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STATISTICAL ANALYSIS OF GROUND LEVEL OZONE AND METEOROLOGICAL PARAMETERS IN BULGARIA – SOFIA FIELD AND PLANA MOUNTAIN

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(*Submitted by Corresponding Member P. Velinov on July 19, 2010*)

Abstract

Statistical analysis of ground level ozone concentration and five other meteorological parameters which is based on systematic measurements during 2007–2009 in Sofia and Plana stations is presented. The parameters are: wind speed and wind direction, total solar radiation, precipitation, air temperature and relative humidity. Diurnal, monthly and seasonal behaviour of the listed above elements is analyzed. The following features, based on this analysis, were established:

• Two main trends clearly emerged – positive correlation of the ground level ozone with solar radiation and air temperature; negative correlation of ozone with relative humidity.

• Positive correlations between the ozone and the measured meteorological parameters have a seasonal course.

• Negative correlation between the ozone and the relative humidity has not a seasonal course.

• Separation of the diurnal data to day and night data allows us to see some effects which are causal by day and night processes, i.e. diurnal data smooth the day and night effects.

Key words: statistical analysis, ground level ozone, systematic measurements, seasonal trend

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INVESTIGATION OF MIDDLE ATMOSPHERE IONIZATION DURING GLE 70 EVENT FROM DECEMBER 2006 BY MEANS OF CORIMIA MODEL AND NORMALIZED CR SPECTRA

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Abstract

The ground level enhancement (GLE) of cosmic rays (CRs) on December of 13, 2006 is one of the biggest GLEs in 23rd cycle (behind GLE 69 from 20 January 2005 only) in minimum phase of solar cycle. The greatest maximum was recorded at Oulu Neutron Monitor Station (92.1 %), i.e. the maximum of GLE70 was recorded at sub-polar stations, which shows that the anisotropy source was located near the equator.

Here we compute in details the ionization effects in the terrestrial middle atmosphere and ionosphere (30-120 km) for various latitudes. The computation of electron production rate profiles q(h) is according the operational model CORIMIA (COsmic Ray Ionization Model for Ionosphere and Atmosphere). This improved CR ionization model is important for investigation of the different space weather effects. The influence of galactic and solar CR is computed with the new version of CORIMIA code, which is with fully operational implementations. The solar CR spectra are taken from recent reconstructions from ground based measurements with neutron monitors. Hence we compute the time evolution of the electron production rates q(h) in the ionosphere and middle atmosphere.

The cosmic rays determine to a great extent the chemistry and electrical parameters in the ionosphere and atmosphere. They create ozonosphere and influence actively the stratosphere ozone processes. But the ozonosphere controls the meteorological solar constant and the thermal regime and dynamics of the lower atmosphere, i.e. the weather and climate processes.

WHAT CAUSES GEOMAGNETIC ACTIVITY DURING SUNSPOT MINIMUM?

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ЧТО ОПРЕДЕЛЯЕТ ГЕОМАГНИТНУЮ АКТИВНОСТЬ В МИНИМУМЕ СОЛНЕЧНЫХ ПЯТЕН?

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В работе показано, что средняя геомагнитная активность во время минимума солнечных пятен в последних 4 циклах последовательно убывает. Кроме того, установлено, что она не зависит от вариаций числа и/или параметров корональных выбросов массы и/или ударной волны, связанной с высокоскоростными потоками солнечного ветра. Показано, что у фонового солнечного ветра две компоненты: одна со скоростью до 450 км/с, другая – выше 490 км/с. Источник медленного ветра – гелиосферный токовый слой, а более быстрой компоненты – полярные корональные дыры. Средняя геомагнитная активность во время солнечного минимума определяется не только толщиной гелиосферного токового слоя, но и параметрами этих двух компонент солнечного ветра, которые изменяются от цикла к циклу.

1. Introduction

Since the beginning of the geomagnetic measurements, the variations in the geomagnetic field have been related to solar activity. It is now known that big sporadic (non-recurrent) geomagnetic storms are caused by coronal mass ejections (CME). CMEs like sunspots are manifestations of the solar toroidal field and during sunspot maximum there is also a maximum in geomagnetic activity. Other sources of geomagnetic activity are the coronal holes – open unipolar magnetic field areas from which the high speed solar wind (HSS) emanates. Geomagnetic disturbances caused by HSS have maximum during the sunspots declining phase. These lead to two geomagnetic activity maxima in the 11-year sunspot cycle. In sunspot minimum, even during long periods without sunspots and without low-latitude coronal holes, geomagnetic disturbances are still observed.

Actually, geomagnetic activity can be divided into 3 components. The first one is the “floor”, equal to a_0 coefficient which represents the geomagnetic activity in the absence of sunspots. It is practically determined by the activity in the cycle minimum and varies smoothly from cycle to cycle. The second component is the geomagnetic activity caused by sunspot-related solar activity

LANGMUIR PROBE MEASUREMENTS ABOARD THE INTERNATIONAL SPACE STATION

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ИЗМЕРЕНИЯ ЗОНДОМ ЛЕНГМЮРА НА БОРТУ МЕЖДУНАРОДНОЙ КОСМИЧЕСКОЙ СТАНЦИИ

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В настоящей работе мы описываем работу прибора Зонд Ленгмюра на борту Международной космической станции. Этим прибором определяются параметры термальной плазмы – электронная температура и концентрация электронов Ne и ионов Ni в окрестности станции. Тем же прибором измеряется и потенциал корпуса относительно плазмы. Прибор расположен на около 1,5 м от поверхности станции на российском модуле «Звезда», который находится в самой удаленной точки, смотря по вектору скорости. Кроме того прибор экранируется от набегающего (по вектору скорости) потока плазмы модулем Multi-Purpose Laboratory (MLM). Измерения показали, что в этой зоне концентрация плазмы на 2 порядка меньше, чем в невозмущенной зон. Потенциал корпуса колеблется между 3 и 20 вольта, но всегда отрицателен относительно плазмы.

Introduction

The Langmuir probes LP are part of the international Plasma-Wave Complex (PWC) “OBSTANOVKA” experiment aboard the International Space Station (ISS). The purpose of the PWC experiment is regular measurements of the wave and plasma parameters near the surface of the Russian module of the ISS – monitoring of the surface charging, noise and perturbations caused by ISS and its various experiments. PWC consists of several instruments [1]. Two of them are the Langmuir probes LP1 and LP2 which are designed and manufactured by Bulgarian scientists.

The Langmuir probe is one of the classical instruments for plasma diagnostics [2] and among the first space-borne instruments. Langmuir probes have been successfully used aboard a number of rockets and satellites for in situ measurements of thermal plasma parameters in the terrestrial ionosphere [3], at other planets [4] and comets [5].

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What Causes Geomagnetic Activity During Sunspot Minimum?[1]

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Abstract—It is well known that the main drivers of geomagnetic disturbances are coronal mass ejections whose number and intensity are maximum in sunspot maximum, and high speed solar wind streams from low latitude solar coronal holes which maximize during sunspot declining phase. But even during sunspot minimum periods when there are no coronal mass ejections and no low latitude solar coronal holes, there is some "floor" below which geomagnetic activity never falls. Moreover, this floor changes from cycle to cycle. Here we analyze the factors determining geomagnetic activity during sunspot minimum. It is generally accepted that the main factor is the thickness of the heliospheric current sheet on which the portion of time depends which the Earth spends in the slow and dense heliospheric current sheet compared to the portion of time it spends in the fast solar wind from superradially expanding polar coronal holes. We find, however, that though the time with fast solar wind has been increasing in the last four sunspot minima, the geomagnetic activity in minima has been decreasing. The reason is that the parameters of the fast solar wind from solar coronal holes change from minimum to minimum, and the most important parameter for the fast solar wind's geoeffectivity—its dynamic pressure—has been decreasing since cycle 21. Additionally, we find that the parameters of the slow solar wind from the heliospheric current sheet which is an important driver of geomagnetic activity in sunspot minimum also change from cycle to cycle, and its magnetic field, velocity and dynamic pressure have been decreasing during the last four minima.

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1. INTRODUCTION

As early as in the middle of the 19th century, it was found that the minima and maxima in the average rate and size of magnetic disturbances at widely separated observatories coincide, and correspond to minima and maxima in sunspot numbers [Sabine 1852]. It is now known that there are two maxima in geomagnetic activity during the sunspot cycle. The major geomagnetic storms which follow the sunspot cycle are caused by coronal mass ejections [Gosling, 1993], and are the source of the maximum of geomagnetic activity in sunspot maximum. Another source of geomagnetic activity are the high speed solar wind streams (HSS), which originate from the coronal holes—open unipolar magnetic field areas [Sheeley Jr. et al., 1996]. Coronal holes are biggest and in most geoeffective position during the sunspots declining phase, causing a secondary maximum in geomagnetic activity.

[Feynman, 1982] showed that for every number of sunspots R, there is some minimum value below which the geomagnetic activity measured e.g. by the geomagnetic aa-index cannot fall. This minimum value depends linearly on the number of sunspots, and is determined by the equation $aa_R = a_0 + b.\ R$, where aa_R is the minimum geomagnetic activity for a given number of sunspots, R is the international sunspot number, and a_0 and b are constants. The values above this line, $aa_P = aa - aa_R$, are due to the contribution of HSS to geomagnetic activity. Therefore, geomagnetic activity can be divided into two parts: aa_R—sunspot-related and due to CMEs, and aa_P—non sunspot-related, due to HSS. [Kirov et al., 2013] noticed that a_0 and b calculated by different authors and for different periods differ, and found that this is not a result of the different computational methods used, but a_0 and b indeed vary from cycle to cycle and have cyclic long-term variations. Moreover, the geomagnetic activity should be divided into 3 rather than 2 components to better track its variations. The first component, equal to the a_0 coefficient, is the "floor" below which geomagnetic activity cannot fall even in the absence of sunspots, and is obviously not related to sunspots. a_0 is practically determined by the activity in the cycle minimum. The second component is the geomagnetic activity caused by sunspot-related solar activity which is described by the straight line $aa_T = b^*R$ so that $aa_R = a_0 + aa_T$. The slope b of this line also changes cyclically. The third component aa_P (the value above aa_R) is caused by high speed solar wind (Fig. 1).

The subject of the present study is to find what determines the height of the geomagnetic activity floor a_0 and, respectively, the geomagnetic activity in sunspot minimum.

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Validation of Cosmic Ray Ionization Model CORIMIA Applied for Solar Energetic Particles and Anomalous Cosmic Rays

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Abstract. Based on the electromagnetic interaction between the cosmic ray (CR) and the atmospheric neutral constituents, CORIMIA (COsmic Ray Ionization Model) gives an estimation of the dynamical ionization condition of the lower ionosphere and middle atmosphere (about 30–120 km). Galactic Cosmic Rays (GCR), modified by solar wind and later by geomagnetic and atmospheric cut offs, produce ionization in the entire atmosphere. In this paper we show the GCR ionization in periods of solar minimum and maximum. Despite the considerably lower energies than GCR, Anomalous Cosmic Rays (ACR) contribute to the ionization state mostly over the polar regions and as we present here this contribution is comparable with those of GCR. Solar energetic particles (SEP), which differ vastly from one another for different solar events, can be responsible for significant ionization over the high latitude regions. Here we compare flows of SEP caused by two of the most powerful solar proton events at February 23, 1956 and January 20, 2005.

Keywords: cosmic rays, cosmic ray ionization, solar energetic particles, numerical modeling
PACS: 96.50.S-, 96.50.Vg, 95.75.Pq

1. INTRODUCTION

Cosmic rays (CR), highly energetic charged particles, have three main components: galactic cosmic rays (GCR), solar energetic particles (SEP), and anomalous cosmic rays (ACR). They modulates ionization state of the Earth's atmosphere and ionosphere and in this way through atmospheric chemistry and global electric circuit, CR may are involved in determining of the Earth's weather and climate (Rozanov et al. [1], Usoskin and Kovaltsov [2], Tinsley et al. [3], Tinsley [4]).

The aim of this work is to present the calculation of GCR, SEP, and ACR electron production rates calculated by the analytical model CORIMIA (COsmic Ray Ionization Model for Ionosphere and Atmosphere). One is emphasized on:

- Short discussion about CR ionization in the atmosphere and ionosphere
- Describing the basic steps of the CORIMIA model and GCR ionization
- Ionization rate during SEP flows caused by two solar proton events
- ACR ionization over the Polar Regions

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Heliospheric Current Sheet as a Factor of Geomagnetic Activity Floor

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Abstract

Observable significant depressions of the Earth`s magnetic field, which are an indicator for changes in the near-Earth space plasma parameters, are caused mainly by transient Interplanetary coronal mass ejections (ICME) and High speed solar wind streams (HSS). However, even in the absence of these two manifestations of the solar activity, when our planet "floats" in the relatively "quiet" space, there are still geomagnetic disturbances. Considering the ICME and HSS free periods for the last four solar cycles, in this work it is shown that the role of the heliospheric current sheet (HCS) in the geomagnetic activity "floor" is significant.

Introduction

According to the NOAA Space Weather Scales (http://www.swpc.noaa.gov/noaa-scales-explanation) a geomagnetic storm can be defined when the geomagnetic planetary index Kp is at least 5 or greater. Considering the global picture of the geomagnetic disturbances most of the time (up to 60 %) during any 11-years solar cycle (SC), Kp is less than 5 (fig. 1). There are two phenomena causing relatively strong geomagnetic storms: high speed streams (HSS) ejected by solar coronal holes and the interplanetary regions identified with the coronal mass ejections (CMEs) [1-2]. However, even in the absence of these two manifestations of the solar activity, when our planet "floats" in the relatively "quiet" space, there are still geomagnetic disturbances. For example each two years around any solar minimum up to 50 % of the time the Earth's is not influenced by HSS nor CME [3] and at the same time Kp is different from zero.

Feynman [4] linked geomagnetic activity and sunspots, in a way to show that the annual average *aa* index can be decomposed into two functions – the first one caused by short lived solar wind sources (CME, short lived coronal holes) and the second one related predominantly to the polar coronal holes (HSS). Further research [5] supplies additional component which expresses the geomagnetic activity in the absence of sunspots, i.e. the geomagnetic activity "floor". All these three components represent how the long-term averages of the solar wind drivers influence the Earth's magnetosphere.

Recognizing the geomagnetic "floor" as an averaged state of the disturbed geomagnetic field when there are no sunspots actually neglects the fact that even in the spotless Sun there can be a HSS reaching the Earth [6]. If we assume an average Kp index (or any other geomagnetic index) in a relatively long time interval with no HSS and ICME (quiet periods), we can define the geomagnetic activity "floor" as a minimal value of the index under which the geomagnetic activity cannot fall. In the specific case when the averaged time interval is short (few hours or days) the geomagnetic "floor" cannot be defined or it will be zero. One of the first questions which arise here is what determines the geomagnetic floor variation? The answer probably includes factors such as properties of the slow solar wind (which originate from regions near the equatorial coronal streamers), properties of the fast solar wind (coming from the polar coronal holes) and conditions inside the magnetosphere.

In this work it is argued that an additional influence on the geomagnetic "floor" can be caused by the heliospheric current sheet (HCS) in sense of its crossing.

HELIOSPHERIC CURRENT SHEET AND GEOMAGNETIC FIELD

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ГЕЛИОСФЕРНЫЙ ТОКОВЫЙ СЛОЙ И ГЕОМАГНИТНОЕ ПОЛЕ

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Гелиосферный токовый слой (ГТС), который разделяет гелиосферу на две области с разной магнитной полярностью, модулирован солнечной активностью. Во время солнечного максимума ГТС сильно накренен, а во время солнечного минимума он почти совпадает с экваториальной плоскости. Некоторые исследования показывают, что параметры солнечного ветра (протонная температура, скорость солнечного ветра, плотность и др.) сильно меняются вблизи ГТС. Земной магнитный диполь пересекает ГТС несколько раз каждый месяц. Целью данной работы является исследование поведения геомагнитного поля на пересечении ГТС. Для этой цели были использованы экспериментальные данные для геомагнитных индексов DST и AE представленные мировым центром для геомагнитных данных Киото, Япония; данные для параметров солнечного ветра из OMNI data base, а также данные о секторной структуре солнечного ветра, представленные от Свалгард.

Introduction

Geomagnetic activity is driven by dynamical processes occurring in the near Earth solar wind. Interplanetary coronal mass ejections (ICME) and high speed solar wind streams (HSS) are most commonly recognized as main generators of magnetic storms [2]. However, small fluctuation of the geomagnetic field ($0<Kp<3$) appears in more than 60% of the time in the last four solar cycles (Fig. 1). Such fluctuation may be caused by properties of the slow solar wind, which originates from regions near equatorial coronal streamers; properties of the fast solar wind, coming from polar coronal holes or conditions inside the magnetosphere. This research examines a possible influence of the heliospheric current sheet crossings on the geomagnetic fluctuations.

Heliospheric current sheet crossings

Heliospheric current sheet (HCS) is a dynamic object which can be described as a plane separating the heliosphere into two regions with opposite magnetic polarity. It is roughly ~10000 km thick at 1 AU [5] and its inclination is modulated by the solar activity - during solar minimum it nearly matches the solar equatorial plane and it is highly inclined during solar maximum [3–4]. A highly variable and high-beta region covers HCS named heliospheric plasma sheet (HPS) [1]. Its thickness ranges from 220000 to 400000 km [5].

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Langmuir Probe Measurements Aboard the International Space Station[1]

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Abstract—In the current work we describe the Langmuir Probe (LP) and its operation on board the International Space Station. This instrument is a part of the scientific complex "Ostonovka". The main goal of the complex is to establish, on one hand how such big body as the International Space Station affects the ambient plasma and on the other how Space Weather factors influence the Station. The LP was designed and developed at BAS–SRTI. With this instrument we measure the thermal plasma parameters – electron temperature Te, electron and ion concentration, respectively Ne and Ni, and also the potential at the Station's surface. The instrument is positioned at around 1.5 meters from the surface of the Station, at the Russian module "Zvezda", located at the farthermost point of the Space Station, considering the velocity vector. The Multi-Purpose Laboratory (MLM) module is providing additional shielding for our instrument, from the oncoming plasma flow (with respect to the velocity vector). Measurements show that in this area, the plasma concentration is two orders of magnitude lower, in comparison with the unperturbed areas. The surface potential fluctuates between –3 and –25 volts with respect to the ambient plasma. Fast upsurges in the surface potential are detected when passing over the twilight zone and the Equatorial anomaly.

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1. INTRODUCTION

The Langmuir probe is one of the classical instruments for plasma diagnostics (Mott-Smith and Langmuir, 1926) and among the first space-borne instruments. Langmuir probes have been successfully used aboard a number of rockets and satellites for in situ measurements of thermal plasma parameters in the terrestrial ionosphere (Brace et al., 1998), at other planets (Krehbiel et al., 1980) and comets (Grard et al., 1989). In general any object with a good conductivity, submerged in plasma can act as a Langmuir probe. We can apply a voltage, changing within a certain range, to the probe and measure the current. The dependency between of the measured probe current and correspondent voltage is called "probe characteristics" or "current–voltage characteristic". From the shape of the curve and the amplitude of the given "current-voltage characteristic" we can obtain the plasma parameters. The interpretation of the results from the Langmuir probe is not an easy task, which is additionally complicated during space experiments by the fact that the probe together with the spacecraft is moving with respect to the ambient plasma. The general form of the equation motion for a spherical or cylindrical probe is given by Hoegy and Wharton (Hoegy and Wharton, 1973). The general equation for the probe current does not give analytic solution and in this case an appropriate approximation should be used. Each of these approximations introduce an error in the interpretation of the results. The accuracy of the approximations depends on the plasma parameters, but also on the velocity of the object and the shape of the probe. Our main goal is to choose proper shaped probe and to use approximations suitable for measurements from a moving object in the Ionosphere. After solving this problem we have to determine how the thermal plasma parameter changes with the proximity from the ISS. Also we need to establish how ISS potential changes under the impact of the different Space Weather factors.

2. INTERPRETATION OF THE "CURRENT–VOLTAGE CURVE"

Typical „current-voltage curve" is shown on Fig. 1. The curve consist of three sections: as in the section of ion saturation (1) the probe potential is negative enough to repel all the electrons, while the ions are

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Geomagnetic Field Disturbances Caused by Heliospheric Current Sheet Crossings[1]

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Abstract—The heliospheric current sheet (HCS) is modified by the solar activity. HCS is highly inclined during solar maximum and almost confined with the solar equatorial plane during solar minimum. Close to the HCS solar wind parameters as proton temperature, flow speed, proton density, etc. differ compared to the region far from the HCS. The Earth's magnetic dipole field crosses HCS several times each month. Considering interplanetary coronal mass ejections (ICME) and high speed solar wind streams (HSS) free periods an investigation of the HCS influence on the geomagnetic field disturbances is presented. The results show a drop of the *Dst* index and a rise of the *AE* index at the time of the HCS crossings and also that the behavior of these indices does not depend on the magnetic polarity.

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1. INTRODUCTION

The Heliospheric current sheet (HCS), the dynamic barrier that separates the Heliosphere into two main parts with dominant opposite magnetic fields, is a result of a combination between the continuous solar wind flow, solar magnetic field and rotation. Its form is modified by the changing angle between the solar rotation axis and the direction of the Sun's magnetic dipole, which strongly depends on the phase of the solar activity. As a well-defined object in the interplanetary space, with its varying behavior, HCS interacts with the Earth's magnetosphere.

With the discovery of the sector structure of the interplanetary magnetic field (IMF) (Ness and Wilcox, 1964; Wilcox and Ness, 1965) it was shown that there are relatively small geomagnetic disturbances caused by sector boundary crossing (Wilcox and Ness, 1967). In the next few years a number of papers examine the relation between IMF and geomagnetic field variations (Mansurov, 1969; Iwasaki, 1971; Friis-Christensen et al., 1971). Detailed and useful list of the interplanetary magnetic sector structure covering the period 1921–1971 was published, based on the polar geomagnetic records (Svalgaard, 1972). Using superposed epoch analysis for 23 sector boundary crossings in 1968, Wilcox and Colburn (1972) examined the behavior of the *Kp* index, which in general shows similar variations at sector boundaries – average *Kp* reaches a peak almost at the time of crossing. Further investigation shows that an increase of the *AE* index at sector boundaries also occurs and a possible explanation is the prolonged period with southward component of the IMF (Hirshberg and Colburn, 1973).

Several decades after these first studies we know that geomagnetic activity is driven by dynamical processes occurring in the near Earth solar wind. Interplanetary coronal mass ejections (ICME) and high speed solar wind streams (HSS) are most commonly recognized as main generators of geomagnetic storms (Richardson and Cane, 2012). Very often, the geomagnetic activity is classified in different strength levels (Gonzalez et al., 1994). Using these classifications it was possible to examine the geoeffectiveness of the interplanetary shocks, ICME and magnetic clouds, sector boundary crossings, etc. It was shown that more than 25% of the 946 sector boundary crossings are followed by intense or moderate geomagnetic activity (Echer and Gonzalez, 2004).

Nearly quiet activity level of the geomagnetic field ($0 < Kp < 3$) appears in more than 60% of the time in the last four solar cycles (Fig. 1). Slight fluctuations may be caused by the properties of the slow solar wind, originating from regions near equatorial coronal streamers; properties of the fast solar wind, coming from polar coronal holes or conditions inside the magnetosphere. This research is focused on the influence of the heliospheric current sheet crossings on the geomagnetic fluctuations in the last five solar cycles.

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Forecasting the sunspot maximum through an analysis of geomagnetic activity

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A R T I C L E I N F O

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Solar activity
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Prediction sunspot maximum

A B S T R A C T

In the present work we show that it is possible to predict the maximum sunspot number for a particular solar cycle from the maximum value of the solar dipole magnetic field of the previous cycle. Based on the measured dipole field maximum, we determine the geomagnetic activity in the upcoming solar minimum during the intervals when the Earth is not exposed to CME and HSS influences. The physical meaning of the relationship between the geomagnetic activity in the solar activity minimum and the maximum value of the solar dipole magnetic field is that the basic factor determining the geomagnetic activity during the minimum is not the heliospheric current sheet thickness but the physical parameters of the slow solar wind in this period.

Then, based on the established relationship between the average geomagnetic activity at the specified minimum and the next solar maximum, we can predict the sunspot maximum of the next solar cycle.

1. Introduction

Predicting solar and geomagnetic activity is one of the biggest challenges to solar-terrestrial physics – not only because the accuracy of the predictions is an indication of our understanding of how the Sun operates and how the solar activity agents interact with the Earth's system, but also because our increasingly technological society is becoming increasingly vulnerable to the possibly adverse effects of space weather.

Nowadays, continuous observations of the Sun by ground-based and space-borne instruments make it possible to forecast with improving accuracy the short-term (hours to days) solar activity like solar flares and coronal mass ejections from active regions, and high speed solar wind streams from coronal holes. On the other hand, the long-term (cycle-to-cycle) variations of solar activity are much less understood, and therefore, the forecast of the future sunspot cycles is still highly uncertain.

At present, various methods are employed: both mathematical predictions (statistical, spectral, neural networks), and more or less physics based forecasts (dynamo model, precursors). However, the resulting forecasts vary over a wide range, even if based on the same methods. Pesnell (2008) summarized the published expected values for the amplitude of the current sunspot cycle 24, and they ranged from below 50 to almost 200 (measured by the original International sunspot number).

More than half a century ago the amplitude of the ~11-year sunspot cycle was found to be well correlated with, and consequently possible to forecast based on the minimum level of geomagnetic activity in the beginning of thecycle (Ohl, 1966) or on the level of geomagnetic activity during the late declining phase of the previous cycle (Ohl and Ohl, 1979). This precursor method based on the level of geomagnetic activity is still considered as the most reliable one.

One disadvantage of this technique is that the forecast can't be made before the previous sunspot cycle has finished, because no method is available to date to estimate in advance the geomagnetic activity around sunspot minimum. Another, even more important problem, is that different modifications of the method yield different results: for example, for cycle 23, Lantos and Richard (1998) forecasted a maximum amplitude of about 168 ± 15, while Hathaway et al. (1999) expected a maximum of about 150 – both well above the observed value. For cycle 24, the forecasts based on geomagnetic activity precursors summarized by Pesnell (2008) ranged between 120 and 160. The reason to apply different modifications is that the physical mechanism responsible for the differences in geomagnetic activity during geomagnetically quiet periods in different sunspot minima is not quite clear yet.

The goals of the present paper are to summarize what we know about the solar sources of geomagnetic activity in sunspot minimum periods, and to investigate the possibility to forecast, based on observations of the

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HIGH SPEED SOLAR WIND STREAMS OVER THE LAST FOUR SOLAR CYCLES

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Abstract

Studying the high speed solar wind streams (HSS) behavior over the course of a solar cycle (SC) can give a valuable knowledge about solar activity. Using the experimental data for the solar wind parameters close to Earth, the variation of the HSS over the last four SC (21÷24) is shown. While the HSS velocity and appearance for the SC 21÷23 have similar distribution – the maximum of both is around declining phase of solar activity cycle; the situation in SC 24 is not well defined. For the last 24 cycle 302 HSS events were isolated and their maximum speed was estimated.

Introduction

According to the flow properties, the near-Earth's solar wind generally is treated as a three component system: high speed streams (HSS), slow solar wind and streams associated with coronal mass ejections (CME) [1]. The frequency of occurrence and intensity of these three components depends strongly on the phase of the solar activity cycle, as large scale Sun's magnetic field modulates the expansion of the solar wind [2]. HSS are characterized with high speed (> 500 km/s), high proton temperature and low plasma density. They originate from coronal holes, which are unipolar open magnetic field areas [3–5]. HSS and CME are the main types of solar generated drivers that affect Earth. The strong sporadic storms during maximum are caused by CMEs [5, 6], and especially by magnetic clouds with strong and smoothly rotating magnetic field inside the structure providing prolonged periods of southward *Bz* [7].

Coronal holes are the largest and the most geoeffective during the sunspot declining phase [8], when a second maximum in the geomagnetic activity is observed (the first maximum is caused by CME).

High speed solar wind streams for solar cycles 21÷23

The periods of HSS for solar cycles 21÷23 are determined by several catalogues: [9–11]. In Fig. 1 and Fig. 2 averaged values of the maximum speed of

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Determining the photocurrent of spherical probes from one-sonde-shading electric field data

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ABSTRACT

We propose a method for determining the saturation photoelectron current density of spherical probes, designed for measuring the electric field by the double-probe technique. Shading of only one of the probes causes specific changes in the electric field, and using the potential difference ΔV between the two probes created by the shading we obtain an analytical expression for the photocurrent density. We derive this expression in two different ways: directly, from the potential difference; and after calculating the resistance of the plasma layer around the probe. In both cases the value of the photocurrent is determined from the ion current. Data for the concentration and the plasma temperature is needed to determine the ion current. We considered two limiting forms of its collection: (1) SAL-sheath area limited case (thin layer); (2) OML-orbital motion limited case (thick layer). We validate the method using data from Intercosmos Bulgaria - 1300 satellite. The photocurrent density is calculated for two shading-of-the-probe instances. The values we obtain are significantly larger than the ones from laboratory measurements, but close to the photocurrent values deduced from other space experiments.

1. Introduction

It is commonly assumed that when measuring the electric field of satellites and rockets by the double probe method it is not necessary to know the photocurrent from each of the probes. This is due to the expected equality of the photocurrents from the two probes and, more generally, to the assumed uniformity of the measurement conditions of the probes. These are not always realistic assumptions, however, as was demonstrated, for example, on Injun 5 (Explorer 40) (Cauffman and Gurnett, 1972), where a difference between the spherical probes saturation photocurrent density - 3.1 nA/cm^2 was observed, due, according to the authors, to a prelaunch probe contamination. Another example of the probes dissimilarity is the measured potential difference $\sim$ 150 mV between the spherical probes on ISEE-1 caused by photocurrent differences (Mozer et al., 1983a). These observations suggest that knowledge of the photocurrent from each probe can be necessary for the accurate determination of the electric field. The photocurrent value can also be used to study the variations in the solar spectrum in the EUV.

Photoemission properties of selected materials used in space exploration are presented in (Feuerbacher and Fitton, 1972). Data from samples at room temperature and vacuum of about 10^{-6} Torr, corresponding, according to the authors, to the conditions on a spacecraft were determined by laboratory measurements. Using the photoyield measurements, combined with a model of the solar intensities (the continuous part of the solar spectrum for the case of a distance of 1 a.u. from the sun and the Lyman-α line), the saturation photoelectron current density from typical satellite surfaces were calculated. Since the electric field measurements were usually done with vitreous carbon (VC) spherical probes, in this section we mostly discuss photocurrent properties of such probes. For one particular type of vitreous carbon (see reference (Mozer et al., 1983b) in (Feuerbacher and Fitton, 1972)) a value for the photocurrent density $I^0ph \sim 2.1$ nA/cm^2 was obtained in (Feuerbacher and Fitton, 1972). From the same laboratory measurement results, but using a different approximation for the spectrum, (which includes more high-energy photons) and a different way of determining the photoemission properties, somewhat smaller value of $I^0ph \sim 1.3$ nA/cm^2 was obtained in (Grard, 1973). Close to these laboratory results is the saturation photocurrent density of the VC spherical probes on GEOS-1 and GEOS-2 satellites determined at the beginning of their operation, and on ISEE-1 satellite (around 3.0 nA/cm^2 and 2.0 nA/cm^2, respectively) (Pedersen et al., 1984). However, many space experiments convincingly demonstrate that photoemission properties of materials in space can significantly differ from those measured in laboratory.

Here are several notable cases. In (Schmidt and Pedersen, 1987) is

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STUDY OF WASTE DISPOSAL THERMAL RADIATION USING SATELLITE DATA AND CONSIDERING SOLAR INFLUENCE

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Keywords: *satellite data, landfills, solar radiation*

Abstract

In the present paper distribution of the waste disposal thermal radiation caused by biochemical processes of decomposition is examined. Using thermal channels of the Landsat 8 (OLI) the waste disposal spectral characteristics are obtained. All this data is compared with solar activity during the same period and differences between internal thermal radiation and solar influences are discussed.

Introduction

With the permanent increasing of human population, a serious problem concerning air and water pollution and also soil contamination arises. This is the problem of waste disposals and its influence on the surrounding environment [1]. These disposals are main source of methane emissions (CH_4), which is one of the greenhouse gases with strong influence on the atmosphere and prerequisite of the greenhouse effect with anthropogenic character. Waste gases are organic products, a result from decomposition of waste in anaerobic conditions. They are composed mainly from methane (CH_4) and carbon dioxide (CO_2) [2].

The areas occupied by waste disposals are rapidly growing, as in some cases they are unregulated. For example in 2012, 481 kg solid waste per single person for the population in European Union is generated [3].

This research focuses on Suhodol waste disposal close to the Bulgarian capital, Sofia. Officially this disposal was formed 30 years ago with purpose of Sofia municipality waste collecting. Its exploitation is achieved in two stages, and the first stage was until 1995.

The main goal of this work is calculating the surface temperature caused by waste internal thermal radiation and determining the places where the temperature is the highest (thermal points). Several time intervals are examined.

In Fig. 1 is shown the location of the waste disposal Suhodol, Sofia. The object is in geographic coordinates 23˚12´03´´ E and 42˚41´26´´ N (WGS 84, UTM 34N).

SOLAR CYCLE BY A LOOK OF HIGH SPEED SOLAR WIND STREAMS VARIATION

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Keywords: *solar activity, high speed solar wind speed, solar wind parameters*

Abstract

In this paper are presented variation of the solar wind parameters during last four solar cycles (21-24) with focus on the high speed solar wind streams (HSS) condition. The averaged values of the parameters for every cycle are calculated and discussed. The results show that Earth is under the HSS influence more than 50% of the total time in each of the last four solar cycles. This fact determines the importance of the studding the behavior of the HSS.

Introduction

High speed solar wind streams (HSS) are one of the solar wind components which originate from unipolar open magnetic field areas known as coronal holes (Tsurutani et al., 1995, 2006). HSS cause relatively weak, but recurrent and long-lasting geomagnetic storms (Borovsky and Denton, 2006). The variations of geomagnetic activity closely follow the variations of the number and intensity of HSS (Richardson et al., 2002) within the solar cycle. Coronal holes are the largest and in most geoeffective position during the sunspot declining phase (Phillips et al., 1995), when the second maximum in the geomagnetic activity is observed. In Fig. 1 is presented an SDO/AIA image (Solar Dynamics Observatory/ Atmospheric Imaging Assembly) of the coronal hole CH869 on 15 June 2018. CH869 have been rotated into an Earth facing position on June 19-21.

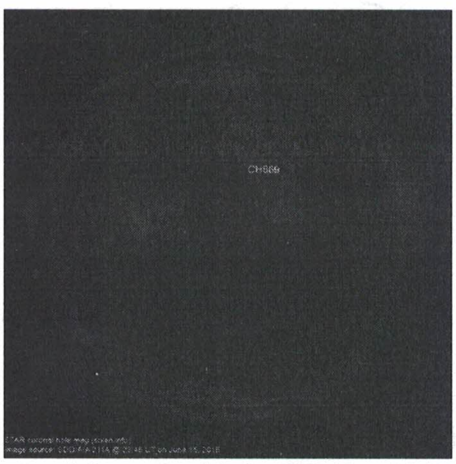

Fig. 1. SDO/AIA image of the coronal hole CH869 at 23:45UT on 15 June 2018 (http://www.solen.info/solar/).

Coronal holes and high speed solar wind streams during 24th solar cycle

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Abstract.

In this work the high speed solar wind streams (HSS) over the 24th solar cycle are examined. 312 HSS events have been determined for the 24th solar cycle and their maximum speed was estimated. The results show that there is no well-defined picks for the maximum solar wind speed, and two picks of HSS count number exists – one during the ascending and the second during the descending phase of the solar cycle.

Key words: High speed solar wind, 24th solar cycle

Introduction

In light of scientific terminology and mostly because of the historical reasons the term "Solar cycle" (SC) is associated with the 11 year sunspot cycle. Since its establishment by Schwabe [*Schwabe*, 1843], sunspot cycle is one of the most usable "tools" for various studies related to the sun and solar-terrestrial physics. Many other processes and phenomena identified on the Sun by humanity have such a long-term cyclicality - sunspot areas, 10.7 cm solar flux, total irradiance, magnetic field, number of coronal mass ejections and flares [*Hathaway*, 2015], coronal holes [*Luhmann, et al.,* 2002], solar wind [*Kojima and Kakinuma,1990; Rickett and Coles,* 1991]. Some of these cause cyclic behavior on different heliospheric and planetary physical processes as geomagnetic activity [*Feynman*, 1982; *Lockwood et al.*, 1999], modulation of cosmic rays [*Parker*, 1965], the structure of the interplanetary magnetic field and heliospheric current sheet [*Svalgaard and Wilcox,1976; Hoeksema,* 1995], the shape of the heliosphere [*Tanaka and Washimi,*1999]. All this listed solar or heliospheric processes have been always compared with the sunspot number.

In the current study, the focus will be on the coronal holes and high speed solar wind streams (HSS) using recent data within 24th solar cycle.

Before its real detection when the existence of the solar wind is a theory, Parker made a suggestion that the properties of the solar wind and in particular solar wind flow depend on the solar activity cycle [*Parker*, 1958]. Several years later series of space probe experiments, as Lunik and Venera and their first detection of flow in the heliosphere [*Gringauz et al.*, 1960], Explorer 10 with the measurements of the solar wind properties close to the Earth's magnetopause [*Bonetti et al.,*1963] and Venus Mariner 2 which detected the variable nature of the solar wind [*Neugebauer and Snyder,*1962] confirmed the Parker's theory and gave a broad field of examination. Up to now our understanding of the solar wind and how it is modulated by solar activity cycle has been rapidly growing.

HSS and recurrent geomagnetic disturbances induced by them are essentially associated with mid latitude coronal holes and thus with solar activity cycle [*Bame et al.,*1976].

Data

312 HSS events have been identified using the hourly values of the plasma parameters gathered in OMNI data base (http://omniweb.gsfc.nasa.gov/) and the criteria for a HSS - an increase of the solar wind velocity by at least 100 km/s in no more than one day to at least 450 km/s for at least five hours along with high proton temperature and low plasma density. Coronal holes data from http://www.solen.info/solar/, provided by SDO/AIA are used as well.

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Results from Langmuir Probe Measurements Aboard the International Space Station

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Abstract.

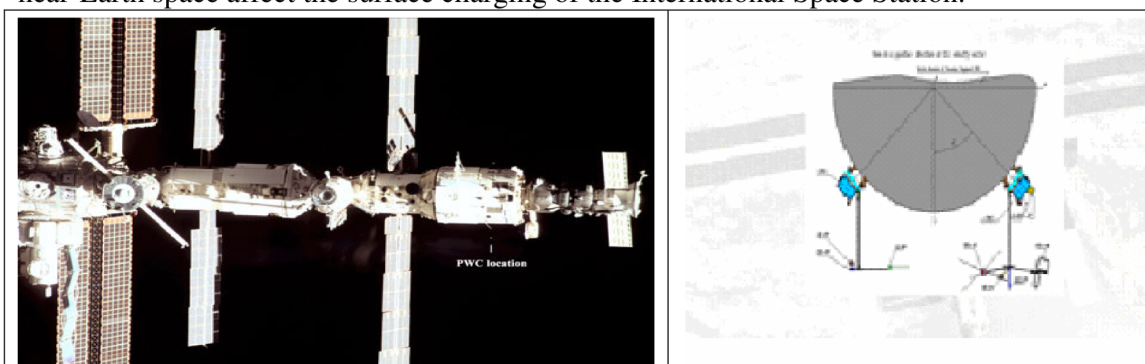
In this paper, the Langmuir probes are described included in "Obstanovka" experiment aboard the International Space Station which has been operating since April 2013. One of the main goals of this experiment is to study the surface charging of super-big objects like the International Space Station.

Introduction

Langmuir probe is a classical instrument for plasma diagnostics, and among the first ones for in situ measurements of thermal plasma in the near-Earth environment. In the last decades, the Langmuir probe is one of the classical instruments for plasma diagnostics [*Mott-Smith and Langmuir*, 1926] and among the first space-borne instruments. Langmuir probes have been successfully used aboard a number of rockets and satellites for in situ measurements of thermal plasma parameters in the terrestrial ionosphere [*Klimov et al.*, 1995], at other planets [*Bogges et al.*, 1959] and comets [*Krehbiel et al.*, 1980; *Grard et al.*, 1989] – e.g. in satellite mission such as Tiros, Explorer, Alouette, ISIS, DMSP, Atmosphere Explorer, Interkosmos, Dynamics Explorer, Kosmos, Interball, Demeter, Astrid, Freja, Kyushu, CHAMP, CRRES, SCATHA, KOREASAT and many others, including several stratosphere rocket launches of the Vertical series, and planetary exploration missions such as Viking (Mars), Cassini (Saturn), Pioneer Venus (Venus), VEGA (Venus and the Comet Halley), etc.

The parameters measured by Langmuir probes are the electron and ion concentrations Ne and Ni, the electron temperature Te, and the satellite body potential Us.

In this paper, the Langmuir probes are described included in "Obstanovka" experiment aboard the International Space Station which has been operating since April 2013. One of the main goals of this experiment is to study the surface charging of super-big objects like the International Space Station. All earlier studies have been conducted for relatively small and homogenous spacecraft, while with the launch and gradual build-up of the International Space Station we face the problems of the interaction of a super-large structure at a low orbit with its environment. For the first time, we have a structure which is not only that large but also so much energy consuming and emitting. Here we demonstrate how the various factors in the near-Earth space affect the surface charging of the International Space Station.



b	a

Fig. 1 (a) location of the PWC modules placed on the outer surface of ISS; (b) cross section of the position of LP1 and LP2on the body of ISS, in the direction of the positive ISS speed vector.

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СРАВНИТЕЛЕН АНАЛИЗ НА ПРОГНОЗИТЕ НАПРАВЕНИ ПРЕЗ 2011- 2012 ОТ ЦЕНТЪРА ЗА ПРОГНОЗИ НА КОСМИЧЕСКО ВРЕМЕ И КОСМИЧЕСКИЯ КЛИМАТ КЪМ ИКИТ-БАН

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Ключови думи: *космическо време, геомагнитна буря, КИМ(Коронарно Изхвърляне на Маса)*

Абстракт: *Направен е анализ на отклоненията между прогнозните и реално измерените стойности на параметрите на космическото време за период от една година. Класифицирани са в три категории прогнозираните параметри и състоянието на космическото време. Различните ситуации, които дава възможност за прогнозиране на космическото време са регистрирани и анализирани от гледна точка на ефективността и последователността на процесите. Основните категории са: 1.) Високо съвпадение между прогнозираните и реализираните параметри; 2.) Ниско съвпадение между прогнозираните и реализираните параметри 3.) Умерено съвпадение между прогнозираните и реализираните параметри. Направена е физическа интерпретация за всичките три категории от класификацията на прогнозите. Оценяването е постигнато по отношение на степента на съвпадение между прогнозираните и измерените параметри на космическото време. Изложени са някои изводи за нивото на ефективност при прогнозирането прилагано в прогнозите. Обсъдени са и системата от параметри използвани при оценка и анализ, които се взимат в предвид при прогноза. Обсъждат се и източниците на данни и модели, които се използват във виртуалното пространство по прогнозиране на космическото време.*
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COMPARATIVE ANALYSIS OF PROJECTIONS IN THE PERIOD 2011 - 2012 BY THE CENTER FOR SPACE WEATHER AND SPACE CLIMATE FORECASTS AT SRIT-BAS

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Keywords: *space weather, geomagnetic storm, CME*

Abstract: *A comparison of the deviations among predicted and measured values of space weather forecasts parameters is made for the period of one year. Three categories of the forecasted parameters and states of space weather are classified. Different situations which are used for possible space weather forecasting are analyzed based on effectiveness and continually. The main three categories are the following: 1) high degree of coincidence between predicted and realized parameters; 2) low degree of coincidence between predicted and realized parameters; 3) moderate degree of coincidence between predicted and realized parameters. Physical explanation of all three classified categories concerning the degree of coincidence between the predicted and the measured space weather parameters is made. Some conclusions for the level of forecasting effectiveness concerning the real methodology of predictions are stated. The complex system of parameters which are taken into account in the outer space is formulated and analyzed. The sources of data and models which are used in the virtual space by prediction of space weather are also discussed.*

Solar Wind Parameters in Periods of Solar Large-Scale Magnetic Field Reversals

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(Submitted on 09.08.2018. Accepted on 07.11.2018)

Abstract. The present paper investigates the behavior of solar wind basic parameters during the large-scale solar magnetic field reversal. Using the superposed epochs method for monthly averaged values of the different solar wind parameters for the last four large-scale magnetic field reversal, it is shown that during the periods of different polarities, some of the parameters as magnetic field B_x and B_y components, as well as B_{scalar} and solar wind speed have seasonal trend. Plasma density and pressure have differences in their magnitude during the different periods.
Key words: Solar wind parameters, Positive and negative polarity

Introduction

Solar Wind (SW) streams, directed away from the Sun, are not uniform. They rapidly change their basic parameters speed V, temperature T, direction and magnitude of the carried magnetic field B, density ρ, pressure P, etc. Studies of the physical processes related to these changes or just observational and statistical comparison between different periods of solar activity, have significant importance for understanding how the solar present state can influence Earth's environment. One of the main factors causing variations and changes of the solar wind parameters is the 11-year solar magnetic field reversal.

Since 1959, when for the first time Babcock (1959) reported that the general magnetic field of the Sun had reversed polarity, numerous observation and theory models have vastly improved our understanding about this phenomenon.

The polarity of the solar magnetic field is directly related to the B_z-component of the interplanetary magnetic field (IMF) (Lyatsky et al., 2003; Youssef et al., 2012) and has influence on the geomagnetic activity (Xu et al., 2009). Also it is important for the cosmic ray drift (Jokipii et al., 1977), as solar cyclic magnetic field modulates the long-term variations of the galactic cosmic rays differential spectrum (Cliver and Ling, 2001; Gushchina et al., 2009). Furthermore, there is a possible link between multi-decadal climate cycles and periodic reversals of solar magnetic field polarity (Miayahara et al., 2008). Based on measurements stored in OMNI data base of the National Space Science Data Center, Kirov et al., (2003) investigate the behavior of the IMF components during negative and positive solar cycles. They show statistically significant difference in the IMF B_x, B_y, B_{long} components in positive and negative polarity solar cycles. Considering the possible relation between the 22-year Earth rotation variation and 22-year periodicity in solar wind parameters, they also suggest that SW mediates the transfer of angular momentum from Sun to Earth.

It is important to note that the unique Ulysses measurements have exposed how the IMF and heliospheric current sheet are influenced by solar cycle variations and magnetic field reversal. Observations of the sector structure

HIGH-SPEED SOLAR WIND STREAMS DURING THE LAST SOLAR CYCLES

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ВЫСОКОСКОРОСТНЫЕ ПОТОКИ СОЛНЕЧНОГО ВЕТРА В ТЕЧЕНИЕ ПОСЛЕДНИХ СОЛНЕЧНЫХ ЦИКЛОВ

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Высокоскоростные потоки солнечного ветра (High Speed Solar Wind Streams, HSS) выявлены как одна из основных причин геомагнитных бурь. После его идентификации в 1962, наше познание об этом проявлении солнечной активности стало более точным. Теперь у нас есть экспериментальные данные о параметрах солнечного ветра в течение последних четырех 11-летних циклов солнечной активности, и мы можем описать поведение HSS за относительно длительный период. Более того, кажется, что настоящий период векового цикла солнечной активности является "переходным" – от экстремально высокой солнечной активности, наблюдаемой в циклах 18–22, до сегодняшнего дня, когда мы наблюдаем чувствительно более низкую солнечную активность (цикл 24). Несколько моделей прогнозируют даже еще более низкую активность в следующих циклах. Имея измерения поведения HSS во время этих двух периодов (высокая и низкая солнечная активность), мы исследуем, как влияет на HSS вековая вариация солнечной активности.

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Introduction

High speed solar wind streams (HSS) and Coronal mass ejections (CME) are recognized as main geomagnetic storm drivers. According [1] HSS are responsible for at least 70% of geomagnetic activity at solar minimum and more than 30% at maximum. HSS are characterized with low speed, temperature and plasma density [2, 3]. They are geoeffective at most during the sunspot declining phase [4], when the second maximum in the geomagnetic activity is observed. Considering the year of identification of HSS (1962), early investigations of the solar cycle evolution of HSS has been presented by [5, 6]. They study variations of HSS during the period 1962–1974 (covering solar cycle 20) with emphasis on the solar wind speed fluctuation, the effect of the temporal evolution of stream structure on long-term averages of the solar wind flow speed, relationship between solar wind stream structure and the interplanetary magnetic field sector polarity. The major conclusion of these studies is that during the solar minimum the most stable streams with the largest amplitude occurred. The Mariner-2, Pioneer-6, 7, Vela and IMP programs are solar wind data sources at the time of solar cycle 20.

VARIATION OF THE SOLAR WIND SPEED IN SOLAR CYCLE 24

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Keywords: *Solar wind parameters, Solar activity, Solar cycle 24*

Abstract: *Solar cycle 24 is characterized with extremely low activity in comparison with Solar cycles 21-23 and probably the most spotless days since Solar cycle 16. Most of the parameters determining solar activity, as 10.7 cm solar radio flux, the polar solar magnetic field, solar total irradiance, etc. reach their lowest values at a minimum between solar cycles 23–24. In this work it is presented variation of the solar wind parameters during the course of Solar cycle 24.*

ВАРИАЦИИ НА СКОРОСТТА НА СЛЪНЧЕВИЯ ВЯТЪР ПО ВРЕМЕ НА 24 СЛЪНЧЕВ ЦИКЪЛ

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Ключови думи: *Параметри на слънчевия вятър, Слънчева активност, 24 Слънчев цикъл*

Резюме: *24 Слънчев цикъл се характеризира с екстремално ниска активност в сравнение с активността на Слънчевите цикли 21–23 и вероятно с най-много дни без слънчеви петна. Повечето от параметрите определящи слънчевата активност, като 10.7 радиоизлъчване, слънчевото полярно магнитно поле, пълната слънчева радиация и др. достигат своите най-ниски стойности по време на минимума между 23 и 24 слънчев цикъл. В настоящата работа са разгледани вариациите на параметрите на слънчевия вятър по време на 24 Слънчев цикъл.*

Introduction

According to the flow properties and mainly to the speed, the solar wind can be decomposed to a three component system: high speed streams (HSS) – with high speed (V > 500 km/s), high proton temperature and low plasma density; slow solar wind – with speed V < 500 km; and streams associated with coronal mass ejections (CME) [1] . The frequency of occurrence and intensity of these three components depends strongly on the phase of the solar activity cycle [2]. HSS and CME are the main types of solar generated drivers that affect Earth. The strong sporadic storms during maximum are caused by CMEs [3,4].

In Fig. 1 are presented the main sources of the different solar wind component. CME originate from active regions (3) with or without filaments or regions of quiescent filaments [5, 6, 7]. HSS are amiitet from coronal holes (2), which are unipolar open magnetic field areas [3, 8, 9]. Coronal holes are the largest and the most geoeffective during the sunspot declining phase [10] (Phillips et al., 1995), when a second maximum in the geomagnetic activity is observed (the first maximum is caused by CME). Streamer belt structures (1) are main source of slow solar wind. In sunspot minimum the solar magnetic field is close to dipolar, almost aligned with the solar rotational axis, and the coronal streamer belt is close to the solar rotational equator. Slow solar wind propagates along the heliospheric current sheet which is the interplanetary projection of the coronal streamer belt separating magnetically the two solar hemispheres. The heliosphere is dominated by fast and much more geoeffective solar wind from super-radially expanding polar coronal holes which dominate during the

HIGH SPEED SOLAR WIND CONTRIBUTION TO THE SOLAR-TERRESTRIAL SYSTEM

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Keywords: *High speed solar wind stream, solar activity*

Abstract: *One of the most sensible drivers of geomagnetic disturbances are high speed solar wind streams (HSS), which have maximum during the descending phase of solar cycle. They are characterized with super-radially expanding from coronal holes. The level of the high speed solar wind streams influence to the geomagnetic field varies from cycle to cycle, and is supposed to be determined by the solar activity and thickness of the heliospheric current sheet which is related to the portions of time that the Earth spends in the slow and fast solar wind domains. Here it is shown the variation of the geomagnetic filed for a relatively long-time periods, when the Earth is under the influence mostly by HSS.*

ПРИНОС НА ВИСОКОСКОРОСТНИТЕ ПОТОЦИ СЛЪНЧЕВ ВЯТЪР КЪМ СЛЪНЧЕВО-ЗЕМНАТА СИСТЕМА

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Ключови думи: *Високоскоростни потоци слънчев вятър, слънчева активност*

Резюме: *Една от най-забележимите причини за наличието на геомагнитни смущения са високоскоростните потоци слънчев вятър, които имат максимална честота на появяване по време на намаляващата фаза на слънчева активност. Те се характеризират със супер-радиално разпространение от слънчевата корона. Нивото на въздействие на потоците бърз слънчев вятър върху геомагнитното поле, варира през различните слънчеви цикли, като се предполага, че това въздействие зависи от слънчевата активност и дебелината на хелиосферния токов слой. Тук е изследвана вариацията на геомагнитното поле за относително дълъг период от време, когато Земята е предимно под влиянието на Високоскоростните потоци слънчев вятър.*

Introduction

Richardson et al. (2000) [1] classified the solar wind into corotating high- speed streams (HSS), slower solar wind, and transient flows associated with CMEs, In order to assess the contribution of each type of solar wind flow to geomagnetic activity during the different phases of the solar activity cycle. They found that, on the average, at solar minimum the Earth is embedded in HSS for ~60% of the time, ~30% for slow solar wind, and ~< 10% for CMEs. Respectively, the average geomagnetic activity at sunspot minimum is dominated by HSS. In a later paper [2] extended the studied period to over 4 solar cycles (1963–2011) and found that the low geomagnetic activity levels during the last solar minimum were associated with low geomagnetic activity averages for each of the three types of solar wind.

The goal of the present paper is to examine the averaged variation of the geomagnetic field (Dst and Kp indexes) during the period of the prolonged HSS influences.

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АНАЛИЗ РАЗВИТИЯ ГЕОМАГНИТНЫХ БУРЬ 8 И 9 ОКТЯБРЯ 2012 ГОДА И ИХ ПРОГНОЗИРОВАНИЯ

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Ключови думи: *космическая погода, прогнозирование, выброс корональной массы, эрупция волокна, корональная дыра, планетарные индексы геомагнитной активности*

Абстракт: *Рассмотрены трехсуточные прогнозы геомагнитных бурь 8 - 9 октября 2012 года Центра прогноза космической погоды и космического климата (ЦПКПКК) при ИКИТ БАН и сделано их сравнение с реальной физической обстановкой в рассматриваемый период. Тогда как буря 8 октября была предсказана ЦПКПКК, то вторая буря оказалась неожиданностью для ЦПКПКК и других прогностических центров в мире. Сделан анализ вероятных причин возникновения существенной разницы между прогнозными и реальными параметрами космической погоды, что полезно для усовершенствования прогнозирования ЦПКПКК после одного года его работы в плане уточнения оценки влияния совокупности разнообразных явлений на Солнце в период максимума его активности.*

ANALYSIS OF THE DEVELOPMENT OF GEOMAGNETIC STORMS ON 8 AND 9 OCTOBER 2012 AND OF THEIR FORECASTING

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Keywords: *space weather, forsecasting, coronal mass ejection, filament eruption, coronal hole, planetary geomagnetic activity indices*

Abstract: *Three-day forecasts of the magnetic storms on October 8 and 9 2012 are considered prepared by the Center of Forecasting of the Space Weather and Space Climate (CFSWSC) in Space Research & Technology Institute of Bulgarian Academy of Sciences. These forecasts are compared with the actual physical state in the considered period of time. While the magnetic storm on 08.10.2012 was perdicted by CFSWSC, the second storm was unexpected for CFSWSC, as well as for the world prognostic centers. An analysis is made of the possible causes for the significant differences between prognostic and actual cosmic weather parameters, which is useful for development of the forecating methods after the first year of work, particularly, for more precise estimation of the influence of different solar phenomena in combination during the solar maximum.*

Введение

За первый год непрерывной работы по подготовлению трехдневных прогнозов Центр прогноза космической погоды и космического климата (ЦПКПКК) при ИКИТ БАН давал в итоге как довольно точные прогнозы, так и прогнозы с умеренным или даже существенным несовпадением с реальной геофизической ситуацией. Прогнозирование базировалось на: 1) Исследование и оценка геоэффективности солнечных событий, самые важные из которых - вспышки, выбросы корональной массы (ВКМ-CME) и эрупции волокон [1,2], а также корональные дыры; 2) Оценка характерстик солнечного ветра у орбиты Земли по измерениям

DETERMINING THE PHOTOELECTRON CURRENT FROM SPACECRAFT SURFACE USING ELECTRIC FIELD SENSORS DATA

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KEYWORDS

photoelectron current, spacecraft, electric field probe, satellite potential, spherical Langmuir probe, bias current, magnetosphere, ionosphere

In this work we consider determining the photocurrent in ionospheric-magnetospheric plasma using data from BULGARIA-1300 and INTERBALL-2 electric field sensors IESP-1 [1] and IESP-2 [2], respectively. The particular interest in the study of the photocurrent and the potential is rooted in the current widespread use of the method due to A. Pedersen for determining the concentration of ambient plasma as a function of the potential – the difference of the potentials between the spacecraft body and the probe (Usp). This method is applicable only when the probe potential is positive, and uses the fact that in this case the balance of currents depends only on the electron current and the photocurrent. Analyzing large collection of satellite data, A. Pedersen and collaborators proposed an empirical model [3] for the connection between the photocurrent density (Jph) and the satellite potential (Vs), which has been used for determining the magnetospheric plasma density from potential measurements. This method has been tested for many satellites.

Instrumentation installed on INTERBALL-2 satellite can be used to determine the photocurrent based on the comparison of the simultaneous potential measurements from the sensor IESP-2 and the electron temperature sensor KM-7 [4]. KM-7 and IESP-2 are structurally identical, since they utilize the same type of probe (spherical Langmuir probe) and measure the same quantity Usp. The probe of KM-7 is protected from UV radiation by a screen. Significant difference between the two sensors is that IESP-2 measures Usp for a fixed bias current (–72 nA / –110 nA) whereas KM-7 records current-voltage characteristics (11 measurements of Usp for different bias current values, from 153 nA to 0.15 nA). Measurements of the potential with KM-7 can be represented as values obtained from 11 virtual sensors of IESP-2 type in a shadow. Comparing the variations of Usp/KM-7 and Usp/IESP-2 allows obtaining the correct value of the bias current when measuring the potential of INTERBALL-2 satellite with respect to the plasma done by IESP-2. Data collected during ~350 orbits for ~800 hours of simultaneous work of IESP-2 and KM-7 in the course of the STO telemetry system at 8000 km altitude was studied. The analysis showed that ~75% of the potential measurements by the IESP-2 give correct values. The comparison between the simultaneous measurements of the potential of the INTERBALL-2 satellite relative to the plasma by the probe instruments IESP-2 and KM-7 permits estimating the density of the photocurrent using the method proposed by Smirnova N. and Stanev G. [5]. This estimate can be used to determine the density of the ambient plasma. Probe instruments IESP-2 and KM-7 were installed independently, but during their work it was established that they can be used as a composite instrument for measuring the parameters of the plasma in the near (2–3 R_E) magnetosphere, which allows to determine the photocurrent and to estimate the validity of the electric field measurements. The prototype of IESP-2 instrument is IESP-1, which was used in the ionosphere. IESP-1 and IESP-2 utilized spherical probes made via