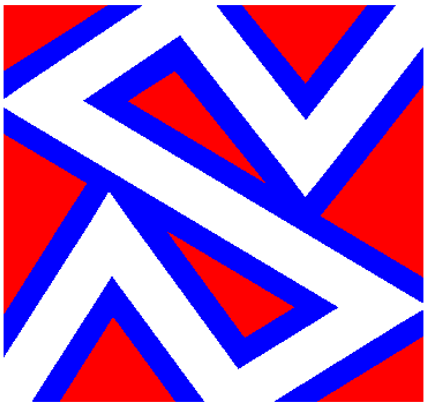
SPACE RESEARCH IN SLOVAKIA

2002 - 2003



SLOVAK ACADEMY OF SCIENCES

COSPAR

SLOVAK NATIONAL COMMITTEE

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Contents.

1. EXPERIMENTS ON THE SATELLITES.

CORONAS-F.

The “CORONAS-F” satellite, the second one of CORONAS satellite series, launched on July 31, 2001 in Russia into a circular orbit with the altitude 507±21 km and 82.5 degree inclination, provided scientific data during the whole period 2002 - 2003. The satellite is oriented towards the Sun. A complex of instruments measuring predominantly corpuscular energetic emissions from the Sun (SKL, coordinated by Skobeltsyn Institute of Nuclear Physics, Moscow, Russia) is a part of experimental devices. Institute of Experimental Physics, SAS, Košice, Slovakia participated at a device SONG measuring energetic neutrons, gammas and protons. Several tens of events with gamma ray increases due to the solar emissions were identified during the two years period.

2. SPACE PHYSICS, GEOPHYSICS AND ASTRONOMY.

The institutes of the Slovak Republic are continuing the space research activities in the directions of space solar physics and X-ray astronomy, interplanetary matter and explorations of the comets, solar wind and its interactions with the Earth's magnetosphere, energetic particles in the magnetosphere and in interplanetary space, atmosphere and ionosphere of the Earth. The following short survey presents selected activities of the abovementioned directions and the obtained results.

The dynamics of cosmic particles with the energies well below those of cosmic rays and well above those of solar wind (from few tens of keV up to several MeV) have been studied by the ***Institute of Experimental Physics, SAS, Košice*** (its Department of Space Physics) in the co-operation with the laboratories in abroad and with P.J. Šafárik University as well as Technical University Košice. In addition, the measurements of secondary cosmic rays observed by ground based methods have been analyzed. The analysis of the data obtained both from the low altitude and high apogee satellites, as well as development and construction of new instruments for the future studies continued in the period of years 2002 and 2003.

Both case and statistical type of studies were done with using the large amount of data by energetic particle instruments DOK-2 on Interball-1,-2, and DOK S on Magion 4 and 5, developed at the Department with cooperation of laboratories in abroad. Comparison with data of US satellite POLAR provided a possibility to study a unique case of ion acceleration at the bow shock to unusual high energies during a space weather event on May 4, 1998, when magnetosphere was strongly compressed. It was suggested that ions are accelerated at the quasi-parallel bow shock to energies as high as 1 MeV and subsequently transported into the magnetospheath during that event. More than 200 cases of energetic ion beams with narrow lines in energy spectrum were observed by DOK-2 on Interball-1 in 1995-1998. These events named as AMI (Almost Monoenergetic Ions) cannot be explained by current models of particle acceleration or escape from the magnetosphere. One hypothesis of the explanation is suggested as the solar wind ions acceleration in a strong electrostatic field burst within a small region. Multispacecraft studies using also

DOK-2 data on Interball-1 were used to describe the motion of the magnetopause due to the variations of interplanetary magnetic field. Statistical study of large amount of upstream ion events by DOK-2 has shown that for the diffusive upstream events observed near the bow shock there is much higher probability of observing high flux of protons for quasi-parallel connections to the model bow shock than for the cases with quasi-perpendicular geometry. This is in accordance with the Fermi acceleration at the shock. While such dependence is clear at low energies (~20-30 keV), it becomes less pronounced with the increasing energy. On the other hand the dependence on geomagnetic activity is increasing with energy. The relative importance of the two possible sources of the seed particles, namely those of solar wind ions and particles leaking from magnetosphere was described up to 300 keV on the large data set. The detailed energy spectra by DOK-2 instruments on Interball-1 and 2 showed many cases of dispersive velocity events. They can be used for remote timing and identification of the place of particle injection during geomagnetic disturbances. The dependence of the dispersive events occurrence on altitude, L and magnetic local time was obtained. A case study by DOK-2 during a small substorm when Interball-1 was near the reconnection point in the central magnetotail region, has shown the strong changes of ion flux anisotropy and fast change of energy spectra when the satellite crossed the neutral sheet. Papers and presentations using the measurements by DOK-2 and DOK-S for physical analysis are in [1,3,13,15,17,25,28,29,30,31,38,39,40,41,42,44,45].

The detailed geographic and geomagnetic (L,B) maps of distribution of gamma ray flux at 500 km were obtained by analysis of SONG device measurement on CORONAS I. Comparison with data from US satellite SAMPEX showed similarities with energetic electron fluxes. Thus the measurements of gamma rays can be one of remote sensing observations of the energetic electron flux in radiation belts within the drift loss cone. Comparison of SONG gamma ray measurements with electron fluxes from AE-8 model was done in.

Data analysis of energetic particle measurements on satellite Active and on MIR orbital station yielded in the distribution of proton spikes near geomagnetic equator at different altitudes, various local times and for various levels of geomagnetic activity. Results using measurements by CORONAS I satellite are in papers or presentations [8,9,10,33].

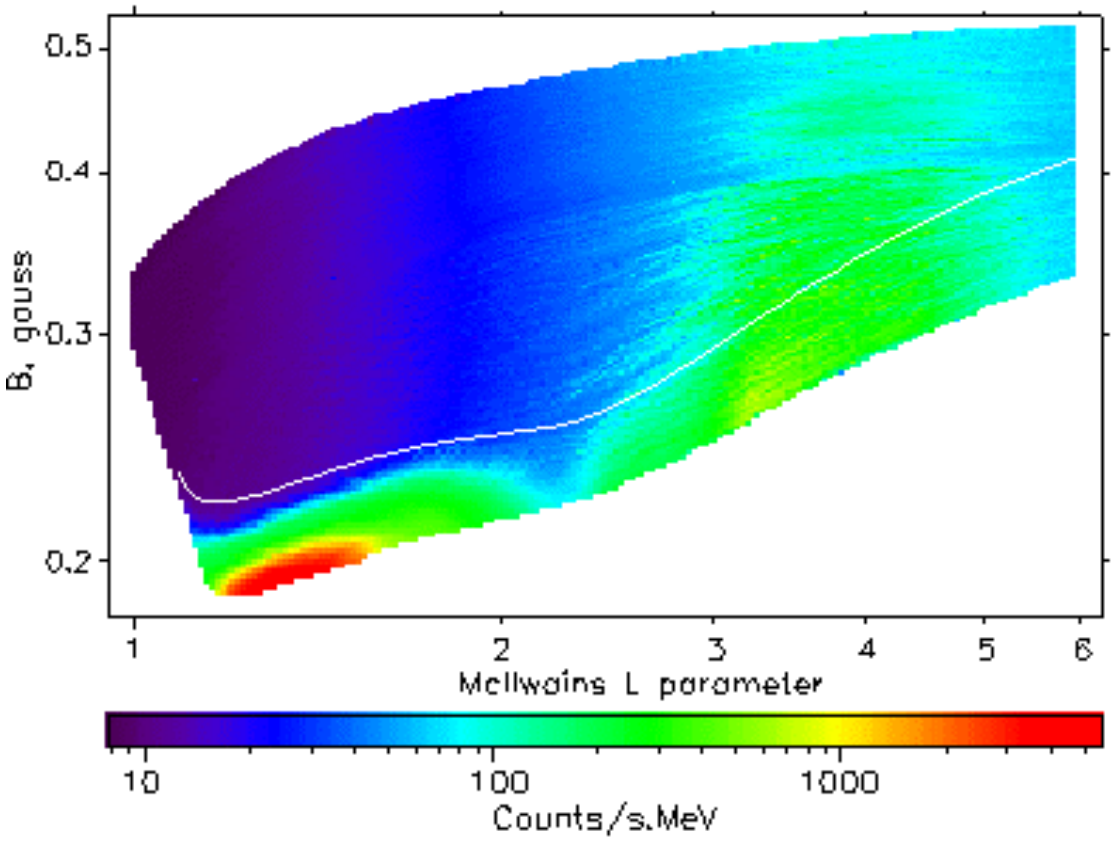

Fig. 1. Gamma ray (3 – 8.3 MeV) flux in LB coordinates obtained from measurements on CORONAS I satellite (altitude ~500 km).

The instrument SONG M measuring the energetic gamma rays and neutrons (its electronic part was designed, constructed and tested in the Department) is working continuously on low altitude polar orbiting satellite CORONAS-F from July 2001 until now. About 40 high energy solar gamma ray emissions were identified from the data in years 2002 and 2003. Results using data from SONG on CORONAS F are in [7,34,35].

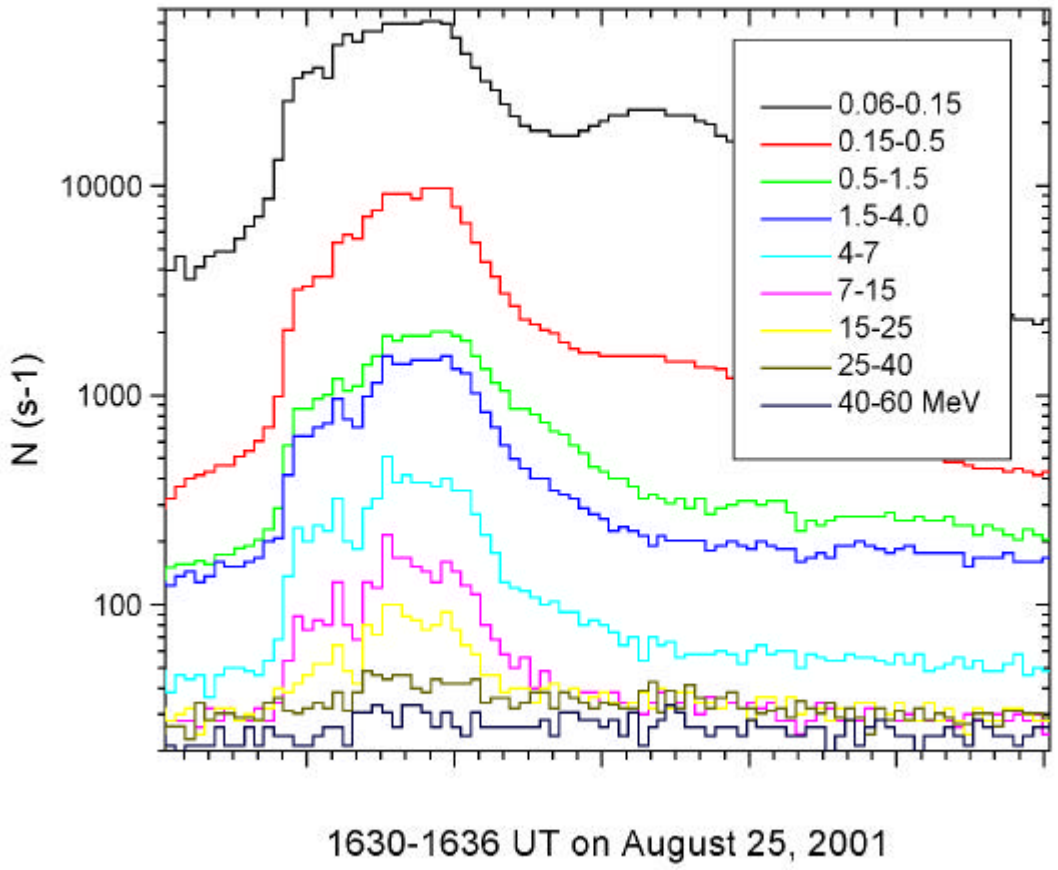

Fig. 2. Example of data obtained from measurements by SONG instrument on CORONAS F satellite. The count rates in different channels are displayed. A strong increase of high energy gamma rays (up to at least 20 MeV) was observed from a solar flare on August 25, 2001. SONG experiment observed also increase due to solar neutrons from that flare.

The institute is continuing the works on design, development and testing of new instruments for the satellite measurements. A photostimulation method was suggested and developed for study of pile-up and dead time effects important for measurements of particle fluxes and energy spectra by solid state detectors in space [2]. The dependence of the registered spectral distortion and the dead time loss on the incident count rate can be observed and recorded clearly with the method. In cooperation with U. of Maynooth, Ireland and STIL Ireland the Electrical Supporting System for the mission ESA-ROSETTA was constructed with the contribution of the Department. In the same cooperation the Department is currently contributing to the design, testing and construction of the Ireland's national instrument NUADU (NeUtral Atom Detector Unit) for

China's Double Star Polar Mission (Principal Investigator Susan McKenna-Lawlor) for the polar mission of the project (joint project of ESA and Chinese Acad. Sci.). The objectives are oriented to processes controlling the ring current characteristics and monitoring of space weather effects in the magnetosphere. The energetic neutral atoms created by charge exchange of energetic ions with the neutrals of exosphere will be observed by a set of 16 solid state detectors regularly spaced over elevation of 180^{o} remotely from the orbit of the satellite.

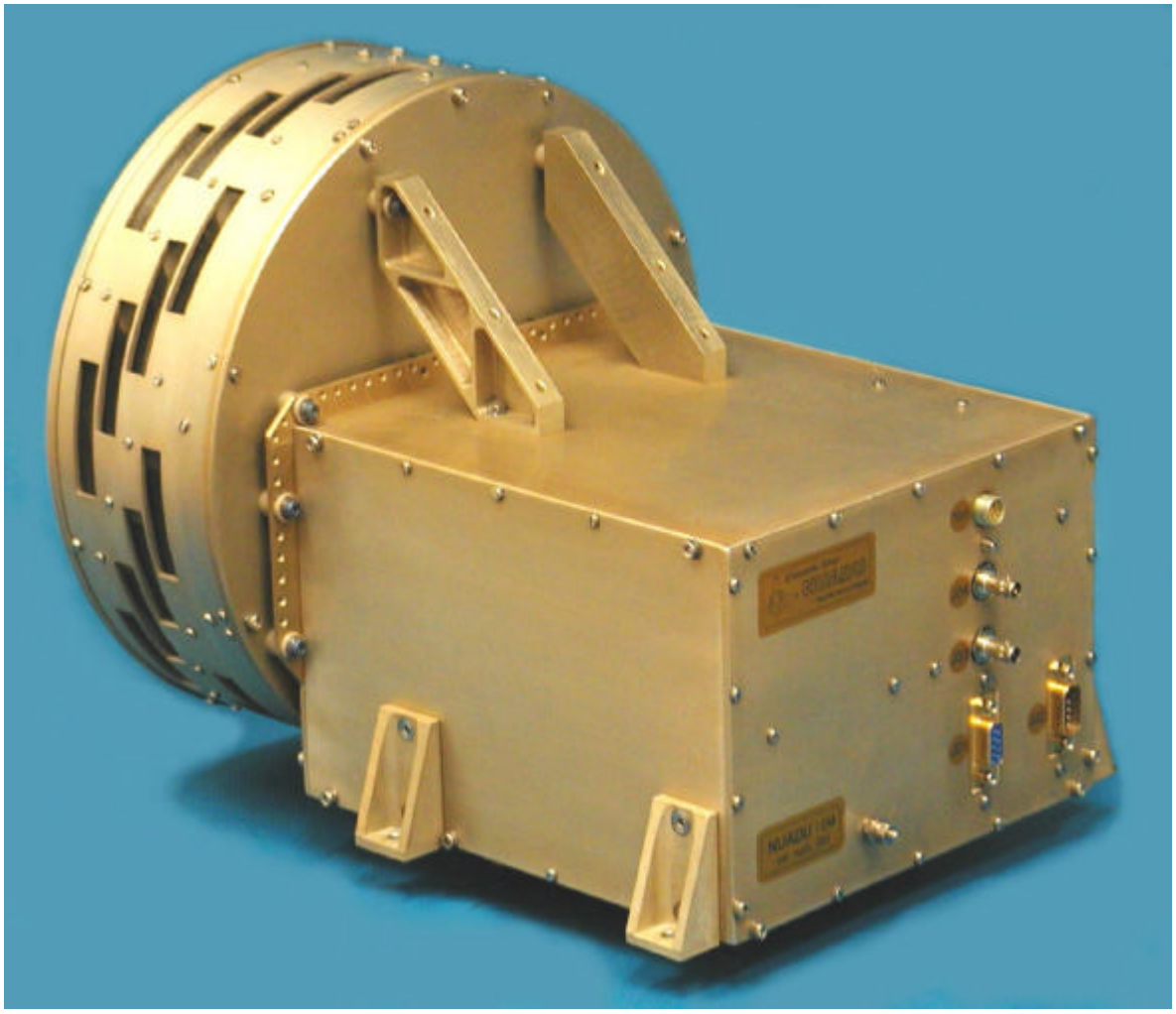

Fig. 3. Ireland's national instrument NUADU (NeUtral Atom Detector Unit) for China's Double Star Polar Mission (Principal Investigator Susan McKenna-Lawlor). Launch is scheduled for July 2004. IEP SAS participated in the development and construction of this experiment.

Data from cosmic ray continuous measurements by neutron monitor at Lomnický Štít with 1 min resolution are now available in real time at http://neutronmonitor.ta3.sk. The modulation of cosmic rays in the heliosphere and sensitivity of neutron monitor to galactic cosmic rays was studied. Connections between cosmic rays, solar variability and space weather effects, as well as temporal evolution of quasiperiodicities in cosmic ray records were examined in the series of papers [11,14,18,19,20,22,23,24,27,31,37,40, 41,42,43]. The geomagnetic effects on cosmic rays have been checked by methods of trajectory computations in model geomagnetic field [4,5,16,26].

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During the years 2002-2003 most of the work in space research at the ***Faculty of Mathematics, Physics and Informatics of the Comenius University, Bratislava*** **(*Department of Nuclear Physics*)** was done in the modeling of cosmic-ray induced cosmogenic nuclides and gamma ray production.

The faculty participated in NEAR mission experiment with gamma ray spectrometer. Our contribution was in simulation of expected gamma ray fluxes and comparison of our simulation with obtained experimental data. Based on this, algorithm for deconvolution of measured spectra into chemical composition of surface was developed. At present we participate at reevaluation of data obtained from detector that landed on the surface of asteroid 433 Eros.

We contributed also to NASA missions to Mars. One of us is supporting scientist for mission Mars Odyssey. For this mission we carried out simulations of gamma ray production and transport from the point of origin to the detector. About two hundred different chemical compositions were supposed and simulated. The results of simulations were used for the study of dependence of production rates of gamma rays on chemical composition, water content and thickness of atmosphere. Results of our simulations are used for physical interpretations of measured fluxes of gamma rays and neutrons escaping from the surface of Mars. Using these data the presence of subsurface water was proved in polar regions and in lower concentration also at lower latitudes of Mars. For validation and benchmarking our simulations thick target experiment simulating the cosmic ray protons bombardment of martian surface was carried out and interpreted. In collaboration with MPI for Chemistry in Mainz we did some simulations also for evaluation of data from APXS working on Spirit and Opportunity missions and will be used also for Rosetta mission to comet.

A number of meteorites were studied from the point of view of cosmogenic nuclide production. Result of these studies were used for determination of their origin, exposure age, terrestrial age and other characteristics. Relation between Martian atmosphere and regolith composition was studied by investigation of neutron-capture produced cosmogenic nuclides that were used as tracers of exchange processes between surface and atmosphere. For Jupiter moon Europe, we evaluated the production of rare gasses and their possible use for determination of exposure ages of Europe`s surface. At present we are involved in preparation of Mars Smart Lander mission experiment measuring in situ production of cosmogenic nuclides.

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Traditionally various aspects of solar-terrestrial physics were studied at the ***Geophysical Institute of the Slovak Academy of Sciences.***

To understand the variability of solar processes more deeply the dynamical characteristics of high-frequency fluctuations of solar activity were considered. For this purpose modern methods of nonlinear analysis of the daily sunspot number data were applied. The time scale behaviour of intermittence together with multi-periodic features visible in sunspot data was analyzed [1]. The plausible association of dynamical characteristics mentioned with turbulent processes in solar dynamo was shown [2]. The high resolution data on solar wind and geomagnetic activity indices were used to study nonlinear characteristics in the development of disturbances. On the basis of the analysis of nonlinear characteristics of the magnetic field it was found that interplanetary disturbances having significant components of intermittent fluctuations are more geoeffective [3]. A neural network model for Dst index prediction was constructed with an optimized input parameter field of principal components [4]. Exploiting artificial neural networks (ANN), a method for geomagnetic storm prediction was proposed, in which the information on occurrence of singular and intermittent fluctuations led to considerable improvement of one-step forecasts. The prediction technique which uses the extra information on local scaling exponents improves the performance of a layered ANN with feedback [5]. The neural network approach made it possible to distinguish the regularities/irregularities in formation of a magnetospheric disturbance and then to judge the geoefficiency of intermittent fluctuations. The incorporation of the contribution of fluctuations and other singularities into the development of magnetic storms led to an enhanced performance level of prediction schemes applied [6]. A classification scheme for changing level of space weather disturbances was proposed on the basis of local descriptors of singularities and their global distributions [7]. The multi-scale description of disturbances has proven to be analogous to the regularity/irregularity description of fluctuations, both leading to an enhanced performance level of prediction schemes [8]. An evaluation of the nonlinear methods for aims of prediction of magnetic storms, including different ANN architectures, outlining their significance in space weather studies, was provided [9].

The analysis of the magnetic storm development is realized within the multilateral co-operation on the ISSI (International Space Science Institute, Bern) project *How to quantify the solar wind-magnetosphere coupling*. The various aspects of modeling of the magnetospheric magnetic field during magnetic storms were discussed. The new approaches were stated to be needed

to describe magnetic fields in the magnetosphere more precisely. Their calculation on the basis of the so-called paraboloid model with its time-dependent input parameters is a way to estimate the contribution of individual magnetospheric current systems to the Dst variation [10, 11]. To quantify the magnetospheric response during the magnetic storms the analysis of two high-speed solar wind streams from solar ejecta (two interplanetary CME events) with regard to the development of storm variations with depressions of -85 nT and -205 nT was carried out. The high time resolution on solar wind parameters (CDAWeb WIND database) and on Sym-H (WDC for Geomagnetism, Kyoto) were used. As shown, the internally generated current systems are an integral part of the solar wind-magnetosphere interaction and the magnetospheric response cannot be accurately represented without their inclusion [12].

The influence of the Sun on the near-Earth environment was manifested in terms of an eclipse-induced effects in the ionosphere and magnetosphere. Using the data on the GMF measurements during the total solar eclipse on 11 August 1999, it has been analytically shown that these effects are quite pronounced and their signatures can be followed in the geomagnetic field. The consistence of theoretical and observed profiles was reported [13].

In the ***Department of Physics of Earth and Planets, Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava,*** the analysis of the height-dependent response of the ionosphere was continued. By means of numerical simulations the effects of the Solar Proton Events (SPE) in October 1989 and November 1989 were studied. The 1-D models for neutral atmosphere and lower ionosphere proposed earlier are reasonable up to 80 km, above which the response becomes underestimated since the lower energy range of high-energy particles is not included into calculations. Below 80 km the electron densities are substantially larger than those of the empirical model for riometric absorption of 2.5 dB, which shows that the October SPE was very strong. Immediately after the onset of SPE, electron densities increase by 2-3 orders of magnitude. Below 80 km, shortly after the onset of SPE the daytime electron densities are by 200% higher than those at night. The composition parameter f^+ significantly decreases during the Oct 89 SPE but not as much as during the Nov 69 SPE. The midday values of f^+ are lower than the night values, and this is true also for the most disturbed days. It has been shown that the influence of neutral species on electron density is very substantial. The electron density is decreased from the very first day for over the whole studied interval [14]. Relative abundance of cluster ions (parameter f+) as well as recombination parameter are reduced for about two weeks after SPE. Calculated values of recombination

parameter for the October 1989 SPE support the idea that the effect of SPE depends on season [15].

In the ***Astronomical Institute, Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava,*** some issues of the solar wind composition were studied using the satellite data (e.g. SOHO, TRACE, GOES). The ionization equilibrium of Fe for the electron kappa-distribution and new atomic data was determined. The diagnostics of the electron kappa-distribution from ionic stage of Fe was proposed. It can be used preferable in the analysis of the ion composition of the solar wind [16]. The excitation equilibrium of Fe, C and O for the electron kappa-distribution was analysed. The synthetic spectrum of Fe for the different distribution shape was computed and the possibilities of determination of the electron distribution shape were discussed. It was shown that especially some C IV line intensities are very sensitive to the shape of the distribution [17, 18]. The excitation equilibrium of the Fe XXV for the electron power distribution was determined. The diagnostics of the shape of the distribution function from intensities of Fe XXV lines was suggested. The results can be used especially in diagnostics of the impulsive phase of solar flares, where the deviations from the Maxwellian distribution can be large [19]. Comparing the SOHO/EIT 195 Å and H á images (Hvar and Modra-Piesok observatories) with the magnetic field extrapolations of MDI/SOHO magnetograms the loop structures of the July 19, 1999 flare were analysed. A new combined extrapolation technique, which includes localised electric currents, was used to model the current-carrying flux rope; the extended helical structure was found and the pitch angle of the helical thread was determined [20]. The analysis of the expanding flare loops of C8.5/1F April 2, 2001 flare in EUV and H-alpha has shown that besides magnetic processes (reconnection with $\beta << 1$) also the other processes with $\beta \sim 1$ can be of use in the flare evolution. A possible role of the "ballooning" instability, destabilising the loops, is discussed [21, 22]. The investigation of the relationship between subphotospheric flows and flaring activity shows the possibility of the direct connection with strong flows in some depths under the photosphere. These flows were found in the places where active quasi-separatrices are located and where the magnetic field lines change their connectivity during flare. The results are only preliminary and need statistical verification [23, 24].

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The activities of ***the Astronomical Institute of the Slovak Academy of Sciences (AISAS)***, Tatranská Lomnica (http://www.astro.sk), related to COSPAR, were devoted to the research in solar and stellar physics using satellite observations, mainly in the UV, XUV and X-ray spectral regions. It concerns mainly solar data of the current SOHO mission and TRACE satellite and from previous satellites of the NOAA and GOES series. Stellar data of the IUE satellite and Hubble Space Telescope were used for research of various variable stars. Other solar studies were focused on relations of the solar corona emission with strength and topology of the large-scale solar magnetic field.

Dynamics and energy transfer in the outer layers of the solar atmosphere was studied in a series of papers devoted to quiet solar network and to active events in the supergranular internetwork using data acquired in frame of the SOHO/TRACE joint operation program (JOP078) using CDS, SUMER, EIT instruments on-board SOHO as well as TRACE. In particular effects of resolution of different instruments were found to be related to phenomenology of the active events (explosive event versus blinker) and relation of plasma in different temperature regimes was investigated [7,8,14,15,26,27].

In order to proceed in investigation of the outer solar atmosphere a new cooperative program for the SOHO mission was prepared. This program was approved as JOP 171 'Solar network: variability and dynamics of the outer solar atmosphere' - joint observing program of CDS, EIT, MDI (on-board SOHO) and TRACE instruments. The main goal of this program is to study quiet Sun supergranular network using intensities and Doppler shifts of the chromospheric, transition region and coronal emission lines by a team of scientists at AISAS and Institute of Theoretical Astrophysics of Oslo University (Norway). First runs of the JOP 171 were performed within the MEDOC12 campaign in the November, 17-19, 2003. Each run took approximately 8 hours. Figure 4 shows typical spectra of different spectral lines obtained by CDS instrument during one JOP 171 run.

The Final IUE (International Ultraviolet Explorer) archive of low dispersion spectra was used to analyse the spectral energy distribution in the continuum radiation of symbiotic binaries Z Andromedae and AR Pavonis. In the case of Z And this confirmed discovery of the eclipse effect in the system [18] and for AR Pav our analysis revealed the presence of an accretion disk in the system powered by intense mass transfer [19]. Application of the newly developed

model to ultraviolet spectra of other symbiotics demonstrated their peculiar profile [17]. High resolution UV spectrum of the emission line He II 1640 A from the HST (Hubble Space Telescope) archive was analysed to study accretion process in the symbiotic star EG And [6].

Investigation of the space-time distribution of the solar corona brightness (Fig.5) revealed a number of regularities over more than five solar cycles. A pronounced north/south asymmetry of the solar corona was identified and discussed including the quasi-biennial oscillations [1,2,5,22].

Observations of ten total solar eclipses (1973-1999) (Fig.6) enable to describe mutual relations between the white-light and green-line coronal structures and the coronal magnetic fields strength and topology [3,4,21,23].

Archive data of the X-ray flares acquired on the orbit (as well as H alpha obtained on the ground) were investigated statistically in order to derive periodicities of their occurrence around the rotational period as well in the interval of the intermediate periods. The intermittent behaviour of different periodicities was discovered [10,11,12,13,24,25].

Relation of the cosmic rays periodicities with the interplanetary magnetic field strength and the green coronal index variability were studied in the range of the intermediate periods [9,16]. Relation of the cosmic rays intensity with the even and odd solar cycle behaviour was also investigated [20].

Besides research activities AISAS devoted part of its manpower to organise the International Solar Cycle Study Symposium 'Solar Variability as an Input to the Earth's Environment' which was held on June 23-28, 2003 at Tatranská Lomnica.

Coming back to 1997 the SCOSTEP adopted the International Solar Cycle Study (ISCS) program to investigate all aspects of the physics of the Sun in the different layers of the solar atmosphere and at various time-scales during the rising phase of Solar Cycle 23. ISCS was designated for the 1998-2002 period of worldwide effort. The first kick-off meeting was held at Nagoya, Japan in conjunction with 1998 COSPAR Planetary Meeting. There were approximately 40 people attending the meeting. The second meeting was held in 2001 at Longmont, Colorado, USA. There were 125 people from 20 countries around

the globe to attend. In 2001 the ISCS steering committee accepted invitation of the Slovak National Committee of SCOSTEP to meet at Tatranská Lomnica, Slovak Republic for the final meeting to summarize results of the ISCS program. The success of ISCS program can be assessed by the participation and papers being presented at this Symposium. There were twenty-seven invited reviews, thirty-four contributed oral presentations and one-hundred fourteen posters construing into the following scientific sessions: Magnetic Field Variations through Cycle 23; Spectral Irradiance Variability Originating in the Photosphere, Chromosphere, and Corona; Solar Global Changes: Atmospheric/Climate Effects of Solar Variability; Parallel ISCS WG1 and WG2/3 Discussion; Comparison of CME Activity; Solar Cycle Maximum and Minimum; Initiation of CMEs; CME, ICME and Space Weather; Interplanetary Shock Waves and Solar Energetic Particles; Future Activities. There is no space here to enumerate even the highlights of the Symposium even COSPAR was among sponsoring organizations of the Symposium. Proceedings of the Symposium, i.e., full text of all the contributions (including posters) is now published (856 pages, altogether) by the European Space Agency (ESA) as the Special Publication No. 535 (2003), ESTEC, Noordwijk, the Netherlands (ed. A. Wilson).

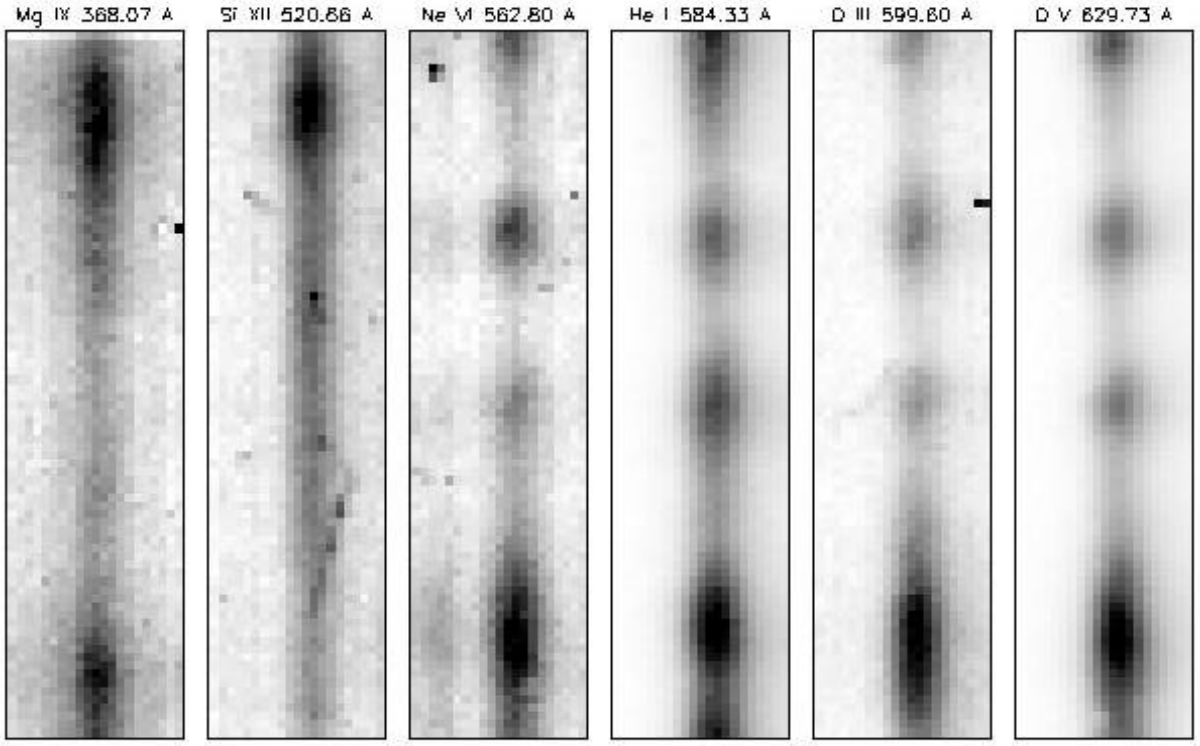

Fig. 4. Sample spectra of different spectral lines obtained simultaneously by the CDS/SOHO instrument during JOP 171 on Nov 19th, 2003.

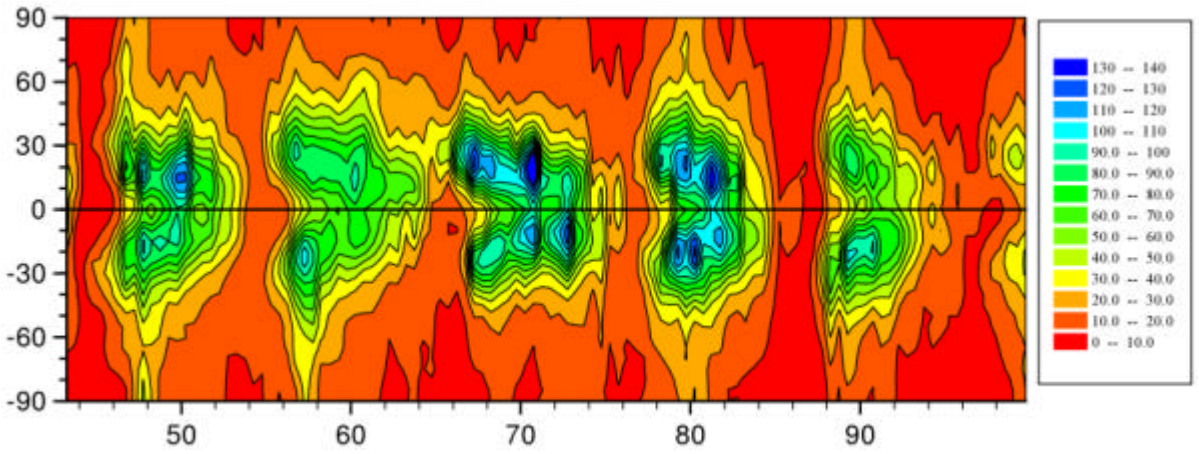

Fig. 5. Time-latitude distribution of the green coronal line intensity (in coronal units) displayed over the epoch 1943-2000 and over the whole range of latitudes. This distribution was used for investigation of the space-time distribution of the solar corona brightness [1,2,5,22].

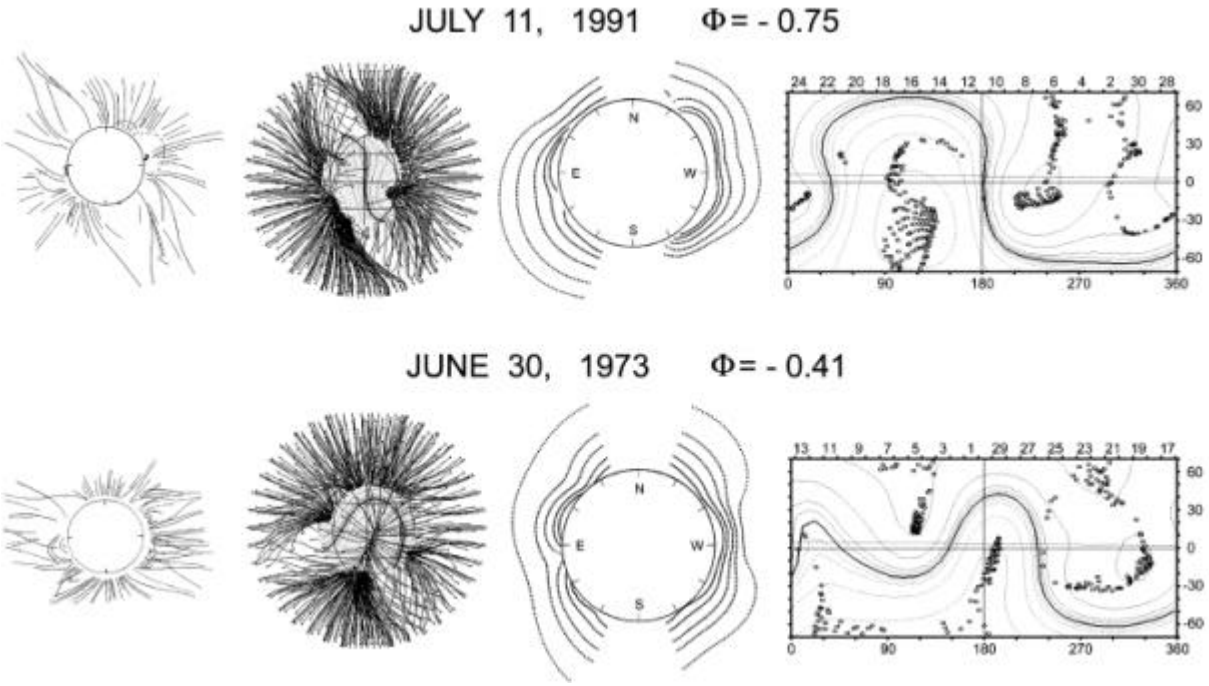

Fig. 6. Comparison of the observed white-light corona shapes with the corona magnetic field topology for two solar eclipses. The four columns represent drawings of the white-light corona structures (left); topology of the open field lines; isolines of the magnetic field strength; and synoptic charts of the radial magnetic filed strength with the footpoints of the open magnetic field lines [23].

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3. LIFE SCIENCES.

The project " Mechanisms of Neuroendocrine, Cardiovascular and Metabolic Adaptation to Simulated Microgravity " was performed on the collaboration of the ***Institute of Experimental Endocrinology, (IEE SAS), Bratislava*** and Faculty of Medicine, Lyon (France) with wide international collaboration under the ESA project “Long Term Bed Rest”. Previous studies showed, that microgravity during space flight induces changes of physiological functions that affect astronauts´ health and performance and the neuroendocrine and metabolic responses to various stressors. Space flight simulations such as prolonged head down bed rest (HDBR) can mimic some of these changes and provide study conditions that are more accessible than during space flight. Therefore ESA, CNES, NASDA are performing extensive studies using long duration bed rest and IEE SAS is participating in this project. The aim of our participation is to investigate neuroendocrine response, especially the sympathetic nervous system, to stressors during bed rest of various durations. The determinations of plasma and urinary catecholamines and their metabolites were performed in human subjects exposed to 3 months HDBR. Preliminary data from the first part of the experiments showed that plasma epinephrine levels were reduced during prolonged HDBR and stayed reduced even 9 days after the HDBR was terminated. Exercise during the bed rest has not significantly affected plasma epinephrine levels. Plasma norepinephrine levels did not show significant changes during HDBR in control or exercised probands, however after termination of HDBR the norepinephrine levels were elevated. These findings are in good agreement with urinary excretion of norepinephrine, which was also elevated. Exercise potentiated the norepinephrine excretion especially after the HDBR termination.

The purpose of the further study was to evaluate how a bout of endurance training will influence endocrine response after short lasting bed rest (HDBR). There were differences in the response of several stress hormones to physical load – treadmill exercise after HDBR and endurance training failed to completely prevent changes in endocrine responses to stress loads seen after short-lasting HDBR, but it has been shown to diminish negative effect of bed rest on growth hormone release and to augment the release of cortisol during exercise. These data demonstrated that simulation of hypogravity during HDBR or prolonged bed rest during the therapy of chronic illness could affect the neuroendocrine response to stress stimuli.

The data obtained are in good agreement with our previous results from the exposure of human subjects to real microgravity during space flights, which indicated activation of sympathoadrenal system mainly during the readaptation period after landing. These data also support the view that simulation of hypogravity during HDBR is a good model to study the effects of microgravity in human subjects. The scientists from IEE applied for participation in the next HDBR trial performed on women and organized by ESA.

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The research work on the project "*Influence of simulated microgravity on human postural responses to sensory stimulation"* was performed at the ***Institute of Normal and Pathological Physiology, SAS, Bratislava.***
The aim of project was to investigate the role of altered sensory interaction in postural instabilities after space flight. During the years 2002-3, voluntary head movements in pitch, yaw and roll plane of one cosmonaut were analyzed before, during and after short space flight. During the first days of weightlessness the angular velocity of head movements increased. Over the next days of microgravity the velocity of head movements gradually decreased. On landing day a significant decrease of head rotation velocity was observed compared to the head movement velocity before space flight. Significant asymmetry in the averaged velocity for forward and backward head movements in pitch plane was observed only on third day of the microgravity period. These results showed that sensory-motor adaptation to microgravity should be monitored by the angular velocity of aimed head movements of cosmonauts. It is known that during spaceflight visual influence on body orientation is increased. We investigated modification of postural responses to somatosensory stimuli by visual scene motion.

Institute of Normal and Pathological Physiology organized the 3rd International Posture Symposium „HUMAN POSTURE CONTROL - Physiology, Disorders, Modeling and Balance Rehabilitation" with 57 active participants from 18 countries. The results were also presented on „6th NASA Symposium On the Role of the Vestibular Organs in Space Exploration" in October 1-3, 2002, Portland, USA.

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In space biology the project *" Study of osteodystrophies, egg-shell formation abnormalities, reproductive and adaptive processes in Japanese quail under hypodynamy, hypergravity and microgravity "* was performed in ***Institute of Animal Biochemistry and Genetics, SAS, Ivanka pri Dunaji***.

The project is a continuation of successful research of Japanese quail embryogenesis under microgravity conditions. The general objective of experiment in the years 2002 - 03 was to determine the effect of simulated weightlessness (hypodynamy) on postembryonic development of Japanese quail hens from the age of 2 to 56 days. Specific objective was to obtain quantitative information about body weight, body weight gain, food consumption, food efficiency, length of thigh, shin and metatarsus, weight of heart, liver and kidneys, age of sexual maturity and survival of quails. The hypothesis for these kinds of experiment was whether hypodynamy would alter normal developmental processes in Japanese quail hens. The results achieved demonstrated that under the used conditions of hypodynamy 40 % survived quail hens were able to develop, although all studied indicators were significantly reduced in comparison with the control group. This experiment offers preliminary, but important insights into simulated microgravity's influence on developing Japanese quails.

The results on postembryonic development of Japanese quail in conditions of simulated weightlessness were presented on XIIth. Conference on Space Biology and Aerospace Medicine, Moscow, RF (June 10-14, 2002) and on the 20th Annual Conference on Animal Physiology, Trest, (Czech Republic) in October 2002.

The further project " *Postembryonic development of Japanese quail in the conditions of hypodynamy*" was performed also at the Institute of Animal Biochemistry and Genetics, SAS, Ivanka pri Dunaji.

Project is an extension of the previous research in the embryogenesis of Japanese quail under the conditions of microgravity that has been successfully performed during the years 1972 to 1999.

The first knowledge of the quail behaviour under the microgravity conditions to the day five of post-hatching development raised a new issue in cosmic biology – the adaptation of the newly hatched organism that has no previous sensory and motor experiences in similar environment. This problem represents a case of primary adaptation to the environment, which in principle does not correspond to genetically coded stereotypes of orientation and motor behaviour.

Solving the problem of the adaptation of hatched quail chicks to the weightlessness in the extent that would enable their development to the

productive age is a prerequisite for achieving the final goal – to close the reproduction cycle of these animals and to breed their cosmic population.

Apparently the key for solving this problem is to establish an experimental model for the study of the postembryonic development of Japanese quails under the hypodynamy conditions to their maturity.

The aim of present experiment (performed in 2002-03) was to study the effect of simulated weightlessness (hypodynamy) on some physiological parameters of blood plasma in Japanese quail chicks from hatching to the age of 56 days.

Eighty Japanese female quail chicks of the Ivanka hypodynamic line were used in the experiment. Forty birds of the control group were reared by a standard method on the floor. The experimental group (40 animals) was kept under the conditions of hypodynamy from the age of 2 days. Hypodynamy was achieved by suspension of quails in individual beds so that they could not reach the floor by legs, but could move with legs, wings and head. All animals were kept under the continuous light regime and had free access to food and water. The temperature was gradually decreased from 35°C to 25°C throughout the experiment. The blood samples were collected into the heparinized test tubes at the age of 1, 28 and 56 days from an adequate number of experimental and control chicks. After centrifugation the concentrations of total proteins, albumins, globulins, uric acid, creatinine, glucose, cholesterol and triacylglycerols in the plasma were determined using the commercial kits.

Our results have shown that differences between the control and experimental group were not significant in the case of total proteins, albumins, globulins, creatinine, glucose and triacylglycerols in the plasma on day 28 and 56. However, in the quails reared under the hypodynamy conditions during the first 28 days the concentration of uric acid increased and remained significantly high until 56 days of age. Similarly, plasma cholesterol was considerably increased at this age. On the other hand, the plasma triacylglycerols were significantly decreased on day 28, and on day 56 there was only a slight decrease in the hypodynamic quail.

The results obtained represent the first knowledge about potential differences in the intermediary metabolism of the Japanese quail reared under simulated gravitation conditions.

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The research work on the project "*Accumulation and persistence of cytogenetic damage induced by radiation and other factors of space flight*" was performed at the ***Institute of Biological and Ecological Sciences, Faculty of Sciences, Šafárik University, Košice***.

On the basis of preceding findings from this group, regarding the accumulation of latent cytogenetic damage in slowly proliferating tissues (liver, kidney) during continual exposure of animals to ionizing radiation, now the latent damage in offspring of irradiated rats has been studied. It was found out that the latent cytogenetic damage manifested itself in F_1 and F_2 generation of progeny of irradiated male rats (3 Gy of gamma radiation) in course of the regeneration of liver after partial hepatectomy. The changes in progeny (decrease in proliferating activity, increase in apoptotic fragmentation of DNA and in frequency of chromosomal aberrations) were similar to those ones in irradiated males of F_0 generation. The extent of the latent changes, however, in the progeny was slighter in comparison with irradiated males of parental generation. This finding argues for an evidence of the transfer of part of latent radiation genome damage from irradiated parents to their progeny.

The study of accumulation and potential transgenerational transfer of the latent damage from exposed individuals to the progeny may be of special importance in connection with the long-term space flights.

In relation to previous findings concerning the transgenerational transfer of directly detectable and latent radiation genomic damage of intact and regenerating liver from irradiated rat males to their progeny, the possibility of elimination of damaged cells by the mitotic death in course of ontogenesis was studied. The elimination of cells was investigated in embryonic tissues and intact liver of irradiated rat male progeny at various stages of intrauterine and postnatal development on the base of analysis of chosen cytogenetic and molecular biological indexes (e.g. proliferating activity, apoptotic fragmentation of DNA, frequency of chromosomal aberrations). It was found that the directly detectable radiation changes quickly disappeared in embryos and new-borns in course of ontogenetic development, so they were nearly absent in 7-day offspring (prepared for publication). These findings suggest that the transgenerational transfer of the latent damage of the liver reflects a radiation induced increase in genomic instability.

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The project "*Changes of the function of neuroendocrine system during exposure to simulated microgravity and hypergravity*" was performed with the participation of ***Institute of Experimental Endocrinology, Institute of Animal Biochemistry and Genetics and Institute of Measurement Sciences***, all in the ***Slovak Academy of Sciences, Bratislava***.

The goal of the investigations in this project is realization of the series of the experiments with rats exposed to hypokinesia or hypergravity for various time periods with the blood sampling during the hypokinesia or hypergravity in special centrifuge by using a canula and determination of plasma levels of hormones, neurotransmitters and metabolites. In selected time intervals it is proposed to measure in isolated organs and tissues the content of neurotransmitters, hormones, production of hormones, activity of enzymes involved in the production of neurotransmitters, expression of genes for coding these enzymes. The results will be used for evaluation of the capacity of the organism to overcome several stress loads. For studies of the effects of hypergravity the Electronic Equipment for Multiple Blood Withdrawal with Telemetric Control from small experimental animals has been developed and tested. The equipment consists of a telemetric transmitter (placed outside the room of the centrifuge) and receiver. Both transmitter and receiver are equipped by microcomputers. Before the start of the experiment it was possible to pre-program the time schedule (sequence) of blood withdrawal for every animal. It was also possible to measure the instantaneous gravitational force using an accelerometric transducer placed near the box with telemetric data transmission. The preliminary tests of the function of equipment were finished and necessary number of equipments is produced by IMS, SAS.

The results on the tests of this equipment were presented on the 8th European Symposium on Life Sciences Research in Space, organized by ESA in Stockholm, June 2-7, 2002.

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4. REMOTE SENSING

Research activities of the ***Institute of Geography, Slovak Academy of Sciences, Bratislava*** in the field of remote sensing concentrated during the last two years on the solution of *CORINE Land Cover 2000 (CLC2000) Project*, launched by the European Environment Agency (EEA) and the Joint Research Centre (JRC). The project is carried out in 30 European countries at present.

The aim of this project is to update the CLC90 database to that in 2000, as well as to identify land cover changes in Europe but also in Slovakia for the years 1990-2000 by application of Landsat TM data. Spatial resolution the database CLC2000 is 25 ha. Spatial resolution CLC-change database is 5 ha. Around 60 % of total area of Slovakia has been finished in January 2004.

The possibilities of application of the CLC90 and 2000 database to identification of land cover changes were tested on example of the Skalica district.

Land cover changes are represented by the decade of the most recent social and property-linked changes (transformation of economic and social relationships – privatisation). Scope and occurrence of these changes are illustrated in Tab 1 and Fig. 7 (Otahel et al. 2003). Privatisation of agricultural land has not been carried out in the extent that might manifest in the change of the rural landscape structure. Collective property dominates. Arable land (211) diminished in favour of urban fabric (112) (36.2 ha) and industrial areas (121) (19.5 ha), also by privatization and its change to small-area vineyards (221) (29.2 ha) or complex cultivation patterns (269.5 ha) now in private ownership. The largest changes occurred in the forest landscape. Broad-leaved forests (311) extended at the cost of transitional woodland (324) (310 ha), while the coniferous forests (312) (7,9 ha) and mixed forests (313) (249.6 ha) diminished.

Table 1. Comparison of the land cover class areas in the years 1990-2000 (in ha)

CLC Class	area 1990 [ha]	area 2000 [ha]	change of area [ha]
112	1 743,1	1 779,3	36,2
121	266,6	312,8	46,1
132	0,0	30,3	30,3
142	186,2	186,2	0,0
211	21 788,2	21 475,3	-312,9
221	618,7	647,9	29,2
222	57,2	0.0	-57,2
231	525,1	494,6	-30,4
242	40,1	309,6	269,5
243	712,6	699,9	-12,7
311	5 395,6	5 706,0	310,3
312	564,6	556,7	-7,9
313	2 341,2	2 091,6	-249,6
321	30,1	30,1	0,0
324	1 163,4	1 112,2	-51,2
411	37,1	0.0	-37,1
511	176,2	176,4	0,3
512	129,8	166,9	37,1

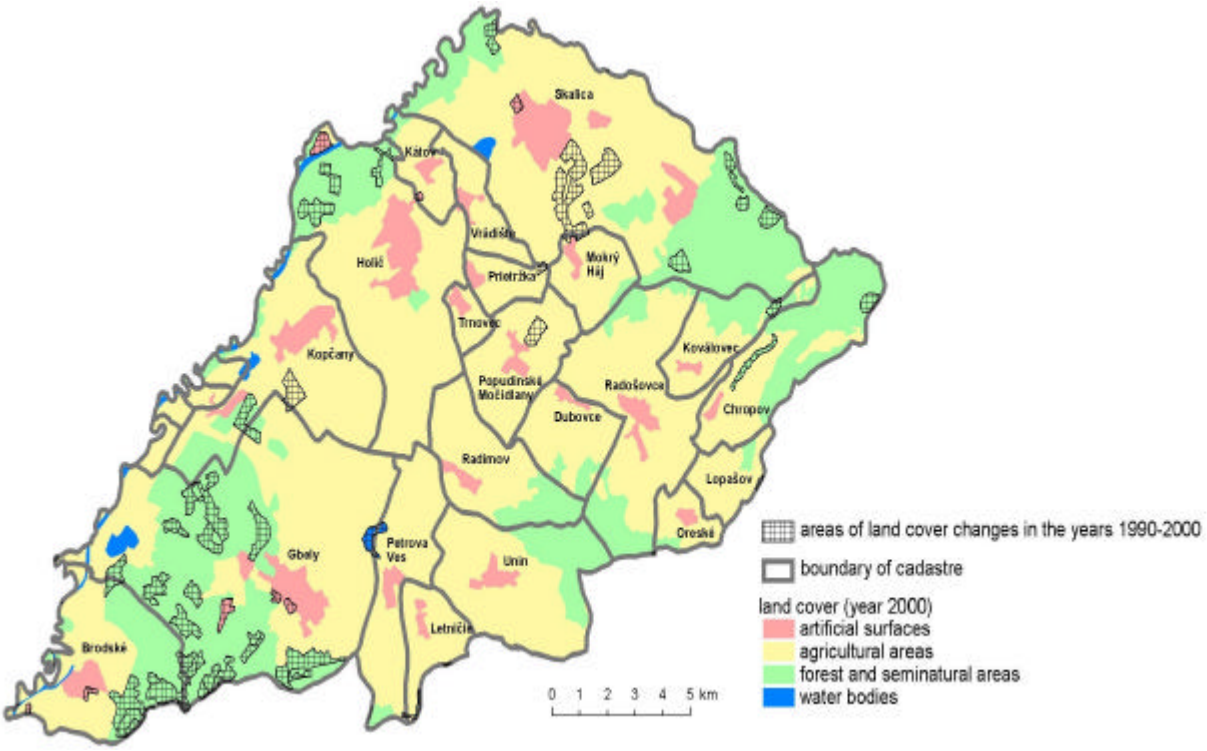

Fig. 7. Location of land cover change.

Activities of the ***Slovak Environment Agency (SEA), Banská Bystrica*** in the area of remote sensing were mostly associated with the work on the CORINE Land Cover 2000 Project (co-ordinatior of the project in Slovakia), which is characterised in the framework of the activities of the Institute of Geography, SAS.

The SEA also participated in solution the problem of the CORINE Land Cover 90 database application to the multitemporal spatial analysis of parasite occurrence in Slovakia and the landscape diversity of Slovakia.

The SEA has guaranted two reference GPS stations based on the NAVSTAR satellite network. Permanent DGPS service with submeter accuracy is available in 2 modes: real-time and offline postprocessing. Real-time navigation and mobile GPS mapping is very useful in case of any hazardous situations like floods, forest fires, earthquakes, water pollution, soil contamination etc.

See URL links:

http://www.sazp.sk/DPZ and http://www.sazp.sk/parasites

Remote sensing activities of the ***Forest Research Institute***, ***Zvolen*** were oriented on the solution of three projects:
1. Project: National Cooperative Program on Assessment and Monitoring of Air Pollution Effects on Forests. *Subproject:* Methods of forest health condition monitoring by using Remote Sensing.
The main result of research in years 2002-2003 was development of methodology for object-based classification of forest health condition from high-resolution satellite data. The methodology was developed for classification of forest decline from satellite IKONOS at the stand level. The model territory was selected in Lomnistá valley in the Low Tatra Mountains (Fig. 8). The object-oriented classification of image gave much better results comparing to classical spectral approach. The first step of classification was segmentation of image into homogeneous regions (objects). The aim of segmentation was to extract spatial units that are defined by natural boundaries (Fig. 9). Then we described forest stand textures and divided segments into categories according to their health condition. In the next step we used discriminate analyses for selection of the best variables for classification of health condition at the stand (segment) level. The classification was carried out on the basis of spectral information, texture and form features of objects and relations to other objects (Fig. 10).

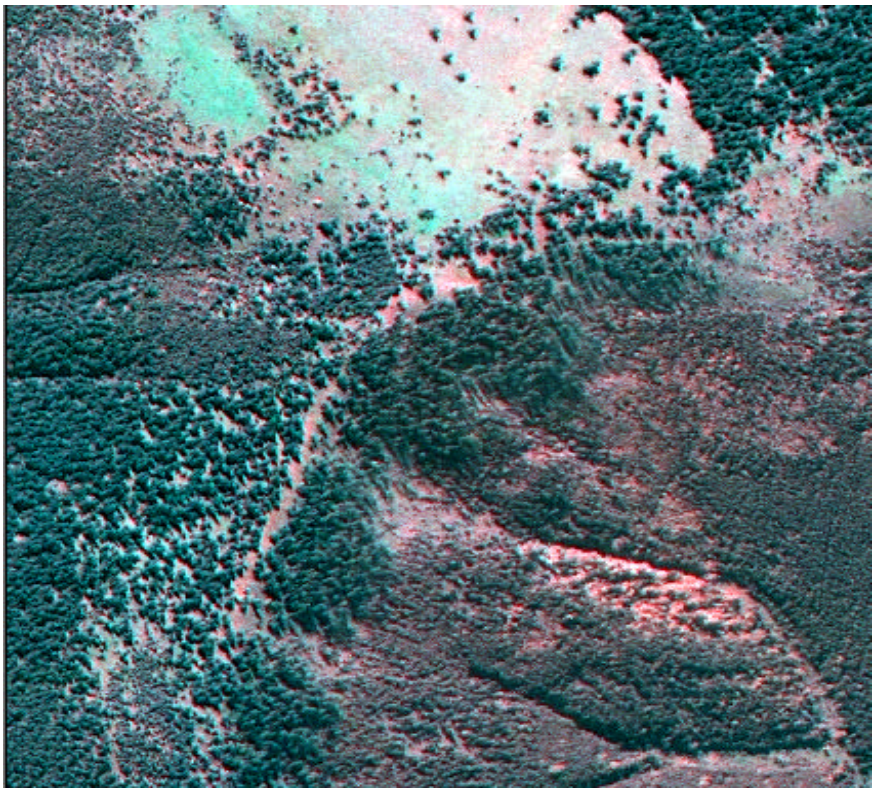

Fig.8. Satellite image Ikonos from august 2002 – test area Struhar in Low Tatras Mountain.

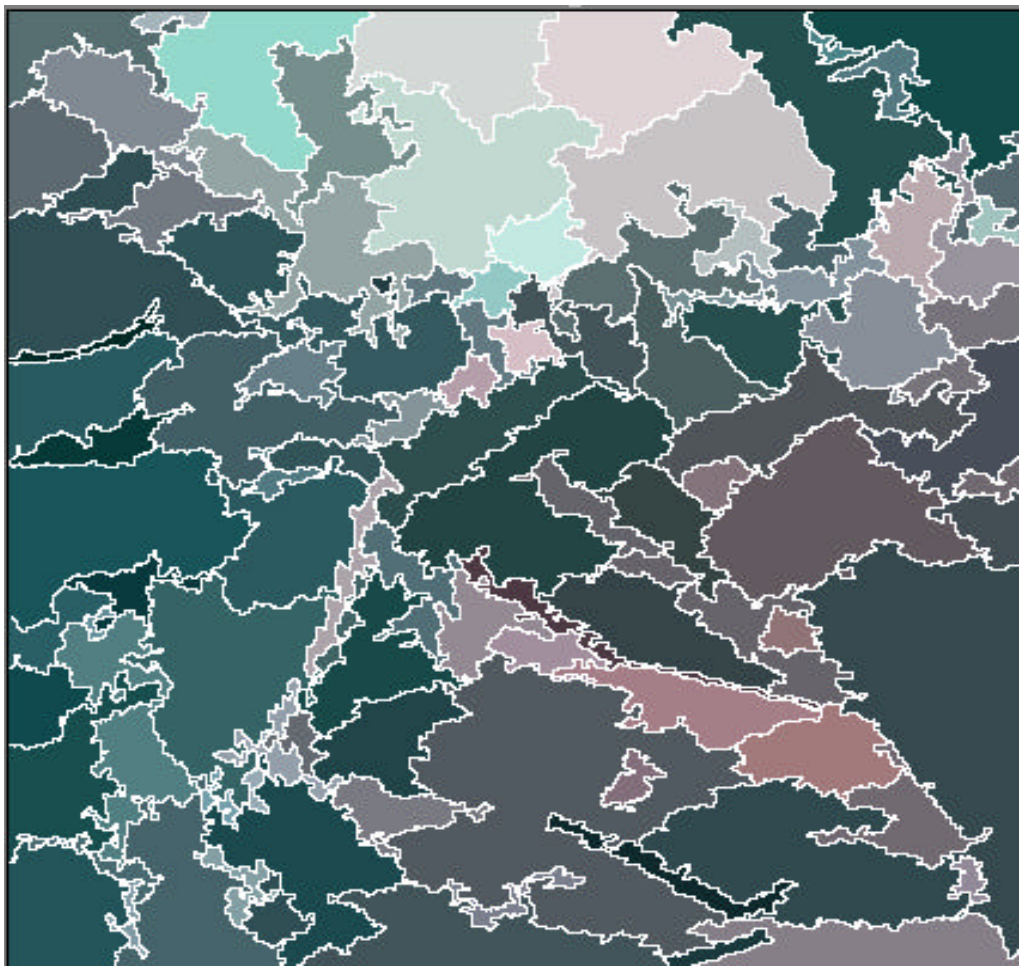

Fig. 9. Segmentation of image into homogeneous objects

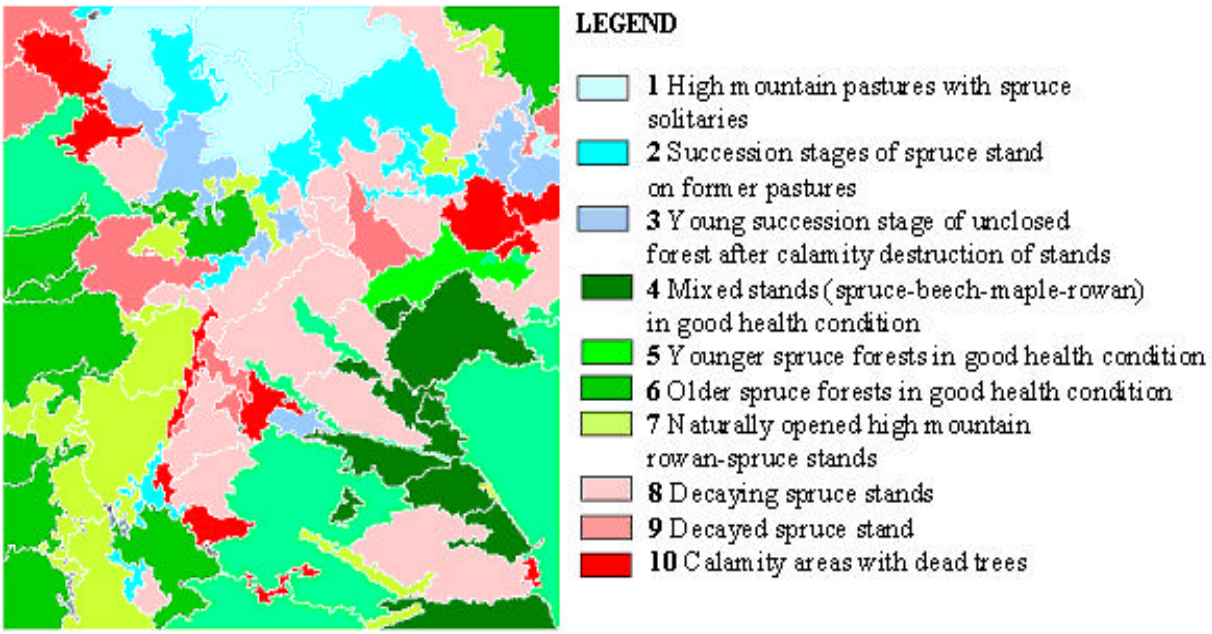

Fig. 10. Classification of forest stand textures from point of view of their health condition.

The second result of the project was classification of forest health condition in Slovakia from Landsat ETM + data from 2002. The result was processed in form of thematic map at scale 1: 500 000.

2. Project: Research methods of mountain forest management observing the principles of sustainable development.

The project deals with development of methodology for classification of ecological stability of forest ecosystems. We used the combined method of research on permanent research plots (PRP) and method of whole–area research and thematic mapping applying remote sensing and the GIS. Satellite remote sensing on the basis of satellite scenes Ikonos (Landsat and SPOT) was applied first of all in stratification and classification of interest territories with regard to textural differentiation, tree species composition, forest coverage, health condition and in thematic mapping of stand and structural types.

In derivation of the tendencies and trends of forest development and thematic mapping in Lomnistá valley historical as well as topical aerial photos of identical localities of the years 1949, 1962, 1973, 1986, 1998, 2000 including satellite scenes were used.

Spatial occurrence, mosaic character, area and spatial arrangement of types and elements of stand structures are the key elements evaluated in the system of the

classification of ecological stability of forest ecosystems and they are the starting point for the proposal of measures in forests. The system of evaluation is based on the comparison of the actual state of mountain forests with potential state, which we derived of knowledge and special surveys.
Classification procedure was verified and applied in practice to the model territory in Lomnistá and Vajskovská valley in Low Tatras Mountains.
3. Project: Environmental monitoring in 2002 according to the "Agreement between the Government of the Slovak Republic and the Government of Hungary about Certain Temporary Measures and Discharges to the Danube and Mosoni Danube, signed April 19, 1995".
Subproject: Aerial inventory of forest health condition in the Gabèíkovo region.
Guaranty: Forest Research Institute Zvolen, Ground Water Consulting Ltd.
Forest Research Institute carried out aerial photography and took 92 infrared aerial photos (Fig. 11) in 17 August 2002 from the area between the river Danube and bypass canal. All photos were scanned, georeferenced in JTSK projection and mosaic.
The method of the maximum likelihood was used for classification of forest damage for each photo. Almost 83 % of forest stands are healthy, 14 % are slightly damaged and 3 % severely damaged. Results were processed in form of thematic map of forest stand damage in scale 1:20 000.

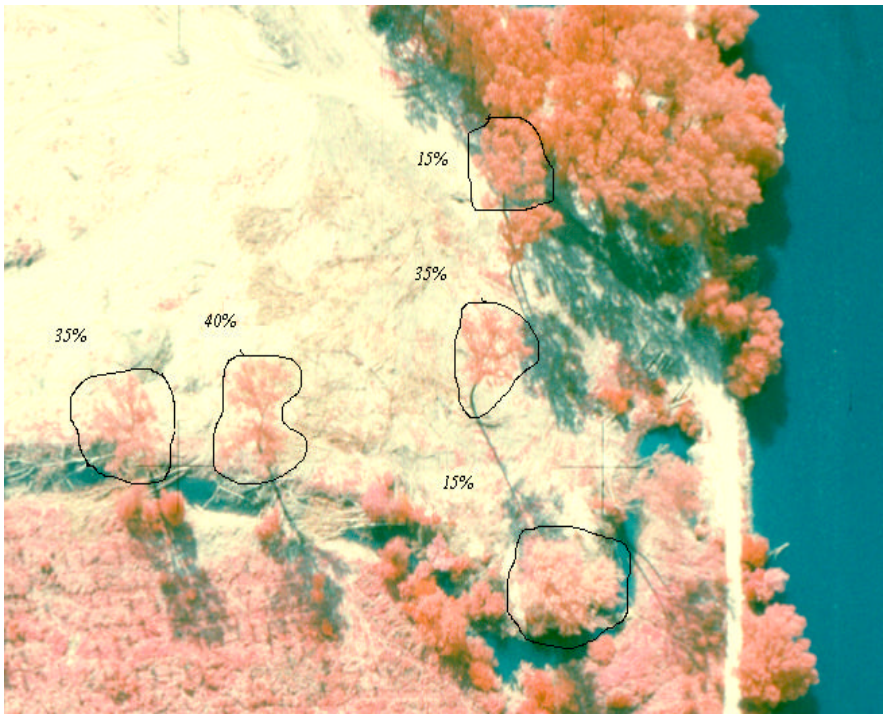

Fig. 11. Infrared aerial photo from August 2002 from Danube floodplain forest – estimated defoliation of poplar trees.

Remote sensing activities of the ***Soil Science and Conservation Research Institute, Bratislava*** have been oriented to Land parcel identification system (LPIS). LPIS establishment in the Slovak Republic is:
-based on colour digital orthophotomaps, background for block creation,
-based on physical blocks according to natural boundaries (building: visual interpretation of digital orthophotomaps, digitalization on-screen by operators),
-validation and specification of the blocks and their internal borders with the farmers.
The digital orthophotomaps cover the whole area of the Slovak Republic (flight 2002-2003, resolution 0.5 m, RSME under 1.5 m). Blocks vectorisation and validation by farmers were performed during 2002-2003. At present time 1 880 000 ha of agricultural land are linked to farmers (about 150 000 blocks). 26 000 agricultural subjects are registered in database.

Control of area- based subsidies with remote sensing.
Control of area-based subsidies with remote sensing data will be started in the Slovak Republic with pilot project in the year 2001. Control with remote sensing data will be provided by combination of digital aerial orthophotomaps with satellite images interpretation and information from LPIS and IACS (farmers claims for subsidies). Used satellite images: IRS – 1 D MS (6.5.2003), IRS – 1 D MS (6.6.2003) and SPOT 5 PAN (30.6.2003).
This activity is coordinated also by JRC experts. The used methodology was based on the Common Technical Specification for CwRS 2003 campaign made by JRC. Two pilot regions (about 30 000 ha agriculture land – 32 agriculture subjects) were checked in 2003.

Regional inventory.
Is one part of Monitoring Agriculture with Remote Sensing (MARS). The task of this activity is land use and crop acreage estimation by satellite image classification and field survey followed by a statistical treatment.
Crop Inventories area was carried out in 2003 for main crops as winter cereals, rape, spring cereals, perennial fodders, maize and sunflower at the national and regional levels. Used satellite images: IRS MS, Landsat TM 5 and 7 from three time horizons (autumn, spring and summer).

Yield forecasting.
The yield forecasting is based on the combination of the satellite NOAA-AVHRR –and SPOT derived daily vegetation index (NDVI) with the WOFOST crop model. Yield forecast was produced for main crops (winter wheat, spring barley, maize, sunflower and sugar beet).

Detection and modelling of potential erosion using remote sensing methods.
Detection of eroded agriculture soils was based on differences in reflectance between eroded soils and non-eroded soils.
The eroded soil areas were identified on the IRS Pan satellite images and Landsat TM images and on archive and recent aerial orthophotomaps visually under Arc View software for more geographical units in three geographical areas.

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5. SPACE METEOROLOGY.

The activities in Space Meteorology have been oriented to the exploitation of satellite and radar information in flood forecasting, weather monitoring and nowcasting. ***Slovak Hydrometeorological Institute***, ***Bratislava*** has been involved in two projects:

Exchange of knowledge, know-how and algorithms in the field of nowcasting and a very short range forecasting on the base of the distance measurements have been the main items in *the CEI Nowcasting Project* (2002 – 2004) in cooperation with Austria, Hungary, Croatia and Slovenia. The main products of the project such the Atmospheric Motion Vectors (AMV), Forecasted Satellite Image (FSI), Convective Cell Detection (CCD), Satellite Tracking and Radar Tracking will be put in operation in forecast offices in the countries mentioned above.

The preparation of the project *SAF Hydrology* (Satellite Application Facility) continued. New working group (the member states of EUMETSAT and Hungary, Poland, Slovak Republic) was established to analyze the exploitation of weather radar and satellite information and other kind of meteorological remote sensing data for the precipitation measurement.

6. Institutions involved in Space Research relevant to COSPAR.

Members of the National Committee of COSPAR with their e-mail addresses are listed too. More informations about space activities in Slovakia can be found also at www.space.savba.sk (the homepage of the recently established ***Slovak Commission for Research and Peaceful Uses of Outer Space at the Council for Science and Technology of Government of Slovak Republic)*** *or at the website of NC http://nccospar.saske.sk.*

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