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SUN AND SOLAR ACTIVITY

UNEXPECTED SOLAR ACTIVITY CYCLE 24 PREDICTION BY VARIOUS METHODS

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A considerable difference in maximum amplitude of the solar cycle (SC) 24 predicted by various methods exists according to conclusion of the Third Official Prediction Panel NOAA, NASA and International Environment Service (ISSE). Aim of our study is to update SC 24 forecast by comparative analysis of this problem using linear autoregressive approaches, nonlinear Neural - based method and method of precursor. As a predictor for construction of SC 24, we used an idea on dynamics of the solar magnetic fields forming solar spots, being basic for estimations of Wolf numbers Wn. For forecasting of variations of predictor – the solar polar field - in SC 24 the singular spectral analysis was used. Results: Our nonlinear Neural-based prediction gave value 70 for SC 24 amplitude in contrast with value 145 from official two predictions based on Neural network methods.

The proposed forecasting by precursor method based on solar polar field variations allows expanding a horizon of Wn prediction on one cycle. The SC 24 maximum is predicted by this method had to happen in April, 2012, and its average amplitude can be as low as 50 or even 20. The prolonged minimum of the Solar Cycle 23 and abnormal predicted values of Wn for the maximum of Solar Cycle 24 remind the scenario of transition of solar activity to the historical Dalton minimum.

GALACTIC COSMIC RAY MODULATION THROUGH THE SOLAR CYCLE

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An approximate model for differential spectra $D(E)$ of galactic cosmic rays in energy interval ~30 MeV - 100 GeV during 11 – year solar cycle is discussed. In the model are used data which cover three solar cycles: 20, 22 and 23. The IMAX92, CAPRICE94, AMS98 and BESS experimental spectra for protons and alpha particles are fitted to the proposed model. The calculation of the model parameters is performed by Levenberg-Marquardt algorithm, applied to the special case of least squares. For protons and alpha particles, the standard deviations between Force Field approximation to the transport equation and our model are ~ (1.5 –2) % for low and middle levels of modulation. A trigonometric parameterization of the model spectrum is presented. A mathematical relation between parameters in the model and the modulation potential Φ is given.

ON THE GEOEFFECTIVENESS OF SOLAR DECAMETRIC TYPE II AND IV BURSTS

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Solar type II bursts are known to be caused by the most geoeffective solar events – the Coronal Mass Ejections (CME). Type IV bursts are also supposed to originate from the CME body.

We analyzed the properties of type II and type IV solar bursts that were registered during the descending part of solar cycle 23 and the onset period of cycle 24 (2003-2010) at frequencies 10-30 MHz. All events demonstrated fine time and frequency structure of various appearances. In several cases type II and IV bursts appear in a certain sequence: powerful type III burst, in few cases followed by burst in absorption then type II burst followed by type IV burst. Sometimes type II bursts show harmonic structure in the form of harmonic F-H pair and in one case the third harmonic was registered.

In this presentation we juxtaposed properties of type II and IV bursts in the decameter (UTR-2), hectometer (WIND/STEREO spacecrafts) wavelength bands with CME parameters obtained in white light and geomagnetic conditions provided by World Data Center of Geomagnetism. According to our analysis about 30% of all registered decameter type II bursts were associated with geomagnetic storms with Dst < -50nT. These geoeffective type II bursts in general had faster drift rates – about 50 kHz/s.

The work was done in the frames of Ukrainian National Academy of Sciences Program “Heliosphere”.

COSMIC RAY MODULATION BY SOLAR WIND DISTURBANCES

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Solar wind disturbances (SWDs), namely interplanetary coronal mass ejections (ICMEs) and corotating interaction regions (CIRs), cause short-term depressions in galactic cosmic ray (GCR) flux. The mechanism of this modulation is still a matter of research from observational point and theoretical modeling. Since GCR flux reflects solar activity, solving this problem represents an important aspect of space weather.

We analyze the influence of different SWD parameters on the amplitude and the duration of the depressions, using ground-based neutron monitor data and in situ solar wind data from the ACE satellite. We test correlations between GCR depression amplitudes and solar wind speed, IMF and IMF fluctuations. Time profiles are also examined. The analysis is performed for SWDs in general, ICMEs, CIRs, mixed ICME/CIR events, events associated with an interplanetary shock, and events without shock.

A statistical analysis is also performed regarding the delay of the depression after the onset of the IMF increase. We find that in the majority of cases the decrease follows the onset in IMF increase with an average delay on the order of the typical shock-sheath thickness. High correlation between the depression magnitude and the increase in IMF fluctuations and strength was found, favoring reduced diffusion as a modulation mechanism. Furthermore, the proxies of time integrals are found to behave as physical quantities. The differences were observed between the data sorted by type (ICME, CIR, and mixed) and shock association. Obtained results can be used to test theoretical models.

THE DRAG BASED MODEL OF ICME PROPAGATION

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One of central issues of space weather is the propagation of interplanetary coronal mass ejections (ICMEs). At the heliospheric distances beyond R=20 solar radii the “aerodynamic” drag is presumably the dominant force governing ICME propagation; therefore, a drag based model (DBM) was established, which can be used to forecast the ICME arrival at the Earth.

First, the model was tested on a sample of CMEs by combining remote observations of the CME take-off gained by the LASCO onboard SOHO, and in situ measurements from ACE and Wind satellites. The results of the DBM were compared to observational data and a fairly good agreement of the two was found. The model was then tested against STEREO observations. The ICME kinematics was inferred from STEREO observations by applying the Harmonic Mean method and compared to the DBM results. In this way we were able to reproduce the propagation of both slow and fast ICMEs, as well as to identify ICME-ICME interactions and a transition from fast-to-slow solar wind regimes. Finally, a statistical study was performed, where parameters were varied within a model in order to obtain optimal values, for which the average difference in the observed and calculated TT is zero (O-C=0) and the O-C scatter gets minimum. The source of the scatter in O–C values was investigated.

The research leading to the results presented in this paper has received funding from European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement No. 218816.

RELATIONSHIP BETWEEN THE EXPANSION SPEED AND RADIAL SPEED OF CMES CONFIRMED USING QUADRATURE OBSERVATIONS FROM SOHO AND STEREO

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The STEREO spacecraft were in qudrature with SOHO (STEREO-A ahead of Earth by 87^{o} and STEREO-B 94^{o} behind Earth) on 2011 February 15, when a fast Earth-directed CME occurred. The CME was observed as a halo by the Large-Angle and Spectrometric Coronagraph (LASCO) on board SOHO.

The sky-plane speed was measured by SOHO/LASCO as the expansion speed, while the radial speed was measured by STEREO-A and STEREO-B. In addition, STEREO-A and STEREO-B images measured the width of the CME, which is unknown from Earth view. From the SOHO and STEREO measurements, we confirm the relationship between the expansion speed (Vexp) and radial speed (Vrad) derived previously from geometrical considerations (Gopalswamy et al. 2009): Vrad = S (1 + cot w) Vexp, where w is the half width of the CME. STEREO-B images of the CME, we found that CME had a full width of 75 degrees, so w = 37.5 degrees. This gives the relation as Vrad = 1.15 Vexp. From LASCO observations, we measured Vexp = 897 km/s, so we get the radial speed as 1033 km/s. Direct measurement of radial speed from STEREO gives 945 km/s (STEREO-A) and 1057 km/s (STEREO-B). These numbers are different only by 2.3% and 8.5% (for STEREO-A and STEREO-B, respectively) from the computed value.

CURRENT SOLAR CYCLE 24: FLARE PHNOMENA, CORONAL HOLES, DEVELOPMENT FORECAST

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Two with a small years of 24 solar cycle development allow to consider the basic characteristics of its early stage. At 22 months of the smoothed Wolf number has reached 20 and the curve of the current solar cycle is almost identical to the initial development stage 10 (series average) and 14 (the lowest of reliable solar cycles) cycles of the solar activity. Launching of space solar observatory SDO allowed with very high spatial and temporal resolution to begin the study of solar flares of small, medium (18) and large (3) importances, including 4 proton events, to identify alleged links between the flares and the solar filaments ejections and to identify the global not even powerful solar flare phenomena. Involvement of the observational data STEREO space observatories gives an opportunity to explore flare events from different points of space and obtain three-dimensional picture of events. During the study period failed to investigate several ejections of giant filaments and come close to identifying a specific pattern of its early development. Studies of coronal holes based on SDO, SOHO and STEREO solar observatories has made it possible to identify the boundaries and the "core" of these objects, which, apparently, are responsible for geoeffectiveness high-speed streams associated with CH. It should be noted that the development of the current solar cycle has not yet led to a marked recovery characteristics of olar coronal holes high-speed streams, which significantly affects on their geoeffectiveness.

INVESTIGATION OF THE STATISTICAL CHARACTERISTICS OF WOLF NUMBERS AUTHENTIC SERIES: SIGNS OF SOLAR CYCLES LIKEHOOD

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In the course of the study the sunspots relative numbers authentic series and possible inclusion in the statistics of individual solar cycles of the reconstructed series, we studied the properties (statistical and observational) of individual 11 - and 22-year cycles of the solar activity. The proximity of the averages values for the duration of cycles is revealed, although the scatter is different in almost twice. More contrast this situation for the duration of the rising branches, both for average and for a dispersion.. Depending on the duration of the cycle, branches of growth and decay on size of the maximum cycle for the components of a reliable series negative correlation between the duration of the rising and the value of the maximum of the cycle and its complete absence for the decay branch. And, on the contrary, for the restored series significant positive correlation between duration of a recession branch and size of a cycle maximum is revealed. Attempted to create a generalized portrait of a authentic solar cycle in order to obtain evidence-based description of the possible and impossible characteristics of individual solar cycles is made.

SOLAR SOURCES OF EXTREME EVENTS IN THE ENVIRONMENT, THE MAGNETIC STORMS.

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The logic of the study of solar extreme events put on the agenda of studying situations where a relatively weak (not extreme) solar flare events are in near-Earth space event of extreme power. Out of 5 magnetic storms with Dst < –300, only two were doubtless a source of extreme solar flares. In the remaining three solar flares were just great and even the average importances. An example of these events are extreme magnetic storm in March 2001, November 2003 and November 2004. In these flare events in time within a single optical flares were realized from two to four X-ray bursts that gave rise to a series of fast coronal mass ejections, whose interaction and has become the most probable cause of the extreme magnetic storms. The report examined the dynamics of active regions, the interaction of magnetic fluxes and the role of the nearby solar structures in the implementation of solar flare events and the preferred direction of disturbances propagation from individual outbreaks. Such an approach enables the prediction of extreme magnetic storms in the period of the flare events preparation.

GREEN AND RED CORONAL LINE DATA EXPLORED OVER THE PERIOD OF ABOUT 6 LAST ACTIVITY CYCLES WITH WAVELET METHODS AND RECURRENCE PLOTS

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Continuous monthly and daily data sets of the whole disc green and red line coronal emission (Fe XIV 530.3 nm, FeX 637.4 nm) covering the period of about 6 last activity cycles has been studied with nonlinear tools to find the periodicity characteristics and phase relationships between them and different solar activity indices. We have used wavelet scalograms and wavelet coherence diagrams which are powerful and sensitive methods for testing time series and cross recurrence plots and recurrence quantifications which give useful methods of visualizing and analyzing both linear and nonlinear time series data. We have compared the green-line data from Norikura and Kislovodsk Observatories,intensities registered by several coronographs and converted to the common photometric scale of Pic du Midi, intensities from several observatories converted to the photometric scale of Lomnicky Stit and published in the form of the rescaled coronal index with cosmic ray intensity, sunspot numbers and solar radio flux registered at different frequencies in Sagamore, Ottawa/Penticon, Nagoya/Toyokava, Hiraiso and Torun, which have been treated as reference data. We have also compared red and green line monthly intensities registered in Kislovodsk coronal station. Analyses used show that variability of the data set converted to the common photometric scale of Pic du Midi and time series from Kislovodsk are closest to the solar indices and radio flux data.

PLASMA DENSITY FLUCTUATIONS IN TURBULENT FLOWS OF ACTIVE REGIONS AT THE SOLAR PHOTOSPHERE

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Results of high-resolution ground-based and spacecraft observations provide good ground for study of small-scale processes in the solar photosphere. Formation of small-scale fluctuations in plasma density of turbulent flows in active regions (plages) of the photosphere and dependence of their characteristics on the magnetic field strength B are considered in the present report. The process can be described in the framework of three-fluid approach. Taking into account a low degree of ionisation of the gas in the photosphere, one can assume that ion-electron plasma is embedded in the flow of gas and has no influence on its motion. According to data of observations the statistics of random velocity field of gas corresponds to the Kolmogorov turbulence. For analysis of the effect of field B on the plasma density fluctuations, analytic expressions describing their spatial spectrum and rms level were derived. Estimations of the spectral shape and the fluctuation level were made for the photosphere near 300 km

altitude under the strength B from 100 to 1000 G. It was shown that the rms amplitude of fluctuations (with length-scales smaller than 100 km) around the mean plasma density has to increase from 8.25 to 8.78 % with B. The spatial spectrum can be approximated by a power law and the power index has to increase from –1.57 (B=100 G) to –1.20 (B=1000 G). Relatively weak influence of B on the fluctuation amplitude results from a more important role of local gradient in the mean plasma density for the fluctuation generation.

CORONAL MASS EJECTION OF 12 JUNE 2010: CME KINEMATICAL PARAMETERS

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We investigate the initiation and development of the limb coronal mass ejection (CME) which launched 12 June 2010, utilizing observations from Mauna Loa Solar Observatory (MLSO), Solar and Heliospheric Observatory (SOHO), Solar Terrestrial Relations Observatory (STEREO) and Solar Dynamic Observatory (SDO). The goal of this study is to investigate the new, relatively fast method for determining true geometric and kinematical CME parameters from simultaneous observation of CMEs by various satellites and ground based MLSO observatory. These parameters are direction of CME motion, velocity and acceleration of the different parts of CME (the frontal rim, the cavity, and the prominence) and CME angular size. Furthermore, we investigate the driving mechanisms of CME and infer the magnetic field properties at the onset of the instability. To determine the driving mechanism, we quantitatively and qualitatively compared the observationally obtained kinematic evolution with that predicted by various CME models, mainly based on toroidal geometry (cf., Chen, 1989; Vršnak, 1990; Forbes and Isenberg, 1991; Amari et al., 2000; Wu et al., 2000; Török and Kliem, 2005).

STUDIES OF CORONAL MASS EJECTIONS THAT HAVE PRODUCED MAJOR GEOMAGNETIC STORMS

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Twenty three major geomagnetic storms (Dst < -150 nT) have been produced in the period 1996 - 2008.

There were 55 possible coronal mass ejections (CMEs) which could have produced these storms. We are studying these CMEs in order to see their propagation and possible interaction into the interplanetary space. We compare different models of CMEs (sphere-like, flux-rope like etc.) to estimate CMEs geometrical parameters (angular widths, propagation direction) and their propagation velocities. We also investigate possible connection between CMEs and the solar seismic signatures. Their in-situ signatures and correlation with geomagnetic indexes are also analysed.

THE UNUSUAL MINIMUM OF SOLAR CYCLE 23: ORIGIN AND HELIOSPHERIC CONSEQUENCES

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Solar cycle 23 was characterized by very weak polar magnetic field and a large number of sunspot-less unprecedented in almost a century. This resulted in atypical conditions in our space environment, including low solar radiative flux, weak solar wind and heliospheric magnetic field and record-high cosmic rays flux. Here I will review some of these unusual conditions in space during the recently concluded solar

minimum and present the first consistent explanation of this deep solar minimum based on dynamo simulations.

CORONAL HOLES, HIGH SPEED STREAMS AND GEOMAGNETIC STORMS

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We have analyzed the data on coronal holes observed in the Sun throughout the activity Cycle 23. It is shown that CH is not merely an undisturbed zone between the active regions. The reduced brightness is the result of a specific structure with the magnetic field being quasi-radial at as low altitude as 1.1R or a bit higher. The plasma outflow decreases the measure of emission from CH. With an adequate choice of the photometric boundaries, the CH area and brightness indices display a fairly high correlation (0.6-0.8) with the solar wind velocity throughout the cycle. The mean brightness of the darkest part of CH is of the order of 18-20% of the solar brightness, while the brightness of the other parts of the CH is 30-40%. It is shown that the parameters of the solar–wind magnetic field are determined at the level of 1.1–1.4 solar radii in the coronal hole, where the field lines are radial at low heights. Traditional comparison of the field parameters at the Earth orbit and at the Earth helioprojection point on the Sun is not quite correct. It is justified as far as the signs of the field and sector structure are concerned. However, the field absolute value is formed in a more extensive area. Taking this into account, we can correlate the field values in the Sun with the values of the IMF and explain the absence of weak fields in the vicinity of the IMF neutral line (two-peak distribution).

EFFECTS OF HYSTERESIS BETWEEN MAXIMUM CME SPEED INDEX AND SOME SOLAR ACTIVITY INDICATORS DURING CYCLE 23

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Using the smoothed time series of maximum CME speed index data set for solar cycle 23 we find that maximum CME speed index and some solar activity indicators show a hysteresis phenomenon. It is observed that total sunspot number, total sunspot area, solar radio flux (10.7 cm) and flare index follow different paths for the ascending and descending phases of solar cycle 23 while saturation effect exists at the maximum phase of the cycle. However we notice that the separations between the paths are not the same for the solar activity indicators we used.

RESONANT EXCITATION OF SOLAR ALFVEN WAVES BY PLANETARY TIDES

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The tides on the Sun induced by the planets are generally considered to be too small to cause any measureable activity on the Sun. However, the tides might be amplified by resonating with the magnetic Alfven waves on the Sun. Preliminary calculations show that such resonances do exist. A simple model based on magneto-tidal resonance is developed and includes differential rotation as well as latitude and depth dependence. In particular, we show that the latitude of resonance migrates toward the equator similar to the sunspots. The results reveal that planetary tides could be important in understanding solar activity and its periodicity.

WHITE LIGHT SOLAR CORONA AT DIFFERENT PHASES OF THE SOLAR CYCLE

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White light corona observations during 3 total solar eclipses (1999, 2006, and 2009) at different phases of the solar cycle and comparative analysis of the results are presented in this work.

Photos are made with objectives with different focus and exposure. Structures of the coronas are determined from composite images. Solar corona flattening is determined and its dependence from the solar cycle phase is investigated.

The connection of coronal structures with the long streamers is also studied.

SOLAR WIND – MAGNETOSPHERE - IONOSPHERE INTERACTIONS

SOLAR WIND INFLUENCES ON THE DIFFERENT INTERPLANETARY AND PLANETARY ENVIRONMENTS

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Approximately at 1.5 solar radii above the solar surface, the Sun's coronal magnetic field is forced open into the heliosphere by the outward pressure of plasma. This region represents the starting point of solar wind into the interplanetary medium. Through its movement, the solar wind interacts with different interplanetary and planetary environments, causing numerous processes and phenomena. The main goal of this work is a comparison between some of the most significant manifestations of solar wind in heliophysics.

STATISTICAL STUDY OF THE SOLAR WIND PARAMETERS AND EVOLUTION OF DST VARIATIONS IN 19-23 SOLAR CYCLES

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Statistical study of the solar wind parameters and evolution of Dst variations in solar cycles allow us to predict the Dst behavior in future. In this connection the solar wind and interplanetary magnetic field (IMF) parameters obtained from the OMNI database and geomagnetic activity represented by Dst index from beginning 1957 to end 2010 were used for our study. Monthly variations of Dst variations and the solar wind parameters were calculated and compared with monthly sunspot numbers for 19-23 solar cycles. Superposed epoch results show Dst variations were the most intensive in 19 and 22 solar cycles. During this unique solar-minimum epoch the solar-wind high-speed streams occurred frequently and were the primary contributor to the recurrent Dst variations. The maximum in monthly Dst variations was observed in 19th solar cycle in spite of the fact that this solar cycle was the most strong in a given time interval. It signifies that corotating interaction regions (CIRs) respond to high-speed solar wind streams and the resultant geomagnetic storms in Dst associated with large, long-lived low latitude solar coronal holes during declining phases and minima of the solar activity had been absenting before the 20th solar cycle. In general, Dst variations in the 19-23 solar cycles were correlated with the solar activity and solar wind electric field. The rate energy input to the ring current did not have dependence on solar activity.

SOLAR WIND PRESSURE INFLUENCE ON MAGNETOSPHERIC SUBSTORM ONSET AND DEVELOPMENT

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Magnetospheric response to the onset and development of two successive substorms, which occurred on August 1, 1998 under different conditions in the solar wind, was investigated. IMF was southward all the time during both events, while the solar wind dynamic pressure strongly increased up to 14 nPa several minutes prior to second event and later on continued to increase with transient fluctuations.

First event was a typical substorm event preceded by pseudobreakup. Both phenomena, substorm and pseudobreakup can be interpreted in the terms of NENL model.

Features attributed to the typical substorm disturbance were also observed during the second event. Among these features we can mention appearance of Pi2 pulsations and energetic particles injections, formation of fast auroral emission and field-aligned currents intensification. However, substorm development in the second case went on with some peculiarities caused by the fact that magnetosphere was strongly compressed by the solar wind dynamic pressure enhancements. Unusual characteristic of this substorm was its localization near polarward boundary of auroral oval in the postmidnight sector.

Another distinctive features of this substorm were compressive energization of plasma sheet particles, enhancement and global modulation of the magnetospheric current systems and controlling of auroral disturbance development by external factor - solar wind dynamic pressure.

LONG-TERM CORRELATIVE STUDY OF THE GEOMAGNETIC ACTIVITY AND INTERPLANETARY PARAMETERS ON 27- DAY AVERAGE BASIS

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In-situ measurements of interplanetary plasma and magnetic field parameters began in late 1962, which by now cover more than four solar cycles. For the reported very long-term correlative study, we have used the 27-day average values of the interplanetary indices (V, B, Bz, T, and N), as well as that of the Ap index, for the years 1965 to 2008. The statistical results so obtained for the whole period, can be summarized as: (1) that only solar wind speed V is strongly associated with its temperature, whereas even marginal correlations are not observed amongst other interplanetary parameters either for the whole period or for the individual solar cycles. (2) That the Ap index is found to be equally affected by the parameters V, B and T for the whole period, as well as for many of the individual solar cycles. (3) that the Ap index is always very strongly correlated with the product VB, with the correlation coefficients as high as 0.86±0.01,for the solar cycle 23. As such our results indicate that the product VB is the most effective parameter in generating geomagnetic disturbances, even when considered on 27-day average basis. Similar results were reported earlier on a day-to-day basis, as well as on the yearly average basis.

ON THE LONG-TERM EVOLUTION OF THE SOLAR WIND DYNAMIC PRESSURE ON MAGNETOSPHERE

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Annual means of a variety of measured and reconstructed solar, heliospheric, and magnetospheric parameters show solar activity signatures at the Hale and Gleissberg cycles timescales. An attempt is made to reconstruct the solar wind dynamic pressure on magnetosphere back to 1870, almost 100 years before the first space measurements, to detect a similar pattern. Also, the consequences on the size of magnetosphere cross-section in the solar wind are discussed, in connection with the variation of the geomagnetic dipole moment in the same time interval.

AURORAL DISTURBANCES ASSOCIATED WITH THE FRONTS OF HIGH-SPEED STREAMS IN THE SOLAR WIND

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Unusually large auroral expansions occur during solar wind structures called Sheaths and CIR. The Sheaths and CIRs, characterized by high solar wind plasma density and intense and variable IMF Bz, are regions of interaction of the undisturbed solar wind with the recurrent streams and magnetic clouds. The Sheaths and CIRs also relate to magnetic storms. Although the auroral disturbances during Sheaths and CIRs have signatures of auroral substorm development (localized onset and formation of the auroral bulge), a question arises if the disturbances are substorms. To answer this question we considered data from the Geotail spacecraft in the magnetotail. Solar wind parameters were taken from the Wind spacecraft observations; the auroral bulge parameters were obtained by the Ultra Violet Imager onboard Polar. Some ten events are selected when Geotail was in the plasma sheet during the auroral bulge formation related to Sheath and CIR. We noted that some signatures of a typical substorm were observed in the magnetotail, namely: tailward-to-earthward plasma flow reversals associated with reconnection process, as well as a sharp decrease of the total pressure following the interval of pressure increase. This enables us to consider the auroral disturbances during Sheath and CIR as substorms.

INTERMEDIATE AND SMALL SCALES OBSERVED BY THE FAST SATELLITE

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Physical mechanisms of magnetosphere-ionosphere coupling at intermediate (1-100 km) and small (< 1 km) scales are not fully understood as yet. The prevailing viewpoint that this coupling is implemented by dispersive Alfvén waves seems to be inconsistent with the seasonal variation in the small-scale electric fields observed in the topside ionosphere, which, on the contrary, can be readily explained in the model of static current circuits. In the present study we investigate this effect by highly resolved FAST observations of the electric fields at altitudes near FAST apogee (h = 4000 km) and clarify if it can be reasonably understood within the frameworks earlier proposed by Lysak [1998] and Golovchanskaya [2007].

FIELD-ALIGNED CURRENTS IN THE MAGNETOTAIL PSBL DURING PERIODS OF DIFFERENT GEOMAGNETIC ACTIVITY

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Field-aligned high-velocity ion beams are frequently observed in the plasma sheet boundary layer (PSBL) and it is naturally to expect associated field-aligned currents (FAC) streaming in the lobe-PS interface. Our analysis of 200 PSBL crossings by Cluster spacecraft revealed two different types of ion beams related with two different regimes of current sheet acceleration. 1) Energy collimated and spatially localized ion beams (beamlets) having a rather long duration (up to 20 min) and energies less than 20 keV, observed during quiet geomagnetic periods, together with isotropic electrons. These features indicate on ion acceleration in spatially localized resonant sources located in the distant current sheet, in the region of closed magnetic field lines and rather far from the distant X-line. FAC of small current density carried mainly by beamlet ions are registered in these cases. 2) In active periods, powerful (up to 140 keV) field-aligned ion beams with large parallel temperatures are observed along with anisotropic electron fluxes, formed out of an accelerated electron beam streaming from the acceleration source and of cold electrons moving towards the source. This feature indicates that the acceleration of ion beams takes place near the X-line. Strong FACs carried by electrons are registered. The observed durations of the current structures may reach several minutes but they are shorter than the durations of the corresponding accelerated ion beams. This may imply that the ion non-adiabatic acceleration in the magnetotail current sheet is more steady process than the process maintaining Hall current system

STUDY OF THE 5577 A AND 6300 A EMISSIONS CHARACTERISTICS DURING SUBSTORMS

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Aurora is closely connected with the solar wind-magnetosphere-ionosphere interaction. The magnetic substorms are clearly expressed in auroral displays. Therefore auroral observations are important for the understanding of these phenomena. We present some results of auroral emissions behaviour during substorms. The 5577 A and 6300 A intensities have been studied. The I6300/I5577 ratio that is widely used as a characteristic of the precipitating electrons energy distribution has been examined. The emissions intensities in front of the polar edge of the auroral bulge, in the polar edge and inside it have been compared and estimations about the nature of the particle precipitation spectra in these regions have been made.

Data from two All-Sky Imagers: at Andenes, Norway, and at Longyearbyen, Svalbard, from 2005-2006 observations have been used.

The interplanetary conditions have been determined by WIND satellite data. The substorm development has been followed up by the magnetic field components data from the IMAGE magnetometer network.

It is found out that the intensity emissions ratio is lower at the polar edge of the auroral bulge than inside it, which bespeaks the most energetic particles precipitation at the polar edge of the substorm bulge. The I6300/I5577 ratio in the arcs inside the auroral bulge is about 1.25 times higher than the one at its polar edge. In some cases, in front of the polar edge of the auroral bulge a region of enhanced red emission is observed, which may result from a downward current

STUDY OF CONFORMITY OF MAGNETIC H AND D COMPONENTS REGISTERED AT HEL OBSERVATORY WITH NEARBY OBSERVATORIES DATA DURING THE PERIOD 1966 - 2008

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The hourly geomagnetic data of the Polish station Hel (geog. lat. 54.61, geog. long. 18.82) for the practically whole interval 1966-2008 of the registration are compared with records of nearby stations: Belsk, Niemegk, Brorfelde, Lovo, Sodankyla and Nurmijarvi using the absolute values of the H and D components and the IHV indices derived from this component. We apply the correlative analysis and the wavelet technique with establishing of the significance levels of the resultant power spectra.

Generally our analysis of the H and D absolute values and IHV indices shows the good quality of the Hel H and D component registrations that agree with the results of other stations at that time. Small inconsistencies in the registrations of H during time period 1982-1986 in the range of oscillations with periods of 480 - 280 days and 160 - 50 days, 1987 - 1989 and in 1998 with the periods of about 260 - 300 days, and registration of D during 1971 - 1975, 1979 - 1980, 1986 - 1990, 1996 - 2002 in the range of oscillations with periods of 50 - 200 days; and 1981 - 1982, 1996 - 1998 in the range of periods of about 150 - 300 days, ought to be corrected by the repeated read-out of types with original data or by using of the neuron network calculations.

MAGNETOSPHERIC RESPONSE TO COMPLEX INTERPLANETARY DRIVING: A MULTI-POINT CASE STUDY AND COMPARISON WITH MODELS

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On 22 November 1997 an interplanetary shock reached the earth magnetosphere and produced a storm with Dst=-75 nT. While the magnetosphere was still in its recovery, a new interplanetary shock hit the magnetopause, causing the development of a new storm with Dst reaching -108 nT. In the course of the two-step storm that took place on 22 - 24 November 1997, multitude substorms developed with AL down to -1400 nT. We use data from both satellites of the INTERBALL pair, POLAR and GOES to study the reaction of the magnetosphere during this complex event. Images from POLAR satellite demonstrated an excellent agreement between auroral arcs and field-aligned currents, registered aboard the low-apogee INTERBALL-Auroral. Peculiar magnetopsheric events in the tail lobes were observed on 23 November 1997, during the second step of the storm. At GOES orbit electron flux decreased with the beginning of the disturbance but in the recovery phase the so-called `killer` electrons appeared. Comparison of magnetic field measured along the orbits of all 5 satellites with Tsyganenko-96 and Tsyganenko-05 models showed that Tsyganenko-05 is an adequate approximation of the magnetospheric magnetic field during disturbances with direct interplanetary driving. This gave ground to calculate the magnetospheric currents. For disturbances due to stored in the tail energy both models fail. At higher altitudes the By component is not adequately modeled.

SOLAR INFLUENCE ON PLASMASPHERE AND MODELING OF 3D PLASMASPHERIC DENSITY DISTRIBUTION USING THE INTERBALL 1 DATA BASE

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A database of all cold plasma measurements aboard INTERBALL 1 obtained in 1995 – 2000 was collected. It includes plasmaspheric density and temperature, spacecraft potential and orbital information. The database is also supplemented by magnetic activity indices and solar wind parameters. The data are used for the analysis and reconstruction of plasmaspheric temperature and density distributions in the equatorial and meridional planes. The comparison of plasmaspheric density with solar wind density revealed their correlation. This correlation is analyzed for different MLT and L values, its possible reasons are discussed. The work is partially supported by the RAS programs P4 and OFN 15.

EFFECTS OF GEOMETRY OF INTERACTION BETWEEN INTERPLANETARY AND TERRESTRIAL MAGNETIC FIELDS ON GLOBAL GEOMAGNETIC ACTIVITY

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The report generalizes results of our study dealt with dependence of geomagnetic activity from geoeffective parameters taking into account mutual orientation of the interplanetary magnetic field (IMF), electric field of the solar wind and geomagnetic moment (M). We attract a reconnection model elaborated by us made allowance for changes of geometry of the solar wind–magnetosphere interaction during annual and diurnal motions of the Earth. We take as our data base IMF and solar wind velocity measured at 1 a.u. for the period 1963–2005 and Kp, Dst, Am indices. It follows from our study that in themselves changes of orientation of the IMF with respect to the geomagnetic field cannot explain observed statistical variations of the indices. Taken as a whole geoeffective parameter suggested by us explains 95% of the indices variations. The geometric factor determined by mutual orientation of the solar wind electric field and M explains 75% of these variations of the indices. Based on our results we suggest a new explanation of semi-annual and UT variation of geomagnetic activity. At last we discuss applications of our results for explanation geomagnetic storms during northward IMF and geoefficiency of CMEs (MCs).

SOURCES AND COMPLEXITY OF THE INTENSE AND SEVERE GEOMAGNETIC STORMS DURING THE MAXIMUM PHASE OF SOLAR CYCLE 23

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Solar energetic phenomena and its consequences in the interplanetary space are governing and perturbing the Earth`s magnetosphere. The response of the terrestrial magnetosphere displayed as geomagnetic storms induce significant effects on the space and ground technological systems. This paper analyses the intense and severe geomagnetic storms (Dst<-100) during the maximum phase of solar cycles 23 (1999 – 2002) as well as two different types of the fast solar wind associated with them. (co-rotating high speed streams and ejecta or magnetic clouds). The B and Bz variability registered simultaneously with the fast solar wind and their role in the strength geomagnetic storm is emphasized.

THE INFLUENCE OF THE INTERPLANETARY CONDITIONS ON GEOMAGNETIC STORMS DEVELOPMENT

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We study the interplanetary conditions of the main phase for 190 geomagnetic storms with Dst < –50 nT driven by large-scale types of the solar wind: CIR (49 magnetic storms), magnetic clouds MC (17), Ejecta (50), and Sheath (40). The remaining 34 magnetic storms have no well-defined sources.

For the investigation of the dynamical connection between the development of solar wind parameters inside the interplanetary drivers and Dst index value during development of the main phase, we apply the comparison an integral electric field sumEy with Dst index (in subgroups with different values of dynamic pressure Pd and of IMF fluctuation level sB).

We show that Dst index decreases with increasing of integral electric field sumEy on the main phase of all types of magnetic storms and the most higher coefficient of correlation between these parameters is observing for storms initiated by the Sheath ahead ICME. It is possible that the dynamic pressure increases the efficiency of electric field for solar wind sources: Sheath ahead ICME, CIR and indefinite type.

The estimations of threshold values of integral electric field sumEy for achievement of level of intensity of moderate (Dst < –50 nT) and strong (Dst < –100 nT) magnetic storms indicate on tendency of its dependence on driver type for magnetic storm: threshold values are in 1.5 times lower for the Sheath ahead ICME than for ICME.

LOW FREQUENCY AKR ON THE POLAR EDGE OF AURORAL REGION

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We investigate waves observed by Interball-2 instruments Polrad and IESP-2M .The frequency of AKR (Auroral Kilometric Radiation) is nearly equal to the local electron gyrofrequency of the generation region. Being electromagnetic radiation, AKR propagates almost straight in the emission cone. Since the altitude dependence of the magnetic field is well known, the AKR generation altitude can be estimated from the AKR frequency. The usual AKR frequencies (100–400 kHz) correspond to altitudes of 3300–9000 km (1.5–2.5RE radial distance).The low frequency AKR emission is identified type of terrestrial AKR emission whose frequency is lower than that of usual AKR, only about 40-50 kHz. If the frequency is interpreted as the local electron gyrofrequency at the generation altitude, the emission must originate from 3-3.5 RE geocentric radial distance. It is known that the low frequency AKR is seen predominantly in substorm bulges. Was found that the low frequency AKR events significant low-frequency wave activity occurs simultaneously.

SEASONAL AND UT VARIATIONS OF AURORAL PRECIPITATION BOUNDARIES AND THE POLAR CAP POSITION

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An influence of a geomagnetic dipole tilt angle on the latitudinal position of auroral precipitating boundaries in the pre-midnight (21-24 MLT) and pre-noon (09-12 MLT) sectors were examined by using DMSP F7 spacecraft observations for 1986. At all geomagnetic activity levels the nightside high-latitude zone of soft diffuse precipitation (SDP) and the polar cap (PC) boundary was found to be at higher latitudes in the winter and at lower latitude in the summer concerning an equinox. While the latitudinal position of the diffuse auroral precipitation (DAZ) boundaries equatorward of the auroral oval does not depend on a season. In the daytime sector the picture of precipitation is opposite. The complete value of the PC boundary displacement from the winter to the summer at both night- and dayside makes ~2.5 degrees. It was found out the daily wave in the latitudinal position of nightside precipitation which is most brightly expressed during winter and autumn periods, is much weaker in the spring and actually absent in the summer Twenty-four-hour variations of precipitating boundaries represent quasi-sinusoidal oscillations with the latitudinal maximum at 03-05 UT and minimum at 17-21 UT. The complete value of daily displacement of boundaries is about 2.5 degrees of latitude. The obtained results show that, testing seasonal and twenty-four-hour variations, a polar cap as a whole displaced in a direction opposite to the geomagnetic dipole tilt angle changes. Seasonal displacement of the polar cap and its UT variations in the winter were occurred without essential change of the PC area.

SPECTRAL PARAMETERS OF HIGH LATITUDE LONG-PERIOD GEOMAGNETIC DISTURBANCES: MORPHOLOGY AND CONTROLLING FACTORS

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Spectral parameters and correlations of geomagnetic pulsations in the frequency range 1-4 mHz (Pc5/Pi3) at high latitudes are analyzed at different spatial and timescales. It is shown that not only spectral power, but also higher spectral parameters demonstrate regular dependence on geomagnetic latitude and local time. Variations of spectral power and, partly spectral shape parameter C_{PC} are controlled by state of solar wind plasma and interplanetary magnetic field in the foreshock. The spectral slope is the most stable and most independent on the interplanetary factors parameter. Its behavior is controlled by the plasma parameters in the magnetosphere and in the magnetosheath and it gives a clear evidence of active answer of the Earth's magnetosphere to the external forcing.

PRECIPITATION OF CHARGED PARTICLES FROM MAGNETOSPHERE: MORPHOLOGY, CONSEQUENCES IN THE IONOSPHERE, AND SOME IMPLICATIONS FOR MAGNETOSPHERIC STUDIES

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Particle precipitation provides the link between magnetospheric plasma domains and atmosphere through the transfer of energy, momentum, influence on the conductivity (Joule heating), etc. The precipitation from different domains differs in duration, location, and altitude of energy deposition. In this review characteristics of the precipitation as well as some processes, which precipitate charged particles from different magnetospheric domain, are briefly discussed. The greatest part of the input power is carried by the precipitating auroral (E<30 keV) electrons, especially during magnetospheric substorms. Interaction of precipitating particles with atmospheric constituents at ionospheric altitudes leads to appearance of the aurora. The aurora "visualizes" magnetospheric processes on the ionospheric "screen". Thus, auroral observations provide a tool for investigation of the magnetosphere. To illustrate this statement, we consider two examples: 1) substorm-related discrete auroral arcs, and 2) sub-oval proton aurora. Comparison of these auroras with some other geophysical phenomena enables us to locate the source of the discrete arcs on the stretched magnetic field lines in the magnetotail, and to relate the sub-oval proton auroras with interaction of ring current ions and cyclotron waves.

LOCATION OF THE ION-CYCLOTRON INSTABILITY REGION RELATIVELY PLASMAPAUSE DURING MAGNETOSPHERIC COMPRESSIONS

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Compression of the magnetosphere by the jump of the solar wind dynamic pressure produces, among other consequences, a large-scale day-side precipitation of energetic protons responsible for sub-oval proton aurora flashes. These flashes are related to sudden appearance of geomagnetic pulsations in the Pc1 range. Both proton precipitation and Pc1 manifest the development of the ion-cyclotron instability in the equatorial plane of the magnetosphere. To determine the magnetospheric domain where the instability develops we combined the projection of the equatorial edge of the proton aurora flashes observed with the IMAGE spacecraft and plasmapause location. The latter was obtained using the on-line service at www.spaceweather.eu provided by V. Pierrard. No proton aurora flashes were found well inside the plasmasphere. Compressions related to wide-band Pc1 bursts produce proton aurora flashes in a wide latitudinal range. Equatorial edges of such flashes typically map into the vicinity of plasmapause. Flashes related to narrow-band Pc1 pulsations were found at distances from 0 to 3 R_E outside the plasmapause. Thus, during magnetospheric compressions the ion-cyclotron instability develops on the dayside in the region of the low density of the cold plasma. The equatorial edge of proton auroras can be used as a proxy of the plasmapause location. It was also found that the location of the equatorial edge of the proton flash and the distance between the flash and plasmapause depends on preceding geomagnetic activity. Stronger geomagnetic activity leads to the earthward expansion of the ion-cyclotron instability region and its approaching to the plasmapause.

RELATIONSHIP BETWEEN SHARP INCREASES OF THE SOLAR WIND DYNAMIC PRESSURE, PROTON AURORA FLASHES, AND GEOMAGNETIC PULSATIONS IN THE PC1 RANGE

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The relationship between sharp increases of the solar wind dynamic pressure, flashes of sub-oval proton aurora on the dayside, and geomagnetic pulsations in the Pc1 range is considered on the basis of solar wind data, proton aurora observations from the IMAGE spacecraft, and observations of geomagnetic pulsations at station Lovozero (L=5.3). It is shown that some 70% of the solar wind pressure jumps are associated with proton aurora flashes equatorward of the proton aurora oval. We noted that pressure jumps related to interplanetary shocks correspond to the flashes more frequently than those related to other discontinuities. This is related to stronger compressions of the magnetosphere during interplanetary shocks, as confirmed by variations in the SYM-H index. Solar wind pressure increases sometimes associate with a sharp change of the regime of geomagnetic pulsations in the Pc1 range. We found that such Pc1 response is always observed when the ground station registering the pulsations is conjugated with the region of the proton aurora flash. The probability to observe the Pc1 response sharply decreases when the ground station is outside the flash area. Thus, the proton aurora flash "highlights" the location of the Pc1 source. Since the pulsations in the Pc1 range are an indicator of the electromagnetic ion-cyclotron waves, we conclude that the flashes are the result of the ring current proton precipitation due to ion-cyclotron instability developing on the dayside under magnetospheric compression and related increase of the ring current proton anisotropy. This work was supported by the RFBR grant 11-02-00397.

SUB-OVAL PROTON AURORA SPOTS AND LOCATION OF THE PC1 INTENSITY MAXIMUM

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Several cases of simultaneous observations of sub-oval proton aurora spots from the IMAGE spacecraft and geomagnetic pulsations Pc1 at stations of the Finnish meridian chain of search-coil magnetometers are considered. During events under study the magnetometer chain was nearly conjugated with the meridian of the proton aurora spot. The maximum of the Pc1 intensity is found at the ground station which latitude is closest to the projection of the proton aurora spot. One event exhibited two-band Pc1. In this case two proton spots were observed at different latitudes. The spot at higher (lower) latitude corresponds to the Pc1 intensity maximum in the lower (higher) frequency band. Such spatial relationship strongly supports the suggestion on the sub-oval proton aurora spots as the result of the ion-cyclotron instability in the equatorial magnetosphere. This work was supported by the RFBR grant 11-02-00397.

MAGNETOTAIL STRETCHING UNDER DIFFERENT SOLAR WIND CONDITIONS

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As known, there is a relationship between latitude of the equatorward boundary of isotropic precipitation of energetic protons and stretching of the magnetic field in the near-Earth magnetotail. The lower the latitude, the more stretched the magnetic field lines. The magnetotail stretching correlates with geomagnetic activity. Also, the lowest location of the isotropy boundary associates with stretching of the magnetic field lines in the widest longitudinal sector. We investigate long-term variations of the magnetotail stretching using the particle precipitation boundary called b2i, which is a proxy of the isotropy boundary revealed from the DMSP satellite data. The data from 1984 till 2009 including three minima and two maxima of the solar activity are used. The more stretched magnetosphere is found during solar maxima. The most dipolar magnetic field lines are observed during the last, extremely long solar activity minimum. The difference in the magnetotail configuration during interaction of the magnetosphere with different solar wind structures is also considered. It is shown that the strongest stretching is observed during the streams containing so-called "magnetic clouds" with southward magnetic field. This agrees

with increased intensity of geomagnetic disturbances during such solar wind streams. Also, this explains why substroms during magnetic clouds occur at lower latitudes and have large longitudinal dimension.

SOLAR AND INTERPLANETARY SOURCES OF MAGNETIC STORMS

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Different large-scale solar wind structures (ICME, Sheath, CIR and others) play important role in solar and heliospheric physics and space weather. We categorized various large-scale types of solar wind as interplanetary drivers of storms: corotating interaction region (CIR) generated by coronal hole, Sheath, interplanetary CME (ICME) including magnetic cloud (MC) and Ejecta generated by coronal mass ejections (CME), and ”Indeterminate” type. We discuss occurrence rate, geoeffectiveness and efficiency of these types of streams. Yearly numbers of different structures are 124 for heliospheric current sheet (HCS), 8 for MC, 99 for Ejecta, 46 for Sheath before Ejecta, 6 for Sheath before MC, and 63 for CIR. Geoeffectiveness (number of selected type of solar wind resulted in magnetic storm with Dst < - 50 nT divided by total number of this type) of MC with Sheath is the largest (61%), geoeffectivenesses for CIR and Ejecta with Sheath are medium (20-21%) and types of Sheath and Ejecta without Sheath have the lowest geoeffectiveness (15 and 8%, respectively). In accordance with `output/input` criteria the highest efficiency in generation of magnetic storms is observed for Sheath and the lowest one for MC. Paper is supported in part by Physical Department of Russian Academy of Sciences, Program N 16, and by RFBR, grant 10-02-00277.

SOLAR EFFECTS IN THE IONOSPHERE

STUDY OF THE IONOSPHERIC SCINTILLATION AND TEC CHARACTERISTICS AT SOLAR MINIMUM IN A WEST AFRICAN EQUATORIAL REGION USING GLOBAL POSITIONING SYSTEM (GPS) DATA

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Ionospheric scintillation is a rapid variation in the amplitude and phase of trans-ionospheric radio signal resulting from density irregularities in the ionosphere. It is referred to us by the index S4. The data used are the scintillation index (S4) and the vertical TEC (VTEC) recorded at the SCINDA (Scintillation Network Decision Aid) GPS station of Abidjan (Latitude = 5.34o N, Longitude = 3.90o W). This work covers the period from January 2008 to January 2009, two years of low solar activity with R12 equal to 2.8 and 4.2 respectively.

The results show that the scintillation is not intense with S4 values lower than 1 in most of the cases and during the course of the day. However, from 2000 to 0200 there are relatively high values of S4 confirming that scintillation is primarily a nighttime observed phenomenon. The scintillation shows a seasonal effect characterized by intense value in the equinoctial months compare to that of the solstice season. The VTEC in general exhibits a diurnal variation as a function of the solar zenith angle. Higher VTEC values are observed around 1100 and 1800 local time and have the same seasonal variation with the S4 index.

O^+/H^+ TRANSITION LEVEL BEHAVIOUR IN THE TOPSIDE IONOSPHERE AT LOW LATITUDES TOWARD VERY LOW SOLAR ACTIVITY LEVELS AT THE END OF 23 SOLAR CYCLE

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Plasma probe data from DEMETER, DMSP-F13 and DMSP-F15 satellites were used to examine the inter-annual behaviour of O^+/H^+ transition level (TL) in the topside equatorial ionosphere. French DEMETER (Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions) micro-satellite was launched on June 29 2004 at near circular Sun synchronous orbit (SSO) with 98° inclination at 710-730km initial height with approximate local time of the orbital ascending node ~22:30LT. Onboard satellite, thermal plasma instrument called `Instrument Analyser de Plasma` (IAP) provides ion mass and densities, ion temperature, three component ion drift and ion density irregularities measurements. In parallel to the DEMETER satellite, DMSP-F13 and DMSP-F15 are on orbit operation since 1995 and 1999 onto circular SSO with ~98 ° inclination at ~830-850km with ascending node local time ~1745 and ~21:30LT, respectively. Onboard ionospheric plasma diagnostics was made by means of `Special Sensor-Ion, Electron and Scintillations` (SSIES-2) instrument. Here we use SSIES-2 and IAP data to present inter-annual variations of the so called O^+/H^+ transition level in the topside ionospheric plasma at low latitudes during the period of declining solar activity. The observed general trends in TL altitude are discussed as a result of the extremely low solar activity toward the end of 23 Solar cycle.

LONGITUDE VS LATITUDE VARIATIONS OF WAVE-NUMBER FOUR (WN4) SIGNATURES IN THE TOPSIDE IONOSPHERE BY MEANS OF DMSP-F13/F15 DATA- SEASONAL AND INTER-ANNUAL VARIABILITY

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Plasma probe data from DMSP-13 and DMSP-f15 satellites were used to examine the longitudinal vs latitude behavior of ion density and temperature distribution in the topside equatorial ionosphere. As a part of "Defense Meteorological Satellite Program", DMSP-F13 and DMSP-F15 are on orbit operation since 1995 and 1999 onto circular SSO with ~98 ° inclination at ~830-850km with ascending node local

time ~1745 and ~21:30LT respectively. Ionosphere plasma diagnostics onboard DMSP-F13 and DMSP-F15 is provided by means of `Special Sensor-Ion, Electron and Scintillations` (SSIES-2) instrument. Here we use SSIES-2 and data to study longitudinal vs latitude variations in the topside ionosphere at low latitudes during four-year period of declining solar activity from January 2002 to December 2005. The observed seasonal and inter-annual behavior of ion density and temperature structures are discussed in the scope of recently discovered “wave-number four” undulation of low latitude F-region plasma by non-migrating tides.

SOLAR ACTIVITY AND EQUATORIAL IONOSPHERIC VARIATIONS CAUSED BY GEOMAGNETIC STORMS

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Intensive ionospheric currents during geomagnetic storms change the quiet ionosphere and short-term variations of the ionospheric characteristics are observed. Under these conditions the critical frequency foF2, virtual height h’F, drift velocities and others ionospheric characteristics are mainly defined by the state of the solar wind flowing around the Earth`s magnetosphere. We studied equatorial ionospheric variations during different solar cycles and compared virtual ionosphere height and critical frequency foF2 at the equator with the interplanetary magnetic field and the geomagnetic data. We show that these variations are defined to a significant degree by the direction of the Bz-component of the interplanetary magnetic field. The ionospheric heights and foF2 variations at the equator during the northward IMF Bz and the southward IMF Bz (the main phase of the magnetic storm) are very distinguished. Distinction between quiet and disturbance periods in the heights can reach up to100 km and more. The critical frequency foF2 is markedly lower during the southward IMF Bz. It is shown that intensity of the equatorial ionospheric variations is different for the same solar wind conditions and depends on solar activity phases. These phenomena can mainly be explained by the solar wind – magnetosphere – ionosphere coupling.

EFFECTS OF GEOMAGNETIC ACTIVITY ON THE E AND F REGION IONOSPHERIC DRIFTS

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Digisonde drifts measurements with DPS 4 equipment started at Pruhonice observatory in January 2004. The paper deals with effects of high solar and geomagnetic activity, which were observed at Pruhonice observatory in ionospheric drifts measurements during 2004 – 2010 years. Interesting changes of the ionospheric drifts were observed during several periods of a suddenly enhanced solar and geomagnetic activity.

In standard autodrifts measurements with DPS 4, the velocity of F region drifts is usually determined near peak of electron concentration profile. From 2005 we started measurements of ionospheric drifts in E region of the ionosphere, by using four fixed frequencies in the height interval 90 – 150 km also. This new experimental arrangement makes possible to study vertical changes and profiles of the ionospheric drifts. In our paper we deals with win ter time significant changes of the drift velocity height profiles in the E region of the ionosphere (90 – 150 km) during geomagnetic quiet conditions. More dramatic vertical changes of all drift velocities components in the height interval 90 – 130 km (with effects of acoustic gravity waves) was observed during geomagnetic storms 14 – 16.12.2006.

In second part of this paper we report an observed nighttime changes of the vertical drift velocity profiles in the F region of the ionosphere during quiet and disturbed conditions at midlatitude station Pruhonice.

ION TEMPERATURE DISTRIBUTION IN THE HIGH-LATITUDE REGION (EISCAT UHF RADAR OBSERVATIONS) – WHAT IS THE FIELD-ALIGNED CURRENTS INFLUENCE?

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We present a study of high-latitude ionosphere response at Tromso (Norway) 02 July 2008). A comparison betweenduring quiet geomagnetic conditions (30 June ground based (EISCAT) and satellite (CHAMP) observations will enable us to delineate field-aligned current (FAC) contributions to observed ion temperature Ti distribution in height and its maximum at F2 region.

THE SOFT X-RAY EMISSION FROM NOCTURNAL ATMOSPHERE DURING THE DESCENDING PHASE OF 23RD SOLAR CYCLE

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Long-term observations with the RPS-1instrument on the CORONAS-F satellite (July 2001 to December 2005) permitted the evaluation of the low energy 3.0-31.5 keV X-ray emission flux radiated by the upper nocturnal atmosphere. The entire nocturnal atmosphere emits energy in the range of 3 to 5 keV, especially in the southern hemisphere, over the Pacific and Indian ocean areas. In the northern hemisphere, the brightest emission from the atmosphere is observed at high latitudes in the region of Earth`s radiation belt (ERB). In lower northern latitudes, the X-ray emission intensity is rather weak especially during the summer, and on 5-8 keV maps there are regions where there are no discernible emissions. At energies higher than 8 keV, only areas over the South-Atlantic magnetic anomaly and ERB at high latitudes are distinctly observed. This emission is produced by X-rays arising from interactions of ERB particles with the ambient atmospheric matter and the detector material.

The global monthly and yearly-averaged X-ray flux distributions were statistically determined for the five-year duration of the CORONAS-F mission. From these distributions, it is possible to infer about the influence of the solar activity and seasonal effects on the fluxes with energy in the range of 3 to 8 keV on descending phase of 23 solar activity cycle. We noted that the emission decreased about 10 times from 2001 to 2005 with the solar activity decreasing.

STATISTICAL STUDIES OF EQUATORIAL SPREAD F DURING DESCENDING PHASE OF SOLAR ACTIVITY.

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This report will present the statistical analysis of data on spread F during period 2002 - 2010 observed at Ho Chi Minh (Vietnam)- a station very close to the magnetic equator. The characteristics of Spread F over Vietnam showed a tendency with a decrease and later occurrence during descending phase of solar activity. The seasonal variation showed maximum in March-April and minimum in December. The Range Spread F that related to scintillations of radio signals between satellites and ground stations occurred pre-midnight and appeared more in February, March and April. The time of appearance of Range Spread F occurred later in descending phase of solar activity. The Frequency Spread F occurred post-midnight and showed maximum of occurrence during equinoxial months. These results were also compared with results of other equatorial stations.

THE SEASONAL BEHAVIOR OF THE REFRACTIVE INDEX OVER DIP EQUATOR (I=0)

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In this study, the seasonal behavior of the refractive index and the electron density distributions over the dip equator are investigated both for collisional and collisionless cases in the by using the real geometry of Earth's magnetic field for north hemisphere with respect to latitudes. It is observed that there is a harmony between the behavior of the electron density distribution and ordinary and extra-ordinary waves both for collisional and collisionless cases at hmF2 peak in the ionosphere.

A STUDY OF POLARIZATION JET INFLUENCE ON THE STRUCTURE OF SUBAURORAL IONOSPHERE

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Polarization jet influence on the structure of subauroral ionosphere is analyzed using numerical modeling of ionospheric F region. The polarization jet was included into the model by adding northward electric field of 5 – 100 mV/m at the jet's latitude band of 1-2 degrees. The results of calculations are compared with experimental data of ground-based ionosperic sounding stations for the spring equinox days. Modeling electron density well agree with measured ionospheric plasma frequencies.

The work is partially supported by the RAS programs P4 and OFN15.

TaD - AN ADVANCED TOPSIDE IONOSPHERE AND PLASMASPHERE ELECTRON DENSITY PROFILER

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The safety and security of space operations requires that spacecraft operators know and understand the environment around their spacecraft. A measure of the ionospheric element of that environment is given by the precise values of the partial total electron content (TEC). While the bottomside part of the ionospheric electron density can be determined, at least over specific locations, from ionogram inversion, in the topside ionosphere direct observations of electron density are sparse. Electron density models of high accuracy are required to fill in the gap.

TaD (TSM-assisted Digisonde) reconstruction model improves the accuracy of the topside ionosphere and plasmasphere electron density (Ne) profiles produced by Digisonde software as a complement to the measured bottomside profile. TaD uses the TSM Profiler (TSMP), developed on the base of TSM (Topside Sounder Model). TSM model obtains topside scale height (HT), transition height (hT), and their ratio (RT), being functions of the day-of-the- year, geomagnetic latitude, local time, solar flux (F10.7), and Kp.

In TaD profiler, the transition height and the plasmasphere scale height are statistically connected to the O+ (topside) scale height. We developed a procedure which changed the Ne integral by varying the scale height factor in order to equalize it with the corresponding measured GPS-TEC value. It is demonstrated that this procedure, which improves significantly the reconstructed Ne profile, can be implemented in the operational Global Navigation Satellite System (GNSS) practice.

SCALING ANALYSIS OF THE SOLAR, GEOMAGNETIC AND IONOSPHERIC DATA

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Scaling analyze based on structure function Tx(a,k) computed using wavelet analysis was used to study possible connection of ionospheric system with the solar and geomagnetic activity. Scale invariance of foF2 was proven for periods 2-32 days. Scaling properties of ionospheric data showed strong dependence on geomagnetic latitude of the station. Similar distribution of scaling exponents h for

ionospheric and geomagnetic activity implicates connection between these systems. On the other side, distribution of h for foF2 and F10.7 was different.

EXPERIMENTAL INVESTIGATION OF THE EFFICIENCY OF FERMENTATION PROCESSES OF WORT PRODUCED FROM RAW MATERIALS GREW IN A PERIOD OF INCREASING SOLAR ACTIVITY

Koucky Ondrej

Heineken Česká republika, a. s.

For all main raw materials like hops and barley used for beer production cultivation conditions are key factors determining their chemical composition. The content and composition of proteins and carbohydrates in barley and alpha- or beta acids in hops are directly influencing fermentation process.

The in line experiment will observe a behaviour of top fermenting yeast during fermentation of high hopped wort produced from raw materials cultivated and treated in a period of increasing solar activity. The process efficiency will be controlled by internal temperature of a fermentor, speed of carbon dioxide release and sensory attributes of semi- and final products.

WAVE-LIKE OSCILLATIONS IN THE IONOSPHERIC E LAYER DATA

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Ionosphere is a very complex system variable on wide range of scales. Besides dominant ionospheric variability that reflects solar activity there is very important part the influence of the lower-laying atmosphere. In the contribution we analyze wave-like variability in the E region ionosphere and search for correlated variability in the other atmospheric regions.

SLOW MAGNETOSONIC WAVES GENERATED IN THE PLASMASPHERE BY IONOSPHERIC TERMINATOR MOTION

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A problem of the structure and spectrum of slow magnetosonic waves in a dipole plasmasphere is solved. Both an analytical (in WKB approximation) and numerical solutions are found to the problem, for a distribution of the plasma parameters typical of the Earth`s plasmasphere. The solutions allow us to treat the total electronic content oscillations registered above Japan as oscillations of one of the first harmonics of standing slow magnetosonic waves. Near the ionosphere the main components of the field of registered standing SMS waves are the plasma oscillations along magnetic field lines, plasma concentration oscillation and the related oscillations of the gas-kinetic pressure. The velocity of the plasma oscillations increases dramatically near the ionospheric conductive layer, which should result in precipitation of the background plasma particles.

THE RELATION BETWEEN THE E-REGION GRAVITY WAVES AND THE F-REGION PLASMA DEPLETION BANDS OBSERVED WITH AN ALL-SKY IMAGER AT ARECIBO OBSERVATORY

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At mid-latitudes, F-region plasma depletion bands called plasma bubbles or medium scale traveling ionospheric disturbances (MSTIDs) have been regularly observed with all-sky imagers using the 630 nm airglow emission. On the other hand, various types of gravity waves (GWs) are often observed in the E-region using the 557.7 nm airglow emission. Recent studies have discovered an electrodynamic coupling between the E and F regions and GWs have been suggested as a potential seeding mechanism for F-region instabilities. In this study, we use 557.7 nm and 630 nm airglow data from an all-sky imager

located at Arecibo Observatory to statistically compare the occurrences of the E-region GWs and the F-region MSTIDs during the period of 2003-2008. A correlation between the occurrences of GWs and MSTIDs is observed suggesting that the GWs are one of the important seeding sources of the mid-latitude F-region irregularities. This relation is found to be affected by the season but not by Kp.

ON MAGNETOSPHERIC SOURCE FOR POSITIVE IONOSPHERIC STORMS

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This study concerns with an unresolved problem of generation of long-lasting ionospheric electron content (EC) enhancements in response to the geomagnetic storms, so-called positive ionospheric storms at low-latitude. A storm event on 14-15 December 2006 was analyzed by using data on vertical total electron content (VTEC) measured by a worldwide network of ground-based GPS receivers and data on 3D ionospheric EC tomography provided by COSMIC/GPS radio-occultation (RO) technique. It was shown that one of very important factors in the study of the ionospheric storms is consistent choice of the quiet time period. Previous studies of this event used moderately disturbed day on December 13 as a day of “quiet conditions”. In contrast, using a period on December 2-4, when the solar and geomagnetic activity was very quiet, allowed revealing prominent positive ionospheric storms on the initial, main and recovery phases of the geomagnetic storm. Analysis of the dynamics of the positive storm over the Pacific Ocean showed an increase of ionization at low latitudes and its uplifting up to heights of ~600 km during the storm main phase. Comparison of the VTEC dynamics with the electron fluxes demonstrate a good overlapping of the observed ionization enhancements with the low-energy particle precipitations at low latitudes above Pacific region. This fact indicates to importance of the magnetospheric mechanism in generation of the positive ionospheric storms.

IDENTIFICATION OF HF PROPAGATION MEDIUM UNDER IONOSPHERIC DISTURBANCES

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We have been actively involved in the research and management activities of EU COST actions related to ionosphere and telecommunications. Examples are COST 238, COST 251, COST 271, COST 296, COST 724, ES 0803. Our main activities have been mainly in the topics of identification, modeling, forecast, prediction, mitigation and planning.

In this paper, we present some work on HF radar operation under ionospheric disturbances.

Dependences of Doppler velocity and Group Range of the echo signal on the geometric Ap index are demonstrated. Thus the effects of space weather on the ionosphere and as a result on HF radar wave propagation are displayed. The results can be used in communication system planning and mitigation.

CONCENTRATION OF IONS IN THE UPPER IONOSPHERE MEASURED BY DEMETER. MORPHOLOGY AND DEPENDENCE ON SOLAR AND GEOMAGNETIC ACTIVITY

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Concentrations of O+, H+ and He+ ions measured in the upper ionosphere by DEMETER satellite are studied. Latitude distribution, seasonal variations and variations in the solar cycle are analyzed for more than four years of continuous measurements from 2004 to 2008, i.e. at declination and minimum of the solar cycle. It is shown that seasonal and solar cycle variations and latitude distribution differ essentially

for oxygen ions and for light (H+ and He+) ions. Variations of concentration of O+ are controlled predominantly by solar radiation, while the variations of concentration of light ions in the upper ionosphere depend predominantly on the geomagnetic activity. During the intervals of low geomagnetic activity a good correspondence is found between H+ concentrations in the upper ionosphere and at the geostationary orbit.

Pc2-3 PULSATIONS ON THE GROUND AND IN THE UPPER IONOSPHERE

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We analyze the parameters of geomagnetic pulsations in the frequency range 50 - 200 mHz (high frequency Pc3 and Pc2) measured on the ground at the meridional chain (MM110) from auroral to middle latitudes and in the upper ionosphere at CHAMP satellite. The spectra of ionospheric pulsations are enriched with higher frequencies in comparison with the ground pulsations. The occurrence rate of high frequency Pc3/Pc2, lying above the frequency of first harmonic of Alfven resonance, their spectral parameters and coherence are studied in the ionosphere and on the ground in dependence on geomagnetic latitude and space weather conditions. It is found that the spectra of high frequency Pc3/Pc2 at CHAMP and high latitudes segment of MM110 are mostly noise-type, but this noise is coherent at big spatial scales, while narrow-band pulsations are typical at middle geomagnetic latitudes. Different scenarios of generation and propagation explaining the observed spatial and frequency distribution of high frequency Pc3/Pc2 on the ground and in the ionosphere are discussed.

THE EFFECT OF SEASONAL AND SOLAR CYCLE VARIATION OF foF2

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In this study, for the solar cycles 21 and 22, the monthly lunch hours median values of ionospheric foF2 at Slough (47.650N-122.290W) and Rome (41.530N-12.290E) are investigated by using different solar activity indices, such as the solar brightness index, sun spot number and solar flux at 2800 MHz. In order to observe the seasonal variations of the ionospheric hysteresis, all months in the solar cycle are arranged in three part of seasons as equinox (March, April, September, October), summer (May, June, July, August) and winter (November, December, January, February). In order to investigate the effects of the hysteresis, the simple regression analysis is used for the method of the study. The results can be listed in three groups: (1) There is a qualitative correlation between the solar index and the ionospheric foF2. This correlation points out the differences between the seasons. (2) Ionospheric hysteresis in the equinox are more pronounced than in the summer and winter. (3) The scale of the ionospheric hysteresis varies according to from an index to an index, a loop to a loop and a location to a location.

AN EMPIRICAL SQ MODEL BASED ON MAGDAS/CPMN DATA DURING 1996-2007

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The solar quiet daily variation (the Sq field) results principally from currents, flowing in the E layer of the ionosphere. In order to understand the coupling of the Sun-Earth system, we examined the dependence of Sq variation on (1) Day of Year, (2) Lunar Age, (3) Solar Activity (F10.7 index), (4) Local Time, and (5) Magnetic Latitude of the stations, we have constructed an empirical Sq model by using MAGDAS/CPMN data during 1996-2007. The MAGDAS/CPMN data for constructing of empirical Sq model are selected under the magnetically quiet condition (Kp<2+). The geomagnetic Sq daily variations at 21MAGDAS/CPMN stations are estimated with the least squares method as a function of DOY, LA, SA and LT.

The empirical model can describe solar-activity and seasonal dependence of solar quiet daily variations (S) and lunar quiet daily variations (L). We performed a spherical harmonic analysis on these S and L variations to examine characteristics of the equivalent external current systems. First, we found that the total current intensity of the S current system is largely controlled by the solar activity. Second, we

found that seasonal variations of the S current intensity exhibit north-south asymmetry; the current intensity of the northern vortex shows a prominent annual variation while the southern vortex shows a clear semi-annual variation as well as annual variation. Lastly, we found that seasonal variations of the L current intensity show an enhancement during the December solstice, independent of the level of solar activity.

WAVE PROCESSES IN THE IONOSPHERE ON PERIOD SCALES RANGING FROM A FEW HOURS TO SEVERAL DAYS UNDER QUIET AND MAGNETICALLY DISTURBED CONDITIONS

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The ionosphere serves as a sensitive detector for studying processes acting in near-Earth space, the atmosphere, and the lithosphere owing to the significant levels of variability in this space-atmosphere interaction region. Of particular interest are wave processes that make a significant contribution both to the energy balance in Earth`s atmosphere regions and to coupling among them. This study is concerned with wave processes in the period range of a few hours to several days in the ionosphere under geomagnetically quiet and disturbed conditions and with their possible relation to transitions through boundaries that connect the interaction region with the lower atmosphere and the magnetosphere. These processes can be remotely sensed and monitored by radio techniques. The dataset includes GPS data from the Kharkiv V. N. Karazin National University Radiophysical Observatory (49.6 N; 36.3 E) and ionosonde, atmospheric pressure, and earthquake data from geophysical databases available on the Internet.

Under quiet conditions, the variations in ionospheric parameter with periods of 3–4 days are often prevalent, which may be associated with planetary-scale waves and mapped down to Rossby waves. In the biosphere, the same periods also belong to the fundamental oscillation periods, which may indicate to possible synchronization among processes in different Earth`s crust and atmosphere regions even during time intervals without powerful disturbances of various origins. This conclusion may be of use for estimating unfavorable consequences of processes in the environment to humans.

A complex rearrangement pattern of the ionospheric wave structure is observed at transitions to magnetically disturbed conditions.

MANIFESTATIONS OF EARTHQUAKE ELECTROMAGNETIC EFFECTS NEAR AND FAR FROM SEISMICALLY ACTIVE AREA

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Recently, significant progress has been made in finding and explaining the mechanisms for electromagnetic effects of earthquakes (including precursors). Usually, the appearance of precursors is examined at a relatively short distances from the earthquakes in the so-called manifestation of precursor area with a scale of R(km) = exp(M) where M is the earthquake magnitude. Our first studies have shown the existence of VLF precursors outside the mentioned above area. In this paper, the examination of precursors both within and outside of the area mentioned above is based on LEO navigation satellite TEC and VLF emission data, respectively. The VLF receiver with a wideband antenna in the 2.5 – 50 kHz band is located in Kharkiv province, Ukraine. The earthquake data are retrieved from http://earthquake.usgs.gov/.

The VLF emissions show a typical diurnal variation with prevailing diurnal and semidiurnal spectral components and an atypical component usually arising the day before strong earthquakes when the diurnal component almost do not display itself. The variations in the VLF signal levels are characterized by the presence of characteristic features a few days before the earthquake onset (the bigger magnitude, the earlier precursor) and by electromagnetic disturbances after the mainshock. The total electron content values show a decrease during the day the earthquake occurs relative to those the day before and after.

Possible mechanisms are discussed for the propagation of disturbances from the earthquake area to the seismically quiet area where the observations are made.

SOLAR INFLUENCES ON THE LOWER ATMOSPHERE AND CLIMATE

TESTING A LINK BETWEEN SOLAR IRRADIANCE AND CLOUD COVER OVER DAILY TIMESCALES

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There is strong evidence to suggest that solar variability over centennial timescales is one of the most influential climate forcing agents, however over daily timescales the importance of solar forcings is still uncertain. This work presents a daily timescale analysis based around several superposed epoch (composite) samples, focusing on the largest Total Solar Irradiance (TSI) increases and decreases obtained from the Active Cavity Radiometer Irradiance Monitor (ACRIM) reconstruction. Furthermore, TSI decreases are examined both in the presence and absence of significant co-temporal Galactic Cosmic Ray (GCR) variations. Using the cloud cover data from multiple satellite programs (ISCCP, MODIS) including some other atmospheric parameters (NCAR reanalysis, annular modes) the strength of correlations to variations in TSI emissions are tested over 41 day period. Neutron monitor data (GCR) and F10.7 (EUV proxy) data are also correlated with corresponding TSI composites. The possibility of a lagged response to TSI is analyzed over 20 day lag period for the selected parameters. The statistical significance of the correlations is evaluated using Monte Carlo based statistical techniques. Our detailed analysis showed no compelling evidence of associations between the daily timescale fluctuations in TSI emissions and cloud cover respectively the analyzed parameters of atmospheric variability. The relevance of our results is examined in relation to a suggested solar – atmosphere link.

OBSERVATION OF PLASMA OSCILLATING STRUCTURES IN EXTERNAL IONOSPHERE OVER EXTRA-TROPICAL CYCLONES

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Earlier, in the authors` paper presented at the SES-2010 conference in Sofia, it was shown that the developed tropical cyclones (TC or hurricanes) significantly affect the ionosphere.

In this paper data of both Cosmos-1809 and Intercosmos-Bulgaria-1300 satellites over the extra-tropical cyclone, that reach hurricane force, are analyzed. They are developing as auroral and polar weather fronts are unstable at mid-latitudes after TC pass through the tropical ridge.

The most striking events, when 11 cyclones were observed by Cosmos-1809 satellite at Sept. 24, 1981 showed that, at the height of the extra-tropical cyclone, in some cases one can distinguish stable plasma structures. These structures have a core, where the oscillations of the density reach 10% and have a transverse scale of 10 km, and the periphery with smaller amplitudes and stretched density oscillations. These density holes filled with the electrostatic turbulence at the frequency of helium. DC electric field and electron heating in these structures are not allocated. On the neighboring orbits they are not observed.

The results obtained deepen the submission of meteorologists that tropical and extra- tropical cyclones affect not only the structure of the stratosphere, but also interrelated with the processes in the ionosphere. Additional energy, coming from the magnetosphere and ionosphere into atmosphere, can sometimes lead to intensificatUnexpected Solar Activity Cycle 24 prediction by various methods.

LONG-TERM SOLAR/GEOMAGNETIC SIGNATURES IN TERRESTRIAL CLIMATE

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The response of the European climate to the long-term solar/geomagnetic activity is investigated by using surface air temperature and solar/geomagnetic indices. A set of 21 time series of air temperature measured at European stations between 1900 and 2006, and 4 European and 14 Romanian stations with 150 year long records were used. Strong and coherent solar signals have been found at Schwabe and Hale solar cycles timescales, with peak to trough amplitudes of several degrees, and, respectively of 0.6-0.8 °C. Interdecadal and centennial trends as defined by 11- and respectively 22-year running averages of the annual mean time series significantly differ from corresponding trends in solar/geomagnetic activity, indicating the presence of temperature variations at the 30-40 year timescale possibly related to the internal dynamics of the atmosphere system. Results show a similar temporal behaviour at all analysed stations with amplitude differences that can be understood in terms of large-scale atmospheric circulation patterns influenced by the solar/geomagnetic forcing at the corresponding timescales, but with local intensity differences.

MEASUREMENTS AND MODELING OF (0,0) AND (1,0) BANDS OF THE O_2 ATMOSPHERIC SYSTEM

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Ground based spectroscopic observations have been used for the effective temperature evaluation. Measurements of rotational absorption lines from the P branches of the (0,0) and (1,0) bands of the molecular oxygen atmospheric system have been performed by the solar telescope of Belgrade Astronomical Observatory and by the spectroscopic system in Stara Zagora. Synthetic spectra of the above bands have been created based on line-by-line calculations. The theoretical equivalent widths have been computed. The theoretical and measured line profiles and their equivalent widths have been compared. The dependence of the equivalent widths on the rotational quantum number has been worked out assuming strong absorption. It allows the evaluation of the effective atmosphere temperature. The possible contaminations as water vapour lines in some cases are discussed. The theoretical estimates and the measurement results have been examined.

NATURAL CLIMATIC OSCILLATIONS DRIVEN BY SOLAR ACTIVITY

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Many climatic parameters (ground and ocean surface temperatures, pressure, atmospheric precipitation, etc.) have temporal variations with characteristic periods from several to several tens of years or more. The unknown cause of these oscillations, together with the similarity of some of them to known solar cycles, has stimulated attempts to relate these two phenomena. The basic arguments against the existence of such a relationship are that variations in climatic parameters do not always occur synchronously with the corresponding 11and 22 year solar cycles: the phase shift between climatic and solar variations is inconstant and changes with time from 0° to 180°. In addition, the energy of terrestrial manifestations of solar activity seems insufficient to stimulate the considered weather climatic processes, at least within the limits of the linear approach. In the present work, it is shown that in some cases, these contradictions can be removed for variations with a period more than 11 years under the assumption that climatic variations are forced oscillations driven by an external force (for example, a force related to solar activity), that implies the existence of intrinsic (natural) climatic oscillations. The result serves as an additional argument in favor of the reality of a sun–climate connection and probably points to its probable nonlinear mechanism.

MECHANISMS OF SOLAR INFLUENCE ON THE EARTH CLIMATE

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The strengths and weaknesses of the three main channels for solar influence on the surface temperature and climate – i.e. total solar irradiance, solar UV and energetic particles – will be discussed. The accent will be put on less known and new mechanisms for particles' influence on climate. Evidences for the greater impact of energetic particles' forcing on the lower stratosphere-tropopause region will be presented. A duly explanation how this forcing can influence the surface temperature - in accordance with the current IPCC concept for radiative forcing – will be presented. The perspectives for future changes in the climate will be discussed.

NEAR GROUND ATMOSPHERIC ELECTRIC FIELD RESPONSE TO FORBUSH DECREASES AS REGISTERED AT SWIDER OBSERVATORY

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Energetic charged particles of galactic cosmic rays (GCR) and stronger energetic solar particles penetrate deep into lower atmosphere ionizing the air and affect onto the value and distribution of electric conductivity, the electric field and other atmospheric electric parameters. The response of the atmospheric electric field (AEF) at ground level to the GCR is difficult to distinguish due to large amount of factors affecting the measured vertical component Ez of AEF. In spite of it we examine a possible influence of the short time scale effects namely the Forbush decreases of GCR intensity onto the AEF registered at Swider Observatory in 1954-2004 interval. The AEF the average diurnal values under analysis have been taken only from the days with the fair weather conditions. We have used the superposed epoch analysis to the separated data sets for geomagnetically quiet days and disturbed days. The preliminary results show that the atmospheric potential gradient decreases on the day before and increases on a 2 - 4 days after the Forbush effects. These results are discussed and compared with previously published results obtained from studies of Nagycenk observatory data (Marcz, 1997), Paratunka station (Kuznetosov and Cherneva, 2008) and Apatity observatory (Kasatkina et al, 2003) data sets. The study GCR effects in atmospheric electricity, taking into account a physical mechanisms of such influence, can help us to understand better the character of solar activity impact on the climate change.

INFLUENCE OF SUN, MOON AND PLANETS ON GLOBAL TEMPERATURE

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It is important to understand that Milankovich theory is one of the versions of the orbital theory of paleoclimate, which has some problems for now. Global synchronicity of sudden climate changes and changes in other geophysical systems force us to search for a new astronomical concept instead of only "insolation-climate" one. The focal point is to understand how and what mechanism governs transformation signals of astronomical origin into global climate change. At first stage we looked for the link between solar activity and climate. We present results of our study the links between changes sunspot numbers W, Earth's global surface temperature Tgl to understand their connection on different time scales in the past, present and close future. We use W for the last 300 yrs and proxy data of Tgl for the last 1000 yrs. In case of necessity we attracted other geophysical and interplanetary data. We apply MGM method of spectral analysis elaborated by us that can quantitatively describe both trends and non-stationary variations; MGM also allows detecting sudden changes in data. Characteristics of cycles in Tgl and W with the same periods are discussed in detail. Based on our analysis of components in the W and Tgl spectra we suggest a possible interpretation of periods in the Tgl spectrum by periods of solar, lunar and planetary origin. We discuss a possible physical mechanism of influence the Sun, the Moon and planets on changes of the global temperature.

THE UV RADIATION AND TOTAL OZONE DURING SOLAR ECLIPSE

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The solar eclipse is an event, which gives the opportunity to receive the important information about the sun itself as well as about the influence of the solar radiation on the processes, defining the atmospheric components dynamics. The measurements of the UV radiation reaching the Earth's surface in time of an eclipse and the total ozone content (TOC), calculated by them give us an idea about this kind of solar dynamics effect on the ozone.

In this paper we present the results from our measurements of the UV radiation and total ozone during the solar eclipses on 11 August 1999 (96% max coverage for Stara Zagora) and 29 March 2006 (76% max coverage). The observations were performed in Stara Zagora, Bulgaria by a ground-based scanning ultraviolet spectrophotometer Photon, which measures the direct solar radiation in the range 255-400nm, with 1nm resolution.

The course of some wavelength irradiances, registered by Photon during these eclipses shows that the radiation decrease about the max phase is different for separate wavelengths. The irradiance at shorter wavelengths was reduced more than at longer ones (limb darkening effect).

The total ozone variability during these eclipses shows almost the same time-patterns features during both eclipses. After the first contact TOC began to decrease till the maximum obscuration, reaching values which turned out to be less by about 75DU for 11 August 1999 and 82DU for 29 March 2006 with respect to the corresponding ones before the eclipses. In both cases, two maxima on either side of the totality were also found.

SOME REGULARITY OF THE TEMPERATURE CHANGE FROM 1880 TO 2010

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Analysis of the spatial structure of the change of the underlying surface temperature and air temperature (on different levels) from 1880 to 2010 was performed on the base of NCEP/NCAR reanalysis and GISS data.

The analysis of GISS data showed, surface temperature changes, in north hemisphere as well as in south hemisphere, had occurred none droningly. The sixty-year variations are observed against a background of common temperature growth. The linear trend in north hemisphere is the same as in south hemisphere. The sixty-year variations in both hemispheres have the identical phase; the amplitude of variation in north hemisphere is greater than in south hemisphere. The variation maxima are in 1880, 1940, and 2005, while the minima are in 1910 and 1975.

The regions of the maximum changes were identified. The similarity of the spatial structure of the change of the underlying surface temperature and near surface air temperature was detected. The observed near surface air temperature changes are greater than the underlying surface temperature variations. The warming in could season and cooling in warm season was observed at high latitudes in second half of XX century.

The revealed regularities are in agreement with physical model of solar activity impact on climate, which was proposed by authors early.

THE RELATION BETWEEN MAGNETOSPHERIC STATE PARAMETERS AND THE OCCURRENCE OF PLASMA DEPLETION EVENTS IN THE NIGHT-TIME MID-LATITUDE F-REGION

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Studies using all-sky imagers have revealed the presence of various ionospheric irregularities in the night-time mid-latitude F-region. The most prevalent and well known of these are the Medium Scale Traveling Ionospheric Disturbances (MSTIDs) that usually occur when the geomagnetic activity is low, and mid-latitude spread-F plumes that are often observed when the geomagnetic activity is high. The

inverse and direct relations between geomagnetic activity and the occurrence rate of MSTIDs and mid-latitude plumes, respectively, have been observed by several studies using different instruments; however, most of them focus on MSTIDs only and use only Kp to characterize geomagnetic activity. In order to understand the underlying causes of these two relations and distinguish between MSTIDs and plumes, it is illuminating to better characterize the occurrence of MSTIDs and plumes using multiple magnetospheric state parameters. Here we statistically compare multiple geomagnetic driver and response parameters (such as Kp, AE, Dst, and solar wind parameters) with the occurrence rates of night-time MSTIDs and plumes observed using an all-sky imager at Arecibo Observatory (AO) between 2003 and 2008. We also present seasonal and annual variations of MSTIDs and plumes at AO. The results not only allow us to better distinguish MSTIDs and plumes, but also shed further light on the generation mechanism and electrodynamics of these two different phenomena occurring at night-time in the mid-latitude F-region.

ON THE COUPLING OF TROPICAL LARGE-SCALE CYCLOGENESIS WITH THE SOLAR ACTIVITY

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The analysis of solar activity (SA) influence on large-scale vortical processes in the Earth atmosphere (tropical depressions, typhoons and hurricanes) is the important part of natural hazards and Earth climate change research. The mutual correlation functions of solar activity (SA) characteristics and tropical cyclogenesis (LVP) intensity are studied and SA and LVP spectrums are compared. The correlation coupling between Wolf numbers W(t) characterizing solar activity intensity with large-scale vortical perturbations (LVP) amount T(t) occurring in the Earth atmosphere is considered. The graphs of W(t) and T(t) for the time interval from 1983 up to 1998 years are shown. A single point of these curves give the number of events during month period and each data set uses 192 points. The behavior of oscillating functions W(t) and T(t) is different. For example, the growth of W(t) is not always accompanied by the T(t) increasing and the peaks of these functions have different position.

TOTAL SOLAR ECLIPSES AND ATMOSPHERIC BOUNDARY LAYER RESPONSE

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Meteorological parameters of the atmospheric boundary layer during 3 total solar eclipses (1999, 2006, and 2009) at different solar activity are compared taking into account geographic environment, the general meteorological conditions, seasons and phase of the Solar cycle.

Atmospheric response during the eclipse was determined using measurements of the temperature of both the air at three different levels - 10 cm, 50cm and 200cm and the soil.

The absolute luminosity of the sky during the eclipse was measured by three photometers - horizontal, in zenith and in the plane of the Sun motion.

INFLUENCE OF SOLAR WIND PARAMETERS TO ELECTRIC CURRENTS AND FIELDS IN MIDDLE ATMOSPHERE AT POLAR AND HIGH LATITUDES OBTAINED BY MODELING

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The electric currents and fields in the middle atmosphere are a result mainly of the tropospheric electrical generators whose activity principally determines their global distributions and magnitudes. Nevertheless, these fields and currents are influenced also by parameters of solar wind (SW) in several ways. An important way of such influence is through the `solar wind - magnetosphere - ionosphere` coupling. The field-aligned currents produce large trans-polar electric potential difference of ~40-140 kV in both polar caps of magnitude depending on SW parameters. These currents are closed in the dynamo-

region, however a part of them penetrate downward and influence the global atmospheric electrical circuit (GEC). We study the influence of the trans-polar potential on the electric characteristics in the middle atmosphere and below by simulation using Maxwell's equations. The electric current generated by ionospheric trans-polar potential difference, determined at surface at auroral latitudes, can reach 20-30% of the air-earth current in GEC. However, in stratosphere, and especially in mesosphere and lower ionosphere this current is larger and dominating, and depends on SW parameters. The currents have also a horizontal component due to their remaining closure below 100 km and because of the asymmetry between potential patterns at both polar caps. Related electric fields in strato/mesosphere show large variability with changes of SW parameters and those of conductivity at polar altitudes. The features thus demonstrated possibly play a role in solar-atmospheric links.

IMPROVED COSMIC RAY (CR) IONIZATION MODEL FOR THE ATMOSPHERE. DETERMINATION OF ENERGY INTERVALS FOR CR PENETRATION

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A new analytical approach for CR ionization by protons and nuclei with charge Z in the ionosphere and atmosphere is developed. For this purpose, the ionization losses (dE/dh) for the energetic charged particles according to the Bohr-Bethe-Bloch formula are approximated in three different energy intervals. More accurate expressions for CR energy decrease E(h) and electron production rate q(h) profiles are derived.

Computations for CR ionization in the atmosphere are made. The contributions of the different approximation energy intervals are presented. In this way the process of interaction of CR particles with the atmosphere are described much more realistically. The full CR composition is taken into account. The computations are made for different altitudes 35-120 km. The proposed improved CR ionization model will contribute to the quantitative understanding of solar-atmosphere relations. The analytical and numerical models include an analytical approximation of the direct ionization by CR primaries as well as CORSIKA/FLUKA programme system Monte-Carlo simulations with account of hadron interactions (0-35 km).

Our improved ionization model is important for investigation of the different space weather effects. CR and XUV radiations create ozonosphere and influence actively the ozone processes. But the ozonosphere controls the meteorological solar constant and the thermal regime of the atmosphere, i.e. the weather and climate. This hypothesis shows solution of the key problems of the solar-terrestrial physics.

HOMOGENIZATION OF THE STARA ZAGORA STRATOSPHERIC NO_2 TIME SERIES

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Since August 1999 daily ground-based spectrometric measurements are carried out during sunrise and sunset at the Stara Zagora (42°N, 25°E) department of SSTRI-BAS, aimed for determination of NO_2 slant column abundance by means of the GASCOD-BG instrument. DOAS technique is applied to retrieve NO_2 amounts from the obtained spectra. Increase or decrease of the stratospheric NO_2 density can change the ozone concentration, which acts on the radiative balance in the stratosphere and troposphere. Therefore the NO_2 trend analysis is very important for the global climate change study. Daily time series of the NO_2 slant column amounts obtained at Stara Zagora Station as well as at other DOAS stations are analysed. Extreme values can be a result of local tropospheric pollutions, a long range transport or are connected with strong lightning processes. These values are removed and monthly averages are determined from the remaining series. Further a regression based on the Ordinary Least Squares method between the station series is performed, in order to homogenize the Stara Zagora NO_2 time series. This enables to derive correctly the NO_2 linear trend, taking into account the auto-correlation

of the NO_2 data. The time series trends obtained at stations located near the same geographic latitude are compared for the same time period.

VARIABILITY OF THE GLOBAL AND THE HEMISPHERE TEMPERATURE ANOMALIES – APPLICATION OF THE COCHRANE-ORCUTT METHOD

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Climate changes focus the attention of science and policy today. A central issue to discuss in the scientific publications is about what is the extent of the human contribution to the climate warming. To get answers, in the last decades much efforts were made to model the processes determining the climate and to make forecasts under definite conditions for the development of the society (climate projections). Another scientific tendency in the efforts to find a more plausible answer involves the application and development of statistics to study the responses of the various climate forcings. Here a classical statistical method is applied - the linear regression, to examine the global and hemisphere warming due to different radiation forcings, by the use of their long and short-time variabilities. The residuals of the regressions are significantly auto-correlated. That is why the Cochrane-Orcutt method is applied to test the statistical significances. By a multiple regression it is found out that the main factor for the temperature increase is CO_2. The impact of the total solar irradiance during the examined time period from 1866 up to 2000 is at the critical level of significance.

THE VARIABLE EARTH RADIATION FIELD AND ITS IMPACT ON HUMANS

RADIATION MONITORING SYSTEM IN SERVICE MODULE OF INTERNATIONAL SPACE STATION

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To give the description of the radiation monitoring system (RMS) of the Service Module of the International space station (ISS) as an image of the perspective RMS for the future space crafts.

The radiation monitoring system is an important part of the radiation safety system of the modern spacecraft. The RMS description and results of its functioning for the period from 2001 to 2010 are presented in the report. This system is based on using the number of semiconductor detectors, permitting to measure the dose rate of the space radiation in the various positions of the ISS. The dates presented in the report demonstrate the dose rate variations in 4-th different locations of the Service module are analyzed in correlation with solar activity variations.

It is demonstrated that the dose variations measured onboard the ISS in the decay phase of the 23-d cycle of solar activity are essentially smaller than the dose variations measured onboard the MIR orbital station in the decay phase of the 22-d cycle of solar activity. The ISS attitude influence on the dose rate measured by the RMS detectors is also considered. The additional dose values caused by the large solar particle events including October 2003 and January 2005 ones are presented; dose rate dynamics during space station crossing of the high latitude trajectory regions in disturbed radiation conditions is also considered.

The results of radiation monitoring obtained with the help of the RMS during a flight of the ISS permits to estimate the radiation loading on the crewmembers for quite and disturbed radiation condition on the trajectory. The analyses of obtained results permits to estimate the ratio of continuous exposure to galactic cosmic rays and Earth radiation belt and a stochastic component caused by the solar proton events appearing during the missions in the total flight dose.

RECENT OBSERVATIONS OF THE RADIATION ENVIRONMENT IN A HUMAN PHANTOM ON THE INTERNATIONAL SPACE STATION

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The radiation field in the International Space Station (ISS) is complex, composed by galactic cosmic rays (GCR), trapped radiation of the Earth radiation belts, solar energetic particles, albedo particles from Earth's atmosphere and the secondary radiation produced in the shielding materials of the spacecraft and in human body.

An essential parameter for assessment of radiation hazards to human in space is the organ dose determination. Human phantoms equipped with radiation detectors are used to obtain a better knowledge of the dose distribution inside the human body.

The Liulin-5 charged particle telescope has directly observed the radiation environment in the tissue - equivalent phantom on ISS from June 2007 to June 2010. The objectives of Liulin-5 experiment are studying the dynamics of depth-dose distribution of the different components of the orbital radiation field in a human phantom and mapping the radiation environment and its variations with time and orbital parameters (such as solar cycle, solar flare events, and altitude).

In this report we present new results of Liulin-5 experiment for radiation quantities obtained from different components of the radiation field in low-Earth orbit (LEO) at the minimum of 23 Solar cycle and comparison with data from other radiation detectors on ISS. The results indicate that during a future

manned mission to Mars at a Solar cycle minimum the astronaut's exposures from GCR can reach the limits set forth in radiation protection guidelines for LEO, e.g. ISS operation.

"KILLER" ELECTRON FLUXES AND DOSE VARIATIONS DURING APRIL-MAY 2010 GEOMAGNETIC DISTURBANCES IN THE R3DR DATA ON ISS

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The R3DR (Radiation Risks Radiometer-Dosimeter (R3D) for the EXPOSE-R (R) facility outside of the Zvezda module of the International Space Station (ISS) is a Liulin type Bulgarian build miniature spectrometer-dosimeter, which worked successfully between March 2009 and January 2011, accumulating about 3 million measurements of the flux and absorbed dose rate with 10 seconds resolution behind less than 0.4 g cm-2 shielding. After the Coronal Mass Ejection (CME) on third of April (09:54 UTC) on fifth of April a shock was observed at the ACE spacecraft at 07:56 UTC, which led to a sudden impulse at Earth at 08:26 UTC. Never the less that the created magnetic substorms on fifth and sixth of April was moderate, a huge outer radiation belt enhancement was created. The R3DR data shows a relatively small amount of relativistic electrons on 5th of April. The maximum was reached at 7th of April with 2.3 mGy dose per day. Till 9th of April 6.1 mGy was accumulated. Till the end of the period on 8th of May totally 9.4 mGy dose was reached. These data were compared with similar observations on American, Russian and European satellites.

SPACE RADIATION DISTRIBUTION FROM THE EARTH SURFACE TO THE MOON ORBIT: THE INFLUENCES ON THE HUMANS AND ELECTRONICS

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This paper summarizes the observations carried out by different Liulin type instruments since 2000 on the ground (3 online ground based instruments), aircraft (more than 2000 flights), and spacecraft (Foton M2/M3 satellites and 4 mission on different positions of the International Space Station (ISS)) and during the Chandrayaan-1 satellite mission at 100/200 km altitude around the Moon. Liulin type instruments are Bulgarian build miniature spectrometers-dosimeters, which measured the flux and absorbed dose rate of the incoming space radiation with high resolution behind less than 1.0 g cm-2 shielding. All data are analyzed and compared to reveal harmonized picture how the different ionizing radiation sources contribute to build the harmful conditions for human's health and electronics. These data are also compared with the existing theoretical models.

INFLUENCE OF THE INTERNATIONAL SPACE STATION ATTITUDE ON DOSE RATE IN THE SERVICE MODULE OF THE STATION WHEN CROSSING THE SOUTH-ATLANTIC ANOMALY

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During orbital manned space flights on the International Space Station (ISS) a considerable part of the radiation dose is absorbed by cosmonauts when crossing the South-Atlantic anomaly (SAA) area, characterized by non-isotropic radiation field. Due to a complicated ISS configuration, the radiation level inside the station can depend on the attitude of the station.

The existence of this effect was proved by the registrations of the Radiation Monitoring System (RMS), stated in the Service module (SM) of the ISS. It was found, that the dose rate, measured by RMS detectors in the SAA, could vary more than twice when changing of the ISS attitude.

The calculation technique of the non-isotropic radiation field in the SAA has been developed on basis of the model created recently at the Research Institute of Nuclear Physics of the Moscow State University. The application of this technique in combination with the SM shielding model has allowed us to take into account the ISS attitude effect for dose rate calculation at different points of the station.

The obtained calculation results have been compared with the RMS measurements registered in the SAA. The satisfactory agreement between calculations and experimental data has been reached.

Using the developed technique, we have calculated the dose values in some points of cosmonaut's body for different positions and attitudes of cosmonaut relative to the ISS. It has been shown that the dose, absorbed by low-shielded organs, such as lens, can vary greatly, depending on the cosmonaut's attitude.

RADIATION ENVIRONMENT AROUND THE MOON IN LOW SOLAR ACTIVITY BY DATA OF RADOM INSTRUMENT ON INDIAN CHANDRAYYAN-1 SATELLITE

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The Radiation Monitor (RADOM) is a miniature dosimeter-spectrometer onboard Chandrayaan-1 mission for monitoring the local radiation environment. Primary objective of the RADOM experiment is to measure the total absorbed dose and spectrum of the deposited energy from high energy particles both en-route and in lunar orbit. RADOM was the first experiment to be switched on after the launch of Chandrayaan-1 on October 2008 and was operational till the end of the mission in August 2009. The RADOM experiment was selected from the number of the AO (Announcement of Opportunity) proposals for India's first mission to the Moon – Chandrayaan-1. For Moon missions the Earth magnetosphere is a source of magnetic field, as the Moon spends about 25% of its orbit inside it. RADOM proved that it could successfully characterize different radiation fields in the Earth and Moon radiation environment. All components like proton and electron radiation belts as well as galactic cosmic rays were well recognized and measured. The modulation of the galactic cosmic rays due to the solar activity was also clearly observed. Outside the radiation belts, en-route to the Moon the particle flux (~3 particle cm^{-2} s^{-1}) and corresponding dose were very small (~12 μGy h^{-1}) which further decreased slightly in the lunar orbit because of the shielding effect of the Moon. Average flux and dose in lunar orbit were ~2.5 particle/cm^2.s and ~10 μGy h^{-1} respectively at 100 km orbit. These increased to ~2.8 particle cm-2 s^{-1} and ~11 μGy h^{-1} respectively, at 200 km orbit. The total accumulated dose during the transfer from Earth to Moon was found to ~1.3 Gy. Due to the lack of significant solar activity only minor variations in the particle flux and dose were observed in the lunar orbit. Comparison of the RADOM observations with theoretical models of radiation environment of both the moon and the earth are underway and shows good preliminary results.

SPACE WEATHER – IMPACT, INSTRUMENTS FOR MONITORING, DATA PROCCESSING

MEASUREMENTS OF ELECTRIC FIELDS IN THE WIDE FREQUENCY RANGE FOR THE RESONANCE PROJECT

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RESONANCE project directed to the study of physical phenomena in the inner magnetosphere of the Earth and in particular nonlinear interaction in magnetized plasma. For this study is very important to have measurements of electromagnetic waves in the wide frequency range without influence of equipment. The best approach for this – to use the same measuring equipment for low and high frequency signals.

In this paper are presented an instrument and sensors for measurements of electric fields in wide frequency range for satellites of RESONANCE project - Analog Measurement of Electric Fields –Wide Band (AMEF-WB). Four spherical probes are used in our experiment to measure 3 electric components of the wave in wide frequency range from DC to 1 MHz.

The AMEF-WB composed of 4 spherical sensors with embedded pre-amplifier electronics mounted on the ends of 4 booms or antenna “arms” and associated electronics, included in the electronic module, to fulfill the onboard signal processing requirements. When measuring the potential difference between two of these sensors, operates as a double probe instrument in which the component of the electric field is determined along the axis defined by the two sensors. Any pair of sensors among the four can be used for this objective which enables the 3 components of the DC and AC vector electric field to be obtained.

ESTIMATION OF INFLUENCE OF SPACE AND TERRESTRIAL WEATHER ON PSYCHOPHYSIOLOGICAL CHARACTERISTICS OF HEALTHY AND SICK PEOPLE. BASIC PROBLEMS AND WAYS OF THEIR SOLVING.

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Stability of functioning of modern transport systems (aviation, automobile, railway, etc.) is in many respects defined by reliability of work of attendants (drivers, dispatchers, etc.). Reliability of work of any operator depends on many factors, including psycho physiological characteristics (PCHPC). There are many unsolved problems in this line of research and especially in problem of influence of space and terrestrial weather on these characteristics. The review on researches in the given direction is presented and basic ways of solving of the specified problems are given.

APPLICATION OF IMAGING HF RIOMETERS FOR INVESTIGATING HF MODIFIED POLAR IONOSPHERE

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The effect of enhanced absorption of the electromagnetic emission in the HF modified lower ionosphere is investigated. Results of two special heating campaigns of February and October 2008 on observations of radio emission at 38.2 MHz from two most powerful in the northern sky discrete cosmic sources (DCSs), namely Cassiopeia A, Cygnus A, which passed through the artificially disturbed ionospheric region are discussed. Observations were performed with the use of a multibeam phased antenna array of the Gakona imaging riometer located at Alaska in the immediate vicinity of the HAARP heater. The amount of the extra absorption of the DCS radiation in the D-region produced by powerful

heater operation is estimated. Formulas have been derived to relate the amount of absorption, collision frequency of electrons and electron temperature in the lower ionosphere. On the assumption that the electron density in the modified domain of ionosphere remains unchanged the increase in electron temperature inside the disturbed region has been estimated as observed during the discreet cosmic source motion over the celestial hemisphere. The estimates are in good agreement with the results calculated using data of cosmic background measurements.

PROPOSAL FOR TWINSAT ELECTROMAGNETIC AND PLASMA MEASUREMENTS

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TwinSat is a proposed new mission that uses a micro and nano satellite pair to make coordinated electromagnetic and plasma observations of the terrestrial ionosphere at various scales by employing a flexible separation strategy. In this report, we discuss the scientific payload for the TwinSat mission. The micro satellite electromagnetic payload will provide vector measurements of the DC electric field, the waveform of 6 electromagnetic field components in the frequency range 0.5 – 350 Hz and the full 6 component spectral matrix for field oscillations in ULF/ELF/VLF and VHF ranges. In addition, sample waveforms at frequencies in the range 22-48 MHz will be returned. Plasma analyzers onboard the micro and nano satellites will measure the variations of thermal and supra thermal (0.3 - 20 eV) plasma parameters and the energy distributions of electron and ion fluxes in the range 0.3 – 300 eV for two directions with time resolution 0.1s. The electromagnetic payload of the nano satellite includes 2 search coil magnetometers covering the frequency range 0.5 – 350 Hz and identical to those installed on the micro satellite. The nano satellite data will be constantly transmitted to the micro satellite through a specialized radio link. The high accuracy of timing and positioning of the nano and micro satellites provides the opportunity to study the spatial structure and the dynamic characteristics of ionospheric disturbances.

SOLAR AND GEOMAGNETIC ACTIVITY EFFECTS ON HUMAN CARDIO-VASCULAR STATE

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There is a growing body of evidence during the last years that geomagnetic activity (GMA) used as an indirect indicator of solar activity affect different functional systems and in particular cardiovascular system. Heart rate variability (HRV) is the oscillation of the intervals between consecutive heart beats (R-R intervals) in ECG. HRV is an important marker of the autonomic nervous system activity. Reduced HRV is a negative prognostic factor often preceding and/or concomitant different cardio-vascular diseases including sudden cardiac death. In this study HRV parameters were analyzed considering GMA. Results revealed that HRV is a sensitive parameter to these environmental parameters variations.

TESTING AN IONOSPHERIC SIGNATURE ANOMALIES ANALYSIS METHOD ON KHARTOUM (MS = 5.5) EARTHQUAKE

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In this paper an ionospheric precursor's analysis method was applied to the earthquake of magnitude (MS = 5.5) event of Khartoum that took place on July 31, 1993 at 21:20:40 UT. The precursor anomaly was checked out via a statistical method where the two bounds were calculated. In addition, the daily

variation of the ionospheric parameter under study (f0F2) is delineated such that the percentage deviation of the ionospheric parameter is detected to be increasing from the upper bound and decreasing from the lower bound. The resultant precursor was found to occur 8 days before the peak shock of the event of the earthquake. It was also found that the size or the magnitude of the detected ionospheric anomaly has a specific characteristic in that, it is much bigger than the one found on the literature's similar study. It was found that the size of the anomaly is (46.3 MHz), and its corresponding value of the percentage deviation is (612.30%).

DATA-INTENSIVE SCIENTIFIC MANAGEMENT, ANALYSIS AND VISUALISATION

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The technologies for data-intensive science need new ways to manage massive amounts of data captured by instruments or generated by simulations, integration of software analysis tools directly into the database, interaction that support visualisation and interactivity. This eResearch becomes more sophisticated and scientists share the data sets among institutions and labs. The new data-intensive paradigm would make easily to capture, organise, analyse, discover, visualise and publish data.

We propose integrated system for scientific data management and scientific data visualisation of data from experiments and numerical simulations in distributed and heterogeneous environment as well as the necessary tools and architectures. We use the paradigm of service-oriented architecture (SOA) that provides the ability to locate and invoke a service across machine and organisational boundaries, both in a synchronous and an asynchronous manner. Scientists are able to flexibly orchestrate these services into computational workflows. As a test suite we use two different, from computational science point of view, research directions: space physics and medicine.

The proposed research is the intelligent approach to solve problems with management and visualisation of data from scientific experiments and numerical simulations that allows better understanding of natural phenomena.

COSMIC RAYS AS BIO-REGULATOR OF DEEP TIME TERRESTRIAL ECOSYSTEMS

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The report presents the results of joint monitoring of the vital dynamics of cellular structures of Saccharomyces cerevisiae for 2001-21011 years in the program study of the effect of solar activity and space weather on the biosphere. Found correlated changes of parameters, depending on variations in cosmic rays. The influence of other external factors is less significant. The maximum changes were observed in the metachromasia reaction of volutin grains. A similar result was confirmed within simultaneous monitoring in Saratov (S. Rogacheva) and Yakutsk (S. Samsonov), and in data processing 50,000 electrocardiograms.

In modern times, the intensity of cosmic rays is not sufficient to provide a serious disruptive effect on biological objects because of the barrier function of the Earth`s atmosphere. However, the situation was opposite in the era of the early formation of the biosphere, and inorganic polyphosphates (the main component of volutin grains) are among the most ancient polymers formed in inanimate nature, and present at all levels of the biological world. We can therefore assume that the observed effect is a manifestation of atavistic adaptive behavior of the first biological objects in a situation where the intensity of cosmic radiation was higher in 8-10 times, and there was no protective atmosphere (or consisted of a different composition). This approach allow:

1. Examine the processes of solar-terrestrial interactions during the formation of the first biomolecules and organisms;
2. Consider the processes of evolutionary adaptation of deep time terrestrial ecosystems.

CEREBRAL PATHOLOGY AND SOLAR ACTIVITY AND METEOROLOGY
(PROJECT: MEDICO-BIOLOGICAL PROBLEMS AS RELATED TO SOLAR ACTIVITY)

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Acute cerebro-vascular disease put significant pressure on society, medical systems and family budgets. This has led to the study of a broad range of possible environmental links in the hope of finding and developing better prevention measures against the disease.

The interest and research of the possible links between cerebral accidents and solar activity and/or meteorology dates back in 1934 when Dull and Dull described the health effects of sudden solar flares. In recent years, this phenomenon has been studies by few groups in the United States, Japan, France, Czech Republic and Israel.

The aim of the poster is to outline a just starting project (2011-2015) focusing on cerebral pathology and its potential correlation with geomagnetic activity and/or meteorology factors.

Over 4500 cases diagnosed with cerebro-vascular pathology (ischemic cerebral stroke, cerebral hemorrhages, transient cerebral cardiovascular conditions and dizziness) in First Municipality Hospital, Sofia, Bulgaria from 2001 till end of 2009 are the subjects in the study so far. Supposed relationships between monthly averages for Wolf numbers, solar flares index and Ap index on one hand, and the occurrence of cerebral pathology on the other will be carefully examined during the project lifetime. Preliminary analysis of data collected allows us to assume the existence of correlation between the geomagnetic activity and cerebral pathology.

EFFICIENCY OF ARTIFICIAL INFLUENCE ON THE NEAR-EARTH PLASMA

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We compare intensity of manifestations produced by HF heating facility and VLF powerful transmitters. Parameters of plasma and electromagnetic waves were detected onboard of satellites in ionosphere and magnetosphere over the ground based facilities: intensity of the low frequency wave (including Getmanzev effect), stimulated particles precipitation, optical emission et al. Integrated efficiency was estimated from direct measurements for low and high altitude satellites. From contrastive analysis we conclude that local effects from VLF transmitters can be of the order as from heaters but VLF global effects are exceeds the HF influence.

THE UPGRADED KHARKIV V. N. KARAZIN NATIONAL UNIVERSITY RADIOPHYSICAL OBSERVATORY

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The Kharkiv V. N. Karazin National University Radiophysical Observatory clustered instruments are located at two sites, Gaidary (49.6 N; 36.3 E) and Grakovo (49.6 N; 37.0 E), where sample clock synchronization is accomplished by using a GPS receiver. It is a powerful tool for identifying hidden linkages between different altitudes from the D region to geostationary orbit. The findings from many experimental studies are presented.

The MF-HF radar (Gaidary) simultaneously employs the differential absorption, spaced antenna, and the ionosonde techniques.

HF Doppler sounding system comprises an HF Doppler radar at vertical incidence at Gaidary (it simultaneously makes soundings at three frequencies) and a passive radar system at Grakovo (it simultaneously observes four frequencies in the 30 kHz – 3 MHz band and eight frequencies in the 1 – 31 MHz band with a velocity resolution of a few m s–1 in most cases).

Satellite Radio Beacon Receivers. LEO Cicada/Cicada-M and GPS/GLONASS navigation satellite TEC observations are made at Gaidary and Kharkiv City.

Magnetometers. Since 2001, the fluxgate magnetometer (Grakovo) has acquired measurements in the south-north (H component) and west-east (D) directions at half-second intervals in the 0.001 – 1 Hz frequency band within which the internal noise varies from 0.5 pT at f = 1 Hz to 50 pT at f = 0.01Hz.

The three-axis saturable-core magnetometer (Gaidary) acquires measurements in the two frequency bands, 0.01 – 0.1 Hz and 0.1 – 5 Hz, where the internal noise level does not exceed 0.075 nT.

HIGH-RESOLUTION EUV IMAGING OF THE SOLAR CORONA IN THE ARKA PROJECT

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ARKA – is a new space-borne mission, being developed in cooperation by Lavochkin Science and Production Association (Russia), Lebedev Physical Institute (Russia) and Smithsonian Astrophysical Laboratory (USA), to be launched in 2018. The main goal of the ARKA project – EUV observation of the solar corona with unprecedented spatial resolution of 0.15 arc.sec./pixel. Such a high resolution will be achieved by using Richey-Chrétien optical schema with F=15 m and large-area 4k x 4k CCD detectors. The instrument promises as significant improvement in resolution over AIA and TRACE as that achieved in going from SOHO/EIT instrument to the TRACE telescope, with consequent likelihood of dramatic advances in our understanding of coronal dynamics. The key scientific goals of these hi-res observations are the following: observations of small-scale magnetic filed in the corona and its role in the heating of coronal plasma, diagnostics of coronal and chromospheric plasma using MHD seismology, observations of when and how 3D magnetic reconnection occurs in flaring active regions, characterization the triggering and initial development of the CMEs.

The ARKA instrumentation is planned to be launched on a KARAT statellite, on the 5th satellite of the Russian small-satellite program. The instrumentation will include 2 high-resolution F=15 m telescopes, one developed by SAO for 193 Å and one by LPI for 304 Å spectral range, a full-Sun context imager for 171 Å and high-energy full-Sun telescope for the 5-100 keV. The two latter instruments will considerably supplement hi-resolution EUV telescopes, allowing full-Sun monitoring of flares and CMEs.

ESTIMATIONS OF SPACE AND TERRESTRIAL WEATHER INFLUENCE ON PSYCHOPHYSIOLOGICAL CHARACTERISTICS OF THE HUMAN ORGANISM AT LONG DAILY MONITORING

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On the basis of daily three-year (2007-2010) monitoring of psycho physiological characteristics for two healthy volunteers, it was shown possibility of reaction of these indicators on variations of space and terrestrial weather. Investigation of dynamics of the rate of simple audio-motor reaction (SAMR) and index of productivity of arbitrary attention (PAA-index) as well as indicators of a small motility of hand were done. Simultaneously a functional condition of cardiovascular and vegetative nervous system and variability of heart rhythm (HRV) were investigated. It is revealed that psycho physiological indicators at both volunteers authentically correlate with HRV and with the level of the geomagnetic activity based on daily Kp-indexes. In the second volunteer stable dependence of SAMR on values of atmospheric temperature and pressure was discovered.

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