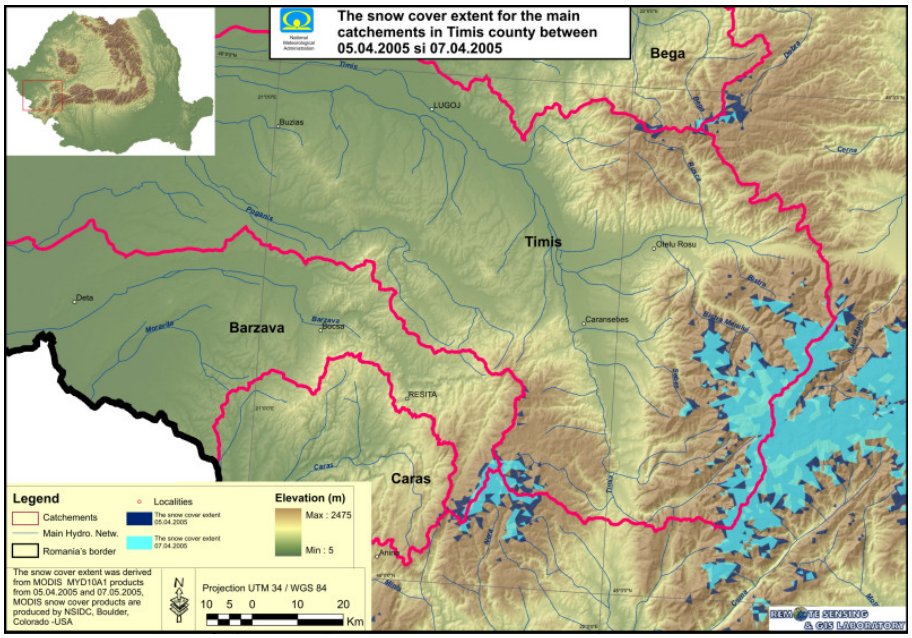
The efforts were oriented towards the development of methods and methodologies for extracting useful parameters from data provided by space platforms in agrometeorological, hydrological, and environmental quality protection applications.
Evaluations of the snow layer water reserves were made for the large Romanian storage lakes' mountain basins in winter- spring through a methodology worked out by the Remote Sensing and GIS Laboratory, using information from the meteorological network, the high and medium resolution satellites, and the facilities offered by data management in a GIS environment.

Within the project "Use of remote sensing data integrated in an agro-hydrological model for the evaluation of the nitrogen pollution effects from agricultural practices, for a Romanian hydrological basin", carried on in collaboration with the CEMAGREF Institute of Rennes, France (Romania-France bilateral program, PAI Brancusi), a methodology for estimating the water discharge and the concentration of nitrogen in the water was carried out and tested for the Vedea basin pilot area. A map of the sensitivity to nitrogen pollution was obtained by using the SWAT agro-hydrological model, coupled with a GIS that allows an efficient management of the geographical data and of associated metadata. The model input data come from three sources: standard databases (hydrological, meteorological, etc.), ground data (agricultural practices), and remote sensing data. The land cover/use was updated, taking as support a recent LANDSAT ETM satellite image from which a supervised classification by five classes, was made.

Within the FP5 European Program's EFFS Project ("European Flood Forecasting System"), a flood forecasting and warning system prototype was made for the Mures River basin.
Other researches aimed at improving the techniques of making updated land cover/use maps, space-maps and thematic maps using satellite data, as well as of working out geo-information spatializing methods and algorithms.

In 2005, in the Remote Sensing and GIS Laboratory satellite images were processed during the flooding events, to delimitate the flood-affected surfaces and to present their evolution over time. Also, the operational making of the maps with the spatial representation of information derived from satellite images and of the various meteorological parameters has started. Products obtained from satellite images are integrated in the agrometeorological bulletin and the maps with the spatial representation of the precipitation amounts recorded daily, monthly and over time intervals of interest and of the snow cover depth are used for the weather forecast.

In order to make up the maps with the specialization of the meteorological parameters, two applications were built in VBA (Visual Basic for Application) for Arc View 9.x. The first application makes the maps for the spatial representation of the precipitation amounts, as well as of the snow cover depth. The application is structured by two main components. The first component performs the reading of a data table with the .DBF extension (dBASE IV) which contains the values representing precipitation amounts recorded daily, monthly or over intervals of interest or the snow cover corresponding to each weather station. The second component allows making the maps containing a zonal disposition of the meteorological parameter.



Snow cover extent in Banat region of Romania derived from MODIS satellite data.

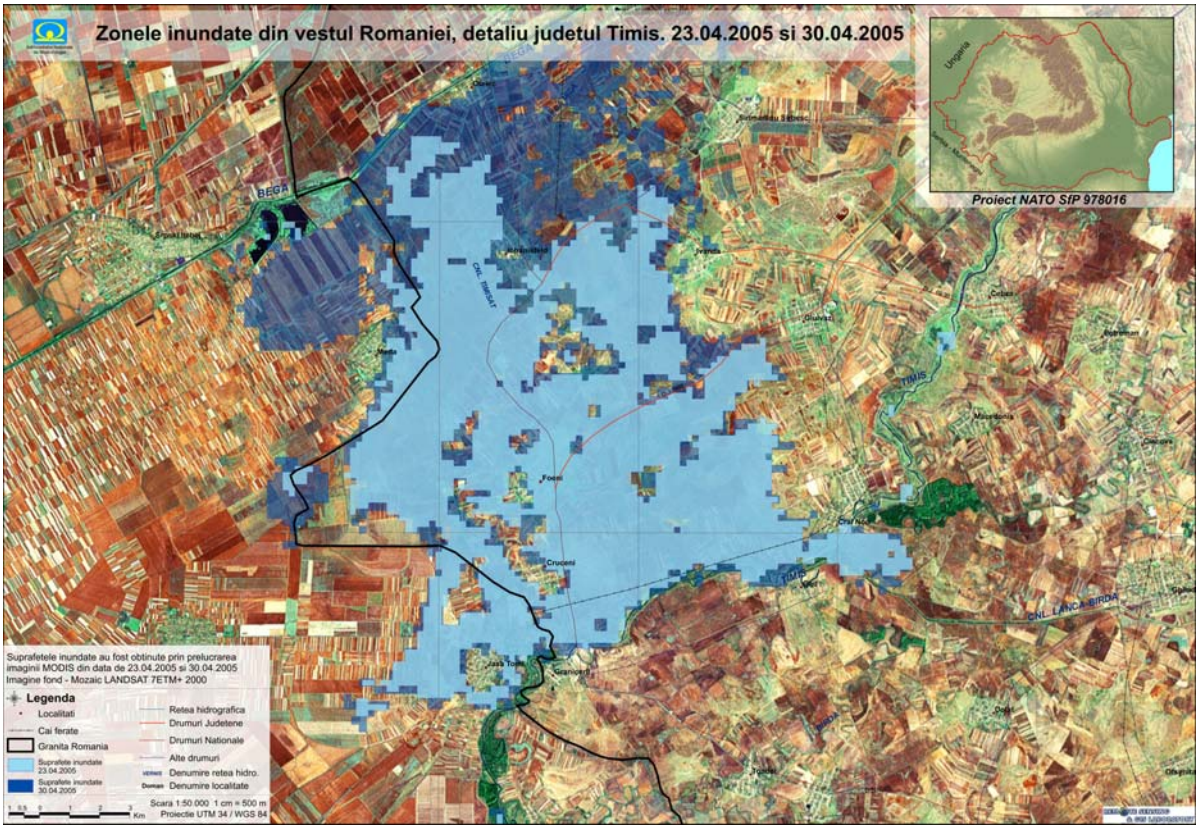
In 2005, the following activities were carried out within the Remote Sensing and GIS Laboratory:

- when floods occurred, satellite images were processed to delimit the boundaries of flood-affected areas and show their progress in time;
- products were obtained by processing satellite images and maps representing in 3D various meteorological parameters. Products derived from satellite images were integrated in the Agrometeorological Bulletin, while 3D maps of precipitation and snow cover depth for daily, monthly, and other intervals of interest were employed in weather forecasting.

To obtain maps representing meteorological parameters' distribution in space, two applications in Visual Basic for Application (VBA) for ArcView 9.x. were worked out. The first does precipitation and snow cover depth maps. Its structure includes two main components:

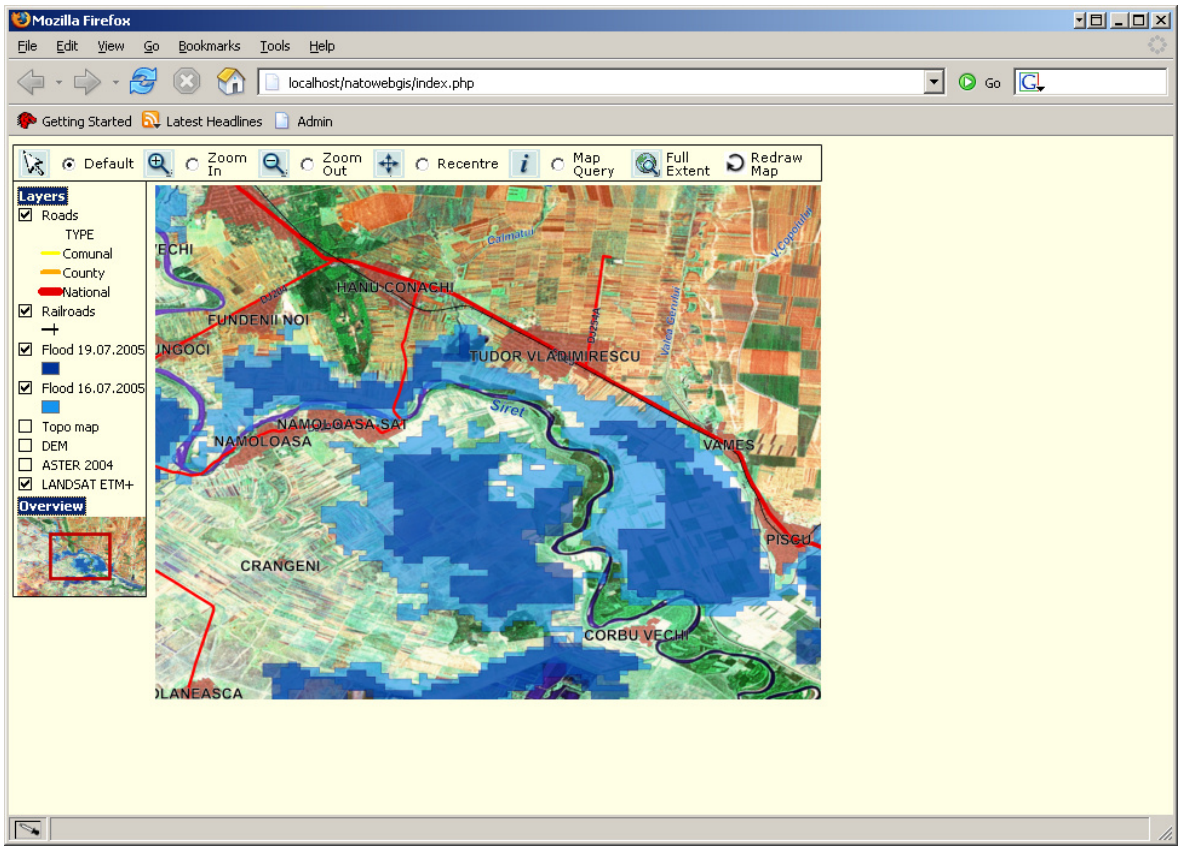
- The first component reads a data table with extension DBF (dBASE IV), which includes precipitation and snow cover values for daily, monthly, or other intervals of interest provided by each weather station;
- The second component allows the carrying out of maps representing the zonal distribution of meteorological parameters.

Within the NATO SfP978016/ /TIGRU Project ("Monitoring of Extreme Flood Events in Romania and Hungary Using EO Data"), applications and products based on remote sensing, GIS, and hydrological modelling techniques were created. The project will facilitate the transfer of information between teams of involved experts from Romania, Hungary, and USA, as well as the development of a spatial-data base to strengthen the international collaboration in surveying dangerous floods.



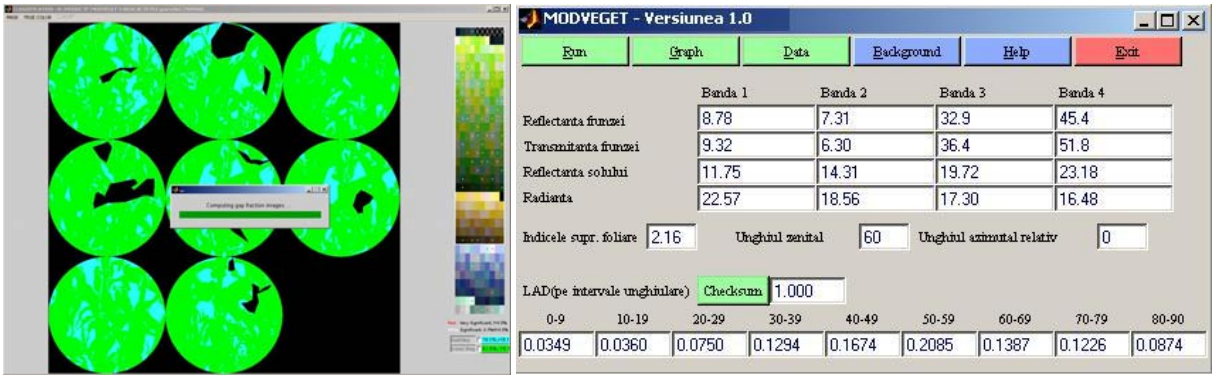
Dynamics of the Flooded Areas (Timis County flood – spring 2005).

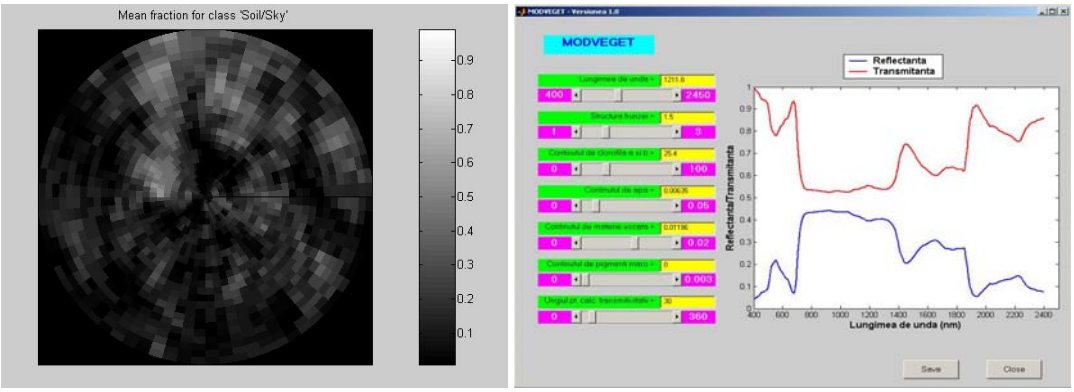
The FLOODSAT sub-system has been developed following a distributed architecture, and end-users can access the system using a simple web browser (like Internet Explorer or Mozilla Firefox) to display, query, analyze and retrieve information's.



Web Interface of FLOODSAT System.

The main research theme of the MODVEGNET project ("Modelling vegetation reflectance to assess the bio-physical parameters from remote sensing data") is to model the field of the radiation reflected by the vegetal covers (crops, surfaces covered by natural vegetation), in the spectral domains from the visible and close infrared, on the basis of data measured or simulated, in various natural conditions. Based on the radiative transfer model, an application was developed, in MATLAB, structured by two modules that can determine the reflectance of a vegetal cover on the grounds of received information. This application is based on the PROSPECT model, coupled to the SAIL model. The use of multispectral satellite data plays an important role in determining the agrometeorological parameters. SPOT-VEGETATION images represented an important data source for the multitemporal analysis of the vegetation evolution. Thus, those images can be used to determine the terrestrial surface, the real evapotranspiration the vegetation indices, etc.





Simulations of the SAIL adapted model for crops leaves reflectance and transmittance data.

2. Research projects, working groups

- NATO SfP 978016 Monitoring of extreme flood events in Romania and Hungary using EO Data
- SATIRISC ("Use of thermal infrared and microwave satellite data in the surveillance of water reserves for population's security") within the Space Program financed by the Ministry of Education and Research and managed by the Romanian Space Agency
- MODVEGET project ("Vegetation reflectance modelling, in order to estimate the biophysical parameters from remote sensing data")
- Project "Use of remote sensing data integrated in an agro-hydrological model for the evaluation of the nitrogen pollution effects from agricultural practices, for a Romanian hydrological basin", carried on in collaboration with the CEMAGREF Institute of Rennes, France (Romania-France bilateral program, PAI Brancusi
- FP5 European Program's EFFS Project ("European Flood Forecasting System")

3. Organization of national and international conferences

- NATO SfP 978016 Monitoring of extreme flood events in Romania and Hungry using EO Data – Final Workshop, Baile Felix, Oradea, Romania, 24 June 2006
- NATO Advanced Research Workshop on Transboundary Floods: Reducing Risks and Enhancing Security through Improved Flood Management Planning, 04-08 May 2005, Baile Felix, Romania.
- NATO SfP 978016 Monitoring of extreme flood events in Romania and Hungary using EO Data – 2nd Co-Directors Meeting, Budapest, 1-2 April 2004
- NATO SfP 978016 Monitoring of extreme flood events in Romania and Hungary using EO Data – 1st Co-Directors Meeting, Bucharest, 23-24 May 2003

4. Participation at national and international symposiums

- "9th AGILE International Conference on Geographic Information Science. Shaping the future of Geographic Information Science in Europe", 20-22 April 2006, Visegrad, Hungary - "Validation of MODIS Snowcover Products in Romania. Methodology and conclusions"
- European Geosciences Union General Assembly 2006, Vienna, Austria, 1-7 April 2006 - "Use of Vegetation NDVI time series for drought monitoring in Romania", "Use of remote sensing data for monitoring and mapping phenology" and "Validation of MODIS snowcover products in Romania. Methodology and conclusions"
- Third International Conference on Early Warning organized by WMO Bonn, Germany, 27-31 March 2006
- ISPRS Mid-term Symposium "Remote Sensing: From Pixels to Processes" 2006, Enschede, The Neederlands
- ENVIROWATER 2006, Concepts for Watermanagement and Multifunctional Land-Uses in Lowlands"

- 5th Annual Meeting of the European Meteorological Society / 7th European Conference on Applications of Meteorology, 12-16 September 2005, Utrecht, The Netherlands
- Conference "The Danube and Europe: Integrated Space Applications in the Danube Basin", 23 – 25 June 2004, Mamaia, Romania

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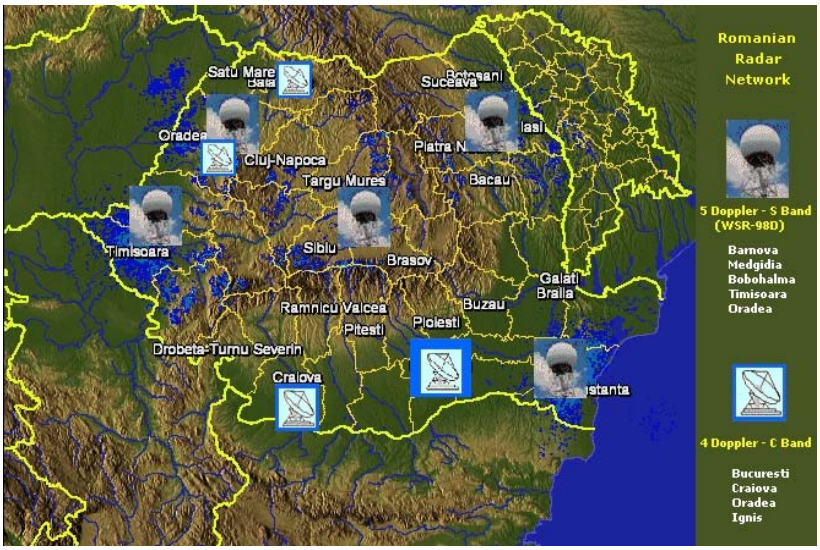
VERY SHORT RANGE FORECASTING – LABORATORY OF NOWCASTING TECHNIQUES

The main very short-range forecasting researches are developed at the Romanian National Meteorological Administration.

1. The main research area

a) Forecasting and monitoring of severe storms

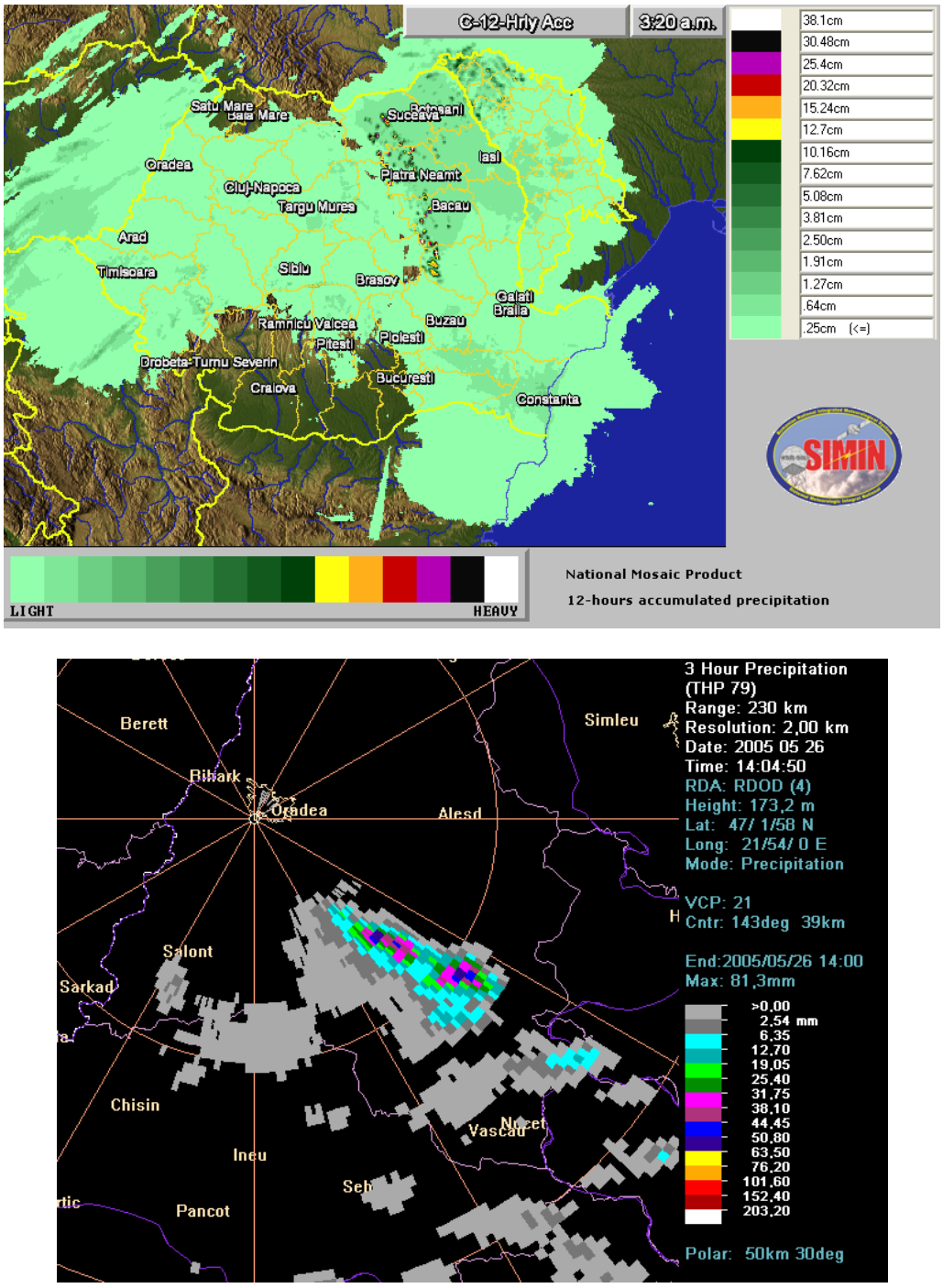
The activity of Laboratory of Nowcasting Techniques, which is the main laboratory for very short range forecasting, also includes operational activities. The very short range forecasting is dedicated only to severe phenomena that occur in Romania. Using the Romanian Radar Network (3 C-band and 5 S-band D Doppler radars), Romanian Lightning Detection Network (8 SAFIR3000 sensors) and satellite imagery (MSG data), the nowcasting forecasters monitor the convective activity. A special attention is paid to the radar structures that can produce severe phenomena and which are associated with regional conceptual models.



Romanian Radar Network.

b) Study of severe storm

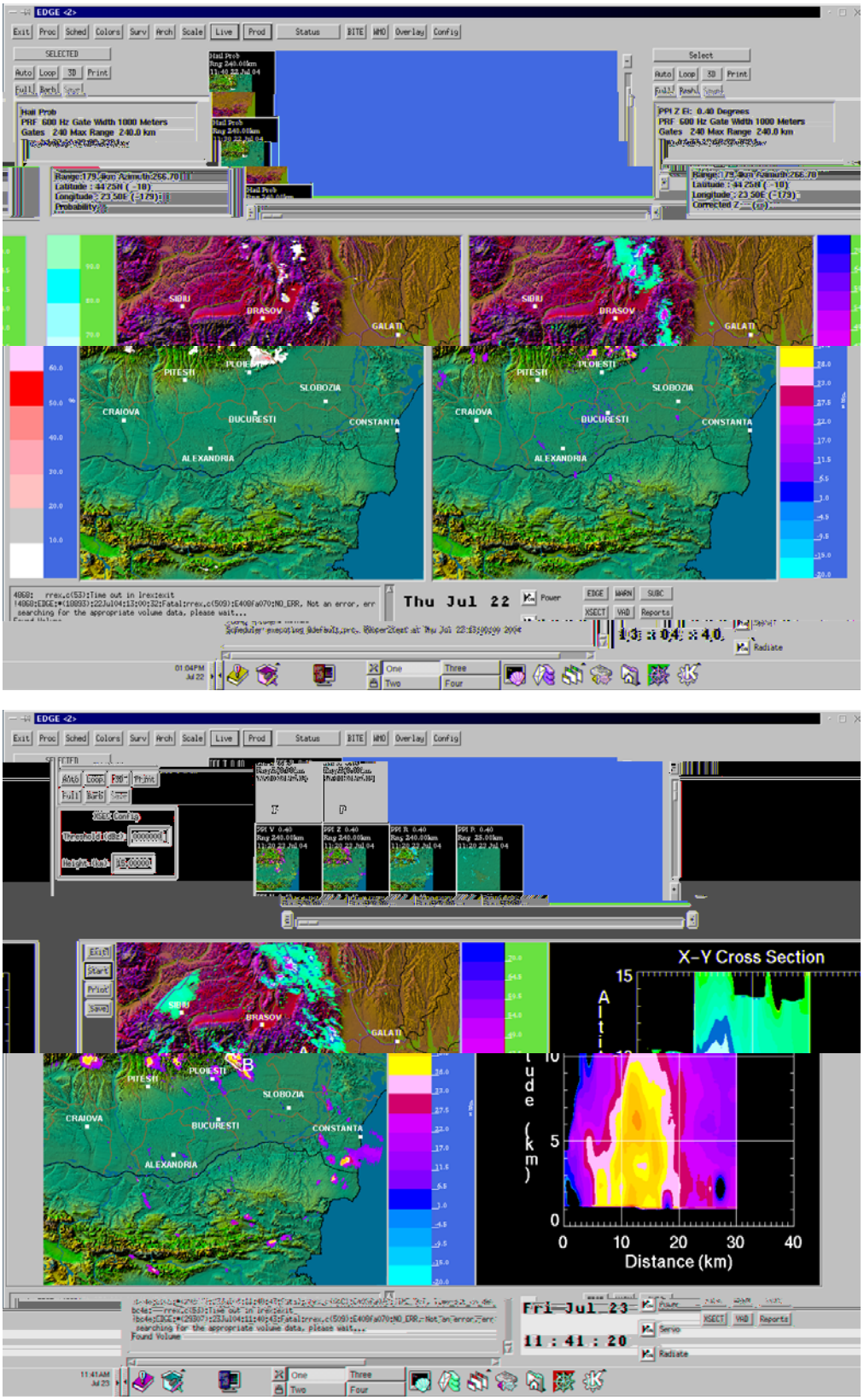
- Study and understanding of the regional mechanisms and processes responsible for development of severe storms in Romania
- Analysis of the main regional conceptual models specific to Romania
- Study and understanding of the interactions between orography and the mesoscale flow
- Analysis of severe mesoscale phenomena (flash-floods, severe winds, large hail, high rate lightning activity and tornadoes)
- Identification of spatial areas with high risk of dangerous phenomena
- Study of frequencies, duration and spatial extension for various severe events
- Study of adaptable parameters for radar algorithms



12-hours accumulated precipitation (top) and 3-hour accumulated precipitation (bottom).

c) Hail

– Monitoring and forecasting of hail using radar algorithms with parameters from soundings
– Study of storms producing hail
– Study of radar-adaptable parameters for hail algorithms



Top: hail probability [%]; Bottom: hail (vertical cross-section in a cloud).

d) Lightning

– In 2002 there was build up the Romanian National Lightning Detection Network (RNLDN) composed by 8 SAFIR3000 lightning detectors

- Since 2003 the lightning data from RNLDN are being used for monitoring the convective activity in day-to-day nowcasting warnings
- In 2004-2005 there were developed methodologies that used the lightning data in forecasting the evolution of convective activity
- In 2005, using archived lightning and radar data, there was developed a method for forecasting the onset of the cloud-to-ground lightning activity correlating the lightning data with sounding-derived parameters
- In 2006 there was developed a statistical model for forecasting the cloud-to-ground lightning activity

e) Satellite Meteorology

Operational activities: Meteosat Receiving System – 2002**,** Meteosat Second Generation Receiving System – 2004**,** MSG NWCSAF Processing System – 2005**,** MSG RGB Processing System – 2006**,** OnLine Satellite Imagery and Products Archive – 2006

Research: Forest Fire Monitoring Using Satellite Data**,** Vertical Atmospheric Profiles of Temperature and Humidity from NOAA/TOVS data**,** Satellite Sea Surface Temperatures**,** Determination of Snow Cover, Snow Melt and Snow Water Content from Satellite Data

f) Nivology

Avalanches have become the second cause of mortality in the mountain area after accidents. Thus, the protection of lives and goods in the existing populated mountain areas or in areas that are to be populated due to the extension of civil construction, as well as of tourists who choose the mountains as destinations for spending their holidays, needs to get a new dimension.

The Romanian nivo-meteorology program started in February 2004, after a training period held in collaboration with Météo-France "Centre d'etudes de la niege" – Grenoble, as a response to the continuously growing need to have more information about the snow cover, to investigate its future evolution and the conditions generating avalanches. By creating this project, Romania will join the European countries into what concerns the monitoring and prevention of the natural mountain disaster.

2. Participation of the Romanian specialists in working groups involved in international projects and programs

- Workshop WMO Working Group for Public Weather Services, 2005
- Workshop HYDRATE Project, 2005
- Training for Flash Flood Guidance at Hydrological Research Center from San Diego, 2005
- Severe Weather Workshop, Norman, Oklahoma, USA, 2005
- Workshop on Enhanced Floods Forecasting in Europe, Romanian Report by E. Anghel and A. Stan-Sion, 2005
- SPRING Experiment, Norma, Oklahoma, USA, 2005
- Tenth Meeting of the Working Group on Cooperation between European Forecaster**s** (WGCEF), 2004
- SIMIN Project, Lockheed-Martin 2001-2003
- RIVERLIFE Project which takes place in the framework of the LIFE Program of the General Directorate for Environment of the European Commission, 2002-2003
- Monitoring of Extreme Flood Events in Romania and Hungary using EO Data (2002-2005) NATO Science for Peace Programme. Project Plan SfP 978016
- Hydrology Satellite Application Facility Project, EUMETSAT, 2006-2010

3. Organization of national and international scientific conferences and training courses

- Annual Scientific Session of the National Meteorological Administration
- International Course on Radar Meteorology and Nowcasting, 2005

4. Participation of Romanian scientists at international symposia and conference

- Project NATO SfP 978016 - Final Workshop, 23-25 June 2006, Oradea, Baile Felix, Romania
- EGU General Assembly, 2-7 April 2006, Vienna, Austria
- 1st Post-EPS User Consultation Workshop, 29-30 March 2006, Darmstadt, Germany
- H-SAF EUMETSAT Project Team Meeting 2nd, 21-22 March 2006, Finnish Meteorological Institute (FMI), Finland
- NWC SAF Product Assessment Workshop, 17-19 October 2005, Madrid, Spain
- European Meteorological Society Annual Meeting 12-16 September 2005, Utrecht, The Netherlands
- International Colloquium of Applied Climatology, 24-28 August 2005, Constanta, Romania
- 2005 Training workshop for UNIDATA software, 25 July - 6 August 2005, Boulder, Colorado, USA
- Nowcasting and Very Short Range Forecasting, 4-7 May 2005, Toulouse, France
- EUMETSAT Training on setting up and installing a EUMETCast receiving station, 07-09 February 2005, Eumetsat, Darmstadt, Germany
- WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO-2005), 4-7 May 2005, Bucharest, Romania
- International Course in Radar Meteorology and Nowcasting, 1-15 December 2004, Bucharest, Romania
- The 3rd European Conference on Severe Storms (ECSS 2004), 9 – 12 November 2004, Leon, Spain
- First EUMETSAT Satellite Application Course for Eastern Europe, 6-10 September 2004, Cheia, Romania
- EUMETSAT 34th WGP meeting and 5th Licensing Agents Workshop at EUMETSAT, September 2004, Darmstadt, Germany
- NWC SAF First Joint Training Workshop, 14-16 June 2004, Madrid, Spain
- Training Workshop on Satellite Meteorology, 13-19 June 2004, Langen, Germany
- Advanced Satellite Data processing methods for flood monitoring, NATO Science for Peace Sub-Programme, 31 May 2004 – 4 June 2004, Bucharest, Romania
- Practical use of MSG Data in Meteorology and Hydrological Forecasting, 12-15 November 2003, Krakow, Poland
- Les Méthodologies, les Produits et les Applications à développer par l'emploi du Meteosat Deuxième Génération: MSG-MAP, 3-14 November 2003, Florence, Italy
- Establishment an efficient flood monitoring tool based on available NASA satellite data, 12 August – 2 September 2003, Dartmouth College, Hanover, USA
- Meteorological Products from the Satellite Application Facilities on Climate Monitoring, 2-11 June, 2003, Belgrade, Serbia and Montenegro

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Stan-Sion, A. and Soci, C., 2005: Severe convection environment in southeastern Romania. *Nowcasting and Very Short Range Forecasting*, Toulouse, France.

Stan-Sion, A. and Soci, C., 2005: Supercell environment in southeastern Romania. *EMS Annual Meeting*, 12-16 September 2005, Utrecht The Netherlands.

Stan-Sion, A., Stumpf, G., Antonescu, B., 2005: An exceptional tornado outbreak during 2005 in southeastern Romania. *EGU General Assembly*, Vienna, Austria.

Aeronautical MET services

Taking into account that Romania was going to become a member of the EU, Romanian aeronautical MET services, completely separated from the national MET services, were constantly developed during this period, so as to meet the EU requirements and to prepare the meteorological services provider to be certified in accordance with the "Single European Sky" Regulations.

Consequently, almost all aeronautical MET stations in the 17 airports in Romania benefit by new AWOS systems, which increase the quality of observations and support new standards and recommended practices of ICAO Annex 3. At the same time, the new systems allow automated collection of data, being very useful to climatological programs at local and national level and to the case studies used in the training courses of the MET services personnel.

Meanwhile, the forecasting activity becomes centralized in one unique forecasting center, located in Bucharest. The center both has WMO tasks and prepares warnings and aerodrome nowcasting and forecasting activities for all 17 airports in Romania. The center has been modernized with flexible forecasting terminals and MESSIR facilities from COROBOR Systems – France.

International Association of Hydrological Sciences

Association internationale des sciences hydrologiques

IAHS ACTIVITIES IN ROMANIA

2004 - 2007

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SUMMARY

Chapter 1 IAHS ORGANIZATION

The activities of IAHS organization in Romania took place under the supervision of 9 national commissions and their national representatives:

Surface Water Commission	Dr. C. Corbus, national representative (NIHWM)
Groundwater Commission	Dr. M. Bretotean, national representative (NIHWM)
Snow and Ice Commission	Dr. M. Simota, national representative (NIHWM)
Water Quality Commission	Dr. L. Constantinescu, national representative (NARW)
Continental Erosion Commission	Dr. P. Stanciu, national representative (NIHWM)
Water resources systems	Dr. R. Drobot, national representative (TUCEB)
Remote sensing and Data	Dr. V. Chendes, national representative (NIHWM)
Transmission Atmosphere-Soil-Vegetation relations	Dr. P. Mita, national representative (NIHWM)
Tracers Commission	R. Petres, national representative (NIHWM)

Romanian IAHS activities implied not only different specialists and researcher in hydrology field, but also professional organizations or institutions, like:

Romanian Association of Hydrological Sciences	- *RAHS*
National Administration Romanian Waters	- *NARW*
National Institute of Hydrology and Water Management	- *NIHWM*
Institute of Research and Environmental Engineering	- *IREE*
Institute of Research and design Danube Delta	- *IRDDD*
Romanian Institute of Marine Research	- *RIMR*
Institute of Geography Bucharest	

One of the most important activities is education and efficiency increasing, which means the implication of some universities:

Faculty of Hydrotehnics Structures	- Technical University of Civil Engineering Bucharest
Faculty of Hydropower	- University Politehnica Bucharest
Faculty of Geography Faculty of Physics Faculty of Mathematics	- Bucharest University

Chapter 2 MAIN RESEARCH ORIENTATION IN THE FIELDS OF HYDROLOGICAL SCIENCES

During the last three years the Romanian hydrology achieved its activity through several exquisite research works covering practically all branches of hydrology.
The development of scientific hydrology in Romania had in view the basic needs of Romanian economy, the participation in the research of the present problems of hydrology as a whole, the harmonization of Romanian research activities with European research main direction, the elaboration of competitive methodologies and not in the last point, the adaptation of Eu Water Directive requirements to reality from Romania and the insurance of the adequate scientific frame in order to assure the implementation of WD.
The demands of the Water Framework Directive mainly extend the objectives of research in the following directions:

- To classify, identify and characterize the water bodies according to the unitary criteria at the level of the entire area of the European Community;
- To protect the inland surface waters, transboundary water courses, coastal waters and groundwater, the protection, maintenance and improvement of the state of the aquatic environment in the Community;
- To ensure the qualitative and quantitative monitoring of surface water and groundwater parameters, as well as the aquatic environment.

All these action directions pursue the preservation and improvement surface water quality, and especially groundwater for the supply of drinkable water for the population and leisure activities, as well as the restoration and protection of aquatic ecosystems affected by anthropogenic impact phenomena.

There are some major tendencies in the hydrological science in Romania now:

- insurance of the quality during the research process: measured data quality insurance, models quality, new approaches in model validation, considering the uncertainty and uncertainty analysis
- using the new technology of Geographical Informational System GIS in hydrology and water management
- space-time analysis based on new data sets, including new types of hydrological data (new types of measurement sensors, new approaches in data analysis)
- intensive utilization of remote sensing and tracers in hydrology field

1. Global climate changes and water resources

The research orientation within these fields was approached in the context in wich the global changes occurred in the direct and indirect human activity have a significant impact on the water resources which decrease while the water needs increase due to the socio-economic development. Knowledge of the present and future state of these strategic resources and of the time and space distributions is an imperative need for sustainable development and management.

In this respect we would like to emphasize the following orientations:

- determination of water resources in the present state
- determination of the water resources in the global climate and landuse cover changes context.
- global distribution of water resources, water supply and water quality

Within these research directions the following issues were approached:

- advanced mathematical modeling of statistical and storage forecasting of hydrological data series
- regionalization methods of the qualitative and quantitative synthetic hydrological characteristics using new GIS technology

- rainfall-runoff deterministic mathematical models for the dynamic simulation of the hydrological data series
- Inventory of quantitative and qualitative water resources of improved resolution by using GIS procedures that define the time and space distribution and regime of water resources and also the vulnerable areas to flood, drought, pollution of the surface water and groundwater.
- Quantification of the impact of climatic and anthropic changes on the components of the hydrological cycle regarding the flow and matter changes
- Quantification of human impact on the extreme hydrological events – flood and droughts. Combined research regarding the physically based analysis of the hydrological processes with socio-economical studied in view to monitor the future character of water resources changes
- Pollutant transport and diffusion models under the circumstances of land use and vegetation cover changes.

2. Hydrological processes dynamics

The research orientation for this field took inherent complexity of the hydrological processes which occurred under homogeneous condition of the vegetation cover, soil, relief, geology, precipitations, temperatures and human impact and also that they manifested differently at various variable time and space scales.
The research area cover study of physical, chemical and biological processes which occur in the water bodies and also the new field of ecohydrology, within the following items were approached:

- development of integrated mathematical models of the physical, chemical and biological processes within water bodies – rivers, lakes, groundwater
- development of determination models for nutrients and pollutant trajectories on slopes, river beds and groundwater
- sedimentation models of reservoirs and the Danube Delta
- development of pollutant transport models in aquifers and non-saturated zone
- research regarding the ecology of river systems and their major beds
- ecohydrology studies of the environment systems at basin level in view of determination of the way of working of theses systems as against water as transportation and accumulation environment
- establishing methodologies concerning in sizing of the protection area for the aquifer systems and for the groundwater catchments

3. Interconnection of systems and water management

In this field the approached research had in view that the hydrological methods and models had to be interconnected with operating systems and tactical and strategical decision on sustainable water management. The following issues were studied:

- decision systems, in the field of water management, based on hydrological forecast
- dynamic-statistical models for long term hydrological forecast coupled with decision systems of water resources supply to users
- automation of the hydrological data flux necessary to the forecast
- optimization models in water management in conflict situation between various interests for the water users
- multi-criterion modeling techniques for the substantiation of decision makers within water management system
- discrete decision in the elaboration of master plans related to risk and lack of certainty of hydrological data
- nonstructural measures in water management
- decision-making and water management measures once with the water resources changes as a consequence of possible climate changes and direct human impact (land use, vegetation cover changes etc)
- monitoring, assessment and management of transboundary water bodies
- developing of decision making system support for water management in extreme situations (flood, drought)

4. Interconnection of hydrological, hydrogeological and meteorological processes

The obvious dependency of the whole hydrological processes on the precipitation and temperatures features made these fields occupy an important place in the strategy of hydrological research.
For example, the coupling of hydrological and meteorological models in view to increase the accuracy and anticipation of the hydrological forecast on river basin and the development of mathematical models of groundwater dynamics in interconnection with surface waters and meteorological factors are two items very important that there were approached.

5. Knowledge, information and technology transfer – formal / continuing education

For this field the research orientation was established taking into account that water is a vital element of life, important in all socio-economical aspects. In the same time, it is obvious the necessity of knowing all quantitative and qualitative aspects related to water, and as consequence, the dissemination of all this knowledge is necessary, but also at the level of direct involved ones on the population problems which should participate consciously in the elaboration and implementation of water policies.
Continuous hydrological educational and instructional systems concern instruction techniques and logistics for education at technicians and researchers level, learning techniques and knowledge testing assisted by computer, modern systems of formal hydrological education at all levels.

The information dissemination issue had approached by introducing elaboration in WEB pages regarding hydrological models representative, computation procedures and results of the operational activities. The public awareness regarding water issues was also integrated in those WEB pages.

6. Surface and groundwater research using natural isotopic tracers

In this field were approached isotopic hydrological and hydrogelogical research. They were carried out at regional or local level and included runoff directions, supply / resupply areas, patern-flow at regional level, aquifer inter and intra relation, time and space evolution of the surface water and groundwater quality.

7. Development of hydrological informational systems

This activity is one of the most important, due to the great necessity to have numerous and good data. The optimization of the hydrological and hydrogeological stations network and the automation of receiving data from measure stations were developed.
It was also important the development of complexes hydrological databases and the integration of these with others environmental databases.
Implementation of monitoring programs for the operation of groundwater catchments concerning the evolution of exploited discharges, of the freshwater head and dynamic levels and of the water quality was one of the very important issues, in compliance with WD requirements.

Chapter 3 PARTICIPATION OF ROMANIAN SPECIALISTS IN WORKING GROUPS INVOLVED IN NATIONAL AND/OR INTERNATIONAL RESEARCH PROGRAMS

The participation of Romanian specialists in national and international programs and projects is an objective necessity mostly motivated by the requirements of the economy to know the main hydrological and hydrogeological characteristics of water resources. That is why the projects and programs had aimed to establish the most efficient methods and models to determine the status of water resources under various circumstances.
The participation of Romanian specialists in international programs aimed at similar objectives – this time expanded at regional level, using at the same time the experience of specialists coming from different countries, involved in giving solutions to the scientific and technical problems raised by socio-economical requirements.

At **national level** the research programs were achieved on concrete request of various ministries, which also financed these programs. Some of most important issues approached within those programs will be presented further on.

1. Development of hydrological, hydrogeological and water management modeling

- The update of the hydrological parameter survey (mean and maximum runoff, and suspended sediment mean runoff) of Romanian rivers using GIS procedures: case studies Banat, Jiu;
- The update of groundwater survey and the application of GIS procedures for the management of survey data, with their adequate allocation to the groundwater bodies identified in accordance to the Water Framework Directive 60/2000/EC;
- The development and implementation of coupled atmospheric, hydrological and hydraulic models (VIDRA, HRM and UNDA – Crisuri River Basin; HRM-CONSUL-UNDA – Timis-Bega River Basin);
- The study of temporal and spatial variability of hydrological processes at regional and global scale, in an anthropogenically modified environment and prone to climatic changes: the quantifying of anthropogenic influences on minimum runoff, the evaluation of annual variability of the phreatic groundwater quality state, the determination of low flow on transboundary rivers in Western Romania, the study of variability and tendency of hydrological, chemical and radioactive parameters specific to the sediments of the Danube River, the Danube Delta and the Black Sea Coastal area.
- Studies concerning eco-hydrological processes and anthropogenic impact on aquatic ecosystems and environment: the application of a complex marine model in view of diagnosing the physical-ecological parameters characteristic to the Romanian coastal area (WBLESS Project), the analysis of changes occurred in aquatic and terrestrial ecosystems as a result of hydrotechnical developments on the lower course of the Olt River, the influence of pollution with suspended materials on aquatic ecosystems in different phases of the hydrological regime (Jiu River)

- Studies for the improvement of the development and management of river basins concept: current concepts of protection against floods, flood risk management national strategy, the delineation of floodable areas in the Somes River catchment through mathematical modeling, ecosystem approach in the development and management of river basins, the elaboration of the Tisza River Basin Management Plan;
- The synthesis of surface runoff characteristics in small catchments: the synthesis of flood wave elements depending on the characteristics of precipitation, the synthesis of the drying out phenomena in small basins, databases representative for the Ciurea and Stana de Vale catchments.
- Studies regarding mitigation/elimination measures of the pollution effects on surface water and ground water resources: integrated exploitation and control system of strategic water resources of Fratesti layers, the adaptation of European models regarding the impact of punctual and diffuse pollution sources on surface and ground waters.

2. Development of hydrological informational system, hydrological databases and support activities using GIS

- The development of a modern administration and exploitation system of the National Hydrological and Hydrogeological Database Management System: automated calculation applications of processing and validation of hydrometric data (CAMDAR, CHELIM, VALMED, RECONDA, HIDROMET, HIDROBAZ), applications for database management (HIDROBD, CARNETH, MACHETA, TRANSPUNEF);
- The update of the national hydrological and hydrogeological national database;
- The drawing-up of the support database in GIS format: digital terrain model.

3. Adaptation of methodologies for groundwater resources evaluation in compliance with WD

- The detailed characterization of transboundary groundwater bodies which are prone to risk;
- The identification, mapping and characterization of limitroph areas to water tapping facilities;
- New program of groundwater monitoring;
- The determination of action directions for the rehabilitation of groundwater bodies prone to risk;
- The re-evaluation of groundwater resources in 4 catchments (Somes-Tisa, Crisuri, Mures, Banat).

At **international level** we can mention participation of Romanian specialists in important international programs:

1. The International Hydrological Program (IHP- UNESCO), which is the most important international program in water domain and within the following issues were approached:

- The investigation of global changes in the geographical area between the Danube River and the Sub-Carpathian hills (IHP – UNESCO Programme, Phase VI).
- The modeling of floods in small catchments, based on data sampled from the representative basins in Romania (IHP – UNESCO Programme, Phase VI).
- The inventory of the main hydrotechnical works in the Danube Basin
- The participation in the development of the FRIEND-AMHY database

2. The Danube Countries Regional Hydrological Cooperation Programme

- Water balance in the Danube Basin - WATBAL
- The modeling of the erosion, transport and sedimentation processes on the Danube River and its main tributaries - SEDAN

Chapter 4. PARTICIPATION ON NATIONAL AND INTERNATIONAL SCIENTIFIC PROJECTS

1. Participation in national projects

- The development of certain remote sensing and GIS methodologies for the evaluation of the environment in the coastal area, and quantification of physical-chemical and biological parameters characteristic to these areas (TEDMAR)
- Geospatial data processing methods in view of emphasizing, monitoring and management of risk phenomena on the Danube and Danube flood plain (MONDUN)
- Instruments, guides and indicators for the integration of environmental aspects in agricultural, forestry and rural water management policies: from the top-down approach to the involvement of local communities (TOGI)
- Urban Water Management Decision Support System (URBWATER)
- National Informational Monitoring System of Activities for the Prevention and Removal of Effects Caused by National Disasters and Industrial Accidents (SINMAPIEDA)
- Infrastructure of Spatial Data for Environment Protection Application (INSPAM)
- The Realization of a National Network and a Unified Informational System for the Management of Information Concerning the Land Cover and Use as a Support to the Development of GMES Applications (LUCIUS)
- Integrated monitoring and determination of flood effects in the lower Siret catchment pilot system
- Integrated platform for the use of environmental isotopes techniques in mineral water resources management – case study in the Oriental Carpathian area
- Agro-geological indicators based on digital terrain information for the characterization of the vulnerability of agricultural systems in hilly areas;
- Informational system for consultancy in agricultural management from areas vulnerable to pollution with nitrates from agricultural sources
- WEB adaptive platform for the integrated water management
- The impact of climatic variability and anthropogenic interventions on the hydrological regime of the Danube River and the dynamics of coastal areas

2. Participation in international projects

- SQUAS PROJECT - “Quantitative hydrogeological study of the alluvial aquifer of Somes-Szamos (Romania-Hungary)
- ASURE (UE-LIFE) Pilot system for the evaluation of the impact of pollution on urban development , using the OPEN-GIS Technology and pollution levels estimation procedures

- MOSYM (UE-LIFE) Modernization of measuring, storage, transmission and dissemination data system at different decision-taking levels;

- EFFS NAS extension (UE-FP5) European Flood Forecasting System

- RIVERLIFE (UE-LIFE) Protection of life through flood damage mitigation

- DIMINISH (UE-LIFE) The development of an integrated basin management in order to correlate the quantitative and qualitative water analyses with socio-economic analyses, using OPEN-GIS technology

- MONDUN (AEROSPATIAL Programme, Spatial Applications Subprogram) Methods of processing of geospatial data in view of emphasizing, mornitoring and management of risk phenomena on the Danube River and the Danube Delta

- Environment Statistics Survey

- TIGRU (NATO) The supervision of floods in Romania and Hungary using satellite data

- NATO SpF 978016 / Monitoring of extrem flood events în Romania and Hungary using EO data

- CECILIA - FP 6 STREP 037005 / Evaluation of impact and vulnerability of climatic Change in Central and Eastern Europe

- Ensembles - GOCE-CT-2003-505539 – Prediction of climatic change and their impact

- HYDRATE – FP 6 037024

- Hydrometeorologic databases and technologies for the efficient forecast of flash floods

- CLAVIER - FP 6 STRP 037013 / Variability and climate change: impact in Central and Eastern Europe

- PHARE 2004 CBC RO-BG / Integrated Management of Transboundary Groundwater between Romania - Bulgaria in Dobrogea Area

- FLOODMED/ Monitoring, forecasting and best practices for FLOOD Mitigation and prevention in the CADSES region

- MOSES / Improvement of Flood Management System

Chapter 5 PARTICIPATION ON NATIONAL AND INTERNATIONAL SCIENTIFIC CONFERENCES

The scientific manifestations organized in Romania – conferences, sessions, symposia, "round tables" – have included in theirs programs from all the branches of hydrology the following topics:

- high or low runoff on rivers, including the Danube
- alluvial runoff
- snow-melting runoff
- the influence of atonal factors (afforested or carstic areas) on the surface runoff, evapotranspiration
- hydrology
- modern methods for obtaining the main parameters of water and solid runoff

At national scientific conferences, as well as international ones, most of the papers have been elaborated by the specialists from National Institute of Hydrology and Water Management, where is the strongest nucleus of hydrology specialists. In this context, numerous manifestations were organized, on national and international level, by this institute.
There are collectives including very good specialists at other institute with same profile, too: IREE, IRDDD, RIMR, Institute of Geography Bucharest and other Institutes of university education: TUCB (Faculty of Hydrotechnics), Polytechnic university Bucharest (faculty of hydraulics and hydraulic engineers), University of Bucharest (Faculty of Geography - hydrology section, Faculty of Geology – Hydrogeology section) and many others institutes from all the country. Some of these institutions also organized scientific national and international manifestations.

National conferences and other scientific manifestation

- NIHWM National Scientific Session "Water for Life", 2004
- NIHWM International Scientific Session "Hydrological Hazards: floods and Droughts", 2005
- Workshop „Advanced Research Workshop – Transboundary Floods", organized within the NATO SfP Project, 2006
- Scientific Debate "Characteristics of Floods occurred in 2005, comparison with other Historic floods", Romanian Academy
- The Institute of Geography Annual Session of Scientific Communications "Geographical Research and Sustainable Development"
- Local and Regional Climatology Colloquium, "OVIDIUS" University, 2005
- Presentation of the final report of the program regarding the water management system for the WFD Conference, organized by MEWM, NAAR, Soil and Water Ltd and Royal Haskoning Romania.
- National Symposium on Geology organized by Al. I. Cuza University
- NAAR and TUCEB Scientific Seminar: Probabilistic and hydraulic design in water management, river hydraulics and management, 2006
- International Workshop "Flood Risk Management and Water Framework Directive", NAAR, 2006

International conferences

- Conference of the Danube Countries "Hydrological Forecast and Hydrologic Databases of Water Management"
    - the 22nd Conference, Brno, 2004

    - the 23rd Conference, Bratislava, 2006
- Conference regarding informational and observation systems as support for decision makers
    - First Conference, Balwois, 2004
    - Second Conference, Balwois, 2006
- Hydrological Forecasts Conference, organized by the Institute of Water Resource Management, Hydrogeology and Geophysics „JOANNEUM RESEARCH" Gratz, Austria
- Annual Conference of the American Meteorological Society, San Diego – California, USA
- International Workshop of the "European Thematic Center of Experience Exchange in the Field of Flood Forecast and Warning" – The current stage and future necessities of development of flood forecast in Europe", Toulouse – France
- Hydrology and water resources in the Danube Area Conference, organized by the European Geosciences Union, Vienna, Austria
- International Workshop "Hydrological Forecast Systems – support for water management and disaster prevention caused by hydrometeorological phenomena, Prague, Czech Republic
- International Workshop organized by the IMPERIAL COLLEGE – LONDON under the aegis of NATO Advanced Research: "Foresight, precaution and risk: preparing for the unexpected – Learning the lessons from past crises and catastrophes to enable early and effective response to future risks", Chisinau – Republic of Moldova
- Expert level meeting on the basis of the Declaration of Collaboration in the field of water management between the Ministry of Environment and Water Management from Romania and the Ministry of Environment, health and Consumer Protection from Bavaria, Germany
- Meeting of legal representatives of the participant countries (CADSES) to the realization of the HYDROCARE Project - Greece
- Working meeting with the purpose of experience exchange with the Ministry of Ecology and Sustainable Development from France, Meteo France, Central Service of Hydrometeorology and Support for Flood Forecast and the Adour Garonne Water Agency, Paris and Toulouse - France
- Participation in the Meeting of the Working Group for the Danube River - Ukraine
- Experience exchange in the filed of hydrology and water management between the MEWM from Romania and Ministry of Environment from Israel, Tel Aviv – Israel

The International Association for the Physical Sciences of the Oceans

I A P S O ACTIVITIES IN ROMANIA
2003 - 2007

The Romanian National Section for IAPSO

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Report of the Romanian National IAPSO Section

Romanian marine sciences researches, relative to IAPSO topics, have been carried out in 2004-2007 period by several research institutes located both in Bucharest and Constanta.

Most of these studies are focused on the western Black Sea Basin, its coastal zone and on its relationship with the River Danube. The main researches have been carried out in the framework of the National Research and Development Programs,MENER, CERES, CEEX.

International or bilateral programs and projects represented also a very important support and framework of marine sciences development in Romania. Among these one could mention: European Commission programmes as INCO-Copernicus, PHARE, Tempus and Erasmus, UN (UNDP, UNEP) and World Bank (GEF) programs as Black Sea Environmental Programme, NATO projects etc. Bilateral co-operation projects between Romanian and French, German, Italian, US, Russian, Ukrainian, Bulgarian, Greek and Turkish teams of scientists constituted also a good opportunity to develop the marine sciences in the Black Sea area.

The technical facilities and logistics available for the marine research has grown continuously as a consequence of the participation of Romanian scientists at national and international research projects.

RESEARCH INSTITUTIONS

The National Institute of Hydrology and Water Management (INHGA)

Objectives:

To develop research activities and to provide operational services of national and international public interest for:

protection of people and socio-economic well-being development and improvement of life's quality protection of the environment

Services for:

- Water resources management
- Energetic
- Environment protection
- Transports
- Agriculture
- Industry

- National defense
- Tourism
- Mass-media

Services & Products:

- Warnings in case of dangerous phenomena (floods, drought, ice jam, accidental pollution) Hydrological forecasts on short, medium and long term
- Development, upgrading and implementation of hydrological models and forecasting
- Technical – scientific guidance and assistance of the hydrological network
- Modernization of the national network
- Parametric hydrology studies
- Impact of human activity and of the climate changes on the hydrological regime
- Eco-hydrology researches
- Studies and researches regarding the protection of water resources
- Assessment of the water resources and the hydrological water balance components
- Studies for integrated and sustainable water management and water development, optimization of the water use, conservation of quantity and quality water
- Development of informational technologies, hydrological data bases and GIS procedures
- Studies regarding the morphology of the Danube River, the Danube Delta and the Black Sea

National Projects

Starting with 2005, through the implementation of the DESWAT – Destructive Water Abatement and Control of Water Disasters, the field of hydrology and water management enters a new stage of development and modernization of the following systems:

- The monitoring of rivers, by installing automatic stations equipped with sensors measuring water, precipitation level, water and air temperature and also measuring the main parameters of water quality

- Short-term and medium-term hydrological forecasts, by acquiring performant forecast models, NWSRFS (USA), etc. and the integration of the Romanian forecast models VIDRA, CONSUL and UNDA in the decisional system of waters.

This project, extremely important for the management of floods and real time warning, is financed by the Romanian Government and it is implemented by the American company LOCKHEED MARTIN OVERSEAS CORPORATION

Main International Projects:

- Country Study Project on Climate Change Impact on Water Resource and Adaptation Measures
- Hydraulic Erosion of the Soil and Sedimentation – modeling and Field Experimentation (EROSLOPE)
- The Modernization of the System of Measurements, Storage, Transmission and Dissemination of Hydrological Data to Various Decision Levels (LIFE-MOSYM)
- Life Protection in Hydrographical Basins within Damages Mitigation in case of Floods (RIVER LIFE)

- Monitoring of Extreme Floods Events in Romania and Hungary using EO Data (TIGRU) - NATO
- Destructive Water Abatement and Control of Water Disasters (DESWAT)-USTDA
- European Flood Forecasting System (EFFS-NAS Extension)
- Water Observation and Information System for Decision Support (WOISYDES)
- Modeling of the erosion, transport and sediment processes on the Danube and its tributaries (PHI – UNESCO – SEDAN), 2004-2007;
- Geospatial data processing methods in order to underline, monitor and administrate the risk phenomena on the Danube and the Danube Meadow, 2004-2006;
- Integrated project regarding the flood and drought forecasts at an European scale (FP6 – UE – EFDIP), 2005-2009.
- Study regarding the climatic changes impact upon the hydrological risk within the integrated project ENSEMBLES (FP6), 2004-2008.

The Romanian Marine Research Institute (IRCM)

The institute was established in Constanta in 1970. It emerged from the fusion of several former small research units: Marine Zoological Station "Prof. I. Borcea", Marine Fisheries Research Station "Dr. G. Antipa", Marine Biology Sector of the Institute of Biology "T. Savulescu", Oceanographic Station of the National Water Council and the Laboratory of Marine Sedimentology of the Geological Institute. Later on, in 1975 the Marine Geology Department of the institute was transferred to the Institute of Geology and Geophysics.

The RMRI address is: 300 Mamaia Boulevard 8700 Constanta, Romania
Tel: +40-41-540 870
Fax: +40-41-831 274
E-mail: ircm@alpha.rmri.ro

RMRI is structured as follows:
- Laboratory of Oceanography
- Laboratory of Marine Ecology
- Laboratory for Ecological Reconstruction
- Laboratory of Fishery Resources
- Laboratory of Marine Technology
- Laboratory of Marine Biochemistry
- Nuclear Unit
- Computer Office

National Programs

- Scientific and technologic partnership for promoting the sustainable management for romanian marine fisheries based on the ecosystemic approach - PSTPMR

Main International Programs

- Nutrients management in the Danube river basin and its impact to the Black Sea (CE/DANUBS)
- ***Regional Program for the development of the infrastructure, monitoring network and forecasting activities in the Black Sea (CE/ARENA)***
- ***European network for the sea level monitoring (ESEAS)***
- Sea-Search Network (MARIS/NL)
- The Dolphins conservation in the romanian Black Sea waters (CE/Life Natura)
- Technical Assistance to suport Romania for the Water Frame Directive implementation and integrated coastal zone managementin on the coastal and transitional waters (SENTER- Haskoning Nederland B.V.)

The National Institute for Marine Geology and Geoecology – GeoEcoMar

Its headquarters is located in Bucharest and has an operational branch in Constanta. GeoEcoMar was established in 1993 on the basis of the Marine Geology and Sedimentology Laboratory and Marine Gravity and Magnetics Laboratory of the former Institute of Geology and Geophysics, now the Geological Institute of Romania (GIR).

The GeoEcoMar's addresses are:

Headquarters: 23-25 Dimitrie Onciu Street,
70318 Bucharest, Romania
P.O. Box 34-51

Tel: +40-1-252 2594
+40-1-252 5512
Fax: +40-1-252 2594
E-mail: office@geoecomar.ro

Constanta Branch: 304 Mamaia Boulevard,
8700 Constanta, Romania

Tel: +40-41-690 366,
Fax: +40-41-510 115

E-mail: nimgg@rcmgg.sfos.ro

The structure of GeoEcoMar corresponds to its main scientific aims. GeEcoMar has four scientific departments (laboratories), a technical and navigational department, a GIS and Databases Group and an operational-financial-administrative one. The scientific departments of the institute are:

- Marine Geology and Sedimentology Laboratory
- Laboratory for Seismoacustics and Physics of the Sea
- Marine Gravimetry and Magnetometry Laboratory
- Marine Geoecology and Geobiochemistry Laboratory

GeoEcoMar in the present has a multidisciplinary marine research vessel and is a converted Atlantic II-type trawler ("***MARE NIGRUM***" - 3,000 t displacement, 82 m length) and it is operational since 2003.

The institute has also a research vessel (R/V **"*ISTROS*"**, 32-m length)

and a floating laboratory **("*HALMYRIS*"**, for 22 researchers) for research campaigns within the Danube River and its Delta.

For more information regarding the GeoEcoMar's structure, main scientific objectives, equipment and other capabilities, visit the web site: www.geoecomar.ro

Main International Projects

- Initial environmental examination study for the study on protection and rehabilitation of the southern romanian Black Sea shore in Romania, ECOH Corporation

- The study on protection and rehabilitation of southern romanian Black Sea shore in Romania . Assisting the JICA team for preparation of the draft final report, ECOH Corporation
- Fesability study for the protection of the coast line in the South Mamaia and North Eforie areas, Japan International Cooperation Agency
- Network for environmental assessment and remediation in the aquatic systems: environmental curriculum and training at the postgraduate level (near 3), Swiss Science Foundation
- RTA intensive course "Remote sensing and geographic information system for integrated marine-coastal management", NATO
- Hotspot Ecosystem Research on the Margins of European Seas, HERMES
- Assessing european capacity for geological storage of carbon dioxide, EU GeoCapacity
- CO2 capture and storage networking extension to new member states, CO2 Net East
- Assessment of the Black Sea sedimentary system since the last glacial extreme, ASSEMBLAGE
- Methane flux control in the ocean margin sediments, METROL
- Black Sea scientific network, Black Sea Scene
- Southern European Seas: Assesing and Modelling Ecosystem changes, SESAME
- International action for sustainability of the Mediterranean and Black Sea environment, IASON
- Black Sea ecosystems recovery programme-TDA (Transboundery Diagnostic analysis) project, UNDP - GEF
- Wasedy Orsed environmental assessment of the barrage lakes from Olt River; Rm. Vâlcea area, COPBIL - ESTROM
- Concepts and science for coastal erosion management, CONSCIENCE

Significant contribution to the physical oceanography, mainly in the field of bathymetry, have been brought by the **Romanian Navy's Maritime Hydrographic Directorate (DHM)** whose address is:

1 Fulgerului Street 8700 Constanta, Romania
Tel: +40-41-651 040
Fax: +40-41-513 065
E-mail:dhm@tomrad.ro;
carto@gmb.ro

The structure of the Romanian Maritime Hydrographic Directorate is as follows :

- The Hydrographic Branch;
- The Nautical Cartographic Branch;
- The Oceanography and Meteorology Branch;
- The Maritime Aids to Navigation Branch;
- The Navigation Equipments Maintenance Branch.

MHD operates the hydrographic vessel **"Eugen Stihi"** and the hydrographic launch **"Oltina"** to perform hydrographic and oceanographic surveys.

MAIN OBJECTIVES OF THE ROMANIAN IAPSO SCIENTIFIC RESEARCH

Most of the Romanian geoscientists contributions concerning the physical sciences of the oceans during the past four years has been carried out both within the national program for interdisciplinary scientific research (MENER, CERES, RELANSIN, CEEX) and several international programs financed mainly by the UN, EEC and NATO organizations. The weight of the international co-operation programs on the Romanian scientific research budget was grown each year during the analyzed period.

Although the scientific contribution of the Romanian scientists covers a wide palette of subjects, these may be gathered into the following main topics: the physical sciences of the Geosphere and the physical sciences of the Hydrosphere. Therefore, the classification of research subjects, related to physical sciences of the oceans, included in this brief report will be issued from the above mentioned major topics.

Physical Sciences of the Geosphere

The most important scientific research objectives belonging to this main topic are:

Bathymetry and geophysical mapping of the aqueous domain

The Romanian authorities and scientific community have focused constant attention during time on the problem of systematically mapping the Romanian sector of the Black Sea continental shelf. Bathymetry and geophysics, both gravity and magnetics maps at scales ranging from 1:500,000 to 1:50,000 and even bigger have been yielded during time. The systematic mapping process, started in the early ’80, has continued with decreased intensity after 1990 and covered the entire Romanian continental shelf as well as large areas of the corresponding continent-sea transition zone. A special attention has been granted to the distribution of the normal geomagnetic field on the northwestern continental shelf of the Black Sea.

The detailed morphology of the sea bottom has also been investigated during several cruises encountered in the framework of international co-operation projects. The cruises have been carried out on the northwestern Black Sea continental margin, in order to study the morphology, structure and sedimentation history of the submarine Danube and Dniepr fan complexes as well as to evaluate the sediment inputs, the role of the different mechanisms of sediment transport and sedimentation, such as mass transport processes, or confined and unconfined flows.

Special hydrographic researches have been continuously performed by the Romanian nautical authorities, according to IHO SP no. 44, Ed. IV, 1998, along the Romanian littoral zone, in harbors, in berthing areas and entrance channels with critical depths for vessels (***1-5, MHD). The sea bottom morphology of the Danube–Black Sea interaction zone, especially in the Sulina channel area, was granted with a special attention. The systematic bathymetry and geophysical mappings are carried out by GeoEcoMar and the maps and most of the surveying results are included in unpublished reports. On the contrary, the bathymetry measurements performed by MHD result in valuable commercial navigation maps.

In order to organize the high amount of geological and geophysical data, as well as the hydrological information acquired during time, complex and multidisciplinary databases and web sites (e.g. www.blackseaweb.net/geoecomar) started to be developed in the past few years as result of the international co-operation. Enhanced procedures for marine and terrestrial geophysical data sets coherence analysis have been also tested.

Interdisciplinary research of the oceanic domain's deep structure

A large amount of geophysical data has been acquired during time on the northwestern continental margin of the Black Sea Basin. In this context, the attention of the Romanian researchers focused mainly on the investigation of the regional and local geological problems of this aqueous basin. The study of the deep geological structure of the northwestern Black Sea continental margin and of the associated geotectonic processes represent major research objectives for Romanian geoscientists. A wide palette of geophysical data, including seismics, gravity and magnetics, have been used in order to create more or less regional models of the deep geological structure of the continental margin's major units. Most valuable information regarding the petrography of the continental shelf sub-bottom has also been brought by the structural and exploration wells drilled during time.

Regional geotectonic settings, compiled by integration of all onshore and offshore data pointed out the major geotectonic structure and the economic perspective of the Romanian continental shelf. Regional geotectonic processes that took place in the past within the Western Black Sea Basin have been encountered as well as those that were mainly hosted by the northwestern continental shelf.

The tectonics and sedimentology of the green schist type basement of Central Dobrogea were detailed both onshore and offshore. Regional seismic and structural wells' results suggested a possible mechanism for the genesis and evolution of the Black Sea Basin and of the Romanian continental shelf in particular.

Several models of the Romanian continental shelf's geological framework have also been proposed by the interpretation of the previously acquired marine gravity and magnetics data, of marine seismic data or by integration of all above mentioned information. 2D models of the deep geological structure of the continental shelf are also forwarded.

High attention was also focused on the continent-sea transition zone where, by a careful integration of the very few well and seismic data available with the gravity and magnetics data acquired meanwhile, a couple of geotectonic settings and cross-sections have been proposed.

The enhancement of the biostratigraphycal knowledge of the offshore area became also possible by a careful examination of all well data and also by well logs geophysical interpretation. Heat flow measurements performed both onshore and offshore, made possible the elaboration of a theoretical model relative to the heat flow and geothermal evolution of the northwestern Black sea Region. Not in the least should be mentioned some unconventional investigation procedures, such as biogeophysical (dowsing) prospecting, experimentally applied offshore for oil and gas.

A very important task for the Romanian geoscientists is also represented by the distinguishing of crustal blocks' movements, which can be considered as relatively local consequences of planetary lithospheric plates movements. Constant efforts have been made within the framework of several international co-operation programmes, in order to regionally point out the vertical and horizontal crustal movements.

Marks of Upper Quaternary sea level changes, due probably both to sea bottom vertical movements and to secular mean sea level variation, on the northwestern Black Sea continental shelf have also been investigated.

Processes and phenomena associated to sea-land interaction zone

The complex processes that exist within any land-sea interaction zone are highly amplified in the Danube River and Delta area by the important amounts of water and sediments of continental origin discharged in the sea basin. The interdisciplinary study of the geomorphologic processes and also of the geological evolution of the Danube River-Black Sea interaction zone is a constant task for sedimentologists as well as for hydrologists. The seasonal variation of the shoreline and the beach morphology have been studied by a multiyear beach profile monitoring.

Geoscientists attention focused on each phase of the complex research process: sediment input, shore erosion, sediment transport and discharge. Erosion processes due to both natural and anthropic causes have been highlighted in front of the Danube Delta and also along the whole southern Romanian.

A Romanian specialized team is carring out an integrated study of the changes in the shoreline configuration and submerged beach topography and also of the modifications in the sediment stock and granulometric structure along the entire Romanian littoral. The surveys are carried out yearly in the underdeveloped part (included in the Danube Delta Biosphere Reserve) and twice a year in the economically developed part (affected by industrial, harbor and, especially, touristic activity). For some touristic beaches where the erosion is very strong, the surveys of this team are carried out monthly or quarterly. At the same time, special experimental research regarding the action of the sea on the land, modified by the existence of the shore protection technical works, have been developed.

Recent efforts focused on the anthropic activity effects, encountered at regional scale, upon the Black Sea environment and, at smaller scale, upon the shoreline and specially upon the beaches.

A new research direction that constantly grew during the past few years refers to the impact that global changes induce on the geo-environmental state of the sea. Assessments based on interdisciplinary observations and records have been made. Climate changes effects upon the hydrological state of the Danube River-Danube Delta-Black Sea system were also took into consideration.

Processes and phenomena associated to oceanic domain

Although the participation of Romanian scientific personnel at international oceanographic expeditions was not significant during the past years, due to the well known financial crisis that affects countries with transition economies, there still may be pointed out valuable Romanian contribution to the study of open sea domain's physical-chemical processes. Physical and chemical phenomena associated to marine gas-hydrates deposits and the production of methane represent research objectives that were recently undertaken. Other new research objectives recently implemented concern the study of greenhouse gases effects, such as CO_2, N_2O and CH_4 and the formation and transport processes.

Physical Sciences of the Hydrosphere

The main research direction focused on the hydrology and hydrophysics of airseawater, land-seawater interfaces and water-mass' inside. The wide palette of surveys and recordings carried out by the scientific personnel of the Romanian oceanologic and hydrologic research institutes may be gathered according to the following topics:

Coastal zone hydrology

The observation on the transfer of solar energy and waves mechanic energy through the air-seawater interface started many years ago and continued during the past analyzed time period. An enhanced monitoring system of the shallow water dynamics, whose main causal factors and effects are winds, waves, currents and sea level variations have been set up. The variations of sea level, waves and currents in the coastal zone of the Black Sea have been recorded through a complex programme of observations and determinations. All this informations are now organized into a specific structured database at GeoEcoMar.

Modelling of the thermal structure evolution, wind driven circulation, wave field, fresh water diffusion and others phenomena are now in work. The short and long term evolution of the physical and chemical parameters of the sea water at Constanta and Mangalia, and of the Danube water at Sulina, as well as the nearshore wave and current regime are currently investigated.

Other research objectives are represented by development of methodology for the management and assessment of marine hydrological parameters and for the forecast of the waves and streams elements in the coastal area of the Black Sea.

On the other hand, studies regarding the corellation with the EU Directive concerning the water resources (coastal and transitory waters) are in work now by NMHI.

Open-sea hydrology

The estimation of the statistical parameters, spatial ranges and time scales of the observed changes in three dimensional water mass distribution represent some of the main results of the surveys performed in open sea. Other research objectives are represented by the assessment of the air-sea fluxes and specific processes (convection, advection, shelf-open sea exchanges) involved in the formation of the cold intermediate layer (CIL) and upper quasihomogeneous layer evolution and by the parametrization of the shelf circulation patterns, including its transient and meso-scale features.

During the last period of time the increase in research capabilities (instruments, computers etc.) led to a more detailed investigation of physical processes over the continental shelf.

Seasonal cruises using CTD instruments have been carried out allowing the detailed threedimensional distribution of the water masses to be charted. Also, the quasi-geostrophic circulation patterns have been inferred from the density distribution. The research, combined with meteorological and hydrological data focused, on one hand, on the temperature evolution of the upper mixed layer, based on the thermal and kinetic energy balance at the air-sea interface.

On the other hand, the characteristics of the cold shelf water generated by winter convection, as well as its subsequent advection toward the shelf edge and the interaction with the open-sea formed cold water were investigated, as the lower boundary of the resulting CIL represents the upper limit of the hydrogen sulfide layer in the Black Sea. A bottom boundary layer, very homogeneous over the entire abyssal area and stationary in time, was identified as a new feature of the Black Sea.

A large database with very powerful and versatile management software was established for all the data collected by the riparian countries.

Owing to a new wave gauge mounted on an offshore oilrig, systematic data are gathered and processed. Also, two numerical wave models have been obtained, adapted and tested for the Romanian shelf with fairly good results.

Permanent Service for Mean Sea Level

RMRI is operating a network of four sea level gauges located on the Romanian shore at Constanta, Tomis, Mangalia and Sulina. All record data are currently being sent in delayed mode to the Permanent Service for Mean Sea Level (PSMSL). The research focused on the estimation of the long-term trend of the sea level variation, as well as on the detection and parametrization of the mesoscale phenomena.

On the other hand, geodetic researches carried out onshore by quite different means, intended to discriminate the participation of crustal movements that is included into the mean sea level's long term global increase, recorded by sea level gauges.

Seawater's Properties Monitoring

Pollutant impact of the Danube River on the Black Sea water has been analyzed during time by different means. Panin et al. and Oaie et al. for instance, brought notable contribution to the understanding of this complex problem.

In the framework of RMRI, ecosystem modelling is a new research direction. Therefore, the sea water's physical properties (temperature, salinity, mixed layer depth, underwater irradiancy), all along with the chemical (nutrients) and the biological (several classes of

phytoplankton and zooplankton) ones are included within a box model designed for the shelf ecosystem.

PHYSICAL OCEANOGRAPHY RESEARCH FRAMEWORK IN ROMANIA

The international co-operation of Romanian physical oceanography research institutes has been carried out during the past years in the framework of the following projects and international programmes:

In the framework program (FP 6)

- **HERMES** – Hotspot Ecosystem Research on the Margins of European Seas
- **IASON** – Sustainable Development of the Mediterranean and Black Sea Environment
- **EU GEOCAPACITY**
- **CASTOR –** Geological storage options for CO2 reduction strategy
- **Euro-EcoGeoCentre**

International Geosphere-Biosphere Programme

The programme is dealing with the land-ocean interactions study within the Coastal Zone Core Programme. GeoEcoMar (national contact institution) and RMRI are the Romanian participants.

Projects in the framework of NATO Science Programme

Black Sea Ecosystem Processes and Forecasting / Operational Database Management System (ODBMS Black Sea) started in 1998 with the participation of Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine. The Romanian participant is RMRI.

Bilateral and Multi-Lateral Scientific Co-operation Programmes

Integrated study of the Danube Delta and the Black Sea – geological recording of the global changes impact on the sedimentary processes France-Romania co-operation, with the participation of IFREMER and GeoEcoMar.

Study of the Northwestern Black Sea deep-sea fan systems co-operation between Germany and Romania with the participation of University of Hamburg and GeoEcoMar.

Assessment of different types of coastal defense works and of their environmental impact Italy-Romania co-operation with the participation of Marine Geology Institute in Bologna and GeoEcoMar.

Influence of fluvial sediment input, sea level, climate and neotectonics on the sedimentary environment in the Black Sea co-operation between France, Germany and Romania with the participation of Universite de Caen, IFREMER, respectively University of Hamburg and GeoEcoMar.

A comparative study of the Adriatic, the Black Sea and other European coastal zones cooperation between Italy, France and Romania with the participation of Marine Geology

Institute in Bologna, respectively IFREMER and GeoEcoMar.

Impact of climatic and sea level changes on a closed basin (the Black Sea) during the Quaternary co-operation between France, Germany and Romania with the participation of IFREMER, respectively University of Hamburg and GeoEcoMar.

Black Sea Action Plan

Black Sea GIS co-operation between the Black Sea riparian countries and the Programme Coordination Unit in Istanbul, Turkey. The Romanian participant is GeoEcoMar.

ROMANIAN PARTICIPATION AT SCIENTIFIC EVENTS INCLUDING IAPSO-INTEREST TOPICS

An exhaustive list of all Romanian participation to worldwide scientific events that included IAPSO-interest topics was not possible to be prepared. Therefore, there have been gathered most of the available information regarding this subject.

Workshops

Euro-EcoGeoCentre – Romania – Workshop "Environmental problems of the Lower Danube, including the Danube Delta, and new ideas for an Integrated Observing and Forecasting System in the Lower Danube, Danube Delta and the Black Sea", Bucharest, 19-22 January 2004

Avalonia – Moesia Symposyum & Workshop, Ghent (Belgium), 2004

Varna Workshop, 23 - 26 October 2004, Varna, Bulgaria

Euro-EcoGeoCentre Workshop "Change in the structure and functioning of the open sea ecosystems", October 27-29, 2005, Snagov

Workshop "River Deltas: Evolution, environmental challenges and sustainable management"; The U.S. Army Engineer Research and Development Center. European Research Office, Danube Delta, September 18-22, 2006

Symposia, Conferences and Congresses

Euro-EcoGeoCentre – Romania – Symposium "The Pollutant Influxes into the semi-enclosed marine basins – Comparison between the European River–Seas Systems of the Baltic Sea, the Mediterranean Sea and Black Sea", Bucharest, 22-24 April 2004

EUROCEAN 2004, European Conference, Marine Science & Ocean Technology, Galway, Ireland, May 10-13, 2004

Euro-EcoGeoCentre International symposium "Semi-enclosed European Seas-Interactions between Major Compartments" April 08-10, 2005, Snagov

4th Congress of the Balkan Geophysical Society "RSG-BGS / EAGE & SEG / EGU & AGU Bucharest 2005" October, 2005, Bucharest

Euro-EcoGeoCentre Workshop "Change in the structure and functioning of the open sea ecosystems", October 27-29, 2005, Snagov

The 7th International Cretaceous Symposium, Neuchâtel, 2005

International Symposium on Earth System, Istanbul (Turkey), 2005

32-nd International Geological Congress, Florence (Italy), 2005

Euro-EcoGeoCentre Conference: "Integrated approach to sustainable development of the coastal zone and deltas", Tusnad, January 17-20, 2006

Travaux Géophysiques, XXXVIII, 2006, Geophysical Institute, Academy of Sciences of the Czech Republic

The 18th Congress of the Carpatho-Balkan Association, Belgrad 3rd-6th September 2006
First International Scientific Black Sea Conference, Istanbul, 8- 10 May, 2006

17th International Sedimentological Congress 2006, Fukuoka, Japan

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