Blue jets and blue starters are partially ionized luminous cones of primarily blue light that propagate upward out of the top of thunderstorms at speeds of order 100 km s^{-1}. Blue jets propagate up ∼40 km, but blue starters, which resemble blue jets, terminate abruptly after only a few kilometers of upward travel. Theories on the origin of blue jets have proposed that they are due to either positive or negative streamers or runaway electrons. New analysis of multi-instrument observations of a blue starter from an aircraft during the Energetics of Upper Atmospheric Excitation by Lightning, 1998 (EXL98) campaign of July 1998, shows that the ionization accounts for ∼3% of the observed intensity. One of the Authors, P. Huet took a remarkable color photograph of a blue jet taken from Runion Island in the Indian Ocean. The jet occurred during a 2 minute exposure of a lightning storm over the ocean using 400 ISO Fujicolor film in a Zenith reflex camera with a 58 mm lens at f/4 or 5.6. We used the background corrected pixel counts of calibrated stars in the image for quantitative brightness calibration, and from the pixel counts in the blue separation of the jet image determined the minimum brightness and energy deposition. This analysis shows that the minimum optical energy deposition was ∼0.5 MJ. An inverted monochrome portion of the Runion Island photograph shows fine structure in the jet and eight streamers 50 to 100 m in diameter associated with the jet never before seen.

AE22A-09 1630h

Three-dimensional modeling of blue jets and blue starters

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Blue jets are narrow cones of blue light propagating upward from the apparent cloud tops at speeds of the order of 100 km/s to a terminal altitude of about 40 km [Wescott et al., GRL, 22, 1209, 1995]. Blue starters are distinguished from blue jets by a much lower terminal altitude. They protrude upward from the cloud top (17-18 km) to a maximum 25.5 km in altitude [Wescott et al., GRL, 23, 2153, 1996]. It has recently been suggested that blue jets correspond qualitatively to the development of the streamer zone of a positive leader and therefore should be filled with a branching structure of streamer channels [Petrov and Petrova, Tech. Phys., 44, 472, 1999]. In our talk we will discuss the physical concept proposed by Petrov and Petrova [1999] as well as will demonstrate a role of blue jets and blue starters in the large-scale atmospheric electric circuit. We will also discuss specific physical reasons and required circumstances for occurrence of blue jets and starters above thundercloud tops and will support our arguments with results from a new three-dimensional model. The model simulates the propagation of branching streamer channels constituting blue jets and starters as a three dimensional growth of fractal trees in a self-consistent electric field created by thundercloud charges. The model is based on a phenomenological probabilistic approach proposed in [Niemeyer et al., IEEE Trans. Electr. Insul., 24, 309, 1989] and is a straightforward expansion of the previously developed two-dimensional version [Pasko et al., GRL, 27, 497, 2000]. The model results indicate that blue jets and starters can be formed by a fast (∼1 sec) accumulation of 110-150 C of positive thundercloud charge distributed in a volume with effective radius 3 km near the cloud top at 15 km. The obtained results closely resemble characteristics of blue jets and blue starters observed by Wescott et al. [1995; 1996] in terms of their altitude extents, transverse dimensions and conical structure, and support the suggestion of Wescott et al. [1996] that blue starters are related to the initial phases of blue jets.

AE22A-10 1645h

The Connection Between Delayed Sprites and Continuing Currents

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A substantial fraction (40% or more) of sprites initiate significantly after (tens to hundreds of milliseconds) the apparently causal lightning return stroke. Recent work [Cummer and Fuellekrug, GRL, 28, 495, 2001] has shown that, in at least a few cases, unusually intense continuing lightning currents are responsible for triggering these so-called delayed sprites. These continuing currents can be detected and analyzed through a quasi-static ULF magnetic field signature that is detectable much farther from the source than most other continuing current signatures. Quantitative analysis showed in one case that the continuing current carried more than 800 C of charge to ground. Beyond their initial detection, many important questions remain regarding the connection of continuing currents and sprites. For example, it is not known whether all delayed sprites are connected to a return stroke through continuing currents. These delayed sprites also provide a unique opportunity to quantitatively test, under extreme circumstances, theoretical predictions of the relationship between lightning charge moment change and sprite initiation. We have quantitatively analyzed high time resolution multi-station ULF magnetic field data recorded in the summer of 1998 for delayed and not-delayed sprites, and we will address these and other issues regarding the connection between these unusually large continuing currents and sprite initiation.

AE22A-11 1700h

Electron energies, densities, and electric fields in sprites from aircraft based optical observations*

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During the EXL98 aircraft mission, sprites were observed by cameras with narrow band filters to measure the N_2^+ 1NG (0,1) band at 4278Å and the N_2 2PG (0,0) band at 3370Å. We discuss the observations, instrumental and atmospheric corrections, and altitude profiles of ionized (1NG) and neutral (2PG) emission observed during a specific sprite. The ratio of ionized-to-neutral emission indicates a relative enhancement of ion emission at altitudes below 55 km. Electron energies are derived from these emission ratios using excitation rates based on both Maxwell-Boltzmann electron energy distributions and the results of a steady state electric field model that solves the Boltzmann equation. The resulting electron energies range from 1.3 to 2.2 eV with the minimum energy near 60 km. In addition, electric field profiles and column electron density profiles have been derived for this sprite. The average electric field above ∼55 km is well below the breakdown field for the atmosphere but below this altitude the electric field follows the breakdown field nearly exactly. The column density shows a broad peak between 59-62 km and drops significantly below 58 km to values ∼100 times less than the peak value. These observations indicate that while ionization appears to be a more significant process at altitudes below ∼55 km, a large amount of energy deposition occurs above 55km.

*The work at NRL was supported by Office of Naval Research and NASA.

AE31A MC: Hall D Wednesday 0830h

Thunderstorm Electrical Effects on the Middle and Upper Atmosphere and Ionosphere II

Presiding: **D D Sentman,** University of Alaska**; V P Pasko,** The Pennsylvania State University

AE31A-0060 0830h POSTER

Terrestrial Gamma-ray Flashes After CGRO: Prospects From HESSI

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Brief (1–5 ms) flashes of gamma-rays coming from the direction of Earth's atmosphere were discovered by the BATSE instrument aboard the Compton Gamma Ray Observatory (CGRO) in 1994. CGRO was deorbited in June 2000, but during its lifetime 75 Terrestrial Gamma-ray Flashes (TGFs) were observed. The source of the photons is generally assumed to lie at atmospheric altitudes of 60–70 km, and to consist of bremmstrahlung radiation from highly relativistic electrons energized by strong mesospheric electric fields overlying thunderstorms.

Because of the high altitude and upward-directed nature of this radiation, neither the gamma-rays nor the assumed causative runaway electron beams can be directly observed except by satellite. To date, no clear optical or in situ electron data exist to shed light on this phenomenon. Since CGRO's demise, there is no longer an orbiting gamma-ray instrument that is well suited for detecting TGF's. We describe the prospects for detecting TGFs with the High Energy Solar Spectroscopic Imager (HESSI), whose launch is imminent. While the BATSE main detectors had an upper energy band of 300 keV – ∼1 MeV, which was too low to resolve the hard (>1 MeV) TGF spectrum, the nine HESSI rear germanium detectors have spectral resolution of 0.1% – 3% up to >10 MeV. In addition, BATSE's triggering circuitry integrated for at least 64 ms (much longer than the duration of a TGF) while the HESSI spacecraft records and telemeters the energy and time of arrival of each photon event. On the other hand, the geometric factor for the HESSI detectors is small compared with that of BATSE. Altogether, we expect a comparable TGF detection rate from HESSI but superior spectral (and temporal) information, which may provide key new evidence for the underlying mechanisms behind TGFs.

URL: http://sprg.ssl.berkeley.edu/∼cpbl/tgf

AE31A-0061 0830h POSTER

Spectral Evidence for Ionization in Air-Filled Glow Discharge Tubes: Application to Sprites

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The question of ionization in sprites and the evidence for VLF backscatter from sprites has motivated a quantitative spectral analysis of the various (classical) regions of the glow discharge tube under DC excitation and at air densities appropriate for sprites in the mesosphere. A PR-650 colorimeter (Photo Research, Inc.) has enabled calibrated irradiance measurements for localized zones along the axis of the discharge tube– in the dominantly blue negative glow, in the Faraday dark space and in the red/pink positive column. Consistent with historical nomenclature, nitrogen first and second positive emission is dominant in the positive column (associated with neutral N_2), and nitrogen first negative emission, with a prominent peak at 4278 A, is dominant in the blue negative glow (associated with ionized $N_2{}^+$). Whereas nitrogen first and second positive emission are also detected in the negative glow, no spectral evidence for ionization (no 4279, no 3914, no Meinel) is found in the red/pink positive column. This negative result is attributed not to an absence of ionization in the positive column, but rather to a sparse population of $N_2{}^+$ relative to neutral nitrogen in this region, and to the prominent emission in the blue part of the spectrum due to nitrogen second positive. A similar interpretation may be appropriate for the time-integrated spectra from the red body of sprites, also lacking direct evidence for ionization.

AE31A-0062 0830h POSTER

Parental thunderclouds of sprites and elves in winter Japan

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We have conducted the observation campaign of sprites/elves in winter since December 1998. We use two observation sites with distance of 300 km to make triangulation: Optical instruments and VLF wave receivers have been installed both at two observation sites. During the campaigns we succeeded in measuring sprites and elves with image-intensified CCD cameras, photometers and VLF receivers. Totally, 21, 2, and 11 sprites were recorded in each campaign, respectively. The elves were detected more frequently than sprites. During 2000/2001 campaign 26 elves appeared on single night. This might be due to large emission extent of elves in horizontal and the fact that elves could be caused by not only positive discharge but also negative one. The number of event is strongly dependent on the parental thundercloud activity and weather conditions above the observation site. In 1998/1999 campaign, we observed the sprites when the cold front was approaching to and collided with the west coast of Japan. The location of sprites determined by triangulation is just above the cloud in the cold front. The height of the cloud top is estimated to be 4-6 km and the width of the cloud is only 30 km. On the other hand, in the 20002001 campaign, sprites were observed above the Pacific Ocean 500 km apart from the coast. Some of them are also associated with clouds at the cold front while some events appeared over the clouds detached from the cold front by >400km. The height of the cloud top are 5-7 km. Differences in dimensions and structures of sprites between in summer and in winter will be discussed in the point of view of the relationship to the characteristics of the parental cloud and discharges.

URL: http://pat.geophys.tohoku.ac.jp/˜yukihiro/

AE31A-0063 0830h POSTER

Coordinated Global Measurements of TLEs from the Space Shuttle and Ground Stations during MEIDEX

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The Mediterranean Israeli Dust Experiment (MEIDEX) is scheduled to fly on-board the Columbia in May 2002, in a 39 inclination orbit for 16 days, passing over the major thunderstorm regions on Earth. The primary science instrument is a Xybion IMC-201 image-intensified radiometric camera with 6 narrow band filters (340nm, 380nm, 470nm, 555nm, 665nm, 860nm). A Sekai color video camera is a boresighted wide-FOV viewfinder. The cameras are mounted on a single-axis gimbal with a cross-track scan of 22 degrees, inside a pressurized canister sealed with a coated quartz window that is mounted in the shuttle cargo bay. Data will be recorded in 3 digital VCRs and downlinked to the ground. During the night-side of the orbit there will be dedicated observations toward the Earths limb above areas of active thunderstorms, in an effort to image TLEs from space. While earlier shuttle flights have succeeded in recording several ionospheric discharges by using cargo bay video cameras, MEIDEX offers a unique opportunity to conduct targeted observations with a calibrated, multispectral instrument. The Xybion camera has a rectangular FOV of 14.04(H) x 10.76 (V) degrees, that covers a volume of 466km (H) x 358km (V) at the Earths limb, 1900km away from the shuttle. The spatial resolution is 665m (H) x 745m (V) per pixel, enabling to resolve some structural features of TLEs. Optical observations from space will be conducted with the 665nm filter that matches the observed wide peak centered at 670nm that typifies red sprites, and also with the 380 and 470nm filters to record blue jets. Observations will consist of a continuous recording of the Earths limb, from the direction of the dusk terminator towards the night side. Areas of high convective activity will be forecast by using global aviation SIG maps, and uplinked to the crew before the observation. The astronaut will direct the camera toward areas with lightning activity, observed visually through the windows and on monitors in the crew cabin. Simultaneously with the optical observations from space, dedicated ground measurements will be conducted on a global scale. Two field sites in the Negev Desert in Israel will be used to collect electromagnetic data in the ELF and VLF frequency range. Additional ground stations in Germany, Hungary, USA, Antarctica, Chile, South Africa, Australia, Taiwan and Japan will also record Schumann Resonance and VLF signals. The coordinated measurements from various locations on Earth and from space will enable us to triangulate the location, and determine the polarity and charge moment of the parent lightning of the optically observed TLEs. The success of the campaign will further clarify the global picture of TLE occurrence.

AE31A-0064 0830h POSTER

Investigating TLE-Producing High Plains Mesoscale Convective Systems with the NLDN and ELF Transients

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During the 2000 STEPS and the 1999 NASA Stratospheric Sprites Balloon campaigns, several remote sensing tools were employed to investigate TLE-producing storms over the High Plains. Low-light video systems deployed at Yucca Ridge documented TLEs (sprites, halos, trolls and gnomes) above a variety of storm systems. A new hybrid ELF/VLF technique used receivers in Israel to monitor sprite-related ELF transients originating in Nebraska, a range of 11 Mm. Over 90 percent of the sprites were associated with distinctive ELF transients. The new geolocation technique positioned these transients largely within the boundary of the parent cloud. Detailed analyses of MCS over the STEPS network on 18 and 19 July 2000 revealed the sprite-producing +CGs tended to cluster near but not coincident with the coldest cloud tops. Two methods of calculating the charge moments of the TLE-parent +CGs confirmed that large values (500 C km and up) are an apparent requirement for sprites. Continued analysis of the large MCS of 18 August 1999 show sprite-producing +CGs tend to congregate below the colder portions of the storms cloud shield within stratiform precipitation areas with relatively low radar reflectivities (25 - 40 dBZ). Five halos were associated with CGs by the NLDN. Furthermore three of the five produced large negative ELF transients monitored in Israel. All five were associated with ELF slow-tails recorded at about 1000 km range.

AE31A-0065 0830h POSTER

ALTITUDE-TIME DEVELOPMENT OF SPRITES

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Data collected from sprites using a 16-channel, multi-anode photometer (MAP) have been recorded at 0.1 ms resolution. The data reveal features about the development of sprites immediately after luminosity becomes visible to the MAP. The majority of the sprites have onsets at an altitude of 70-75 km, and subsequently propagate both upward and downward from this initial altitude. The statistical lifetime of the emissions measured by the blue-sensitive MAP are approximately 1.3 ms at the sprite initiation altitudes. The statistical lifetime measured by a red-sensitive High Speed Imager (HSI) at these altitudes is a factor of 6-8 longer than MAP lifetimes. The speeds of propagation are between 10^7 and 10^8 ms^{-1}, and the upward propagating luminosity, called branches, have a higher speed than the downward propagating luminosity which are referred to as tendrils. These observations are consistent with other observations and predictions that sprites can both perturb the mesosphere and be affected by changes in mesospheric neutral density. The early time development of sprites appears consistent with positive and negative streamers in highly overvolt-aged conditions seen in the laboratory.

AE31A-0066 0830h POSTER

Statistics of TLE Types and Properties Observed During the 1999 Sprites Balloon Campaign

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Historically, the process of sprites or Transient Luminous Event (TLE) detection has required an alert human observer to notice them on a low light level TV (LLTV) monitor, either in real time or playback. The payloads of the 1999 Sprite Balloon Campaign have all sky uplooking photometers not sensitive to events below the balloons. We have used the photometer data to find more TLE's that were missed, by checking it at the times reported by National Lightning Detection Network (NLDN). During Flight 1 (07/06/99) we surveyed 3 hours of data, containing 1652 strokes. We found 56 TLE's, 7 associated with +CG's and 49 with -CG's. During flight 3 (08/21/99), we surveyed 2 hours of data, containing 1017 strokes with 104 TLE's, 28 associated with +CG's and 76 with -CG's. During Flight 3, ground observation was possible. So far we have identified 26 sprites, sometime mixed with other TLE phenomena, 28 stand-alone sprite halos, and 7 elves. Some of these events were not associated with NLDN events. Since most of the unidentified balloon-observed events were associated with -CG's, we suggest that most of them were sprite halos. There was enough time delay between the CG strokes and the light pulses to rule out elves. For the +CG TLE's we have found a 100 C-km threshold value of the charge moment of the TLE itself. We do not find a similar threshold for -CG's.

URL: http://www.uh.edu/research/spg/Sprites99.html

AE31A-0067 0830h POSTER

The ULF Magnetic Fields Generated by Thunderstorms: A Source of ULF Geomagnetic Pulsations?

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It has long been known that thunderstorms produce strong electric field fluctuations in their immediate vicinity but it has been little recognized that these storms are also a source of strong ULF magnetic field fluctuations. Some characteristics of the magnetic field fluctuations were documented for a thunderstorm occurring in 1990 [Fraser-Smith, *Geophys. Res. Letts.*, *20*, 467–470, 1993]. We now provide further measurements of these magnetic field changes for an intense isolated thunderstorm that passed over the San Francisco Bay area on 9 September 1999. The thunderstorm is characterized by NLDN measurements of its associated lightning and, as compared with the earlier measurements, the new measurements have much greater time resolution and more components of the magnetic field changes are measured. Given the possibility that the thunderstorm-related ULF magnetic field changes can stimulate ULF hydromagnetic waves in the ionosphere, these measurements suggest, once again, that thunderstorms may be a source of ULF energy in the magnetosphere that can contribute to the generation and amplification of some classes of ULF geomagnetic pulsations. In addition, it may also be significant that there are a large number of thunderstorms (∼ 2000) in progress at any time at low (tropical) latitudes, and thus they are ideally located to inject ULF hydromagnetic waves into the radiation belt at frequencies corresponding to some of the ion gyrofrequences.

AE31A-0068 0830h POSTER

Ultra-Long Lightning Continuing Current

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Particularly intense cloud-to-ground lightning discharges can exhibit continuing current of $\geqq$ 500 ms duration. Evidence for this ultra-long lightning continuing current is reported from horizontal magnetic field recordings in the frequency range from 0.1-20 Hz at Hollister, California, 1-2 Mm away from the lightning flash location. These measurements are compared to the temporal evolution of lightning discharges monitored with the Lightning Mapping Array (LMA) during the Severe Thunderstorm Electrification and Precipitation Studies (STEPS) campaign and Video recordings from continuing current in distinct cloud-to-ground discharges. Lightning discharges with ultra-long continuing current may be associated with successive mesospheric transient optical emissions above mesoscale thunderclouds, denoted dancing sprites.

AE31A-0069 0830h POSTER

Threshold charge moment changes for sprite initiation and lightning-to-sprite delays

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Measuring the lightning charge moment change required to initiate sprites helps to understand the mechanism that generates these mesospheric optical emissions and their effect on this region of the atmosphere. The transient magnetic field radiated by lightning discharges was continuously measured remotely by using a wide band ELF (Extremely Low Frequency) receiver at Duke University during the summer of 2000. Optical emissions from sprites were directly monitored on video recordings made at Yucca Ridge Field Station, Colorado, during the STEPS (Severe Thunderstorm Electrification and Precipitation Study) Campaign in May, June, and July 2000. By using a deconvolution method based on a mode-theory electromagnetic propagation model, the current moment and charge moment of the recorded sprite-associated lightning discharges were calculated. The high time resolution of our measurements enables us to accurately measure the charge moment change at the time of sprite initiation, which is the goal of this study.

The current and charge moment waveforms of the 881 lightning discharges accompanied by sprites during the STEPS campaign of 2000 were extracted. We analyze in detail only those sprite events with clear sprite currents or with short lightning-to-sprite delays (<6 ms) because of the sprite onset time uncertainty from the video images. Data analysis shows the threshold charge moment change for sprite initiation varies from 123 (C-km) to 2470 (C-km). Also we investigated the experimental data supporting the theoretical prediction that lightning discharges associated with high speed of charge removal can produce sprites with small charge moment change. The frequency of mesospheric sprite current occurrence is found to vary from 0 to 42% from day to day, with an average of 8.7% over the 17 days studied. Sixty-five sprites associated with sprite currents were analyzed and the statistical distribution of these charge moment changes is given. Also the statistical distribution of lightning-to-sprite delays is given with an estimated average of 36.8ms. The deduced threshold charge moment change is compared with theoretical expectations.

AE31A-0070 0830h POSTER

Characterization of Fine Structure in Sprites

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During the summer months of 1998-2000, Stanford University fielded campaigns to telescopically image sprites. The campaigns were conducted at Langmuir Laboratory (operated by New Mexico Institute of Mining and Technology) in Socorro NM and Yucca Ridge Observatory in Fort Collins CO. The experiment consisted of two intensified CCD cameras, two photometers, and crossed magnetic loop VLF antennas. One camera was mounted on a 16in diameter, 72in focal length Newtonian telescope with a field of view of 0.72x0.9 degrees and the other had a 50mm lens with a field of view of 9x12 degrees. Similarly one photometer was mounted on an 8in diameter, 1200mm focal length Newtonian telescope with a circular field of view of 1 degree and the second was red-filtered and had a wider field of view of 3x6 degrees. All four instruments were mounted on the same platform and were aligned. Video data was stored on VHS tapes with the photometer signals recorded on the audio channels. GPS video time-stamping and IRIG-B code were used for timing. Data from these campaigns reveal streamer structures within sprites ranging from 25m to 200m in width. Streamer morphologies are diverse ranging from single columns to multiply-forked structures to chains of beads. Faint downward branching is observed prior to some large sprite events. Streamers are seen to develop on time scales from less than 17ms to over 100ms. Streamer sizes and velocities are compared to existing models and charge moments for associated sferics are presented.

AE31A-0071 0830h POSTER

Transition betwendiffuse and structured regions in sprites.

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Sprites occur in the mesosphere above lightning storms. Individual sprites can be large covering altitudes from about 30 km to 100 km with a diameter of up to almost 100 km. Images of sprites taken at 1000 frames per second show considerable temporal and spatial structure. In particular, there appears in the image data a well-defined transition between spatially diffuse optical emissions at high altitude, and the more structured streamer region below. Theoretical analysis predicts such a transition region, and we report here on a comparison between model predictions and actual observations of the transition region. Analysis of 25 events shows the mean transition altitude to be 78 km with a standard deviation of 4 km. The transition altitude is sensitive to variations in the electron density profile in the mesosphere and lower ionosphere. We compare the observed measurements with a number of model profiles from existing literature.

AE31A-0072 0830h POSTER

Fingers/Embers/Trolls Occurring in the Wake of Sprites

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Sprites are large optical discharges above active thunderstorms, propagating downward and upward from approximately 70 km altitude. Following sprites, researchers have observed streaks of luminosity propagating upwards from cloudtops through the channels of originally downward propagating sprite tendrils. These were termed sprite-jets (Stanley et al, 1996), fingers (Moudry et al. 1999), trolls (Lyons et al., 2000) and embers (Stenbaek-Nielsen et al., 2001) by different scientists. (Since the term sprite-jet is potentially confused with both sprites and jets, that name for these events is no longer used.)

The first high speed (1 ms) imager data of these event show fine details. The fingers/embers/trolls proceed as follows: a small bead brightens at some relatively low (<25 km) altitude. It then "drains" down through the pre-existing (sprite tendril) channel, with speeds of $\sim 10^6$ m/s. A few (1 to 20) ms later, another bead, either higher, to the side, or sometimes even lower than the original one, brightens and likewise "drains". As higher and higher beads brighten and "drain" down, the apparent motion is upward. Since the period between successive "draining" is not regular, the average upward speed is not constant, but varies from event to event.

With regular TV-rate (17 ms) cameras, the downward motion is blurred and only the average upward motion is visible. Several events observed in 1998 had speeds around 10^5 m/s (Moudry et al., 1999), similar speeds to those found later by Lyons et al. 2000.

These fingers/embers/trolls occur only in the wake of a sprite. Sometimes only one single bead is observed, sometimes none, sometimes multiple ones lasting more than 100 ms after the sprite. With only a limited dataset, these events have been observed to reach more than 50 km altitude. Thus far no models have been attempted to explain the phenomena.

One possibility is that these events are perhaps analog to the K-events (or M-events) of lightning. Another of the many possibilities is that they are caused by the K (or M) events. They may also be the smaller cousins of "palm trees" (Desrochers et al. 1995), which have so far not been observed with a high speed imager.

AE31A-0073 0830h POSTER

Space-time and Spectral Structures of Sprite Halos Obtained from High-speed Photometric and Imaging Observations

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We carried out optical observations of lightning-induced luminous events at Yucca Ridge Field Station, Colorado, USA, from 1996 to 2000, using two multi-anode array photometers (MAP), an image intensified CCD cameras and other optical instruments. The MAP has 16 channels aligned vertically and each channel has a field-of-view of 0.67x10.75 degrees. Consequently, the total size of field-of-view is 10.75x10.75 degrees. The time resolution of MAP is 50 microseconds so that we can detect temporal and spatial structures of sprite halo emissions. The two MAPs are equipped with different color filters, red (380-500 nm) for mesurement of N2 1st positive band and N2+ Meinel band, and blue (560-800 nm) for mesurement of N2 2nd positive band and N2+ 1st negative band, respectively. Using data obtained from these instruments, we estimated the altitude range and the horizontal extent of sprite halos. Sprite halos move downward as focusing into the center of diffuse glows. It is found that the starting and ending altitudes are about 83 and 67 km, respectively, on average, and that the mean speed of downward motion is about 1/6 of the light speed. On the other hand, the estimated horizontal extent of sprite halos are about 40 - 110 km with a mean value of 78 km. A mean duration of sprite halos is found to be about 1 ms. Using the ratios of blue to red siganls obtained from two MAPs during the SPRITES'99 campaign, we estimated the energies of electrons inducing sprite halo emissions by assuming a more realistic non-Mawellian energy distribution as well as a standard Maxwell-Boltzmann distribution. Futhermore, we calculated the charge moments of causative CGs using NLDN data and investigated the relationship between the charge moments of causative CGs and the time delays from VLF sferics to the onset of sprite halos. By comparing the observational results with the model calculation presented by Barrington-Leigh et al. [2000], we will discuss the generation mechanism of sprite halos.

AE31A-0074 0830h POSTER

Monitoring Space Vehicle Floating Potential with a Charged Particle Spectrometer

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For negative floating potentials, ionospheric positive ions are accelerated to the detector picking up kinetic energy equal to the floating potential; for positive floating potentials, electrons are accelerated toward the detector. This leads to a measurable difference between the unaccelerated neutrals and the accelerated ions or electrons. Recent advances in position sensitive detection systems for ions and electrons make it possible to fabricate charged-particle spectrometers to measure neutral winds and ion-drifts from Low Earth Orbit (LEO) platforms. Furthermore, the new detector technologies allow large reductions in mass and power in high sensitivity charged-particle spectroscopy, enabling a miniaturized (< 500 grams) spectrometer for ambient neutrals, ions, and electrons. Random thermal velocities of the most abundant ions and neutrals in the ionosphere are on the order of 1 km/s. A typical LEO satellite velocity is 8 km/s, requiring that the detectors for neutrals and ions look in the forward or ram direction within an angle of approximately 18 radian (about 7.5 degrees). The neutral-ion data obtained in a ram pointing spectrometer provide energy spectra of the neutral atoms He, O, and Ar, molecular nitrogen and oxygen, and the positive ion constituents of the ionosphere. Least squares fits of drifting Maxwellian distributions for both ions and neutrals to the energy spectra may be used to infer the floating potential of the spectrometer with respect to the ambient plasma. The neutral wind, ion-drift and the corresponding temperatures may also be obtained from the same data. An orbiting spectrometer separates different masses in energy, making it possible to also estimate the contact potential error of the charged-particle optics. A smaller correction due to the space charge of the ionizing electron beam is discussed and it is shown that this error could also be estimated accurately by scanning the electron beam intensity and tracking the spectral energy shift.

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Pan, C., The rotation of ron-rigid Earth., *Eos Trans. AGU, 82*(47), Fall Meet. Suppl., Abstract U41A-00005, 2001.