Analyses of electron runaway in front of the negative streamer channel

X- and γ-ray emissions, observed in correlation with negative leaders of lightning and long sparks of high-voltage laboratory experiments, are conventionally connected with the bremsstrahlung of high-energy runaway electrons (REs). Here we extend a focusing mechanism, analyzed in our previous paper, which allows the electric field to reach magnitudes, required for a generation of significant RE fluxes and associated bremsstrahlung, when the ionization wave propagates in a narrow, ionized channel created by a previous streamer. Under such conditions we compute the production rate of REs per unit streamer length as a function of the streamer velocity and predict that, once a streamer is formed with the electric field capable of producing REs ahead of the streamer front, the ionization induced by the REs is capable of creating an ionized channel that allows for self-sustained propagation of the RE-emitting ionization wave independent of the initial electron concentration. Thus, the streamer coronas of the leaders are probable sources of REs producing the observed high-energy radiation. To prove these predictions, new simulations are planned, which would show explicitly that the pre-ionization in front of the channel via REs will lead to the ionization wave propagation self-consistent with REs generation.

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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, Russian Federal Nuclear Center
Authors: Babich, L. P. (Ekstern), Bochkov, E. I. (Ekstern), Kutsyk, I. M. (Ekstern), Neubert, T. (Intern), Chanrion, O. (Intern)
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Assessment of Unusual Gigantic Jets observed during the Monsoon season: First observations from Indian Subcontinent

Gigantic Jets are electric discharges from thunderstorm cloud tops to the bottom of ionosphere at similar to 90 km altitude and electrically connect the troposphere and lower ionosphere. Since their first report in 2002, sporadic observations have been reported from ground and space based observations. Here we report first observations of Gigantic Jets in Indian subcontinent over the Indo-Gangetic plains during the monsoon season. Two storms each produced two jets with characteristics not documented so far. Jets propagated similar to 37 km up remarkably in similar to 5 ms with velocity of similar to 7.4 x 10(6) ms(-1) and disappeared within similar to 40-80 ms, which is faster compared to jets reported earlier. The electromagnetic signatures show that they are of negative polarity, transporting net negative charge of similar to 17-23 C to the lower ionosphere. One jet had an unusual form observed for the first time, which emerged from the leading edge of a slowly drifting complex convective cloud close to the highest regions at similar to 17 km altitude. A horizontal displacement of similar to 10 km developed at similar to 50 km altitude before connecting to the lower ionosphere. Modeling of these Gigantic jets suggests that Gigantic Jets may bend when initiated at the edge of clouds with misaligned vertical charge distribution.

General information
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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, Indian Institute of Geomagnetism, Duke University, AGH University of Science and Technology, Georgia Institute of Technology, Indian Institute of Tropical Meteorology â?? IITM, University of the South Pacific
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Scopus rating (2013): SJR 1.886 SNIP 1.51 CiteScore 4.06
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Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
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Electron acceleration during streamer collisions in air

High-voltage laboratory experiments show that discharges in air, generated over a gap of one meter with maximal voltage of 1 MV, may produce X-rays with photon energies up to 1 MeV. It has been suggested that the photons are bremsstrahlung from electrons accelerated by the impulsive, enhanced field during collisions of negative and a positive streamers. To explore this process, we have conducted the first self-consistent particle simulations of streamer encounters. Our simulation model is a 2-D, cylindrically symmetric, particle-in-cell code tracing the electron dynamics and solving the space charge fields, with a Monte Carlo scheme accounting for collisions and ionization. We present the electron density, the electric field, and the velocity distribution as functions of space and time. Assuming a background electric field 1.5 times the breakdown field, we find that the electron density reaches $2 \times 10^{21}$ m$^{-3}$, the size of the encounter region is $3 \times 10^{-12}$ m$^3$ and that the field enhances to $9$ times the breakdown field during $10^{-11}$ s. We further find that the radial component becomes comparable to the parallel component, which together with angular scattering leads to an almost isotropic distribution of electrons. This is consistent with laboratory observations that X-rays are emitted isotropically. However, the maximum energy of electrons reached in the simulation is $600$ eV, which is well below the energies required to explain observations. The reason is that the encounter region is small in size and duration. For the photon energies observed, the field must be enhanced in a larger region and/or for a longer time.
Perturbations to the Lower Ionosphere by Tropical Cyclone Evan in the South Pacific Region

Very Low Frequency (VLF) electromagnetic signals from navigational transmitters propagate worldwide in the earth-ionosphere waveguide formed by the earth and the electrically conducting lower ionosphere. Changes in the signal properties are signatures of variations in the conductivity of the reflecting boundary of the lower ionosphere which is located in the mesosphere and lower thermosphere, and their analysis is, therefore, a way to study processes in these remote regions. Here we present a study on amplitude perturbations of local origin on the VLF transmitter signals (NPM, NLK, NAA and JJI) observed during tropical cyclone (TC) Evan, 9-16 December 2012 when TC was in the proximity of the transmitter-receiver links. We observed a maximum amplitude perturbation of 5.7dB on JJI transmitter during 16 December event. From Long Wave Propagation Capability model applied to three selected events we estimate a maximum decrease in the nighttime D-region reference height (H') by ~5.2 km (13 December, NPM) and maximum increase in the daytime D-region H' by 6.1 km and 7.5 km (14 &16 December, JJI). The results suggest that the TC caused the neutral densities of the mesosphere and lower thermosphere to lift and sink (bringing the lower ionosphere with it), an effect that may be mediated by gravity waves generated by the TC. The perturbations were observed before the storm was classified as a TC, at a time when it was a tropical depression, suggesting the broader conclusion that severe convective storms, in general, perturb the mesosphere and the stratosphere through which the perturbations propagate.

General information
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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, University of the South Pacific, CRAAG
Authors: Kumar, S. (Ekstern), Amor, S. N. (Ekstern), Chanrion, O. (Intern), Neubert, T. (Intern)
Pages: 8720–8732
Profuse activity of blue electrical discharges at the tops of thunderstorms

Thunderstorm clouds may reach the lower stratosphere, affecting the exchange of greenhouse gases between the troposphere and stratosphere. This region of the atmosphere is difficult to access experimentally and our knowledge of the processes taking place here is incomplete. We recently recorded a color video footage of thunderstorms over the Bay of Bengal from the International Space Station. The observations show a multitude of blue, km-scale, discharges at the cloud top layer at ~18 km altitude and a pulsating blue discharge propagating into the stratosphere reaching ~40 km altitude. The emissions are related to the so-called blue jets, blue starters and possibly pixies. The observations are the first of their kind and give a new perspective on the electrical activity at the top of tropical thunderstorms; further, they underscore that thunderstorm discharges directly perturb the chemistry of the stratosphere with possible implications for the Earth's radiation balance.

General information

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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, IDC - Interdisciplinary Center Herzliya, Indian Institute of Geomagnetism, Indian Institute of Tropical Meteorology, Danish Meteorological Institute
Authors: Chanrion, O. (Intern), Neubert, T. (Intern), Mogensen, A. (Intern), Yair, Y. (Ekstern), Stendel, M. (Ekstern), Singh, R. (Ekstern), Singh, D. (Ekstern)
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ISI indexed (2013): ISI indexed yes
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The influence of bremsstrahlung on electric discharge streamers in $N_2, O_2$ gas mixtures: Paper

Streamers are ionization filaments of electric gas discharges. Negative polarity streamers propagate primarily through electron impact ionization, whereas positive streamers in air develop through ionization of oxygen by UV photons emitted by excited nitrogen; however, experiments show that positive streamers may develop even for low oxygen concentrations. Here we explore if bremsstrahlung ionization facilitates positive streamer propagation. To discriminate between effects of UV and bremsstrahlung ionization, we simulate the formation of a double headed streamer at three different oxygen concentrations: no oxygen, 1 ppm $O_2$, and 20% $O_2$, as in air. At these oxygen levels, UV-relative to bremsstrahlung ionization is zero, small, and large. The simulations are conducted with a particle-in-cell code in a cylindrically symmetric configuration at ambient electric field magnitudes three times the conventional breakdown field. We find that bremsstrahlung induced ionization in air, contrary to expectations, reduces the propagation velocity of both positive and negative streamers by about 15%. At low oxygen levels, positive streamers stall; however, bremsstrahlung creates branching sub-streamers emerging from the streamer front that allow propagation of the streamer. Negative streamers propagate more readily forming branching sub-streamers. These results are in agreement with experiments. At both
polarities, ionization patches are created ahead of the streamer front. Electrons with the highest energies are in the sub-streamer tips and the patches.
Influence of the angular scattering of electrons on the runaway threshold in air

The runaway electron mechanism is of great importance for the understanding of the generation of x- and gamma rays in atmospheric discharges. In 1991, terrestrial gamma-ray flashes (TGFs) were discovered by the Compton Gamma-Ray Observatory. Those emissions are bremsstrahlung from high energy electrons that run away in electric fields associated with thunderstorms. In this paper, we discuss the runaway threshold definition with a particular interest in the influence of the angular scattering for electron energy close to the threshold. In order to understand the mechanism of runaway, we compare the outcome of different Fokker–Planck and Monte Carlo models with increasing complexity in the description of the scattering. The results show that the inclusion of the stochastic nature of collisions smooths the probability to run away around the threshold. Furthermore, we observe that a significant number of electrons diffuse out of the runaway regime when we take into account the diffusion in angle due to the scattering. Those results suggest using a runaway threshold energy based on the Fokker–Planck model assuming the angular equilibrium that is 1.6 to 1.8 times higher than the one proposed by [1, 2], depending on the magnitude of the ambient electric field. The threshold also is found to be 5 to 26 times higher than the one assuming forward scattering. We give a fitted formula for the threshold field valid over a large range of electric fields. Furthermore, we have shown that the assumption of forward scattering is not valid below 1 MeV where the runaway threshold usually is defined. These results are important for the thermal runaway and the runaway electron avalanche discharge mechanisms suggested to participate in the TGF generation.
Positive streamer initiation from raindrops in thundercloud fields

The threshold field for the electric gas discharge in air is \( \approx 26 \text{kVcm}^{-1} \text{atm}^{-1} \), yet the maximum field measured (from balloons) is \( \approx 3 \text{kVcm}^{-1} \text{atm}^{-1} \). The question of how lightning is stimulated is therefore one of the outstanding problems in atmospheric electricity. According to the popular idea first suggested by Loeb and developed further by Phelps, lightning can be initiated from streamers developed in the enhanced electric field around hydrometeors. In our paper, we prove by numerical simulations that positive streamers are initiated, specifically, around charged water drops. The simulation model includes the kinetics of free electrons, and positive and negative ions, the electron impact ionization and photon ionization of the neutral atmospheric constituents, and the formation of space charge electric fields. Simulations were conducted at air pressure 0.4 atm, typical at thundercloud altitudes, and at different background electric fields, drop sizes, and charges. We show that the avalanche-to-streamer transition is possible near drops carrying 63–485 pC in thundercloud fields with intensity of 10 kVcm\(^{-1}\) atm\(^{-1}\) and 15 kVcm\(^{-1}\) atm\(^{-1}\) for drops sizes of 1 mm and 0.5 mm, respectively. Thus, the electric field required for the streamer formation is larger than the measured thunderstorm fields. Therefore, the results of simulations suggest that second mechanisms must operate to amplify the local field. Such mechanisms could be electric field space variations via collective effects of many hydrometeors or runaway breakdown. ©2016. American Geophysical Union.
All Rights Reserved.
A model for electric field enhancement in lightning leader tips to levels allowing X-ray and γ ray emissions

A model is proposed capable of accounting for the local electric field increase in front of the lightning stepped leader up to magnitudes allowing front electrons to overcome the runaway energy threshold and thus to initiate relativistic runaway electron avalanches capable of generating X-ray and ray bursts observed in negative lightning leader. The model is based on an idea that an ionization wave, propagating in a preionized channel, is being focused, such that its front remains narrow and the front electric field is being enhanced. It is proposed that when a space leader segment, formed ahead of a negative lightning leader, connects to the leader, the electric potential of the leader is transferred through the space leader in an ionizing wave that continues into the partly ionized channels of preexisting streamers of the space leader. It is shown with numerical simulations that the ionization channels of streamers limit the lateral expansion of the ionization wave, thereby enhancing the peak electric field to values allowing an acceleration of low-energy electrons into the runaway regime where electrons efficiently generate bremsstrahlung. The results suggest that the inhomogeneous ionization environment at the new leader tip amplifies the production rate of energetic electrons relative to a homogeneous environment considered in the past studies.

General information

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Organisations: National Space Institute, Astrophysics, Russian Federal Nuclear Center
Authors: Babich, L. P. (Ekstern), Bochkov, E. I. (Ekstern), Kutsyk, I. M. (Ekstern), Neubert, T. (Intern), Chanrion, O. A. (Intern)
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First observations of transient luminous events in Indian sub-continent
The article offers information on the initial observations of flashes of lightning discharge observed above thunderstorms. It mentions that the transient luminous events (TLE) are classified on the basis of their geometrical shape and luminosity into Sprites, Halos and Blue Starters. It also focuses on the first sprite observed in the Indian subcontinent on April 11, 2012, whose optical measurements were conducted at Allahabad, India using the charge-coupled device camera system.

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Relativistic Electrons in Electric Discharges
Thunderstorms generate bursts of X- and Gamma radiation. When observed from spacecraft, the bursts are referred to as “Terrestrial Gamma-ray Flashes” (TGFs). They are bremsstrahlung from energetic electrons accelerated in thunderstorm electric fields. The TGFs were rst observed in the 90ties at the time when also gigantic electric discharges were observed...
at 10-90 km altitude in the stratosphere and mesosphere, the so called “jets” and “sprites”, commonly referred to as “Transient Luminous Events” (TLEs). TGFs were first thought connected to TLEs, but later research has pointed to lightning discharges as the source. The “Atmosphere-Space Interactions Monitor” (ASIM) for the International Space Station in 2016, led by DTU Space, and the French microsatellite TARANIS, also with launch in 2016, will identify with certainty the source of TGFs. In preparation for the missions, the Ph.D. project has developed a Monte Carlo module of a simulation code to model the formation of avalanches of electrons accelerated to relativistic energies, and the generation of bremsstrahlung through interactions with the neutral atmosphere. The code will be used in the analysis of data from the two space missions. We have studied the electron acceleration and photon generation in a constant electric field under a variety of conditions. These include the energy and number of seed electrons, electric field and altitude. We found that the distributions of avalanche electrons and photons are insensitive to these conditions, with exception of the electric field magnitude where the photon distribution becomes progressively more forward directed for increasing field magnitude. However, exploring photon transport to the top of the atmosphere, the angular beaming properties were found to wash out because of Compton scattering. However, we only explored the properties of the complete number of photons reaching space, not the distribution at specific locations as in the case of a satellite. With this reservation we conclude that it is not possible to deduce much information from a satellite measurement of the photons alone on the conditions of the source region. With one exception: the spectral hardness increases with altitude of the source, again caused by reduced Compton scattering with altitude. Applying the code to a thunderstorm cloud we further found that an impulsive electric field of about 5 times the local breakdown field appears plausible for TGF generation, because it minimizes the electron avalanche time and length and the total electric potential required.

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Organisations: National Space Institute, Solar System Physics
Authors: Cinar, D. (Intern), Neubert, T. (Intern), Chanrion, O. A. (Intern)
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Runaway electrons from a ‘beam-bulk’ model of streamer: application to TGFs
The generation of x- and gamma-rays in atmospheric discharges has been studied intensively since the discovery of terrestrial gamma-ray flashes (TGFs) by the Compton gamma-ray Observatory in 1991. Emissions are bremsstrahlung from high energy particles accelerated in large scale atmospheric electric fields associated with thunderstorms. Whereas observations now are many, both from lightning and the laboratory, the phases of the discharge where emissions are generated are still debated and several processes for electron acceleration have been put forward by theorists. This paper address the electron acceleration in streamer region of lightning. We present the first ‘beam-bulk’ model of self-consistent streamer dynamics and electron acceleration. The model combines a Monte Carlo Collision code that simulates the high-energy electrons (100 eV) and a fluid code that simulates the bulk of the low-energy electrons and ions. For a negative streamer discharge, we show how electrons are accelerated in the large electric field in the tip of the streamer and travel ahead of the streamer where they ionize the gas. In comparison to the results obtained with a classical fluid model for a negative streamer, the beam-bulk model predicts a decrease of the magnitude of the peak electric field and an increase of the streamer velocity. Furthermore, we show that a significant number of runaway electrons is lost by diffusion outside of the streamer tip. The results presented here do not yet include extra amplification nor acceleration far away from the streamer to explain the electron energies seen in TGFs. Still, in the light of those results, we emphasize that the production of runaway electrons from streamers needs to be simulated including the self-consistent feedback of runaways on the streamer. Simulations with a beam-bulk model may not only help to understand the fundamental atmospheric processes behind TGFs, but also pave the way for the interpretation of remote sensing of the most energetic discharges in the Earth’s atmosphere and thus help to address their environmental impact.

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Organisations: National Space Institute, Solar System Physics, Masaryk University, Ecole Centrale de Paris
Authors: Chanrion, O. A. (Intern), Bonaventura, Z. (Ekstern), Cinar, D. (Intern), Bourdon, A. (Ekstern), Neubert, T. (Intern)
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On the electric breakdown field of the mesosphere and the influence of electron detachment

It has been suggested recently that electron associative detachment from negative atomic oxygen ions provides an additional source of free electrons in electric discharges of the mesosphere, the sprites, and gigantic jets. Here we study attachment under some simplifying assumptions and show that the threshold field decreases with time and can reach values well below the conventional threshold field. The concept of a fixed threshold field therefore itself breaks down. We find that the growth rate decreases with decreasing electric field and that long exposure time of electric fields therefore is needed for electron avalanches to grow. Detachment is likely to affect the conductivity of streamer filaments and other long-lasting space charge structures like gigantic jets or the ionization state of the mesosphere when illuminated by thunderstorm fields. Detachment by itself does not directly affect small-scale streamer formation or explain the time delays of sprites as proposed by others. © 2013 American Geophysical Union. All Rights Reserved.
The Properties of a Giant Jet Reflected in a Simultaneous Sprite

Thunderstorm clouds may discharge directly to the ionosphere in spectacular luminous jets - the largest electric discharges of our planet. The properties of these "giants," such as their polarity, conductivity, and currents, have been predicted by models, but are poorly characterized by measurements. A recent observation of a giant, fortuitously illuminated by an unusual sprite discharge in the mesosphere, allows us to study their electric properties and effects on the atmosphere-ionosphere. We show from a first-principles model of the combined giant and sprite event that the observations are consistent with the nature of the giant being a leader in the stratosphere of line charge density similar to 0.8 mCm(-1) and of multiple streamers in the mesosphere. It is further shown that the giant modifies the free electron content of the lower ionosphere because of electric field-driven ionization, electron attachment and detachment processes. This is the first time that sprites are used for sounding the properties of the mesosphere. The results presented here will allow evaluation of theories for jet and gigantic jets and of their influence on the atmosphere and ionosphere.
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Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.449 SNIP 1.324
Web of Science (2010): Indexed yes
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Scopus rating (2009): SJR 2.347 SNIP 1.359
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Scopus rating (2008): SJR 2.101 SNIP 1.296
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.054 SNIP 1.26
Web of Science (2007): Indexed yes
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Web of Science (2006): Indexed yes
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Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.116 SNIP 1.455
Web of Science (2003): Indexed yes
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Relativistic electron beams above thunderclouds
Non-luminous relativistic electron beams above thunderclouds have been detected by the radio signals of low frequency similar to 40-400 kHz which they radiate. The electron beams occur similar to 2-9 ms after positive cloud-to-ground lightning discharges at heights between similar to 22-72 km above thunderclouds. Intense positive lightning discharges can also cause sprites which occur either above or prior to the electron beam. One electron beam was detected without any luminous sprite which suggests that electron beams may also occur independently of sprites. Numerical simulations show that beams of electrons partially discharge the lightning electric field above thunderclouds and thereby gain a mean energy of similar to 7MeV to transport a total charge of similar to-10mC upwards. The impulsive current similar to 3 x 10(-3) Am-2 associated with relativistic electron beams above thunderclouds is directed downwards and needs to be considered as a novel element of the global atmospheric electric circuit.

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Authors: Füellekrug, M. (Ekstern), Roussel-Dupre, R. (Ekstern), Symbalisty, E. M. D. (Ekstern), Colman, J. J. (Ekstern), Chanrion, O. A. (Intern), Soula, S. (Ekstern), van der Velde, O. (Ekstern), Odzimek, A. (Ekstern), Bennett, A. J. (Ekstern), Pasko, V. P. (Ekstern), Neubert, T. (Intern)
Relativistic runaway breakdown in low-frequency radio

The electromagnetic radiation emitted by an electron avalanche beam resulting from relativistic runaway breakdown within the Earth's atmosphere is investigated. It is found from theoretical modeling with a computer simulation that the electron beam emits electromagnetic radiation which is characterized by consecutive broadband pulses in the low-frequency radio range from similar to 10 to 300 kHz at a distance of similar to 800 km. Experimental evidence for the existence of consecutive broadband pulses is provided by low-frequency radio observations of sprite-producing lightning discharges at a distance of similar to 550 km. The measured broadband pulses occur similar to 4-9 ms after the sprite-producing lightning discharge, they exhibit electromagnetic radiation which mainly spans the frequency range from similar to 50 to 350 kHz, and they exhibit complex waveforms without the typical ionospheric reflection of the first hop sky wave. Two consecutive pulses occur similar to 4.5 ms and similar to 3 ms after the causative lightning discharge and coincide with the sprite luminosity. It is concluded that relativistic runaway breakdown within the Earth's atmosphere can emit broadband electromagnetic pulses and possibly generates sprites. The source location of the broadband pulses can be determined with an interferometric network of wideband low-frequency radio receivers to lend further experimental support to the relativistic runaway breakdown theory.
More evidence for a one-to-one correlation between Sprites and Early VLF perturbations

Past studies have shown a correlation between sprites and early VLF perturbations, but the reported correlation varies widely from ∼50% to 100%. The present study resolves these large discrepancies by analyzing several case studies of sprite and narrowband VLF observations, in which multiple transmitter-receiver VLF pairs with great circle paths (GCPs) passing near a sprite-producing thunderstorm were available. In this setup, the multiple paths act in a complementary way that makes the detection of early VLF perturbations much more probable compared to a single VLF path that can miss several of them, a fact that was overlooked in past studies. The evidence shows that visible sprite occurrences are accompanied by early VLF perturbations in a one-to-one correspondence. This implies that the sprite generation mechanism may cause also sub-ionospheric conductivity disturbances that produce early VLF events. However, the one-to-one visible sprite to early VLF event correspondence, if viewed conversely, appears not to be always reciprocal. This is because the number of early events detected in some case studies was considerably larger than the number of visible sprites. Since the great majority of the early events not accompanied by visible sprites appeared to be caused by positive cloud to ground (+CG) lightning discharges, it is possible that sprites or sprite halos were concurrently present in these events as well but were missed by the sprite-watch camera detection system. In order for this option to be resolved we need more studies using highly sensitive optical systems capable of detecting weaker sprites, sprite halos and elves.

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Production of runaway electrons by negative streamer discharges

In this paper we estimate the probability that cold electrons can be accelerated by an ambient electric field into the runaway regime, and discuss the implications for negative streamer formation. The study is motivated by the discovery of ms duration bursts of γ-rays from the atmosphere above thunderstorms, the so-called Terrestrial Gamma-Ray Flashes. The radiation is thought to be bremsstrahlung from energetic (MeV) electrons accelerated in a thunderstorm discharge. The observation goes against conventional wisdom that discharges in air are carried by electrons with energies below a few tens of eV. Instead the relativistic runaway electron discharge has been proposed which requires a lower threshold electric field; however, seed electrons must be born with energies in the runaway regime. In this work we study the fundamental problem of electron acceleration in a conventional discharge and the conditions on the electric field for the acceleration of electrons into the runaway regime. We use particle codes to describe the process of stochastic acceleration and introduce a novel technique that improves the statistics of the relatively few electrons that reach high energies. The calculation of probabilities for electrons to reach energies in the runaway regime shows that even with modest fields, electrons can be energized in negative streamer tips into the runaway regime, creating a beamed distribution in front of the streamer that affects its propagation. The results reported here suggest that theories of negative streamers and spark propagation should be reexamined with an improved characterization of the kinetic effects of electrons.

General information
State: Published
Organisations: Solar System Physics, National Space Institute
Authors: Chanrion, O. A. (Intern), Neubert, T. (Intern)
Number of pages: 10
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Main Research Area: Technical/natural sciences

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BFI (2016): BFI-level 2
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Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 2.288 SNIP 1.362 CiteScore 3.39
Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 2.324 SNIP 1.349 CiteScore 3.27
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 2.357 SNIP 1.44 CiteScore 3.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.365 SNIP 1.35 CiteScore 2.93
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.239 SNIP 1.301 CiteScore 3.03
ISI indexed (2011): ISI indexed yes
Characteristics and conditions of production of transient luminous events observed over a maritime storm

On the night of 15/16 November 2007, cameras in southern France detected 30 transient luminous events (TLEs) over a storm located in the Corsican region (France). Among these TLEs, 19 were sprites, 6 were halos, and 5 were elves. For 26 of them, a positive “parent” cloud-to-ground lightning (P+CG) flash was identified. The peak current of the P+CG flashes for the sprites had an average value of 63 kA and had a maximum value of 125 kA. The flashes for the halos and the elves had average values of 272 and 351 kA, respectively, and they had maximum values of 312 and 384 kA, respectively. No TLEs were detected after negative CG flashes with very large peak currents. Among the 26 P+CG flashes, 23 were located in a stratiform region with reflectivity values lower than 45 dBZ. The CG flashes in this region were classified into two groups according to the time interval separating them from the following flash: one group with values less than 2 s and one with values greater than 2 s. About 79% of all CGs were produced in a sequence of at least two flashes less than 2 s apart. For 65.5% of the sequences, the first flash was positive with an average peak current of 73 kA, while the later +CG flashes in a sequence had much lower peak currents. Several triangulated sprites were found to be shifted from their P+CG flashes by about 10 to 50 km and preferentially downstream. The observations suggest that the P+CG flashes can initiate both sprites and other CG flashes in a storm.

General information

State: Published
Organisations: Solar System Physics, National Space Institute, Universite de Toulouse, Polytechnic University of Catalonia, Universite d’Orleans
Authors: Soula, S. (Ekstern), van der Velde, O. (Ekstern), Palmiéri, J. (Ekstern), Chanrion, O. A. (Intern), Neubert, T. (Intern), Montanyà, J. (Ekstern), Gangneron, F. (Ekstern), Meyerfeld, Y. (Ekstern), Lefeuvre, F. (Ekstern), Lointier, G. (Ekstern)
VLF observations of ionospheric disturbances in association with TLEs from the EuroSprite-2007 campaign

Two Very Low Frequency (VLF) AWESOME remote sensing systems located at Algiers, Algeria (36.45°N, 3.28°E) and Sebha, Libya (27.02°N, 14.26°E) monitor VLF signal perturbations for evidence of ionospheric disturbances. During the EuroSprite-2007 campaign a number of Transient Luminous Events (TLEs) were captured over the Mediterranean Sea by cameras at Pic du Midi (42.94°N, 0.14°E) and at Centre de Recherches Atmospheriques (CRA) in southwestern France (43.13°N, 0.37°E). The cameras observations are compared to collected VLF AWESOME data. We consider early VLF perturbations observed on 12-13, 17-18 October and 17-18 December, 2007. The data from the two VLF receivers confirm the association between TLEs and early VLF signal perturbations with the perturbations amplitudes dependent on the observation configuration i.e. whether the TLE is near the receiver, near the transmitter, or far from both and the scattering process. The results also reveal that the early VLF perturbations can occur in the absence of a TLE.

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Number of pages: 9
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Ratings:
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.36 SJR 1.996 SNIP 1.313
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.288 SNIP 1.362 CiteScore 3.39
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.324 SNIP 1.349 CiteScore 3.27
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.357 SNIP 1.44 CiteScore 3.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.365 SNIP 1.35 CiteScore 2.93
ISI indexed (2012): ISI indexed yes
Analysis of thunderstorm and lightning activity associated with sprites observed during the EuroSprite campaigns: two case studies

During the summers of 2003 to 2006 sprites were observed over thunderstorms in France by cameras on mountain tops in Southern France. The observations were part of a larger coordinated effort, the EuroSprite campaigns, with data collected simultaneously from other sources including the French radar network for precipitation structure, Meteosat with images of cloud top temperature and the Météorage network for detection of cloud-to-ground (CG) flash activity. In this paper two storms are analyzed, each producing 27 sprite events. Both storms were identified as Mesoscale Convective Systems (MCS) with a trailing stratiform configuration (ST) and reaching a maximum cloud area of ~ 120,000 km². Most of the sprites were produced while the stratiform area was clearly developed and during periods of substantial increase of rainfall in regions with radar reflectivity between 30 and 40 dBZ. The sprite-producing periods followed a maximum in the CG lightning activity and were characterized by a low CG flash rate with a high proportion of + CG flashes, typically around 50%. All sprites were associated with + CGs except one which was observed after a − CG as detected by the Météorage network. This − CG was estimated to have − 800 C km charge moment change. The peak current of sprite-producing + CG (SP + CG) flashes was twice the average value of + CGs and close to 60 kA with little variation between the periods of sprite activity. The SP + CG flashes were further characterized by short time intervals before a subsequent CG flash (median value <0.5 s) and with clusters of several CG flashes which suggest that SP + CG flashes often are part of multi-CG flash processes. One case of a lightning process associated with a sprite consisted of 7 CG flashes.

General information
State: Published
Broadband Electromagnetic Pulses Coinciding with Sprite Luminosity

General information
State: Published
Organisations: National Space Institute
Authors: Fullekrug, M. (Ekstern), Roussel-Dupre, R. A. (Ekstern), Symbalisty, E. (Ekstern), Chanrion, O. A. (Intern), Van Der Velde, A. (Ekstern), Whitley, T. (Ekstern), Neubert, T. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 254984
Publication: Research › Paper – Annual report year: 2009

ELF/VLF signatures of sprite-producing lightning discharges observed during the 2005 EuroSprite campaign
During the summer of 2005, transient luminous events were optically imaged from the French Pyrénées as part of the EuroSprite campaign. Simultaneously, extremely low frequency (ELF: 3–3000 Hz) and broadband very low frequency (VLF: 3–30 kHz) data were recorded continuously at two separate receivers in Israel, located about 3300 km from the area of the parent lightning discharges responsible for the generation of sprites. Additionally, narrowband VLF data were collected in Crete, at about 2300 km away from the region of sprites.

The motivation for the present study was to identify the signature of the sprite-producing lightning discharges in the ELF and VLF electromagnetic frequency bands, to qualify and compare their parameters, and to study the influence of the thunderstorm-activated region on its overlaying ionosphere. For the 15 sprites analyzed, their causative positive cloud-to-ground (+CG) discharges had peak current intensities between +8 and +130 kA whereas their charge moment changes (CMC) ranged from 500 to 3500 C km. Furthermore, the peak current reported by the Météorage lightning network are well correlated with the amplitudes of the VLF bursts, while showing poor correlation with the CMCs which were estimated using ELF methods.

Additionally, more than one +CG was associated with six of the sprites, implying that lightning discharges that produce sprites can sometimes have multiple ground connections separated in time and space. Finally, for a significant number of events (33%) an ELF transient was not associated with sprite occurrence, suggesting that long continuing current of tens of ms may not always be a necessary condition for sprite production, a finding which influences the estimation of the global sprite rate based on Schumann resonance (SR) measurements.

General information
State: Published
Organisations: Solar System Physics, National Space Institute, Tel Aviv University, Open University of Israel, University of Crete
Authors: Greenberg, E. (Ekstern), Price, C. (Ekstern), Yair, Y. (Ekstern), Haldoupis, C. (Ekstern), Chanrion, O. A. (Intern), Neubert, T. (Intern)
Pages: 1254-1266
Publication date: 2009
Main Research Area: Technical/natural sciences

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Journal: Journal of Atmospheric and Solar - Terrestrial Physics
Volume: 71
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Ratings:
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Scopus rating (2016): SJR 0.76 SNIP 0.86 CiteScore 1.39
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.93 SNIP 0.943 CiteScore 1.48
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.966 SNIP 0.938 CiteScore 1.45
Production of Runaway Electrons in Conventional Atmospheric Discharges

General information
State: Published
Organisations: National Space Institute
Authors: Chanrion, O. A. (Intern), Neubert, T. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 254237
Publication: Research › Journal article – Annual report year: 2009

The global hunt for Sprites

General information
State: Published
Organisations: National Space Institute
Recent results from studies of electric discharges in the mesosphere

The paper reviews recent advances in studies of electric discharges in the stratosphere and mesosphere above thunderstorms, and their effects on the atmosphere. The primary focus is on the sprite discharge occurring in the mesosphere, which is the most commonly observed high altitude discharge by imaging cameras from the ground, but effects on the upper atmosphere by electromagnetic radiation from lightning are also considered. During the past few years, co-ordinated observations over Southern Europe have been made of a wide range of parameters related to sprites and their causative thunderstorms. Observations have been complemented by the modelling of processes ranging from the electric discharge to perturbations of trace gas concentrations in the upper atmosphere. Observations point to significant energy deposition by sprites in the neutral atmosphere as observed by infrasound waves detected at up to 1000 km distance, whereas elves and lightning have been shown significantly to affect ionization and heating of the lower ionosphere/mesosphere. Studies of the thunderstorm systems powering high altitude discharges show the important role of intracloud (IC) lightning in sprite generation as seen by the first simultaneous observations of IC activity, sprite activity and broadband, electromagnetic radiation in the VLF range. Simulations of sprite ignition suggest that, under certain conditions, energetic electrons in the runaway regime are generated in streamer discharges. Such electrons may be the source of X- and Gamma-rays observed in lightning, thunderstorms and the so-called Terrestrial Gamma-ray Flashes (TGFs) observed from space over thunderstorm regions. Model estimates of sprite perturbations to the global atmospheric electric circuit, trace gas concentrations and atmospheric dynamics suggest significant local perturbations, and possibly significant meso-scale effects, but negligible global effects.

General information

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Publication information

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Volume: 29
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BFI (2016): BFI-level 1
Scopus rating (2016): SJR 2.187 SNIP 1.904 CiteScore 3.7
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.518 SNIP 1.687 CiteScore 3.55
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.741 SNIP 1.514 CiteScore 3.94
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 3.699 SNIP 2.145 CiteScore 4.77
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
A PIC-MCC code for simulation of streamer propagation in air

A particle code has been developed to study the distribution and acceleration of electrons in electric discharges in air. The code can follow the evolution of a discharge from the initial stage of a single free electron in a background electric field to the formation of an electron avalanche and its transition into a streamer. The code is in 2D axi-symmetric coordinates, allowing quasi 3D simulations during the initial stages of streamer formation. This is important for realistic simulations of problems where space charge fields are essential such as in streamer formation. The charged particles are followed in a Cartesian mesh and the electric field is updated with Poisson's equation from the charged particle densities. Collisional processes between electrons and air molecules are simulated with a Monte Carlo technique, according to cross section probabilities. The code also includes photoionisation processes of air molecules by photons emitted by excited constituents. The paper describes the code and presents some results of streamer development at 70km altitude in the mesosphere where electrical discharges (sprites) are generated above severe thunderstorms and at ~10km relevant for lightning and thundercloud electrification. The code is used to study acceleration of thermal seed electrons in streamers and to understand the conditions under which electrons may reach energies in the runaway regime. This is the first study in air, with a particle model with realistic spatial dependencies of the electrostatic field. It is shown that at 1atm pressure the electric field must exceed ~7.5 times the breakdown field to observe runaway electrons in a constant electric field. This value is close to the field where the electric force on an electron equals the maximum frictional force on an electron - found at ~100eV. It is also found that this value is reached in a negative streamer tip at 10km altitude when the background electric field equals ~3 times the breakdown field. At higher altitudes, the background electric field must be relatively larger to create a similar field in a streamer tip because of increased influence of photoionisation. It is shown that the role of photoionization increases with altitude and the effect is to decrease the space charge fields and increase the streamer propagation velocity. Finally, effects of electrons in the runaway regime on negative streamer dynamics are presented. It is shown the energetic electrons create enhanced ionization in front of negative streamers. The simulations suggest that the thermal runaway mechanism may operate at lower altitudes and be associated with lightning and thundercloud electrification while the mechanism is unlikely to be important in sprite generation at higher altitudes in the mesosphere.
On-board processing of video image sequences

The ldquoatmosphere-space interactions monitorrdquo (ASIM) is a payload to be mounted on one of the external platforms of the Columbus module of the International Space Station (ISS). The instruments include six video cameras, six photometers and one X-ray detector. The main scientific objective of the mission is to study transient luminous events (TLE) above severe thunderstorms: the sprites, jets and elves. Other atmospheric phenomena are also studied including aurora, gravity waves and meteors. As part of the ASIM Phase B study, on-board processing of data from the cameras is being developed and evaluated. On-board there are six video cameras each capturing images of 1024×1024 pixels of 12 bpp at a frame rate of 15 fps, thus totalling 1080 Mbits/s. In comparison the average downlink data rate for these images is projected to be 50 kbit/s. This calls for efficient on-board processing to select and compress the data. Algorithms for on-board processing of the image data are presented as well as evaluation of the performance. The main processing steps are event detection, image cropping and image compression. The on-board processing requirements are also evaluated.

Parameterisation of the chemical effects of sprites in the middle atmosphere

Transient luminous events, such as red sprites, occur in the middle atmosphere in the electric field above thunderstorms. We here address the question whether these processes may be a significant source of odd nitrogen and affect ozone or other important trace species. A well-established coupled ion-neutral chemical model has been extended for this purpose and applied together with estimated rates of ionisation, excitation and dissociation based on spectroscopic ratios from ISUAL on FORMOSAT-2. This approach is used to estimate the NOx and ozone changes for two type cases. The NOx enhancements are at most one order of magnitude in the streamers, which means a production of at most 10 mol per event, or (given a global rate of occurrence of three events per minute) some 150-1500 kg per day. The present study therefore indicates that sprites are insignificant as a global source of NOx. Local effects on ozone are also negligible, but the local enhancement of NOx may be significant, up to 5 times the minimum background at 70 km in extraordinary cases.
The Eurosprite 2005 campaign
In this report we give an overview of the Eurosprite observation programme and present the results of the Eurosprite 2005 campaign. These campaigns search for occurrences of transient luminous events, such as red sprites, above thunderstorms in France, Spain, northern Italy, Switzerland and southwestern Germany. Low-light video cameras are used to register the events. Simultaneously, meteorological observations and continuous recordings of electromagnetic emissions in the VLF-ELF-ULF range and of infrasound are carried out. During the Eurosprite 2005 campaign, two camera systems were operated at two locations in southern France. In total 64 sprite events were captured. Due to unfavourable conditions, none of these were captured simultaneously at
both stations. The campaigns constitute a long-term effort but have already provided several new results, mainly concerning the correlation between optical and non-optical means of sprite detection. The campaigns will be extended into a global sprite-watch partnership and in addition space-borne instruments will be deployed.

**General information**

**State:** Published

**Organisations:** Solar System Physics, National Space Institute, Electronic Engineering, University of Leicester, Danish Meteorological Institute, Hungarian Academy of Sciences, University of Oulu, University of Bath, University of Crete, Université Toulouse III - Paul Sabatier, Commissariat a l'Energie Atomique

**Authors:** Arnone, E. (Ekstern), Berg, P. (Ekstern), Boberg, F. (Ekstern), Bór, J. (Ekstern), Chanrion, O. A. (Intern), Enell, C. (Ekstern), Ignaccolo, M. (Ekstern), Mika, Á. (Ekstern), Odzimek, A. (Ekstern), van der Velde, O. (Ekstern), Farges, T. (Ekstern), Laursen, S. (Intern), Neubert, T. (Intern), Sátori, G. (Ekstern)

**Pages:** 29–40

**Publication date:** 2008

**Host publication information**

**Title of host publication:** Proceedings of the 33rd Annual European meeting on Atmospheric Studies by Optical Methods (33AM)

**Place of publication:** Kiruna, Sweden

**Publisher:** Swedish Institute of Space Physics

**ISBN (Print):** 978-91-977255-1-4

**Series:** Swedish Institute of Space Physics. I R F Scientific Report

**Volume:** 292

**ISSN:** 0284-1703

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**Conference:** 33rd Annual European meeting on Atmospheric Studies by Optical Methods (33AM), Kiruna, 01/01/2007

**Source-ID:** 209850

**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2008

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**TLEs Observations during the summer and fall Eurosprite 2007 campaign in South-Western France and North-Eastern Spain**

**General information**

**State:** Published

**Organisations:** National Space Institute

**Authors:** van der Velde, O. A. (Ekstern), Soula, S. (Ekstern), Montanya, J. (Ekstern), Romero, D. (Ekstern), Chanrion, O. A. (Intern), Neubert, T. (Intern), Pineda, N. (Ekstern), Gangneron, F. (Ekstern), Meyerfeld, Y. (Ekstern)

**Publication date:** 2008

**Event:** Paper presented at European Geosciences Union General Assembly 2008, Vienna, Austria.

**Main Research Area:** Technical/natural sciences

**Source-ID:** 233677

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**2D axisymmetrical particle modelling of the production of thermal runaways electron by sprite streamers**

**General information**

**State:** Published

**Organisations:** Solar System Physics, National Space Institute

**Authors:** Chanrion, O. A. (Intern), Neubert, T. (Intern)

**Publication date:** 2007

**Host publication information**

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**Main Research Area:** Technical/natural sciences

**Conference:** European Geosciences Union General Assembly 2007, Vienna, Austria, 15/04/2007 - 15/04/2007

**Source-ID:** 209726

**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2007
A semi-autonomous optical observatory for sprite observations

General information
State: Published
Organisations: Solar System Physics, National Space Institute
Authors: Chanrion, O. A. (Intern), Neubert, T. (Intern)
Publication date: 2007

Host publication information
Title of host publication: Proceedings of the Second International Symposium on Lightning Physics and Effects
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 209725
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

The chemical impact of transient luminous events in the middle atmosphere

General information
State: Published
Organisations: Solar System Physics, National Space Institute
Publication date: 2007

Host publication information
Title of host publication: Proceedings of the IUGG XXIV General Assembly
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 209729
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

The Sprite 2005 Observation Campaign: A training opportunity for the CAL young scientists

The four year "Coupling of Atmospheric Layers (CAL)" EU FP5 Research Training Network project studied unanswered questions related to transient luminous events (sprites, jets and elves) in the upper atmosphere. Consisting of ten scientific work-packages CAL also included intensive training and outreach programmes for the young scientists hired. Educational activities were based on the following elements: national PhD programmes, activities at CAL and other meetings, a dedicated summer school, and two European sprite observational campaigns. The young scientists were strongly involved in the latter and, as an example, the "EuroSprite2005" observational campaign is presented in detail. Some of the young scientists participated in the instrument set-up, others in the campaign logistics, some coordinated the observations, and others gathered the results to build a catalogue. During the four-month duration of this campaign, all of them took turns in operating the system and making their own night observations. The ongoing campaign activities were constantly advertised and communicated via an Internet blog. In summary the campaign required all the CAL young scientists to embark on experimental work, to develop their organisational skills, and to enhance their ability to communicate their activities. The campaign was a unique opportunity to train and strengthen skills that will be an asset to their future careers and, overall, was most successful.

General information
State: Published
Organisations: Solar System Physics, National Space Institute, University of Crete, Danish Meteorological Institute, University of Bath, Belgian Institute for Space Aeronomy, University of Leicester, Paul Sabatier University
Authors: Chanrion, O. A. (Intern), Crosby, N. (Ekstern), Armone, E. (Ekstern), Boberg, F. (Ekstern), Van der Velde, O. (Ekstern), Odzimek, A. (Ekstern), Mika, A. (Ekstern), Berg, P. (Ekstern), Enel, C. (Ekstern), Ignaccolo, M. (Ekstern), Steiner, R. (Ekstern), Laursen, S. (Intern), Neubert, T. (Intern)
Pages: 3-9
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Advances in Geosciences
Volume: 13
ISSN (Print): 1680-7340
Des éclairs aux frontières de l'espace

General information
State: Published
Organisations: Solar System Physics, National Space Institute
Authors: Valin, M. (Ekstern), Sentman, D. (Ekstern), Blanc, E. (Ekstern), Soula, S. (Ekstern), Chanrion, O. A. (Intern)
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Ciel et Espace
Volume: 433
Original language: French
Source: orbit
Source-ID: 208829
Publication: Communication › Journal article – Annual report year: 2006

Excitation and ionisation of the atmosphere by streamers

General information
State: Published
Organisations: Solar System Physics, National Space Institute
The Planetary rate of sprite events

General information
State: Published
Organisations: Measurement & Instrumentation, Department of Electrical Engineering, Solar System Physics, National Space Institute
Publication date: 2006
Event: Poster session presented at European Geosciences Union General Assembly 2006, Vienna, Austria.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 205833
Publication: Research - peer-review › Poster – Annual report year: 2006

Simulation of streamer initiation using a Particle in Cell code with Monte Carlo Collisions: Application to Sprite ignition.

General information
State: Published
Organisations: Solar System Physics, National Space Institute
Authors: Chanrion, O. A. (Intern), Neubert, T. (Intern)
Publication date: 2005
Event: Poster session presented at European Geosciences Union General Assembly 2005, Vienna, Austria.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 207367
Publication: Research › Poster – Annual report year: 2005

Spritewatch tutorial for the eurosprite 2005 observational campaign

General information
State: Published
Organisations: Solar System Physics, National Space Institute
Authors: Chanrion, O. A. (Intern)
Publication date: 2005

Publication information
Original language: English
Series: CAL network internal report
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 207527
Publication: Research - peer-review › Report – Annual report year: 2005

New parametrisation of chemical effects of sprites in the middle atmosphere,

General information
State: Published
Organisations: Solar System Physics, National Space Institute
Publication date: 2002
Main Research Area: Technical/natural sciences
Projects:

Analysis of Lightning and TLEs observed by ASIM and LIS on the International Space Station

National Space Institute
Period: 01/12/2017 → 30/11/2020
Number of participants: 4
Phd Student:
Dimitriadou, Krystallia (Intern)
Supervisor:
Chanrion, Olivier (Intern)
Köhn, Christoph (Intern)
Main Supervisor:
Neubert, Torsten (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Marie Curie (EU-stipendium)
Project: PhD

Analysis of space and ground observations of thunderstorms
National Space Institute
Period: 01/12/2017 → 30/11/2020
Number of participants: 4
Phd Student:
Tomicic, Maja (Intern)
Supervisor:
Köhn, Christoph (Intern)
Neubert, Torsten (Intern)
Main Supervisor:
Chanrion, Olivier (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Relativistic electronics in electric discharges
National Space Institute
Period: 01/11/2010 → 16/04/2014
Number of participants: 6
Phd Student:
Cinar, Deniz (Intern)
Supervisor:
Chanrion, Olivier (Intern)
Main Supervisor:
Neubert, Torsten (Intern)
Examiner:
Budtz-Jørgensen, Carl (Intern)
Marisaldi, Martino (Ekstern)
Østgaard, Nikolai (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut, samfinansiering
Project: PhD

Activities:

Analysis of thunderstorm systems and lightning activity associated with sprites observed during the Eurosprite campaigns:
2- Case studies
Olivier Chanrion (Speaker)
Analysis of thunderstorm systems and lightning activity associated with sprites observed during the Eurosprite campaigns: 1- Statistical studies  
Period: 2 Jul 2007 → 13 Jul 2007
Olivier Chanrion (Speaker)
National Space Institute
Solar System Physics

The chemical impact of transient luminous events in the middle atmosphere  
Period: 2 Jul 2007 → 13 Jul 2007
Olivier Chanrion (Speaker)
National Space Institute
Solar System Physics

2D axisymmetrical particle modelling of the production of thermal runaway electrons by sprite streamers  
Period: 16 Apr 2007 → 20 Apr 2007
Olivier Chanrion (Speaker)
National Space Institute
Solar System Physics

The 2005 Eurosprite Observation Campaign  
Period: 28 Aug 2006 → 1 Sep 2006
Olivier Chanrion (Participant)
National Space Institute
Solar System Physics

Related event

The 2005 Eurosprite Observation Campaign
28/08/2006 → 01/09/2006
33rd Annual European Meeting on Atmospheric Studies by Optical Methods, Kiruna, Sweden.
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Particle simulation of sprite streamer
Period: 8 Jan 2006 → 11 Jan 2006
Olivier Chanrion (Speaker)
National Space Institute
Solar System Physics

Description
Place: CAL 3rd year meeting, Cambridge, United Kingdom

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Coupling of Atmospheric Layers – EU FP5 RTN Project: Training and Outreach Programme
Period: 14 Nov 2005 → 15 Nov 2005
Olivier Chanrion (Participant)
National Space Institute
Solar System Physics

Related event

Coupling of Atmospheric Layers – EU FP5 RTN Project: Training and Outreach Programme
14/11/2005 → 15/11/2005
Communicating European Research 2005 International Conference. Brussels, Belgium
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Simulation of streamer initiation using a particle in cell code with Monte Carlo collisions: application to sprite ignition
Period: 20 Jun 2005 → 24 Jun 2005
Olivier Chanrion (Participant)
National Space Institute
Solar System Physics

Related event

Simulation of streamer initiation using a particle in cell code with Monte Carlo collisions: application to sprite ignition
20/06/2005 → 24/06/2005
Elounda, Crete, Greece
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Simulation of streamer propagation using a PIC-MCC code: Application to sprite discharges
Period: 9 May 2005 → 13 May 2005
Olivier Chanrion (Participant)
National Space Institute
Solar System Physics

Related event
Simulation of streamer propagation using a PIC-MCC code: Application to sprite discharges: The multiscale nature of spark precursors and high altitude lightning
09/05/2005 → 13/05/2005
Leiden, The Netherlands
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.