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UNIVERSAT-2006

University Satellites and Space Science Education

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ABSTRACTS

Moscow 2006

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A NOVEL APPROACH OF SATELLITE TRACKING OF ENDANGERED SPECIES

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This paper aims at studying the behavior of migratory birds and tracking endangered species of birds like swam, cranes etc using wildlife tracking satellite. Data collected through satellite tracking helps us to understand and protect the endangered and threatened species of the world. Scientists have attached tiny transmitters to wild animals for years, tracking their radio signals with receivers nearby on the ground. Now they track wildlife ranging over much wider areas with receivers high above the ground. A receiver in an orbiting space satellite can hear a transmitter attached to an animal. Even if the animal is out of sight over the horizon from a tracker on the ground, a satellite high in space still can hear the transmitter and repeat its signal down to trackers on the ground. The research comprises of study of factors such as breeding movements, spring and fall migration of migratory birds.

PROGRESS IN LUNAR EDUCATIONAL INITIATIVES

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With the resuming of robotic lunar mission planning in several countries, there is an opportunity for including educational activities at low cost and minimal interference with primary mission goals. This paper describes current initiatives in that direction by members of The Planetary Society and the International Space University.

THE ROLE OF SOUNDING ROCKET EXPERIMENTS IN SPACE SCIENCE AND TECHNOLOGY EDUCATION AT BOSTON UNIVERSITY

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Sounding rocket programs at Boston University provide unique opportunities to train future space scientists and engineers. Besides fitting the typical schedule of a student, they allow a small group of students to be involved in all aspects of a space project from its inception through execution to a conclusion involving scientific discovery. These programs are cradles of innovations where the interdisciplinary nature of space experimentation is nurtured. They typically involve a number of students who gain in-depth experience into well-defined and critical components of a space mission. The sounding rocket experiments offer an opportunity to take more risks in terms of their science return. Some of these risks come in the form of new technology invention and development. Sounding rockets, with their flexible schedule and fewer formal procedural requirements, thus play an important role in maturing technology and developing new capabilities for satellite missions. In this talk we will highlight the unique aspects of several sounding rocket experiments that we have conducted. We will also describe a Student Launch Program experiment where the proposal was developed as a class project in the astronomy department at Boston University and the flight hardware was built through the Senior Design Project class in the College of Engineering. The students involved in this program gained valuable experience with a mini-satellite mission. These sounding rocket experiments and satellite missions have spawned a culture of interdisciplinary space experimentation at Boston University. We believe that these programs are essential for the long-term vitality of the space program and a technology-savvy workforce of the 21st Century.

NSPO'S MICROSATELLITE PROGRAMS

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A six-microsatellite constellation was recently launched as part of a meteorological research initiative of the National Space Organization (NSPO) of Taiwan. When reached their final mission orbits, the constellation will provide thousands of data points covering the globe for the research community daily. From satellite design, launch, deployment to their operation, data processing and dissemination, the final outputs will benefit the science community with better atmospheric data and whether prediction capabilities. Other initiatives of university microsatellites managed by NSPO are aiming at enhancing the science and engineering education with hand-on experience of the academic teams and promoting international cooperation in exchanging design experience and science experiment ideas.

PARTICLE DETECTORS NETWORKS FOR THE FUNDAMENTAL PHYSICS, SPACE WEATHER AND EDUCATION

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A network of middle to low latitude particle detectors called SEVAN (Space Environmental Viewing and Analysis Network) is planned to be developed within the framework of the International Heliophysical Year (IHY) in order to improve fundamental research of the space weather conditions and provide possibilities to perform short and long-term forecasts of the dangerous consequences of the space storms. The network will detect changing fluxes of the most of species secondary cosmic rays at different altitudes, latitudes and longitudes those constituting powerful integrated device in exploring solar modulation effects. Based on our experience with data analysis of multivariate time-series from particle detectors located at Aragats Space-Environmental Center in Armenia we designed and fabricated several new-types of particle detectors measuring charged and neutral component of secondary cosmic rays. In order to keep the instruments inexpensive the options are kept flexible by using modular designs. The price of a fully autonomous single unit, with facility to send data to the internet will not exceed $20,000 US, so that the network of nations involved in space research can be significantly expanded to enable them to participate in IHY. At any time one can cascade these single units to achieve additional functionality. Like the world network of neutron monitors, the new monitors will measure the neutron fluxes and in addition they will measure charged particle fluxes with different energy thresholds, thus allowing the investigation of additional populations of primary ions. These units plan to be deployed at universities and research centers of the developing countries to perform survey and monitoring of most dangerous space storms and to introduce the space research to new generations of students and researchers.

ULTRAVIOLET RADIATION DETECTOR OF THE MSU RESEARCH EDUCATIONAL MICROSATELLITE "UNIVERSITETSKIY - TATYANA"

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An optical detector that is a part of the research equipment system installed aboard the MSU research and educational supersmall satellite "Universitetskiy-Tatyana" and intended to study the atmosphere in the ultraviolet spectrum is described. The method of digital oscilloscope was applied for recording time profiles of the atmosphere glow intensity in a wide range of durations. Intense ultraviolet flashes have been detected in the equatorial region of the Earth. Examples of temporal profiles of the flashes recorded by the detector, their geographical coordinates distribution and measured atmospheric radiation intensities including Aurora light are presented.

THE UNITED NATIONS BASIC SPACE SCIENCE INITIATIVE

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Pursuant to recommendations of the United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) and deliberations of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), annual UN/European Space Agency workshops on basic space science have been held around the world since 1991. These workshops contributed to the development of astrophysics and space science, particularly in developing nations. Following a process of prioritization, the workshops identified the following elements as particularly important for international cooperation in the field:

1. operation of astronomical telescope facilities implementing TRIPOD,
2. virtual observatories,
3. astrophysical data systems,
4. concurrent design capabilities for the development of international space missions, and
5. theoretical astrophysics such as applications of nonextensive statistical mechanics.

Beginning in 2005, the workshops focus on preparations for the International Heliophysical Year 2007 (IHY2007). The workshops continue to facilitate the establishment of astronomical telescope facilities as pursued by Japan and the development of low-cost, ground-based, world-wide instrument arrays as lead by the IHY secretariat.

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ENERGY SPECTRA OF SOLAR PROTON FLUXES USING DATA FROM THE "UNIVERSITETSKIY - TATYANA" SUPERSMALL SATELLITE

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The "Universitetskiy-Tatyana" is a supersmall satellite launched on January 20, 2005. Despite the fact that 2005 was the quiet Sun year, several solar energetic particle events were observed. Energy spectra of proton fluxes for five solar events were studied using data from the "Universitetskiy-Tatyana" supersmall satellite flying on the polar orbit at the altitude of 950 km and inclination of 83 degrees. Proton fluxes were measured within the wide energy range (E>1 MeV) by the instrument designed and created at SINP MSU. The solar energetic particle distribution (peaked values of fluxes during a solar event) was described by a power law function of rigidity. Spectral indices of the energy spectra for proton fluxes measured onboard the "Universitetskiy-Tatyana" satellite and GOES satellites fit satisfactory. Features of solar energetic particle event occurrence in quiet Sun years are discussed. Identity of the studied energy spectra with ones measured during the other periods of solar activity is presented.

TRANSIENT UV FLASHES IN THE NIGHT ATMOSPHERE

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Data of the "Universitetskiy-Tatyana" satellite's UV detector on transient flashes in the night atmosphere are presented. They are compared with the world data on transient luminous events.

NIGHT ATMOSPHERE UV RADIATION AS MEASURED BY THE UV DETECTOR ON BOARD THE "UNVERSITETSKIY - TATYANA" SATELLITE

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The results of the measurements of the night atmosphere UV radiation (at the wavelengths of 300-400 nm) by the UV detector onboard the "Universitetskiy-Tatyana" satellite are presented. Duty cycle of the UHECR space detector "TUS" were calculated with the use of the presented results.

A SERIES OF ATLASES ON METHODS OF SPACE IMAGES INTERPRETATION AS A NEW TOOL FOR REMOTE SENSING EDUCATION IN EARTH SCIENCES

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Special manuals in the form of atlases of satellite images and their interpretation results are within the best tools for support of the geographical and ecological research and thematic mapping. The team of the Moscow State University geographers, in cooperation with the Institute of Space Research, Russian Academy of Sciences, and other organizations, have developed a series of such atlases. The first two volumes, named "Interpretation of multiband aerospace images. Techniques and results" were devoted to the processing of the multispectral imagery. The first one is based on photoimages, taken with MKF-6 camera from Soyuz-22 spacecraft. The second volume used images taken by Fragment scanner system from Meteor-30 satellite. They were prepared in the international cooperation within the frames of "Intercosmos" and were published in 1982 and 1988 in Berlin in three languages: Russian, English and German. The following triad is the methodological basis of the atlases: satellite images - interpretation techniques - interpretation results. In 1997 the new scientific-methodological atlas "Space Methods for Geoecology", prepared by the geographers of the Moscow State University, was published. It represents the methods of satellite images' application for ecological purposes. It generalizes the experience and achievements on space methods application in geoecology and shows the ways of satellite images use in wide spectrum of geographical investigations, also for geoecological monitoring and for investigation and solution of the ecological problems. The Atlas characterizes the possibilities of space methods for investigation of the global ecological problems, such as global climate warming, loss of plant biomass, depletion of ozone layer. More details are given for Russia and neighboring territories: regional ecological problems, related to sea level fluctuations, air pollution and water contamination, anthropogenic impact in different natural conditions - in tundra, forest, steppe, desert zones. Problems of deforestation, erosion, desertification, technogenic impact in mining

and industrial regions, problems caused by urbanization and nature management, as well as problems of natural disasters and nature conservation are examined in Atlas. The Atlas is passed to dozens of the universities, connected with the Moscow University Laboratory of Aerospace Methods, which has functions of Inter-university Aerospace Center. Now it is successfully applying for geographical education. We have received acknowledgements from the university teachers for using of Atlas in lectures and training process. Direct usage of Atlas is for teaching remote sensing courses with purpose to show wide possibilities of space images applying in many directions of geographical investigations and various techniques of images using for different purposes. But its undirect using for teaching geographical and ecological courses, when images become the tool for understanding of geographical lows and patterns may be even more important. The experience of Atlas application in the educational process at the Faculty of Geography, Moscow State University, shows that it may be successfully use in both directions: remote sensing education and geographical education. But possibilities of the Atlas application are more wide. It may be used not only by university teachers, but also by the specialists in the Earth sciences, especially geoecologists; it will be also interesting for everyone, who would like to know more about ecological problems and their solutions using remote sensing methods.

EXPRESSO: A CNES STUDENT CALL FOR IDEAS IN THE FIELD OF ORBITAL SYSTEM AND STRATOSPHERIC BALLOONS

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As responsible for the technical relations with the Universities at the CNES Toulouse centre, I would like to present an brief overview of French national space agency - French space policy, CNES and European and international partners, CNES budget (national and contribution to ESA), major CNES programs. I also intend to speak about the specificity of French engineering schools and universities. I will describe several previous CNES student projects done with CNES support (ARSENE and SARA) and present the current EXPRESSO student call for ideas: the aim of this student call Different fields which could be addressed, the types of projects which could be proposed, the organization which could be envisaged (inside France, with European and international cooperation), the plan and the schedule for future action, an overview of the different propositions which have been submitted to CNES at the date of this presentation will be presented.

ELECTRON OUTER BELT DYNAMICS DURING APRIL-MAY, 2005 – CORONAS-F AND "UNIVERSITETSKIY - TATYANA" SATELLITES DATA

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Dynamics of electron population in the outer radiation belt of the Earth (ERB) during magnetic storms and during quiet time have been studied practically from the beginning of cosmic era. The relativistic electron flux decreases during the main phase of the storm, and then recovers and increases from late main phase to the recovery phase. For the time period from April to May, 2005 we have the opportunity to study ERB electron variations both in magnetically quiet time (April) and during and after the strong magnetic storm (May). Using data from two low-altitude satellites - CORONAS-F and Universitetskiy-Tatyana we have measured the fluxes and energy spectra within the following energy ranges: solar electrons 0.3-12 MeV and protons 1-90 MeV (CORONAS-F), 0.07-0.9 keV electrons and 2-100 MeV protons (Universitetskiy-Tatyana). CORONAS-F was launched on July 30, 2001 into a circular polar orbit (altitude of 500 km, inclination of 82.5 degrees). In 2005 the altitude was significantly lower, about 350 km. The Universitetskiy-Tatyana satellite is the first Space Scientific and Education supersmall satellite of the Lomonosov Moscow State University. It was launched on January 20, 2005 into a circular polar orbit with the altitude of 950 km and inclination of 83 degrees.

TRAPPED PROTON FLUXES OBSERVED ON CORONAS-I,F SATELLITES DURING THE SOLAR MINIMUM

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Trapped 1-100 MeV proton fluxes measured in 1994 and 2005 on the polar Coronas-I and Coronas-F (at the altitude of 500 km) satellites are presented in the report. Experimental data are shown in (L,B) and geographical coordinates (up to L=5). They are compared with the other satellite data (Electron) and with the prediction of AP8 model. It is shown that on drift shells $L < 1.5$ there is an essential difference between the proton fluxes within the energy range of 1-5 MeV measured on the satellites and data predicted by the AP8 model. The data obtained for protons with energy over 10 MeV coincide satisfactory with the AP8 model.

RESEARCH AND CAPACITY BUILDING IN FUTURE OF SPACE MANAGEMENT IN NIGERIA

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This paper gives a general overview of research and capacity building as they relate to future of space management in Nigeria. Definitions of some common terms are presented. Social or space management models were examined while action plans for different levels were recommended. At the individual and national levels, training and information sharing are considered crucial to ensure sustainability and equity. At Government level, allocation and timely release of funds and other resources to future of space management projects should be pursued vigorously. The paper further recommends that a multi-disciplinary and multi-location research and development strategy should be adopted for future of space management projects.

MODEL OF PROTON SPATIAL-ENERGETIC DISTRIBUTION IN THE EARTH'S RADIATION BELTS

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A model of the equilibrium distribution of the Earth's radiation belt protons is offered for tutoring students in the high school. The average quiet time structure of the energetic protons of the Earth's radiation belt can be explained as an equilibrium balance between radial diffusive transport, losses due to Coulomb collisions, charge exchange with the ambient neutral hydrogen geocorona and drift of the protons under the influence of the magnetospheric convection. The mode of transport is diffusion due to substorm-associated fluctuations in the large-scale electric and magnetic fields. Attention is restricted to the equatorially mirroring protons within the energy range of 1 keV - 1 MeV. Theoretical predictions of the proton energy spectra at L values between 1 and 6.6 can be compared with an available experimental data.

DSATELLITE ACTIVITIES IN MEXICO AND LATIN AMERICA

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In this paper is presented a review of Microsatellite and Nanosatellite activities in Mexico and Latin-America. Also, in basis of Cubesat's platform, is showed how some countries in South America are realizing theirs own experimental satellites. Afterwards, Mexican Nanosatellite laboratory model is analyzed and studied with the purpose of collaboration with Mexican Scientifics in the construction of a Nanosatellite. This model will evolve gradually towards a 3.5 kg Mexican Nanosatellite project, attractive in terms of development time as well as in manufacture and launching costs. Is also presented the preliminary subsystems design of this Nanosatellite. Finally, are given some comments about the future of this project and the way in which the Russian and Mexican groups will to take part.

DUAL MICRO-SPACECRAFT CONFIGURATION AS A TOOL FOR THE GEOMAGNETIC STORM FORECASTS

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Two micro-spacecraft constellation with solar sails partially compensating the solar gravity allow their placement in the points along the Sun-Earth line behind the standard L1 point, i.e. further out from the Earth and closer to the Sun. The distances of the placement from the Earth and the base distances between such satellites depend on the ratios of their mass to the sail area. It can be selected in the way needed for the warning of the coronal mass ejection arrival several or many hours before the upcoming geomagnetic storm. Measurements of the magnetic field vector are necessary and sufficient for this purpose on each spacecraft. No plasma measurements are needed for this purpose, which makes the weight of spacecraft minimal. The sail can be used also as a solar panel, an antenna is oriented to the Earth for the radio transmission and device for obtaining a stable mechanical orientation of the spacecraft is directed along the Sun-Earth line. Time delays and known base distances between satellites allow using of the solar wind velocity measurements with a sufficient accuracy for the warning of the coronal mass ejection arrival to the Earth. Sky maps obtained with micro photo cameras and processed onboard can give the accurate spacecraft orientation needed for the determination of the crucial quantity: magnetic field vector orientation. Together with measured magnetic field strength and the solar wind velocity one can obtain information for the robust forecast of geomagnetic storms.

THE CURRENT POSITION AND THE PROSPECTS OF THE AMATEUR RADIO SATELLITES PROPOSALS

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This paper presents the brief review of the current position and the prospects of amateur radio satellites. Since the first launch of the amateur radio satellite at December 12, 1961 this sector of intellectual activity steadily developed in many countries. In 1969 it was formed the AMSAT unit (www.amsat.org) in USA which stimulate the radio amateurs worldwide. Some years later the amateur satellite development groups were formed in many countries, including USSR where RS-1 satellite was launched in 1972. At nowadays such activity is coordinated by The International Amateur Radio Union (IARU) which publishes the list of satellite projects for which frequencies have been coordinated (see http://www.iaru.org/satellite/sat-freq-coord.html).

Recent achievements in the field of amateur radio satellites are based on two projects - OSCAR-40 (launched at 1998) and OSCAR-51 (launched at 2004). This satellites lead to the formation of the new approaches. Special emphasis is devoted to the status of AMSAT-NA EAGLE satellite project and the AMSAT-DL P3E. Another crucial aspect of amateur radio satellites is using them as the platforms for scientific and educational projects. Since early days of SSTL in Surrey, UK, the UoSAT satellites carry out educational programs. Few amateur satellites served as the simple gate to space for Argentina, Brazil, Chile, Pakistan, Portugal, S.Korea, Algiers, Israel, etc. Now we have Canadian microsatellite MOST (Microvariability and Oscillations of Stars) which is operated within amateur bands. Also we might have in mind the development of modern information technologies and microelectronics in connection with amateur radio satellites. Next step is the CubeSat program proposed by Prof.R.Twiggs in Stanford University and originally designed by California Polytechnic State University. Total weight of the CubeSat is around 1 kg so it's called "nanosatellites".

The Soviet space industry gave Russian radio amateurs the unique possibility for satellites' development. In 1970s few groups were formed in order to develop radio amateur satellites and now the group in Kaluga continue

this work. Since 1991 they've produces and launched 10 satellites: from RS-16 to RS-25, (Mozhaetz-5). Now a new student satellite Baumanetz-175 (RS-27) is being prepared for the launch. The great success was achieved with "Universitetskiy-Tatiyana" satellite dedicated to the 250th anniversary of the Moscow State University (http://cosmos.msu.ru). It's also named as RS-22. It was launched as piggy back at January 20, 2005 and is operated as scientific and educational platform in MOST style. Kaluga Amateur Radio Center keeps the control of RS-22 and collect the data which is analyzed in Moscow University.

The radio amateur in space becomes available not only in the form of satellites. It became very popular after the Russian cosmonaut Musa Manarov conducted direct QSO with ground amateur stations. Today we have amateur radio on International Space Station and every crew provides very useful educational programs. The commander of the 13th crew, Bill McArthur conducted 38 special sessions with schools in US and elsewhere (see www.ariss.org).

During this Conference, we have historical record that more than 75 amateur radio satellites were launched now. We expect that next 75 will be launched very soon. It's became evident that through amateur radio hobby we grow up the next generation of space explorers and educators. Microsatellites play a crucial role in scientific and technological achievements so we have a bright future for our programs.

Section II. Space Researches in University Education - Heliobiology, Ecology, Atmosphere Sciences, Remote Sensing

SPACE METHODS IN EDUCATION OF ECOLOGISTS

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Application of space methods at the solution of the environmental problems finds reflection in teaching a lot of disciplines of a geoecological cycle baccalaureate and master degree preparations (geology, geography, landscape, a remote quality monitoring of a condition of an environment etc.). At ecological faculty of the Peoples Friendship Russian University the students began to get acquainted with the materials of space shootings already during the first year at physical geography lessons, studying various genetic forms of relief (fluvial, glacial and eolic). Space materials are already planned to use within the frames of territories field ecological practice. Results of the decoding of the pictures made with an interval of 10-20 years evidently show the character of changes natural ecosystems at increasing of anthropogenous pressure. During the second year the students who have already mastered elementary receptions of work with pictures, and know their characteristics, make geological interpretation of various structures of the Earth's crust in various landscape conditions, from deserted areas up to tundra, from mountain - folded areas up to plains. The result of these works is construction of elementary circuits of an estimation of a geoecological condition of the chosen territory. The most accessible objects of research are the separate areas of city of Moscow which serve as original standards for decoding various components of an anthropogenous landscape. The results of the works are schematic maps of an estimation of a geoecological situation in the separate areas of Moscow by comparison of the positive and negative factors influencing condition of an environment revealed at decoding of remote materials. These works are a part of lessons in landscape. The following stage of acquaintance of the students with the space methods is the special course

"Remote methods and mapping for master's degree" during the first year of geoecology. Within the framework of this year the students observe the features of displaying of the natural and technogenic dangerous and catastrophic processes on materials of remote sounding.

INTERNET SEMINARS AS A NEW WAY OF INTER-UNIVERSITY AEROSPACE CENTER ACTIVITY

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Internet-based learning has the greatest value in terms of access to information, novelty of information, its update rates and comprehensiveness. In such a dynamic field as remote sensing, the Internet resources already beat traditional libraries and image depositories. Internet-seminars of the Inter-University Aerospace Center pursue the purpose to use achievements of scientific and technical revolution in the educational purposes, for distant training. The following Internet-seminars were held during the period of 2000-2005:

- "Obtaining satellite images over Internet". Opportunities of Internet-access to the satellite images with various spatial resolution were characterized.
- "Digital processing of remotely sensed images. Handling multispectral images in the MultiSpec freeware". This program is a multifunctional yet very compact and easy-to use-tool for multispectral image classification. Three tutorials covers all the basic aspects from image input to spectral signature analysis, unsupervised and supervised classification.
- "Aerospace images for the school geography studies: Mountains. Altitudinal zonality". It is an illustrated application of aerial and satellite imagery for the school geography studies on the example of Caucasian mountains. The tutorials progressed from visual interpretation to simple classification and from small to detailed spatial scale.
- "Images of new types. Terra: ASTER, MODIS, MISR". The possibilities of obtaining and use of the new satellite imagery were shown. The tutorials compare new images properties with that of Landsat/ETM and Resourse O/MSU-E.
- "Aerospace images for study of high mountain regions: Glaciation dynamics. Natural hazards". Multi-temporal images of the Caucasus were

compared and analyzed. Several examples illustrated the possibilities of study of the changes in glacial lakes and other objects.

- "The International Space Station as an ecological patrol. A role of manned space platform and orbital stations in studying global changes of the Earth". The modern environmental researches carried out at the Russian segment of the ISS (including the program of monitoring of the dangerous natural phenomena and accidents "Hurricane" of the Institute of Geography RAS) were represented.
- "Space researches of the great oceans. Researches of the World oceans by means of remote sensing". Basic problems and methods of the remote sensing of the oceans are introduced, oceans fields and the phenomena investigated by the remote sensing methods are briefly considered.

Topics and methods for the seminars are defined by the novelty of techniques and/or imagery, accessibility for variously experienced users, suitability for low-speed Internet connections and for low-end computers, demonstration of geographical applications as well as technology. The material of the Internet-seminars is planned to fix as an electronic manual.

BIOENGINEERING IN AEROSPACE APPLICATIONS: A STUDY ON AEROSPACE MEDICINES

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This paper aims at the study and modelling of biological and physiological effects of atmospheric and space flight conditions (weightlessness, space radiation, acceleration, and altitude stress) on the human being; and the prevention of adverse effects of those environments. Our thrust is on studies and effects of flight through the atmosphere or in space upon the human body and with the prevention or cure of physiological or psychological malfunctions arising from these effects. By mathematical modelling and simulations, our vision is to come up with an alternative 'Aerospace medicine' with special interests on stress, physiological, and radiation effects of conventional medicine on the human being with direct application to aerospace flight and environments.

MOSCOW UNIVERSITY, VOROBJEVY GORY: AN AEROSPACE ATLAS FOR SCHOOL STUDENTS

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This educational Atlas is developed at the Laboratory of Aerospace Methods of the Cartography and Geoinformatics department, Faculty of Geography, Lomonosov Moscow State University (MSU). The Atlas is designed primarily for MSU students, scientific personnel, graduates and guests; for the students of the Young Geographers School at the Faculty of Geography, MSU; for the similar schools at other MSU faculties, and for Moscow schoolchildren for use in the Moscow studies subject. Moreover the Atlas can be interesting for students and staff of the University as an original guidebook. The second purpose of the Atlas is a practical familiarization with the aerospace images, training of the correct understanding of photographs and of the ability to obtain certain information from them. The application of the images in school education is a natural consequence of the latest developments in space research and of the wide application of aerospace information for scientific and economic purposes. The Atlas is based on aerospace images and consists of three parts. The first part presents the MSU location in Moscow, history and nature of the University territory at Vorobievy (Leninskye) gory. Types of images, ways of image processing and thematic interpretation are described in the second part. The third part is devoted to the specific objects of the MSU campus and its neighbourhood and to the development of the new University territory.

AEROSPACE IMAGES IN SCHOOL EDUCATION

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The necessity of aerospace education has arisen with the appearance of aerospace images and the beginning of wide application of aerospace information for science and economic purposes. The best approach would be to begin the teaching of image interpretation and understanding of the ways to use the aerospace information at school. Quality of teaching and quality of the pupils knowledge in many respects depends on the supply of necessary teaching aids. The Laboratory of Aerospace Methods at the Faculty of Geography, the Moscow State University, have been working for many years in the field of application of aerospace images in school education. According to the concept of the Laboratory of Aerospace Methods a satellite image is not just an illustration, but also a rich information source. The training aids are elaborated on the basis of aerospace information and coordinated with the school geography curriculum. As an example of new school training aids, which are based on aerospace images we present the wall posters Natural zones in satellite images , satellite image atlas The Earth is the planet of people. Vision from space , and an educational aerospace atlas Moscow University, Vorobjevy Gory .

IONOSPHERIC EFFECTS OF THE SOLAR RADIATION

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Low-altitude orbits of the microsatellites are mostly suitable for studying of the upper ionosphere dynamics. Here we present examples of the low- and mid-latitude ionosphere response to enhancements of the ionization caused by solar X-ray flares and solar energetic particles (SEP). Using ROCSAT-1 data we demonstrate that

- at sunlit hemisphere the ion density at altitudes of 600 km increases up to 80% in response to flare-associated enhancements of the solar X-ray emission;
- ionospheric response to the SEP events is revealed both at sunlit and nightside hemispheres, where the ion density increases up to 40% and 100%, respectively;
- direct ionization impact of the X-ray flares leads to increasing ionospheric conductivity and as result to intensification of the ionospheric current at low latitudes.

The latter is revealed as a variation of the low-latitude geomagnetic field, so called Dst-variation. The presented examples indicate to importance of simultaneous measurements of the solar radiation (electromagnetic and particles) and key ionospheric parameters, such as ion density, temperature and velocity.

ESPACE - A NEW MASTERS PROGRAM DEDICATED TO EARTH OBSERVATION FROM SPACE

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Satellite techniques gain more and more in importance for Earth System Science. Design, development and analysis of such missions requires knowledge from a broad spectra of fields, ranging from modelling components of the Earth system down to the behavior of the satellite system itself. The classical educational programs (such as geophysics, geodesy, mechanical or electrical engineering) which lead to careers, e.g., in space agencies, research institutes or industry, cover only part of this spectra.

In order to bridge the gap between the different Earth science and engineering programs, the Munich Universities have decided to set up a common international M.Sc. course in the field of "Earth Oriented Space Science and Technology (ESPACE)". ESPACE connects know-how in spacecraft technology and orbit mechanics with applications in Earth System Science, Remote Sensing and Navigation. It takes advantages of the Munich situation with its unique concentration of expertise in three universities, research institutions (like the German Aerospace Center, DLR) and space industry. The intention of ESPACE is to set up an educational network in the field of the Earth Oriented Space Research, connecting the M.Sc. course with a doctoral program and the research work of the involved institutions. In future, connections to similar programs across Europe are considered.

THE COMPUTER-BASED PRACTICAL STEREO MEASUREMENTS TRAINING COURSE IN THE AEROSPACE EDUCATION FOR THE STUDENTS OF GEOGRAPHICAL SPECIALITIES

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Geographers have always been interested in acquisition of three-dimensional geographical information of a studied area by means of satellite images. Many current and future images' acquiring satellites are, and will be, capable of performing stereo imaging of the Earth surface. This is the reason to train the geography students for stereoscopic measurements which are computer-based nowadays. A number of digital photogrammetric systems (such as PHOTOMOD of Racurs company or Image Station of Intergraph company) that are on the market now provide the technology for compilation and update of topographical maps with the use of aerial and satellite images. However, these universal systems do not take into account the specific features of the photogrammetric use of the imagery in geographic and geologic research, they are difficult to understand and expensive. Therefore they are not really applicable for education in natural science departments of the Universities. Digital photogrammetric systems, specially designed for educational purposes, which are comprehensible and at a reasonable price are used at the Faculty of Geography of the Moscow State University in the aerial and satellite images stereo measurements training course. Two main systems are the computer-based stereocomparator supporting visual stereo measurements at the personal computer monitor and the research stereo correlation utility for automated measurements of the aerial and satellite images for digital elevation models construction. Two practical exercises from the special computer-based stereo measurements training course are presented as an example.

SATELLITE TELEMETRY AND REMOTE SENSING TECHNIQUES IN ECOLOGICAL AND ZOOLOGICAL EDUCATION

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Worldwide the spatial orientation, habitat selection, and behavior of many animal species is already being investigated by means of the Argos Satellite System. Satellite telemetry utilizes a platform transmitter terminal (PTT, that could include sensors to measure depth, temperature, light level and humidity) attached to an animal which sends an ultra high frequency (401.650 MHz) signal to satellites. The satellites calculate the animal's location based on the Doppler effect and relay this information to receiving/interpreting sites on the ground. Two satellites are needed to obtain location information. Accuracy varies from within 150 m to 3 km. Global Positioning System (GPS) positions are processed along with Argos locations through the Argos system with an accuracy of 5-15 m (such tags could include GSM modem to send data directly to a hand phone of a researcher). Not only the cost of PTT and GPS tags is high ($900-3000), but the researcher must pay for the data acquisition and processing which can cost $90-260 per month per animal. That's why Universities launch their own satellites to receive data from these tags at lower cost (like TUBSAT-A of Technical University of Berlin). Department of Vertebrate Zoology of Lomonosov Moscow State University (MSU) conducts research with a variety of animals that needs satellite tracking. Some of the species are endangered, like the sea-eagle (Haliaeetus pelagicus) and the swan goose (Anser cygnoides), for which satellite telemetry has been employed to trace migration routes in the Far East region together with our colleagues from Tokyo University. The lightest PTT known nowadays weighs 9.5 g, that still limits the use of satellite telemetry for tracking a large number of small animals like passerine birds, rodents and amphibians - the subjects of study of the students of the 1-2 year at Zvenigorod Biological Station (MSU) during their summer practice. That's why one should find perspective to invent smaller transmitters for future research and education. Another useful

tool for studying animal habitat selection and human environmental pressure is remote sensing. Laboratory of Geoecology of North (MSU) includes a group of scientists specialized in decoding of the Earth images received from satellites. The group has developed its own program "Timan" for images decoding. Together with the students from the Department of Vertebrate Zoology (MSU) they conducted a research on the migration and habitat selection of the Barnacle goose (Branta leucopsis) in Barents Sea region and whales' movements near Sakhalin. The group has also organized a student training course "Remote sensing techniques in studying the environment and soil cover" at the Faculty of Soil Science (MSU).

NETWORKING: A MANAGEMENT STRATEGY FOR FUTURE OF SPACE MANAGEMENT

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As a management strategy for future of space management, appropriate approach to networking will certainly bring out the expected results in terms of organizing the people to working groups, forming clear objectives making the people to participate, getting the necessary financial needs and working and avoiding unhealthy competition among other networks. Networking stands to be a practical oriented management tool which co-opts people right from the grassroots even to an advanced level of policy making. This paper discusses the concept of networking among the stakeholders in future of space management.

SSETI, THE STUDENT SPACE EXPLORATION AND TECHNOLOGY INITIATIVE

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Students of distributed Universities across Europe built and launched a satellite called SSETI Express in a very short time. Collaboration between the pan-European network of students, Universities and experts involved in the Student Space Education and Technology Initiative (SSETI) has been carried out mainly via Internet.

ANAGLYPH STEREO PRESENTATION IS A NEW FORM OF AEROSPACE EDUCATION

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Anaglyph method of a visual perception of 3-D images consists of the following: simultaneous presentation of the complement images of stereomate (left image of the red color, right image of the blue color); following visual perception of these images through the left red filter and through the right blue filter. At present, practical using of this well-known method is developed for remote aerospace education. A stereomate of the anaglyph images is projecting to the screen from a display of digital photogrammetric equipment. Multiple audience (for example, student group) can simultaneously visual percept of 3-D model and measuring cursor through elemental color filters (color glass). It is very important because traditional photogrammetric equipment has oriented for alone operators. The main task of the preparation of educational photogrammetric stereo presentation includes constructing of anaglyph stereomate on computer display and its projecting to the demonstrating screen for the purpose of the forming of projected stereo model. The method of the forming of the best quality photogrammetric anaglyph stereomate has been developed in Laboratory of Aerospace Methods of the Moscow State University.This method consists of:

- formation of the stereomate from initial digital images or from analog-to-digital conversion of aerospace photo images;
- accounting of the parameters of digital image pixel, estimation of the optimal measurement of longitudinal parallaxes for the best visual stereo perception, mutual geometrical correction of the digital stereomate images;
- formation of the digital anaglyph images and their color correction, mutual orientation of the digital anaglyph images, constructing of the digital anaglyph stereomates;
- estimation and production of the optimal conditions of anaglyph stereo presentation.

Some important and interesting results were obtained by proposed method for the organization of the education process of the aerospace disciplines.

Section III. Technology Education: Design, Development and Management of University Satellites

MODULE "DUST" OF EQUIPMENT "CHISTOTA" ON RESEARCH DUST VICINITY OF THE "PHOTON-M" SPACECRAFT

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The equipment "Chistota" for the control of parameters of external atmosphere of the spacecraft "Photon-M" #2 was developed and manufactured in the Laboratory of Space Instrument Development of the Samara State Aerospace University. Flight of the spacecraft "Photon-M" #2 took place in June 2005. Module "Dust" is intended for gathering data of dust particles characteristics in the vicinity of the spacecraft. For the given purpose two gauges, established on the spacecraft's surface were used. The combined gauges measured the temperature of the gauge's surface, fixed sunlight's presence, registered flying by dust particles in the optical way, weight of the adsorbed substance on a surface of the quartz resonator. The obtained experimental data have shown, that the temperature gauges have appeared disabled, gauges of a flare, quartz and optical gauges have carried out the problem. Now the obtained data is being processed, but it is already possible to conclude that the obtained results are sufficiently interesting: approximately during three hours of operation it was observed a decrease of the settled weight on quartz gauges, and optical gauges gave considerably greater concentration of dust particles. Processing of the results will be completed in summer 2006.

THE PROJECT OF THE SCIENTIFIC - EDUCATIONAL SMALL SATELLITE FOR RESEARCH OF EARTH UPPER ATMOSPHERE DENSITY

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At the end of 80th years the project of a small spherical satellite "PION" was developed in Kuybishev aviation institute (nowadays the Samara State Aerospace University). The satellite was intended both for calibration of ground resources of tracing space objects and for refinement of density of the Earth's upper atmosphere. Six satellites were launched during the period from 1989 to 1992. The results of the experiments admitted useful both for perfecting radar aids of space control, and for improvement of navigation-ballistic support of low-altitude spacecrafts. In order to determine the atmospheric density it is necessary to know the aerodynamics of the object and its orientation relative wind of rarefied gas. These reasons lie in the basis of choice of the spherical form of "PION" satellite and they can be adopted for the offered satellite. However basic difference of the offered project is refusal from usage of the conventional ground infrastructure used now for navigation-ballistic tracking and control of spacecrafts' motion, that sharply reduces the price of implementation of the project and, in case of success, will create premises for development of the permanent system of the Earth's upper atmosphere monitoring. In order to reach this effect it is offered to use successfully existing state-of-the-art commercial information and telecommunication environment - satellite radio navigation systems such as GPS/GLONASS, low-orbital communication satellite systems such as GlobalStar/Iridium/Orbcomm, a global INTERNET network. Development of such satellite will allow to research dynamics of the Earth's upper atmosphere density, including its short-period variations. The main applied problems of the project are the following:

- The improvement of the technology of continuous monitoring of the Earth's upper atmosphere density for improvement of quality of operating navigation-ballistic tracking low-altitude spacecrafts;
- The improvement of the technology of using of navigation receivers for operating definition of the Earth's upper atmosphere with a minimum time lag;

- The improvement of the technology of support of constant access to onboard satellite systems and transmission of the scientific data from the satellite to customers using the low-altitude communications satellites networks (Global Star, Orbkomm) and a global INTERNET network (without using the existing ground control centers);
- The improvement of the perspective damping system of satellite.

The educational tasks of the project are the following:

- The improvement of the remote training educational technologies using direct access to the onboard measurements;
- The improvement of quality of student education on space trades at the expense of possibility of their involvement into development of small satellite, access to the process of direct measurement of motion parameters, obtaining and processing of the measured information;
- The Internet information resource developed in support of the project will popularize the achievements of space sciences especially among the youth.

USAGE OF STATE-OF-THE-ART INFORMATION TECHNOLOGIES FOR TRACKING SCIENTIFIC - EDUCATIONAL PROJECTS

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In order to rise the educational effect, to strengthen the interest to space researches on the part of the youth it is necessary to develop special information resources, permitting to approach the users located on the Earth to that occurs in space. It is a lot of experiments in space devoted to the studies of the behavior of substance in space conditions with the purpose of development of the theoretical basis of space production in microgravitation. It is desirable to know microgravitational environment in flight time. The purpose of the developed scientific - educational program complex is forming on the Earth of a virtual model of microgravitational environment in which space experiments are carried out, and virtual motion model of the spacecraft on the basis of telemetry data. The first version of such program complex was developed in order to support the students' research experiments onboard microgravitational space platform (MSP) "Foton-M2" which has been launched in June, 2005. Within the framework of this information project it was realized the constant simulation and prediction of MSP motion and microgravitational parameters onboard directly in flight time with representation of this information to the users via INTERNET. The motion parameters were determined by means of information from the navigation receiver and magnetometer, included in the equipment "MIRAGE" placed on MSP board. The information from MSP were transmitted to the Earth by telemetry channel handled in the special program unit. There was a solution of the navigation task and corners of orientation and angular velocities of motion were determined. Data about the full MSP state vector, adduced to a certain moment, further acted in the motion simulation unit of virtual "Foton" where they were used in the capacity of initial entry conditions at integration of the motion differential equations system. Besides, microacceleration levels were calculated in various points of the bay of scientific equipment caused both MSP dynamics and aerodynamic braking. In the unit of visualization the information processing acting from the simulation unit

and its representation in visual and user-friendly sort was made. This unit was built into the INTERNET site created specially for support of the given program. Users from directors of experiments and other interested persons could get access to this information by entering the password and coordinates of allocation of the experimental gear in connected coordinate system. The developed program complex concerns to the class of the distributed program systems. The program complex is logically divided into two parts: server and client. The server part includes the subsystem of data acquisition, a control system of databases (DBMS), the subsystem of simulation of motion and the subsystem of support of link with a client part. The client part includes the subsystem of visualization, the subsystem of additional scaling and the subsystem of support of link with a server part. The given program complex was implemented in Java 2 language which doubtless advantage is multi-platform, concluding in independence of the program from the computer and operating system, that beyond all bounds expands a circle of users of such a program.

ACCURATE SATELLITE TRAJECTORY DETERMINATION USING IGS PRECISE EPHEMERIS

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Errors in determination of an object position in standard regime of satellite navigation systems functioning can amount to several meters. One of causes of such a precision level is inexactitude of ephemeris registered by the receiver during the satellite measurements. In gravimetry and for some other special tasks it is allowed to work up measurements not immediately but after some time, that gives a possibility to determine an object position more precisely at the expense of more accurate determination of satellite coordinates and velocity. International Global Navigation Satellite Systems Service (IGS) let users of satellite navigation systems free access to the information of rather precise coordinates of every satellite in Greenwich coordinate system with two week delay. It is declared that precision level of these position data does not exceed 15-20 mm for GPS satellites, and 50-60 mm for GLONASS satellites. Data are renovated every fifteen minutes. An algorithm using precise position IGS information and estimating errors of primary determination of satellite coordinates and velocity with following their compensation was elaborated to define trajectory parameters of every satellite more precisely. As a result of applying this algorithm the trajectory of every satellite was defined as precise as IGS data. This algorithm can be used in order to simulate approximate observable parameters for the "Universitetskiy-Tatyana" satellite more precisely. This procedure consists of two steps. First, we simulate the spacecraft's motion for the certain period of time by taking the parameters of its orbit. Then, we determine approximate observable parameters using precise trajectory of every navigation satellite.

AN OVERVIEW OF PRACTICAL GPS NAVIGATION FOR STUDENTS

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Practical GPS navigation includes a training course for the students providing them easier interaction with GPS hardware and its applications. Several methods of GPS positioning are introduced.

DELFI-C3: DELFT UNIVERSITY OF TECHNOLOGY'S NANOSATELLITE

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In-orbit demonstration of functionality and performance improves confidence in the technology. Although generally an extensive qualification approach prior to launch is followed, for micro- and nanotechnology, nanosatellites can be a suitable qualification platform. For several years a standard has been developed for such satellites, aimed at university projects and other non-commercial applications. Initiated by Stanford University's Space Systems Development Lab and California Polytechnic State University San Luis Obispo (CalPoly), the CubeSat concept has been developed to offer students the opportunity to gain experience in space technology by working on a real space mission. Delfi-C3, a two-year student satellite project of the Faculty of Aerospace Engineering and the Faculty of Electrical Engineering, Mathematics and Computer Sciences of Delft University of Technology in the Netherlands is based on this CubeSat standard. The Delfi-C3 satellite will act as a technology test-bed for three payloads. A Thin Film Solar Cell experiment will be performed to verify the performance of these cells in the space environment. In addition, an autonomous Sun Sensor using a wireless data link will be demonstrated. The third new technology will be an advanced high efficiency transceiver sized for application in pico- and nanosatellites. Delfi-C3 is scheduled for a piggyback launch in the second quarter of 2007 and is a precursor of the extensive MiSat program, which started in 2005 with the aim to develop micro- and nanosatellites that will demonstrate a wide range of Micro Systems Technology and Micro-Electronics for use in spacecraft. Connected with MicroNed and MISAT, a number of successors for Delfi-C3 are foreseen to provide early on-orbit demonstration of these technologies every one or two years. In the presentation, the Delfi-C3 mission and satellite with its payloads are addressed. Furthermore, some technical solutions and the way the project is implemented in the university's educational program are presented.

SIMULATION OF CODE AND DOPPLER GPS & GLONASS OBSERVABLES AND FEASIBLE POSITIONING ALGORITHMS FOR THE "UNIVERSITETSKIY - TATYANA" SATELLITE

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This report deals with feasible positioning and velocity algorithms of complex processing of GPS&GLONASS code and doppler observable parameters. Algorithms of complex processing can give more accurate navigational results than algorithms which use observable parameters of GPS only or GLONASS only. The reason of it is that the volume of initial information in complex processing increases. However, the constructing of such algorithms needs exactness because there are essential differences between two satellite systems. These differences are described in the report and the appropriate models of satellite observable parameters are built. The main distinction of the constructed algorithms from standard is the increasing of a number of defined parameters by one. This parameter is the unknown value of divergence between system time scales of GLONASS and GPS. Therefore, it s necessary to have measurements of not less than five satellites to solve the navigational task instead of four in standard algorithm. The constructed algorithms can be applied to processing of real experimental data or of observable parameters that was simulated. This paper deals with approximate observable parameters for the "Universitetskiy-Tatyana" satellite that was simulated. The algorithm of the modelling of the observable parameters consists of several steps. First, we take the parameters of the orbit of the "Universitetskiy-Tatyana" satellite and simulate its motion at the certain period of time. Second, we take the ephemerids of GLONASS&GPS satellites for the same period of time. Then, using modelled coordinates and velocities of the satellites in Greenwich coordinate system we can find necessary pseudo-ranges and pseudo-velocities for the "Universitetskiy-Tatyana" satellite. At the end, we can combine these pseodo-measurements with needed errors such as clock errors of the satellites and receiver or ionosphere and troposphere errors.

DESIGN AND IMPLEMENTATION OF "BAUMANETS" MICROSATELLITE

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The BAUMANENTS spacecraft which is being developed by Bauman Moscow State Technical University in association with Federal Unitary Enterprize "NPO Mashinostroenie" is considered. Several options of the satellite layout, considered at concept design stage are shown. Influencing factor is mutual influence of heat control system, structural elements and set of equipment on board of the satellite. Peculiarities of connection of the satellite with rocket launcher at launch facility are shown. Selection of major design decision is justified. Additional peculiarities of creation of the satellite is the fact that working drawings and documentation was developed immediately after concept design stage. Stages of the experimental realization of the satellite are described. Detailed description of thermo-vacuum and electrical tests are shown: autonomous, connection, complex. Corrections implemented in documentation and construction at the stages of systems' development and their implementation and tests are shown.

THE FIRST UKRAINIAN NANOSATELLITE - MAIN GOALS AND COMPLEX OF SCIENTIFIC INSTRUMENTS

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The goal of the project FORTUNA is to carry out the fundamental scientific investigations of ionosphere physics and to develop the methods of near-Earth space monitoring. This is the common project of the Lviv Center of Institute of Space Research of National Academy of Science of Ukraine, Yuzhnoye Design Office and the young scientists and students of the leading universities of Ukraine. Scientific goals of the project include: measurements of thin structure of electric currents and electromagnetic fields of the ionospheric plasma; measurements of kinetic parameters of the plasma; correlative analysis of the connections between the ionospheric disturbances and meteorological and seismic activity.In order to realize mentioned above tasks the following complex of scientific instruments was developed: a three-component flux-gate magnetometer; wave probe; electric field sensors; kinetic plasma parameters sensor. The nanosatellite will be operated on a polar and circular orbit, with altitude of up to 450 km. Such an orbit will allow to cover all the Earth's surface and intersections of the main morphological regions of the ionosphere: polar cusps, etc. During some circuits the satellite will pass over the heating stands of Radio-astronomical institutions of National Academy of Science of Ukraine (Kharkiv) and the acoustic source of the Lviv Center of Institute of Space Research of National Academy of Science (Lviv). It gives the possibility to carry out the coordinated experiments in the atmosphere heating and registration of the effects from the satellite onboard. There will be also a possibility to study the influence of a powerful heating complex onto auroral ionosphere when the satellite will be flying over the European ionosphere association EISCAT (Tromse, Norway). The use of the nanosatellite will allow to register both the ionospheric disturbances caused by solar and geomagnetic activity and ionospheric responses to the natural and technogenic influences from below. The launch of the nanosatellite FORTUNA is scheduled for 2009. The research was partly supported by NSAU Contract 1-02/03 (1274).

SIMULATION OF CARRIER PHASE GPS OBSERVABLE PARAMETERS AND FEASIBLE ATTITUDE DETERMINATION ALGORITHMS FOR THE "UNIVERSITETSKIY - TATYANA" SATELLITE

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Attitude determination is widely used in navigation, geodesy, construction, magnetometry, gravimetry and so on. Carrier phase observable parameters of radio signals transmitted by navigation satellites, when obtained from multiple antennas, potentially could provide the most accurate and stable solution for attitude determination among other methods. Introducing additional information on the antennas relative positions results in additional accuracy of the solution. A wide variety of estimation techniques is used (including restricted least-squares methods, modifications of Kalman filtering, etc.) No single method could provide the appropriate result due to some special properties of the problem, therefore a proper combination of several techniques should be used. Obtaining that solution is rather sophisticated process but some general approaches could be introduced to even non-specialists, for example, students, to get them generally acquainted with some obstacles in attitude determination. Thus, the motion of the "Universitetskiy-Tatyana" satellite and carrier phase observable parameters should be simulated. This simulation could be based on the already developed practical training for students in satellite navigation. Carrier phase measurements received by the hardware are distorted due to the effects of radio-signal propagation through the environment. That is why some signal-processing techniques are to be applied. In addition the presence of undetermined ambiguities is the essential property of carrier phase observable parameters. Those ambiguities should be resolved using different approaches.

AN OVERVIEW OF PRACTICAL TRAINING FOR STUDENTS IN SIMULATED SATELLITE NAVIGATION AND ATTITUDE DETERMINATION FOR "UNIVERSITETSKIY - TATYANA" SATELLITE

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The practical training has been developed in order to provide a basic introduction for students into satellite navigation, satellite motion in space, Kepler orbits, and computational techniques involved in dealing with problems of navigation. This introduction takes the "Universitetskiy-Tatyana" satellite as an example for simulation process. Theoretical material of the training includes several topics such as basics of celestial mechanics, Kepler's laws, including applicable formulae for a satellite orbit calculation, description of reference systems used in satellite navigation, general approaches to positioning using satellite navigation systems, a general description and functionality of these systems (GPS and GLONASS), observable parameters obtained from GPS and GLONASS satellites, and finally iterative least-squares method. A general overview on the errors of satellite navigation observable parameters due to signal propagation through space is given. Practical simulation includes visualization of the motion of satellites and its orbits, the constellation used for navigation, modelling the satellite navigation observable and least-squares method. All the quantities used in simulation are very close to those appearing in reality. For example, all ephemeris data is being taken from a standard RINEX files recorded during field surveys. Also the technique for satellite trajectory propagation (orbital prognosis) is presented. Unfortunately, the actual telemetry data is not available from the "Universitetskiy-Tatyana" satellite. Using of the actual data could be of great interest for the practical training. In order to provide more profound introduction into satellite navigation techniques several feasible exercises have been proposed. References are also given to allow consulting an additional material.

TRACKING PROGRAMS FOR GROUND STATIONS

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To track and control a spacecraft on the orbit the special software is needed, which manages the transceiver of a ground station (switching on/off, transmission of controlling commands) and also receives, processes, stores data obtained from the board of a spacecraft. The software also shows situation (computed trajectory of a spacecraft, range of radio visibility) on display of computer. There are two types of such software: original programs that are written specially for certain ground stations and freely distributed in the internet for wide range of users. The present work is concerned with preliminary review of universal programs of the second type, since they are widely available, most of all for schools and universities which may not dispose sufficient means to develop own software or to buy specialized software. We have acquainted with thirteen free programs from which eight are written for Windows and five for Linux. As criterion we chose following parameters: easiness to install and run, interface convenience and clearness, possibility to update the TLE information from internet. At present, program that meets mentioned criteria is Orbitron written by Sebastian Stoff. It is significant that all examined programs can depict only the simulated range of radio visibility of the Earth surface from the spacecraft but not the range of radio visibility of the spacecraft from the ground station. It is not available to specify such value in any of examined programs.

USE OF MICROSATELLITE TECHNOLOGY IN AEROSPACE EDUCATION BY THE EXAMPLE OF BAUMANETS MICROSATELLITE PROJECT

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BAUMANETS microsatellite project is currently being carried out by Bauman Moscow State Technical University (BMSTU) in cooperation with "Mash -inostroenie" Production Association. The goal of the project is the development of a microsatellite with mass of 97 kg, with remote sensing camera and scientific equipment on board. Students have already developed the spacecraft and ground support equipment, conducted research and testing, developed scientific experiments and software. First time in Russia the project of such magnitude is completely implemented by students, with participation of experts from aerospace industry. During the flight of the satellite the students will control the spacecraft, operate and maintain mission control center based at BMSTU, conduct on-board experiments and process remote sensing data together with domestic and international partners.
The main results of the project are the following:

- Modernization of educational process and laboratory activity using satellite experience;
- Organization of a new laboratory at the University;
- Development of international cooperation;
- Project started in December 2003;
- Design works were ended in May 2004;
- Final assembly was ended in December 2005;
- Launch is scheduled for March 2006. Life span: 1.5 years;
- By now, over 100 students have participated in the project;
- 20 reports were published;

- Over 20 students graduated from BMSTU and got fixed up in a job in the leading Russian and international aerospace companies.

Such real-life projects, which have tangible practical application and include full life-cycle from the development, manufacturing, testing and launching to the operation and scientific experiments in cooperation with domestic and international partners, are used to attract the students' interest in aerospace and increase quality of education. Modern information technologies, miniaturization and commercial availability of the components, access to affordable communication channels make implementation of such projects possible even by a single University. Need in such project comes from the fact that currently Russia experiences decline of interest in aerospace disciplines due to shift of interest to economic, legal, information areas. Due to break between industry and academia and decrease of number of new projects the students have less opportunities to get practical experience. Meanwhile, modern labor market in aerospace shows increasing requirements of university education quality. It's caused by technological progress in the industry, world globalization and cooperation, increase of share of information technologies in final product and in its development.

GLOBALSTAR EXPERIMENT ON BOARD "BAUMANENTS" SPACECRAFT

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A set of instrumentation for conducting scientific experiments including satellite modem Qualcomm GSP 1620 is installed onboard of BAUMANENTS spacecraft which was developed by Bauman Moscow State Technical University in association with Federal Unitary Enterprise "NPO Mashinostroenie". This experiment is a continuation of the project carried by the Russian Research and Development Institute of Space Instrument-Making onboard of the TNS-01 satellite. The BAUMANETS satellite will be operated on near-polar orbit at the altitude of 500 km. The following theoretical calculations were performed: zones of visibility of the Baumanets satellite's modem's antenna, Doppler frequency translation. Maximum and average duration of communication windows were assessed, as well as volumes of transferred information. It is shown how equipment is positioned on panels of the spacecraft, their connection with onboard computer and control & navigation system. Necessity of employment of commutating unit in wiring system is explained. The software for onboard computer controlling the modem, which allows to initiate communication both by the satellite's initiative and by the ground-based user was developed. Typical algorithms with modem commands are shown. Hardware and software went through significant amount of ground testing, which included a series of special tests. Results of such tests and implemented changes are presented. Within the frames of the additional experiment the information coming from the modem will be used in order to define the orbit parameters of the satellite. Mathematic model of this experiment is presented, as well as algorithm of solution and results of numerical experiments.

SYSTEM OF CHARGE MEASUREMENT OF THE FOTON-M2 SPACECRAFT

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The charging of the spacecrafts and their elements leads to failures of electric equipment. This problem is shown especially sharply on geostationary satellites which are operated on high orbit for long time. The charging of the spacecraft occurs as a result of the influence of some the factors, in particular surrounding space plasma and solar electromagnetic radiation on its surface. The sign and value of electric charge formed on surface of the spacecraft depend on a activity ratio of the processes providing receipt on a surface and a drain from it of positive and negative charged particles, and also from the characteristics of the constructional materials and features of the spacecraft's geometry. In order to study the charging process, its influences on working capacity of the electronic equipment four superficial gauges and one remote charging sensor were installed on the spacecraft "Foton-M2" (altitude of the orbit - 300 km, duration of flight - 14 days). These sensors together with the equipment for information processing allow to measure charged particles flux on the surface of the spacecraft and own charge during all stages of the flight. Preliminary mathematical simulation of the charge process of the spacecraft allowed to choose key parameters of the charging sensors. The values of the potentials received as a result of the experiment in general coincide with theoretical estimations, but allow to specify the mechanism of production of superficial charge of the spacecraft. Preliminary processing of the received data has shown, that the maximal potential does not exceed 7 Volts.

MODELLING OF MICROELECTROMECANICAL INSTUMENTS FOR NANOSATELLITES

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Modern anosatellites apply different mechanical and electromechanical sensors and transducers both in measurements and in fulfillment equipment (for example, as inertial sensors) [1]. Some of these devices are modeled by linear vibration systems. In the analysis and computing of the linear mechanical systems also electromechanical one may applicated "traditional" well-established methods such as drawing up differential equations with subsequent direct computing of them. In case of system with more than two degrees of freedom difficulties in computation process grow step by step according to growing up the number degrees of freedom. Properties of mechanical circuit are characterized by complex number value so called mechanical impedance. The mechanical impedance is denoted as ratio of force to velocity $Z = \frac{F}{V}$. The electrical oscillation circuits process accounts integro-differential equations. In linear case they are transformed to algebraist ones by symbolic method or method of complex amplitudes. In mechanical systems vibrations accounts similar integro-differential equations. Therefore, method of electromechanical analogies is based on this resemblance. However, the total mechanical impedance of a set of impedances in series is given by equation: $\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3} +, etc.$ The overall mechanical impedance of a number of impedances in parallel is given by equation:$Z = Z1 + Z2 + Z3 +, etc.$ But in electrical circuits total impedance of connected components calculated quite the contrary: $\frac{1}{z} = \frac{1}{z_1} + \frac{1}{z_2} + \frac{1}{z_3} +, etc.$ for parallel and $z = z_1 + z_2 + z_3 + etc.$ for series. This unaccordance generated problems in building up an adequate model and differential equations for its computing. The way out of this situation was given by F.A. Firestone [2,3] and after was continued by P.A. Popov and V.I. Shorov [4]. According to physics sense we divided quantities on two kinds: across elements (velocity, voltage) and through elements (force, current). In this case mechanical impedance is ratio of through to across quantities and electrical is vice versa. Complex mobility is given by as ratio velocity to force $K = \frac{V}{F}$ is correct mechanical characteristic of mechanical circuit instead of "traditional" impedance with completely equivalent to

electrical impedance. Thus, complex mobility (named as H) for series mechanical circuit is given by equation: $H = H_1 + H_2 + H_3 +, etc.$, and for parallel is $\frac{1}{H} = \frac{1}{H_1} + \frac{1}{H_2} + \frac{1}{H_3} +, etc.$ Now with applying complex mobility method to building up models of mechanical and electromechanical systems with many degrees of freedom such as ramified circuits appears possibility to consider different mechanical or electromechanical sensors and transdusers.

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THE T-REX PROJECT

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The T-Rex project started in April 2005 at the Institute of Astronautics as a part of the practical course "Space Technology". T-Rex stands for TUM (Technische Universitet Munchen) Payload Experiment on REXUS. REXUS (Rocket-borne Experiments for University Students) is a ballistic rocket, which will be launched in Kiruna (Sweden) in 2006. The goal of this student experiment was to construct a scientific payload to measure accelerations in different axes which occur due to the movement of the carrier rocket. The students participating in the practical course were split up into three teams: Software, Hardware and Structure & Tests. The project itself focused on using commercial of the shelf (COTS) components. Hence, low cost acceleration sensors (G-sensors) have been used which were not "space-proven".

The paper presents the work and collaboration of the students in order to accomplish the requirements of the experiment which includes, for example, construction of the actual hardware, the programming of the microcontrollers and prototyping. Furthermore, the results demonstrating the evaluation of the employed sensors are presented.

SWAP AND LYRA INSTRUMENTS ONBOARD PROBA2 MICROSATELLITE

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PROBA2 is an ESA microsatellite (not larger than a domestic washing machine) that will be launched in 2007 into a dawn - dusk Sun-synchronous orbit. Its primary goal is technology demonstration; however, it will also carry scientific instruments. SWAP (Sun Watcher using Active Pixel sensor and image processing) and LYRA (Large-Yield RAdiometer) are the two major components of the scientific payload. They are developed by the international consortia led by the Royal Observatory of Belgium. SWAP telescope will obtain images of the solar corona in the extreme ultraviolet (UV) using a novel Active Pixel Sensor (APS) detector. LYRA is based on a new "solar blind" diamond detector and will monitor the solar irradiance in four UV band-passes. SWAP and LYRA data will be of use for solar physics, aeronomy and space weather studies. The main characteristics of SWAP and LYRA instruments are presented. The participation of the students and young scientists in the SWAP and LYRA data analysis is greatly encouraged through the open data policy.

Section IV. Basic Space Sciences in High-School and Cooperation in Space Education Projects

REVIEW OF PERSPECTIVE OF COOPERATION WITH UNIVERSITIES FOR REALIZATION OF EXPERIMENT "SPACE SOLAR PATROL"

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It is known, that the short-wave radiation of the Sun in range of 0.1 - 200 nm represents one of key elements of solar-terrestrial relationship system, and its flux monitoring at orbit of the Earth allows to decide a series of fundamental and applied problems of physics of the Sun, upper atmosphere and ionosphere. In spite of the fact that nowadays the wide experience in satellite measurements of soft X-ray and extreme ultraviolet (EUV) radiation of the Sun has been accumulated, the gaps in realization of full permanent monitoring of this radiation still remain. So, in the operational space experiments: SOHO, TIMED and SORCE, - devices, which determining a spectral distribution and absolute values of fluxes of solar radiation (such as spectrometers and photometers), are operated within different spectral ranges. Besides, TIMED and SORCE have not provided the permanent monitoring of the Sun, because the time of measurements are 3 min and 60 min, consequently, for hour and a half orbit of these satellites. Moreover, SORCE instrumentation does not cover the main part of EUV radiation. Existed permanent measurements from full disk of the Sun by ionization chambers of GOES occur only in a narrow spectral interval of 0.05 - 0.8 nm. One of the most perspective ways to realize this monitoring is the launch of "Space solar patrol" (SSP) instrumentation, developed by S.I. Vavilov State Optical Institute [1,2]. Thus, the cooperation with the Universities is possible and even desirable (for example, the small satellite "Mozhaets", developed by A.F. Mozhaiskiy Military Space Academy is one of the variant for SSP launching [1,2]) both in field of choosing of a satellite for the SSP installation, and in the field of the measured data processing.

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SIMPLE PARTICLE DETECTOR FOR EDUCATIONAL PURPOSES

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In physics and space education involvement of students in the experimental studies is of crucial importance. It is necessary to select a topic interesting from the scientific point of view and simple enough to allow students understand and participate in all stages of experiment from measurements via data analysis to physical inference. Also the experimental results should be apparent and allow on-line analysis and interpretation. It's very important to connect the physical inference not only with progress of the fundamental science, but also with applied problems, and, if possible, with real life problems. Particle detector designed and commissioned in Cosmic Ray Division of Alikhanyan Physics Institute fulfills these requirements. Particle detector is measuring count rate (number of hits per minute) of secondary cosmic rays. Simple microcontroller driven electronics, allows to measure separately fluxes of neutrons, low energy charged component (mostly electrons and muons) and high energy muons. From the scientific point of view it is an advanced detector, measuring the characteristics of global geophysical parameters in much more details comparing with existent networks of particle detectors. Basic physics is extremely interesting and up-to-date. Particle detectors measure changing fluxes of particle fluxes. By measuring neutral and charges species of secondary fluxes it is possible to reconstruct primary flux of cosmic rays incident on the terrestrial atmosphere (mostly protons for energies up to several tens of GeV). Changes of the primary flux depends on solar activity and reflect major solar events: flares, acceleration of particles, coronal mass ejections. Physics of Solar flares is one of the fastest developing fields of high energy astrophysics both from theoretical and experimental points of view. The universal processes of particle acceleration by the stellar objects and shocks are one of main unsolved problems vital for understanding the Universe and our nearest star gives us an excellent possibility to study these processes in virtu. Space Weather is another aspect of solar "modulation": many space and surface technologies are affected by the consequences

of violent solar explosions. Solar modulation effects usually lasts not more than 2 weeks, the time while group of spots travels via the visible solar disc. The effects of solar modulations are reflected in the noticeable changes of the count rates of particle detectors. For the data analysis we prepare simple and powerful platform allowing remote on-line data analysis. Revealing and enumerating the peaks, estimating significance decreases and increases of count rates, estimating correlations between charged and neutral fluxes and many other operations are feasible via our DVIN3 software. The students will get experience in the statistical procedures necessary for the physical inference using measurements of their own detector. Solar modulation effects and physical characteristics and analysis of the major solar events are possible only by joining data from space-born and surface particle and radiation detectors. The students will participate in data exchange and joint analysis within several scientific networks, thus understanding that communicating the results of own research is an obligatory part of global scientific process.

SUMMER SPACE SCHOOLS AS AN EFFECTIVE FORM OF OPERATION WITHIN THE FRAMES OF INTERNATIONAL EDUCATIONAL SPACE PROJECTS

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Now in Russia and in other countries the interest of the youth to obtaining derivation and the subsequent operation in the field of space-rocket engineering diminishes. It is necessary to look for new forms of engaging of the youth into cosmonautics. Organization of international space schools is one of perspective variants of such activity. In their frames young people can listen to the lectures of famous scientists and specialists on pressing questions of space engineering, to work at joint projects, to exchange the ideas and the obtained results, to acquaint with the Russian crop and natural sights. All this will allow Russia to be integrated more actively into the global scientific - educational space and will create the joint projects in the field of space research. Realization of Summer space schools "Future space technologies and experiments in space" on the basis of the Samara State Aerospace University is a positive example of implementation of these ideas. In 2003 and 2004 the students from 15 universities of Netherlands, France, Spain, Italy, Greece, Germany, Sweden, Finland, Poland, the Great Britain participated in Russian - European summer space schools. Russian participants represented the Moscow State University, Moscow State Technical University, Penza, Saratov and Izhevsk (http://www.volgaspace.ru/school). State Research-Production Rocket Space Center "TsSKB-Progress", Volga region branch of the Russian Academy of Cosmonautics named after K.E.Tsiolkovsky and Delta-Utec SRC (Netherlands) took part in organization of the School. The School was supported by the Russian Space Agency, Office of Educational Programs of European Space Agency, Administration of the Samara Region, the Samara Provincial Duma. The main aim of the School was to engage the youth (students, post-graduate students) to involve in setting and realization of space experiments, new fundamental knowledge directed on obtaining and improvement of technologies which can find applied meaning. Implementation of such

experiments can be done on microgravitational space platforms of type "Foton/Bion" which are designed and manufactured in Samara. The program of the School included lectures, seminars using of the SSAU laboratory base, presentations of perspective space projects and programs, mini-conferences of School's participants, round tables dedicating on problems of space education and involvement of the youth in space research. Within the framework of the Schools the participants jointly worked at space projects, in particular at project YES2 which is initiated by the European Space Agency.

COUPLING OF ATMOSPHERIC LAYERS EU FP5 RTN PROJECT: ENGAGING SCIENTISTS IN TRAINING AND OUTREACH ACTIVITIES

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Exploration of the solar system, as well as near-Earth scientific missions and ground-based observatories, present many new opportunities for enhancing science education across grade levels. Sprites, jets and elves are 'celestial fireworks', also referred to as 'Transient Luminous Events (TLEs)', sprites specifically as 'high altitude lightning'. In 2002 the four year 'Coupling of Atmospheric Layers (CAL)' research training network (RTN) project was funded by the European Commission to study TLEs. In order to study these phenomena the CAL project is very inter-disciplinary and concerns thunderstorms, electrical- and space radiation effects in the stratosphere, mesosphere and lower thermosphere. CAL consists of ten scientific work-packages and two work-packages specifically dedicated to the training and outreach programme of the project. The educational 'training' programme work-package is a key ingredient in the CAL project and covers the implementation of the training activities aimed at the young scientists hired through the CAL project, as well as participating senior scientists. Educational activities are based on the following elements: national Ph.D. programmes, activities at CAL and other meetings, European observational campaigns and a dedicated summer school. As part of their CAL 'educational-outreach' work, all CAL young scientists are producing educational material concerning their research for middle school levels and above in both English and in their native language. As a result each young scientist will have experience in constructing a web-site, writing an 'outreach' article, and giving a presentation to the general public and a school. This presentation will show how training and outreach activities have been implemented into the CAL project and is intended to be an example and inspiration of how any 'space project' can be a unique opportunity to provide such types of learning activities for both young and senior scientists. The importance of engaging scientists in these types of activities can not be emphasized enough.

ABOUT THE REMOTE COOPERATION IN THE FIELD OF SPACE-PHYSICS EDUCATION

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During the last two years the Skobeltsyn Institute of Nuclear Physics (SINP) of the Moscow State University and the Physics and Mathematics Faculty of the Kostroma State University (KSU) have developed a model of a space-physics educational process via Internet. Fourth-year students from KSU have done their course works on the topic Solar cosmic rays. They have also adapted for using via Internet a lab exercise on the same topic from the Space-physics lab exercises developed by SINP. This adaptation provides step-by-step execution of the tasks using the information from different satellites. The purpose of such adaptation is to make the exercise more accessible for the students from the other Universities and Institutes. Implementation of the degree works on space physics under the guidance of the SINP scientists is next in turn. Its main feature is spatial remoteness of the students from the scientific supervisors and remote control via Internet. The degree works are based on remote processing and analysis of the "Universitetskiy" satellite scientific data from the remote accessible database.

DATA SERVICES FOR SINP MSU SPACE EXPERIMENTS

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Internet-based online data services are developed at the Skobeltsyn Institute of Nuclear Physics, the Moscow State University, in order to provide an easy and effective access to the data of space radiation measurements. The main concepts for the space experiments data management, loading and access are presented.

PROJECT OF THE RUSSIAN ACADEMY OF SCIENCES – "CHIBIS". MICRO-SATELLITE PLATFORM FOR APPLIED-SCIENTIFIC STUDIES

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The program of scientific research onboard the micro-satellite "Chibis" - "Basic research of the methods of the space monitoring of potentially dangerous and catastrophic phenomena with the use of micro-satellite technologies" - is a subprogram of the Program of basic research of the Presidium of Russian Academy of Sciences "Changes in the environment and climate, natural catastrophes". Space monitoring offers great possibilities for the detection and estimations of potentially dangerous and catastrophic phenomena on the Earth's surface, in the atmosphere, traced to the ionosphere and to the magnetosphere. Some problems, such as, for example, detection of forest fires are already successfully solved with the aid of the space means. On the basis of tasks named above the model composition of the useful scientific payload of the developed "Chibis" spacecraft is determined in the Space Research Institute of RAS, including the following:

1. Magnetic-wave complex (MWC);
2. Complex of atmospheric studies (CAS);
3. Complex of photometric equipment (CPE).

The details of the micro-satellite "Chibis" are presented.

BASIC SCIENTIFIC RESULTS OF THE FIRST SCIENTIFIC-EDUCATIONAL MICRO-SATELLITE "KOLIBRI -2000"

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The results of space research are used in many applications, including the education. Work with the schools is a natural method to inform the wide public about the role and value of space studies for humanity. The first Russian-Australian scientific-educational micro-satellite "Kolibri-2000" (total mass of 20,5 kg) was injected into orbit of International Space Station (ISS) by separation from the transport vehicle 'Progress' on March 20, 2002. It began the development of tasks for scientific-educational micro-satellite (SEM). In spite of small size, SEM had 3.6 kg of scientific payload, which provides an opportunity to carry out rather wide scientific studies both in the field of "classical" space physics and in the field of space weather, atmosphere-ionosphere connections, etc. It serves also for the tasks of space education. According to the preliminary ballistic calculations, "Kolibri-2000" had to fly about 4 months; however, on April 17-20, 2002 altitude of its orbit began to reduce, first of all due to the increase of the solar activity. In this paper we address the influence of the processes occurred on the Sun on April 14-24, 2002 on the ionosphere; changes in the fluxes of energetic particles, magnetic and electric fields has been examined.

INTERUNIVERSITY AEROSPACE CENTER - COLLABORATION OF NIS UNIVERSITIES

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During the period of fast development of the satellite investigations a quite necessity in the specialists in the Earth sciences working with satellite images have been arise. So, the Ministry of High Education had introduced new remote sensing courses at geographical faculties of Universities. The Interuniversity Scientific and Methodological Center for Aerospace Methods of Research and Mapping was created in order to render scientific and methodological assistance to other Universities in the field of organizing of the up-to-date courses on remote sensing methods of research, as well as to co-ordinate their activities in this sphere. The Center was established in 1978 by the Administration of the Moscow University under the agreement with the Ministry of Higher Education; it is based at the Laboratory of Aerospace Methods, the Department of Cartography and Geoinformatics, the Faculty of Geography. Among the main activities of the Center are the following: training courses to improve the qualification of university teachers, which are held every 1,5 or two years; joint interuniversity research on scientific projects within the programme "Universities of Russia"; development of training manuals and visual aids for the courses on aerospace methods. Subjects of collective training courses and teaching seminars concern with particular stages of development of the remote sensing methods of research. Six teaching seminars organized at the base of the Moscow University in the middle of 1990's were devoted to interpretation of multiband aerospace images; computer interpretation of aerospace images; remote sensing and geoinformatic; educational GIS; space images in school education. Two field teaching seminar in the Elbrus region were devoted to ground surveys at a high-mountain region and aerospace monitoring of mountain territories Each teaching seminar was attended by teachers from 30 to 40 Russian Universities. Among the participants there were mainly those teaching the courses related to aerospace methods at the natural science faculties of the Universities, pedagogical and other institutes,

as well as the specialists from the organizations concerned with remote sensing. To the end of century we changed the form of training activity to distant electronic Internet-Seminars. Seven Internet-Seminars took place in 2000-2005 and they are characterized in special report at this symposium. Interuniversity research on scientific projects includes space methods of geoecology and educational geoinformation systems. The Atlas Space Methods of Geoecology was created within the frame of interuniversity cooperation. The Center was working with repairing of teaching sets of space images, a series of scientific methodological atlases: "Interpretation of multiband aerospace images. Techniques and results"; teaching and methodological manuals on the principles of aerospace methods and their application to geographical research. Accomplished research of the Center includes 8 collective training courses and 7 Internet-seminars, 15 manuals, 8 sets of space images and atlases. So, a new generation of remote sensing specialists was bring up due to the 28-years activity of the Interuniversity Aerospace Center.

LIFE OF THE EARTH IN THE SOLAR ATMOSPHERE (MULTIMEDIA MANUAL)

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The purpose of this manual is to illustrate the major physical processes occurring in the Sun - Earth system and ecology of the planet life. The material includes three individual parts: "The Earth", "The Sun" and "The solar-terrestrial connections". Sections do not require cross-references since each of them is self-complete. Inside the sections the material is located in sequences based on the principle: from simple to complex. The material is designed for students of the senior classes of high school and junior university level interested in the problem. The section "The Earth" is devoted to the description of the basic characteristics of the planet: internal structure, magnetic field, lithosphere and atmosphere together with various tectonic, hydro- and atmospheric processes occurring in them. The top layers of an atmosphere, an ionosphere, a zone of polar lights, radiation belts, magnetosphere are also considered. The section "The Sun" includes the following subsections: the Sun as a star, internal structure of the Sun, Solar atmosphere, solar activity, cyclicly of the solar activity, helioseismology. In the section "The solar-terrestrial connections" the previous material is used to present the influence of the active solar processes on the most various aspects of terrestrial life: ecological, biological, mental, social, economic and so forth. The problem of the solar activity forecasting is considered as the key parameter determining a condition of the so-called space weather.

SPACE RESEARCH SCIENTIFIC AND EDUCATIONAL PROJECT OF MOSCOW STATE UNIVERSITY

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The scientific and educational project of space research has been aimed to incorporate modern space research in the university and high education, to popularize basics of space physics, and to enhance public interest in space exploration. On January 20, 2005 the First Russian University satellite "Universitetskiy" was launched into circular polar orbit (inclination 83 deg., altitude 940-980 km). The scientific equipment, as well as the mission control and information receiving center, was designed and developed in Moscow State University. The scientific program includes measurements of space radiation within different energy ranges, and Earth UV luminosity and lightening. A multimedia lectures "Life of the Earth in the Solar Atmosphere" containing the basic information and demonstrations of the solar influence on the Earth was developed. Also there was developed a dozen of special computerized lab exercises based on the experimental quasirealtime data obtained from this satellite. Educational program of the project (both the multimedia lectures and lab exercises) is concentrated to upper high school, middle university and special level for space physics students. The scientific and educational project of Moscow State University is a non-profit project and is open for all interested parties.

THE ROLE OF REFERENCE FRAMES IN THE ANALYSIS OF PHYSICAL PROBLEMS

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The examples of applied physics analysis which require defining of the so called reference frames lay in the basis of the present paper. For each process-phenomenon we try to find a proper reference frames. Its inaccurate choice consequently causes deformation or even complete distortion of our understanding of the phenomenon. Thus it forms the source of misinterpretations and wrong trails in the development of physics.

14 BISSAT, AN INTERNATIONAL STUDENT EXPERIENCE

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On August 2003 an accident with the Brazilian Launcher, VLS, destroyed the UNOSAT (www.space.unopar.br) that was the first Brazilian University Undergraduate Student nano-satellite. Three months later an invitation to put some of the UNOSAT hardware inside the Ukrainian University micro satellite, MS-Ex, appeared. The MS-Ex satellite was developed by a group of students of the Dniepropetrovsk National University, Ukraine, with the help of the young engineers of the Spacecraft Design Office of Yuzhnoye. In this way both MS-Ex and a new Brazilian nanosatellite 14 Bissat project started, coordinated by two doctorate students with undergraduates. The name of 14 Bissat is to commemorate the 100-years anniversary of the flight of the first airplane by the Brazilian Santos Dumont in Paris and is an acronym of Brazilian International Student Satellite. Soon a new team of the Universidade Norte do ParanA, Brazil, was formed and discussion on the 14 BISSAT preliminary design began. After the exchange of basic information between Brazilian and Ukranian sides, it was decided to use the same configuration as for the UNOSAT. The Brazilian students had to do a much more compact design as the volume was going to be four time smaller. As the previous satellite, it was going to download a voice message and a packet of telemetry. As the information is going to be sent by amateur radio band a collaboration was gotten by the Brazilian amateur radio association called ABRASAT (www.abrasat.org). The different project parts were divided among thirteen students: structure, radio link, solar panels, energy controller module, telemetry and instrumentation. They were also responsible for the systems tests, integration and follow final tests. In nine months the students did the design, integration and tests of the 14 BISSAT. Besides putting on practice the disciplines of their respective courses, new skills were gotten such as international information exchange using internet resources as emails and chats.

The team had to overcome a series of difficulties as lack of experience, resources, bibliography, and time. But with some indigenous ideas the students and teachers managed to finish the nanosatellite. It is explained an aerospace management procedure that contributed to keep to project schedule. It was used only non space qualified parts, therefore a simple qualification procedure followed. International collaboration was a key factor for the success in the preliminary project phase and in construction. Numerous benefits for the students arose from the program: capacity to overcome academic obstacles, responsibility, high quality and reliable project/manufacture, teamwork and international experience. Nowadays another group of the Metropolitana-IESB develops the flight module that is expected to be launched in 2006.

THE 19TH CENTURY OBSERVATION OF LIGHT PHENOMENA VERSUS SPACE-TIME CONTINUUM

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The paper presents the most important optical phenomena analysis of which contributed to strengthening the conviction that the ether existed. The authors show endeavors for adjustments of optical phenomena and electrodynamics processes with the 19th century concept of ether. These acts led to formulation of the principle of relativity and in consequences to the concept of space-time continuum.

TEACHING ABOUT THE OUTER SPACE IN THE POLISH COLLEGE

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Since January 2006 the Lyceum of the Catholic Tutors Association in Warsaw is cooperating with Moscow State University in order to learn the latest results of space research. The aim of the cooperation is getting familiar with the Russian education on the academic level within the range of present space knowledge. Our activity is aimed at the enlargement of high school students interest in natural science, particularly the Solar System, space physics and also at raising the level of physics instruction in Polish colleges. Our work is based on the educational materials prepared by the students and young scientists from the Lomonosov Moscow State University. The materials entitling "Life of the Earth in the Solar Atmosphere" have been prepared in Russian in a form of multimedia lectures. Once a week after the lessons our students (age 15-16), meet as volunteers with a teacher of physics and get familiar with the materials. Among them are such who understand Russian or just learn it come in. First some pieces dealing with the structure of the Earth, the Solar System, the solar physics and space research are translated from Russian. Than the translated materials are discussed in the accessible and interesting manner. The translated and didactically worked out texts will be made available to all our school students as well as to other high school students in Poland in a form of a suitable publication. On the basis of the manual "Practice Exercises in Outer Space Physics" published by the Moscow University we plan to prepare exercise sets connected with the physical phenomena in the outer space and the solar physics intended for our school and other schools. The exercises are based on the scientific information obtained from the satellite developed by the students and young scientific workers of the Moscow University and launched on 20th January 2005 from "Plesetsk" space-launch complex in order to monitor physical conditions and space around the Earth. From the position of this satellite the space appears to us as the complicated dynamic system, the practically inexhaustible natural laboratory, wherein numerous physical processes take place.

AEROSPACE AND REMOTE SENSING EDUCATION IN THE GEOGRAPHY SCHOOLS OF MOSCOW AND CAMBRIDGE UNIVERSITIES

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The education considered includes the Earth observation, observation of planets, and associated remote sensing techniques applied by geographers. The two well-known universities under comparison, namely the Lomonosov Moscow State University, and the University of Cambridge, UK have well established traditions of geographical remote sensing. Faculty of Geography, Russia, is one of the largest in the world with its over 860 staff and over 1000 undergraduates. It has several laboratories dedicated to photogrammetry, remote sensing and aerospace methods, and participates in large national Earth observation programmes, such as developing and assessing first multispectral cameras for the Earth-orbiting spacecraft. Basic remote sensing courses are offered to all undergraduates specialising in physical geography (over two thirds of all students). Many specialized courses, including field remote sensing, are offered to students at the Dept of Cartography and Geoinformatics (over 100 undergraduates). There is a remote sensing and GIS specialization in the Faculty's MSc in Geography. Several textbooks have been published specifically on Remote Sensing for Geography. Computer facilities are variable, and the library though good, but is not up-to-date. The undergraduate course is 5 years long and includes four field courses and three dissertations. Cambridge's Department of Geography is smaller (about 110 staff and less than 400 undergraduates). It also has rich traditions in remote sensing and incorporates the famous Cambridge Aerial Photography Unit, which has several small planes and specialized imaging equipment. Undergraduates have some remote sensing courses and there is a successful one-year MPhil in GIS and Remote Sensing. Overall the Cambridge department is better equipped with computers and specialised equipment per student, and has very good library and information resources. The undergraduate course is 3 years long and includes one field course and one dissertation. Overall the Cambridge s remote sensing education is less developed at the undergraduate level, but offers more opportunities that in Moscow at MPhil/MSc and

PhD level. Moscow-Cambridge cooperation in remote sensing goes back to at least 1993 with a long-term joint research project on ecosystem assessment in the Arctic. A further initiative being explored is an international field school in remote sensing techniques for ecosystem assessment, to be held in the Russian European Arctic on July/August 2007.

THE EDUCATIONAL PROGRAM OF THE YOUTH CENTER "SPACE COMMUNICATIONS AND INFORMATICS"

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The Youth Center "Space Communications and Informatics" was established in Troitsk as a voluntary non-profit organization. The Center is supported by Administration of Troitsk and the individuals who are interested in space science, amateur radio and computing. The technological base of the Center includes the amateur radio station RK3DXB which is operated as the satellite control communications unit and is connected with local schools' network via Internet. The main purpose of the Center is to stimulate the interest of the youth in space research through the projects based on the using of the microsatellites and space communications. The educational program consists of the following topics adopted for the pupils from the 9th up to the 11th grade (Russian scale):

1. Space communications. This topic includes the principles of communications with space vehicles, command controls, the telemetry receiving and data processing, regulations for operation in space for amateur satellites.

2. Solar-terrestrial physics. This topic was chosen as the main since the moderators of the Center are the scientists who work with satellite data in connection with monitoring of space weather. The purpose of this group is to study how the data from the educational microsatellites is related with other solar-terrestrial physics resources.

3. Remote sensing. This topic is based on the vast information available via Internet from remote sensing satellites. Pupils receive the images from NOAA satellites and conduct the comparative analysis of data. The Center has its own receiving device used as an educational tool.

4. International Space Station. This topic is based on the interest to the manned space flights. The Center has a device to listen of ISS at 143.75 Mhz, a connection with amateur radio station on ISS, participates in the Russian ARISS program. Pupils analyze the public information about scientific experiments onboard ISS.

5. Amateur Radio Club Station. The key point of all educational programs is the training how to receive and to transmit information via amateur radio. This topic includes the study of modern digital technologies in the amateur radio field, observations of the amateur microsatellites, support of the further development as IPRL and software applications.

6. Modern electronics and computing. This topic includes the basics of electronics and personal computing, PC hardware, Internet resources, modern technologies and their possible application in the amateur radio field.

Every pupil has personal plan according which he must prepare the review text for the chosen item, present it at the seminar and apply for one of all-Russian Youth Conference (usually in connection with the World Space Week or Day of Cosmonautics, April 12). The Center's experience confirms that teenagers involved in such sort of activity demonstrate perfect creativity and become best students at the Universities. As usual after graduate course they become the leading persons in any field of business. The Center's activity is displayed at the site www.space.ttk.ru.

ESTIMATION OF THE AMPLITUDE OF THE SECOND ZONAL HARMONIC OF THE EARTH'S GRAVITATIONAL FIELD BASING ON THE DATA OF SECULAR AND LONG-PERIODIC VARIATIONS OF THE SATELLITE'S ORBITAL PARAMETERS

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The long-periodic perturbations of the Kepler orbital parameters of the satellites are studied on the basis of NORAD data (www.celestrak.com). Basing on the model of such perturbations [1] we carry out the harmonic analysis of the perigee argument and the mean anomaly of the orbit. At first the secular perturbations of the orbital parameters are subtracted from the corresponding orbital parameters using the linear least-squares method [1,2]. Then the parameters of the quasi-harmonic residual process are determined [1,2]. The estimation of these parameters allows to determine the amplitude of the second zonal harmonic of the Earth's gravitational field. The results of calculations for the METEOR and the NOAA satellites are presented. This algorithm is suggested for using within the frames of Space-physics lab exercises [3].

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THE COMPUTER METHODS OF THE SUNSPOT EVOLUTION INVESTIGATION BASING ON THE DATA FROM SOHO SPACECRAFT

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The aims, tasks and theoretical basis of the computer processing of the Sun images in order to study sunspot dynamics are presented in the report. The proposed methods are intended both for the studies of the solar activity during the different periods of the solar cycle and for using for the educational purposes within the frames of the Space-physics lab exercises. The main educational task of this work is to study the dynamics of the spot's areas from its origin to dissipation. The scientific part of this work includes comparative analysis of spot's dynamics during the solar cycle at different latitudes. The authors propose to develop the models of the connections between the spot irradiation dynamics and the magnetic field using the spot's magnetograms. The methods include the development of the interactive software which allows to analyze the spots' area according to the chosen chromaticity level, producing of the corresponding time series and their analysis by different methods. The software operation and its first results are presented.

THE INVESTIGATION OF THE WAVE PROCESSES IN THE EARTH'S MAGNETOSPHERE BY USING THE SATELLITE ANTENNA ARRAY OF VARIABLE CONFIGURATION

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The problem of using of the data of the Earth's magnetosphere's conditions obtained by the spacecrafts at the different orbits as a set of data from interferometer antenna array of variable configuration is discussed. So far the data from the different satellites is considered separately as the local data for each satellite. In the frame of this approach it's impossible to construct the logical scheme of estimation of the spatial-temporary spectrum density of plasma waves in the magnetosphere of the Earth. All the main methods of investigation of the wave properties are based on the theory of the interferometer antenna array. Within the frames of classical theory of the antenna array the postulate of constancy spatial distribution of antenna nodes is suggested [1-2]. But the satellites move in space along the complex trajectories. Thus it is not possible to apply this theory for the satellites' data. In this work the new method of data processing from a set of satellites is suggested. This method allows to represent the satellites' data sets as data from an antenna array with variable configuration. We suggest a new method of estimation of the plasma waves power spectrum for the antenna array with moving antenna nodes. This method is based on the maximum entropy method and some specific modifications [3-5].

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INVESTIGATION OF THE EARTH'S MAGNETOSPHERE STRUCTURE USING THE MAGNETOMETERS ONBOARD THE SPACECRAFTS

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The report concerns the problem of the calculation of the magnetic dipole moment of the Earth according to the data of the magnetometers onboard the satellites. In order to solve this problem it is proposed to use the least-squares method for the dipole model in coordinates of magnetic latitude and magnetic longitude. The preliminary results of the data processing are discussed. The way to expand this model in order to estimate the deviation of the magnetic field from dipole and its variation during the solar cycle are suggested. The possibility to use these methods within the frame of the Space-physics lab exercises is discussed.

ESTIMATION OF THE ATMOSPHERE'S DENSITY BASING ON THE VARIATION OF THE FOCAL PARAMETERS OF THE SPACECRAFT'S ORBIT

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The Space-physics lab exercises [1] include the exercise of the estimation of the average atmosphere's density at the satellite's orbit and its variability basing on the focal parameters of the satellite's orbit [1]. The focal parameter of the orbit is calculated from the NORAD data (www.celestrak.com). In order to calculate the atmosphere's density it is necessary to calculate the variation rate of the focal parameter. But it is well-known that the estimation of the derivatives entails essential computing errors. The present work suggests three methods for estimation of derivative of the focal parameter. The first is the least-square method for a chosen time interval. The second is the finite difference method, and the third is the smoothing spline method. The last method allows to obtain the best estimation for minimum time period and to calculate variation of the atmosphere's density for the solar flare.

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ESTIMATION AND COMPARING OF THE POSITION OF THE OUTER RADIATION BELT MAXIMUM AT THE ALTITUDES OF 1000 AND 500 KM BASING ON THE "UNIVERSITETSKIY" AND "CORONAS-F" SATELLITES DATA

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The procedure of the estimation of the position of outer Earth Radiation Belt (ERB) maximum (at 1000 and 500 km altitude) basing on the measurements of electron fluxes obtained by the "Coronas-F" and "Universitetskiy" satellites is discussed. The elliptic model of maximum's position is used. The ellipse is constructed by using of the least-squares method for the extremums of the electron flux corresponding to the crossings of the outer ERB's maximum by the satellites' orbits. The main results of data processing are presented. The questions of using the results of this work for the Space-physics lab exercises are discussed.

THE INVESTIGATION OF THE CONNECTIONS BETWEEN THE DATA OF THE DIFFERENT CHARGED-PARTICLES DETECTORS ONBOARD THE CORONAS-F AND UNIVERSITETSKIY SATELLITES

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The problem of the investigation of the connections between the data of the charged-particles detectors for the different energy ranges and type of the particles (electron/proton) is discussed [1]. It is connected with a problem of spatial-temporary distribution of the particles of different energies and types in the Earth's magnetosphere. The main idea of this approach is based on the using of the method of principal component to the data from different detectors. The main results of such approach using for the data from the "Coronas-F" and "Universitetskiy" satellites are discussed.

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