

Book **of** **Abstracts**

Seventh Workshop

**"Solar Influences on the Magnetosphere,
Ionosphere and Atmosphere",**

Sunny Beach, Bulgaria, 1-5 June 2015

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Bulgarian Academy of Sciences

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Sun and Solar Activity

Sunspot observations in the past and the activity in the Maunder minimum

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ABSTRACT

A wealth of information about the solar activity in the last 400 years is provided by historical sunspot observations. We will present an overview of sources and show how much more information can be extracted from those data apart from sunspot numbers. The Maunder minimum is a period of very low activity in the second half of the 17th century. The reliability of the observations of that time is evaluated.

Effects of the Solar eclipse event 20. 3. 2015 in the ionosphere observed at ionospheric observatory Pruhonice.

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ABSTRACT

Paper presents changes of the state of the ionosphere observed during Solar eclipse 20.3.2015 at ionospheric observatory Pruhonice. Solar eclipse above Pruhonice started 08:36 UT and finished 10:45 UT with magnitude 0.743. Ionospheric vertical sounding measurements and electron density profiles with delay time 3 minutes allow observation short time changes of the ionosphere during eclipse event. Digisonde DPS4 D, installed at the Pruhonice observatory, is working as Doppler radar and allow ionospheric drift measurements during the Solar eclipse with the same time resolution. The ionosphere during the eclipse was also strongly affected by geomagnetic storm (with Dst index -223) which started 17.3.2015.

Advances in solar bursts observations by the low-frequency radio telescopes of a new age

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ABSTRACT

Observations of solar radio emission and influence of solar activity on interplanetary media, magnetosphere, ionosphere and atmosphere of the Earth is one of the most important task today. A great variety of the bursts is observed at frequencies below 100 MHz. This paper is devoted to the subarray of Giant Ukrainian Radio Telescope (GURT) and results of observations with this instrument of sporadic solar radio emission within 10 - 70 MHz range. Wideband observations in decameter and meter wavelengths ranges considerably raise the registration probability of harmonic bursts pairs. The examples of such phenomena registered in 2012 and 2014 are given. Also the demonstrations of ionospheric scintillations of cosmic radio sources are presented

Flare Production Potential of Sunspot Groups

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ABSTRACT

Here, we analyzed solar flare production potential of each sunspot groups since 1996. For this purpose about 4260 NOAA active region data were checked; about 12330 flares were counted then flare production potential of each sunspot groups were calculated. In result of our analysis we found that the flare production potential of an A, B, C, D, E, F, and H groups are 0.05, 0.09, 0.21, 0.56, 1.15, 2.18 and 0.12, respectively. The daily and monthly average flare numbers and intensities were calculated. To do that each flares converted to same unit multiplying by 10, 100, and 1000 for C, M and X-classes flares respectively.

Results of the educational project Mame radi Slunce/I Love My Sun 2014-2015

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ABSTRACT

We show results of Czech version of the I Love My Sun project developed by Tulunay et al., 2013. During 2014-2015 we performed 13 presentations in Czech basic schools in Prague, Tanvald and Zeleznice. The lectures are preceded and followed by the children drawing a picture of the Sun. The goal of the project is to show the children the importance of solar activity and space weather. Combination of children's activity and presented scientific knowledge results in understanding what the Space weather mean to our lives as well as increase of children's interest in physics and related subjects.

Geoeffectivity, distribution and the flare activity of the very large and gigantic sunspots groups

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ABSTRACT

The studies of the laws of the appearance of very large (Sp \approx 2300 MOS) and gigantic (\approx 3000 MOS) sunspot groups it can help to understand conditions, with which solar flare events prove to be to a high degree geoeffectivity, causing into environment the disturbance (R4-5; S4; G4-5). In the reliable cycles SA such sunspot groups appeared in the transition periods (SC 17-18) between the epochs "lowered" and "increased" SA. The appearance of such sunspot groups the phenomenon is sufficiently rare inside the epochs. Such sunspot groups according to the evolutionary and flare characteristics and on their influence on environment it is possible to divide on

- the sunspot groups are the complexes AR, whose components appear in immediate proximity from each other (VIII-IX 1859, III 1989, X - XI 2003). Magnetic configuration such AR substantially opened contributes to realization in environment extreme and large geomagnetic (G5, G4) disturbances and SPE (S4, S3);

- the flare productive groups of spots (III-IV of 1947, X 2015) the significant new magnetic fluxes in which float up only in the center section, causing large, but not extreme solar flare events. They do not reveal the general magnetic configuration of the AR bipolar structure, they are not accompanied by significant CME and it is not practically geoeffective: They do not cause in environment the significant geophysical disturbances, except electromagnetic impact - disturbances of class (R);

- the quite sunspot groups with the low and average level of flare activity.

Development of the current 24 solar cycles (77 months)

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ABSTRACT

At the present moment within the framework narrower than the realized history of reliable solar cycles (SC) becomes understandable that, beginning from maximum 22nd and on the end of 23th cycles of solar activity (SA), the condition for the generation of solar magnetic field significantly changed and its gave beginning to new period "lowered" SA - the epoch of the SCs of low and average value. Begun in 2009 the current 24 cycle SA only by April 2014 was reached maximum ($W^* = 82$) and is developed as the SC of low height. The current cycle - the first component physical 22-year SC and according to the Gnevyshev's rule, which undoubtedly works inside the epochs, following 25 SC must be above, the cycle of average value. One of the most interesting special features of 24 cycles is uncommonly large quantity ($\sim 1/3$) of complexes active regions (CAR), intermediate structure between AR and complexes of activity. From the above it follows that the 24th cycle develops according to the scenario typical SCs the epoch of "lowered" SA. On this scenario the most powerful flare events usually occur on the phase of the decrease and sometimes on the phase of increase. Geoeffectivity of solar flare phenomena and coronal holes remains anomalously low: for $\sim 6.5y$ is registered one very large, two large magnetic storms ($Ar \approx 70$), 11 solar proton events ($E_{pr} > 10$ MeV) with the proton fluxes is more than 100 pfu, of which 3 events were with the proton fluxes more than 1000 pfu.

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CME in the interplanetary medium by observations of IPS at the decameter wavelengths

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ABSTRACT

We carry out interplanetary scintillation (IPS) observations of cosmic radio sources with using URAN decameter radio telescope system (8 - 32 MHz, Ukraine). During the last few years the registration, control and others systems of the radio telescopes composing URAN system (UTR-2, Grakovo; URAN-1, Zmiyov; URAN-2, Poltava; URAN-3, Lviv; URAN-4, Odesa) were essentially improved. These improvements and the development of the new effective methods for weakening ionospheric and interference effects allow us to raise efficiency of IPS observations and experimental data reliability. Among other these allow us to find and to study large scale moving disturbances in the solar wind associated with coronal mass ejections (CME). In particular, we manage to find and to study the large scale disturbance in the solar wind associated with Valentine`s day CME. It is established that coronal mass ejection in the interplanetary medium continues slowing at distances from 1 to 1.7 au from the Sun, its velocity tending to the velocity of the ambient solar wind, the angular size being not less than sixty six degrees. We show the high efficiency of IPS method in the decameter range of radio waves for studying the solar wind and CME in the interplanetary medium.

The Relationship between the Sunspot Counts and Ionospheric Critical Frequencies during Solar Cycles 23

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ABSTRACT

We analyze temporal variations of different group sunspot counts and ionospheric critical frequencies (foF1, and foF2), taken from Chilton station, for the time period of 1996-2009, which covers the entire solar cycle 23. We found that all sunspot count data sets show very good agreement with ionospheric critical frequencies except small group sunspot counts. To obtain the degree of relationship between solar and geomagnetic data sets, correlation analysis were applied, and found that the correlation between these data sets (solar indices and ionospheric critical frequencies) is the best in case of large group sunspot counts, while it is not meaningful in case of small ones. Thus we may conclude that sunspot count in different groups behave differently, and affect to the ionospheric critical frequencies in a different manner.

Space Weather Research with HORIZON 2020: The Solar Energetic Particle Perspective

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ABSTRACT

Solar Energetic Particle (SEP) events are a key ingredient of Solar-Terrestrial Physics both for fundamental research and Space Weather applications. Space Weather research from the SEP perspective was carried out in the National Observatory of Athens (NOA) within the SEP Server and COMESSEP projects under the Seventh Framework Programme (FP7-SPACE) of the European Union. The main research results of these projects will be first reviewed. Recently, the `HESPERIA` space weather project within the HORIZON 2020 of the European Union, coordinated by NOA (Project Coordinator: Dr. Olga Malandraki) kicked-off in Athens. The project will produce two novel SEP operational forecasting tools based upon proven concepts. It will also advance our understanding of the physical mechanisms that result into high-energy SEP events through the systematic exploitation of the high-energy gamma-ray observations of the FERMI mission and other novel datasets (PAMELA; AMS), together with in situ SEP measurements near 1 AU. Publicly available software to invert neutron monitor observations of relativistic SEPs to physical parameters that can be compared with the space-borne measurements at lower energies will be provided for the first time. In order to achieve these goals

HESPERIA will exploit already available large datasets stored into databases such as the neutron monitor database (NMDB) and SEPServer that have been developed under FP7 projects from 2008 to 2013. The structure of the HESPERIA project, its main objectives, as well as the added value to the SEP research will be presented and discussed.

Acknowledgment: 'This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 637324'

White Light Coronal Structures and Flattening During Six Solar Eclipses

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ABSTRACT

Solar corona is very important part of the solar atmosphere, which is not available every time and it is very difficult to observe it. From solar corona we can get more information about outer sun layers. Large-scale structure of the solar corona can be studied during total solar eclipses.

The structure, shape and brightness of the solar corona significantly change from eclipse to eclipse. They depend on activity of the sun. At maximum solar activity, the corona is very bright and uniform around the solar limb. There are a lot of bright coronal streamers and other active regions on it. During minimum of solar activity the solar corona stretches at the equator and become elliptical.

Flattening index is the first quantitative parameter introduced for analyses of the global structure of the solar corona. It varies with respect to the phase of the solar activity and sunspot number. In this paper we study the solar corona during the 1990, 1999, 2006, 2008, 2009 and 2012 total solar eclipses. We obtain flattening indices for all the six eclipses by using a new computer program. Our results are in a good agreement with published results.

On the origin of solar proton events: comparison between solar cycles 23 and rising half of 24

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ABSTRACT

We present a list of solar proton events identified in SOHO >8 MeV energy channel together with their solar origin - flares and coronal mass ejections (CMEs), in the period 2009-2014. We evaluated the occurrence rates of the proton-associated solar eruptive phenomena (flares and CMEs) and the observed in situ particles. The results are complemented by linear and partial correlation coefficients calculated between the properties of the solar activity and the proton peak intensity. We compare the obtained results with previous studies over solar cycle 23.

Average physical properties and two populations of sunspot

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ABSTRACT

On the base of data of 7 observatories of the Sun Service of the USSR and observatory Mount-Wilson (USA) a statistical relationship between the vertical magnetic field strength of a sunspot and its area $H = a + b \log(S)$ in 1920-2014 is found. It is confirmed that this dependence, as well as the closeness of relation between H and $\log(S)$, varies in time. Existence of two sunspot populations ('large' and 'small' sunspots) that differ in their properties is confirmed. This fact may evidence the existence of a spatially distributed dynamo on the Sun. In the light of the last data on progress of the 24th cycle of solar activity it is shown that for large sunspots the tendency to monotonous decrease of the magnetic field of sunspots noted by Livingston and Penn has been reversed in 2008.

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Prediction of the orientation of the Bz component of ICMEs inside and at 1AU

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ABSTRACT

The direction of the axial component of the magnetic field of a pre-eruptive filament and of the corresponding CME caused by filament eruption may be established observationally. This is a fundamental component in determining the geo-effectiveness of Interplanetary (I)CMEs. Filament channels, filaments, and the CME and ICME are all part of a multi-scale chiral system (i.e. possessing chirality) and the analysis of such chiral systems is a powerful tool to determine the topology of the magnetic fields involved in eruptive solar events later seen in space as ICMEs. There is a body of observational and data analysis work which allow the development of step by step methods to determine the sign of helicity (chirality) of filaments and filament channels (dextral or sinistral). I will show how these methods can be turned into a simple empirical predictor of CME geo-effectiveness (improve predictions of the relative strength of southward and northward components of the magnetic field in ICMEs) and have the ability for predictions inside 1 AU, e.g., at Mercury (MESSENGER) or future missions (e.g., Solar Orbiter, Solar Probe Plus).

Coronal Holes and Their Relationship With Active Regions, Filaments and CMEs

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ABSTRACT

The aim of this work is to understand the formation and evolution of low-latitude corona holes (CHs), including low-latitudinal extensions of the polar CHs, by studying the distribution of the open field in time and how it is affected by emergence of new magnetic flux near coronal hole boundaries, by differential rotation and turbulent advection of flux. It also discusses the influence of filament channels formed at CH boundaries. New active regions at the boundaries of an isolated CH can decay into smaller CHs which can later merge with the pre-existing one. Alternatively, ARs can decay and form a new filament channel at the coronal hole boundary. CH boundaries continuously evolve in time; a long-living CH loses and gains area simultaneously, moving across the disk. This is possibly a result of a constant replenishment of the open field from a decaying active region, of interchange reconnection, or the formation and eruptions of filaments at the CH boundaries. It is important to study time-scale of low-latitude CHs with evolution of ARs and filaments at their boundaries. This work is addressing the following questions: Why do some ARs contribute to the open field of the nearby CHs and some do not? Why do some ARs prefer to form a filament channel at the CH boundary? How do filament eruptions and CMEs at CH boundaries contribute to CH evolution? How the presence of CHs influences the direction of CMEs in the low solar corona?

Solar flare model, MHD simulations and comparison with observations

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ABSTRACT

The solar flare model is based on the accumulation of magnetic energy in the current sheet, which is formed above the active region. Fast magnetic energy release occurs at the transition of the current sheet in an unstable state. Numerical MHD simulation shows creation of a current sheet in the corona. According to the solar flare electro-dynamical model a source of thermal X-ray emission situates in the current sheet. Plasma heating in the sheet occurs due to magnetic energy dissipation. In the numerical simulation no assumptions about the flare mechanism have been done. Due to complexity of the magnetic field, it is necessary to develop the special method of current sheet search in the calculated magnetic field. The method of search is based on the property of the current sheet, according to which the local maximum of the current density is located in the current sheet center. In order to determine whether a given point of the current density maximum corresponds to the current sheet center, the program permits to build the magnetic field configuration. The current sheet is the most clearly presented in such a plane. The search system is used now for study of the solar flares physics. The found current sheet position coincides with the observed position of the X-ray source for the flare 27, 2003 02:53 in the active region NOAA 10365. This coincidence can be considered as a direct indication on the correctness of flare theory based on current sheet creation in the corona.

The mechanism of solar cosmic ray acceleration and cosmic ray propagation in the interplanetary space

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ABSTRACT

Solar cosmic rays are the least studied of solar flare manifestation. The accelerated protons measured with the neutron monitors have an exponential spectrum, but delayed proton flux demonstrates a power spectrum. From the analysis of the GOES spacecraft measurements of protons it follows that the characteristics of accelerated protons reaching the Earth's orbit depend on the flare position on the solar disk. The so-called fast proton component arrives to the Earth from Western flares with a sharp (~5 min) front. Its delay (less than 20 minutes) is determined by the time of flight without collisions. These particles arrive to Earth along magnetic Archimedean spiral field lines. Protons from Eastern flares are transferred across the field lines with the solar wind velocity and diffuse due to scattering on inhomogeneities. The front of proton flux (duration is bigger than 10 hours) from flares appeared on the Eastern part of the disk is gently sloping. The protons of such flares begin to register with the delay more than three hours. There is no need to explain the fast and delayed proton components acceleration by two different mechanisms (acceleration in the flare and acceleration in a shock wave). The part of protons accelerated by the Lorenz electric field in the current sheet arrives to the Earth along the magnetic field lines and forms the fast component, but the other part of protons is propagating across the magnetic field forms the delayed component. The observed proton energy (~20 GeV) cannot be gain in shock waves.

Solar Research with ALMA

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ABSTRACT

The Atacama Large Millimeter/submillimeter Array (ALMA) is a new powerful interferometer consisting of 66 high-precision antennas operating at wavelengths of 0.3 to 9.6 mm. Designed for a broad range of scientific studies from Solar System objects to earliest galaxies, it will enable observations of the Sun at high spatial, spectral, and temporal resolution. ALMA will give a unique new insight into chromosphere, filaments, prominences and flares, their structure and dynamics. We present an overview of ALMA capabilities, and discuss future possibilities for solar observation based on state-of-the-art simulations. Moreover, work flow for preparation and submission of proposals and the role of ALMA Regional Nodes (ARCs) will be described.

Helicities, tilt angle of sunspot groups and solar dynamo

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ABSTRACT

A key driver of solar dynamo is mirror asymmetry of solar convective flows. Observational methods for quantification of this driver was developed last years only. Tilt angle statistics provides an important information for the mirror asymmetry. We present and discuss contemporary progress in observation of mirror asymmetry and embedding of the data in context of solar dynamo theory.

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CMEs and frequency cut-off of solar bursts

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ABSTRACT

Observations of solar bursts with high-frequency cutoff by the radio telescope UTR-2 (near Kharkiv, Ukraine) at 8-33 MHz on 17-19 August 2012 are presented. Such cut-off may be attributed to the emergence of the burst sources behind limb of the Sun toward the Earth. The events are strongly associated with solar eruptions occurred in a new active region. Ray tracing calculations show that the CMEs play a constructive role for the behind-limb bursts to be detected in ground-based observations. Likely, due to tunnel-like cavities with low density in CMEs, the radio emission of solar bursts is directed to the Earth.

Convective and turbulent atmospheric processes in the cone of the lunar shade during total solar eclipses

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ABSTRACT

Unusual research on convective and turbulent processes in the atmosphere under the lunar shadow cone during two total solar eclipses is presented in the work. Optical method is used for image vibration monitoring of the unclipped limb of the solar disk during the phase evolution of the eclipse. The observations were made with 200/2 250 mm reflector with a 3x focal reducer, cruciform slit and micrometric plug in the focal plane, equipped with photographic tract. The solar disk image vibration amplitude, caused by atmospheric processes (turbulence, convection and advection) is measured.

Microclimatic parameters of the ground atmospheric layer (temperature, humidity, wind speed and cloudiness) are also measured. Measurements are conducted before and after the eclipse, and during the all partial phases of the eclipse for high accuracy of the optical method and separate determining of the contribution of turbulent and convective processes.

The results of identical optical observations of two total solar eclipses - August 11, 1999 (Ravnets, Bulgaria) and 29 March 2006 (Manavgat, Turkey) are showed in this work. Some parameters of the dynamic processes in the ground atmospheric layer were evaluated using the results from measurements of the statistical characteristics of the image vibration levels of the limb of the solar disk. A comparative analysis of the dynamics of microclimatic parameters in the ground atmospheric layer during different phases of the total solar eclipses is made. It was found that the effects of impact differ significantly for the three parts of the day - morning, noon and afternoon.

Multi-instrumental Observations of a Solar Prominence Eruption

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ABSTRACT

We analyze the morphology and kinematic evolution of a loop-like prominence eruption, observed on 2010 September 15 at the northwestern solar limb. We use observations from the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO) taken in 304 Å... EUV passband. We also analyze observations from the Extreme Ultraviolet Imager (EUVI) onboard the STEREO A and B spacecrafts. Due to the position of the two STEREO observatories at the time of observations (separation angle of 157 degrees) we can combine limb with on-disk observations.

The filament's behavior before the eruption is traced in a series of H α images from the Kanzelhöhe Observatory, Austria. Images obtained by the Large Angle and Spectrometric Coronagraph (LASCO)/C2 onboard SOHO are also analyzed in order to investigate the close association between the prominence eruption and a coronal mass ejection.

We examine the changes in the height and the velocity of the prominence during its eruption. The kinematic evolution suggests a full type of prominence eruption. The triggers of the eruption are discussed.

Analysis of the Nonlinear Behavior of the Accretion Flows

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ABSTRACT

In this paper a research of the accretion flow structures in disks on Cyg X-1 and SgrA* have been done. We analyze the behavior on the advective hypothesis. We discuss influence of the self-induction advection over components on the systems disk - corona in these real objects.

The Main Properties of the Activity of the Northern and Southern Hemispheres as the Basis of the Solar Cycle Formation.

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National Academy of Sciences of Ukraine.

This work is a continuation of the research of activity cycles of the northern and southern hemispheres of the Sun. We showed the basic properties of the cycles based on the application of wavelet analysis of daily and monthly average values of indexes of the North (N) and South (S) hemispheres: WN, WS (the Wolf number), SpN, SpS (summary of sunspots groups) and FIN, FIS (Flare index) for all time of their presentation.

We received the main data cycles: the start and end time, increase phase, maximum and decrease phase, global Wavelet spectra, prevailing processes of cycle formation, time of their existence, spotless periods. We showed the difference of these indicators for the studied indexes. On the basis of the daily index values we identified features of alternating predominance of activity of the northern and southern hemispheres.

Start and end times of the activity in each of the hemispheres of the Sun in each cycle are synchronized in a certain way. Application of the method of bandpass filtering results of wavelet analysis allows differentiating between the two cycles: "11-year-old" part, interim periods from 2 to 7 years in the transition from cycle to cycle, spectra periods forming phase of heightened activity.

The results obtained can be the basis for forecasting solar activity and should be taken into account in the theory of the formation and development of the activity cycle.

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Solar Wind-Magnetosphere Interactions

The influence of Apr 10, 2001 CME on the magnetosphere

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ABSTRACT

Coronal mass ejections are huge explosions of plasma that could trigger geomagnetic storms. On Apr 10, 2001 a halo CME was registered by LASCO at 05:30 UT. It was detected into the interplanetary space as an ICME on Apr 11 at 22:00. The geomagnetic storm associated with this event reached its minimum Dst value one hour later. We analyse the CME properties that may have produced the geomagnetic storm and calculate the probability (Srivatsava, 2005) of this (I)CME to have triggered a strong geomagnetic storm. We also investigate the quantity of energy deposited into the magnetosphere during the main phase of this storm using two different formulas by Akasofu (1981) and Wang et al. (2014).

Geophysically Induced Currents, a space weather hazard.

Case study – Europe under intense geomagnetic storms of the solar cycle 23

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ABSTRACT

The interaction of the solar wind and heliospheric magnetic field with the magnetosphere and ionosphere results in variations of the geomagnetic field that induce hazardous electric currents in grounded technological systems (electric power and hydrocarbon transportation networks), the so-called GICs. In order to evaluate the hazard induced on the European continent, we present a study of the surface electric field induced by 16 intense (Dst < -150 nT) geomagnetic storms, based on the analysis of the geomagnetic records from the European network of observatories, study that tend to solve the geophysical part of the problem. The evolution during storm development and the sources of the disturbance field are explored in case of the largest geomagnetic storm in the cycle 23 (Dst = -422 nT, November 20-21, 2003), and the geographical distribution of the maximum induced surface geoelectric field over Europe by the 16 storms considered in the study is presented.

Comparison of substorms during two solar cycles maximum: (1999-2000 and 2012-2013)

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ABSTRACT

We presented the comparative analysis of the substorm behavior in the periods of two solar cycles maximum. The substorms, observed during the large solar cycle maximum (1999- 2000, with $W_p > 100$) and during the last maximum (2012-2013 with $W_p \sim 60$), were studied. All considered substorms were divided into 3 types according to auroral oval dynamic. First type - substorms which observed only in auroral latitudes ('usual' substorms); second type - substorms which propagate from auroral latitudes (70°) ('expanded' substorms, according to expanded oval); third type is substorms which observed only at latitudes above $\sim 70^\circ$ in the absence of simultaneous geomagnetic disturbances below 70° ('polar' substorms, according to contracted oval). Our analysis was based on the 10-s sampled IMAGE magnetometers data, the 1-min sampled OMNI solar wind and interplanetary magnetic field (IMF) data. There were analyzed above 1700 events of 'expanded', 'polar' and 'usual' substorms in 1999- 2000 and in 2012-2013 years. The following substorm characteristics have been studied: (i) the seasonal variations of substorms, (ii) the substorm onset latitude, (iii) the maximal reaching latitude, (iiii) latitudinal range of all three types of substorms. We compare these substorms characteristics and the solar wind conditions observed before substorm onsets.

Cross Correlation Analysis of Mozambique's 7.0 M Earthquake Using the Empirical Mode Decomposition

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ABSTRACT

Precise determinations of ionospheric anomaly variations associated with earthquakes require the elimination of other sources of ionospheric variabilities like ionospheric storms, geomagnetic perturbations or geophysical noise. However, revealing the seismo-ionospheric anomalies when the ionosphere is known to be a complex and nonlinear system is of utmost importance. To overcome this constraint, Hilbert-Huang transform (HHT), which is a far better technique for both nonlinear and non-stationary system like ionosphere, was applied together with the cross correlation coefficient method to a 7.0 magnitude earthquake that occurred in Mozambique on 23rd of February, 2006. Three Stations (two within the earthquake preparation zone) with hourly data of f0F2 for one month were used for the study. The results clearly revealed anomalies that are as a result of the earthquake. These were first noticed 10 days and another 3 days before the occurrence of this large earthquake.

Ionospheric modeling for Over the Horizon Radar applications considering solar activity level

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ABSTRACT

Over the horizon radar (OTHR) is a high frequency radar system that covers an area located beyond the horizon line using ionospheric reflection. The use of the ionosphere as part of the signal channel implies a substantial uncertainty in the actual ray path due to its non-homogeneous structure and its time variability. In fact, the ionosphere varies in wide range scales, both spatial and temporal. The spatial scale ranges from thousands of kilometers to less than a meter, and time scale from several years to hours and minutes. Several radar parameters have to be matched to the prevailing ionospheric conditions. For example, the Maximum Usable Frequency (MUF) and Least Usable Frequency (LUF), which characterize HF range supported by the ionosphere, strongly depend on the amount of ionization. In this work we will focus on ionospheric variability linked to solar activity variations using the International Reference Ionosphere model (IRI). The variability expected in selected radar parameters will be assessed during maximum and minimum solar activity conditions.

Geomagnetic activity effect over continuous Doppler sounding records in Tucuman

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ABSTRACT

The Institute of Atmospheric Physics in Prague, Czech Republic, has developed, constructed and installed several continuous HF Doppler sounders, including special software. One of the goals is for studying gravity waves in the ionosphere taking into account that HF Doppler technique is a sensitive method for monitoring transient changes and wave activity in the ionosphere, and that a better understanding of atmospheric gravity waves will be extremely useful in the study of coupling between different atmospheric regions. In this work we analyze data obtained from the system installed in Tucuman (26.8 S; 65.2 W), Argentina, in 2012, to study the effects of different levels of geomagnetic activity over the continuous Doppler sounding records. Quiet and disturbed days were selected according to Dst index values for the periods with data availability. A preliminary qualitative description of the observed effects is made compared to theoretically expected results.

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Effects of filtering solar activity from noon and midnight hmF2 to assess long-term variability

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ABSTRACT

Long-term variations and trends in the ionosphere are linked mainly to the increase in greenhouse gases concentration, but also to natural causes such as solar and geomagnetic activity long-term changes and secular variations in the Earth magnetic field. In order to analyze ionospheric trends and determine the proper role of each external forcing, solar activity effect must be filtered out first since around 90% of ionosphere parameters variance is due to solar variations. In this work, the effects of filtering solar activity from hmF2 at 12 LT and 0 LT are analyzed comparatively through the effects on long-term trend calculation, considering that the behavior of the daytime ionosphere is strongly controlled by solar radiation, while nighttime ionosphere is controlled mainly by recombination processes and ionospheric dynamics.

A comparative study of ionospheric conductivity variations due to solar activity and Earth magnetic field

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ABSTRACT

The conductivity of the ionosphere is extremely important in geophysical processes. It plays a critical role in magnetosphere-ionosphere and thermosphere-ionosphere coupling processes. Solar EUV irradiance and Earth magnetic field are among the variables involved in this conductivity. Both present changes, and so does their contribution to the ionospheric conductivity. Considering the theoretical equations of Hall and Pedersen conductivity, the effect of solar activity and Earth magnetic field variations are analyzed comparatively. IRI2012, NRLMSIS-00 and IGRF models were used to estimate the parameters involved. The expected consequences of the upper atmosphere cooling due to increasing greenhouse gases concentration is also discussed in comparison to both natural forcings here considered.

Substorms observations during two strongly disturbed periods - in March 2012 and March 2015

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ABSTRACT

In this work two events of strong geomagnetic activity were examined: the period 7-17 March 2012, which is one of the most disturbed periods during the ascending phase of Solar Cycle 24, and the severe geomagnetic storm on 17-20 March 2015. During the first period four consecutive magnetic storms occurred on 7, 9, 12, and 15 March. These storms were caused by Sheath, MC and HSS, and the detailed scenarios for the storms were different. The second event is a storm of fourth level with $K_p = 8$, the strongest one during the last four years. A geomagnetic storm of such intensity was observed in September 2011. Since then, the level of K_p never exceeded the value 7. Object of our study were the substorms registered during these periods. Observations of the Multiscale Aurora Imaging Network (MAIN) in Apatity have been used. The substorm developments during different storms were compared. Solar wind and interplanetary magnetic field parameters were taken from OMNI data base. Substorm onset time and the subsequent development were verified by data of IMAGE magnetometers network and by data of the all-sky cameras at Apatity. The particularities in the behaviours of substorms connected with different storms during these two interesting strongly disturbed periods are discussed.

Delayed response of global TEC to ionization variations seen from combined SolACES-SDO/EVE solar EUV spectra

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ABSTRACT

The ionospheric response to solar EUV variability during 2011 - 2014 is shown by a simple EUV proxy based on primary ionization calculations using combined solar spectra from SDO/EVE and SolACES on board the ISS. The daily proxies are compared with global mean TEC analyses, and describe 71% of the TEC variability at the short-term and seasonal time scale. At time scales of the solar rotation and longer, there is a time lag between EUV and TEC variability of about one day, indicating dynamical processes in the thermosphere/ionosphere system. This lag is not seen at shorter time scales. If this time lag is taken into account, the EUV proxy will explain more than 76% of the global TEC variability.

Post-Storm High-Latitude Geomagnetic Pc5 Pulsations and VLF Emissions as a Result of Solar Wind Disturbances

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ABSTRACT

It is well known that strong solar wind disturbances under southward IMF (Interplanetary Magnetic Field) direction lead to significant space weather violations such as magnetic storms with large geomagnetic activity mainly in the night sector of the auroral latitudes. In the late recovery storm phase, when IMF turns northward and a solar wind energy input stops, the magnetosphere starts to relax, geomagnetic activity drops, but some post-storm effects occur as the different magnetospheric auto-oscillations generation. They get excited mainly in the dayside of the Earth and are observed on the ground. The typical magnetosphere relaxing waves can be the geomagnetic Pc5 pulsations at several minutes period with quasi-monochromatic structure. The main source of these Pc5 pulsations can be the magnetic field line resonance (FLR). Several expressive events of such Pc5 pulsations are shown. The auto-oscillations in the relaxed magnetospheric plasma maser can be observed in the higher frequency band too, namely, as a special regime of the electron-cyclotron instability at several kHz (Very Low Frequency - VLF) emissions, known as quasi-periodic VLF waves. The example of non-typical quasi-periodic picturesque VLF events and their relation with Pc5 pulsations is presented. The trigger of both discussed above processes onset seems to be related with a sudden appearance of some inhomogeneities in the solar wind or IMF.

Small-scale ionospheric irregularities and ionosphere total electron content fluctuations

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ABSTRACT

Efficacy of radio astronomical observations at low frequencies (10-100 MHz) essentially depends on the state of the ionosphere, which distorts the characteristics of the received signals. In particular, this is due to the effect of the radio waves scattering by ionospheric irregularities. This effect is cause of discrete cosmic radio sources scintillation. In many cases, correction for scintillation can reduce measurement error. Often, the immediate acquisition of ionospheric scintillation data is impossible concurrent with the main observations. In these cases, it may be useful to make use of indirect estimation of scintillation characteristics by other methods. To this end, we examine the relationship between the characteristics of ionospheric scintillation of powerful compact cosmic radio sources and TEC fluctuations in the area of the radio telescope. Ionospheric scintillation characteristics were obtained at frequencies of 20-30 MHz (radiotelescope `URAN-4` - Odessa, Ukraine. For determination of TEC fluctuations were used data of the GPS Earth Observation Network.

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Geomagnetic Pc1 Pulsation Behavior Depending on Solar Activity

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ABSTRACT

The latitude feature of Pc1 geomagnetic pulsations was studied on the base of the Scandinavian magnetometer chain near the maximum and minimum of the 24-th solar activity cycle. In the minimum (2008) there were about 30 magnetic storms, but in 2009 - only 5. The number of the hours with Pc1 was ~100 in 2008 and only ~20 in 2009. During the solar minimum, the shape of the Pc1 dynamic spectra was, generally, simple and the wave duration < 3-5 hours. However, during the declining (2006) and increasing (2010) solar activity stage, the spectral structure of Pc1 became more complicated and the wave duration increased up to 10-12 hours. We compared the total, right-hand and left-hand polarized Pc1 pulsations at two latitude spaced stations: SOD ($\varphi=63.8^\circ$, $L\sim 5.3$) and NUR ($\varphi=56.6^\circ$, $L\sim 3.5$). It was found that in 2003 (near solar maximum), the Pc1 pulsations were stronger at NUR with left-hand polarization. It means that the station was located in vicinity of the wave exit point from the ionosphere. However, in the solar minimum, the Pc1 events were stronger at SOD and demonstrated the left-hand polarization too. Our finding supports the idea that the area of Pc1 wave generation could be related to the vicinity of the plasmopause.

Seasonal variations in GPS-TEC during the period 2002-2013 over the low latitude station Bangalore, India

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ABSTRACT

The Total Electron Content (TEC) is computed from Global Positioning System (GPS) from Bangalore (13.020N, 77.570E) IGS station for the period 2002 to 2013. We present the mean monthly, seasonal, and annual variation in the ionospheric TEC during quiet and disturbed period. The total 4383 days during the period 2002-2013, out of which 4229 days GPS data were analyzed. We also found that the both average GPS-TEC were positively correlation with solar flux for the entire 12 year period. This study investigates the seasonal response of TEC during the solar minimum and maximum period. We also discussed the variations in GPS TEC in quiet and disturbed period during descending phase of solar cycle 23 and ascending phase of solar cycle 24. TEC directly affects the communication system, mainly due to the effect of solar activity on the ionospheric Total Electron Content (TEC) produces most of the effects on GPS signal.

Key Words: GPS, TEC, Low Latitude

Spectrum of the geomagnetic field variations based on digital data from magnetic station `Odessa` in the area of magnetic anomaly

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ABSTRACT

On the territory of Odessa and the surrounding area of Odessa region there is one of the largest magnetic anomalies of Ukraine. Magnetic anomalies can form their own `magnetosphere` and have their own response to external influences such as solar activity and various phenomena in the ionosphere. We investigated the variability of the total induction vector of the geomagnetic field in the time interval 2008 - 2013. Digital data with every minute readout was received at the magnetic station `Odessa`. We used the method of short-term Fourier analysis (STFT) to search for periodicities and their time-frequency distribution. The obtained periods were isolated and analyzed separately using the Fourier-bandpass filter. There are periods of daily (24 hours), semi-diurnal (12 hours) and short-term fluctuations of the geomagnetic field with periods 8, 6, 5, 4 hours. In winter, the oscillation amplitude is low, it's increasing in spring, in summer it becomes maximal, in autumn the amplitude is lessening. During magnetic storms, period values can vary by several hours (~ 3.5 - 1 hour). Before and after the magnetic storm the amplitude oscillations with periods 6, 8 hours increase with a following slow decline. The amplitudes of the oscillations with periods of 4, 5 hours increase less and accurately during a magnetic storm. Analysis of the low-frequency component of geomagnetic field

variations shows 10 - 84 days periods. Possible reasons which form periods of variability taking into account solar-terrestrial relations and tidal processes in the ionosphere are presented in the paper.

Density variations of the upper atmosphere of the Earth in the period of 23-24 solar cycles according to observations of satellites drag

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ABSTRACT

A sensitive indicator of changes in the density of the upper atmosphere of the Earth is a drag of low-orbit satellites. Application of the method of frequency-time analysis allows revealing the detailed structure of these changes.

We investigated the drag dynamics of five satellites with circular orbits and eight satellites with elliptical orbits. The study period includes: recession phase and long duration minimum of the 23rd cycle of solar activity (2005-2008), a growth phase and a maximum of the 24th cycle of activity (2009-2014).

In the dynamic motion of all the investigated objects regular drag effects with periods of 2 - 4 years and effects with periods of less than a year associated with the solar activity clearly appeared.

The results of sporadic effects of x-ray and ultraviolet radiation of strong solar flares, the flow of electrons and protons, coronal mass (CME), the shock waves in the solar wind clearly appeared.

According to drag satellites, we researched the effect of thermal and gravitational tides on the density of the upper atmosphere and its dependence on the latitude.

The data obtained allow to investigating and predicting the results of integrated effects of space weather and tides on the conditions of the upper atmosphere.

PC index as a proxy of the solar wind energy entered into the magnetosphere: relation to interplanetary electric field and magnetic storms

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ABSTRACT

Relationships between the *PC* and *Dst* indices was analyzed for 187 magnetic storms observed in epoch of solar maximum (1998-2004). Storms were separated in different classes according to their intensity and behavior/ Results of statistical analysis demonstrate that depression of geomagnetic field starts to develop as soon as *PC* index steadily excess the threshold level $\sim 1.5\text{mV/m}$ (like to case of magnetic substorms). *Dst* index in course of magnetic storms (during 10 hours preceding the maximal depression of geomagnetic field) generally follows the time evolution of the smoothed *PC* index with typical delay time of $\sim(1)\text{hour}$, the smoothing window width of $\sim 60\text{-}90$ minutes seems to be optimal for revealing the regularity. The storm intensity (Dst_{MIN}) is linearly related to maximal value of the hourly mean PC_{MAX} value observed about 1 hour before the moment of maximal depression. The conclusion is made that the *PC* index provides the information on the solar wind energy that entered into magnetosphere.

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Solar Influences on the Lower Atmosphere and Climate

Solar activity and variations of the wind stress in the Pacific ocean zone

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ABSTRACT

The wind stress anomalies is investigated by the use of National Centers for Environmental Prediction reanalysis data in the extratropical zone of Pacific ocean (30-50°N 160°E-150°W) for of the model of the effects of solar activity on the climate characteristics of the troposphere. Anomalies calculated with respect to the 1961-1990 normal. It has been found that wind stress may affect the temperature of the ocean surface at different time scales, coinciding with the well-known the cycles of solar activity. Intensification of the zonal component wind stress lead to towards lowering sea surface temperature. In addition, a regional study of ocean heat content according to the ERA-Interim data in period from 1955 to 2013 was conducted. It was found that the three periods of ocean heat content anomalies exist. The first period of 1955-1975, anomalies of heat content is has positive values, but tend to fall. In the second period 1976-1987 observed a reduction in ocean heat content in the layer 0-700m. The third period 2000-2013 characterized by positive values of heat content anomalies. At all times, there are significant changes in the wind stress.

Development of a Greek solar map based on solar model estimations

Joint funding between KRIPIS-THESPIA and ARCHIMED programmes

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ABSTRACT

The realization of Renewable Energy Sources (RES) for power generation as the only environmentally friendly solution, moved solar systems to the forefront of the energy market in the last decade. The capacity of the solar power doubles almost every two years in many European countries, including Greece. This rise has brought the need for reliable predictions of meteorological data that can easily be utilized for proper RES-site allocation. The absence of solar measurements has, therefore, raised the demand for deploying a suitable model in order to create a solar map. The generation of a solar map for Greece, could provide solid foundations on the prediction of the energy production of a solar power plant that is installed in the area, by providing an estimation of the solar energy acquired at each longitude and latitude of the map.

In the present work, the well-known Meteorological Radiation Model (MRM), a broadband solar radiation model, is engaged. This model utilizes common meteorological data, such as air temperature, relative humidity, barometric pressure and sunshine duration, in order to calculate solar radiation through MRM for areas where such data are not available. Hourly values of the above meteorological parameters are acquired from 39 meteorological stations, evenly dispersed around Greece; hourly values of solar radiation are calculated from MRM. Then, by using an integrated spatial interpolation method, a Greek solar energy map is generated, providing annual solar energy values all over Greece.

Variations of the vertical temperature profile of extratropical cyclones in the solar activity minima

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ABSTRACT

We studied variations of the vertical temperature profile in the central parts of the warm and cold sectors during the emergence and evolution of extratropical cyclones in the Northern Hemisphere at solar minimum. The dynamics of vertical temperature profile during cyclogenesis over the land and the ocean under quiet and disturbed geomagnetic conditions is analyzed. The classic cyclolysis occurs under quiet geomagnetic conditions in winter; the temperature decreases in the warm sector and increases in the cold one at heights of up to 300 hPa. Under disturbed geomagnetic conditions, the

temperature in the cold sector increases more slowly. The warm sector of the cyclone is characterized by an insignificant increase and stabilization of the temperature. This possibly results in slower cyclolysis and an increased lifetime of the cyclone. The analysis of vertical temperature profile during cyclogenesis over the land and the ocean under quiet and disturbed geomagnetic conditions is detected that the amplitude of the temperature variations in the surface layer (below 850 hPa) over the land is substantially greater than the ocean.

Influence of geomagnetic activity on SST changes

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ABSTRACT

In this paper the nature of long-term changes in sea surface temperature (SST), covering the time period from 1854 to 2014, and their relationship with variations of geomagnetic activity (aa-index) are discussed. Based on a comprehensive analysis of the observational data and the model of influence of solar activity on the climate being developed by us, it has been established that the climate response to the influence of solar and geomagnetic activity is characterized by significant spatial and temporal heterogeneity, is regional and depends on the climate era.

The characteristic feature of the spatial distribution of the response is the presence of areas of both positive and negative correlation. The exception is the era (1910-1948), in which the response to geomagnetic activity in SST was positive in almost all regions, i.e. it was global. In this era of increasing the geomagnetic activity is characterized by significant positive trend, the maximum for the entire considered time period (1868-2014). Regions of the oceans where the long-term changes in temperature over the entire considered period are determined mainly by variations of geomagnetic activity are detected.

It is shown that the extent of the connection between SST and the variations of the geomagnetic activity depends significantly on the time scale. This dependence is caused by the fact that most of the SST variations with a time scale of less than 5 years are due to processes that are not related to solar and geomagnetic activity.

The `Sun-climate` relationship and tree-rings widths

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ABSTRACT

The `Sun-climate` relationship in the light of dendrochronological data is the main subject of the present study. The annual rings width time series of 44 tree samples collected from Central and West Bulgaria has been studied and the obtained results are discussed there. Certain evidences for existence of modulated by solar and geomagnetic activity cycles by duration of 20-22, ~ 33, ~60, 80-90 and ~ 200yr has been found. On the base of established statistically significant cycles kinematical models of few tree ring width time series are built. They has been extrapolated for the next few decades (until 2045 AD). These results in the light of expected long term solar activity and climate changes has been discussed.

Impact of energetic particles on the Earth atmosphere. Overview of activities of WG3 COST ES1005 and the ISSI Team.

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ABSTRACT

The summary and progress on the main topic `Impact of energetic particles on the Earth atmosphere` covering tasks of WG3 of TOSCA COST ES1005 and the ISSI (International Space Science Institute) Team on `Specification of Ionization Sources Affecting Atmospheric Processes` during period of activities (2011-2015) will be presented here.

The overview of the main advances will cover subjects defined as WG packages: - Observations of energetic particles in the Earth atmosphere. - Atmospheric ionization by energetic particles. - Impact of energetic particles on the global electric circuit. - Impact of energetic particles on aerosol and cloud formation. - Definition of energetic particles inputs for climate modeling. - Impact of energetic particles on climate.

Finally open questions and summary coming out of the results of work will be presented as a conclusion.

Seventh Workshop

"Solar influences on the magnetosphere, ionosphere and atmosphere",
Sunny Beach, Bulgaria, 1-5 June 2015

The variability of the spatial pattern of surface temperature response on solar and geomagnetic activity

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ABSTRACT

On the basis of NCEP/NCAR reanalysis and AA-index data (1948-2012), we examined the changes of the spatial pattern of surface temperature response on geomagnetic activity variations. The response magnitude of surface temperature on variations of solar activity (SA) level increases, when the time scale rises. The largest changes are observed in high-latitude regions at the cold season.

The surface temperature changes, connected with solar activity variations and consequently with geomagnetic activity variations, have nonhomogeneous distribution in area and at time, but there are regions, where surface temperature response on geomagnetic activity variations is stable in time.

There are detected the spatial distribution of regions of positive and negative response on solar activity is different in SA cycle with different polarity of poloidal magnetic field at SA increase phase. The changes of surface temperature in high-latitude regions are considerably larger in periods of negative polarity of solar poloidal magnetic field. The greater increase of temperature in east hemisphere is observed, when poloidal magnetic field is positive, but the greater increase of temperature in west hemisphere is observed, when poloidal magnetic field is negative.

Neutral atmosphere influence on sporadic E layer

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ABSTRACT

We analyzed neutral atmosphere temperatures, zonal and meridional mesosphere winds, and sporadic E layers parameters foEs and hEs from summer campaign 2009. Permanent wave activity was detected in the datasets. However, main coherent modes detected in whole height profile correspond to eigenmodes of planetary waves.

Cosmic Ray Intensity and Solar Activity Variations Possible Effects on the Rainfall in Turkey and Azerbaijan and Caspian Sea Level Changes

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ABSTRACT

The possible effects of cosmic ray intensity and solar activity variations on the rainfall over Turkey and Azerbaijan (middle-latitude Turkey - Caucasus/Caspian Sea region) and Caspian Sea level changes are investigated. Rainfall data for Turkey and Azerbaijan as climate parameter and sunspot number and cosmic ray intensity data as space weather indicators are used. Considered rainfall period was from January 1975 to the end of December 2008 meanwhile Caspian Sea level data were from 1900 to 2000. Multi-Taper Frequency Spectrum method (MTM) is applied to obtain the cyclic behavior of considered parameters. The most pronounced power peaks found by MTM were 1.2, 2.1-2.2 and 3.6-3.9 years (significance level > 99.9 %) which were reported earlier for some solar and cosmic ray activity indicators. Correlation analysis was also used in this study. Results did not reveal a remarkable correlation between rainfall and solar activity. It is concluded that in comparison to solar activity, cosmic rays have more significant effect on rainfall and sea level changes in studied regions and considered period. Cosmic ray intensity variations and solar wind changes caused effects could be considered as one of possible bridges in study of solar-climate relationships.

Temperature variations of the ground atmospheric layer over the territory of karst massifs and the 11 year solar cycle

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ABSTRACT

Research on the air temperature course of the of ground atmospheric layer, located near the entrances of four show caves - Saeva dupka, Ledenika, Snezhanka and Uhlovitsa for the 1968 - 2014 period is presented in this work. The data are derived within the detailed micro-climatic monitoring of the caves and karst areas around them. Annual average number Wolf - W and Ap - index are used as indices of solar activity.

It was found that different lengths of solar cycles and different lengths of the upstream and downstream part of the curve complicate coordination of the duration of one cycle to another. Just because of this, procedure was used to bring the individual solar cycles to a standard using the years of maximum and minimum as a reference points. All the data were normalized in such a way that in the course of every 11 years solar cycle, the maximum value of the studied variable by module was equal to one.

The results of the research showed that there is a positive correlation between the deviations of the average annual, summer and autumn temperatures and solar activity (W and Ap) in western phase of the quasi biannual variations. Periods with eastern phase correlation practically absent from the annual seasonal distribution of temperatures. The average annual temperatures in the four caves reach their maximum three years after the peak of solar activity. Negative correlations between the values of temperatures and W and Ap are observed in winter and spring.

Investigation of annual and monthly periods to receive and accumulation solar energy using a Weather station Vantage Pro2 Plus

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ABSTRACT

In a period of four years are measured, collected and compiled database of solar energy. This is performed by using automatic weather station Vantage Pro2 Plus. It is a semi-professional type, and one of its sensors is specifically designed for measuring solar radiation. With these data is tracked the solar energy characteristics in different days, months and years. Also shown is the degree of repeatability in the corresponding months of different years. We calculated the annual repeatability of measurements. Monthly repeatability compares with annual and the latter turned out to be significantly better.

Estimation of Solar Activity Influence on Vertical Extension of Sprites

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ABSTRACT

The downward propagating positive streamers of sprites are considered as factor of chemical (concerning mainly NO_x constituents) and thermal disturbances in the lower mesosphere and upper stratosphere. A single sprite occupies thousands of cubic kilometers in the middle atmosphere. The total rate of sprites over the globe is estimated to be 1-3 per minute. Therefore, a reasonable question is whether sprites and, thus, their effects on the chemical balance (mainly below 60 km) are dependent on the solar activity. Once initiated, the sprites terminate at different altitudes, depending on the applied electric field, according to the requirement that the driving electric field has to exceed the threshold electric field for propagation of a positive streamer. We estimate the altitude of termination of streamers as function of solar activity level by otherwise equal conditions. The streamer driving quasi-static electric fields below 60 km are evaluated by modeling during solar minimum and maximum, respectively by a model proposed by us earlier and based on the continuity equation for the Maxwell's current. The computations show that, usually, during solar minimum the sprites reach a lower altitude than during solar maximum: hence, the total chemical effect of the first ones is larger (although for very weak sprites the difference can be reversed). The difference in lower sprite boundary, determined by the solar activity, varies from several hundred meters to more than 1 km, depending on different factors, such as the lightning parameters and the coefficient of conductivity reduction in the source thundercloud.

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Effects of Solar Proton Events on the development of cyclonic activity at extratropical latitudes

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ABSTRACT

Influence of energetic Solar Proton Events (SPEs), with particle energies above 100 MeV, on the development of extratropical cyclonic activity was studied. A pronounced intensification of cyclonic processes at middle latitudes was revealed on the days following SPE onsets both in the Northern and Southern hemispheres. Most statistically significant effects were detected in the North Atlantic region near the south-eastern coasts of Greenland and in the Southern Ocean near the Queen Maud Land coasts of Antarctica. It was stressed that the North Atlantic region near the Greenland coasts is most sensitive to SPE influences due to low geomagnetic cutoff rigidities allowing precipitation of particles with energies ~100 MeV, as well as to high temperature contrasts creating favorable conditions for cold advection necessary for the cyclone development. The results obtained suggest an important contribution of cosmic ray variations in the mechanism of solar activity effects on the lower atmosphere circulation, weather and climate.

Possible response of cloud cover to solar variations at low and high altitudes in various datasets: Sun versus solar wind

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ABSTRACT

The effect of solar variability on terrestrial climate is largely unknown, despite increasing research efforts. One major component of the radiation budget is the contribution of clouds, thus it is important to quantify their possible response to solar variations (or at least to clearly assess whether such a response exists or not). Studies showing correlations at long-term scale are contradicted by results stating that correlations might be random or they are affected by artefacts. We present a review of results showing solar fingerprints identified in high and low cloud cover data retrieved by satellite instruments. Another problem related to cloud cover is that it is not accurately shown in General Circulation Models due to the fact that continuous, long-term observations of cloud cover are missing. Comparison with long term reanalysis data is also shown, which might indicate whether observation and reanalysis data show similar fingerprints. We show results identifying area where the correlation is coherent and supported by valid mechanism. This might also help in identifying possible mechanism of energy transfer from Sun to clouds. High clouds seem to be affected by solar variability via sea surface temperature, while low clouds might be affected by solar UV, cosmic rays or, as we lately have shown, interplanetary electric field variations. Possible mechanisms connecting various solar proxies as solar radiation, cosmic rays, solar wind fields with clouds are also briefly presented.

Supramolecular physics in the problems of solar influence on the atmosphere and climate

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We are developed a new direction in the physical chemistry of the cloudy condensation - supramolecular physics which is physics outside the molecules (atomic-molecular core) when evolution into composite formations (clusters) the environmental electromagnetic radiation takes part being absorbed by those components of molecular complex which are excited to Rydberg states and thus increasing stability of the molecular complex. During the solar radio bursts and especially during the increases of the ionospheric microwave Rydberg emission intensity (during the solar flares and geomagnetic storms), there will take place the induced population of the Rydberg levels with larger orbital quantum momentum l in dissociative recombination process. As a result, the probability of the cluster ion dissociation in the atmosphere will decrease. During the recombination process an electron is accelerated toward a positive ion by their mutual Coulombic attraction, gaining enough energy to vibrational excitation of the ambient molecular gas, so that in a single collision it can lose a large fraction of its kinetic energy. Recombination is typically very much lower relatively with frequency of the electron - neutral molecule collisions. Usually the time of dissociative recombination of molecular ion is 10-11 sec and this is close by the life time ($2 \cdot 10^{-16} \cdot n^3$) for Rydberg n state in the processes of the "collisional dissociative recombination" ($n > 10$). During this time there is the induced electron transition with the change of l at the flux of microwaves from ionosphere equal before 10^{10} radioquanta/cm² s. Therefore the probability of the increasing l may be not zero.

Data Processing and Modelling

F-region vertical drift characteristics in midlatitudes

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ABSTRACT

Detail analyses of F-region drift velocity vertical component using Digisonde DPS-4 are presented. Drift data, measured at midlatitude ionospheric station Pruhonice, were collected during the year 2006. During the year 2006, solar and geomagnetic activity was low. Hence these data provide insight into the drift behavior during quiet conditions. In time series, following typical diurnal trend is evident: a significant decay to negative values at dawn; generally less pronounced negative peak at dusk hours. During daytime vertical velocity rises from small negative values in the morning through zero near noon to a small positive values in the afternoon. Nighttime values display large variability without a regular pattern. All the characteristics of the drift behavior are analysed with respect to seasons.

Tropospheric systems influence on the ionospheric plasma

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ABSTRACT

Correlation coefficients of long time series of the ionospheric plasma critical frequencies foF₂, monitored by mean of vertical sounding from European stations, are analysed with respect to latitudinal and longitudinal difference and surface distance of stations. Time series of critical frequencies are highly correlated reflecting the dominant solar influence. Correlation coefficients are high not only for raw data and subtracted mean courses but for fluctuations around mean as well. At the surface distance exceeding 1000 km and/ or about 10 degrees of latitudinal difference between stations, the correlation coefficients of fluctuations decrease rapidly. The existence of the break point at 10 degrees in longitude and/or 1000 km could be explained by the local influence of the neutral atmosphere and the wave activity. As a possible source of the common influence on scale 1000 km/10 degree we propose tropospheric systems that are known to be an important source of atmospheric waves in a broad period range. Large tropospheric mesoscale systems have typically up to 2000 km in size.

Analysis of GLE on November 6, 1997

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ISTP SB RAS

ABSTRACT

We have investigated the variations of rigidity spectrum and anisotropy of cosmic rays (CRs) during GLE of November 6, 1997, using ground-based and satellite observations of the CR intensity on the worldwide network of stations. The spectrographic global survey has been used.

This paper presents the rigidity spectrum, CR variation spectra and relative variations of the CR intensity with a rigidity of 4 GV in the solar-ecliptic geocentric coordinate system at certain periods of the event. The acceleration of protons during this GLE is shown to happen up to $R \sim 7$ GV. The differential rigidity spectra of CRs in the range of rigidities from ~ 0.3 to ~ 7 GV during the event under consideration are not described by a power or exponential function of particle rigidity. During GLE, the Earth was in the loop-like structure of the interplanetary magnetic field.

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Protons surfatron acceleration by electromagnetic wave in space plasma

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ABSTRACT

Surfatron acceleration of protons by electromagnetic wave in space plasma is considered. The surfatron effect of protons acceleration is investigated through numerical simulations, on the basis of nonlinear, nonstationary, second order differential equation for the wave phase at the charge trajectory. Different cases of initial particles energy and initial wave phase on the charge trajectory are studied. The charge capture by the wave may occur after some time of cyclotron rotation and following strong relativistic acceleration. The temporal dynamics of protons surfatron acceleration for different variants of initial particles parameters are elaborated. The optimal conditions for maximum ultrarelativistic particles surfatron acceleration by the electromagnetic wave in space plasma are considered. The analytical approximations of protons energy growth for different cases are elaborated.

On the electron capture probability in surfatron acceleration

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ABSTRACT

Cases of surfatron acceleration of electrons by electromagnetic waves packet in space plasma were presented. One case with low and one with considerably higher possibility to get into surfatron mode were chosen. Based on the nonlinear, non stationary, second order differential equation for the phase of the wave on the electron trajectory the analysis was made. The equations were solved numerically. Calculations were done for different values of the initial sets of the particle parameters and wave packet phase. The results showed that there are cases of the initial sets of parameters with very low and other ones with high value of probability for the particle capturing. Calculations for the one of the non effective sets and another one, common case were shown in tabular form. The graphs of initial stage of the particle capturing in different cases were presented. Conclusions about capturing particles in the surfatron acceleration mode by the wave packet in space plasma were made.

The Atlantic multidecadal oscillation influence on temperatures and on structural changes

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ABSTRACT

The cooling and the following warming periods in the Northern Hemisphere are very well captured by the statistic models taking in consideration Atlantic multidecadal oscillation (AMO). It is found that the AMO temperature influence increases from South to North, which is related to the heat transfer from the tropics to the Northern Atlantic by the thermohaline circulation. It is demonstrated, that structural breaks of the Northern Hemisphere and global temperatures are connected with AMO. The AMO influence removed temperature series show only one significant break. The strong AMO influence on the Northern Hemisphere and global temperatures will reduce the temperature increase in the next decades but when the AMO index will begin rising again the warming rates will achieve values close to the obtained ones during the last decades or greater than them due to higher dioxide content.

GUV 2511 instrument installation in Stara Zagora and first results

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ABSTRACT

In February 2015 a Ground-based Ultraviolet Radiometer (GUV) 2511 was installed in Stara Zagora. The GUV 2511 instrument is designed for measurements of the downwelling global irradiances at 305, 313, 320, 340, 380, 395 nm and of the irradiance in the visible range of 400-700nm. The instrument allows obtaining the total column ozone (TCO) in the atmosphere, the determination of the UV-index and the retrieval of cloud optical thickness. In the paper the first results of the measurements are presented and the methodology to derive TOC is described.

Kinetics of electronically excited O₂ molecules in the mixture of CO₂, CO, N₂, O₂ gases

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ABSTRACT

CO₂, CO, N₂, O₂ gases are the main components in the atmospheres of terrestrial planets. Electronically excited molecules play very important role in chemical kinetics of a mixture of atmospheric gases. We apply the Rosen-Zener approximation to calculate the removal rates of O₂* in inelastic collisions with CO₂, CO, N₂, O₂ molecules. The calculated quenching rate coefficients of electronically excited O₂ molecules are used in the simulations of vibrational populations of O₂ electronic states in the mixture of these gases. It is suggested that three-body collisions are the production mechanism of initially excited O₂. Vibrational populations of singlet oxygen are calculated at mixture pressures of 10⁻¹-100 Pa. Similar behaviour of the populations is seen in the cases of N₂-O₂ and CO-O₂ mixtures. The principal influence of carbon dioxide molecules is shown in the case of CO₂-O₂ mixture. The results can be applied in the study of electronic kinetics of O₂* at the altitudes of nightglows in the atmospheres of terrestrial planets.

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Instrumentation for Space Weather Monitoring

Space weather related studies with the Chinese solar radio instruments

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ABSTRACT

We review the possibilities for space weather research using the solar radio instruments in China, both operating and/or in commissioning phase. These are the Solar broadband radio spectrometer (SBRS) and the Chinese spectral radioheliograph (CSRH). The broad frequency range of SBRS (70MHz-7.6 GHz) extended to lower frequencies by the Wind/WAVES satellite can be used to follow solar eruptive phenomena from the low corona into the interplanetary space, respectively. In addition, the new radio positioning capabilities of CSRH will allow, for the first time, to locate the radio emitting plasma in the low and middle corona (0.4-15 GHz). These radio observations have a broad range of implications, from forecasting to understanding the physical nature of a variety of solar phenomena such as flares, coronal mass ejections and solar energetic particles.

Instrumentation for monitoring the space radiation environment during ExoMars 2016 and 2018 interplanetary missions

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ABSTRACT

Deep space manned missions are already a near future of the astronautics. Radiation risk on such a long-duration journey appears to be one of the basic factors in planning and designing the mission.

The paper relates to scientific objectives and instrumentation for investigation of the radiation environment to be carried out during the ExoMars 2016 and 2018 missions to Mars.

Described are: 1) The charged particle telescope and the experiment Liulin-MO for measurement the radiation environment onboard the ExoMars 2016 Trace Gas Orbiter satellite as a part of the Fine Resolution Epithermal Neutron Detector (FREND) and 2) Liulin-ML experiment and instrument for investigation the radiation environment on Mars as a part of the active detector of neutrons and gamma rays (ADRON) on the surface platform for ExoMars 2018 mission. Presented are the instruments calibration results.

Liulin detectors will be used in combination with the neutron detectors to study the radiation conditions both from charged particles and neutrons during the cruise phase, in Mars orbit and on the surface of Mars.

Development of the GPS TEC fluctuations at the high latitude ionosphere during geomagnetic storm

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ABSTRACT

We report the development of the GPS TEC fluctuations over Europe during the 2 October 2013 geomagnetic storm. The data of GPS stations spaced in the latitudinal range 67-54°N over longitude of 20°E were involved in this investigation. The magnetograms of the IMAGE network and geomagnetic pulsations at the Lovozero and Sodankyla observatories were used as an indicator of auroral activity. As a measure of fluctuation activity the rate of TEC (ROT) was used. On 2 October 2013 the strong geomagnetic field variations took place near 05UT at the auroral IMAGE network. We found a good agreement between development of the substorm activity and GPS-TEC fluctuations. The strong TEC fluctuations were observed at auroral and subauroral stations. The moderate short term phase fluctuations were also found near 05 UT at the middle latitude GPS station Kaliningrad.

The GPS measurement from stations with geomagnetic coordinates higher than 55°N and different longitudes were used to construct the spatio-temporal development of the fluctuations. Similarly to the auroral oval the spatial distribution of the GPS fluctuations demonstrate the irregularity oval evolution. During this storm the irregularity oval essentially expands against the quiet day and it is observed below 60°N. The analysis reveals that the irregularity oval is very sensitive to change of the auroral activity and can be used as an indicator of the space weather conditions.

We thank the Institutes who maintain the IMAGE Magnetometer Array, Grant of RFBR 14-05-98820 r-sever-a and grant of RFBR 14-07-00512.

Solar Effects in the Biosphere

Influence of Geomagnetic Activity on Season Variations of Myocardial Infarction at Subauroral (Yakutia) and Low Latitudes (Bulgaria)

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ABSTRACT

The problem of possible influence of the solar and geomagnetic activity on the human health was discussing during the last decades. It was established that the heart and cardiovascular system could be the main targets of this negative action. Here we present the results of comparison of the seasonal variations of emergency medical calls on occasion of the myocardial infarctions in Yakutsk (subauroral geomagnetic latitudes) with a planetary geomagnetic activity near the maximum (1992) and minimum (1998) of solar activity and their good agreement have been found. However, the seasonal behaviour of deaths from myocardial infarctions at low latitudes (Bulgaria) showed significant differences. In Bulgaria, the maximum of infarctions was in winter without a strong correlation with the magnetic activity but they were controlled by Pc1 geomagnetic pulsations at periods of about 0.5-2.0 Hz. In Yakutsk, there are several maxima coincided with the increase of geomagnetic activity. We suppose that at subauroral latitudes, unlike low latitudes, a major role in the increase in the number of infarctions play those magnetic storms which demonstrate the strongest disturbances (substorms) at local (i.e. in Yakutsk) night. Typically, substorms are accompanied by irregular 0.3-4.0 Hz geomagnetic Pi1 pulsations decreased quickly with latitude and, therefore, observed seldom at low latitudes. We suppose that Pi1 at subauroral latitudes like Pc1 at low ones could be biotopic.

The relative role of space weather factors in Chizhevsky-Velkhover effect

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ABSTRACT

Daily monitoring of metachromatic reaction *Saccharomyces cerevisiae* was carried out in 2000-2013, Institute of Microbiology NASU. Statistical treatment of the monitoring data carried out by IZMIRAN. Levels of metachromasia were marked: MTH=1, if no metachromatic reaction was observed (volutin granules stained in the blue color); MTH=2, if in the color of the volutin granules predominant saturated violet color; and MTH=3, if the color of the volutin granules was red.

Results:

1. Total statistical distribution for ap-index and MTH=(1,2,3) is random within measurement error.
2. Total statistical distribution for solar radio waves F10,7 intensity is random with MTH=(1,2). Weak dependence is observed for solar radio waves F10,7 intensity with MTH=3.
3. Distributions of galaxy cosmic rays variation in all days in 2000-2013 and in days, when MTH=0 are equal within measurement error
4. Distribution of galaxy cosmic rays variation in days with MTH=(1,2) is quite equal the total distribution. The picture appears if one build the distribution with random sample of days, so one can set independence the MTH=(1,2) from galaxy cosmic rays variation.
5. Distribution of MTH=3 considerably depends of galaxy cosmic rays intensity variation; it means, that galaxy cosmic rays intensity variation is the main biotropical agent of the cosmic weather for sell structures.

Conclusions: Galaxy cosmic rays intensity variation insert the main contribution on the sell structures in Chizhevsky-Velkhover effect. The solar factors insert less contribution. The contribution of geomagnetic fields is indistinguishable from random.