TEPA 2013

THUNDERSTORMS & ELEMENTARY PARTICLE ACCELERATION

Abstracts

September 9-13, 2013
Nor Amberd International Conference Centre
of the Yerevan Physics Institute,
Byurakan, Aragatsotn Province, Armenia

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Organizers:

Cosmic Ray Division of Yerevan Physics Institute, Armenia

Skobeltsyn Institute of Nuclear Physics of Moscow State University, Russia

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BACKGROUND

Studying of the High-energy Phenomena in the atmosphere is important for several reasons:

- *It provides unique information about particle acceleration and multiplication in the lower and upper atmosphere during thunderstorms;*
- *Generation and propagation of huge fluxes of electrons, positrons, gammas and neutrons in the atmosphere and in space are newly discovered global processes that should be studied by experimental and theoretical methods;*
- *Electromagnetic emissions connected with thunderstorms trigger various dynamic processes in the Earth's magnetosphere, causing global geo-effects and changing electrodynamics properties of the ionosphere.*
- *The large fluencies of energetic electrons, photons and neutrons produced by runaway electron avalanches can potentially be a danger to individuals in aircraft.*

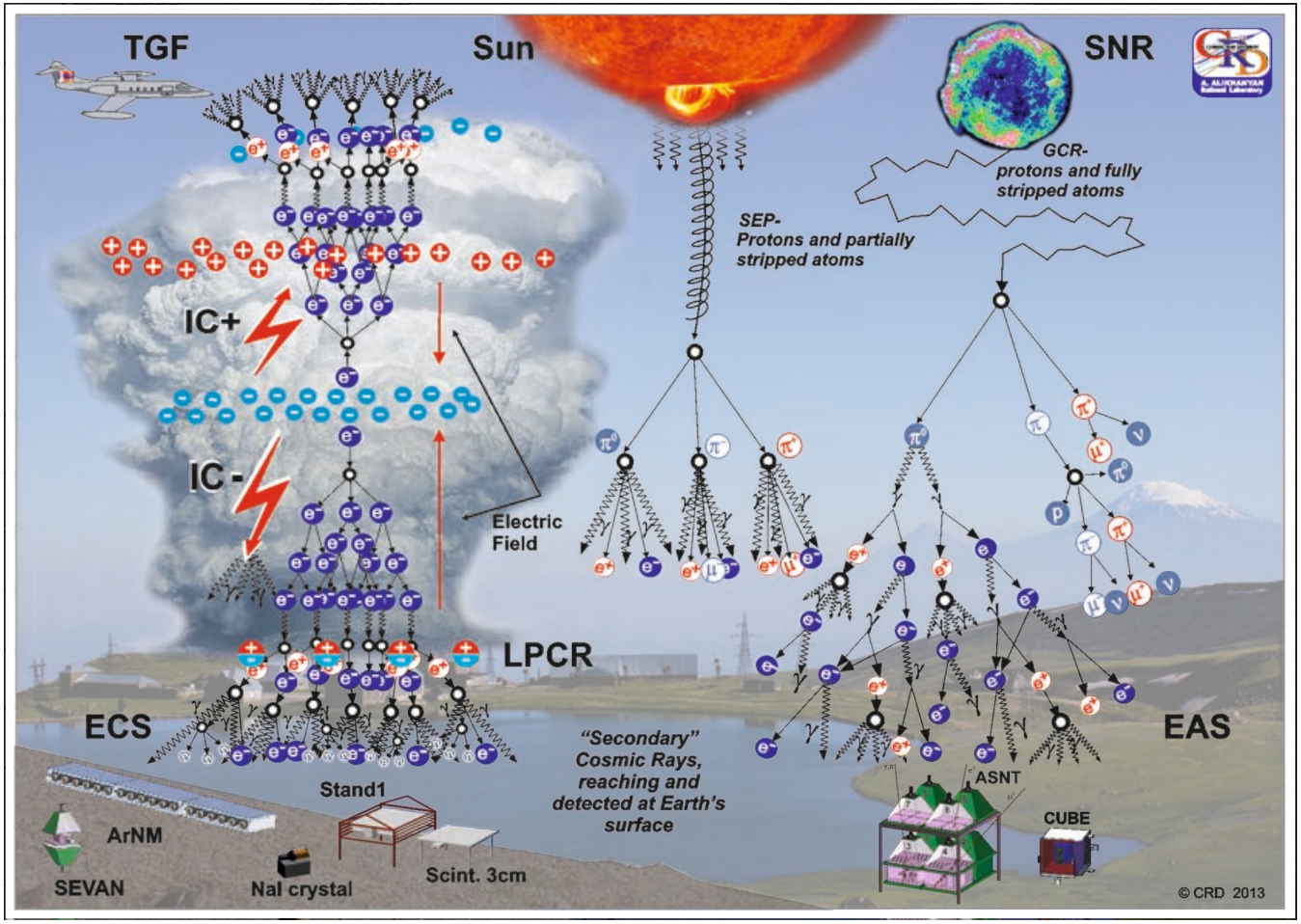
GOALS AND STRUCTURE OF THE CONFERENCE

The aim of the Conference is two-field:

1. To organize a large forum for discussing thunderstorm correlated observations of particle fluxes in the atmosphere and space and models of high energy phenomena originated in the atmosphere;
2. To discuss possible directions for the advancement in research, and for international cooperation between scientific groups using different experimental methods.

Based on these goals the following topics will be covered:

- *Research of the Thunderstorm ground enhancements (TGEs), measurements of electrons, gamma rays and neutrons by networks of particle detectors located on Earth's surface in correlation with thunderstorms;*
- *Research of the Terrestrial gamma-ray flashes (TGFs) observed by the orbiting gamma-ray observatories;*
- *Radio emissions produced by TGFs.*
- *Monitoring of thunderclouds from orbit;*
- *Methods of the remote sensing of the thunderstorm structure and electric field;*
- *Relation of the lightning occurrences to the TGE and TGF initiation;*
- *X-ray emissions from lightning;*
- *Relations to the climate and space weather issues;*
- *Possibility of joint observations by space-born and ground-based facilities.*


TGF
Sun
SNR
GCR-
protons and fully
stripped atoms
SEP-
Protons and partially
stripped atoms
IC+
IC -
Electric
Field
LPCR
ECS
EAS
"Secondary"
Cosmic Rays,
reaching and
detected at Earth's
surface
Stand1
ArNM
SEVAN
Nal crystal
Scint. 3cm
ASNT
CUBE
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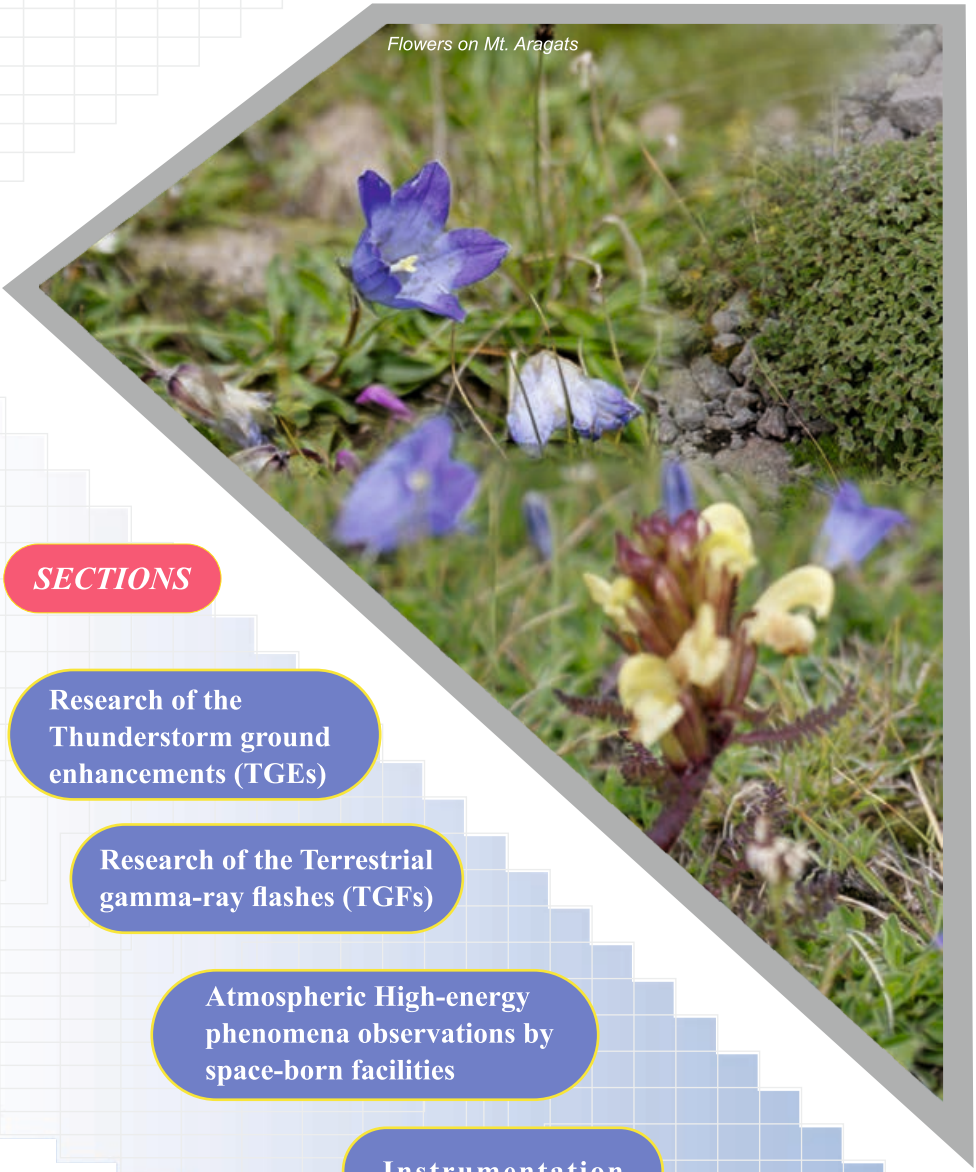
THUNDERSTORMS & ELEMENTARY PARTICLE ACCELERATION (TEPA-2013)



Flowers on Mt. Aragats

SECTIONS

- **Research of the Thunderstorm ground enhancements (TGEs)**
- **Research of the Terrestrial gamma-ray flashes (TGFs)**
- **Atmospheric High-energy phenomena observations by space-born facilities**
- **Instrumentation**
- **Relations to the climate and space weather issues**

RESEARCH OF THE THUNDERSTORM GROUND ENHANCEMENTS (TGEs)

North peak of Mt. Aragats

Sacral “Vishapaqar” stone near Aragats Research Station

Thunderstorm ground enhancements - model and relation to atmospheric flashes

A. Chilingarian

Yerevan Physics Institute, Yerevan, Armenia

Abstract

In the beginning of last century C.T.R. Wilson proposed that strong electric field of the thunderclouds might accelerate electrons to very high energies. However, this and many other electromagnetic processes in our atmosphere are poorly understood till now; the key questions about the thundercloud electrification and lightning initiation remain unanswered. During recent decades several observations of gamma ray, electron and neutron fluxes correlated with thunderstorms were reported. Nonetheless, the origin of these fluxes is under debate till now. The direct registration of the particle showers initiated by the runaway electrons (the most popular theory) was missing. We present the experimental evidence of the microsecond duration electron bursts originated from runaway electrons accelerated in thunderclouds. The electron acceleration downward becomes possible after creation of the Lower Positive Charged Region below the main negative charged layer in the middle of the thundercloud. Our analysis is based on the vast thunderstorm data from the Aragats Mountain in Armenia, 3200 m above sea level. Varieties of particle detectors located at Aragats Space Environmental Center are registering neutral and charged particle

fluxes correlated with thunderstorms, so-called Thunderstorm Ground Enhancements. Simultaneously the electric mills and lightning detectors are monitoring the near-surface electric field and types of lightning flashes. In the paper we present the comprehensive model of TGE initiation. We demonstrate the necessity of the Lower positive charge region development for the lower dipole operation and TGE initiation. Our observations establish direct relationship of the negative electric field strength and rain rate with TGE amplitude.

Observation of Thunderstorm Ground Enhancements with intense fluxes of high-energy electrons

A. Chilingarian, ***B. Mailyan***

Yerevan Physics Institute, Yerevan, Armenia

Abstract

The high altitude (~3200m above sea level) of Aragats Space Environmental Center (ASEC) and low elevation of the thunderclouds provides a good opportunity to detect Thunderstorm Ground Enhancements (TGEs), particles of which rapidly attenuate in the atmosphere. In 2012 and 2013, we have estimated the energy spectra of several TGEs and revealed significant electron fluxes extended till 30-40 MeV. Measured in the one and the same event gamma ray and electron fluxes allow to estimate the height of the thundercloud above the detector. Proceeding from the energy spectra and the height of the cloud we estimate the electron spectra on the exit from the electric field of the thundercloud, the number of excess electrons in the cloud and avalanche multiplication rate. The electron spectrum is harder than the previously measured spectra of 2 largest TGE. Since the obtained spectral shape is closer to the background secondary cosmic ray electron spectrum, we proposed that the electric field length on October 7, 2012 TGE at 15:08 UT was shorter in comparison with the largest TGEs.

Thunderstorm Ground Enhancements - Gamma ray differential energy spectra

A. Chilingarian, ***G. Hovsepyan*** *and L. Kozliner*

Yerevan Physics Institute, Yerevan, Armenia

Abstract

The energy spectrum of the electrons and gamma rays born in Thunderstorm ground enhancements (TGEs) shed light on the origin of TGE, on RREA development in thundercloud, on the nature of the seed particles and on strength and elongation of atmospheric electric field. However, till now the measurements of energy spectra of TGE electrons and gamma rays are rather scarce. For the first time we present differential energy spectra of gamma rays in wide energy range 4-100 MeV for 5 TGE events detected in 2012-2013 at Aragats. We use the special technique of electron/gamma ray fraction determination to select TGE events with very small contamination of electrons.

The network of large NaI spectrometers located 3200 m above sea level measured energy spectra of gamma rays. The power law indexes of "small" TGEs are rather close to the background cosmic gamma ray spectrum ($\gamma \sim -2$ at altitude 3200 m above sea level); thus we may deduce that these small events are due to modification of the energy spectra (MOS) of cosmic ray electrons in electric field of thundercloud. Larger TGEs measured by NaI network and 2 largest TGE events earlier recovered from energy

releases in 60 cm thick scintillator have much steeper energy spectra usual for the avalanche process in atmosphere. The classification of TGEs according to intensity and gamma ray spectral index pointed on 2 main mechanisms of the TGE gamma ray origin – runaway process and modification of electron energy spectra in the thunderstorm atmospheres.

Role of the Lower Positive Charge Region (LPCR) in initiation of the Thunderstorm Ground Enhancements (TGEs)

A. Chilingarian, ***H. Mkrtchyan***

Yerevan Physics Institute, Yerevan, Armenia

Abstract

Despite the ubiquity of thunderstorms, lightning, and related electrical phenomena, many important electromagnetic processes in our atmosphere are poorly understood; the key questions about the thunder- cloud electrification and lightning initiation remain unanswered. The bulk information on particle fluxes correlated with thunderstorm can be used to better understand the electrical structure of thunderclouds. Only very specific electric configuration of the lower part of the cloud can support the sustainable acceleration of the electrons. Our analysis is based on the thunderstorm data from the Aragats Mountain in Armenia, 3200 m above sea level Varieties of particle detectors located at Aragats Space Environmental Center are registering neutral and charged particle fluxes correlated with thunderstorms, so-called Thunderstorm Ground Enhancements (TGEs). Simultaneously the electrical mills and lightning detectors are monitoring the near-surface electric field and type of lightning occurrences; weather stations are measuring plenty of meteorological parameters. In the present paper we relate particle fluxes to the electrical structure of thunderclouds, namely, to the origination of the Lower Positive

Charged Region (LPCR) below the main negative charged layer in the middle of the thundercloud, and to lightning occurrences. Only after creation of the lower dipole in the thundercloud can the electrons be accelerated and particle flux be directed downward. Maturity of the LPCR is correlated with increasing particle fluxes. Thus, the temporal evolution of TGE gives direct evidence of the maturity of LPCR, its initiation, and it's decaying.

Production of the gamma rays in the thunderstorm electric fields with strength below the run-away threshold due to MOS effect (Modification of secondary cosmic ray Spectra)

A. Chilingaryan, ***L. Vanyan***

Yerevan Physics Institute, Yerevan, Armenia

Abstract

Only few from hundreds of TGEs detected by particle detectors of Aragats Space Environmental Center exhibit huge particle multiplication inherent for avalanche processes. Most of peaks in particle count rate time series are rather small – only few percent above the mean. The simulations of secondary cosmic ray electrons propagation in weak electric fields (with the strengths smaller than the critical value, so called RREA threshold) were performed to give an insight in the physical process of gamma ray generation, not accompanied with RREA process. 2 scenarios of "small" gamma events were considered:

1. The strong electric field regions in the thunderclouds are located at high altitudes above the detectors; RREA electrons are attenuated in the air and do not reach detectors located on the earth surface beneath thunder-clouds.
2. Strength of the electric fields does not reach the threshold value to unleash runaway electron avalanches. However,

these fields provide additional energy to CR electrons by Modifying their spectra (MOS process); consequently their live time increases, and additional path lengths of electrons enlarge the probability of creation bremstrahlung gamma rays. As a result of this process we obtain addition gamma rays at the observation level.

The first explanation suggests exponential energy spectra of arriving gamma rays due to spectra of avalanches particles. However, the energy spectra of most of measured on Aragats "small" TGEs are well fitted by the power function. Therefore, the second scenario is most probable. Despite that both Terrestrial gamma flashes (TGFs) and Thunderstorm ground enhancements (TGEs) are mostly explained by runaway process requiring very strong electric fields emerging in clouds, we have proved significant contribution of MOS process in TGEs. We demonstrate that MOS process only can provide sufficient number of gamma rays with sufficient energies to be registered by ground-based detectors as TGE.

Neutron production during TGEs

A. Chilingaryan, ***L. Vanyan***

Yerevan Physics Institute, Yerevan, Armenia

Abstract

Despite several observations of additional flux of neutrons during thunderstorms supported by in-deep analysis of possible experimental uncertainties and simulations of radiation propagation in atmosphere the origin of neutrons is still under debate. The most realistic explanation of the neutron flux is the photonuclear reaction of the bremstrahlung photons born by the high-energy electrons accelerated during runaway process in the large electrostatic fields of thunderclouds. However, the claim of Gurevich et al., 2012, on necessity of 3-orders of magnitude larger gamma ray flux than measured to explain neutron flux by the photonuclear process get recently support in theoretical study of T. Fülöp and M. Landreman, 2003). The confusing situation with explanation of the measured physical effect leads to several speculations in absolutely different areas[1]. In this report we intend to confirm the photonuclear nature of neutrons detected in

[1] See for instance "Cold fusion" site
http://discovermagazine.com/2012/nov/27-big-idea-bring-back-the-cold-fusion-dream#.UeD4iBZIx8s

correlation with thunderstorm and demonstrate coherence of measured “parent” gamma ray and neutron fluxes.

Statistical analysis of the Thunderstorm ground enhancements (TGEs) detected on Mt. Aragats

A. Chilingarian, ***T. Karapetyan***

Yerevan Physics Institute, Yerevan, Armenia

Abstract

Starting from 2008 experimental facilities of the Aragats Space Environmental Center (ASEC) routinely measure time series of secondary cosmic ray fluxes. At these years of the minimum of solar activity we analyze the new high-energy phenomena in terrestrial atmosphere. Namely, Thunderstorm ground enhancements (TGEs) and Extensive cloud showers (ECSs). Several new particle detectors were designed and fabricated having lower energy threshold to detected particle fluxes from the thunderclouds; some of them have possibility to distinguish charged and neutral fluxes. During 2008-2012 years ASEC detectors located at Aragats, Nor Amberd and Yerevan were detected ~300 TGE enhancements. Amplitude of majority of them is less than 5%; however, 13 TGEs have amplitude exceeding 20%. The maximal value of observed enhancement was 271% (September 19, 2009). The paper summarizes five-years study of the TGEs on Aragats. The statistical analysis revealing the month and day-of-time distributions of TGE events, as well as the amplitude and event duration diagrams are presented.

Observation of Gamma Rays at Ground Level Associated with Nearby Thunderstorms

M. Cherry, *R. Ringuette, D. Granger, G. Guzik, M. Stewart, J. Wefel*

Louisiana State University, Louisiana, USA

G. Case

La Sierra University, Riverside, California, United States

Abstract

An array of NaI(Tl) scintillators at Louisiana State University has been used to detect bursts of 50 keV - 2 MeV gamma rays at ground level. After 2.5 years of observation, twenty-four events with durations 0.02- 4.2 msec have been detected associated with nearby lightning. Nine of the events occurred within 6 msec and 3 km of negative polarity cloud-to-ground lightning strokes with measured currents in excess of 20 kA. Three of the events were coincident events observed by detectors separated by ~1000 m. Events tended to occur mainly during the summer months, when storms in southern Louisiana tend to be associated with disturbances in the Gulf of Mexico rather than frontal lines.

On the possibility of location of radiation-emitting region in thundercloud

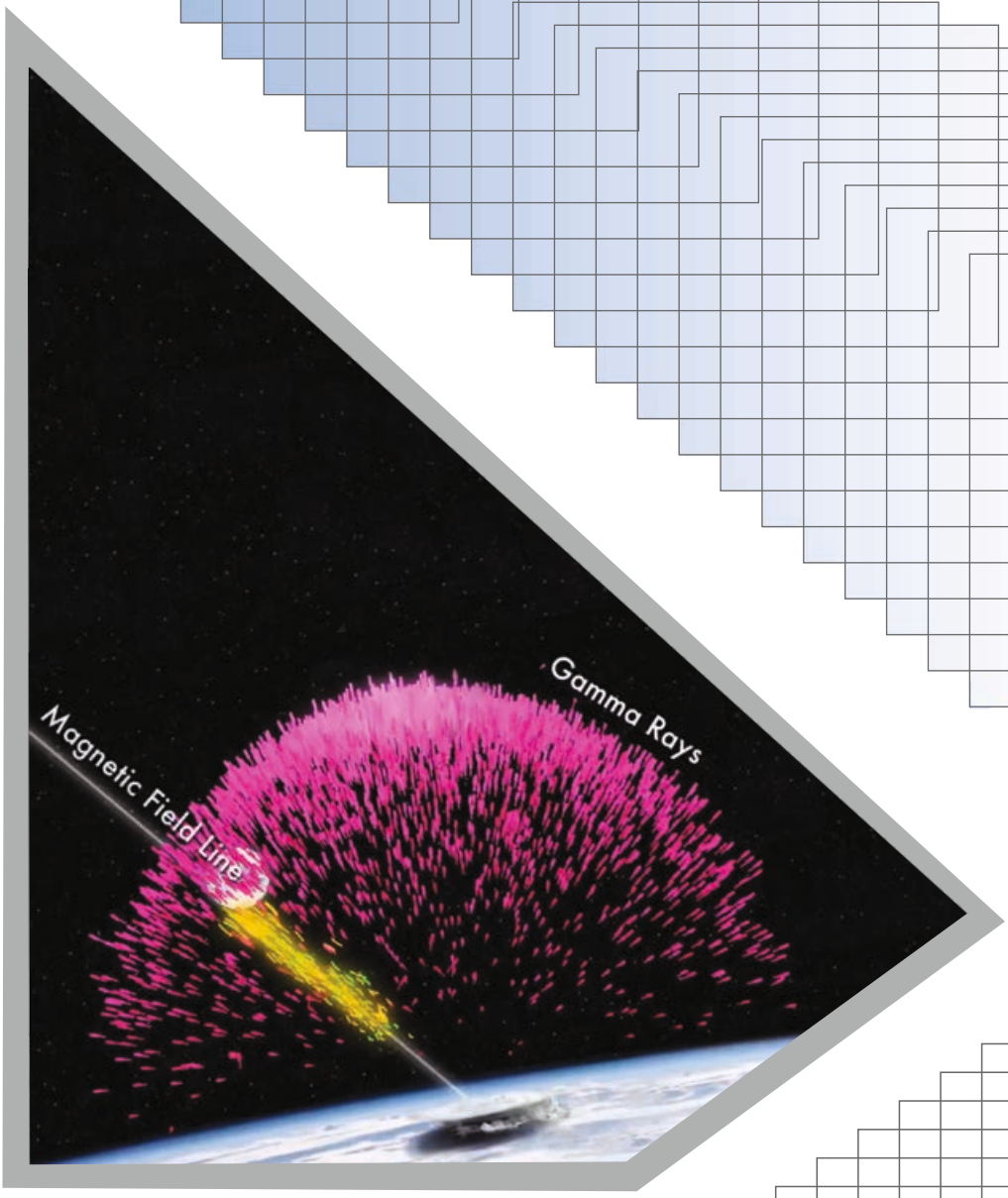
A. Chilingarian, ***N. Bostanjyan,*** *T. Karapetyan, L. Vanyan*

Yerevan Physics Institute, Yerevan, Armenia

Abstract

We present and discuss the modulation effect that large electric fields within thunderclouds pose on the flux of high-energy muons. The muon flux depletion, observed by the particle detectors of Aragats Space Environmental Center helps to locate the radiation-emitting region in the bottom of thundercloud. The decrease in the count rate of high-energy muons during thunderstorms along with simultaneous large enhancements in the count rates of low energy electrons and gamma rays can be used also for the estimation of the net potential drop in the lower dipole of the thundercloud.

RESEARCH OF THE TERRESTRIAL GAMMA-RAY FLASHES (TGFs)


Gamma Rays
Magnetic Field Line

New results from the Fermi GBM extended TGF sample

M. Briggs

National Space Science Technology Center, Alabama, USA

Abstract

A new data type and TGF detection method have been implemented for the Gamma-ray Burst Monitor (GBM) on the Fermi Gamma-ray Space Telescope. Individual photon data, with 2 microsecond and 128 energy channel resolution, are now recorded continuously: starting from 2010 July in regions selected for high TGF activity and then from 2012 November whenever the GBM detectors are on. Previously GBM TGFs were detected in-orbit using 16 ms integrations; they are now found at much higher sensitivity by searching the individual photon data on the ground, finding fainter and shorter TGFs. Using the extended intensity range of this sample, we corrected for detection efficiency and detector deadtime to obtain, in a model independent manner, the TGF fluence distribution arriving at the instrument. Assisted by the extended duration range of this sample, we found a strong anti-correlation between TGF duration and the probability of an associated detection by the World Wide Lightning Location Network (WWLLN). This anti-correlation shows that most of the WWLLN radio detections temporally and spatially coincident with TGFs are of the current flow of the TGF itself rather than of associated lightning.

Terrestrial Gamma-ray Flashes studies with AGILE

M. Marisaldi; *F. Fuschino; C. Labanti; M. Tavan; A. Arga*

Italian National Institute for Astrophysics, Bologna, Italy

M. Galli

National Agency for New technologies, Energy and Sustainable Economic Development, Bologna, Italy

Abstract

The AGILE satellite detects more than 10 Terrestrial Gamma-ray Flashes (TGFs) per month in the latitude belt +/- 2.5 deg. The current TGF sample comprises about 400 TGFs with maximum energy lower than 30 MeV detected by the Minicalorimeter (MCAL) instrument. The characteristics of the AGILE events are analyzed and compared to the observational frame established by the two other currently active missions capable of detecting TGFs from space, RHESSI and Fermi. Longitude and local time distributions are compatible with previous observations, while duration distribution is biased towards longer values. This can be explained as due to the dead time, which substantially prevents observation of events with duration shorter than about 100 microseconds. The intensity distribution is compatible with previous observations, when dead time is taken into account, pointing towards a true fluence distribution at satellite altitude that can be described with a power law with index -2.4 and a

rolloff at low fluence values. The TGFs cumulative spectrum supports a low production altitude, in agreement with previous measurements. We also present an update on the study of TGFs with maximum energy higher than 30 MeV, which exhibit characteristics partially different from those of lower energy events, and address the possible effects of TGF particle, gamma-ray and neutron irradiation on electronic components.

Terrestrial Gamma ray Flashes observed over low cloud tops

T. Gjesteland, *N. Østgaard*

Birkeland Centre for Space Science, University of Bergen, Bergen, Norway

S. Laviola, E. Arnone,

Institute of Atmospheric Sciences and Climate (ISAC) of the Italian National Research Council (CNR), Bologna, Italy

M. Marisaldi, F. Fuschino

Italian National Institute for Astrophysics, Bologna, Italy

A. Collier

South African National Space Agency, University of KwaZulu-Natal, South Africa

Abstract

We will present three Terrestrial Gamma ray Flashes (TGFs) observed over the Mediterranean sea. All three TGFs were produced in thunderstorms with cloud tops less than 10 km altitude, which is lower than the suggested typical TGF production altitude (15 km). The event on May 27, 2004 happened during spring when the cloud top in the Mediterranean sea is ~6-8 km. The two other TGFs occurred during fall. For these we have a cloud top estimation of 10 km. One of the

Mediterranean TGFs is among the 1% brightest TGFs ever measured by RHESSI. We have estimated that the three Mediterranean TGFs must contain up to 10^{21} initial photons, with energy above 1 MeV at source in order to escape atmospheric attenuation, which is three to four orders of magnitude higher than the commonly accepted value.

Search and candidates of TGF in SPI experiment of INTEGRAL observatory

*A. Pozanenko, **P. Minaev,** S. Grebenev, S. Molkov*

Space Research Institute of Russian Academy of Sciences, Moscow, Russia

V. Vybornov

Pushkov institute of terrestrial magnetism, ionosphere and radio wave propagation (IZMIRAN), Moscow, Russia

Abstract

Several observations of the Earth were performed by INTEGRAL observatory in 2006 and 2012. Aim of observations was Cosmic X-ray Background (CXB) measurement by the Earth occultation technique. We use data obtained in the observations for searching TGF in SPI experiment of INTEGRAL mission. Despite the INTEGRAL orbit is elliptical most intense TGFs could be registered by SPI / INTEGRAL. We discuss algorithms of TGFs search of present TGF candidates. We also discuss the physical parameters of the TGFs resulting from upper limits in case if none of the candidates will be confirmed.

New experiments for TGF study onboard ISS and Chibis-2 satellite

A. Vostrukhin, *F. Fedosov*

Space Research Institute of Russian Academy of Sciences, Moscow, Russia

Abstract

Talk presents proposed instruments for TGF study onboard International Space Station (ISS) and Chibis-2 satellite. Those are being developed in Russian Space Research Institute of RAS and based on high Technology Readiness Level (TRL) and flight-proven instruments and allow to measure gamma rays and neutrons. Gamma detector based on 3 inch LaBr3 detector measures gamma rays in 100keV - 10MeV range. Helium-3 detectors register neutrons in < 500keV energy range and plastic scintillator fin the energy range >above 500keV. Instruments provide fine time resolution as well as external triggering for TGF events.

Relativistic runaway electron breakdown and Terrestrial Gamma ray Flashes from GEANT4 simulation

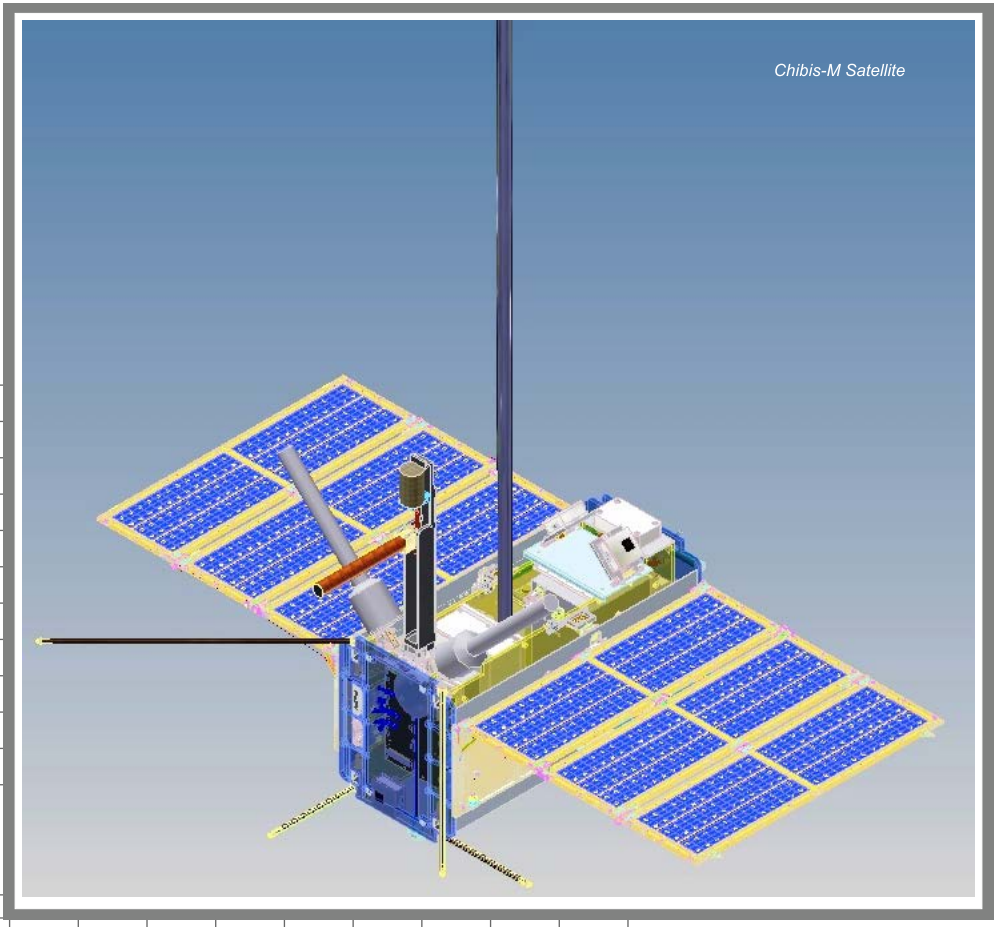
Yu. A. Tsalko, *V. V. Tikhomirov, H. P. Marozava*

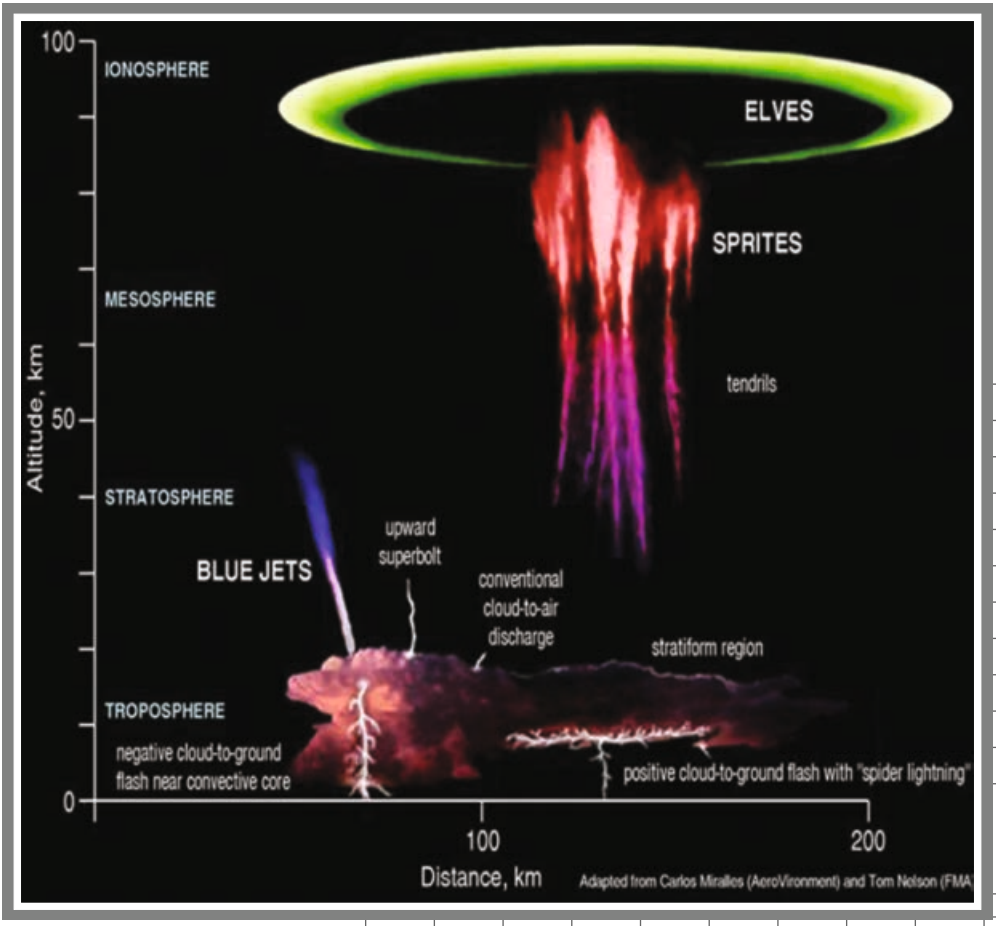
Research Institute for Nuclear Problems, Belarusian State University, Minsk, Belarus

Abstract

Numerical simulation of a relativistic runaway electron breakdown in the upper atmosphere is performed using GEANT4 simulation toolkit. General features of a relativistic runaway electron avalanche are reconstructed and properties of radiation accompanying breakdown are obtained. An existence of feedbacks arising from the generation of various particles in a relativistic runaway electron avalanche is established, which leads to a significant increase in number of particles in the avalanche. Generation of high-energy spectral component of a Terrestrial Gamma ray Flashes is considered and comparison with recently observed hard photons from Terrestrial Gamma ray Flashes up to 100MeV by AGILE team is performed. The dependence of the high energy part of the photon spectra on altitude was investigated and was shown that at reasonable parameters of the atmospheric electric field the simulated hard photons have spectral index close to the observed value.

ATMOSPHERIC HIGH-ENERGY PHENOMENA OBSERVATIONS BY SPACE-BORN FACILITIES




100
IONOSPHERE
ELVES
SPRITES
MESOSPHERE
tendrils
Altitude, km
50
STRATOSPHERE
upward
superbolt
BLUE JETS
conventional
cloud-to-air
discharge
stratiform region
TROPOSPHERE
negative cloud-to-ground
flash near convective core
positive cloud-to-ground flash with "spider lightning"
0
100
200
Distance, km
Adapted from Carlos Mirallles (AeroVironment) and Tom Nelson (FMA

Overview of MSU orbital observation of TLE's and future prospects

M. Panasyuk

Moscow State University, Moscow, Russia

Abstract

Moscow State University's observations of Transient Luminous Effects in the Earth's atmosphere onboard Tatiana-1, Tatiana-2 and Chibis satellites will be presented in this talk as well as perspectives of future plans for spaceborn experiments on TLE’s and TGF's study.

Attempt to search for a correlation between atmosphere glow measured by Universitetsky Tariana-2 satellite and geography of ionosphere heating stations.

B. Khrenov, *G. Garipov, P. Klimov, M. Panasyuk, S. Sharakin, I. Yashin*

Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russia

Abstract

Data on the atmosphere glow map and on global distribution of transients measured by detectors of Universitetsky-Tatiana-2 satellite were analyzed in attempt to find correlation with geography and time regime of stations for ionosphere heating.

Additional analysis of MSU microsatellite Tatiana-2 TLE data with data of IKI RAS microsatellite Chibis-M

G. Garipov, *P. Klimov, M. Panasyuk, S. Svertilov, B. Khrenov, I. Yashin*

Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russia

Abstract

During the operation time of ultra violet (UV) and infra red (IR) radiation detector installed on broad Tatiana-2 satellite from October 2009 to January 2010, the large statistics of transient luminous events was obtained (more than 2000 UV and IR flashes). Global geographical distribution of measured TLE shows their concentration above thunderstorm regions, but significant amount occurs far from cloud cover and lightning activity regions. The launch of the Chibis-M satellite allows verifying and performing a crosscheck of two data sets. The data of microsatellite Tatiana-2, whose trajectory over South America coincides with the maximum gradient of the global magnetic field and the preliminary data obtained by microsatellite Chibis-M, along the path of which the magnetic field remains almost constant, are discussed.

Analysis of satellite Tatiana-2 data correlation with cloud cover and regions of thunderstorm and lightning activity

V. Morozenko, *G. Garipov, B. Khrenov, P. Klimov, M. Panasyuk,S. Sharakin, I. Yashin*

Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russia

Abstract

Moscow State University micro-satellite Tatiana-2 was launched in September 2009 and during three months of successful operation measured large amount of UV flashed from the transient luminous events (TLE). The obtained number of events allows to produce geographical distribution analyses and to conduct research of their correlation with cloud coverage (meteorological satellite data) and lightning activity (ground based lightning networks). These analyses are discussed in the presented report.

“Chibis-M” observations of lightening radio-emission: capabilities and basic results

M. Dolgonosov, *V. Gotlib, L. Zelenyi, V. Karedin*

Space Research Institute of Russian Academy of Sciences, Moscow, Russia

O. Ferenz

Eotvos University, Budapest, Hungary
"Chibis-M" team ;

Abstract

Lightning activity generates puzzles for scientists for many years. New features of the lightning phenomenon were discovered relatively recently after launching into space satellites ALEXIS and FORTE. One of phenomena discovered on the basis of obtained from space data was Trans-Ionospheric Pulse Pairs (or TIPPs) that was thoroughly investigated later by many researches. TIPPs are pairs of pulses in VHF range. It was postulated that TIPPs associated with thunderstorms. To study processes related to thunderstorm activity microsatellite "Chibis-M" was launched. This microsatellite carries on board variety of detectors in a wide range of spectrum: radio-frequency analyzer, IR and UV detector, X and gamma-ray detector and plasma spectrum analyzer. In this report, we would like to present analysis of the radio emission from lightning in the range of 26-48 MHz obtained for the period of the campaign in 2012. The main questions that we plan to cover in this report are as follows: classification of events and their characteristics. In our report we also intend to provide the

alternative explanation of TIPPs origin and its discrete nature. Some statistical estimation of geographical occurrence of TIPPs and its correlation with the optical emission will be presented.

Microsatellite *"Chibis-M":* observation of terrestrial lightening radiation from space

L. Zelenyi, S. Klimov, ***V. Gotlib***

Space Research Institute of Russian Academy of Sciences, Moscow, Russia

A. Gurevich

Lebedev Physical Institute of Russian Academy of Sciences, Moscow, Russia
"Chibis-M" team ;

Abstract

At the beginning of 2012 microsatellite Chibis-M was launched. Chibis-M was piggyback of Russian freighter spacecraft Progress and MSS crew participated in placing it on orbit. General task is to study the complex processes that occur during terrestrial lightning activity. The main feature of this satellite consists in operation of all detectors (X and gamma-ray, optical camera, radio-frequency analyzer, UV and IR detector, and plasma spectrum analyzer) as one flying device. In this case lightning emission could be registered simultaneously in wide range of electromagnetic spectrum that provides unique capabilities for investigation of marvelous phenomena of atmospheric discharge and developing of its theory. In this report we are going to present basic capabilities of the microsatellite platform Chibis, composition of Chibis-M and its first results. In particular, radio emission from lightning in 26-48 MHz, UV and IR detection of optical emission will be presented. Some estimation of terrestrial

lightning typical parameter will be also presented. Platform Chibis and the method of its placing on orbit are promising for future low-cost scientific missions. We also intend to inform participants of the conference on our next project for studying lightning from space: microsatellite Chibis-AI.

Some phenomena in studies of transient luminous events measured by “Universitetsky-Tatiana-2”

G. Garipov

Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russia

Abstract

Global distribution of the flashes searched by the set of scientific payload on-board Universitetsky-Tatiana-2 satellite measured transient millisecond flashes in two wavelength bands UV(240-400nm) and IR(610-800nm) and charged particles flux, mainly electrons with energy more than 1 MeV. Several characteristics of this contradict conventional knowledge on lightning origin. Transient flashes, measured by the satellite frequently have been detected in cloudless regions. The global network of lightning radio detectors does not see those events. These evidences point on their upper ionosphere origin. Expected precipitation of electrons in conjugate points was not detected. At the same time flashes are mainly observed above continents stretching along magnetic meridians. This fact indicates the important role of geomagnetic field and the role of electrically active zones of the continents in formation of electric field in the ionosphere. The observed absence of transient events above the Sahara Desert

stresses the role of water vapor in formation of electrically active zones not only in the troposphere but also in the ionosphere.

Lifting building materials for the construction of Aragats Research Station (in the middle of the 20th century).

Artem and Abraham Alikhanyan brothers

Spectroscopic measurements of transient luminous events. Current status of problem and detectors developments in SINP MSU

S. Sharakin, *G. Garipov, B. Khrenov, P. Klimov, V. Morozenko, M. Panasyuk, I. Yashin*

Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russia

Abstract

Review of present-day experiments on spectroscopy of transient luminous events (TLE) and program of transients' spectroscopy measurements in SINP MSU are presented.

Development of a Transportable LIDAR System For The Measuring Electric Field Inside The Clouds

H. Hovsepyan, R. Hakhumyan, ***A. Ghalumyan***

Yerevan Physics Institute, Yerevan, Armenia

Abstract

Intensive studies in fields of high-energy phenomena in the atmosphere revealed electron acceleration and the bremsstrahlung photons generation caused by the electric field emerging in the thunderclouds. Large quasi-electrostatic fields inside the clouds have a tripole structure with main negative layer in the middle of cloud, main positive on the top and smaller positive "pocket" sitting just on the bottom of cloud. The upper dipole is accelerated electrons upward and crossing ~500 km gamma rays from the electron-gamma ray avalanches are routinely detected by the facilities of orbiting gamma ray observatories (Terrestrial gamma flashes, TGFs). Lower dipole accelerates electrons downward and the networks of particle detectors located on the Earth's surface observed hundreds of particle fluxes (so called, Extensive cloud showers, ECSes). Further studies demand knowledge of electrical field distribution inside clouds. We are suggesting a method of the remote measurement based on transportable LIDAR system using precise polarization technique.

New opportunities of TUS detector on-board Lomonosov satellite for TLE measurements

P. Klimov, *G. Garipov, B. Khrenov, V. Morozenko, M. Panasyuk, S. Sharakin, I. Yashin*

Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russia

Abstract

Moscow State University in collaboration with other Russian and foreign institutions is preparing a new scientific and educational satellite Lomonosov. Scientific payload of these satellite contains ultra-high energy cosmic rays (UHECR) detector TUS. It will observe faint fluorescent tracks of extensive air shower (EAS), produced by a primary energetic particle in the atmosphere. TUS consists of large Fresnel-type mirror-concentrator (~2 sq. m.) and photo receiver placed in the focal plane (matrix of 16x16 PM tubes with a spatial resolution in the atmosphere ~ 5 km). Electronics allow achieving a microsecond time sampling for the fastest events and sub-millisecond time resolution for the slower ones (transient luminous events, micro-meteors). In addition to the main photo receiver, which measure UV light collected by a mirror, there was installed a pin-hole camera with two multi anode PM tubes orientated directly to the atmosphere. It has the same FOV, but smaller aperture ratio. Detector TUS will produce measurements of TLE initial stage with high temporal resolution and very low threshold. It gives opportunity to measure dim

flashes in the upper atmosphere, which were observed by Tatiana-2 satellite and obtain there spatial structure. After the saturation of photo receiver in case of powerful TLE measurements continue by pin-hole camera. In the presented work a possibility of transient luminous events measurements from space by TUS detector with high sensitivity and temporal resolution is discussed.

Calibration experiment with 3 electric mills EFM-100 performed on Aragats in 2012

Y. Khanikyanc, *A. Reymers*

Yerevan Physics Institute, Yerevan, Armenia

Abstract

We present characteristics for 10 events of Thunderstorm Ground Enhancements (TGEs) registered at Aragats during October 4-9, 2012. Results of near surface electric field measurements with three Atmospheric Electric Field Monitors (Boltek, Model EFM-100), as well as measurements with STAND 3cm electron/gamma ray detector (1x1m^2 area, 3cm thick molded plastic scintillator) are summarized. Three identical EFM-100 detectors were calibrated at the same place on a calm clear day. Then they were mounted at different heights (maximal difference of altitudes ~60m) in different locations (within 500 m from each other). The STAND 3cm detector is located approximately 20 m away from one of EFM-100 electric mills. Ten TGE events have been recorded. For all ten TGE events, the count rate enhancement of the STAND 3cm detector is accompanied by strong near-surface electrical field disturbances. In most of the recorded events, the TGEs were observed during large negative near surface electrical field exceeding 10kV/m.

Pre-lightning radio signals generated by cosmic ray air showers

V. Gharibyan

DESY, Hamburg, Germany

Abstract

A new type of radiation could be responsible for narrow bipolar radio pulses observed shortly before lightings. This radiation is generated by high energy cosmic rays and is associated with macro-charge of induced atmospheric showers. Calculations for fair weather conditions will be presented and thunderstorm amplification possibility will be discussed. An accelerator 'proof of concept' experiment is proposed.

Geophysical Research Network Operating in the Aragats Space Environmental Center

A. Reymers

Yerevan Physics Institute, Yerevan, Armenia

S. Chilingaryan

Yerevan Physics Institute, Yerevan, Armenia
and Karlsruhe Institute of Technology, Karlsruhe, Germany

Abstract

Geophysical research network of the Aragats Space-Environmental Center (ASEC) provides monitoring of different species of secondary cosmic rays and various geophysical parameters. ASEC network monitors located at two high altitude stations on Mt. Aragats in Armenia and Yerevan headquarters of Cosmic Ray Division (CRD) of A. Alikhanian National Laboratory. Developed scientific infrastructure is intended for the research of the solar modulation effects, high-energy atmospheric events and for issuing warnings and alerts on the violent consequences of solar eruptions and catastrophic meteorological events. We also plan to measure the height and structure of thunderclouds by performing optical monitoring of the transient luminous events. Information from all measuring channels is assessable on-line in fast and user-friendly fashion. Forecast and nowcast of the events under development requires fast joint analysis of the multivariate information and decision

making on the level of the emerging risks. We present the structure and operation characteristics of the ASEC networks as well as description of software infrastructure for fast and reliable data transfer to MySQL databases and mirror sites.

Advanced Data Extraction Infrastructure (ADEI) for multivariate visualisation and statistical analysis of ASEC data

A. Reymers

Yerevan Physics Institute, Yerevan, Armenia

S. Chilingaryan

Yerevan Physics Institute, Yerevan, Armenia and Karlsruhe Institute of Technology, Karlsruhe, Germany

Abstract

Advanced Data Extraction Infrastructure (ADEI) has been developed to provide data exploration capabilities to a broad range of physical experiments dealing with time series. The ADEI web interface is supporting most of existing browsers and follows guidelines set by Google-maps application to provide quick and easy navigation through the image data. Due to intelligent caching techniques, ADEI is capable of interactively plotting data for any given time scale from few hours up to the yearly overview of complete ASEC operation time. Export of selected data is possible in multiple formats. ADEI is licensed under GNU General Public License and uses only free open source technologies. ASEC data is published online at http://adei.crd.yerphi.am

A Distributed Detector Array Correlating X-Ray Emissions from Lightnin flashes with Meteorological Data in the American Midwest

Ch. Fasano, *C. Turner, R. Williams, E. Bell, B. Shannon,*

Monmouth College, Monmouth, USA

Z. Monti, A. Keller

Monmouth College (Creighton University), Monmouth, USA

Abstract

Severe thunderstorms that produce copious lightning are common throughout the American Midwest. To understand photon emission from these storms, we are building and deploying 10 detector packages throughout Western Illinois at local high schools, where students will assist us in accumulating data. These packages, designed to record X-rays, E-Fields, and an array of meteorological data, are built to be reliable, relatively inexpensive, and easy to construct and deploy. Our packages are expandable as well to allow us to add the ability to collect additional data in a simple and straightforward way. Because of the ease of construction and deployment, we hope that we and others may replicate the design to create a kind of X-Ray detection network that when correlated with other measurements, provide us with a way of understanding X-Ray production from lightning and the meteorological conditions and storms that allow for X-Ray production. In this talk we describe our detectors and deployment. Preliminary data, if available, will be presented as well. This work is supported by the National Science Foundation (NSF AGS-1232594).

CsJ(Tl) detectors for registration atmospheric gamma ray photons with energies greater than 200 KeV

E. Mnatsakanyan, *K. Avagyan*

Yerevan Physics Institute, Yerevan, Armenia

Abstract

In order to expand energy range of the registration of the gamma ray photons to low energy domain (0.2 – 2 MeV), we have developed a new detector on the base of CsJ(Tl) crystals. New detectors will be installed on three altitudes: Yerevan-1000 m.a.s.l; Nor-Amberd-2000 m.a.s.l and Aragats-3200 m.a.s.l. Each detector consists of one CsJ(Tl) crystal covered by magnesium oxide on four sides. Upper side is covered by beryllium plate with thickness of 150 μm + aluminium foil - 30 μm. Two photomultipliers FEU-110 type are attached to the bottom side of crystal. Signals from FEU-10 entered data acquisition system (DAQ) consisting of two channel amplifiers; discriminators, shapers and coincidence scheme. In report detailed descriptions, characteristics, performance of the detectors and preliminary results will be presented.

Fast optical monitor for lightening detection on board Chibis-2 mission

A. Pozanenko, *A. Chernenko, A. Kiselev, V. Klimenko, P.l Minaev, S. Khandorin, A. Tonshev*

Space Research Institute of Russian Academy of Sciences, Moscow, Russia

Abstract

We discuss details of Fast Optical Monitor (FOM) proposed for Chibis-2 mission. The main goal of the FOM experiment is the searching for optical emission of TGFs and with other instruments on board Chibis-2 satellite, multi-wavelength investigation of this phenomenon. A fast CCD camera will operate with frame rate of 1 KHz and provide coordinates of the lightening with the temporal accuracy of 1 ms and spatial accuracy of about 10 km. It would provide not only mapping of Earth lightning activity but also supply positions of TGF, registered simultaneously with Chibis-2/NGS radio experiment, independently from WWLN.

Calibration of the NaI network on Aragats

*K. Arakelyan, A. Daryan, G. Hovsepyan, **L. Kozliner**, A. Reymers*

Yerevan Physics Institute, Yerevan, Armenia

Abstract

The Aragats Space Environmental Center (ASEC) provides monitoring of different species of secondary cosmic rays and consists of two high altitude research stations on Mt. Aragats in Armenia. Energy spectra and correlations between fluxes of different particles, measured on Earth's surface address the important issues of the solar modulation effects and the atmospheric high-energy phenomena. Along with solar modulation effects, ASEC detectors register several coherent enhancements associated with thunderstorm activity. The experimental techniques used allowed for the first time to simultaneously measure changing fluxes of the electrons, muons, gamma rays, and neutrons correlated with thunderstorm activity. Ground-based observations with a complex of surface particle detectors, measuring in systematic and repeatable fashion, gamma quanta, electrons, muons and neutrons from atmospheric sources are necessary for proving the theory of particle acceleration and multiplication during thunderstorms. Established on May 26 2011, network of 5 large NaI(Tl) (thallium-doped sodium iodide) crystals in the new ASEC laboratory on Aragats is of great importance for the investigation of thunderstorm phenomena because NaI(Tl) detectors have a higher efficiency of gamma ray detection comparing with plastic ones. The NaI network consists

of 5 NaI crystal scintillators of size 12.5 x 12.5 x 30 cm. The NaI crystal is placed into sealed aluminum (1 mm thick) housing (because the crystal is hygroscopic) with transparent window attached to the photo-cathode of the photomultiplier tube (PM). We will present the calibration of the NaI spectrometric network and methods of selection of the photomultiplier parameters.

Maximal Energy of Solar Accelerators: evidence from space born and Earth's surface measurements

H. Rostomyan

Yerevan Physics Institute, Yerevan, Armenia

Abstract

On January 20, 2005, 7:02-7:04 UT the Aragats Multidirectional Muon Monitor (AMMM) located at 3200m registered enhancement of the high energy secondary muon flux (threshold ~5 GeV). The enhancement, lasting 3 min has statistical significance of ~4 and was related to the X7.1 flare seen by the GOES, and very fast (>2500 km/s) CME seen by SOHO. Worldwide network of neutron monitors detects Ground Level Enhancements (GLE) #69 arriving very fast after flare; recovered energies of solar protons demonstrate rather hard spectra prolonged up to 10 GeV. The solar proton spectrum incident on the Earth's atmosphere was simulated and transport till AMMM detector located under 14 m of soil and concrete. The most probable minimal solar proton energy corresponding to the measured 5 GeV muon flux is within 20-25 GeV. On March 7, 2012 Large aperture telescope of Fermi gamma-ray observatory detected the ever highest energy gamma rays from the Sun with energy about 4 GeV. The minimal energy of the solar protons accelerated during the flare and producing 4 GeV gamma rays

should be ~25 GeV. Thus, both measurements with secondary muons and gamma rays prove maximal energy of solar accelerators not smaller than 25 GeV.

Cosmic ray measurements in High Tatras and in Kosice: status of experiments and perspectives.

I. Strharsky, ***R. Langer***

Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovakia

Abstract

For study of relations between atmospheric electricity and cosmic rays the measurements at high altitudes are of essential importance. In addition to 1 min neutron monitor (NM) measurements at Lomnicky stit (LS) available in real time at http://neutronmonitor.ta3.sk, recently (a) the new registration units for 1 sec measurements and with e.g. possibility to measure time of access of each pulse from NM was constructed; (b) SEVAN unit in Kosice with testing run since October 2012 until March 2013 was shifted to LS and in July 2013 put in operation; (c) measurements of thermal neutrons (device joint with Lebedev Phys. Inst. in Moscow); (d) dosimetric measurements at LS and indication of lightning in Kosice are in testing mode. Barometric pressure correction for SEVAN is presented. The devices along with the examples of the data obtained are presented and perspectives of the measurements are discussed.

The thermospheric auroral red line polarization: a new window on the near space environment

J. Lilensten, *M. Barthélémy*

Institute of Planetology and Astrophysics of Grenoble, Grenoble, France

Abstract

The polarization of emission lines is a noteworthy observational parameter in astronomy. Theoretical considerations have suggested that the polarization of the thermospheric oxygen red line (630 nm) could exist in the polar cap region. We present here its measurement at Svalbard over a series of campaigns (2007 - 2012) with a dedicated optical instrument. We assign its origin and variability to complementary effects between permanent low-energy electron precipitation and sporadic auroral events. We show that the Degree of Linear Polarization (DoLP) makes it possible to derive the local configuration of the magnetic fields. We also show what parameters are influencing the Amplitude of Linear Polarization (AoLP) and how the measurement of the polarization may become a proxy for space weather. With the additional measurement of the ESR Incoherent Scatter radar, we provide a comparison between theory and measurement, which shows that the scattering of the energetic electrons is still largely unknown. Finally, we show the extension of this work to other wavelengths at Earth, and to other planets.

Accessing near-Earth space data through the ESPAS e-science platform: an overview of the system design of the first working prototype

J. Lilensten
Institute of Planetology and Astrophysics of Grenoble, Grenoble, France

A. Belehaki
National Observatory of Athens, Athens, Greece

M. Hapgood
Space Environment Group at Rutherford Appleton Laboratory

Abstract

The aim of ESPAS platform is to integrate heterogeneous data from the earth's thermosphere, ionosphere, plasmasphere and magnetosphere. ESPAS supports the systematic exploration of multipoint measurements from the near-Earth space through homogenised access to multi-instrument data. It provides access to more than 40 datasets: Cluster, EISCAT, GIRO, DIAS, SWACI, CHAMP, SuperDARN, FPI, magnetometers INGV, SGO, DTU, IMAGE, TGO, IMAGE/RPI, ACE, SOHO, PROBA2, NOAA/POES, etc. The concept of extensibility to new data sets is an important element in the ESPAS architecture. Within the first year of the project, the main components of the system have been developed, namely, the data model, the XML schemas for metadata exchange format, the ontology, the wrapper installed at the data nodes so that the main platform harvest the

metadata, the main platform built on the D-NET framework and the GUI with its designed workflows. The first working prototype supports the search for datasets among a selected number of databases (i.e., EDAM, DIAS, Cluster, SWACI data). The next immediate step would be the implementation of search for characteristics within the datasets. For the second release we are planning to deploy tools for conjunctions between ground-space and space-space and for coincidences. For the final phase of the project the ESPAS infrastructure will be extensively tested through the application of several use cases, designed to serve the needs of the wide interdisciplinary users and producers communities, such as the ionospheric, thermospheric, magnetospheric, space weather and space climate communities, the geophysics community, the space communications engineering, HF users, satellite operators, navigation and surveillance systems, and space agencies. The final ESPAS platform is expected to be delivered in 2015.

Comments on meteorological conditions during Thunderstorm ground enhancements

A. Chilingarian, ***H. Mkrtchyan***

Yerevan Physics Institute, Yerevan, Armenia

Thunderstorm ground enhancements (TGEs) – is a new discovered high-energy phenomenon in terrestrial atmosphere comprising in the detection of the particle fluxes (mostly electrons and gamma rays) on the Earth surface in correlation with thunderstorms. This enigmatic phenomena, predicted in 1924 by one of the first particle physicists and founders of the topic of atmospheric electricity sir C.T.R. Wilson till now did not get full explanation.

TGEs occurred during disturbances of the intracloud electric field, mostly during prolonged periods of the negative values (up to -40 kV/m) of its proxy - near surface electric field. Usually TGEs are accompanied by rain or snow and atmospheric discharges. And it is interesting to know what meteorological conditions supports the initiation of TGE.

In this paper we analyze the temperature and relative humidity relations measured at different weather conditions: thunderstorms, TGEs, fair weather. Our studies help to outline the domain in the temperature-relative humidity scatter plot, when the TGEs are possible. The TGE and meteorological data were obtained during expeditions on Mt. Aragats in 2011-2012.

Nor Amberd Research Station

TEPA DISCUSSIONS

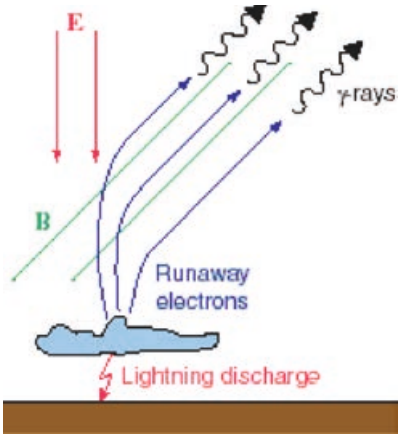
TGEs and TGFs - what we can learn by comparisons of both?

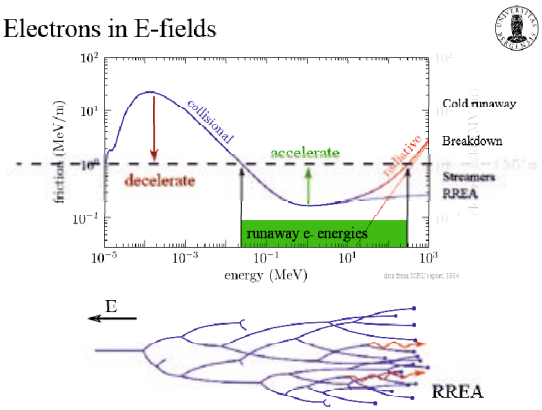
Particle fluxes & atmospheric discharges - any causal relation?

High energy physics in atmosphere - perspectives for coming, years.

Data bases of TGEs & TGFs are they available for community?

Transient energetic events in in the Earth' s atmosphere (TGF, TGE, TLE, particle precipitation,etc) can they all be explained in one theoretical framework?





CRD PUBLICATIONS ON THUNDERSTORM GROUND ENHANCEMENTS (TGEs)

Full texts available from http://crd.yerphi.am

- Chilingarian, A.Daryan, K.Arakelyan, et al., G**round-based observations of thunderstorm-correlated fluxes of high-energy electrons, gamma rays, and neutrons,** Phys.Rev. D., **82,** 043009, 2010
- A. Chilingarian, G. Hovsepyan, and A. Hovhannisyan, **Particle bursts from thunderclouds: Natural particle accelerators above our heads,** Physical review D 83, 062001 (2011).
- A. Chilingarian, B. Mailyan and L. Vanyan, **Recovering of the energy spectra of electrons and gamma rays coming from the thunderclouds,** Atmospheric Research 114–115, 1–16, (2012).
- A. Chilingarian, N. Bostanjyan, and L. Vanyan, **Neutron bursts associated with thunderstorms,** Physical Review D 85, 085017 (2012).
- Chilingarian, A. and Mkrtchyan, H., **Role of the Lower Positive Charge Region (LPCR) in initiation of the Thunderstorm Ground Enhancements (TGEs)**, Physical Review D 86, 072003 (2012).
- Chilingarian, N. Bostanjyan, T. Karapetyan, L.Vanyan, **Remarks on recent results on neutron production during thunderstorms**, Physical Review D 86, 093017 (2012).
- A. Chilingarian, B. Mailyan, **Recovering of the TGE electron and gamma ray energy spectra,** Journal of Physics: Conference Series 409 (2013) 012214
- A Chilingarian, N Bostanjyan, T Karapetyan, **On the possibility of location of radiation-emitting region in thundercloud, Journal of Physics**: Conference Series 409 (2013) 012217
- Karen Avakyan, Karen Arakelyan, Ashot Chilingarian, Ara Daryan, Lev Kozliner, Bagrat Mailyan, Gagik Hovsepyan, David Pokhsraryan, David Sargsyan, **NaI Detector Network**

at Aragats, Journal of Physics: Conference Series 409 (2013) 012218

- A Chilingarian, N Bostanjyan, T Karapetyan, L Vanyan, **Neutron production during thunderstorms,** Journal of Physics: Conference Series 409 (2013) 012216
- A Chilingarian, Thunderstorm Ground Enhancements (TGEs) - **New High- Energy Phenomenon Originated in the Terrestrial Atmosphere,** Journal of Physics: Conference Series 409 (2013) 012019
- A Chilingarian, G Hovsepyan**, Extensive Cloud Showers (ECS) – New High-Energy Phenomena Resulting from the Thunderstorm Atmospheres,** Journal of Physics: Conference Series 409 (2013) 012221
- A Chilingarian, L Vanyan, **Simulations of the secondary cosmic ray propagation in the thunderstorm atmospheres resulting in the Thunderstorm ground enhancements (TGEs),** Journal of Physics: Conference Series 409 (2013) 012215
- Ashot Chilingarian, Hripsime Mkrtchyan, **Lower positive charge region (LPCR) and its influence on initiation of Thunderstorm ground enhancements (TGEs) and cloud-to-ground (CG-) and intracloud (IC-) lightning occurrences**, Journal of Physics: Conference Series 409 (2013) 012219
- Karen Arakelyan, Karen Avakyan, Ashot Chilingarian, Ara Daryan, Laura Melkumyan, David Pokhsraryan, David Sargsyan, **New low threshold detectors for measuring electron and gamma ray fluxes from thunderclouds**, Journal of Physics: Conference Series 409 (2013) 012223
- A.Chilingarian, T. Karapetan, LMelkumyan, **Statistical analysis of the Thunderstorm Ground Enhancements (TGEs) detected on Mt. Aragats**. J. Adv. Space Res. (2013), http://dx.doi.org/10.1016/j.asr.2013.06.004
- A. Chilingarian, Mailyan B., Vanyan L., **Observation of Thunderstorm Ground Enhancements with intense fluxes of high-energy electrons,** Astropart. Phys. (2013), http://dx.doi.org/10.1016/j.astropartphys.2013.06.006

HOW TO ANALYSE TGE WITH ADEI CODE, SOME EXAMPLES.

On-line producing of the Figures multipletime series, Sceen-shots of current session, scatter plots, histograms and other… (see for details ADEI WIKI)[1]

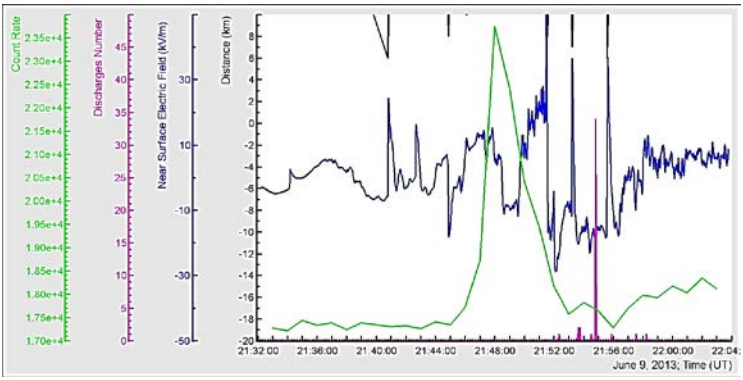


Figure 1. 9 June, 2013 TGE, black – Distance to cloud-to-ground lightning measured by EFM-100 electric mill; blue the disturbances of near surface electric field measured by same device, rose – the atmospheric discharges number (intercloud negative IC- discharges) measured by Boltek's StormTracker within 1 km from detector location; green one-minute count rate of the network of 5 NaI crystals

[1] http://adei.crd.yerphi.am/

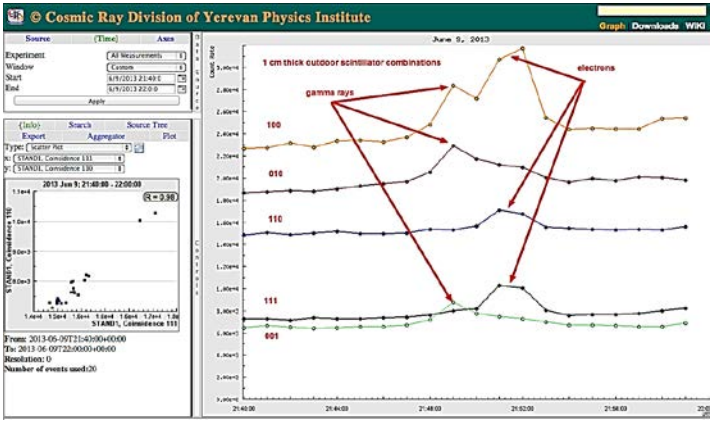


Figure 2. 9 June 2013 2-peak TGE; current analysis with different combinations of stacked STAND detector reveals gamma ray and electron fractions of TGE

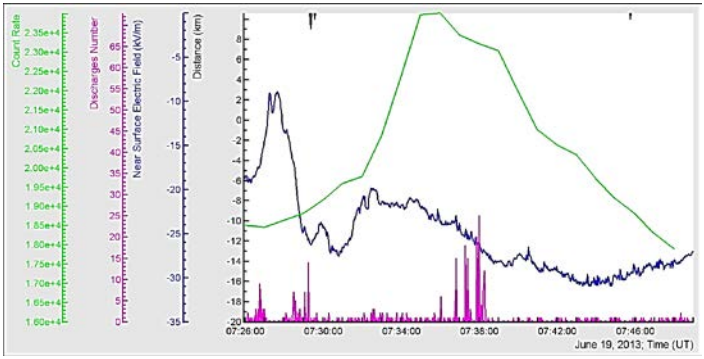


Figure 3. 19 June, 2013 TGE, black – Distance to cloud-to-ground lightning measured by EFM-100 electric mill; blue the disturbances of near surface electric field measured by same device, rose – the atmospheric discharges number (intercloud negative IC- discharges) measured by Boltek's StormTracker within 1 km from detector location; green one-minute count rate of the network of 5 NaI crystals.

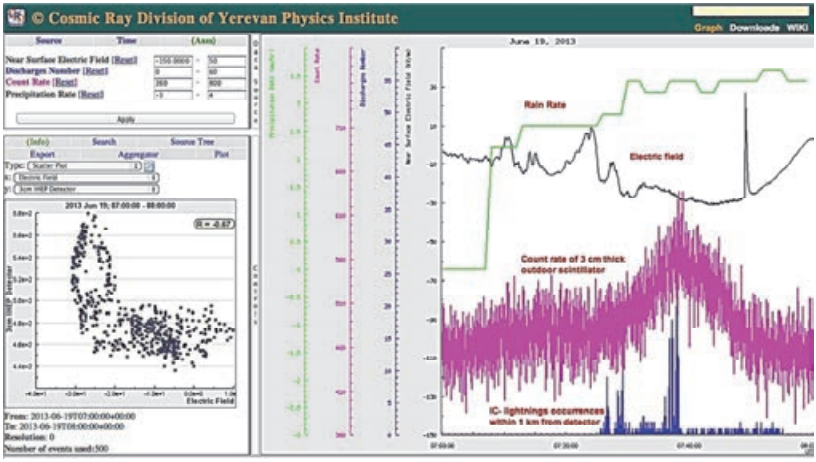


Figure 4. Screen shot of on-line analysis of 19 June TGE. Note correlation of particle flux and electric field strength apparent on the scatter plot.

LIST OF TEPA-2013 REGISTERED PARTICIPANTS

Country, city	Name	Email	Affiliation
Armenia, Yerevan	Bostanjyan Nikolay	nikolai@yerphi.am	Yerevan Physics Institute
United States	Briggs Michael	Michael.S.Briggs@nasa.gov	University of Alabama
United States, Baton Rouge	Cherry Michael	cherry@lsu.edu	Louisiana State University
Armenia, Yerevan	Chilingaryan Ashot	chili@aragats.am	Yerevan Physics Institute
Russian Federation, Moscow	Dolgonosov Maxim	cactus@iki.rssi.ru	Space Research Institute of RAS
United States, Monmouth	Fasano Christopher	cfasano@ monmouthcollege.edu	Monmouth College
Russian Federation, Moscow	Fedor Fedosov	fedosov@l503.iki.rssi.ru	Space Research Institute of RAS
United States, Huntsville, AL	Fishman Gerald	fishman@msfc.nasa.gov	NASA - Marshall Space Flight Center
Russian Federation, Moscow	Garipov Gali	ggkmsu@yandex.ru	Skobeltsyn Institute of Nuclear Physics
Germany, Hamburg	Gharibyan Vahagn	vahagn.gharibyan@desy.de	DESY
Norway	Gjesteland Thomas	thomas.gjesteland@uib.no	University of Bergen
Russian Federation, Moscow	Gotlib Vladimir	gotlib@iki.rssi.ru	Space Research Institute of RAS
Armenia, Yerevan	Hovsepyan Gagik	hgg@yerphi.am	Yerevan Physics Institute
Armenia	Karapetyan Tigran	ktigran79@yerphi.am	Yerevan Physics Institute
Armenia, Yerevan	Khanikyants Yegiya	khanikync@mail.yerphi.am	Yerevan Physics Institute
Russian Federation, Moscow	Klimov Pavel	pavel.klimov@gmail.com	Skobeltsyn Institute of Nuclear Physics
Russian Federation, Moscow	Khrenov Boris	bkhrenov@yandex.ru	Skobeltsyn Institute of Nuclear Physics
Armenia, Yerevan, Israel, Tel Aviv	Kozliner Lev	lkozliner@mail.ru	Tel Aviv University, Yerevan Physics Institute

Country, city	Name	Email	Affiliation
Slovak Republic, Svit	Langer Ronald	langer@ta3.sk	Institute of Experimental Physics of the Slovak Academy of Sciences
France, Grenoble	Lilensten Jean	jean.lilensten@obs.ujf-grenoble.fr	Institute of Planetology and Astrophysics of Grenoble
Armenia, Yerevan	Mailyan Bagrat	bagrat_mailyan@yerphi.am	Yerevan Physics Institute
Italy, Bologna	Marisaldi Martino	marisaldi@iasfbo.inaf.it	Italian National Institute for Astrophysics
Russian Federation, Moscow	Minaev Pavel	minaevp@mail.ru	Space Research Institute of RAS
Germany, Munich	Mirzoyan Razmik	Razmik.Mirzoyan@mpp.mpg.de	Max Planck Institute
Armenia, Yerevan	Mkrtchyan Hripsime	hripsime@yerphi.am	Yerevan Physics Institute
Armenia, Yerevan	Mnatsakanyan Edik	vanmnats@yahoo.com	Yerevan Physics Institute
Russian Federation, Moscow	Morozenko Violetta	Morozenko_viola@mail.ru	Skobeltsyn Institute of Nuclear Physics
Russian Federation, Moscow	Panasyuk Mikhail	panasyuk@sinp.msu.ru	Moscow State University
Russian Federation, Moscow	Pozanenko Alexei	apozanen@iki.rssi.ru	Space Research Institute of RAS
Armenia, Yerevan	Reymers Artur	artur@yerphi.am	Yerevan Physics Institute
Armenia, Yerevan	Rostomyan Hasmik	hasmik_rostomyan@mail.yerphi.am	Yerevan Physics Institute
Russian Federation, Moscow	Svertilov Sergey	sis@coronas.ru	Skobeltsyn Institute of Nuclear Physics
Armenia, Yerevan	Vanyan Levon	levon@yerphi.am	Yerevan Physics Institute
Russian Federation, Moscow	Vostrukhin Andrey	vostrukhin@iki.rssi.ru	Space Research Institute of RAS