MTA CSFK GEODETIC AND GEOPHYSICAL INSTITUTE

Csatkai u. 6-8., 9400 Sopron
9401 Sopron, Pf.5.
Tel: +36 99 508 343; Fax: +36 99 508 355
E-mail: Wesztergom.Viktor@csfk.mta.hu, web: www.csfk.mta.hu, www.ggki.hu

I. The main tasks of the institute in 2017

The object of the current basic research in the Geodetic and Geophysical Institute is the observation, modelling and interpretation of the physical condition and processes of planet Earth, as well as the development of the related theoretical (mathematical, physical) and experimental methods and instrumentation. The public responsibilities covered by our basic activity are: continuous observation of the solid Earth and the space around Earth (geodynamics, geomagnetism and aeronomy), maintenance of the national seismological network and service, provision of data associated with international cooperation, as well as operation of temporary surveillance systems. The activities of the institute that have direct economic importance are the natural resource exploration and the analysis of geological- geo-physical hazards.

Research topics of the Institute that have traditionally outstanding success even by international standards are geomagnetism, magnetotellurics, seismology, aeronomy and geodynamics. Through its broadband electromagnetic measurements the Széchenyi István Geophysical Observatory of the Hungarian Academy of Sciences has a significant role in global networks of observatories and in international projects diagnosing the upper atmosphere and the plasma environment of the Earth.

The Infrastructural developments from different grants (two GINOP applications: Cosmic Effects and Risks, Zero Magnetic Field Laboratory) and expanded international co-operations (ESF Topo-Europe, AlpArray, ARISE) are all building a basis for new interdisciplinary research topics.

II. Outstanding results of research and other activities in 2017

a.) Outstanding results of research and other activities

Strengthening the research infrastructure and expanding international co-operations:

Establishing the Zero *Magnetic Field Laboratory* in the Széchenyi István Geophysical Observatory allows us to simulate the interplanetary space conditions and ensures special laboratory environment for space physics and material science experiments, and to develop space devices.

The construction of an *ionosonde* antenna system is already in progress along with the deployment of a DPS4D. The new radar equipment will be applied for monitoring the planet's plasma environment, and also for observing the condition and the dynamic processes of the Earth's ionosphere. By joining the Global Ionospheric Radio Observatory (GIRO) network, the observatory becomes an active participant in the international space weather surveillance system with access to global aeronomical research data.

The *infrasound station* established at the Piszkéstető Observatory opens up new possibilities for atmospheric tomography examinations and observations in connection with electrical atmospheric phenomena, respectively observing and locating sound bursts associated with meteorite impacts.

Within the framework of a Hungarian - Romanian - Dutch collaboration, for the space geodetic observation of the recent geodynamic processes of the tectonic units in the

Carpathian - Pannon Basin - Dinarides, construction of *radar reflector network* in the area of the Carpathian subduction, as well as in areas with post-volcanic activities, and respectively in an area affected by salt tectonics was started.

In the AlpArray project Hungary participates with 23 broadband seismological stations. In addition, at the very eastern part of the network, the institute established a borehole (underground) seismic station with a good signal/noise ratio. The *AlpArray* network became fully comprehensive with the sea bottom seismological stations, installed in 2017 in the Mediterranean Sea.

The *Einstein's Telescope* (ET) is a third-generation gravity wave detector concept with a broad spectrum and a sensitivity which is more than ten times better than the LIGO. The Matra Gravitational and Geophysical Laboratory (MGGL) initiated by the Wigner research centre has been established near Gyöngyösoroszi, Hungary in 2015, in the cavern system of an unused ore mine. The Laboratory is located at 88 m below the surface, with the aim to measure and analyse the advantages of the underground installation of third generation gravitational wave detectors. Specialized instruments have been installed to measure seismic, infrasound, electromagnetic noise, and the variation of the cosmic muon flux. The research potential of the MGGL for detecting gravitational waves was demonstrated in a study, as well preliminary results of the noise characterisation of natural and manmade sources. Based on the preliminary results additional systematic experiments are planned.

Magnetosphere physics: The occurrence of magnetic reconnection has been studied in the space between the terrestrial magnetopause and the shock on the basis of in situ data of the MMS (Magnetospheric Multiscale Satellite) probes. In a detailed case study, MMS data were introduced to map the key regions of magnetic reconnections, enabling the comparison of different theoretical space and time descriptions and simulations (liquid and kinetic models) with different data scales. It has been found that the physical characteristics of some turbulent reconnections are in some respects similar to the 2-dimensional laminar cases studied so far. The presence of coherent magnetic structures detected by MMS compared to the simulations can indicate that the reconnection is actually a 3-dimensional multi-scale process. These results are also important because turbulence generates inhomogeneous electrical, magnetic, velocity and density fluctuations, and these may - in principle - prevent the occurrence of the reconnection. On the other hand, due to fluctuations and short time scales, the detection of the reconnection in a turbulent environment is complicated. The direct consequence of this is the underestimation of the prevalence rate, so currently it is not possible to accurately determine the role of reconnection in turbulence-triggered dissipation processes.

Based on nonlinear models of turbulence, it was examined whether the degree of dampening turbulent fluctuations can be predicted. These multi-scale turbulence models do neither include the intermittent current structures and the magnetic reconnection generated by the recently discovered turbulence, nor the also wave-particle interactions. The degree of damping fluctuations was estimated by using the data of the Cluster probes in the solar wind. Using the magnetic data of the four probes of the Cluster, a 'wave-telescope' technique was used to generate the wave rate - frequency Euler-spectrum (in the coordinate system of the probes), and then different wavelengths were studied, how the energy distribution of the induced frequencies were varying. The widening of energy distribution in connection with the wavelengths is proportional to the degree of damping. They found that magnetic fluctuations are much faster than predicted by turbulence models. Therefore, some of the energy of the magnetic field should be transformed into other energies on smaller spatial and time scales by wave-particle interactions and/or magnetic reconnection.

The one year long simulation of the Grand Unified Magnetosphere-Ionosphere Coupling Simulation (GUMICS-4) code was compared (using the data measured by the Cluster SC3 probe, determined by the magnetic field, electron density and solar wind speeds) with the data measured by the Cluster SC3 probe. It has been proven that GUMICS simulations give realistic results in the solar wind near the bow-shock. They provide the magnetic field and the plasma moments in an adequate manner and respond to changes in the solar wind pressure, but the reliability is deteriorating behind the bow-shock, when gradually moving away. The location of the magnetopause in the simulations using the plasma momentum is very difficult to determine, also it is inaccurate, and there is no match between the measured and the simulated data in the magnetosphere.

Earth's shock wave is known to be able to accelerate the particles efficiently, known as diffusive shock wave acceleration, or first-order Fermi acceleration. In front of the Earth's magnetosphere, as a result of the slowing solar wind, the shock wave, or the so-called terrestrial bow-shock is a natural space plasma laboratory, where this process can be studied in-situ with satellite measurements. The terrestrial bow-shock can increase the energy of the particles by at least two orders of magnitude. There are two important ion groups in the Earth's shock wave environment, the field-aligned ion beam consists of solar wind ions that are reflected in a perpendicular portion of the shock wave, the other ion group being on the other side of the shock wave on the parallel side, the so called diffusive ions that gain energy through the diffusion acceleration process. The behaviour of diffusive ions and the acceleration process are characterized by the diffusion coefficient in the equation, describing the phenomenon, which basically determines the efficiency of the acceleration. It has been shown that a strong reflected ion beam can significantly reduce the diffusion coefficient, thus further increasing the efficiency of the already efficient acceleration process. This is the first time that this occurrence is described. Japanese researchers have confirmed data based on satellite results with computer simulations, thus proving the existence of this new, unknown phenomenon.

Aeronomy, Atmospheric Physics: The study of the relationship between solar activity and the lower ionosphere was extended to the higher regions of the ionosphere (90-150 km) by analysing two of the largest solar flares of the 23rd solar cycle (Bastille Day event - 14th of July 2000, Halloween event - October-November 2003) and two other, intensive X class flares (September 2001 and December 2006). The minimum ionosphere frequency (*fmin*) and the critical frequency (*foE*) changes of the E layer have been studied in the ionograms of several European ionosphere stations located in a meridional location. Observing the above events, the *fmin* parameter was increased (by 2-7 MHz) after the largest solar flare. The *fmin* parameter changes with the latitude of the ionospheric station, but after smaller X-ray flares which did not coincide with proton events latitude dependence of the *fmin* parameter was modest. Besides that in the specific period, when the *fmin* parameter was increasing, the deficiency of the *foE* parameter has been observed in both cases. The disappearance of the ionospheric layers was observed for hours or even days (fade-out effect) at ionospheric stations at higher latitudes (Tromso, Loparskaya, Sodankyla). Based on the method used, it was possible to differentiate the ionisation due to the increase in X-rays from that caused by high-energy particles. It has been shown that the effect of charged particles is not limited to the polar region (> 60°), but can be detected at midlatitudes as well (e.g. Chilton, Juliusruh).

The identification of Schumann resonance (SR) transients is important for the background SR analysis, as transient signals distort the spectral behaviour of time series. The effect of SR transients in the ELF data in Nagycenk, Belsk (Poland) and Rhode Island (USA) was investigated in connection with the background SR spectrum properties. It was found that the distribution of the integrated values of the spectrum density of the raw data segments can be used to identify the data segments containing SR transients. According to the distribution, they determined an adaptive limit value (16 times the core-distribution width), over which the data of the transients is showing an already significant distortion in the frequency values of the SR modes. Using this procedure, it is possible to locate sources of SR transients globally with the "time of arrival method" based on the arrival time of the transients.

They continued to observe and analyze sprites within an international co-operation. They set up a hypothesis which does not only provide an explanation for the experience described above, but it describes the formation of sprite producing lightning flashes in the stratiform region of mesoscale convective systems in a plausible and coherent way.

They also found a correlation between the brightness of the sprites and the change in the charge momentum of the source lightnings.

Seismology, earthquake risk: For the reliable estimation of the focal mechanism of small sized (M<4) earthquakes, neither the available polarity data nor the well-modelled close seismograms alone are sufficient. A new probabilistic method has been developed that involves the inversion of both waveforms and polarity data. The JOWAPO (joint waveform and polarity) procedure explores the posterior distribution function of the model parameters and estimates the maximum likelihood DC mechanism, the optimum focal depth and the scalar momentum of the event. The uncertainty of the solution is given by confidence regions. The method was tested on two earthquakes whose focal mechanism is well-known from other sources. The results demonstrate that if some of the waveforms are used in the inversion, the uncertainty of the generally weakly defined solution - calculated from purely polarity data - is greatly reduced. If the polarity data is sufficiently large, then the algorithm will still be able to use the waveforms of a single station.

The 1 year long Hungarian records available in the AlpArray project allowed preliminary investigations, such as microsemic noise-based surface wave tomography. For the calculation of the three-dimensional S-wave velocity distribution of the transition zone between the Eastern Alps and the Pannon Basin, the data of the AlpArray stations in Hungary and near the western border (36 stations) and the 2006-2007 Carpathian Basin Project records (35 stations) were used. In the case of Rayleigh wave group velocity distribution maps, the resolution reached at periodic intervals of between 5 and 25 s in the examined area is at least 80 km, and in the Little Hungarian Plain and in the north-east of the Transdanubian Mountains it reaches 40 km. The specified S-wave velocities at a depth of 5 km are between 2.6 km/s and 3.5 km/s, 15 km deep between 3.3 and 3.7 km/s, and 25 km deep between 3.4 and 4.2 km/s, the latter partly reflects in the crust, partly in the mantle. Their results showed a low-speed zone in the lower crust of the Balaton Uplands area. Its origin is unclear and it cannot be ruled out that it can be associated with earlier volcanic activities in that area.

A relationship was determined in the Pannon Basin for the attenuation of the instrumental parameters of the ground motion (maximum acceleration - PGA, Maximum speed - PGV). Since the introduction of modern digital registration, the records of earthquakes in the Pannonian basin have been collected from both the permanent and the temporary stations as well as from neighbouring countries. The records were processed uniformly and the PGA and PGV values were calculated from the appropriate signal/noise ratios. Using the resulting data system, an equation describing the attenuation of horizontal and vertical ground accelerations and velocities was determined depending on the magnitude and the epicentral distance.

With the Department of Geotechnical and Engineering Geology of BME further developments were done for determining the method for the liquefaction potential. A relationship has been developed based on the combined use of two measurement types, the Cone Penetration Test (CPT) and the Vs (shear wave Velocity) measurements. To characterise the excitation, both conventional stress and energy-based approaches has been applied. On the basis of their experience, the method has segregated those sites that have suffered from liquefaction and those have suffered less, better, than those using classically only one measurement type. Software has been developed to implement Kramer and Mayfield (2007) procedures to determine the degree of endangerment of soil liquefaction and its return period depending on the depth. The method combines the disaggregation matrices computed for different exceedance frequencies during probabilistic seismic hazard analysis with one of the recent models for the conditional probability of liquefaction.

Geodynamics: Three-dimensional numerical modelling was used to investigate the Rayleigh number, depth viscosity, mantle's viscosity layers, internal heat production, temperature and depth-dependent viscosity on the thermal structure of the mantle upwellings (mantle plumes) and the topographic and geoid anomalies above them. For the simplest, starting models where viscosity exponentially increases with depth, there is a much higher temperature difference between the plumes and the environment, as well as a higher order of magnitude surface elevation. As a result of the viscosity layers and the internal heat production, the thermal anomaly of the plumes is greatly reduced, and in the case of the examined models this approaches best to the value of the upstreams of the earth mantle. However, it has been shown that in these models, the surface protuberance many times larger than in case of ocean hotspots. Depending on the temperature and depth-dependent viscosity, the thermal anomalies of the plumes are also reduced, although not so much as in the presence of viscosity layers. This is due to the fact that numerically it has not been able to handle a degree of temperature dependency as in reality. However, in these models, the maximum value of the protrusion falls in magnitude to the height of the Earth's ocean hotspots. For geoid modelling, it is also important to take the temperature dependence into account. Models with only high depth-of-viscosity are rather characterised by negative geoid anomaly above plumes.

The distribution of tidal stresses on Earth's surface and inside the Earth's surface was determined with special attention to their effect on earthquake activity. Lunisolar stress tensor components were studied using the PREL (Preliminary Reference Earth Model) model on the Earth's surface, depending on the width and the depth of the Earth (to the depth of the core-mantle boundary). The results of the calculations show the increase in tension generated by the lunisolar effect within the Earth, which reaches a few kPa values between 900 and 1500 km depths, i.e. well below the deep-seated earthquakes. At the depth of the overwhelming part of seismic energy accumulation (around 50 km) the stresses of lunisolar origin are only (0.0-1.0)$\cdot 10^3$ Pa. Although these values are much smaller than the earthquake released stress (1-30 MPa), the contribution of tidal forces to seismic events cannot be excluded.

Gravimetry: Gravity tidal measurements were continued to investigate the dependence of tidal effect on the area. Based on the preliminary studies, the impact of ocean tidal loads (FES2014 model) from west to east (Conrad Observatory, Austria → Tarpa, East-Hungary) decreases by about 0.7 μGal for the M2 wave group, thus the effect in the simulated δO1 /δM2 quotient - given that in O1 it is approx. 1 order of magnitude less - shows a strongly growing tendency. This is confirmed by measurements carried out with the best-rated feed-back instruments (G1188, Scintrex CG-5), although its scale is only one third of the simulated one. The data detected with the own measuring system (G949), apart from Conrad observation measurements, show very good consonance with the simulated coefficients. Since the measurement system at the Conrad Observatory at the start of the measurements (2012) was far from complete, it may be that the resulting shortcomings cause the non-matching value. To clarify this, the instrument was released again at the end of 2017. For accurate processing of gravimetric measurements, it is essential to know the precision of the scales of the instrument. The mass measuring calibration measurements of the instruments involved in the above measurement program (~ 400 attempts with 7 instruments) were summarized. With theoretical studies and error propagation models they clarified the extent of accuracy expected, based on the uncertainty of the geometric/physical parameters of the test mass. It was found that the calibration signal (~ 110 μGal) cannot be considered more reliable than 0.2 to 0.3 μGal, but due to the characteristics of the spring-loaded instruments with elasto-mechanic sensors, the available accuracy is preferably 0.5-1 μGal.

The process of optimum discretization of ocean surface models, required to calculate the effects of ocean loads, has been developed. The optimization is based on the fact that, due to errors in the data, it is possible to derive an infinite number of statistically equivalent solutions, which allow for a given surface to be replaced by a minimum number of triangular variable-side triangles. From these triangles polyhedrons can then be defined by means of which, for example, the effect of the load can be calculated analytically. Reducing the number of elements can result in a significant reduction in the computation time (up to 10%), as appropriate, while the modelling error remains consistent with the input data failure. Their studies have shown that a 10 km x 10 km model description of the oceanic surface exists of approx. 18 million triangles, which can be reduced to 2 million, as above. Of course, this method can be used for any geophysical interface.

Space Geodesy: The Copernicus Earth Observation Program of the European Space Agency has opened a new era in geosciences with its global, coordinated, high resolution observations both in space and time. The interferometric processing of the SAR scenes of the microwave remote sensing Sentinel-1 satellite allows determination of surface deformations with high precision (<cm) within half a wavelength. The processing of Sentinel-1 SAR data requires both large storage and computing capacity, so a dedicated data and processing center has been set up for systematic determination of surface deformations.

Integrated Sentinel-1 PSI and GNSS technical facilities and procedures for the determination of 3D surface deformations caused by environmental processes - the use of space geodesy methods and developments in the observation of tectonic processes was studied in the ESA project. Such integrated benchmarks have been developed, that provide a long-term stable reflection for Sentinel-1 scenes during the ascending and the descending satellite passes. Using exclusively the satellite observations of Sentinel-1, the surface deformation field in 3D can only be determined with bias. Therefore a process based on Kalman filtering has been developed, that combines the absolute positioning provided by global navigation systems with relative surface changes based on interferometric processing of Sentinel-1 images. With this, it is possible to produce high-precision, 3D, absolute deformation data time series from the integrated points. At first, based on the procedure developed the continuous, high time and spatial resolution of the areas affected by the major geological and geophysical risks (Danube, Lake Balaton) were examined.

b.) Science and society

The Institute's tasks beyond its basic research are the exploration of natural resources and the analysis of geological and geophysical risks, the observation of the condition of the near Earth space, and the tasks of the National Seismological Network. In these areas, the institute provides continuous expert support to government agencies, justice and disaster management, but these services are also available to the wider society. In the framework of the National Risk Prevention Program for the ORFK - MTA CSFK GGI - AEGON, GGI contributes information and expertise activities to the public, which are related to the reduction of risks, caused by space weather and geo-environmental phenomena. The institute is a regular participant at the "Magyar Tudomány Ünnepe" (Celebration of Hungarian Science), at the Earth Day, and at geoscience lectures, it is organising programs, presentations and performing sessions for a wide range of society. Space research, and especially the work of the seismological observatory attracts major media interest.

In the framework of the "Magyar Tudomány Ünnepe" (Celebration of Hungarian Science), the 60th anniversary of founding the István Széchenyi Geophysical Observatory was celebrated also the foundation stone of the Zero Magnetic Field Laboratory (ZBL) was laid down. The laboratory offers a unique opportunity for space physics, geophysics, material sciences and life sciences experiments at international levels, thus it can be a catalyst for cooperation between domestic and foreign research sites, universities or even industrial players. In addition to the ceremony, visitors were also presented with introductory presentations and instrument shows demonstrating the activity of the institute.

In addition to popular public lectures to the general public, the Institute emphasises supporting the work of organizations promoting the security of the society. It is actively involved in the training of the Nemzeti Közszolgálati Egyetem (National Civil Service University) and the Országos Katasztrófavédelmi Főigazgatóság (National Disaster Management Directorate).

III. Domestic and international K+F partner connections of the research center in 2017

Scientific agreements

Institute of Geodynamics of the Romanian Academy, Bucharest, Romania: correlation, interpretation and monitoring of active geodynamic processes in the Carpathian-Pannonian Region; investigation of geological structures and formations with geological, geochronological and geophysical methods, evaluating mineral resources.

Global Coordination of Atmospheric Electricity Measurements (GloCAEM), University of Reading: research on the global atmospheric electric circuit.

National Institute for Earth Physics - Magurele, Romania: seismicity patterns; seismotectonics; lithosphere structure; ionosphere and atmosphere measurements.

International collaborative institutes and organizations

ARISE (Atmospheric Dynamics Research InfraStructure in Europe): 3D mapping of Earth's atmosphere from the surface to the mesosphere*;*
School of Earth and Environment, University of Leeds: satellite interferometry, interferometric processing of Sentinel-1 scenes, determination of 3D deformation fields;
Conrad Observatory, Austria: application of highly sensitive inclinometers for the observation of tectonic processes;
Massachusetts Institute of *Technology*: aeronomy, characterization of internal and external sources of Schumann resonance;
The Catholic University of America, NASA Goddard Space Flight Center: solar wind-magnetosphere energy coupling;
INTERMAGNET: international geomagnetic observatory network for space weather applications and global field modelling;
AlpArray Steering Commitee: ETH Zürich, University of Vienna, University of Berlin, National Institute of Oceanography and Experimental Geophysics (OGS), ISTerre Grenoble, Istituto Nazionale di Geofisica e Vulcanologia, Prague IG ASCR, GeoForschungsZentrum Potsdam, MTA CSFK Geodetic and Geophysical –Institute - comprehensive study of alpine orogeny;

Eötvös Loránd University, Faculty of Natural Sciences; Lithosphere Fluid Research Laboratory: research of the magnetotelluric deep structure and xenoliths of mantle origin for the research of the listosphere-asthenosphere boundary.
Wigner Physical Research Center: Establishment of a magnetic null space laboratory, preparation of the Einstein Telescope experiment.

Organizing international and outstanding national scientific events

ESF TOPO-TRANSYLVANIA Preparatory Meeting, Kisdisznód (Cisnadioara, Romania), June 18-20, 2017
ESF TOPO-TRANSYLVANIA Progress Meeting, Gyula, October 24-25, 2017
The goal of the ESF TOPO-EUROPE project is the observation and modelling of the tectonically most interesting part of the European lithospheric plate, the Carpathian subduction, volcanism associated with the subduction and the effects of volcanic activity on salt tectonics by means of complex space geodesy, furthermore magnetotelluric- and seismic tomography. Beside GGI, the project leader, the initiative has been joined also by the ELTE (Eötvös Loránd Public Research University of Budapest), by the Romanian Institute for Earth Physics, by the Romanian Institute of Geodynamics, by the Sapientia University, and the Babes-Bolyai University, as well as by the Utrecht University - the world-leading center for lithosphere dynamics.

Hungarian Space Research Forum, MTA CSFK Geodetic and Geophysics Institute, Sopron, April 5-7, 2017
A joint conference organised by the Hungarian Astronautical Society (MANT) and the Geodetic and Geophysics Institute (GGI), co-organized by the Károly Simonyi Technical Faculty of Wooden Material Sciences and Art, at the University of Sopron, represents a scientific event with the oldest traditions in the national space research. Its aim is to create a profile as comprehensive as possible for Hungarian space research community and for the space industry, as well as to involve university students and PhD students in the research work. Hungary has been a full member of the European Space Agency (ESA) since 2015 and by now the first experiences of the membership have gathered. The forum promotes the exchange of views, the strengthening of existing professional relationships and the creation of new collaborations within the Hungarian space research community.

"Recent Hungarian results of the lithosphere-research" Budapest, MBFSZ ceremonial hall, December 7, 2017

Visiting researchers from abroad

Geothermal Energy System - Thermo-mechanical control on geothermal energy resources: case studies in the Pannonian Basin and other natural laboratories (Guest editors: Sierd Cloetingh, Jan-Diederik Van Wees, Viktor Wesztergom) special issue was published in the journal of Acta Geodaetica et Geophysica (Vol. 52, Issue 2, ISSN: 2213-5812). The thematic special issue reviews the latest results of the lithosphere research through 6 manuscripts, with special focus on the Pannon Basin and other areas of tectonic and geothermal significance.

Presentation of the co-operation with domestic and cross-border higher education institutions

The institute has traditionally maintained strong relationships with higher education institutions, in favour of research manpower management, knowledge transfer and projects that require broader cooperation. The institute supports participation in specialized higher education, and its researchers participate in the graduate and postgraduate studies in geodesy and geophysics at the Sopron University, Budapest University for Technology, Eötvös Loránd University, Babes-Bolyai University. They provide BSc and MSc teaching services and participate operating PhD schools (core members, doctoral board).

Educational activities in foreign universities
Babes Bolyai Univetsity, Kolozsvár - Cluj: Pure Geophysics, Geophysical Research Methods.

Education in the Doctoral School:
Budapest University of Technology, Vásárhelyi Pál Doctoral School: Inertial Structure of the Earth, geophysical data processing.
Sopron University, Cziráki József Wood Science and Technology Doctoral School: Measurement theory, Digital image processing. Sopron University, "Róth Gyula" Doctoral School: Modelling of geodynamic processes, Environmental science applications of GNSS systems, Measurement of environmental movements, Methodology of scientific research, Space weather and climate, Geomagnetism, Atmospheric electrodynamics, Structure and processes of the Earth’s interior

Thesis supervision (PhD dissertation):
ELTE Doctoral School of Earth Sciences: 5 people
ELTE Environmental Science Doctoral School: 2 people
University of Sopron (EMK, KTK, FMK): 2 people.

IV. Brief introduction of major national and international grants won in 2017

NKFIH K124241: *The structure and geodynamics of the Eastern Alps - Pannon Basin transition zone based on the data of the AlpArray Seismological Network.* In the project supporting the Hungarian research of the AlpArray international project, the structural and geodynamic research of the transitional zone of the Eastern Alps - Pannonian basin is carried out. The required data is provided by the Hungarian permanent seismic station network and the AlpArray temporary network. Project Cost: 28,306 thousand HUF (88 kEUR), Duration: November 1, 2017 – October 31, 2021

NKFIH K115836: *Study of the global, regional and local electromagnetic environment using ELF transients*. The aim of the research is to develop ELF transient-based environmental monitoring techniques to investigate the directional dependence of the electrical conductivity of the upper earth's crust, the electrical state of the Earth's surrounding ionospheric boundary layer, the electromagnetic coupling processes of the atmospheric layers, the impact of spatial events on the environment and the distribution of intense lightnings in space and time. Project Cost: 19,864 thousand HUF (62 kEUR), Duration: January 1, 2017 - December 31, 2019

NKFIH K124366: *Geophysical noises in detecting gravitational waves*. The planned purpose of the MGGL subterranean laboratory is measuring, examining, identifying and characterising the seismic, the electromagnetic, and the geophysical noises and their sources in the infrasound range. Consortium leader: Wigner FK. Project Cost (GGI Budget): 7.557 thousand HUF (23 kEUR), Duration: September 1, 2017 August 31, 2020

GINOP-2.3.3-15 Establishment of *Zero Magnetic Field Laboratory* (consortium leader). The project aims to create an electromagnetically "clean" laboratory chamber, in which the static and variable geomagnetic field can be compensated, and by the efficient shielding of the remaining field, the Earth's magnetic field can be reduced by about five orders of magnitude, so a magnetic environment, typical for the interplanetary space can be created. Project cost: 435 Million HUF (1359 kEUR), of which GGI paid: 175.4 Million HUF, term: June 1, 2017 - May 31, 2019.

Academic grants for H2020 preparation (Total grant awarded: HUF 29,574 Million HUF/92 kEUR):

- TopoEurope - Study of the lithosphere dynamics of the inner Carpathian bend;
- AlpArray - to participate in the AA Steering Commitee, borehole seismometers for a more accurate seismic imaging of the sediment covered lowland areas
- DPS4D ionosphere radar installation costs (Cosmic Effects and Risks)
- Partial deployment of the Sentinel-1 processing centre for ESA PECS application.
- Preparation for the European Plate Observing System ERIC

V. The most significant scientific publications in 2017

Barnafoldi GG, Bulik T, Cieslar M, David E, Dobroka M, Fenyvesi E et al. (25): First report of long term measurements of the MGGL laboratory in the Matra mountain range. CLASSICAL AND QUANTUM GRAVITY 34:(11) Paper 114001. 22. (2017)

Barta V, Haldoupis C, Satori G, Buresova D, Chum J, Pozoga M, Berenyi KA, Bor J, Popek M, Kis A, Bencze P: Searching for effects caused by thunderstorms in midlatitude sporadic E layers JOURNAL OF ATMOSPHERIC AND SOLAR-TERRESTRIAL PHYSICS 161: 150-159. (2017)

Bányai L, Szűcs E, Wesztergom V: Geometric features of LOS data derived by SAR PSI technologies and the three-dimensional data fusion. ACTA GEODAETICA ET GEOPHYSICA 52:(3) 421-436. (2017)

Cloetingh S, Van Wees J-D, Wesztergom V: Thermo-mechanical controls on geothermal energy resources: case studies in the Pannonian Basin and other natural laboratories. ACTA GEODAETICA ET GEOPHYSICA 52:(2) 157-160. (2017)

Gribovszki K, Kovács K, Mónus P, Bokelmann G, Konecny P, Lednická M (6): Estimating the upper limit of prehistoric peak ground acceleration using an in situ, intact and vulnerable stalagmite from Plavecká priepast cave (Detrekői-zsomboly), Little Carpathians, Slovakia—first results. JOURNAL OF SEISMOLOGY 21:(5) 1111-1130. (2017)

Jorgensen AM, Heilig B, Vellante M, Lichtenberger J, Reda J, Valach F, Mandic I: Comparing the Dynamic Global Core Plasma Model with ground-based plasma mass density observations. JOURNAL OF GEOPHYSICAL RESEARCH: SPACE PHYSICS 122:(8) 7997-8013. (2017)

Mentes Gy: The role of recent tectonics and hydrological processes in the evolution of recurring landslides on the Danube's high bank in Dunaföldvár, Hungary. GEOMORPHOLOGY 290: 200-210. (2017)

Kiss A, Földváry L: Uncertainty of GRACE-borne long periodic and secular ice mass variations in Antarctica. ACTA GEODAETICA ET GEOPHYSICA 52:(4) 497-510. (2017)

Szalai S, Szokoli K, M Metwaly, Gribovszki Z, Prácser E: Prediction of the location of future rupture surfaces of a slowly moving loess landslide by electrical resistivity tomography. GEOPHYSICAL PROSPECTING 65:(2) 596-616. (2017)

Vörös Z, Yordanova E, Varsani A, Genestreti KJ, Khotyaintsev YV, Li W et al. (27): MMS Observation of Magnetic Reconnection in the Turbulent Magnetosheath. JOURNAL OF GEOPHYSICAL RESEARCH: SPACE PHYSICS 122:(11) 11,442-11,467. (2017)