Russian Academy of Sciences

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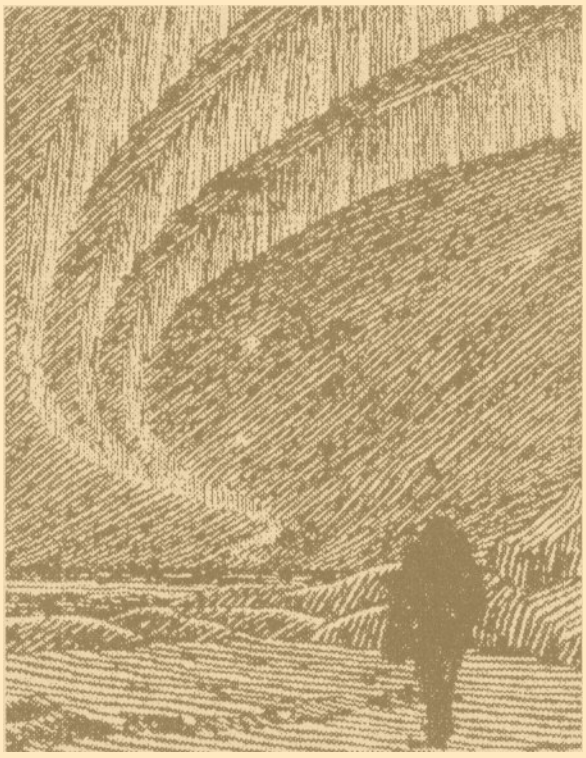
PHYSICS OF AURORAL PHENOMENA

30th Annual Seminar

27 February - 2 March 2007

Abstracts



Apatity

2007

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KOLA SCIENCE CENTER
Polar Geophysical Institute

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CONTENTS

SESSION 1. GEOMAGNETIC STORMS AND SUBSTORMS

SESSION 2. FIELDS, CURRENTS, PARTICLES IN THE MAGNETOSPHERE

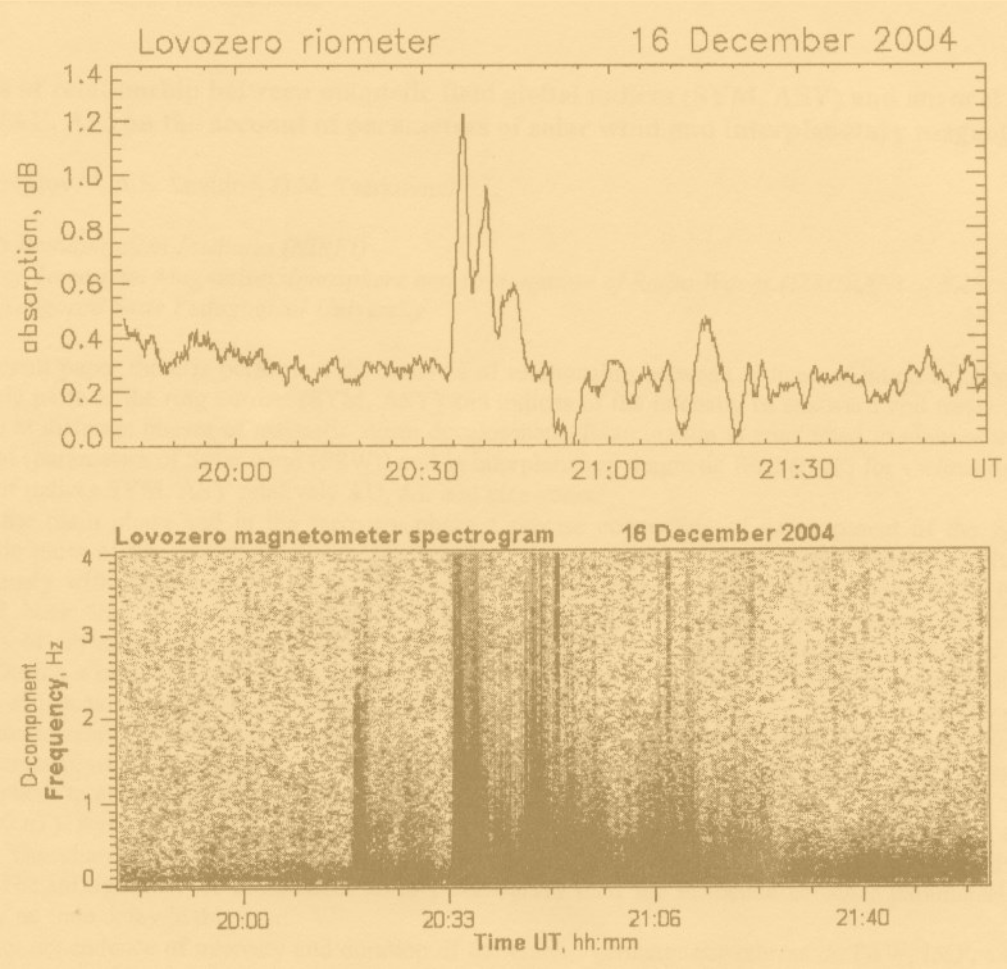
SESSION 3. WAVES, WAVE-PARTICLE INTERACTION

SESSION 4. THE SUN, SOLAR WIND, COSMIC RAYS

SESSION 5. IONOSPHERE AND UPPER ATMOSPHERE

SESSION 6. LOW ATMOSPHERE, OZONE

SESSION 7. HELIOBIOSPHERE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20:30
21:00
21:30
UT
Lovozero magnetometer spectrogram
16 December 2004
D-component
Frequency, Hz
4
3
2
1
0
20:00
20:33
21:06
21:40
Time UT, hh:mm

Topology of high latitude magnetosphere and the main features of auroral phenomena

E.E. Antonova (*Skobeltsyn Institute of Nuclear Physics Moscow State University, Space Research Institute RAS, Moscow, 119992, Russia, antonova@orearm.msk.ru*)

Processes in the plasma sheet are usually considered as a source of the main auroral phenomena including auroral substorms and storms, The reasons leading to the appearance of such point of view are summarized. The results of experimental observations demonstrating the existence of high latitude quasiring plasma structure are analyzed. This plasma structure supports the high latitude continuation of the ring current – cut ring current. The possibility of observation of the picture of upward field-aligned currents using the data of auroral oval observations is discussed. The existence of field-aligned potential drops in the upward current region is taken into account.
It is shown that the results of theoretical analysis of the development of large-scale electrostatic disturbances in the magnetosphere give the possibility to explain the main properties of Region 1 and Region 2 field-aligned currents of Iijima and Potemra. The reasons of the substorm onset on the equatorial boundary of auroral oval and formation of bright thin auroral forms are discussed.

Analysis of relationship between magnetic field global indices (SYM, ASY) and auroral electrojet indices (AU, AL) on the account of parameters of solar wind and interplanetary magnetic field

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In the present paper there is performed the analysis of relationship between indices of intensity of symmetric and asymmetric parts of the ring current (SYM, ASY) and indices of the intensity of eastward and westward electrojets (AU, AL) at different phases of magnetic storm development. Examination is conducted in view of the situation in Solar wind (parameters of Solar wind (PSW)) and in interplanetary magnetic field (IMF) for various time delays (0 - 2 hours) of indices SYM, ASY relatively AU, AL and vice versa.
Thus, in the main phase and in the recovery phase a precise connection of development of the symmetric and asymmetric parts of the ring current with auroral electrojets is found. The intensity of eastward electrojet varies synchronously with indices SYM, ASY. The connection of westward electrojet with index SYM is the highest, when a 2 hour time delay between them is used. The role of magnetosphere-ionospheric current systems in oscillation of asymmetry of magnetic field at the level of ground surface in particular sectors of local time is defined. During a magnetic storm the westward electrojet takes almost whole auroral oval region, and the eastward electrojet displaces from the classical spatial situation (MLT ~ 17 - 22) in a day time. The results of correlation examination of relationship between indices SYM and ASY with PSW and IMF show that the velocity of solar wind and its concentration exert the greatest influence on Dst variation. The average time of response of the magnetosphere to changes of PSW is about 30-40 minutes for geomagnetic storms of high and moderate intensities (Dst <-100 nT). By and Bz IMF has the greatest influence on auroral electrojets during geomagnetic storms of any intensity. The characteristic time of response of the polar magnetosphere to dynamics of By IMF is about 30 minutes. The influence of Bz component takes place earlier than the influence of other parameters, i.e. there is practically no time delay in this case.
The general dependence of intensity and duration of the viewed geomagnetic storms on PSW, IMF, an impulse and dynamic pressure of the solar wind is revealed. The duration of geomagnetic storms correlates with concentration, impulse of pressure of solar wind and Bz IMF. The intensity of storms correlates only with Bz.
The study was carried out under the financial support of the RFBR (grant 06-05-64482).

Appearance of long period oscillations in the magnetosphere during changes of solar wind parameters at magnetic storm of 15 May 2005

V.B. Belakhovsky, V.C. Roldugin (*Polar Geophysical Institute, Apatity, Russia*)

At 02:38 UT shock wave in the solar wind with pressure of 35 nPa and positive impulse in Bz component to 30 nT reaches the Earth and most observatories registered an SSC event. A substorm occurred in the morning and midnight sectors of auroral oval in this moment. At 05:59 UT the value of Bz component drops from +35 nT to -40 nT and strong magnetic disturbances appear in the auroral oval. At 08:45 UT the Bz component changes quickly

from -15 nT to +15 nT and this moment is not accompanied by any disturbances on the Earth, but coincides with the beginning of regular and intensive Pc5 on GOES-12 in azimutal hn component.
The compression of the magnetosphere by shock wave at 02:38 UT produces quasi-periodic oscillations of magnetic field in auroral zone with simultaneously observed two periods of about 8 and 13 minutes; in the polar cap only one period of about 10 minutes is observed. On GOES-10 satellite, which is located in the evening sector, there are oscillations with a period of about 13 min in south-north hp component.
With the appearance of negative Bz the magnetic field near GOES10&12 stretches into the tail, since he component prevails over the others. Insensitive oscillations with a period of about 10 minutes in the auroral zone in the evening and night sectors are observed; in the polar cap any insensitive short period oscillations are absent. On both GOES-10 and GOES-12 the intensive oscillations with two periods 7 and 15 minutes are observed in azimutal hn component; in sunward he component the period on the satellites was equal to 9-10 min. The satellites were situated near midnight at this time.
The regular pulsations with a period of 7.5 min, which appeared on GOES-12 on 3.6 MLT at the moment of the Bz positive jump, arc accompanied by similar pulsations at ground-based observatories near the satellite magnetic field line. However, pulsations at the ground-based observatories begin earlier, so we have no reason to connect them with the positive step of Bz component.
There was no correlation between magnetic pulsations observed from GOES-10&12 and ground-based stations with variations in all IMF components on the WIND spacecraft. So we think that in all three above examined intervals oscillations have inner- magnetosphere origin, and at least the first and second ones may be caused by flapping waves in the magnetotail.

Direct penetration of polar electric field to the equator during a magnetic storm

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[2]*Institute of Geology and Geophysics, Beijing, China*

The dynamics of low-latitude geomagnetic disturbances during the magnetic storm on November 9-10, 2004 has been studied using the data of the Chinese meridional station chain depending on the location of the auroral western electrojet. It is shown that the character of temporal variations of low-latitude geomagnetic disturbances at the meridian of western electrojet intensity maximum essentially depends on the L-parameter. It is apparently associated with the penetration of the disturbance electric field into low latitudes.
This study was supported by RFBR grant № 06-05-96118, NSFC grant № 06-1000013-8823 and partially by the program of the Presidium of RAS no. 16, p.3.

The influence of high-speed solar wind streams on the auroral bulge parameters and parameters of the substorm westward electrojet

I.V. Despirak, B.V. Kozelov, A.A. Lubchich (*Polar Geophysical Institute, Apatity, Russia*)

Solar wind parameters determine the energy input into the magnetosphere, a part of this energy dissipates during magnetospheric substorms. It is known that substorm expansion from the auroral zone up to very high latitudes is possible under high speed (V) of the solar wind and southward component of the interplanetary magnetic field (Bs). However, the high-speed solar wind streams, depending on the periods of solar activity, have different nature. There may be recurrent streams from coronal magnetic holes and flare streams connected with coronal mass ejections (CME). This study is dedicated to the investigation of the influence Of different high-speed solar wind streams on the auroral bulge parameters and parameters of the substorm westward electrojet. For this purpose, the data from the IMAGE magnetometer network have been compared with the data from the Wind and Polar satellites. Solar wind parameters were taken from the Wind spacecraft observations and the auroral bulge parameters were obtained by the Ultra Violet Imager onboard the Polar, the characteristics of the substorm westward electrojet were derived from the observations of the ground-based stations of the IMAGE magnetometer network.
We investigate the influence of solar wind parameters (V and Bs) during CME and recurrent high-speed streams on characteristics both of the auroral bulge- poleward propagation of auroras, longitudinal and latitudinal dimensions of the auroral bulge- and of the substorm westward electrojet- position of the center of electrojet (that is, the locaton of the region of maximal westward current) and poleward boundary of the westward electrojet. The difference in the behaviour of substorm parameters during CME and recurrent high-speed streams are discussed.

Simulation of the onset of magnetic reconnection in the Earth's magnetotail

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Magnetic reconnection is believed to trigger substorms and bursty bulk flows in the Earth's magnetosphere. However, the underlying problem of the onset of reconnection in collisionless plasma is not fully solved yet: the presence of the finite normal magnetic field, which is typical for substorm growth phase, magnetizes electrons and, hence, virtually stabilizes the current sheet, inhibiting fast reconnection. The recent findings in the linear stability theory suggest the important role played in the onset mechanism by the population of electrons that are not trapped inside the tail current sheets. Simulation of such passing electrons requires kinetic treatment of particles and implementation of open boundary conditions. This paper is a report on the results of the reconnection onset simulations in the magnetotail using the particle code P3D [Zeiler, 2002] with open boundary conditions. The initial geometry is similar to that of the GEM Reconnection Challenge [Birn et al., 2001]. The bursts of spontaneous reconnection and plasmoid formation are observed in the outflow regions, which resemble the onsets of reconnection in the magnetotail.

High-latitude electrojets, auroral oval and auroral particles precipitation

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The evolution of our understanding of sources and time-space dynamics of the high-latitude magnetic disturbances is briefly presented. There are considered: i) electrojets at latitudes of aurora zone due to fluxes of solar charged particles moving directly from the Sun (the Birkeland concept) or from the boundary of the forbidden region (Alfvén analysis) to the upper atmosphere along the dipolar field lines; ii) the so-called SD (according to Chapman) current system in the ionosphere including the eastward and westward electrojets (EE and WE) at latitudes of auroral zone; iii) magnetic field variations monitored by the chain of magnetic observatories in Scandinavia (the Harang effect) with the EE and WE discontinuities at latitudes of auroral zone ; iv) dynamo theory of magnetic disturbances in the ionosphere as presented by Nagata, Fukushima; v) magnetic disturbances attributed to corpuscular precipitations and the resulting morning maximum of geomagnetic activity along a spiral introduced by Nikolski; vi) auroral electrojet models considering the WE along the auroral oval as considered by Akasofu, Chapman, Meng and Feldstein, Zaitsev; vii) the polar electrojet in the cusp region controlled by the interplanetary magnetic field By component as analyzed by Friis-Christensen, Lassen, Wilhjelm, Wilcox and Sumaruk, Feldstein.
Location of electrojets is determined here based on latitudinal variations of H and Z components of the geomagnetic field at three meridian chains of magnetic observatories. It is compared with the statistical data on auroral oval location and boundaries of precipitation regions structure of auroral energy electrons at the ionosphere height during the corresponding level of disturbances. Electron and ion spectrograms, magnetic field variations and plasma drift measurements on board DMSP F13 and DMSP F14 satellites, when they intersect high-latitude regions at dusk, noon and dawn hours, are used for determination of types of precipitating particle fluxes, their boundaries, location of flowing in the ionosphere and out of the ionosphere field-aligned currents, location of polarisation jet. All these geophysical phenomena are discussed in their connection with electrojets location and dynamics during the varying level of disturbances. The observation results are compared with EE and WE models with one-vortex and two-vortex system of ionospheric currents.
These studies are supported by RFBR grant 06-05-64374 and Program №16 of RAS Presidium (V. Vorobjev) and grant SAS (A. Prigancova). The collaboration between IZMIRAN and the Royal Institute of Technology was supported by the Royal Swedish Academy.

Magnetic reconnection: How the outflow regions are affected by plasma properties

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The complexity of magnetic reconnection can only be understood in a proper manner, if an adequate combination of theoretical calculations, numerical simulations and observational investigations can be achieved. Therefore, we present a comparison of theoretical aspects of reconnection with a numerical simulation. In the time-dependent Petschek model of magnetic reconnection the accelerated plasma leaves the reconnection site in enclosed regions, bounded by shocks – the outflow regions. During their propagation these regions can be seen as travelling manifestations of the reconnection process, leading to several disturbances in the surrounding medium. The behavior of the outflow regions underlies several assumptions concerning the surrounding plasma. Velocity, extension and shape of the outflow regions are determined by the medium. Theoretical calculations are restricted by certain idealizing assumptions. We compare the effects of these assumptions on the behavior of the outflow regions with results from a numerical simulation.

The ULF (f=1-6 mHz) wave signature of the super strong magnetic storm recovery phase

N.G. Kleimenova, O.V. Kozyreva (*Institute of the Earth Physics RAS, Moscow, Russia*)

A magnetic storm recovery phase starts with the northward IMF Bz turning and the beginning of the ring current decay. Hereby we discuss the properties of typical ULF (f=1-6 mHz) pulsations in the storm recovery phase. Six severe magnetic storms in 2000-2004 with Dstmin< -300 nT are selected for the analysis. It is found that the ULF wave signatures of different storms are different. However, all magnetic storms under consideration demonstrate the morning and daytime enhancement of the Pc5 range geomagnetic pulsations with the large amplitudes up to 500-600 nT. The pulsations are observed in the wide latitude area, sometimes even on the global scale. Very often the beginning of Pc5 pulsations is accompanied by a substorm onset in the evening sector. As this takes place, these morning Pc5 pulsations are accompanied by the night-evening irregular Pi3 type pulsations within a similar frequency range, but with different spectral distribution. The major part of the morning-daytime Pc5 pulsations has quasi-monochromatic spectra with one or two spectral peaks. Usually, at least one of the spectral maxima is latitude independent. The main behavior of these geomagnetic pulsations do not coincide with that expected from the field line resonance model. It is found that a possible trigger starting the ULF generation is an impulsive increase of the solar wind dynamic pressure or transients in the IMF. Only a small part of the observed Pc5 pulsations can be attributed to the field line resonances (FLR). A number of problems still remain unsolved: for instance, why the morning Pc5 pulsations are typical only for a storm recovery phase; what role the ULF wave generation can play in the dissipation of the energy, which is loaded in the inner magnetosphere during the main phase of the magnetic storm.
This study was supported by RFBR grant 05-05-64495 and partly by RAS Program No 16.

Numerical modeling of global reaction of ionosphere to magnetospheric substorm

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Model studies of the global substorm effects in the Earth's ionosphere both taking into account and neglecting particle precipitation are carried out. The substorm starts at 00 UT and lasts for 4 hours. The calculations were performed for equinoctial condition in the solar activity minimum on the basis of Global Self-consistent Model of the Thermosphere, Ionosphere, and Protonosphere (GSM TIP), designed in the WD IZMIRAN, including the use of the new block of electric field calculation in the Earth's ionosphere.
It is shown that taking into account particle precipitation in the auroral zone brings about the global change of substorm effects in the ionosphere. So, at the substorm beginning unless taking into account particle precipitation the positive (negative) disturbances in the F-region of the ionosphere appear in the morning (near-midnight) sector

of the local time. At that, in the latitudinal course of the positive (negative) disturbances three maximums are formed – in auroral zones and at geomagnetic equator. In the polar caps the positive (negative) disturbances appear in the near-midnight and pre-sunrise (morning and daily) hours. At the same time the negative perturbations stretch through the auroral zones to the geomagnetic equator, forming three maximums in the latitudinal course of perturbation – in the polar caps and on noonday meridian at geomagnetic equator. At subauroral latitudes the positive ionospheric perturbations appear in pre-midnight hours with maximums on geomagnetic latitudes ±60° and at geomagnetic equator.

Taking into account the particle precipitation brings about strengthening of positive perturbations in the pre-midnight hours, a little strengthening of the negative effect in the post-midnight hours and weakening of the negative effect at noon and reduces the formation of negative (positive) disturbance regions in auroral zones instead of positive (negative) disturbances. The perturbations in the polar caps weaken.

At a later time taking into account particle precipitation brings about significant strengthening of the positive perturbations on the morning meridian at all latitudes. Besides, the area of the region occupied by negative disturbances decreases. Then, these positive perturbations at mid-latitudes practically disappear and remain at geomagnetic equator only. Henceforth, the area of the negative perturbation regions is the least and positive disturbances in the north polar cap are much stronger without taking into account particle precipitation. The maximum of the positive disturbances at geomagnetic equator is shifted from the morning sector to post-sunset. During 4 hours after the substorm ending the regions with rather strong disturbances remain in the night sector of auroral zones and geomagnetic equator.

Thereby, it is shown that particle precipitation exerts the powerful influence on the global distribution of substorm effects. Upon substorm completion the ionospheric disturbances remain still for a long period which is due to the disturbance dynamo field in the ionosphere.

Auroral zone breakup localization on Barentsburg TV camera data

I. A. Kornilov (*Polar Geophysical Institute, Apatity, Russia*. kornilov@pgi.kolasc.net.ru)

A well-known phenomenon is the so called flame aurora, when the upward moving wave of luminosity can be detected in the brightening auroral arc. This wave is an optical manifestation of precipitating electrons velocity dispersion, i.e. movement from the region of injection of more energetic electrons reaching the ionosphere first. Measuring time delays of the arc brightness at different heights (and so for the different electron energies), it is possible to localize the place of electrons injection inside the magnetosphere. This method can be applied for Barentsburg TV data (camera can see the vertical structure of aurora in the northern region of auroral oval near the southern horizon of the field of view). An efficient procedure was developed to reveal and measure this very weak and hardly detectable effect, and the initial results are presented.

Zooming of auroral breakup portrait

T. A. Kornilova, I. A. Kornilov (*Polar Geophysical Institute, Apatity, Russia*. kornilov@pgi.kolasc.net.ru)

Fine spatial and temporal details of aurora in the region of breakup development several minutes before the expansion phase were investigated by auroral zone TV camera data. Weak auroral structures drifting towards the place of future breakup from other active regions of the oval, and very likely initiating breakup, were revealed. Some physical parameters of those structures, such as the size, speed of motion, etc., as well as those of the pre-breakup arc, were measured. An important difference in the development of pseudo and moderate breakups, and breakups occurring during strong geophysical activity and occupying the major part of the oval were discovered. Our investigation shows that the pseudo and ordinary breakups develop from an equatorward drifting pre-breakup quiet arc. In contrast, the breakup occurring during a prolonged disturbed period emerges from the breakup arc which is condensed from E-W extended pulsating aurora structures. The features of auroral development a few minutes after the breakup onset are considered.

Relative order of auroral structure during substorm activation

B.V. Kozelov (*Polar Geophysical Institute, Apatity, Murmansk region, 194209 Russia*)

During the last decade the complexity in magnetosphere-ionosphere plasma has been widely discussed in many papers. The most popular approaches are based on the turbulence or/and self-organized criticality paradigms. However, there is no clear evidence that the dynamics during the discussed events is really organization, but not disorganization. The problem is that the magnetosphere-ionosphere system is an open non-equilibrium system, therefore classical thermodynamics is not directly applied to it. Hereby we use an approach based on the S-theorem by Yu.L. Klimontovich. This approach allows us to compare the ordering, which characterizes the current (non equilibrium) state of the system by experimental data. The considered characteristic is an analogy of entropy, which was extended to non equilibrium states. TV observations of the auroral structure during substorm activation at the Barentsburg observatory (Svalbard) have been used as a data set. Dependence of the ordering on the spatial scale has been analyzed. We have found that the ordering of the aurora increases during the substorm activation.

Long period pulsations of the initial phase of the strong magnetic storm on May 15, 2005

O. Kozyreva, N. Kleimenova (*Institute of the Earth Physics, Russian Academy of Sciences, Moscow, Russia*)

We analyze the geomagnetic disturbances observed on the Earth's surface during the initial phase of Strong magnetic storms such as on May 15, 2005. The ground-based geomagnetic data, collected from 158 magnetic observatories over the world, are used for the analysis. The initial phase of this storm is characterized by the strong solar wind dynamic pressure and very intense fluctuations of the interplanetary magnetic field (IMF). It is shown, that the strong substorm (up to ~1000 nT), developing during the storm initial phase in the very large longitude area: from evening to morning local geomagnetic time sectors. The magnetic bay, increasing in the amplitude, rapidly propagates to the polar cap latitudes up to the geomagnetic pole. The global spatial-temporal dynamics of the geomagnetic pulsations in the 1-6 mHz frequencies range shows that the most intensive fluctuations were observed in the morning sector in the region of equivalent ionospheric current maximum, on the latitudes of the order of 72-76°.
The wavelet structure of the magnetic pulsations in the polar cap and of fluctuations in IMF is very similar with the maximum at frequencies lower 4 mHz. This fact suggests the possibility of the wave penetration from the solar wind.
We compare this storm with another strong storms such as November 7-11, 2004, July 15-17, 2000, produced by the passage of the interplanetary magnetic cloud to the Earth’s magnetosphere. It is assumed that the geomagnetic pulsations in the polar cap are mainly generated by the penetration and nonlinear transformation of fluctuations in the corresponding periods in the IMF and solar wind in the sheath region of an interplanetary magnetic cloud.
This study was supported by the Grant №05-05-64495 of Russian Foundation for Basic Research

Comparative study of the auroral breakup and pseudobreakup by CRRES particle measurements

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Pseudobreakup and normally developed substorm were registered within one hour interval on January 24, 1991 by ground-based magnetometers and particle detectors on board CRRES satellite. The comparison of the observations allows to propose some suggestions as to why pseudobreakup did not develop into an active substorm. We found that field aligned electron flux was smaller and effective energy was lower than during the substorm activations. Also the proton enhancement was smaller in intensity and was restricted only by soft spectral energy region as compared with regular breakup. IMS Bz component during and after the pseudobreakup remains southward and therefore possibly enhanced convective electric field may suppress the expansion phase.

Thinning and stretching of the magnetotail's plasma sheet

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[3]*Imperial college, UK*
[4]*CESR, France*

With Cluster observations in the magnetotail we study the dynamics of plasma sheet thinning and stretching during 39 intervals. The cross-tail current density generally scales J0 ~ Tp/Bz, but with frequent transient variations. Typical pre-onset values are Bz ~ 1-2 nT , J0 ~ 4-8 nA/m2, thickness >3000 km. The current density increase on average is not accompanied with a corresponding number density increase. About 30% of events are characterized by the large (>5 nT) guide field component, implying adiabatic particle dynamics even with small Bz. Most of local onsets, associated with ends of our thin sheet intervals, were with tailward flows. In some cases the embedded current sheet structure was detected and, therefore, the estimation of thickness requires some caution.

Sources of Ap-index seasonal periodicity

A.A. Petrukovich, M.Yu.Zakharov (*Space Research Institute, Moscow, Russia*)

The seasonal periodicity of geomagnetic activity and Ap-index in particular is a well known phenomenon, addressed to by many publications. Its suggested sources include axial hypothesis (basically, heliospheric factor), Russell-McPherron effect (GSE-GSM IMF transformation) and equinoctial hypothesis (basically, magnetospheric/ionospheric response factor). The previous analyses were based on the index data only, not including solar wind observations. In our investigation we express Ap-index as a function of solar wind and IMF and determine that the seasonal periodicity in Ap-index on average (1963-2000) consists of 56% of magnetospheric response, 29% of heliospheric factor, 7% of R-M effect and 8% is due to non-linear terms. We present the details of the method and discuss implications for continuation of analysis and identification of particular sources of heliospheric and magnetospheric influence.

THEMIS - the first multiple wide-coverage spacecraft project to address the magnetotail plasma dynamics

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We present information concerning the organization, instruments and scientific data, and examples of scientific goals of the forthcoming THEMIS project, which opens a new era for detailed multiple-spacecraft studies of magnetospheric dynamics with meso-scale and large-scale coverage of the magnetosphere. The potential area of the most effective research using THEMIS includes (among others) the substorm onset mechanism and plasma sheet BBFs, dynamic tail configurations and plasma pressure distributions, morphology and mechanisms of particle acceleration and loss in the radiation belt, magnetopause processes, solar wind triggers and transformations during the propagation of plasma parcels from solar wind through magnetosheath and magnetopause. This is where many important hypotheses could be observationally tested and where a wide scientific community can contribute. The presentation goal is also to help the Russian researchers to be easily included and use effectively the possibilities provided by this new exciting project.

Standard magnetosphere models tuning for THEMIS project

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Empirical magnetosphere (magnetic field) models, which have been constructed based on billions of in situ spacecraft measurements, have the well-known caveats: they represent mostly average magnetosphere conditions, and heavily depend on solar wind parameters used as input. The errors of field representation and mapping are difficult to evaluate. We propose and realize another approach of tuning the standard data-based magnetosphere models (Tsyganenko's T96 and T01) by fitting them to real observations of many spacecraft covering the mid-tail region which are expected during THEMIS project. We also evaluate the errors in the mapping obtained with this modeling approach. The main idea of our approach is to base the model selection on the observed magnetic fields, rather than base the choice on the solar wind information. To test the tuning algorithm and estimate the mapping error we constructed and modeled an artificial event. We used one standard model (T01) to calculate the "simulated data", and then fit another standard model (T96) to the simulated data. (We emphasize, that although both T01 and T96 are both empirical models, they use different functions and had been obtained from different data sets, with different application domains). Then we traced the spacecraft locations along the model field lines with one hour time increment to the Earth surface using both initial (T01) and tuned T96 models and compared the results to get the mapping uncertainties.

The polar cap magnetic activity (PC index) as an indicator of the current state of the magnetosphere

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The PC index estimates the polar cap magnetic activity generated by the solar wind and the embedded magnetic field. The unification of the calculation procedure for the indices derived on the basis of magnetic data from Thule (PCN) and Vostok (PCS) stations [Troshichev et al., JGR, 11 1, A05208] made it possible to obtain the unified PCS and PCN indices, which are well consistent with one another in their value and behavior and linearly correlate with the geoeffective interplanetary electric field (Em). Being proportional to Em the PC index can be regarded as a measure of the electric field impacting the magnetosphere. PC responds to changes in the impacting Em with mean delay time of about 20 minutes. If the solar wind dynamic pressure pulse simultaneously impinges the magnetosphere the delay time reduces up to few minutes.
The relations of the polar cap magnetic activity (characterized by the unified PC indices) to magnetic disturbances in the auroral zone (AE/AL/AU indices) has been examined for both isolated magnetic disturbances and periodical substorms. The statistical analysis of sudden auroral magnetic disturbances occurring on the background of the quiescent magnetic field showed that the sudden onset is preceded by the growth of the PC index at the foregoing growth phase (during hour previous to substorm onset. The PC index in the summer polar cap (the summer PC) turned out to be growing much faster than that in the winter polar cap and reached, by time of the sudden onset, a higher value than the winter PC index, irrespective of the disturbance intensity. After the sudden onset (during the expansion phase) the summer PC index changes little (or even decreases in cases of long substorms), contrary to the winter PC index that changes in conformity with the course of the magnetic substorm. The results give evidence that the summer PC index, being mostly affected by the geoeffective interplanetary electric field, is not responding to the auroral disturbances. The periodical (sawtooth) substorms represent a good illustration of linkage between the incoming energy and the substorm intensity in cases of long impact of a geo-effective solar wind. Substorms occur if the growing PC index exceeds a value of ~ 2 mV/m during tens of minutes. The substorm onsets follow the PC enhancement with a delay in the range of 15 - 60 minutes, if the PC index remains less 4 mV/m. With further increase of the PC index the average delay time is shortened and can drop to zero, if the PC value exceeds 6-8 mV/m. A decrease of the PC index to a level lower than 2 mV/m is definitely followed by a substorm decay. The observation that the substorm onsets followed the PC index variations, no matter whether the IMF is continuously southward or fluctuating, is indicative of an intrinsic cycle time of 2-3 hours typical of the solar wind-magnetosphere coupling.
Thus, the PC index demonstrates two important peculiarities: Firstly, the index adequately responds to geoeffective changes in the solar wind parameters, and therefore it can be regarded as a characteristic of the solar wind energy transferred into the magnetosphere. Secondly, the PC enhancement anticipates the substorm development, the substorm intensity being dependent on the preceding PC level. In such a manner, the PC index can be used as a reliable tool for the magnetosphere current state diagnosis.

Electron precipitation power during a substorm: DMSP spacecraft empirical model and comparison with the results of Polar UVI observations

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An energetic model of auroral precipitation during a substorm is presented. This model is based on statistical treatment of precipitation characteristics obtained with DMSP F6 and F7 spacecraft. Auroral boundary positions and average electron precipitation flux in different regions were used to calculate the precipitation power during all substorm phases. Mathematical formulas which allow calculating auroral precipitation power during all substorm phases depending on the magnetic activity expressed by the AL index value are shown. The comparison of our results with the auroral precipitation power computed by other methods including the Polar ultraviolet imager (UVI) observations was made.
This study is supported by the RFBR grants 06-05-64374 and Program №16 of RAS Presidium.

Dynamics of localized precipitation of energetic protons during geomagnetic storms

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Localized precipitation of energetic protons (LPEP) observed by low-orbiting satellites has been found to be a counterpart of magnetospheric EMIC waves observed on the ground as pulsations of the Pc1 frequency range (Yahnina et al., 2003). In this paper the LPEP dynamics during geomagnetic storms is described. Six storms occurred in 2003-2005 are selected using a criterion of "classical" variation of Dst-index representing a fast decrease (the main phase) and a slow increase (the recovery phase) of Dst. Observations of LPEPs are provided with NOAA satellites (three-to-four satellites were in orbit during each storm providing a good MLT coverage). The MLT and latitudinal LPEP locations are considered during both main and recovery phases. During main and early recovery phase the LPEPs are detected in the evening sector, and then, one-two days after the time of Dst minimum, they occur on the day and morning side. The latitude of the LPEP increases during the recovery phase. During the main phase the intensity of the precipitating flux in LPEP is much larger than during the recovery phase. These and some other properties of the LPEP dynamics revealed from this study agree with known properties of Pc1/EMIC waves registered during geomagnetic storms.
This study was supported by the RFBR grant 05-05-64214 and by research program of the Presidium of RAS No16 (part 3) “Solar activity and physical processes in the Sun-Earth system”.

Впечатления и рассуждения по поводу виртуальной интернет-конференции, посвященной утренним спиралям и вечерним пальцам полярных сияний

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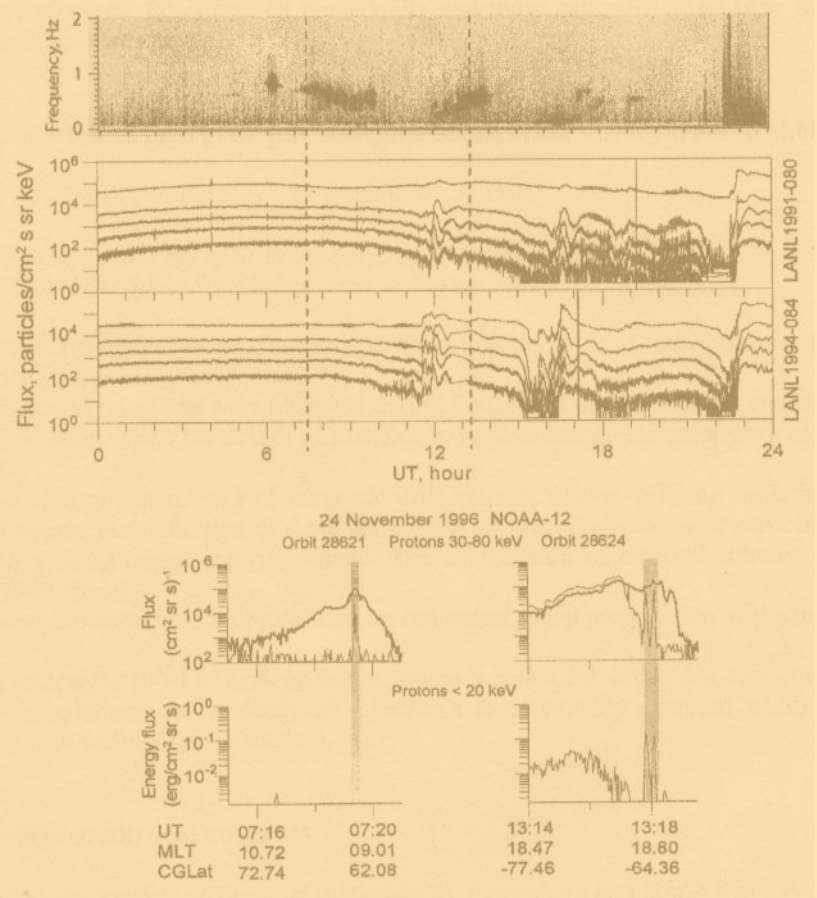
Первая интернет-конференция, проведенная сотрудниками Университета Джонса Хопкинса в ноябре 2006г. привлекла неожиданно большое число участников. Лишь некоторые
из участников ограничились в своих презентациях ответом на поставленные вопросы, многие представили свои соображения по поводу общих проблем магнитных бурь, суббурь, возмущений на Солнце и в солнечном ветре.
Поскольку виртуальные конференции обещают стать распространенным способом научного общения, имеет смысл поделиться впечатлениями о прошедшем мероприятии и его научных результатах.


Frequency, Hz
Flux, particles/cm² s sr keV
LANL1991-080
LANL1994-084
UT, hour
24 November 1996 NOAA-12
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Flux (cm² sr s)⁻¹
Protons < 20 keV
Energy flux (erg/cm² sr s)
UT 07:16 07:20 13:14 13:18
MLT 10.72 09.01 18.47 18.80
CGLat 72.74 62.08 -77.46 -64.36

Estimation of reconnection magnetic flux from variation of plasma velocity obtained in numerical simulation of reconnection process

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Magnetic reconnection observed at the magnetopause and in the magnetotail plays an important role in the dynamics of the Earth's magnetosphere.
The problem is to estimate key parameters of reconnection, such as reconnected magnetic flux.
We propose hereby a method of evaluating the reconnected flux using variation of plasma velocity produced by reconnection in the inflow region. Unfortunately, plasma velocity is hard to measure in the magnetotail due to the very low density in the lobes.
To test the method we use data obtained by numerical simulations of reconnection.
It was shown analytically that the time integral of normal component of the plasma velocity Vz is proportional to the reconnected flux.
Comparison of magnetic flux obtained numerically and those estimated from time integral shows a rather good coincidence with accuracy of 10%.

Radial propagation of energetic particles injections from observation of their drift dispersion

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We investigate the propagation of energetic particles injection's front into the inner magnetosphere observed by CLUSTER satellite system.
The energy dispersed injections were observed during a substorm of 23 Feb 2004 at about 03:20 UT at perigee, near the midnight meridian. The time delays of particles in various energy channels were calculated using the data from four spacecraft.
A well known energy dependence of magnetic drift velocity allows defining times and locations of the drifting particles start points. For definition of these parameters we trace trajectories of particles in the magnetic field back in time in the guiding center approximation. The contribution of external sources is taken into account using Tsyganenko 1989 model.
Comparing measurements from four satellites we can assess radial propagation of the injection's front and define its speed.
The obtained velocity is 100-130 km/s on 8-9Re, which is consistent with a few former estimations.
These results supplement the tendency of injection’s front velocity decrease while approaching the Earth and confirms optimistic outlook for the method.

Spectral studies of auroral currents

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The keograms obtained by the digital all-sky cameras of the MIRACLE instrument network are used to select the events, where the latitudinal positions of the discrete auroras are quasi-stable for hours. The one-minute magnetometer data obtained by the meridional chain of observational stations of the IMAGE network are used for the spectral analysis applied to the differences between the signals of neighboring stations. The magnetic-difference data are employed to extract the signals of local (ionospheric) currents and to eliminate the contributions of distant sources. The numerical filtering via the typical spectral windows usually used in the spectral analysis of time series reveals the equidistant spectra in the range of ten-minute periods. The main features as well as the probable origins of the spectra obtained are discussed.
The author is grateful to the Finnish Meteorological Institute and other participants maintaining the MIRACLE network for the ASC and magnetometer data granted.
This study was supported by the RFBR grant 07-05-00104.

Ionospheric contribution in the formation of the polarization jet

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The ionospheric participation in the formation of the polarization jets (PJ), which are intense westward plasma drifts (with the velocities ranging from about 1 km/s to 4-5 km/s at the altitudes of plasma magnetization) localized within narrow latitudinal intervals ranging from less than 1 to 2-3 degrees and situated almost at the equatorward edge of the diffuse aurora during the evening and pre-midnight hours of the magnetic local time, is analyzed. The polarization jets are also well known as subauroral ion drifts (SAID) and subauroral electric fields (SAEF). Our analysis employs the numerical solutions of the differential equations for the electric field and for the ionospheric plasma with the given flux of precipitating auroral electrons and given effective magnetospheric conductivity. The earthward displacement of the plasma sheet that is modeled by changes in the effective conductivity provides a westward drift located at subauroral latitudes during the evening and pre-midnight hours, but the maximum drift velocity is lower than 1 km/s, if the ionospheric Pedersen conductivity Ep remains unchanged. During the evening and pre-midnight hours, the field-aligned currents flow downward into the ionosphere. These currents reduce Σ_p and provide an additional increase in the plasma drift velocity, which reaches the typical PJ values. It is found that the efficiency of this mechanism depends on the illuminance in the conjugate ionospheres. Therefore, the polarization drifts are most probable at equinoxes. The results obtained are compared with the experimental data and with the earlier theoretical PJ studies.
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Cross-tail velocity component in the Bursty Bulk Flows

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Fast plasma flows in the magnetotail plasma sheet (so-called Bursty Bulk Flows - BBFs) play a key role in the magnetospheric transfer processes. According to theoretical considerations the BBF velocity direction in the plasma sheet should coincide with the tail axis. In fact, a substantial cross tail velocity component is observed inside the plasma sheet.
We have studied space occurrence of large Vy events at downtail distances more than 10 Re and their relation to BBFs using Geotail magnetic field and plasma data. We have found out:

- The great majority of the magnetospheric plasma sheet fast flows have Vy-component, quite comparable with the corresponding Vx-component. The ratio $|Vy_{max}/Vx_{max}|$ of maximal Vx and Vy values, averaged by all events, is about 0.45.
- In the great majority of events the Vy sign changes during the BBF passage so that the Vy maximum (minimum) is achieved just before or after the BBF front, whereas the subsequent minimum (maximum) is observed nearer to the rear part of the fast flow. So Vy changes in the same way as in the vortex plasma current. Such plasma vortices in the surrounding plasma are predicted by the theory.
- The Vy extreme values are often observed deep inside the BBF, which contradicts the theoretical conception. Such situation took place in more than 50% of events. It may be due to the interaction of flows with different velocity values in the succession of events.

Thus, we conclude that large cross-tail velocity values in the plasma sheet result from BBFs interaction with the background plasma or with each other.

The guide component of magnetic field in flapping current sheet

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CLUSTER observations of the flapping current sheet revealed the presence of a strong guide component of the magnetic field. To analyse statistically its magnitude and occurrence we have surveyed rapid crossings of the current sheet during the 2001 and 2004 CLUSTER tail seasons. We have used three independent methods to determine the current sheet orientation and finally selected 57 events when their results agreed to within 15 deg. This data set allows us to conclude that a strong guide field (a few times as much as normal component) is an intrinsic feature of highly inclined current sheets, whereas it is not always the case for XY sheets. The correlation of B-guide with IMF By, known for standard current sheets, is also significant for horizontal flapping sheets. However, the guide component of a vertically oriented sheet points in the positive Z GSM direction irrespective of the sign of IMF By. We infer that inclined current sheets are formed as a result of a vertical shear of a horizontal sheet.

On the seasonal variation of electric and magnetic turbulence at high latitudes

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It is well known that the small-scale turbulent electric and magnetic fields at high latitudes as well as the associated discrete auroral features exhibit a seasonal variation. Up to recently there was only one explanation of this effect in which a conjugacy of wintertime and summertime ionospheres due to Alfvén wave communication was supposed and a non-zero field-aligned potential drop suggested [e.g., *Volkov and Maltsev*, 1986]. However at high-latitudes where the turbulent electric and magnetic fields occur, the Alfvén wave communication between the ionospheres may not be the case. This is especially true for the turbulent fluctuations in the regions of NBZ field-aligned currents under positive BZ IMF conditions, which are generated on the open magnetic field lines. Instead, the turbulent field-aligned currents (FACs) may close to only one of the ionospheres and a front of outgoing Alfvén wave propagating to infinity. In the present study the seasonal variation in the high-latitude electric and magnetic turbulence is explained under such an assumption, the ionospheric Pedersen conductivity considered season dependent, while the conductivity of Alfvén front $\Sigma_A = 1/(\mu_0 V_A)$, V_A the Alfvén velocity, taken independent of season.

High-latitude ionospheric convection patterns dependent on the IMF orientation

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The IZMEM model provides high-latitude ionospheric plasma convection patterns in both hemispheres as a function of the IMF orientation. Model electric potentials are compared with electric field measurements from the DE2, FAST and DMSP satellites along high-latitude passes of the Northern and Southern hemispheres. We consider the model convection patterns, the number of convection cells, and the possibility of verifying them experimentally. Any description of the global high-latitude ionospheric convection is based on a certain hypothesis. Because of this and because of the complexity of the phenomenon, there is still no generally accepted description of the spatial configuration of the convection or the number of convection cells during the northward IMF. As a result, components of complicated two-cells convection pattern may be interpreted as independent cells. Likewise, the ambiguity may result in the number of cells being underestimated.
It has been shown that the IZMEM model electric potentials are in rather a good agreement with the measurements along the satellite passes, which makes the global spatial convection patterns for these plausible. For small IMF magnitude and positive Bz ionospheric convection patterns generally consist of two cells with a positive potential cell on the dawnside and a negative potential cell on the duskside. For IMF By<0 (By>0) a positive (negative) potential cell becomes dominant in the northern hemisphere, and oppositely in the southern hemisphere. During

Bz>>0 the convection pattern changes from the standard two-cell pattern to a more complicated one. IZMEM shows two additional convection cells in the dayside polar cap, positive (negative) potential cell is present duskward (dawnward) of the noon-midnight meridian, and may cause three-cell or four-cell convection pattern.
This study is supported by RFBR grant 05-05-65196. The collaboration between IZMIRAN and the Royal Institute of Technology was supported by a grant from the Royal Swedish Academy of Sciences.

Using the mobile communication system for data acquisition and equipment remote control tasks

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Presently mobile telecommunication networks are quite commonly available. With the rapid expansion of such systems, new capabilities of data acquisition and control of science equipment became available. These capabilities have to change our mind about some technical aspects of geophysical observations. We have developed a communication system, which uses the potential of mobile telecommunication network allowing implementing various schemes of data transmission and remote control in geophysical tasks. This fact may allow to organize the observation process more efficiently, namely controlling the characteristics of equipment software, responding to conditions changes, and also obtaining data shortly after recording.
One way to use the communication system is to develop the communication channel for transmission of data from remote observations to a dedicated data collection host in the almost real-time mode. To implement this scheme we need to connect the communication system to already existing data acquisition system and choose a suitable data transmission mode. The mode is dependent on the volume and rate of the data flow, our special needs and objectives of using the data. The scheme is described above was implemented for transmission the hourly-by-minutes magnetometrical data from Lovozero Observatory.
Another way is to use the communication system to control equipment software. This scheme allows to carry out a remote control the equipment and promptly obtain characteristics of conditions and results of observation. To implement this scheme there needs to be a permanent connection between communication system and local equipment control system. We also need to use special software to implement the remote control functions. The scheme can be modified to implement the controlling functions via special Internet web page. This scheme allows to carry out a remote control of equipment by PC, most of handheld computers, and some of Internet-enabled mobile phones. The above scheme is going to implement the control of spectrograph and video camera software at the Polygon (Testing ground) (Apatity).
The main goal of the development and implementation of various schemes of data transmission and remote control is to expand controlling abilities of existing data acquisition systems and help to realize data analysis and visualization tasks in geophysics.

A comparative study of turbulent electric field spectral and scaling properties in regions 1 and 2 of the Birkeland field-aligned currents, polar cap and dayside cusp

B.V. Kozelov and I.V. Golovchanskaya (*Polar Geophysical Institute, Apatity, Russia*)

In our previous study [*Kozelov and Golovchanskaya*, GRL, 2006], by examining spectra, probability density functions (PDFs) and generalized structure functions (GSFs) of the electric field fluctuations at high latitudes we showed that these are a manifestation of turbulence developing on the scales from ~0.5 km (or smaller) to ~ 1000 km. In the present analyses we compare the quantitative characteristics of the turbulent electric fluctuations, such as the slopes of the spectra, PDF scaling index and the conditioned GSF scaling exponent in four different high-latitude domains: regions 1 and 2 of the Birkeland field-aligned currents, polar cap and dayside cusp. The domains are recognized by a large-scale electric field pattern as well as by signatures of particle precipitation derived from the electric field and particle observations of DE2 spacecraft. The results of comparison are discussed with application to the turbulence generation mechanism.

Multi-scale features of aurora and electric field fluctuations at the high latitudes

B.V. Kozelov (*Polar Geophysical Institute, Apatity, Murmansk region, 184209 Russia*)

A study of statistical features of auroras and electric field fluctuations at the high latitudes is presented. Data from all-sky television (TV) observations from the Barentsburg observatory (Svalbard) have been used. The results of avalanche analysis of the data by spatio-temporal techniques employed to identify and select avalanche-like

transients, as well as characteristics, which are commonly applied to turbulent flows (probability density function (PDF) and generalized structure function (GSF) for fluctuations), are considered. Data of electric field fluctuations observed by low altitude satellite DE-2 at the auroral latitudes have also been analyzed. The scaling features obtained can be interpreted as signatures of turbulent motion of the magnetosphere-ionosphere plasma. Possible implications of the results for the validity of self-organized criticality (SOC) models and turbulence models of the magnetosphere-ionosphere system activity are discussed.

Changes of the total ion pressure in the nightside inner magnetosphere

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The total ion pressure has been considered in the range of the magnetic shell parameter *L* from 2.3 to 6.7 in the nightside magnetosphere (20-24 MLT). The data of the LEPA and EPAS particle detectors and the magnetic field measurements on-board CRRES satellite have been used. The LEPA instrument measurements give a distribution of low -energetic (0.1-30 keV) ions and electrons, while the EPAS measured higher energy electrons (21.5-285 keV, 14 energy channels) and ions (37-3200 keV, 12 energy channels).
The dynamics of the whole energy range of the electrons and ions have been considered to estimate the total plasma pressure during several events in active periods before the substorm onsets.
The total ion pressure reaches a maximum at L ~ 3 –4. Moving outward, on L > 4 the CRRES traverses the Alfven boundaries of the low energy electrons, when the average energies of electrons gradually increase. Earthward from these boundaries, the total ion pressure increases sharply. This increase coincides with an enhancement of the low energy ion pressure and disturbs the nearly monotonous drop of energetic ion pressure as a function of the parameter *L*. Addtional contribution to the particle pressure changes is given by further substorm-associated injections of the energetic particles.

Solar proton anisotropy and dropout effects in the polar cap and auroral zone during the period of extended substorm activity

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Measurements of the latitude distribution of solar protons by Coronas-F polar orbiter during solar proton events allows to study dynamics of the proton penetration boundary. Polar cap and penetration boundary relative position were investigated due to the South-North anisotropy registered during SCR event on October 26-27, 2003. Several effects of the proton radial distribution were found suggesting specific field line stretching inside the magnetosphere trapping region during the period of extended substorm activity.

Real-time assessment of geomagnetic activity based on satellite magnetic field measurements

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Because of the negative effect of the environment, a satellite's orbit may be changed, or even its crash can take place. The environment effect monitoring is based on dynamic models of the upper atmospheric density parameterized by the solar and geomagnetic activity. Satellite measurements of the magnetic field and modern magnetospheric magnetic field models may be used for real-time monitoring of geomagnetic field state. In our idea, satellite data of the magnetic field module and its components measured along each orbit (or any of its segments) should be compared with a magnetic field model for some external conditions. These conditions are to be arranged into groups according to geomagnetic activity grades. Geomagnetic activity grades (quiet, weakly disturbed, disturbed, strongly disturbed conditions) are determined by the model input parameterized by Solar Wind/Interplanetary Magnetic Field or indices of geomagnetic activity. Model magnetic field calculated for all points of the satellite orbit for each geomagnetic activity grade is compared with real-time satellite measurements. The on-board computer chooses the geomagnetic activity grade that gives the best agreement of the observed data

with the model. In our paper we present some examples of real-time monitoring of the geomagnetic activity grades based on the comparison of the magnetic field measurements of CHAMP low-orbiting satellite with Paraboloid model of the magnetospheric magnetic field.
This study is supported by INTAS grant 03-51-5359 and RFFI grants 05-05-65 196, 04-05-64890

Solar wave and corpuscular conductivity influence on the Main Earth's magnetic field modeling

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IGRF (IGRF-2000, IGRF-2005) models of the Main Earth's magnetic field are deriving from low-orbiting satellites data measuring the magnetic field on/above the F-layer level of the ionosphere (400-600 km above the Earth's surface). The data are processed to extract the Main magnetic field generated by sources internal to the Earth from the magnetic field measured by a satellite. It is assumed that near a satellite orbit internal (external) magnetic field increases (decreases) from the orbit to the Earth. But on E-layer located lower the satellite orbit there are currents such as dynamo and magnetospheric ones. Magnetic field generated by these currents increases from the satellite orbit to the Earth as internal field, when it is generated by sources external to the Earth. Therefore, IGRF coefficients represent both the main (core) fields and the external field generated by ionospheric current systems.
We have analyzed dipole and quadrupole model coefficients of the Earth's internal magnetic field calculated for some dates from 2001-2004 period using CHAMP magnetic measurements, and the relation of the model coefficients with the solar emission intensity and Bz component of Interplanetary Magnetic Field. The coefficients of correlation between the model coefficients and the daily means of F10.7 describing the solar emission intensity are about 0.7. The coefficients of correlation between model coefficients and the sum of hourly means of negative Bz are about 0.5. The amplitude of secular variation of the model Earth's internal magnetic field cleared from variations of analyzed parameters of the solar wave and corpuscular conductivity is 2.5 times smaller than the amplitude of IGRF-2000 and IGRF-2005 models that may modify the concept about velocity of changing of secular variation of the Earth' magnetic field.
This study is supported by INTAS grant 03-51-5359 and RFFI grants 05-05-65196, 04-05-64890

Dependence of the corrected geomagnetic coordinates of high-latitude observatories on the season, universal time and geomagnetic activity level

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Solar magnetospheric (GSM) and Corrected Geomagnetic (CGM) coordinate systems are used to analyze geophysical phenomena on the Earth's surface and in the Earth environment. The input parameters for computing the GSM-coordinates of the given point are the number of day of a year and Universal Time (UT). Calculations of CGM-coordinates of any point on the Earth's surface are based on the magnetic field line tracing from the specified point up to the magnetic equator plane using one of the magnetospheric magnetic field models and tracing back from the produced point to the ionosphere using only dipole magnetic field. The model magnetic field and coordinates of magnetic field line points are usually presented in GSM coordinate system. In that case CGM-coordinates of any points will depend on the season, UT and the used magnetic field model.
Thus CGM-coordinates of geomagnetic observatories continuously change during the year and the day and depend on the geomagnetic activity level. The geomagnetic activity level defined by the indices of geomagnetic activity or parameters of the Solar Wind/Interplanetary magnetic field is one of the input parameters of any magnetic field model, besides change of the activity level causes a change of magnetospheric boundaries geometry. Modern tables of GCM-coordinates of geomagnetic observatories do not inform us about CGM temporal variations. There have been demonstrated variations of CGM-coordinates of high-latitude magnetic observatories, for which temporal variations are the most appreciable. CGM-coordinates were calculated using IGRF, Tsyganenko's and Paraboloid models of magnetosphric magnetic field.
This study is supported by INTAS grant 03-51-5359 and RFFI grants 05-05-65196, 04-05-64890

The polar cap boundary as an open/closed field line boundary derived by different magnetospheric magnetic field models

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The polar cap may be defined as a near-polar region of magnetic field lines open to the Interplanetary Magnetic Field (IMF). To determine the location of the polar cap boundary, or open/closed field line boundary, there may be used different magnetospheric magnetic field models. The IGRF model presenting the main magnetic field of the Earth from internal sources only allows to determine high-latitude points of the Earth's surface mapping on to the equatorial plane outside of the magnetopause. These field lines are open for the IGRF magnetic field model, and IGRF open/closed field line boundary may be assumed as a polar cap boundary as the first approximation. The modern magnetospheric magnetic field models accounting for external sources depend on the parameters of IMF and geomagnetic activity levels. Depending on the input model parameters the magnetic field line tracing and the magnetospheric geometry are changed and cause the polar cap boundary. We used IGRF-2000, Tsyganenko's and Paraboloid models for locating open/closed field line boundary for different IMF conditions: quiet, weakly disturbed, disturbed ones.
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On the use of the object oriented data structure for geophysical data storage and processing

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Since the IGY the world geoscience has collected a huge array of various geophysical data. To use it effectively the gap between modern information technologies and Earth science should be reduced. We present the potential of object oriented data structure of the Framework Atmosphere Model (FrAM) to satisfy the needs of reliable storage and processing of geophysical data.
The Framework Atmosphere Model (FrAM) is being developed as a universal modelling tool for the research of interrelation of the broad range of various processes and phenomena in the upper atmosphere. It is organised in the open framework, including the controlling Model Manager and the set of subordinate independent Models of separate atmospheric regions and processes, user-selected at the model configuration stage. These sub-models exchange data through the Manager using a unified interface. Functionally each Model is a method of obtaining the numerical values of a certain set of physical parameters in certain spatial grid nodes. As it is easy to see, the experimental data sources fall into this formal definition as well and they can be integrated into the framework system. It allows using the object oriented data structure created in the course of the FrAM development for handling geophysical data of any origin (not only modelling ones). The features of such use of FrAM software are discussed.
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Asymmetrical 1D configurations of thin current sheet in the magnetotail with constant B_Z

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Numerical self-consistent model of the high-temperature collisionless thin current sheet (TCS) in the Earth's magnetotail, based on the macro-particle method, has been used for investigation of asymmetrical 1D configurations of the TCS with constant B_z. The simplified 1D3V variant of the model is considered, when all functions are depending only on z coordinate in GSM coordinate system, electrostatic effects are not taken into account, plasma is considered to be electro-neutral and only ion current is calculated. In this model TCS is formed by two plasma flows, moving along magnetic field lines from lobes with hydrodynamic velocity V_D , concentration n_0 and ion

temperature T_0 . These plasma flows are simulated by the generation of Maxwell distribution in lobes on small spatial scale far enough from the boundary of the model region. Stress tensor is calculated and force balance boundary condition is used. For simulation of the asymmetrical configurations we start from the quasi-equilibrium symmetric configuration of the TCS and smoothly switch the asymmetry in the plasma flows in the lobes. As a result of the simulation a few asymmetrical configurations of the TCS were obtained.

Global geomagnetic and auroral response to the variations in the solar wind dynamic pressure

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Study of the features of negative sudden impulses (SI-) formation, has shown, that the global magnetosphere-ionosphere response caused by the sharp magnetosphere expansion has a number of differences from that caused by the sharp magnetosphere compression.
On the basis of the results about manifestation of the global response to variations of the dynamic solar wind pressure, the possible physical scenario of SI+ (SI-) formation is proposed.
The results of the study show that sharp compression (expansion) of the dayside magnetosphere results in the following basic processes responsible for SI + (SI-) generation:
1. The sudden magnetosphere compression results in the amplification of field-aligned currents (FACs) intensity of region 0 (R0) and region 1 (R1) and under certain conditions also FACs of region 2 (R2) amplification. The expansion of the magnetosphere results only in R1 FACs amplification. The growth of intensity of the electric field and its penetration from the high to low latitudes takes place.
2. The generation of SI + and SI-, is accompanied by a sham intensification of auroral luminosity because of electron precipitation near noon at latitudes of ~75 deg with the subsequent expansion of the precipitation region on the evening and morning sides at the velocity of ~10 km/s proportional to the propagation velocity of the disturbance along the magnetopause, as well as to the pole at the velocity of ~1-5 km/s. However, SI- can result in the decrease of particles precipitation intensity which is manifested in the reduction of auroral luminocity region.
3. The amplification of Hall ionospheric currents between R0 and R1 FACs layers, R1 and R2 FACs layers, stream ionospheric currents on the dayside, closing R0 and R1 FACs and the spreading currents to the lower latitudes and to the polar cap region takes place. The compression (expansion) of the magnetosphere results in the amplification (weakening) of magnetopause currents.
4. The fast magnetosonic wave propagating in non-uniform magnetospheric wave guide with the subsequent transformation in Alvenic wave at sharp plasma boundaries is generated. MHD-disturbances propagate with the velocity decreasing in magnitude with the growth of latitude (or L-shell).
Thus, SI+ (SI-) formation at high latitudes occurs due to the reconstruction of ionospheric currents as a result of sharp change of ionospheric conductivity at the latitudes higher than 70 deg and effects of the MHD-waves propagation giving the greater contribution at lower latitudes.
The study is financially supported by the program of the Presidium of the Russian Academy of Sciences №16, part 3, grants of the RFBR № 06-05-96118, INTAS № 06-1000013-8823.

Characteristics of negative sudden geomagnetic impulses: Comparison with the sudden geomagnetic impulse caused by the growth of the solar wind dynamic pressure

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The features of the meridional and azimuth propagation of sudden geomagnetic impulses, formation of their equivalent ionospheric current systems during periods of expansion of the magnetosphere under different direction of IMF By and Bz components and different magnitude of IMF By are studied. The results of the present research

with results obtained earlier in studies of the positive sudden impulse (SI+) in the paper [Solovyev et al., 2005) are compared.
It has been found that the negative sudden impulse (SI-) as well as SI+ are propagating poleward at the velocity of 1-5 km/s. However, for SI- in contrast to SI+ the poleward propagation does not depend on the IMF Bz-component sign. The azimuth propagation of SI- occurs similarly to the propagation of SI+ to the west (east) from a noon meridian in the morning (evening) sector. Velocities of azimuth propagation have been registered mainly in two ranges V1=4-12 km/s and V2 =17-30 km/s. The analysis of the events observed at different IMF |By/Bz| (>l or =< 1), at positive and negative IMF By shows that the character of the propagation of SI- does not vary depending on the magnitude and direction of IMF By.
The comparison of global geomagnetic and auroral observations by data of the "Polar" satellite shows that the propagation of SI- along the azimuth with the velocity V1 coincides in value and in direction with the expansion of auroral luminosity region from the dayside to the night side along the aurora oval. The similar dynamics of aurora is observed in the SI+ events. However SI- can also result in the decreasing of particles precipitation intensity which is manifested in the reduction of auroral luminosity region.
Distributions of equivalent ionospheric currents observed during SI- events are not a mirror reflection of distributions of currents during SI+ as it is supposed in the papers [Araki, 1994; Fujita et al., 2004). We assume that at sharp expansion of the magnetosphere unlike the compression, only the region 1 field-aligned currents are intensified, the ionospheric conductivity is changed at latitudes >70 deg. As a result, in the high-latitude ionosphere the observed distributions of currents appear.
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Estimates of ionospheric conductivity from wavelet spectra of electric and magnetic fluctuations at high latitudes

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We have estimated the height-integrated Pedersen conductivity of ionosphere Σp from DE-2 16 Hz electric and magnetic fields measurements. The conductivity was calculated from the ratio of wavelet spectral densities for the magnetic and electric components. The values of conductivity obtained in this manner for different scales permits to get insight into the nature of turbulent field fluctuations.

Magnetosheath turbulence and Low Latitude Boundary Layer (LLBL) formation

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Simultaneous observations of plasma parameters and magnetic field in the low latitude boundary layer (LLBL) measured by Interball/Tail probe and in the magnetosheath measured by Geotail satellite are analyzed for the event of March, 2, 1996. The high level of magnetic field fluctuations is one of the main features of magnetosheath observations. It is shown that the amplitude of such fluctuations is higher than the value of the magnetic field under the magnetopause in the analyzed event. Results of observations show that fluctuations of the magnetic field in the magnetosheath can be an important factor in the conditions of magnetopause formation. Local disruptions of magnetopause pressure balance under the influence of such fluctuations can lead to magnetosheath plasma penetration inside the magnetosphere and formation of LLBL. The role of the magnetopause pressure balance disruption in the formation of reconnection events is discussed.

Registration of GIC in power systems of the Kola Peninsula

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The Kola power system, located at high latitudes and comprising extensive power lines, going in various directions is subject to the geomagnetic disturbance impact. Some cases of emergency blackout of the highest class voltage power mains have been registered, which had been caused by geomagnetically induced currents (GIC).
To study the geomagnetic disturbance impact on the power systems of the Kola Peninsula, the Centre of physical-technical problems of energetics of the North jointly with the Polar Geophysical Institute have developed a system of GIC monitoring in “Kolenergo”company networks. A system of digital registration of GIC has been developed, which provides a continuous measurement of DC of dead-grounded neutral of the power autotransformer at the power system substations of 110-330 kV class and the monitoring of the frequency spectrum of the industrial frequency voltage (50 Hz). The monitoring of the development of magnetospheric disturbances is based on the data of the ground-based magnetometers of the PGI and Scandinavian countries. During the last three years there have been identified 15 cases of appreciable (over 5 A) current development in the neutral, connected with the development of geomagnetic disturbances. The GIC development is observed mainly in the night sector at the sufficiently high activity level.
Not every single disturbance of the geomagnetic field causes essential development of GIC in the “Kolenergo” company networks. It is explained by the geographical location of power mains, by their orientation, predominantly, in the north-south direction.

Interaction of interplanetary shock with the Earth's magnetosphere: The results of MHD modelling for an artificial event

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Interaction of an interplanetary shock with the Earth's magnetosphere is studied using the results of both global MHD and local magnetosheath models. When the interplanetary shock interacts with the bow shock, several new MHD discontinuities would appear. There is a slight deceleration of the shock front in the magnetosheath. Interaction of the interplanetary shock with the magnetopause (if the magnetopause is assumed to be a tangential discontinuity) results in a transmitted fast shock in the magnetosphere and a reflected fast rarefaction wave in the magnetosheath. The magnetopause begins to move Earthward with a high velocity, more than 200 km/s. We get that the transmitted fast shock would go through the plasmapause without noticeable reflection. However, the global MHD models predict reflection of the fast shock somewhere inside the magnetosphere and it is confirmed by observations. Another result of the modelling is that an increase of magnetic field after the interplanetary shock may intensify the magnetic reconnection at the magnetopause for any IMF orientation.

Numerical modeling of electric field in the inner magnetosphere with changing plasma concentration in the outer magnetosphere.

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A numerical self-consistent model was developed to investigate the formation of the electric field convection in the inner Earth’s magnetosphere.
In this model particles are divided in 128 energies. Velocity is determined by averaging the drift motion along a magnetic flux tube. Electric potential is calculated on the basis of field-aligned and ionospheric current. Magnetic field is assumed to be dipole, and distribution function is isotropic.
The presented numerical computation is aimed at the understanding of how electric field in the inner magnetosphere changes with changing plasma concentration in the outer magnetosphere. A possibility of interchange instability is investigated also.

Spectral studies of auroras in the polar caps of northern and southern hemispheres of the Earth during the IGY, as well as in Spitsbergen on the eve of the IHY

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In 1957-59 within the framework of the International Geophysical Year (IGY) (the period of a very high solar activity) spectral observations of auroras were carried out in the USSR at stations of Heiss island, Pyramida (Arctic), Mirny, Vostok (Antarctic), using C-180-S cameras, designed by Prof. A.I. Lebedinsky.
Based on a unified programme (photographic film Dn, exposure time 10 minutes, spectral resolution of 5 nm) registrations of auroral spectra were carried out in the dark time of the day in autumn, winter and spring. The films development was centralized and the obtained materials were collected at the World Data Center ICD-B2 in Moscow. The photometric processing was carried out at the Auroral Laboratory of the PGI. There were registered the basic emissions of auroras: 630.0 nm, 557.7 nm, 427.8 nm and 319.4 nm on spectra of auroras with the intensity of I – II IBC points.
At the visual comparative evaluation of intensities of emissions 630.0 nm and 557.7 nm it turned out that the number of spectra, in which the red line 630.0 nm exceeded the green one 557.7 nm more than 2 times and more at all the stations, was very significant (on the average – 60%) This testified of the fact that during that period the number of auroras prevailed in the polar caps, which conventionally could have been referred to red auroras of type A, although, the observers of shapes of auroras visually estimated them as light-green ones.
In December-January 2005-2006 (the minimum of solar activity) a spectral camera, designed in the PGI (CCD All-sky spectrograph) was in operation in Spitsbergen (Barentsburg) and allowed to obtain auroras spectra with exposure time of 1 min under the spectral resolution of 0.6 nm. The intensities of emissions 630.0 nm and 557.7 nm for 10 minutes were summed up during the processing. Photometric visual evaluations of the number of spectra, in which emission 630.0 nm exceeded 2 and more times the intensity of emission 557.7 nm proved this number to be very small – 2.5 %. This testified of the fact that during the period of the minimum of solar activity at the Barentsburg observatory, mainly green auroras prevailed. The reasons of the obtained regularities are discussed as a conclusion.

Research carried out by the Polar Geophysical Institute in the Antarctica

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The paper has been prepared in view of the 50 years since the beginning of Russian (Soviet) expedition's research activity on the regular basis in the Antarctica. The paper presents the basic results, obtained by the Polar Geophysical Institute researchers in their investigations of geophysical phenomena in the Antarctica and there is included a list of PGI scientists, who wintered at various stations. The PGI researchers performed photometric, photographic, spectral observations of auroras, radar observations of radioaurora at Antarctic stations. In the framework of P.N.Lebedev FIAN program the PGI researchers used to launch daily radio-sounding balloons for studying the cosmic rays characteristics. Over 40 researchers from the PGI wintered at various Antarctic stations in numerous expeditions. Based on the observation results obtained at various stations more than 70 papers have been published.

Влияние высыпаний магнитосферных электронов на оценку сроков возможной гибели цивилизации

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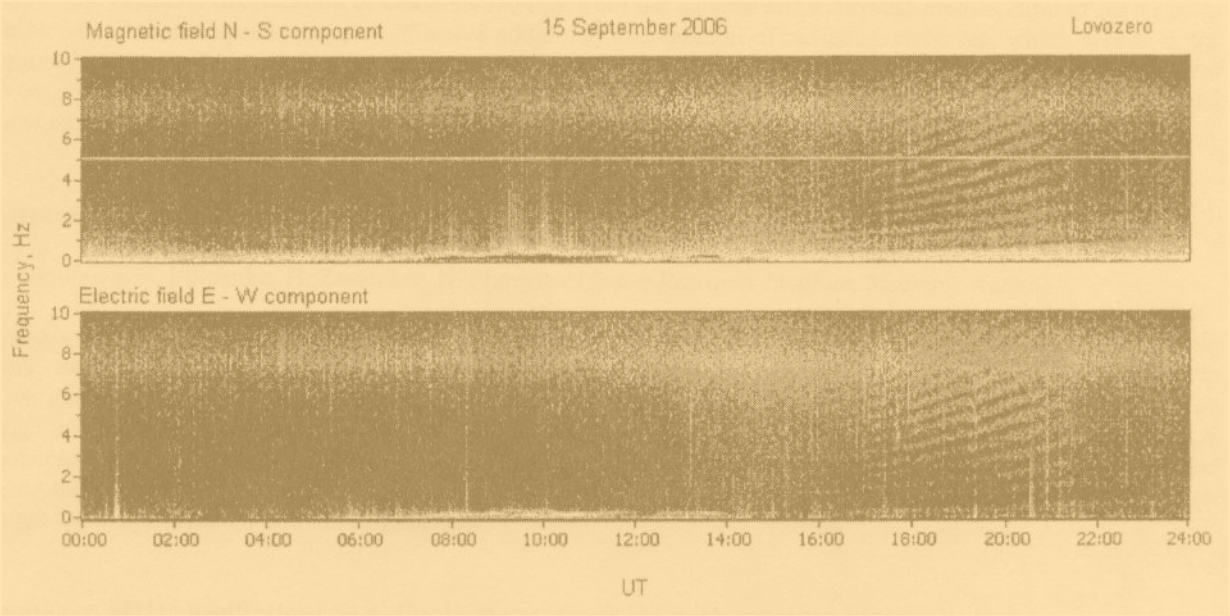
В ходе эксперимента с аппаратурой ГРИФ на орбитальной станции «Мир» с помощью широкоапертурного (поле зрения ~1 ср) сцинтилляционного рентгеновского спектрометра РХ-2 проводились мониторные наблюдения неба с целью регистрации всплесков в диапазоне энергии фотонов 10-300 кэВ. Благодаря комплексному составу аппаратуры, включавшей помимо рентгеновского и гамма приборов также детекторы заряженных частиц, осуществлялась достаточно эффективная фильтрация имитаций астрофизических всплесков высыпаниями магнитосферных электронов и сильноионизирующими ядрами. В докладе будут освещены характеристики потоков электронов в областях околоземного пространства, соответствующих

дрейфовым оболочкам L = 1.7, 1.4, 1.1, наблюдавшиеся в течение всего времени эксперимента с октября 1995 г. по июнь 1997 г., и их влияние на класс лже-астрофизических регистраций в околоземном пространстве. С учетом данных, полученных в эксперименте ГРИФ и данных BATSE CGRO, сделан вывод о том, что основная масса источников гамма-всплесков относится к эпохе красных смещений $1 < z < 5$.


Magnetic field N - S component
15 September 2006
Lovozero
Electric field E - W component
Frequency, Hz
0
2
4
6
8
10
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
24:00
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Numerical study of chorus generation on the basis of the backward-wave oscillator model

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We study a model of chorus generation in the Earth's magnetosphere on the basis of numerical simulations. The model is based on the backward wave oscillator (BWO) regime of the cyclotron interaction of electrons with whistler-mode waves, i.e., on the absolute instability in the near-equatorial region of the magnetosphere. For realistic fluxes of energetic particles, the instability of parallel-propagating whistler-mode waves can become absolute if a step-like distortion exists in the distribution function of energetic electrons. Numerical modeling allows us to reproduce the main features of chorus emissions, such as their typical amplitudes, characteristic size of the source region, temporal pattern as quasi-periodic or chaotic sequences of wave spikes, and frequency drift. The magnetic-field inhomogeneity is significant for the generation regimes of whistler-mode waves. In particular, this inhomogeneity determines the size of chorus source region, and it ensures the preference for rising-tone emissions under typical magnetospheric conditions. The frequency variation in chorus emissions arises due to the combined effect of the adiabatic deceleration of electrons moving from the equator and nonlinear modification of the velocity distribution. This modification causes effective additional deceleration of radiating electrons, which results in the frequency increase. The modeling confirms the idea that different frequencies within an individual chorus element can be generated at different distances from the source center and, therefore, the dynamic spectrum of individual chorus elements can differ noticeably between different observation points in the source region.

Upstream waves and ground Pc3 pulsations

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We analyze high-resolution magnetic and plasma data from the Interball-Tail and Geotail satellites, and Antarctic ground stations during the satellite crossing of the dayside foreshock and magnetosheath. In this study we try to answer the following questions: what is the mode of upstream waves? How do the properties of upstream turbulence change upon the transition of the bow shock? Is there a direct correspondence between the upstream waves and magnetospheric Pc3 pulsations? What is the main interplanetary factor which controls the Pc3 activity inside and outside the magnetosphere? What is the mechanism of ULF wave energy transmission from the upstream region through the magnetosheath into the magnetosphere?

Resonance MHD-oscillations in a dipole magnetosphere with rotating plasma

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The structure and spectrum of azimuthally small-scale slow magnetosonic (SMS) waves were theoretically investigated in a model of axisymmetric magnetosphere with dipole magnetic field and rotating plasma. The external currents in a subequatorial region of the magnetosphere were regarded as a source of SMS waves under study. The spectrum of resonance SMS waves and their longitudinal and transverse structures were determined and compared with those of azimuthally small-scale Alfven oscillations. Frequencies of the fundamental harmonics of these waves were shown to differ considerably (approx. two orders of values). Unlike Alfven waves, SMS oscillations had a very steep fall-off of the magnitute when approaching the ionosphere. The structure of SMS waves across magnetic shells is a typical resonant one, while Alfven waves could have a "travelling wave"-like transverse structure.
This study was partly supported by RFBR grant 06-05-64495, IN TAS grants 06-1000013-8922 and Program Presidium of RAS 16.

Geomagnetic disturbances and ULF waves related to theta-aurora

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We have developed a technique for studying simultaneously the ULF activity in the nominal Pc5-6 frequency band, global patterns of UVI emission measured from Polar satellite, and boundaries of dayside magnetospheric regions obtained from DMSP charged particle flux measurements. This technique produces a sequence of two-dimensional "snap-shots" of the UVI images with overlaid magnetic station location and DMSP satellite tracks. For several events in 1997-99 the occurrence of theta-aurora was compared with dynamics of simultaneous ULF activity and geomagnetic disturbances. The equivalent ionospheric currents estimated from ground magnetic disturbances were found to be oriented approximately along theta-auroras. The ULF dynamic spectrograms have been inferred from the polar arrays (Greenland, MACCS) of geomagnetic stations. The comparison of the time variations of UVI intensity integrated over the part of the polar cap, dominated by theta-aurora (>85 geomagnetic latitude), and dynamic spectra from the polar magnetic stations enabled us to reveal the ULF activity related to the theta-aurora activation. The occurrence of these quasi-periodic variations in the polar cap signify that a theta-aurora indeed develops on closed field lines.

A method of retrieving the soliton component of a signal

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A new method of detecting unambiguous solitons and determining their parameters, based on the solution of the scattering problem for the Derivative Non-Linear Schrodinger (DNLS) equation, is proposed. The integral reflection coefficient has been used as a detector of the DNLS solitons. Application of this technique to numerically simulated signals showed that it is more efficient than a standard Fourier transform and can be used as a practical tool for the analysis of outputs from non-linear systems.

Vortex structures in the polar cusp. Theory and Cluster observations

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Recent multipoint measurements provided by CLUSTER fleet have revealed that electromagnetic vortex structures in the polar cusp possess characteristic scales of the order of a few ion Larmor radii. The theory of such phenomena in inhomogeneous plasma incorporating the finite ion Larmor radius effect has been developed. The application of the theory to interpretation of vortex structures observed by the CLUSTER is carried out. The theoretical estimations of the wave propagation angles, polarization, minimal spatial scales as well as plasma density perturbations in the vortex structures were found to be in reasonable agreement with observations.

On the latitude-stability of Pi2 domain from the evidence of "BEAR" magnetic pulsations data

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The stability of Pi2 generation domain is set by the comparison of local extremes of vertical component in narrowband filtered Pi2 magnetic pulsations being obtained at high-latitude network during the "BEAR" experiment, with their local sources positions, which were defined in terms of generalized gradient technique for the filtered horizontal Pi2 field components. Locations of these features are in a good coincidence for a single source of pulsations.
As a possible reason of this stability the self-focusing of Lengmuir waves is considered, that is associated with the energetic particles expansion at the inner radiation belts and with Kelvin-Helmholtz instability growth with efficient role of Stokes correction for waves' dispersion. It is noted also that in an average Pi2 period their oscillations corresponded to the 3D-current system behavior, but there are some features of their sources dynamic, which are not confined to a simple resonant model of Pi2 excitation.

Nonlinear mirror waves: Collapse or solitons?

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A unified theory of the large-amplitude mirror waves in non-Maxwellian space plasmas is developed. In the standard quasi-hydrodynamic approach, the most general equation governing nonlinear dynamics of large-amplitude mirror waves is derived. In the linear approximation it is reduced to the classical mirror instability with the linear growth rate expressed in terms of an arbitrary ion distribution function. In the nonlinear regime the mirror waves form solitary structures that have the shape of magnetic holes. The formation of such structures and their nonlinear evolution has been analyzed both numerically and analytically using Lyapunov stability formalism. It is shown that the basic mirror mode nonlinear equation yields the stationary solution in the form of 1D soliton in which the nonlinearity is balanced by the dispersion due to the finite ion Larmor radius (FLR) effect. It is found that the collapse of the mirror magnetic holes due to the strong nonlinearity is terminated by the presence of the FLR effect.

Role of the ULF wave activity in solar wind-magnetosphere interactions and magnetospheric electrons acceleration

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The comparative statistical analysis has elucidated the role of ULF activity in the magnetospheric field and particle response to solar wind forcing. Statistical analysis of correspondence between the various SW/IMF parameters and interplanetary/magnetospheric turbulence level has revealed, apart from the well-known correlations, some new features of the near-Earth environment control by the solar activity.
Special attention is paid to the inter-relation between high-energy electron flux intensity and ULF activity. The ULF index demonstrates a high positive correlation with the electron flux for the whole period of observations.
As a quantitative measure of the SW/IMF turbulence level and the ground ULF activity in Pc5 frequency band we have used the ULF wave power indices [Kozyreva et al., 2006] constructed from the world array of ground magnetometer data and the plasma and magnetic field data from interplanetary spacecrafts.

Stability of the distribution function with velocity space holes

A.M. Sadovski (*Space Research Institute of RAS (IKI), Moscow, Russia*)

The stability of non-isotropic ion distribution functions with velocity space holes of peculiar type expected to occur in the vicinity of the magnetic field reversal region is investigated. It is shown that such distributions may be unstable to the excitation of electromagnetic waves. The growth rate of the excited waves is calculated as a function of the particle's temperatures and hole parameters.

Modelling the generation of EMIC waves in the Earth's magnetosphere

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We performed the calculation of the generation coefficient of EMIC waves on the basis of recently published empirical models of global distribution of the cold plasma and energetic protons in the quiet-time equatorial magnetosphere. The procedure includes 1) the calculation of growth rate in the magnetosphere under a reasonable suggestion on distribution of the cold plasma density along the field line; 2) the account of attenuation of the wave amplitude due to ionosphere reflection. The resonant properties of the ionospheric reflection coefficient are taken into account. The generation coefficient G is obtained for $3<L<9$ and any MLT. Keeping in mind that generation requires $G > 1$, we conclude that the generation is possible at low L-shells in the evening –night sector at frequencies 0.2-2 Hz. At larger L the region of generation occupies dayside and morning sector, and possible frequencies decrease (0.1 – 0.5 Hz). At the same time G strongly increases with increase of L, suggesting a larger probability of the EMIC waves generation at larger L. The results of the modeling are in general agreement with statistical properties of the EMIC waves registered in the magnetosphere.
This study was supported by the RFBR grant 05-05-64214 and by the research program № 16 of the Division of physical sciences of RAS "Plasma processes in the solar system".

Ground-based observations at L ~ 6 of multi-band structures in VLF hiss

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We present ground-based observations of banded structures (BS) in auroral hiss. This BS hiss was detected at Porojarvi station in Northern Finland, mainly in the local evening from 19 to 23 MLT, during magnetically quiet periods; half of all the events observed corresponded to AE < 50 nT. The structures, which resemble those observed by low-altitude satellites, can be related to the cyclotron resonant interaction of VLF waves at frequencies near the lower-hybrid resonance with suprathermal protons in the upper ionosphere and magnetosphere. The maximum probability distribution of band spacing for the events observed at Porojawi is reached in the frequency range of 200–300 Hz, which corresponds to proton gyrofrequencies at altitudes of 4000–3000 km. We found that the BS hiss was detected in the region of evening-side downward field-aligned currents and rather intense precipitation of ions with energies 1–30 keV, detected by DMSP spacecraft. We propose that the observed BS hiss can be formed not only due to absorption at the proton gyroharmonics, as is usually assumed for similar structures observed onboard satellites, but also due to the generation by energetic protons with an anisotropic velocity distribution.

Localization of the Pc1 source

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H.U. Frey (*Space Science Laboratory, University of California, Berkeley, California, USA*)

Recent observations from the IMAGE spacecraft revealed a new type of proton aurora – subauroral proton spots, which were mapped onto the vicinity of plasmapause. We demonstrate that these proton aurora spots are due to the specific type of the localized energetic proton precipitation that is observed by low-orbiting satellites. This precipitation is closely related to generation of electromagnetic ion-cyclotron waves in the magnetosphere. On the ground these waves are registered as geomagnetic pulsations Pc1. Consideration of simultaneous IMAGE and ground-based data shows that, indeed, when the proton spot is nearly conjugated with the ground station equipped with a pulsation magnetometer, the station always observes Pc1. Moreover, there is a good agreement between appearance/disappearance of the spot and beginning/end of the Pc1 train. We conclude that the subauroral proton spots are two-dimensional images on the ionospheric "screen" of magnetospheric regions where an intense scattering of the energetic protons into the loss cone occurs due to development of the ion-cyclotron instability.
The study was supported by the RFBR grant No 05-05-64214 and by research program of the Presidium of RAS No16 (part 3) "Solar activity and physical processes in the Sun-Earth system".

Storm-time Pc1-2 waves evolution: A case study

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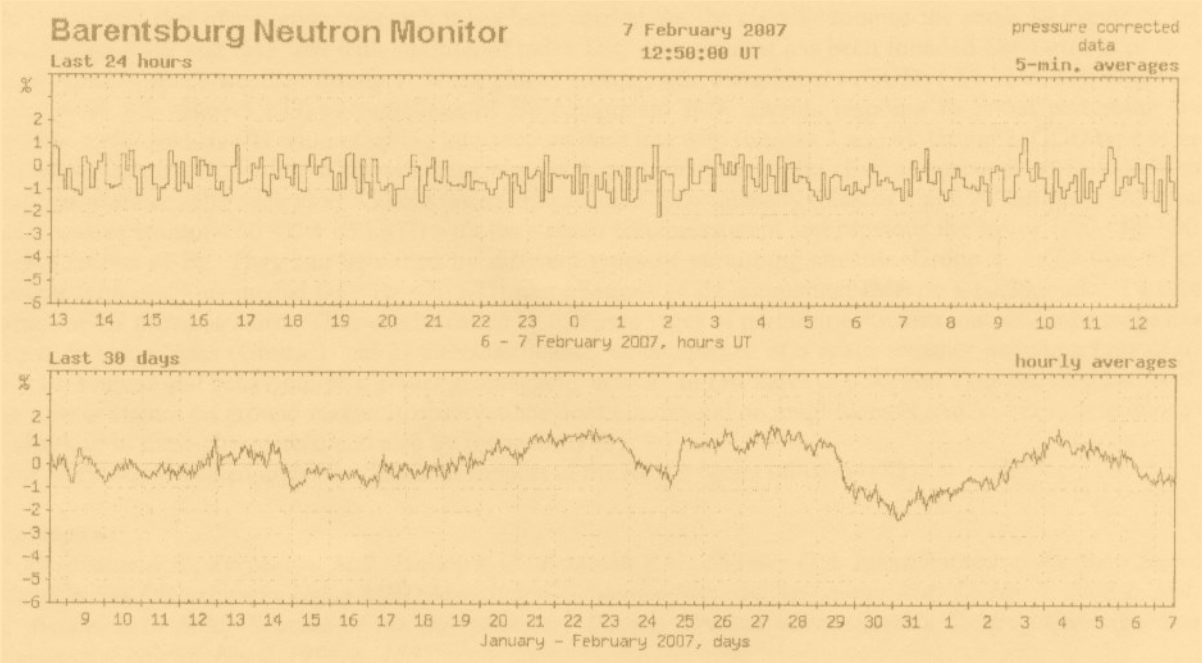
We have analyzed the properties of the 0.1-5 Hz geomagnetic pulsations recorded by an array of Northern mid-latitude and Southern high-latitude magnetic observatories during the maximum and early recovery phase of the great magnetic storm on April 6-7, 2000. These pulsations started during the storm main phase as IPDP-like phenomenon observed in the morning sector at mid-latitudes, and then transformed into superposition of the hydromagnetic (HM) whistlers and structured HM emissions observed both at mid and high latitudes. An intensity of structured HM emissions matched very well to the solar wind dynamic pressure pulses, while an intensity of HM whistlers was not obviously related to them. The structured HM emissions ended as HM whistlers, which had the same frequency as preceding emission did and appeared to be out of phase between the Northern and Southern hemispheres during the solar wind pressure and IMF reductions. These observations indicate that throughout the recovery phase of magnetic storm the magnetosphere was in the meta-stable state, so external disturbances, such as solar wind pulses or IMF sudden changes, could stimulate a spontaneous generation of long-lasting hydromagnetic emissions.
This study is supported by INTAS grant 03-51-5359 and Program Presidium of RAN №16.


Barentsburg Neutron Monitor
7 February 2007
12:50:00 UT
pressure corrected data
Last 24 hours
5-min. averages
%
2
1
0
-1
-2
-3
-4
-5
-6
13 14 15 16 17 18 19 20 21 22 23 0 1 2 3 4 5 6 7 8 9 10 11 12
6 - 7 February 2007, hours UT
Last 30 days
hourly averages
%
2
1
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-1
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-4
-5
-6
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7
January - February 2007, days

Establishment of perturbing solar stream types on a complex or a space weather parameters

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The research was guided on an establishment of solar sources of 18 solitary large-scale disturbances registered near the Earth. Among the causes it has been assumed following types of phenomena of solar activity: flashouts (sf), coronal holes (CH), actuated fibrils (SDF), heliospheric current sheet (HCS) and their composite combinations. It has been conducted the classification of events on parameters of solar wind (PSW) and interplanetary magnetic field (IMF) and separately on values of dynamic pressure of a solar wind by artificial neural network. A result of operation became partitioning viewed solitary events into 4 classes: intensive streams such as sf-CH (class 1) and weak intensity streams such as sf-CH (class 2), middle intensity streams such as CH-SDF, SDF (class 3) and weak intensity streams such as CH-SDF, SDF (class 4). Executed classification of solitary events singles out the same classes of initial perturbing solar streams, but in addition allows to draw a deduction on their vigour. It confirms the results received earlier on the same material in operation [1] on basis MHD approach, according to the scheme [2].
In the second part of the given research it has been carried out the classification of the same 18 events in view of parameters PSW and IMF, but with addition of index Dst. As a result it has been founded out 4 groups of the basic complexes of space weather. Group 1: Weak global geomagnetic disturbances (GGD) (-50 <Dst nTl) with previous very weak (-5 <Bz nTl) perturbations of Bz component IMF. Events response to initial perturbing streams preferentially such as CH without taking into account their intensity (classes 3 and 4). Group 2: GGD type of middle intensity storms (-100 <Dst nTl) with previous weak perturbations of Bz. Events response to initial perturbing streams preferentially such as sf without taking into account their intensity (classes 1 and 2). Group 3: GGD such as an intensive storm (-150 <Dst nTl) with the sudden commencement and previous the strong (-20 <Bz<20 nTl) perturbations of Bz. They can be called by different types of perturbing streams. Group 4: GGD type of middle storms with previous medial (-5 <Bz <20 nTl) perturbations of Bz component IMF on a background of a recovery phase of the previous storm. They can be called by different types of perturbing streams, but with advantage of sf.
Thus, in some cases (Group 1 and 2) the classification of complexes of a space weather including type of a solar stream sources and behaviour of a global geomagnetic activity of Dst index is possible. Thus the establishment such as a Solar stream on ground magnetic observations does not depend on amplitudes N and V, but is determined from behaviour of these parameters, and also by Bz quantity [3].
The work was executed under the financial support of the RFBR (grant 06-05-64482).

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Dynamics of turbulence parameters of the magnetosheath depending on the orientation of the interplanetary magnetic field

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The influence of the tangential component of interplanetary magnetic field (IMF) (Btan) on the bow shock (BS) by spectral characteristics and parameters of turbulent pulsations of medium and the balance of energies of the magnetosheath (MS) in view of macroparameters of the Solar wind is considered. For this purpose the analysis of observations on board a space craft (SC) Interball-1 is compared to simultaneously received results in experiments «Sura - SC Wind» on the radio translucence of the near-Earth space plasma in three sessions during 1997.

For the sessions, during which SC Interball-1 was in flank parts of the MS at increase Btan there was revealed the depression of spectral power of Alfven and magnetosound pulsations on the critical frequencies near the beginning of a dissipative interval. At the localization of SC in the sunflower part of the MS the power of these pulsations grew with the increase of Btan. The power of stream pulsations close to a dissipative interval decreases for all sessions.
The internal scales of sound and magnetosound turbulences vary in phase and scales of Alfven turbulences - in the antiphase with changes of Btan. The internal scales of magnetosound pulsations demonstrate an inverse relation from Btan quantity and direct dependence for Alfven pulsations. The pulsation velocities of a turbulence calculated on experimental data grow with increase Btan for the subsolar part of the MS and decrease with the increase of Btan tor the flank parts. Theoretical values of scales and the pulsation velocities are compounded with the values obtained in the experimental data. The comparison of the experimental parameters of a turbulence to theoretical estimations of its small-scale structure allowed to estimate the dimensionless numbers of simularity for the MS.
The analysis of data of the experiment on radio translucence «Sura - SC Wind» is compounded with the deductions touching the intensity level of turbulence apparent on SC Interball-1.
The study was performed under the financial support of the RFBR (grant 06-05-64482).

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Barkhatov N.A., Belliustin N.S., Bougeret J.-L., Sakharov S.Yu., Tokarev Yu.V. Influence of the solar wind magnetic field on the Earth 's magnetosheath turbulence behind the bow shock. Radiophysics and Quantum Electronics. 2002. V.44.P. 993

Evolution of large-scale magnetic patterns on the Sun over the solar cycle

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We have used high-resolution measurements of magnetic field at the Kitt Peak National Solar Observatory to study large-scale patterns and their evolution over the solar cycle. An efficient approach based on filter procedure is applied to original synoptic maps. By using this technique we have modeled the solar magnetic field viewed as a star. Our results show that the small-scale magnetic fields play a minor role in the formation of large-scale patterns particularly during a solar minimum. Evolution of the magnetic field over a full magnetic cycle is restored. The proposed technique can trace a neutral line configuration at the solar source of the Heliospheric Current Sheet.

Kinematic reconstruction of the heliospheric current sheet from synoptic charts

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The MHD models, which enable us to obtain the spatial distribution of the magnetic fields and calculate key parameters, require computational power and demand a high level of numerical modeling skills. Though kinematical models are as usual neglected they can be useful in some aspects and can be used as supplements to MTID simulations. In this paper dynamic reconstruction of the heliospheric current sheet (HCS) using kinematical model and smoothed synoptic charts of magnetic fields on the Sun as boundary conditions was performed. We have restored three-dimensional topology of the HCS during some periods of solar cycle (in maximum and minimum of activity). The results provide evident picture of the spatial global distribution of the magnetic fields from 1 solar radius to 5 AU and help to estimate the complexity of the HCS and relative contribution of different factors such as differential rotation, solar wind velocity discontinuity etc. The results also show the determined inconsistency of the direct synoptic charts application and the necessity of improving initial data processing in order to obtain snapshot-like charts.

Solar cosmic ray research with the Baksan neutrino observatory arrays

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Extensive Air Shower (EAS) arrays in a 1-particle operation mode are cosmic ray detectors of great area and appear to be more sensitive than standard neutron monitors to solar cosmic ray at rigidity range > 5 GV. The paper is devoted to the GLE events study with data of EAS-arrays: Andyrchy (37 m2, 2050 m a.s.l.), Carpet (200 m2, 1700 m a.s.l.) and the Baksan Muon Detector (BMD, 190 m2, 5 m w.e., 1700 m a.s.l.) of the Baksan Neutrino Observatory (BNO) located at the North Caucasus (43.28°N, 42.69°E). At the BNO geomagnetic cutoff _ 6GV EAS-arrays were registered 15 of 30 (or 50 %) of total GLE events occurred in the period since 1982. The 20 January, 2005 GLE effect was equal at the Carpet array (0.90±0.03%, 32 sigma) and at BMD (0.22±0.04%, 5.5 sigma). The start of increase was registered at 06:55 UT and maximum - at 07:15 UT. Adding these data to the GLE modeling using neutron monitor data allowed deriving more accurate spectrum of solar protons in the 5-10 GV range. The coupling functions for the Baksan EAS arrays were calculated with KORSICA code.

Variations of neutron component during solar flare on December, 13, 2006 according to the data of Baksan neutron monitor

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According to the data of Baksan neutron monitor (BNM) variations of relativistic solar protons (RSP) and galactic cosmic rays (GCR) are considered during the solar flare on December, 13, 2006. Quit and active days are investigated before, during and after the solar flare. Increase of the Baksan neutron monitor count rate at that moment of registration of GLE event is not significant. However, the appreciable increase of a daily variation of the neutron component next day after flare is observed. It can testify that distributions for RSP and GCR energies and pitch angles on a day of flare and after it are different. Character and probable reasons of discrepancy between semidiurnal increase of count rate at the BNM and duration of clear day are analyzed. The beginning of optical flare is considered, as a natural reference point for studying temporal characteristics of event of RSP and the processes connected to it. After optical solar flare, the longer phase of the ejection and propagation of relativistic solar protons, and of the front of a shock wave and emission of coronal substance (ECS) follows. According to the example of solar flare on December, 13, 2006, general characteristics of variations of neutron component (RSP and GCR) agree well with the classical theory of variations of cosmic rays.

The galactic cosmic ray intensity during the minimum of solar cycle 24 in the inner and outer heliosphere and in the heliosheath

M.B. Krainev (*Lebedev Physical Institute, Russian Academy of Sciences, Moscow, Russia*)

The behavior of the galactic cosmic ray (GCR) intensity in the present-day solar activity minimum is of special interest as 1) for the fist time there are the GCR data for the regions not only inside the termination shock surface but in the heliosheath beyond it as well; and 2) the distribution of the GCR intensity during the present-day A<0 minimum should be much more inhomogeneous than during the previous A>0 minimum.
In the talk we compare the GCR intensity near the Earth with that in the periphery of the heliosphere and discuss our notions of the heliosheath, important for the GCR modulation.

Some new results from the detailed information in the regular balloon monitoring of cosmic rays in Apatity and Dolgoprudny

M.B. Krainev (*Lebedev Physical Institute, Russian Academy of Sciences, Moscow, Russia*)

The long-term experiment of the regular balloon cosmic ray monitoring in the Earth's atmosphere has been carried out by Lebedev Physical Institute, RAS, for almost 50 years (since July 1957) and still provides useful data on both galactic and solar cosmic rays. However there are some flaws in the standard method of data registration which hinder getting good data. To overcome some of these shortcomings we suggested to record beside the standard information so called detailed information (the form and characteristics of every pulse received). By now these data recorded for about 1500 flights: 1300 flights in Dolgoprudny (since May 1996) and 200 flights in Apatity (since October 2005).
In the talk we consider some new important features of the data which could be got only using the detailed information and discuss the influence on the RMCRM data of the varying radio-background.

Solar flare multiwave investigations and a physical model

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Visible and UV radiations are not suitable for hot plasma investigations in the corona. The real information about solar flares can be obtained from X-ray, radio frequency, and relativistic particles measurements. New observations justify the flare scenario predicted by the electrodynamical model based on numerical 3D MHD simulations. RHESSI measurements show the plasma heating above an active region in the place, where current sheet was created due to disturbances focusing. These disturbances arrive from the photosphere in a preflare state. The measured plasma parameters above an active region during the flare correspond to plasma heating (T~3keV) in the current sheet due to the magnetic reconnection. Phenix-2 radio telescope measurements show a high frequency continuum appearing simultaneously with hard X-ray pulse (t~1min). The radio continuum frequency (1.5 – 15 GHz) corresponds to the plasma frequency obtained from X-ray measurements. The current sheet magnetic field obtained from MHD numerical simulation is in agreement with the observed plasma pressure. The photospheric hard X-ray sources seem to be created by electrons accelerated in the electric field applied along the magnetic lines. Applications of solar flare models that used magnetic tubes interaction and magnetic ropes ejection with a current sheet appearance are also discussed.

Magnetic field dynamics above the active region AR 0365 in preflare state

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According to observation data primordial solar flare energy release takes place in the solar corona above an active region. It can be explained by energy accumulation in the magnetic field of a current sheet (CS), which is created in the vicinity of a singular line in the corona by focusing of disturbances. After the quasistationary evolution the CS transfers into unstable state, and explosive energy release occur, which causes the flare and/or CME. For the MHD simulation of flare energy accumulation in the corona above the real active region all conditions must be taken from observational data. The initial magnetic field must be set several days before the flare, when currents in corona are practically absent. To obtain the potential field using photospheric line-of-sight field distributions obtained by SOHO MDI, the method of numerical Laplace equation solved with inclined derivative as the boundary condition is developed. For MHD simulation it is necessary to set the evolution of two magnetic field components parallel to the photosphere, but now such data are not available for the active region AR 0365. The calculated potential field is used for setting such a boundary condition in each moment of time. This method of boundary condition setting is valid, because the magnetic field on the photosphere is defined mainly by currents under the photosphere. Thus, we have a possibility to obtain more properly all main field singularities in corona, than for the magnetic field

approximation by dipoles or magnetic charges used in previous works. The MHD simulation for the real active region faces some difficulties due to numerical instabilities near the boundary of the computational domain. To stabilize such instabilities a number of numerical methods are developed and programming is implemented in the PERESVET code. The finite-difference scheme for MHD equations is absolutely implicit, and it is conservative, relative to the magnetic flux. In the regions near the boundary there is additionally used the artificial viscosity. The calculations permit to obtain a stable solution near the nonphotospheric boundary, if the size of a photospheric boundary of the computational domain is at least exceeds several times the size of the active region. The previous calculations for the active region AR 0356 show the appearance of an instability near the nonphotospheric boundary for the size of the photospheric boundary of the computational domain equal to 1.2×10^{10} cm. The MHD calculation for the size of the photospheric boundary equal to $4x10^{10}$ cm shows the absence of instabilities near the nonphoptospheric boundary. For the size of $4x10^{10}$ cm the potential field posses all main singularities of AR 0365 field. The calculations of potential field are performed for regions with sizes $1.2x10^{10}$ cm, $1.5x10^{10}$ cm, $2x10^{10}$ cm, $4x10^{10}$ cm and $6x10^{10}$ cm. The MHD calculations during three days show several CS creation in the corona in the vicinities of singular lines. The results of simulations permit to find the positions of emission sources, caused by explosive energy release in the created CS and compare it with the observations of emissions in different ranges (radio. optical, X-rays) for all flares of May 26 and 27, 2003. The performed simulation shows the possibility of further updating of numerical methods for acceleration of calculations.

Diurnal variation of cosmic ray intensity

V.C. Roldugin *(Polar Geophysical Institute, Apatity, Russia*)

The morphology of diurnal variations of the cosmic ray intensity is studied using data from 17 stations for 1985 and 1986. Theses variations are most intensive at geomagnetic latitudes between 40° - 60° and are controlled by magnetic local time. Their maximum occurs at 1300 – 1500 MLT . The amplitude is highly changeable and reaches to 0.8%; strong variations continue for 1-3 weeks. According to the Apatity neutron monitor data for 1985-2000, these periods are reliably characterized by Kp, Ap, Ae and WN indexes increase, but the correlation coefficients are not too large (cc=0.20 – 0.22).

Fractal characteristics of heliosphere plasma layer transitions in 2006

T.E. Val'chuk *(Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (IZMIRAN) RAS, Troitsk of Moscow region*)

The detailed study of heliosphere plasma layer transitions is performed in the decline phase of solar activity on the yearly interval of 2006. The annual list of sector structure transformations is constructed on the basis of the ACE spacecraft data. Parameters of the solar wind (SW) plasma and interplanetary magnetic field (IMF) in the near-Earth cosmic space (revealed from the Wind spacecrafts data) are used in the analysis of fractal dimension variations calculated for the intervals of these IMF polarity transformations. SOHO and LASCO spacecraft materials, representing the situation in solar activity phenomena on the Sun, allow us to understand the solar prehistory of the SW flows expanding to the Earth orbit. MDI magnetograms of the Sun give the opportunity to reconstruct the position of large unipolar regions in the equatorial belt of the solar disk, which is revealed in the sector structure of IMF parameters of SW flows after its expanding up to the Earth. The fractal characteristics of SW plasma and IMF show the fractal dimension falling down to ~1.5 in the regions of heliosphere plasma layer transition. The fractality of SW flows is discussed.

Relativistic solar cosmic rays in the December 13, 2007 GLE

E.V. Vashenyuk, Yu.V. Balabin, B.B. Gvozdevsky, L.I. Schur (*Polar Geophysical Institute, Apatity, Russia*)

Characteristics of relativistic solar protons (SRP) have been derived using optimization methods from the data of ground based cosmic rays detectors in the event of December 13, 2006, which occurred in conditions of the solar activity minimum. The SRP dynamics during the event has been investigated. There has been demonstrated the existence of two populations (components) of particles: a fast one and a lagging (slow) one. The fast component with a rigid energetic spectrum and strong anisotropy is manifested by a pulse like increase at stations Apatity and Oulu receiving particles at small pitch-angles. The lagging component has a wider pitch-angle distribution, which

stipulated the effect of moderate increase at Barentsburg station and the majority of neutron monitors of the worldwide network. A good agreement of energetic spectra, obtained from the data of ground-based observations with the data of direct measurements of solar protons by balloon-sounds in Apatity and onboard spacecrafts is found.

Cosmic ray research in Spitsbergen

E.V. Vashenyuk, B.B. Gvozdevsky, Yu.V. Balabin, L.I. Schur (*Polar Geophysical Institute, Apatity, Russia*)

By spring 2003 the 6-HM-64 neutron monitor was installed and put in operation in the Russian settlement of Barentsburg in Spitsbergen archipelago (N78.5 E 15.1). For the first time, the registration of cosmic rays started at this unique high latitude point of the Earth. Using a neutron monitor in Barentsburg 3 events of relativistic solar cosmic rays (SCR) were registered: 28.10.2003, 29.10.2003 and 2.11.2003. The analysis using the data of the worldwide network of neutron monitors and computations of their asymptotic cones has shown the steady north-south anisotropy in a relativistic SCR flux during all three events. The cause of this anisotropy could be an asymmetry in the large-scale IMF structure, generated under the action of a number of consecutive coronal mass ejections (CME) from a complex of active regions on the Sun in late October, 2003. With installation of a neutron monitor in Spitsbergen the opportunities of studying cosmic rays coming from high latitude areas of the heliosphere and the Earth magnetosphere have considerably extended. The instrument is equipped with modern computerized data collecting system and presenting data in real time in the Internet.

Первые результаты измерений высотного хода концентрации озона в Антарктиде на станции Новолазаревская в 2006 г.

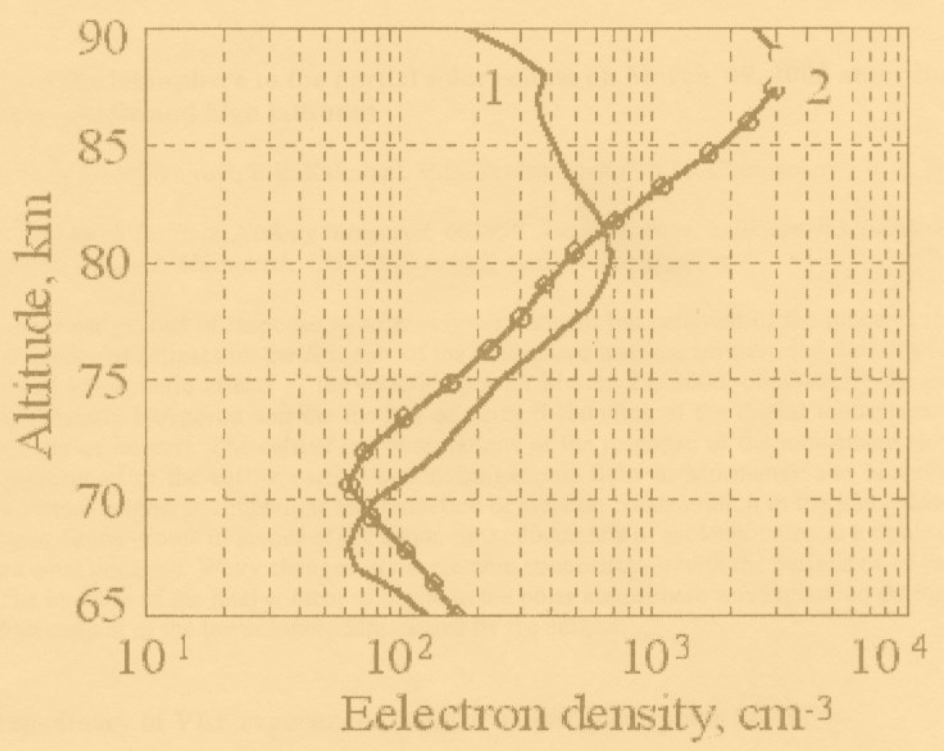
А.А. Иванов, А.С. Петкун, Т.И. Сысоева, В.П. Челибанов (*Физический институт им. П.Н. Лебедева, Москва, Россия*)

В докладе будет рассмотрен первый опыт измерения концентрации озона прибором, разработанным ООО «Оптек» Санкт Петербург.
Измерения проводились в трех фиксированных точках по высоте еженедельно в течение года.
В тоже время фиксировались метеопараметры точки измерений.
Будет представлена схема прибора и алгоритм обработки данных.
В докладе будут показаны выборочные таблицы измерений высотного хода озона и метеопараметров, видео и фото материалы эксперимента.

Обзор аэростатных измерений в Антарктиде за 2002 – 2006 годы

Т.И. Сысоева (*Физический институт им. П.Н. Лебедева, Москва, Россия*)

В докладе будут представлены программы аэростатных исследований 48 – 52 Российских Антарктических Экспедиций в Антарктиде.
Основные работы проводились на станциях Новолазаревская, Прогрес, Восток и на борту научно-исследовательского судна «Академик Федоров».
За обзорный период все исследования велись только на привязных аэростатах отечественного производства: МПА, ПАК – 60, АПА – 1.
Ведутся подготовительные работы к старту свободных (автоматических) аэростатов, предположительно со станции Прогрес – 2, по циркумполярному вихрю.
Будут представлены результаты измерений в виде таблиц, графиков, рисунков и видеоматериалов.


90
85
80
75
70
65
Altitude, km
1
2
10 1
10 2
10 3
10 4
Eelectron density, cm-3

The simulation of the ionospheric electric potential distribution with field-aligned currents satellite data and the model of inhomogeneous ionospheric and magnetospheric conductivities

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The response of the modelled electric potential distribution to the Region 1 and Region 2 field-aligned current (R1 and R2 FAC) variations was studied using the framework metamodel approach that allows to couple different models of atmospheric regions and processes (from the basic to comprehensive ones). For simulation the following subordinate models were taken: a filed-aligned currents model, an electric potential model, a model of inhomogeneous ionospheric and magnetospheric conductivities. These models were linked through the framework atmosphere model architecture. The average R1 and R2 FAC distributions derived from Dynamics Explorer 2 and Magsat satellite observation were used as the model input. We have used different methods of ionospheric and magnetospheric conductivities specification to study the electric potential behaviour under quiet and disturbed helio-geophysical conditions. For the comparison we use the calculation results of the corresponding modules of the Upper Atmosphere Model (UAM) with the same input data. This study was supported by the grant N 05-05-97511 of the Russian Foundation for Basic Research.

The response of the ionosphere to the partial solar eclipse on March, 29, 2006 according to observations at middle and high latitudes

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The majority of investigations of response to solar eclipses concern the behavior of the ionosphere at heights over 100 km. The influence of eclipses on the *D* region of the ionosphere was less investigated. For this reason the results of observations of ionospheric effects of the solar eclipse on March, 29, 2006, obtained by the method of partial reflections near Nizhniy Novgorod and the method of vertical sounding at the digital ionospheric station "Bazis" near Murmansk are of interest. The carried out observations of the response of the ionosphere to the solar eclipse qualitatively correspond to the earlier carried out investigations. Both in Murmansk and Nizhniy Novgorod the increase in the virtual heights of reflections and reduction of electron concentration in the ionosphere was registered during the eclipse. Some proofs in favour of the action of the linear law of recombination at heights of the lower part of the *D* region were obtained. Wavy changes of the electron concentration with the periods of 15 minutes and more were found. The increase of the total content of ozone in the polar atmosphere was registered during the decrease of the total electron content of the lower ionosphere caused by the eclipse.

About the expediency or VLF experiment reconstruction at the polar latitudes

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G.F. Remenets (*Radio Physics Institute, St. Petersburg State University, Russia*)

As known from the theoretical analysis (solution of an inverse VLF problem) of the RAS Polar Geophysical Institute experimental data there is a new geophysical phenomena – appearance of a sporadic D-layer (SDL) of ionization in the polar atmosphere (the height interval ~ 10 – 40 km) [1, 2]. The space and time scales of the events are equal to a few thousand km along the longitude, nearly one thousand km along the latitude and tens of minutes or a few hours. The value order of the electric conductivity in the SDL is the same as in the regular D layer (RDL), but in the former the property is produced by some 10^6 - 10^7 ions. per cm^3 at the 30 km height.
According to the experimental data it was stated, that the ionization flood, producing the SDL, is characterized by a cutoff near 60 degrees of the latitude. This fact means that the prime ionization flood has the corpuscular nature. Using the solar proton monitoring, it was concluded that the prime flood consisted of electrons. The electrons are ultrarelativistic with energy of nearly 100 MeV as only such electrons are capable of generating some tens percents of their kinetic energy into X rays and gamma rays due to their friction in the middle atmosphere at the attitude of nearly 40 km. The secondary flood of the rays ionizes a part of the atmosphere below in the interval of 10 – 40 km.
So if in 1926 the fact of RDL was established using the Holingworth curves, then 55 - 60 years after by the similar VLF radio wave propagation technique the phenomenon of SDL in the polar middle atmosphere was established

too. The importance of this fact for the vital objects placed at the altitudes of radiation and the possible danger for the telecommunication systems from the ultrarelativistic electrons are evident. So it is necessary to implement an international program for continuation of the ground VLF studies, which are uncomparably cheaper than satellite monitoring, which has not been carried out so far in the range of the ultrarelativistic electrons.
The result of the quantity analysis of the 10-th of April 1992 strong disturbance is presented. In the maximum of disturbance the effective height lowered to 40 km, which is significantly lower than in the eases of the most intensive events of solar proton precipitations.

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The influence of the sub – IAR structure on the artificial ULF signal spectra

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The influence of the highly non uniform sub – IAR structure on the amplitude spectra of the signals generated by the Kola ground based ULF facility in the frequency band 0.5 – 12 Hz was investigated using numerical simulations. The sub – IAR structure exists due to the strong variation of the refractive index of normal waves in the ionosphere at the heights interval between the basement and 200-300 km. It was shown in the article [1] the sub – IAR structure is responsible for the forming the broad spectral maximum (BSM) in the background magnetic noise at frequencies (2-6) Hz. The strong difference between day and night spectrum shapes of artificial signals was detected during the 1998 & 2001 experimental campaigns using the Kola ground based ULF facility [2,3]. Namely, there was detected the increase of the signal amplitude on frequency at distances of about 1000 km in the night time. The numerical simulations for the magnetic components of the signal generated by the horizontal magnetic dipole (such approximation is valid for the Kola ULF emitter at long distances) were carried out for different ionospheric conditions. There could be drawn a conclusion that the experimentally observed spectral peculiarity of the night signal spectra may be explained by the presence of the sub – IAR structure in the lower ionosphere. Such conclusion is based on the comparison of the calculated spectra, the refractive index profiles and the experimental data.
The study was supported by the RFBR N 04-02-17333grant.

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Response of LEO satellite drag parameters and total electron contents to anomalies in the upper atmosphere during extreme solar events

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Low Earth orbiting (LEO) spacecraft is a vital instrumentation for the investigation of the current status of the Earth and its change. Numerous satellite missions were launched aiming to extend the knowledge of the detailed structure of the Earth's gravity field. In order to separate the signal from noise the modeling of the non-gravitational forces acting on the spacecraft is of major importance. For LEOs the atmospheric drag is in particular difficult to model since it contains both time and space related effects. It depends among others on the solar activity measured by the intensity of the solar radiation or magnetic activity.
We analyze Precise Science Orbits and Level 2 Products of the German CHAMP (CHAllenging Mini-Satellite

Payload) mission, which was launched in July 2000 to a height of 450 km and steadily decreased to about 350 km height, in order to detect anomalies in the behavior of the along track acceleration arising from drag effects. We predict precise reference orbits for short passes in the region where coronal mass ejections and flares are expected to have their impact on the ionospheric density profile and compare this data with the post-processed precise orbit.
We further checked the TEC (total electron content) maps of IGS (Int'l GNSS Service) which are derived from GPS measurements from more than 100 stations concerning an extraordinary change of the ionosphere. We used GPS week 1405 for the time series and the deviation from the mean was calculated for the same time of each day to eliminate the daily variations. The resolution is 5x5 degrees in latitude and longitude and two hours in time. We found the VTEC values exceeding the mean values of this week, rising up to 300% of the mean.

Modeling of the ionospheric electron density dependence on the soft electron precipitation during geomagnetic storm on 26 October – 01 November 2003

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Reconstruction of the electron density spatial distribution obtained from the satellite radio tomography data during the geomagnetic storm on 26 October – 01 November 2003 has been compared with the numerical modeling results produced by the well-known ionosphere models: two variants of the global numerical upper atmosphere model UAM (with the empirical thermosphere model MSISE00 (UAM-MSIS) and the self-consistent variant with the theoretical thermosphere (UAM-T)) and the empirical ionosphere model IRI-2001. As a whole the subauroral and high-latitude ionosphere behavior observed by the radio tomography in the European-Arctic (the Kola Peninsula – Moscow) longitude sector is satisfactorily described by the global theoretical upper atmosphere model (UAM-T) both in the quiet and extremely disturbed conditions. The observed data agree with the theoretical results better than with the empirical ionosphere model IRI-2001. The UAM provides a good agreement with the observed ionospheric trough dynamics, in particular with the polar boundary position. Divergence occurs in some characteristics of the high electron density regions, related with the energetic electron precipitation. It is demonstrated, that decrease of such divergence can be achieved by correction of the initial specified input distribution of precipitating from the magnetosphere energy electron fluxes, especially by increasing the soft precipitating electron intensity (average energy E ~400 eV) and latitudinal extending of the precipitation zone.
This study was supported by the Grant N 05-05-97511 of the Russian Foundation for Basic Research.

The anticorrelation between SRS and geomagnetic activity levels at mid latitudes

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April 2006 was chosen for the analysis of the dependence of the intensity of the background noise Spectral Resonance Structure (SRS) on the magnetic activity. This month was characterized by moderate activity with several separated magnetic events and plenty of quiet days. The data collected at mid-latitude New Life station ((NL, 55,97^{O} N., 45,74^{O} E.) were processed for obtaining the ULF spectra. The SRS spectrograms of the D component (as more dominant and detected practically every night) were evaluated tor four levels: strong – 9, moderate – 6, week – 3 and 0 – the absence of any one. The K index of magnetic activity was picked up at the Sodankyla Geophysical Observatory (http://www.sgo.fi/Data/archive.php). There was chosen the daily sum of K index from H, D components of Sodankyla magnetometer divided by the factor of 5 for matching the SRS level scale. The very distinct anticorrelation exists between SRS and geomagnetic activity levels. Such behavior of SRS spectra could be explained by the change of ionospheric conditions (the growing attenuation in the *E*-layer, the dumping electron density at the maximum of F-layer, the changing ULF refractive index profile, etc).
The authors are very grateful to the SGO observatory for using the magnetic data from their site.

A thermospheric model of the early Martian atmosphere

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A thermospheric model of the CO_2-rich Martian atmosphere exposed to intense XUV flux that was expected during the Sun's evolution has been developed to study its photochemistry and thermal balance that are essential for determining the evolution of the Martian atmosphere with regards to its CO_2 and H_2O inventory. During the first Gyr after the Sun arrived to the Zero-Age-Main-Sequence, high XUV radiation fluxes in a range from about 10 to 100 times the average flux of the present Sun were expected to be responsible for much higher temperature in the thermosphere and exosphere of the planet. The diffusive-photochemical and thermal balance model of the early Martian thermosphere and ionosphere has been applied for investigating the solar radiation impact due to photodissociation and ionization processes, heating in exothermic chemical reactions, and cooling by the CO_2 IR emission in the 15 μm fundamental band. Neutral chemical composition of the early Martian thermosphere has been calculated and an important effect of the FUV-radiation of the young Sun on both chemical and thermal upper atmosphere structure demonstrated. It has been found that high XUV radiation flux results in a hot and expanded early thermosphere with the exobase level as high as about several thousand km (4.5 Gyr ago). Model simulations also indicate that the high temperature of the early Martian thermosphere could result in "blow-off" conditions for neutral hydrogen atoms even for high CO_2 atmospheric mixing ratios of 96%.

Response of planetary atmospheres over time to extreme solar conditions

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The European Commission will announce the call for Research Infrastructure proposals for its 7-th Framework Programme (FP7) in Autumn 2007. In preparation for this, we participate in the EUROPLANET (European Planetology Network: http://europlanet.cesr.fr) project with a *J*oint *R*esearch *A*ctivity related to the "Response of planetary atmospheres over time to extreme solar conditions." The scientific focus of this planned *JRA* is a coordinated study of the behaviour of the upper atmosphere, ionosphere, magnetospheric environment and thermal and non-thermal atmospheric loss processes of Earth, Venus, and Mars during "extreme solar events". Such events can serve as a proxy for the influence of the active young Sun with implications for the evolution of planetary atmospheres (solar system and even beyond -exoplanets), water inventories and habitability. The extreme events studied by our team involve enhanced solar EUV and X-ray radiation, neutron fluxes, coronal mass ejections (CMEs) and related intense solar proton/electron fluxes (e.g., SPEs), auroral phenomena, magnetic storms, etc. and the related responses of planetary atmospheres include: thermospheric and ionospheric density variations, changes in atmospheric composition including ozone depletion leading to changes in heating/cooling, temperature and wind perturbations, photochemistry, collisional excitation, deactivation and cooling due to IR-, optical and UV-emissions, magnetospheric compression, enhancement of secondary particles, etc. Studies of the evolution of the spectral irradiances (X-ray, EUV, UV) of solar-type stars of different ages will be used as a proxy for reconstructing the history of the Sun's radiation output. Complementary information concerning solar mass loss (solar wind) will be

derived from studies of the energy distributions of flare related CMEs during low and high solar activity by extrapolating CME related solar mass loss to the early stage of the solar system using solar proxies. The available resources or our team contains both, space based and ground based data sets as well as theoretical tools.

Space based and airborne data sets:

Energetic particle data (40 keV, several 10s MeV) recorded at L1 over eleven years by the LION instrument on SOHO, data which will be obtained by the WAVE instrument on board of STERO, particle, near-Earth proton fluxes will be used from GOES satellites, magnetic field and electromagnetic data from the Phobos 2 mission to Mars and its Moons, plasma data from ASPERA-3 (Mars Express / MEX) and ASPERA-4/magnetic MAG data (Venus Express / VEX), CLUSTER and Double Star, ENA data from MEX, VEX, and NUADU (Double Star). Density and temperature changes in the Earth's thermosphere during extreme solar events will be analyzed using low perigee satellite data (e.g., CHAMP, GOCE). Short/medium duration ionospheric disturbances can be monitored using GPS and GLONASS transmissions revealing large variations in the northern hemisphere total electron content (TEC). Europe's GOMOS/Envisat instruments provide observations of both short-term (days) and long-term (months) atmospheric effects caused by extreme solar events such as SPEs. GOMOS which was developed at the FMI measures e.g. ozone, NO_2, and NO_3 in the stratosphere and mesosphere. Data obtained by the Millimetre-wave Airborne Receivers for Spectroscopic CHaracterisation in Atmospheric Limb Sounding (MARSCHALS) project will be utilized to analyze the chemistry and composition in the Earth's thermosphere. Solar and stellar data needed for the reconstruction of the history of the Sun's radiation and particle emissions will be available from observations obtained aboard the SOHO, STEREO, ASCA, ROSAT, EUVE, FUSE, and IUE a satellites . New specific observations will be obtained by XMM/Newton, Chandra and Suzaku. Feasibility studies to observe the stellar hard non-thermal emission with Symbol-X will be performed.

Ground based observations:

These observations will include radio tomographic monitoring of the TEC allowing reconstruction of the 2-D structure of the terrestrial ionosphere/thermosphere during extreme solar events. Parameters of the ionosphere will be determined using the EISCAT radar network and magnetometer chain in northern Europe. Furthermore, continuous registration of cosmic rays by the Russian (PGI) neutron monitors located at high latitudes will be used to provide ongoing diagnostics of the near-Earth space environment. A technique is available to identify the characteristics of relativistic solar protons and their sources on the Sun from the data of ground based cosmic ray detectors.

Modelling tools:

Test-particle/Monte Carlo, MHD, hybrid, diffusive-photochemical, thermal balance, and global circulation models are available for: investigating ionized and neutral atmospheres, solar wind/planetary interactions, and particle energy deposition in the upper atmospheres. The 1-D Sodankylä Ion and Neutral Chemistry Model will be used to study the ionospheric-atmosphere interaction processes, caused by e.g. proton/electron precipitation or X-ray flares, which lead to changes in atmospheric composition.

We outline on this poster the scientific idea behind our project which will connect existing and establish new databases concerning planetary responses to extreme solar events made available to the general scientific community. Besides the relevant enhancement in science the results of our JRA will have interesting synergies to space weather effects on satellites (drag, anomalous behaviour / failure), navigation and tracking difficulties, spacecraft/mission design, as well as radiation hazard issues for future manned missions (e.g., Moon, Mars).

Hot particle populations in the upper atmospheres of terrestrial planets

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Planetary atmospheres not only consist of the thermal background gas but also of a number of particles with distinctly higher energies. They are produced by various photochemical processes in the planetary ionosphere-thermosphere and populate the upper atmosphere. Based on a Monte Carlo model, energy and density distributions of these species at the exobase are calculated, which in turn provide the input for a simple numerical exosphere model. Examples of our results are shown for Venus and Mars for low and high solar activity as well as for Mercury, which is different inasmuch as it holds only an exosphere. The importance of the hot particle populations for the atmospheric loss process is discussed and their relevance for the atmospheric evolution of Earth-like (exo)planets is emphasized.

Numerical modeling of the large-scale modification of the daytime middle-latitude F2 layer by powerful HF waves with different frequencies

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Mathematical models of the ionosphere may be applied to predict the large-scale F2-layer modification by high power radio waves. One of such models has been developed in the PGI. This model has been recently utilized to study the expected F-layer response to powerful HF waves for the "Sura" heating facility (Nizhny Novgorod, Russia) for nocturnal conditions (*Mingaleva and Mingalev*, 2006). It has been found that the strong dependence exists of heater induced electron temperature and concentration changes at the level of the F2-layer peak on the incident wave frequency for nocturnal conditions.
The purpose of this paper is to examine how the pump frequency affects the changes in the large-scale structure of the middle-latitude F2 layer near the "Sura" heating facility for daytime conditions. It appears that the most effective frequency for the large-scale F2-layer modification by powerful HF waves exists for daytime conditions. To obtain the maximal effect of HF heating on the electron concentration at the level near the F2-layer peak, the ionospheric heater has to operate at a frequency slightly less than the F-layer critical frequency. Relative amplitudes of variations of ionospheric quantities, produced by the HF heating, ought to be less for daytime than for nocturnal period.

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The role of the atomic oxygen concentration in the ionization balance of the lower ionosphere during solar proton events

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The height profile of atomic oxygen concentration is one of the most important parameters in the theoretical considerations concerning the ion composition and electron density in the lower ionosphere. In the absence of experimental data on the atomic oxygen concentration at altitudes below 85 km, theoretical profiles O(h) estimated with diffusive-photochemical models are used. Variations in such estimates can exceed an order of magnitude. In the present paper we investigate the influence of the atomic oxygen concentration on the ionization balance at mesospheric altitudes during a Solar Proton Event (SPE) on 17 January 2005. The ion loss rate of NO^+ and O_2^+ through the formation of hydrated ion clusters: $NO^+ \rightarrow NO^+(H_2O)_n$ and $O_2^+ \rightarrow O_4^+ \rightarrow O_2^+(H_2O)_n$ as well as the ion loss rate of O_2^- through formation of complex negative ions, are estimated based on an ion-chemical model of the D-region and theoretical O-profiles with maximal and minimal values. We also estimate the effective rate coefficients for the competing processes of NO^+, O_2^+ and O_2^- loss in the reactions with the atomic oxygen.
It is demonstrated that , when the atomic oxygen concentration in the mesosphere is increased by 4-5 times, the maximal height where the ion cluster formation ceases is decreased by 3-4 km. The maximal height for the formation of complex negative ions is decreased by 5 km by changes in the O-profile. The increase of the O-concentration leads to the decrease of the λ=N-/Ne and f+ parameter (which describes the ratio of simple positive molecular ions to cluster ions), which in turn results in a decrease in the effective recombination coefficient and in an increase of the electron concentration. Taking into account available different models of atomic oxygen, the electron density estimated during the SPE at 09:50 UT and 12:30 UT on 17 January 2005 is increased by 2-2.5 times at h<70 km when O is increased by 4-5 times. Therefore, the choice of profile for atomic oxygen is critical, influencing the model accuracy for ion composition, effective recombination coefficient and electron concentration. It is shown that, during SPE, when the ionization of the mesosphere is of a high degree, the experimental data on the electron density obtained with the incoherent scatter technique as well as with partial reflection technique may be used as a criterion for choosing the O-profile.

Magnetic disturbances produced via ionosphere electron heating in the vicinity of auroral electrojet

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A more realistic model of the magnetic disturbances produced by the ionosphere electron heating in high latitudes is proposed. The heated volume of the ionosphere is located at the border of a band of enhanced conductivity and current density, as well as outside and inside the band. The calculated magnetic disturbances have been compared with those for homogeneous case. The magnitude of the disturbances in their maximums does not differ significantly, however, isocontours of the disturbances in the vicinity of the inhomogeneities are stretched along the border. So, the observation of the artificial disturbances is possible far away from the heating site under the condition of the auroral electrojet and/or inhomogeneous conductivity.

Evaporation of close-in giant planets due to intense XUV radiation

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Astrophysical observations of young stars indicate much larger X-ray and EUV fluxes than stars with the age of our present Sun. Because of this one can expect that during and after giant planet formation the early high radiation flux of a parent star in the short wavelengths will have great impact on atmospheric loss from such a planet . We discuss physical conditions under which hydrodynamic “blow off” can occur and solve the system of hydrodynamic equations for a hydrogen atmosphere to study thermal escape processes from a “Hot Jupiter”. We show that at very high EUV fluxes the incoming stellar energy is converted into kinetic and thermal energy of planetary hydrogen wind, which can significantly erode the planetary atmosphere. Additionally, Roche lobe effects are considered since they can dramatically increase the loss rates from gas giants at very close orbits.

Generation of circular large-scale traveling ionospheric disturbances in the auroral zone

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We proposed methods for visualization of a wave front of auroral traveling ionospheric disturbances (TIDs) on the basis of phase measurements of the total electron content (TEC) using the international GPS network. For definition of the wave front shape, phase velocity and source coordinates of the TID during large magnetic storm on 29.10.2003 we used the data obtained by GPS receivers located in five sectors of the northern hemisphere: West-American, East-American, European, East-Asian and Far-Eastern. The proposed methods make it possible to determine experimentally that the large-scale wave of a solitary type with the circular front shape is generated in the northern ionosphere as a result of auroral perturbation. The apparent center of this TID is located near the geomagnetic pole. The wave has a period of about 40-60 min and travels equatorward at the distance of up to 4500 km. The TID velocity in different sectors varies from 700 to 1200 m/s. Such wave disturbance is characterized as ionospheric response to the sudden storm commencement (SSC) and occurs during sharp changes of the Earth magnetic field. The relative amplitude of TID dI/I is of the order of 10-14%. The comparison with the ionosonde data has shown that this value of dI/I corresponds to the relative amplitude of electron density disturbance in the maximum of the F-layer up to 40%.

The method of determination of the SRS characteristics and its application to a case study of sharp changes of the IAR properties during a substorm

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The ionospheric Alfven resonator (IAR) has a ground-based magnetic signature, called a spectral resonant structure (SRS). Evaluation of IAR parameters from SRS observations is an important problem. Most results in this field have been revealed by visual inspection of spectrograms of geomagnetic fluctuations in the range of 0.1-10 Hz. At the same time some attempts have been also undertaken to develop automated methods of the SRS analysis. The conventional approach often applied to acquire the spectral scale (the difference between SRS eigenfrequencies) is to represent spectra as pseudo-spectra. We present a similar data processing scheme, which, however, makes use of the fact that if the resonator input is white noise then its output may be accurately represented by an autoregressive model (Maximum Entropy Method). The virtue of this approach is that the maximum of autoregressive presentation of pseudo-spectra may be evaluated easier and more reliably than from pseudo-spectra obtained by Fourier transform. We process several events, which show that the use of physical model in data processing ensures robustness of results.
In particular, the SRS event of 24 December 2005 registered in Barentsburg, Svalbard is to be of great interest, because our method displays a feature that can be hardly revealed from visual inspection. This feature is a sharp increase of the SRS frequencies and frequency scale. The increase took place during a substorm. The substorm occurred just poleward of the Scandinavian coast and was documented by data from ground-based magnetometers of the IMAGE network and by all-sky TV camera observations in Barentsburg. The ground data show that the substorm auroras and electrojet propagated toward the pole, and at the maximal stage of the substorm stopped at the several tens of kilometers distance southward of Barentsburg. The changes in the SRS characteristics were registered right at this time. According to the IAR theory this can be interpreted as the effect of depletion of the F-region. Some past studies demonstrated the existence of the F-region depletion (the auroral ionospheric cavity) juxtaposed with the poleward edge of the substorm auroras. This cavity is due to the downward field-aligned current closing the upward current related to auroras. Thus, our interpretation is that in the fortunate case under study the cavity appeared just above the SRS observation point, and the related ionospheric modification produced a sharp increase of the IAR/SRS eigenfrequencies and frequency scale.
The study was supported by the RFBR grant No 05-05-64214 and by research program of the Presidium of RAS No16 (part 3) “Solar activity and physical processes in the Sun-Earth system”.

The newly constructed meridian spectrometer S-180: Design, calibration and preliminary results

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We present S-180 meridian spectrometer constructed for studying the spectral composition and spatial distribution of the nightglow and aurora. The spectrometer is able to obtain the spectral image along the main arc of sky hemisphere. It has the spectral range of 380÷875 nm. It operates at the rate of 1 frame/min. The device can work both offline and as a part of a computer network. The calibration of spectrometer aimed to correct both geometrical distortion and photometric errors specific to CCD imaging devices. We present our estimates of sensitivity, spectral range and especially system noise characteristics. In order to correct these errors automatically we built a mathematical model describing CCD matrix parameters and developed a software package for semi-automatic data processing. The preliminary results obtained in Barentsburg (Spitsbergen archipelago) are presented. These results demonstrate that the spectrometer is an informative tool for studying processes in the upper atmosphere. When combined with an all-sky camera the device provides the broad view of the general auroral situation necessary for interpretation. This instrument can be used for observation of both auroras and nightglow as well as for monitoring of the lower atmosphere condition. The software used in data acquisition system offers flexibility, which allows to realize an extensive range of operation modes. The device is operable under the most heavy field conditions.

Modeling of seasonal effects of geomagnetic storms in the Eastern Asia ionosphere

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The results of studies of ionospheric effects of geomagnetic storms observed in different seasons are presented. The morphological analysis is performed using the data of the network of ionospheric stations located at different latitudes in the longitudinal sector 90--130° E. Significant differences in the ionospheric response to a geomagnetic storm are obtained depending on latitude and season. At middle latitudes, the most interesting is the fact of prevailing of the positive and negative phases of ionospheric disturbance in winter and summer, respectively. For interpretation of the observed variations in the ionospheric structure, a modeling is performed, using a theoretical ionospheric model. The analysis of the processes governing the response of the midlatitude ionosphere to a geomagnetic storm showed a good agreement between the results of modeling and measurements and made it possible to detect the determining role of the neutral composition in the observed variations in ionospheric parameters. At auroral and subauroral stations, the variability of electron concentration during a storm is much better pronounced. According to the results of the analysis of the trajectories of the ionospheric plasma convection, this variability is caused by the joint action of the convection and energetic electron precipitations. The disturbances in the neutral composition in this latitudinal region influence the background electron concentration level.

Response to the June 17, 2006 earthquake in the lower ionosphere

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A strong earthquake with the magnitude of 7.7 points took place on 17.07.2006 at 08.19.25UT on the western coast of Indonesia (-9.33°, 107.26°) in very quiet conditions in the geomagnetic field (ΣKp=5). This paper analyses the experimental data, obtained in the Kola Peninsula to identify any response to the earthquake. During the considered days – July 16-18, according to satellite data (GOES11, GOES12) there was observed quite insignificant X-ray emission with the wave length <0.5-4A°. There was not observed any absorption of cosmic radio emission according to the data of Ivalo riometer. From the daily amplitude spectra of July 17 there were found oscillations periods of a few hours. Prior to the beginning of the earthquake of July 17 the amplitude of ordinary component of the wave decreases abruptly at the altitude of 101 km as well as the electron concentration and the critical frequency of the sporadic layer. The obtained profiles of electron concentration using the method of partial reflections have shown that at the moment of the earthquake the altitude of the maxima of electron concentration increased a few km (3-5 kms) and additional maxima appeared. Oscillations of the signal amplitude with periods of a few hours had been caused by inner gravitational waves. Atlassov K.V. et al. (1978) showed, that such periods were typical for inner gravitational waves, registered at the altitude of 90 km in Yakutsk.

Influence of magnetospheric inputs definition on modeling of ionospheric storms

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Usually for numerical modeling of ionospheric storms corresponding empirical models specify the parameters of neutral atmosphere and magnetosphere. Statistical kind of these models renders them impractical for the simulation of the individual storm. Therefore one has to correct the empirical models using various additional speculations. The influence of magnetospheric inputs such as distributions of electric potential, number and energy fluxes of the precipitating electrons on the results of the ionospheric storm simulations has been investigated in this paper. With this aim for the strong geomagnetic storm on September 25, 1998 hour global distributions of those magnetospheric inputs from 20 to 27 September were calculated by the magnetogram inversion technique (MIT). Then, using a 3-D ionospheric model two variants of ionospheric response to this magnetic storm were simulated using MIT data and empirical models of the electric field (Sojka et al., 1986) and electron precipitations (Hardy et al., 1985). The comparison of the obtained results showed that for the high-latitude and subauroral stations the daily variations of electron density calculated with MIT data are closer to the observations than those of empirical models. In addition using the MIT data allows revealing some peculiarities both in the daily variations and global distributions of electron density during the strong geomagnetic storm.

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The application of the ELF electromagnetic waves to ionospheric studies by means of the ground-based vertical sounding technique

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Extra low frequency (ELF) waves (3-300 Hz) have not yet been used in the vertical sounding of the ionosphere before. Papers dedicated to ionospheric studies have been claiming the ELF electromagnetic field with frequencies under 30 Hz could not be affected by the ionosphere at distances less than the equivalent height of the ionospheric waveguide (the lower ionosphere altitude). Another reason is the technical difficulties to generate ELF waves by means of ground-based equipment. However, important arguments convince that ELF vertical soundings are worth to be employed in the ionospheric research. In the ELF frequency range under 30 Hz electrical properties of the ionosphere depend on the following important parameters: the altitudinal electron density profile including the external ionosphere, effective collision frequency of electrons with neutral particles and effects of the geomagnetic field. In addition, the ion to neutral collisions and the mean mass distribution profiles of the positive ions should be taken into account at the frequencies of 0.1 - 30 Hz. Any analysis of experimental data becomes essentially complicated due to the dependence of ionospheric parameters on the horizontal co-ordinates if the distance between a receiver and the ELF exciter is much greater of the ionosphere effective height. In this case ELF ionospheric applications are of less use. In the present paper we discuss the applicability of the ELF vertical sounding technique with frequencies under 30 Hz for remote studies of the ionosphere structure. It is based on the ELF experimental results obtained on the Kola Peninsula during different seasons such as the vernal equinox, autumn and even in winter time, when the ionosphere is not illuminated by the Sun at high latitudes.

Orientation of the cross-field anisotropy of small-scale ionospheric irregularities and the direction of plasma convection

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The relationship between the orientation of the small-scale ionospheric irregularity anisotropy in a plane perpendicular to the geomagnetic field and the direction of plasma convection in the F region is investigated. The cross-field anisotropy of irregularities is obtained by fitting theoretical expectations for the amplitude scintillation of satellite radio signals to the actual measurements. Information on plasma convection was provided by the SuperDARN HF radars. Joint satellite/radar observations in both the auroral zone and the polar cap are considered. It is shown that the irregularity cross-field anisotropy agrees quite well with the direction of plasma convection with the best agreement for events with quasi-stationary convection patterns.

Radio tomography and HF interferometer observations of the artificially modified ionosphere

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A high frequency (HF) ionospheric modification experiments were carried out in Russia on 15 August 2005 and in Norway on 6 October 2005, using the Sura and EISCAT HF heating facilities. Simultaneous radio tomography electron density observations and stimulated electromagnetic emission (SEE) interferometer measurements

performed during the heating sessions are discussed. Both transmitters operated at 4544 kHz and the main lobes of the Sura and EISCAT antennas were inclined by 12° and 8° south of vertical, respectively. The data analysis shows that both small-scale plasma enhancements and large-scale density irregularities can be generated by the HF waves either at mid- or high latitudes. A zone of reduced plasma density is induced by the heating facilities in the heated region at heights from ~ 200 km up to much higher altitudes than the position of the ionospheric F2-region maximum. Wavy latitudinal density structures propagating out of the heated area are also observed. The satellite records show that the scintillation peaks caused by anisotropic irregularities in a plane orthogonal to the geomagnetic field are deviated relative to the magnetic zenith direction. The interferometer data also shows disagreements between the SEE origin location, the magnetic zenith direction and position of the heating antenna main lobe. The events reveal different electron density changes due to heating. Meanwhile, SEE signals are detected during both experiments, however their spectral features are different. Besides, the patch of the SEE spatial positions is smaller, if the electron density changes are greater.

The response of the polar lower ionosphere to powerful solar flashes on December, 5-14, 2006

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The data of observations using a method of partial reflections of the lower ionosphere above Tumanny (69.0 N, 35.7 E) during powerful solar X-ray flashes in the period from December, 5 till December, 14, 2006 are presented. According to the results of satellite observations over this period 4 X-ray flashes of X class, 5 flashes of M class, and about 30 flashes of C class occurred on the Sun. From the most powerful flashes only two flashes of classes X9 (on December, 5) and M7 (on December, 6) took place, when the lower ionosphere above Tumanny was illuminated by the Sun. During the solar disturbances the strong change of lower ionosphere structure and an extraordinary high increase in electron concentration up to the values of $3 \cdot 10^3$ cm^{-3} at heights of 50-60 km were fixed. During almost the entire period of observations the lower ionosphere above Tumanny was in disturbed condition. As the majority of flashes took place, when the region of observations was on the dark side of the Earth it is possible to explain the marked disturbances of the ionosphere by powerful emissions of solar substance and high-energy solar particles.

Visualization of the summer middle latitude wave processes

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The results of optical observations on 13.08.2005 during HF pumping of the ionosphere at the Sura heating facility (Nizhny Novgorod, Russia) are reported. For observations a color digital camera CoolSNAP with 2 minutes exposure mode and zenithal directed photometer (with optical filter 630 nm) were used.
During the time period from 21:55 to 22:15 the airglow irregularities in D- region of the ionosphere (65 – 70 km, accordingly to the Earth's shadow) and aligned perpendicularly to sunward direction had been visualized from the digital camera data. For this time period the photometer registration had significant intensity variations. During time period from 22:01 to 22:11 heating facility was switched off, thus it can be considered that the spatial and temporal airglow variations with intensity of up to ~1 kR of 630 nm channel caused dispersion of the sun light by optical irregularities. The duty cycle of the heating facility was the following: the pump frequency 4300 kHz, 3 minutes switched on, 7 minutes – pause. The periodical dispersed light enhancement effect should be attributed to the acoustic-gravity waves interference, which transient zenith at mesopause altitudes. The MHD waves with a period of ~1 – 2 minutes can be exited after the radio emission ending at altitudes close to the pumping wave reflection (4300 kHz), which wave length are close to the irregular Pi2 magnetic field pulsation. Wave propagation occurs downward along the magnetic field line with the following transformation into acoustic-gravity wave and visualizing in the vicinity of boundary between sunlit and darken regions (half-shadow) of the mesosphere.

Phase velocity of ~1-m electrojet irregularities at large flow angles and improved procedure for electron drift estimates in the STARE method

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The purpose of the present study is to re-examine the EISCAT and STARE data statistics on the electron flow velocity in the auroral E region published by Uspensky et al. (2006). We show that a reasonable estimate of the electron drift can be obtained from the STARE velocities, if one considers the electron collision frequency increase with the electron drift/electric field and assumes non-orthogonality of auroral backscatter. Our statistics covered the local afternoon-evening time when the Finland and Norway STARE radar line-of-sight was significantly away from the direction of the electron flow.

Simulation of the magnetosphere-ionosphere convection for the inhomogeneous ionospheric-magnetospheric conductivity.

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It is known that the value of the evening convection vortex is larger than the morning vortex , that had been caused by high dawn ionosphere conductivity. This result has been confirmed by the numerical simulation of this work. We have also investigated dependence convection from the enhanced magnetospheric and ionospheric conductivities at midnight. The high conductivity near the midnight enhances the morning vortex, which became comparable with the evening vortex. The results of our calculations agree with the empirical model convection during the expansive substorm phase.

A model study of the wind influence on the ionospheric F2-layer behaviour during the April 2002 magnetic storms

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The ionospheric F2 layer parameters were calculated by the Upper Atmosphere Model (UAM) for the period of April 15-20, 2002 including the geomagnetically disturbed days. The calculations have been performed in four versions with the same initial conditions: 1) with the NRLMSISE-00 neutral composition and temperature data and the theoretically calculated neutral wind velocities; 2) with the NRLMSISE-00 neutral composition and temperature data and the horizontal neutral wind velocities calculated by the empirical model HWM-93; 3) with the neutral composition, temperature and wind velocities calculated by the UAM fully self-consistently; 4) with the theoretically calculated neutral composition and temperature, but with the horizontal neutral wind velocities calculated by the HWM-93. The modelling results were compared with the observation data obtained by seven incoherent scatter radars enclosing the region of high, middle and low latitudes of the Northern Hemisphere. The comparisons showed that use of the HWM-93 winds did not improve the agreement between the model results and measurements, only several details of the F2-layer behaviour may be attributed to the influence of the winds calculated in the UAM.
This study was supported by the Grant No.05-05-97511 of the Russian Foundation for Basic Research.

Сравнительный анализ параметров f0F2 и hmF2 ионосферы по данным НЗ, ВЗ и IRI

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В работе представлены результаты экспериментальной проверки методики оперативного получения ионосферных параметров слоя F2 (высоты максимума hmF2 и критической частоты f0F2) в средней точке трассы по данным наклонного зондирования (НЗ). В работе использовались данные 2004-2006 гг. регулярных наблюдений ЛЧМ-ионозонда ИСЗФ СО РАН на трассах НЗ разных направлений и дальности (Норильск—Торы, Усолье—Торы, Магадан—Торы). Для проверки расчетных значений использовались экспериментальные данные станций вертикального зондирования (ВЗ), ближайших к средним точкам трасс, и данные модели IRI. Для трассы Норильск—Торы использовались данные ионосферной станции ВЗ в Подкаменной Тунгуске, для трассы Магадан—Торы использовались данные дигизонда в Якутске, для трассы слабонаклонного зондирования Усолье—Торы использовались данные дигизонда в Иркутске.
В ходе вычислений (в рамках плоскослоистой ионосферы) экспериментальная дистанционно-частотная характеристика трассы по модифицированному методу «кривых передачи» (метод Смита) пересчитывалась в высотно-частотную характеристику (ВЧХ) средней точки трассы. Таким образом, оперативно определялось значение f0F2 средней точки трассы. Для определения hmF2 использовался профиль Ne(h), восстановленный из ВЧХ по методике Huang-Reinisch (которая широко используется в дигизондах по всему миру).
Пересчет данных НЗ в параметры ионосферы в средней точке трассы может использоваться для регионов, где отсутствуют ионосферные станции, может помочь при решении задач оперативной диагностики и прогноза, при создании региональных моделей ионосферы и при адаптации различных моделей к реальным условиям. Работа выполнена при поддержке Российского фонда фундаментальных исследований (грант № 05-07-90212).

О возможном влиянии температуры поверхности Земли на вариации излучения верхней атмосферы

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Анализируется особенность поведения межгодовых вариаций атмосферной эмиссии 557.7 нм в 23 солнечном цикле, заключающаяся в нарушении синфазности с изменением солнечной активности. При сопоставлении среднегодовых значений интенсивностей эмиссии 557.7 нм с гелиогеофизическими и атмосферными параметрами ($F_{10.7}$, числа Вольфа, температура мезосферы, общее содержание озона) высокая корреляция получена с аномалиями вариаций глобальной температурой поверхности Земли. Схожий эффект влияния температуры у поверхности Земли отмечается в работе [1] для критической частоты Е-слоя ионосферы на средних широтах. В качестве возможного объяснения полученной корреляции многолетних вариаций эмиссии 557.7 нм и температуры поверхности Земли предлагается механизм, основанный на экспериментальном факте существования квазистационарных планетарных структур в свечении верхней атмосфере [2] и гипотезе орографически – термического возбуждения планетарных волн [3]. Согласно предлагаемому механизму изменение контраста среднегодовых температур в системе материк – океан (или в пределах материков) может обуславливать изменения положений (или амплитуды) максимумов квазистационарных планетарных структур и вызывать модуляцию свечения верхней атмосферы в фиксированной долготной зоне.

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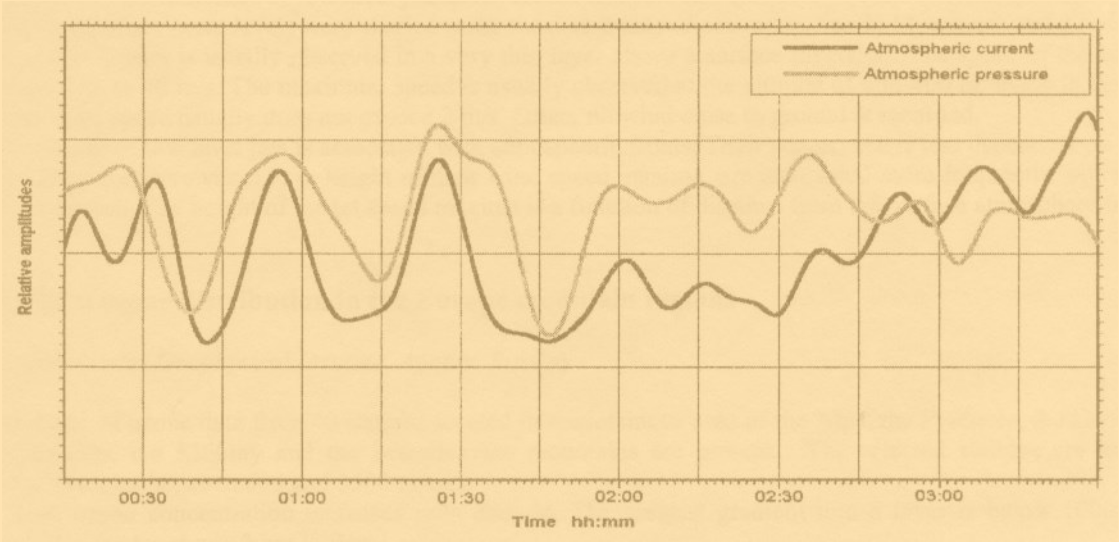
Atmospheric current
Atmospheric pressure
Relative amplitudes
00:30
01:00
01:30
02:00
02:30
03:00
Time hh:mm

Investigation of aero-electrical characteristics of the atmosphere surface layer in Arctic

O.I. Akhmetov, Yu.V.Fedorenko (*Polar Geophysical Institute, Apatity, Russia*)

In this study, the aero-electrical characteristics of the atmosphere surface layer are discussed so that the spatial structure of atmosphere currents of mechanical charge transfer in rain drops simultaneously with air streams is investigated.
The correlation function dependence of atmospheric current antenna signals (that was obtained by the diversity technique from July to October 2006) based on wind and rain meteorological data was studied. Time shifts between atmospheric current antenna signals depending on the wind velocity and direction were studied.
It is shown, that in the rain the current density of charge transfer by rain drops is spatially non-homogeneous in intervals of approximately tens of meters and it is a lot more than the current density of the charge transfer by electrical forces. So, during a heavy rain signals power at 1 Hz is able to increase by more than 20 dB.
During wind more than 2 m/s time shift between signals in the frequency range 0.01-0.1 Hz depending on wind direction and velocity was found. It was caused by aero-electrical structures movement. The spatial horizontal scale of these structures was estimated approximately to be 20-600 meters.

Climatology of the low level jets in the Kola Peninsula

V.I. Demin (*Polar Geophysical Institute, Apatity, Russia*)

The statistical characteristics of low level jets in the Kola Peninsula (the frequency of occurrence, seasonal variation, the wind speed maximum level) were studied using the data from radiosound station in Murmansk and Kandalaksha. The night jet stream is usually observed in a very thin layer above a surface inversion. The speed of the air stream can be as high as 20 m/s. The maximum speed is usually observed at the altitude of 200-400 m, while in the surface layer the wind speed usually does not exceed 2 m/s. Often, no wind close to ground is recorded.
Another group of low level jets is associated with atmospheric fronts. Their occurrence is less dependent on the time of day. They are more variable in height of their wind speed maxima, are associated more frequently with elevated frontal inversion. The height of the jet speed maxima is a function of distance from the surface atmosphere front.

On vertical ozone distribution in the Europe mountain regions

V.I. Demin (*Polar Geophysical Institute, Apatity, Russia*)

The analyses of ozone data from 40 stations located in mountainous area of the Alps, the Pyrenees, the Carpathians, the Apennines, the Khibiny and the Scandinavian mountains are present. The selected stations are located at different altitudes between 600 and 3500 m a.s.l.
The mean ozone concentration increases with altitude. The greatest gradient into a layer is below 1000 m. The increase at altitudes above 2 km is slow.
The differences between the winter ozone values at the same level in all mountain systems are little enough. However the summer ozone levels in central Europe are higher than in the North. Moreover the seasonal variations at stations located in northern Europe and stations located in Central Europe are different. For example, the ozone concentrations in the Khibiny and Scandinavian mountains have a maximum in spring. In the Alps the period of the maximal ozone is shifted to the late spring and summer months.

Comparison of radiosound and mountaintop observations in the Khibiny

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A series of observations on top of Lovchorr mountain (1095 m a.s.l., Khibiny) was compared with data from the nearest radiosound station in Kandalaksha. Correlations between the geopotential height, air temperature, mixing ratio and wind speed on the mountain top and at the similar height in free atmosphere were found. For example, the mean temperature differences between mountain top and free atmosphere are less than 1-2°C. The lower temperatures on the mountain top are caused by the forced rise of air on windward slopes.

The mountaintop observations give quite good representations about the climate of free atmosphere and they supplement appreciably the data of the air radiosounding, which are less regular.

On diurnal and seasonal variations in surface ozone in the island of Spitsbergen

V.I. Demin, M.I. Beloglazov (*Polar Geophysical Institute, Apatity, Russia*)

The surface ozone monitoring station of the Polar Geophysical Institute in Spitsbergen is situated on the west coast of the island. The ozone measurement was performed using electrochemical and chemical luminescent gas analyzers. The automatic meteorological station is included in the measurement complex.
The seasonal ozone variation shows a pronounced maximum of the monthly mean values in the late spring (April-May) and lower maximum in autumn similar to many other Arctic sites. The spring maximum is caused by intensification of stratosphere-troposphere exchange. In our opinion the intensification of cyclonic activity and macroturbulence exchange in the region are caused of the autumn maximum. The surface ozone concentrations in the Polar day period do not exceed the ones in the polar night period. Furthermore, the summer ozone concentrations are the lowest.
The highest ozone concentrations are caused by long-range (inter-continental) transport of ozone from Europe. For example, at the end of April and beginning of May, 2006 the ozone concentrations in Spitsbergen exceed the recorded values, which are uncharacteristic for high latitudes. The episode was caused by advection of air mass polluted by agricultural fires in the Baltic and East Europe countries (report of Finnish Meteorological Institute).

Meteorological conditions of excavation icing

V.I. Demin[1], Yu.L. Zyuzin[2], A.V. Kova1ev[2], O.V. Neelov[2], I.V.Kalabin[2], S.S. Pugachev[2]

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The strong icing of excavation in the Khibiny mountains for positive air temperature (about 3-4.5°C) is caused mainly by meteorological factors. Meteorological conditions of this process were studied experimentally. The ice forming begins, when the specific humidity decreases below the critical value. In that case the walls of excavation are cooled because of the energy consumption for aqueous evaporation in a very dry injected atmospheric air. Meteorological criteria of the icing appearance are established.
Our research makes possible the automatic control of heating of the injected air, which excludes the appearance of icing. At the same time the proposed method is more economical, than a present ones.

Impact of solar activity on the atmospheric processes in the southern polar region

L.V. Egorova, V.Ya. Vovk and O.A. Troshichev (*Arctic and Antarctic Research Institute, St-Petersburg, 199397, Russia*)

Fluxes of galactic cosmic rays altered by solar wind and spikes of solar cosmic rays are usually examined as one possible mechanism of solar activity influencing the Earth's atmosphere. The detail analysis of the meteorological data from Antarctic stations Vostok and Dome C made it possible to conclude that dramatic changes of the troposphere temperature, observed in the Central Antarctica, are related to the interplanetary shocks, accompanying Forbush decreases (FD) and solar protons events (SPE). The temperature effects on the ground level are caused by quick change of the interplanetary magnetic field (IMF) and corresponding variations of the geoeffective electric field (E_{SW}) carrying by the solar wind. The warming is observed at altitudes $h<5$ km and cooling at $h>8$ km, when the changes in the IMF B_Z component are negative and E_{SW} increases. The effect reaches its maximum within one day and is damped equally quickly. The availability of the katabatic type of the atmospheric circulation in the southern near-pole region and opposite character of the altitude dependence for the temperature, pressure and wind speed deviations in cases of the negative and positive ΔE_{SW} makes it possible to suggest that the geoeffective electric field E_{SW} promotes, through the global electric circuit, the appearance and development of the cloud layer in the upper troposphere. The cloud layer would efficiently backscatter the long wavelength radiation going from the ice sheet, but it would not affect the adiabatic warming process. As a result of the radiative cooling reduction the atmosphere would be heated below the cloud layer and would be cooled above the layer, as it was observed. Indeed, the analysis of aerological observations at Vostok station demonstrated the cloudness increase above the station

under conditions of the negative IMF Bz. The troposphere warming in the Central Antarctica is followed within a few days by the reconstruction of the wind pattern above the entire southern polar region. The dramatic deviation of atmospheric winds from the regular pattern ("anomalous winds") at the Antarctic continental and coast stations, succeeding strong southward IMF, leads to decay of the circumpolar vortex at about the periphery of the Antarctic continent. As a result, the surface easterlies at the coast stations are replaced by southerlies, and the cold air masses rush from Antarctica to the Southern Ocean. The mechanism of the influence of the global electric circuit on the cloud layer properties is unclear and needs further consideration.

A simple model of long-term changes in the stratospheric circulation

A.Yu. Karpechko (*Finnish Meteorological Institute, Sodankylae, Finland*)

A simple quasi-geostrophic beta-plane model is used to study a response of the stratosphere to long-term changes in the differential radiative heating (DRH). The zonal mean circulation in the model is driven by two counteracting processes: dissipation of vertically propagating planetary waves and the DRH parameterized in terms of a Newtonian cooling. While the former process drives the circulation away from the radiative equilibrium the latter one tends to restore it. The waves are exited at the lower boundary of the model by a perturbation in the geopotential height field. The DRH in the model varies periodically to simulate the annual cycle, with the winter maximum increasing linearly from year to year. The increase is assumed to represent roughly changes in the concentration of radiatively active gases (e.g. polar ozone losses and/or increase in the concentration of greenhouse gases). It is found that under weak wave forcing the zonal mean circulation strengthens linearly following the changes in the DRH. However, the response of the model to strong wave forcing is essentially non-linear. The application of these results to the real stratosphere is discussed.

Ground-based microwave instrument for stratospheric ozone measurements: New design and some results of observations

Y. Y. Kulikov, A.A. Krasilnikov, V.G. Ryskin, V.N. Shanin, A.M. Shchitov (*Institute of Applied Physics RAS*)

In the present paper there is discussed a new mobile microwave ozonometer, which is intended for measurements in field conditions. Some scientific tasks require the development of a new portable microwave instrument for ozone measurements and a new approach for design:
Uncooled millimeter-wave receiver;
Multichannel spectrometer with bank of filters with spectral bandwidth of 240 MHz and the variable frequency resolution: 1.0 – 10 MHz;
Local oscillator of the receiver with fixed frequency (101.7 – 1 10.8 GHz);
Relative frequency instability 10^{-6};
Image channel filter – other-worldly wave guide;
System noise temperature (SSB) – 2000 K;
Altitude range of ozone measurements: 20 – 60 km;
Methods of calibration – variation of zenith distance or hot and cold reference loads;
Total weight of MM-wave receiver less than 10 kg;
Power consumption ~ 100 W.
This talk will provide an overview of new portable device observations.
The device was used in research of influence on an ozone layer of launching a heavy rocket «Proton» at Baikonur cosmodrome. Besides, we successfully used the portable instrument in the field campaigns on board an icebreaker during the summer navigation on the route Murmansk-Severnaya Zemlya-Murmansk (August 2005) and so in the observation of ozone in the upper atmosphere during a Total Solar Eclipse of 29 March 2006 (Caucasus, Kislovodsk).

Model simulation of circumpolar vortex flows in the Earth's atmosphere for different seasons

I.V. Mingalev, V.S. Mingalev (*Polar Geophysical Institute, Apatity, Russia*)

The mathematical model of the global neutral wind system is applied to investigate how the horizontal non-uniformity of the atmospheric temperature affects the formation of the lower and middle atmosphere circulation, in particular, the large-scale circumpolar vortices, for conditions of different seasons. The applied model produces

three-dimensional global distributions of the zonal, meridional, and vertical components of the neutral wind velocity and neutral gas density. All three components of the neutral wind velocity are obtained by means of a numerical solution of the appropriate momentum equations for viscose gas. The hydrostatic equation, usually utilized in the global circulation models, is not used in the model. The utilized model does not include the internal energy equation for the neutral gas. Instead, the global temperature field is assumed to be a given distribution obtained from the NRLMSISE-00 empirical model. The simulations are performed for winter, spring, summer, and autumn conditions. The simulation results indicate that the horizontal non-uniformity of the neutral gas temperature affects considerably the formation of global neutral wind system in the lower and middle atmosphere, in particular, the large-scale circumpolar vortices which are appreciably distinct for conditions of different seasons.

The solar proton penetration boundaries in the Earth's magnetosphere: Their influence on the ozone layer of the Earth

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It is well known, that solar flares, producing the intensive fluxes of high-energy protons, strongly influence on the near-Earth environment and Earth's atmosphere. In particular, solar protons caused the ionization of the Earth's atmosphere at high latitudes at altitudes below 100 km. Each pair of ions produces additional molecules of nitrogen and hydrogen oxides, which destroy ozone. 3D models were used to study the response of ozone and other chemical species after three major SPEs, that occurred during Solar Extreme Events during October-November 2003 (SEE-2003). As input parameters the data about the flux of solar protons measured by GOES and CORONAS-F satellites were used. Due to the low polar orbit of CORONAS-F satellite fluxes of solar protons were measured in the south and north polar caps (areas of open magnetic field lines) during 15-20 minute intervals every ~45 minutes. Since during SEE-2003 events strong magnetic storms (Dst = -350 nT and more) took place, high energy solar protons penetration in the polar caps during the main phase of magnetic storms should be taken into account. It was shown that during the main phase of magnetic storm (near the midnight the October, 29-30) the solar protons with the energy of 14-26 MeV penetrate the southern hemisphere up to geographical latitudes lower than 45 degrees (L<3). For the comparing, the penetration boundary of 14-26 MeV protons at noon of October, 28 was observed near 70 degrees. Significant variations of the polar caps area (where solar proton flux was observed) are important for the calculations in the used 3D model.
This study has been partly supported by grant N 06-05-64436-a of the Russian Foundation for Basic Research.

On Schumann resonance amplitude variations during the Forbush-effect

V.C. Roldugin, M.I. Beloglazov (*Polar Geophysical Institute, Apatity, Russia*)

For 12 events of galactic cosmic rays (GCR) Forbush-decreases in 2000-2005 the comparison of temporary courses of GCR intensity at the Apatity station with the first Shumann resonance amplitude, as a parameter of global lightning activity, has been carried out. The analysis shows that the reduction of the first Shumann resonance amplitude during GCR Forbush-decreases in comparison with quiet conditions is registered in one case only – the strongest event in January, 2005. In all other cases no any statistically significant effect is revealed.

Detection of the pulsed signals in photocurrent and in the zenith of free atmosphere at Novolazarevskaya station (Antarctica): Effect of the solar irradiance?

C.N. Shapovalov and O.A. Troshichev (*Arctic and Antarctic Research Institute, St.Petersburg*)

The pronounced signals in the microphotocolorimeter currents were detected under the condition of absence of the working substance in 1997 at the Antarctic station of Mirny and later in St.Petersburg. Taking into account the – specific features of these signals it was suggested that they are produced by unknown irradiation of solar or space origin. To explore the origin of the radiation in more detail the precise registration of the pulsed signals has been established in April of 2004 at Novolazarevskaya station (Antarctica). The statistically significant number of signals, above 10 000, has been registered for 2.5 years of observations (April 2004 – September 2006). The time distribution of the daily number of signals for this period included the wide periodical maximums, which turned out

to be well consistent with the behavior of such indicators, characterizing changes in the solar activity, as solar flux F10.7 cm. and the total solar irradiance (TSI). In 2005 the searches of the pulsed signals were started with use of spectrometer *AvaSpec*-2048 in zenith of free atmosphere at Novolazarevskaya, the precise time of observations being provided with GPS system. The pulsed signals have been found in five lines, lied in the UV range of spectra, the standard deviation energy (SD_{EA}) for which was an order of magnitude more than that for noise fluctuations. They are 332 nm, 333.5 nm, 342.5 nm, 351.5 nm and 395.2nm. These pulsed signals were compared with variations observed at the appropriate frequencies 331.9 nm, 333.4 nm, 342.5 nm, 351.4 nm and 395.4 nm for solar spectra measurements on board the SORCE spacecraft. The comparison of pulsed signals detected in the atmospheric and extra-atmospheric conditions has been carried out for the period from September 01, 2005 to December 17, 2005. For all five frequencies there was found the definite consistency in the time behavior of values of the mean daily energy standard deviations taking place at Novolazarevskaya (SD_{EA}) and in SORCE experiment (SD_{SSI}), the best correlation being presented for frequency 351.5 nm. A conclusion was made that occurrence of the pulsed signals is of regular character and appear to be related to the solar life. Although signal variations are like the changes in some characteristics of solar activity, nevertheless the run of the pulses number correlates imperfectly with the behavior of any definite characteristic. That is why we suggest that the pulsed signals are caused by some unknown irradiation, which either takes its origin within the Sun or is guided by the solar activity.

Аномалии приземного озона в Московском регионе в 2006 г.

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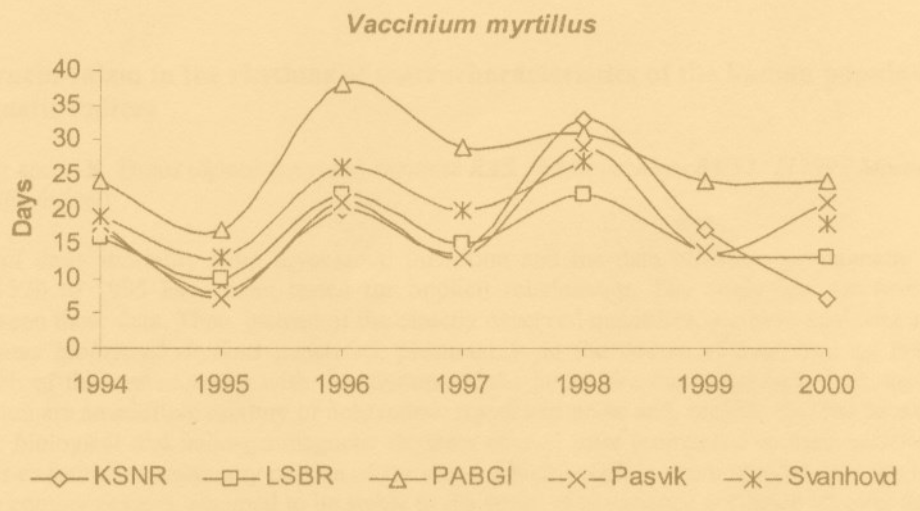
По уровням приземного озона в светлое время суток 2006 г. оказался вторым по величинам суточных максимумов в теплый период за 16 лет наблюдений. С мая по июль в регионе наблюдалось несколько эпизодов с высоким уровнем приземного озона (O_3); более высокие среднемесячные концентрации были только в 2002 г., когда они сопровождались лесными и торфяными пожарами. Первый эпизод наблюдался в первые дни мая и обнаруживает явную связь с эпизодом аномально высокого озона, наблюдаемым также на Кольском п-ве, в Финляндии, Исландии и на архипелаге Шпицберген, где был вызван, преимущественно, сжиганием сельскохозяйственных остатков на полях стран Прибалтики и России. Другие эпизоды наблюдались в третьей декаде июня и второй июля. Концентрации озона выше предельно допустимых наблюдались на станции Росгидромета Долгопрудный и нескольких станциях ГПУ «Мосэкомониторинг» в Москве и Зеленограде. Как правило, опасные концентрации озона имели место при температуре 28 ^oC и выше при неблагоприятных метеорологических условиях. Для анализа причин столь высоких концентраций приземного озона в регионе были рассмотрены их связи с метеопараметрами (температура, относительная влажность, характеристики ветра, индекс метеорологического загрязнения атмосферы) и концентрациями других малых газовых составляющих (МГС) – диоксидом азота (NO_2) и монооксидом углерода (CO), - являющихся продуктами выбросов в атмосферу. Определены характеристики, связывающие концентрации приземного озона и других МГС, в частности, O_3-CO, в различные сезоны. Результаты наблюдений приземного озона в регионе показывают необходимость совершенствования системы его мониторинга с объединением усилий заинтересованных учреждений, входящих в системы РАН, Росгидромета и региональных правительств.

Изменчивость приземного озона в Европе

А.М. Звягинцев, Г. Какаджанова и Г.М. Крученицкий (*Центральная аэрологическая обсерватория Росгидромета*)

По данным 14-летних наблюдений на 97 равнинных (лежащих на высоте до 500 м над у.м.) европейских станциях, входящих в систему EMEP, разработана эмпирическая модель для «нормального» распределения приземного озона в различные сезоны и времена суток на территории Западной и Центральной Европы. Для каждой из станций результаты моделирования доступны в аналитическом виде; карты «нормального» распределения полей приземного озона и их стандартных отклонений представлены для различных сезонов и различных часов суток. «Нормы» распределения приземного озона для каждой из станций включают постоянные составляющие среднесуточной концентрации озона, периодические составляющие ее изменчивости в течение года и суток, а также стандартные отклонения остатков. Полученные «нормы»

могут быть использованы для выявления аномалий во временном ходе приземного озона и определения достоверности его климатических изменений. Выявлены положительные тренды приземного озона на различных станциях Европы (0-8 мкг $м^{-3}$ за 10 лет или, что то же, до 1% в год). По-видимому, для некоторых станций полученные оценки трендов приземного озона связаны с недостаточной стабильностью наблюдений. Тем не менее, представляется, что наибольшие тренды имеют место в континентальных районах Центральной Европы; тренды близ побережья океана, Северного и Средиземного морей меньшие. Для станций, для которых доступны синхронные наблюдения озона и метеопараметров (в основном, в Германии), найдено, что в рассматриваемый период имели место статистически значимые тренды температуры, превышающие среднеглобальные. Из сопоставления временных рядов приземного озона и метеопараметров (температуры, относительной влажности, зонального и меридионального ветров) на этих станциях сделан вывод, что долговременные изменения приземного озона в заметной мере связаны с изменениями метеопараметров.


Vaccinium myrtillus
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Pasvik
Svanhovd

Possible solar association of large-scale auto-wave processes in terrestrial ecosystems: Arguments *pro* and *contra*

P.A. Kashulin, N.V. Kalacheva (*Polar-Alpine Botanical Garden-Institute, Apatity, Russia*)

The auto-wave phenomena are widely distributed in living systems on the bio membrane, cell, and some tissue levels of its structure organization. Much less we know about occurrence the alike processes on the population levels and little aware of their possible biological significance. Some examples for large-scale, both steady state and dynamical wave-like population and community space–temporal changes are considered under solar-terrestrial links paradigm. Those are as follows: the large scale flowering waves in large bamboos plant populations which are represent the *Bambuseae* subfamily of Poaceae family. The flowering waves were observed in different continents every 40 to 60 yr and were followed by "death waves" of the flowered plants. The front of the plant mortality waves is strictly adjacent in space to onset flowering wave front distribution. The span in the flowering wave propagation for these species is typically lasted for 5-6 yr. Another example is widely known space – time distribution of coniferous destruction occurrence in Fennoscandia and in Central Europe. The distribution has appearance of large-scale space waves propagated North in Finland and South in France, respectively with period in 2-3 yr. The example for steady-state waves is synchronic population cycles for hare *Lepus americana*. The waves sweep territory with approximate radius in thousands km throughout the Northern Canada and change in opposite phase to cycles of *Lepus timidus* in Finland. The consistent scheme for explanation of considered phenomena suggesting the possible role of solar and associated geophysical factors as driving pacemakers are considered.

Analysis of synchronizm in the rhythms of macrocharacteristics of the human population and helio-geomagnetic indices

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The dynamics of daily mortality from myocardial infarction and the data on helio-geomagnetic activity for the interval from 1970 to 1995 have been tested for implicit relationship. The study has not revealed any direct correlation between these data. Then, instead of the directly observed quantities, we have analyzed some parameters of the *endogenous biological rhythms* generated, presumably, in the course of evolution by helio-geomagnetic activity in search of their relationship with the rhythms of the latter. We have assumed, first, that the data series under examination are an additive mixture of nonrandom signal and noise and, second, that the chosen parameters of the endogenous biological and helio-geomagnetic rhythms change little (compared to their variation range during the period under examination) over any portion of the series which length is much smaller than the total observation time. The noise component was assumed to be stable in the sense of covariance sequence all over the interval under discussion.

For the parameters describing the relationship between the population and helio-geomagnetic data, we have taken the frequencies of their leading rhythms. It is suggested that the frequency of the leading rhythm of helio-geomagnetic indices is not constant because of the complexity of processes in the Sun and the interaction of the solar wind and interplanetary magnetic field with processes in geospace [1]. The dynamics of the population parameters, in turn, has a rhythmic nature; i.e., one can always isolate a leading rhythm in the population time series [2-5] which frequency is controlled by the leading rhythm of helio-geomagnetic indices as a result of internal adaptation processes in each particular organism.

Primary children morbidity – an informative criterion of risk assessment for population health

I.N. Perminova, A.L. Kosova, E.V. Perminova (*Polar Geophysical Institute, Apatity, Russia*)

Nowadays a quantitative assessment of geophysical factors contribution to population health is a very complex problem in the ecoepidemiological studies. The Kola peninsular territory is ranked among the most polluted areas in Russia and at the same time it is situated in the auroral zone, in this connection the studies on correlation between the children morbidity dynamics in different towns of the Murmansk region and the solar activity indices are most important and interesting. General children morbidity levels in the Murmansk region exceed 1,3-1,5 times on a permanent basis those in the rest of Russia.

Our studies, previously carried out in Apatity, revealed mainly a strong and mean correlation of the general children morbidity and the leading disease classes with the solar activity indices like sun spot indices (W), $F_{10,7}$ cm and the cosmic ray flow.

Heliobiosphere

The data of official statistics on the primary children morbidity in six manufacturing towns of the Murmansk region differing in anthropogenic pollution profile were used in this study from 1998 till 2005.
The comparative analysis revealed the following trends:
- the primary children morbidity levels arranged by decrease in the following order: Murmansk, Monchegorsk, Olenegorsk, Apatity, Kirovsk, Kandalaksha;
- in most cases, as in the Murmansk region on the whole, two maximums are observed in the primary children morbidity: the first peak coincided with the maximum of solar activity in 2001 and was lower than the second one, which accounts for 2003 – a year of high solar flash activity;
- in Olenegorsk and Kirovsk the lack of evident maximum in the primary children morbidity apparently correlated with the character of the public health services activity during that period.
It is supposed that the analysis by the leading disease classes will determine the contribution of geophysical, geochemical and climatic factors to the children morbidity levels.

AUTHOR INDEX

L

M

N

O

P

R

S

T

U

V

W

Y

Z