has revealed substantially more events than in the original catalog. Particular attention is paid to charge moment changes in three major classes of storms, (1) MCSs with many SP+CGs in the stratiform region, (2) supercells with only sporadic sprite events during restricted portions of their life cycle, and (3) MCSs and supercell storms which, in spite of many +CGs, produce no transient luminous events. In addition, the characteristics of continuing currents in High Plains lightning discharges monitored using high speed video cameras (1000 fps) is compared with ELF/ULF measurements (Courtesy: Martin Fullekrug). Additional observations of sprites and elves were obtained during summer 2003, in conjunction with an upgraded Duke University ELF transient monitoring system. Some initial results will be presented.

AE41B-04 1115h INVITED

Fine structures, velocity and the ELF signature of gigantic jets*

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Gigantic jet is a type of transient luminous events that optically connect thundercloud-top and the ionosphere [Su et al., Nature 423, p974-976, 2003]. The dynamical evolution of gigantic jets can be divided into three stages: the leading jet, the fully developed stage, and the trailing jet. At the fully developed stage, the upper portion of the gigantic jets is very similar to classical sprites, and the lower portion remembers blue jets. In this talk, a few interesting properties and the spatial-temporal evolution of the fine structures of gigantic jets will be discussed. The ELF and the lightning signatures of the gigantic will also be compared, and a possible generating mechanism will be presented. * This work was partially supported by 92-NSPO(B)-ISUAL-FA09-01 and NSC 92-2111-M-006-002

AE41B-05 1135h

Dynamics of Streamer-to-Leader Transition in Transient Luminous Events Between Thunderstorm Tops and the Lower Ionosphere

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Sprites commonly exhibit vertically oriented branched structures filling large volumes of atmosphere in the altitude range 40-90 km above thunderstorms [e.g., Gerken and Inan, JASTP, 65, 567, 2003]. These structures likely represent scaled by atmospheric pressure versions of weakly ionized thin channels of ionization, called streamers, which are commonly observed during initial stage of discharge development in short (several cm) gaps in relatively cold (i.e., 300 K) air at ground pressure [Raizer, Gas Discharge Physics, 1991, p. 334]. The appearance of sprites is very different from the lightning phenomenon occurring at near ground pressures, which deposits large amounts of energy in relatively small volumes leading to total single ionization of atoms [Raizer, 1992, p. 373]. Recent observations of transient luminous events (TLEs) emanating from thundercloud tops, exhibiting some lightning like features near the cloud tops, and then propagating upward through the altitude range typically occupied by sprites [Wescott et al., JGR, 106, 21549, 2001; Pasko et al., Nature, 416, 152, 2002; Su et al., Nature, 423, 974, 2003] represent an opportunity to study a transition from lightning-like structures at thundercloud altitudes to large scale filamentary sprite-like structures at the lower ionospheric altitudes. It is likely that this type of TLEs originates from a streamer zone of conventional lightning leaders and represents a "final jump stage" of the leader process, when the streamer zone of a leader makes contact with the opposite electrode (i.e., ionosphere) [Pasko and George, JGR, 107, doi:10.1029/2002JA009473, 2002]. The understanding of streamer-to-leader transition and scaling of this transition as a function of atmospheric pressure therefore represents a first neccessary step toward understanding of complex dynamics of optical features observed in these events. In this talk we will present results of modeling studies, which allow investigation of effective time scales of the initial stage of air heating in streamer channels up to 5000 K at which the thermal ionization becomes important. The model is zero-dimensional and accounts for time dynamics of air heating and ionization at a fixed point inside of the streamer channel. The model is derived from previous studies conducted for similar purposes at ground pressure [Lowke, J. Phys. D: Appl. Phys., 25, 202, 1992; Naidis, J. Phys. D: Appl. Phys., 32, 2649, 1999; Vidal et al., IEEE Trans. Plasma Sci., 30, 1339, 2002]. In the first part of the talk for calibration purposes we will present comparisons of our model and available laboratory data on time scales of air heating in streamer channels at ground and near ground pressures [Larsson, J. Phys. D: Appl. Phys., 31, 1998] following approach described in [Naidis, 1999]. In the second part we will present results corresponding to a range of air pressures, electric fields and electron densities representative of conditions in streamer channels at TLE altitudes. The obtained transition times indicate that the re-brightening events observed by Pasko et al. [2002] and trailing jet events observed by Su et al. [2003], which terminate at altitudes around 50-60 km, likely correspond to the final section of an upward leader, which was not able to complete the next step due to a dramatic increase in air heating time scales above 50 km.

AE41B-06 1150h

The Sprite2003 Campaign

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During the northern hemisphere summer of 2003, from July 18 to September 18, a sprite observation campaign was conducted with measurements from Southern Europe, coordinated with measurements from the magnetically conjugate region in South Africa. The goal of the campaign was to investigate the electromagnetic signatures of sprite emissions, their effect on the ionosphere above, and possible effects of the relativistic acceleration process manifested in the magnetically conjugate hemisphere. Measurements in Europe included optical video imaging from a remotely controlled, semi-automatic, camera system located at the Observatoire Midi Pyrenee, in the Pyrenee mountains in Southern France, and ELF-HF electromagnetic observations from several locations. The observations in South Africa included kHz time-resolution measurements of optical emissions taken by an array of 6 photometers and VLF electromagnetic emissions. The presentation will give an overview of the campaign, the meteorological conditions, and present some first results.

URL: http://www.dsri.dk/~neubert/sprite2003

AE41B-07 1205h

A Semi-Automatic, Remote-Controlled Video Observation System for Transient Luminous Events

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In support for global ELF/VLF observations, HF measurements in France, and conjugate photometry/VLF observations in South Africa, we developed and operated a semi-automatic, remotely controlled video system for the observation of middle-atmospheric transient luminous events (TLEs). Installed at the Pic du Midi Observatory in Southern France, the system was operational during the period from July 18 to September 15, 2003. The video system, based two low-light, non-intensified CCD video cameras, was mounted on top of a motorized pan/tilt unit. The cameras and the pan/tilt unit were controlled over serial links from a local computer, and the video outputs were distributed to a pair of PCI frame grabbers in the computer. This setup allowed remote users to log in and operate the system over the internet. Event detection software provided means of recording and time-stamping single TLE video fields and thus eliminated the need for continuous human monitoring of TLE activity. The computer recorded and analyzed two parallel video streams at the full 50 Hz field rate, while uploading status images, TLE images, and system logs to a remote web server. The system detected more than 130 TLEs - mostly sprites - distributed over 9 active evenings. We have thus demonstrated the feasibility of remote agents for TLE observations, which are likely to find use in future ground-based TLE observation campaigns, or to be installed at remote sites in support for space-borne or other global TLE observation efforts.

URL: http://www.dsri.dk/~neubert/sprite2003

AE42A MCC: Level 2 Thursday 1330h

Electrical Effects of Thunderstorms on the Middle and Upper Atmosphere II Posters *(joint with A, SA, SM)*

Presiding: **D D Sentman,** Geophysical Institute, University of Alaska, Fairbanks**; V P Pasko,** Pennsylvania State University

AE42A-0784 1330h POSTER

The Spectroscopy and Energetics of Red Sprites

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During the past decade, the study of red sprites has evolved from the observation of general physical properties and application of relatively simple models to detailed research into the fundamental nature of the morphology, chemistry, and energetics of this highly dynamic phenomenon. Spectroscopy is one area that has provided significant information on the energetics and chemistry of sprites. This includes observations from video spectrographs and narrow band imaging and photometry. This talk will review spectroscopic and photometric observations and present recent results on ionization and electron energetics observed in sprites.

AE42A-0785 1330h POSTER

Numerical Simulation of the chemical effects of sprite phenomena in the mesosphere

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We conducted numerical simulation of the chemical effects of sprite halos in the mesosphere. Our target is to clarify how much O(^{1}D) is produced by dissociation of O_2 in a single sprite halo event. Monte Carlo simulation is performed to examine a quasi-static condition of the electron energy distribution functions (EEDFs) and to obtain the rate coefficients of electron impacts (especially in the processes related to ionization of N_2 and O_2, dissociation and dissociative attachment of O_2) for a non-thermal case of interest. Numerical simulation showed that ambient electrons are heated by intense lightning-induced electric field, up to an average energy of 2-7 eV, which is sufficient to dissociate O_2. The EEDFs are characterized by a non-Maxwellian distribution, but are in a quasi-static condition. The consistency of cross section data is evaluated, and the rate constants defined by the EEDFs as functions of E/N are compared with the previous results of other researchers. Thus, the effect of the uncertainty of the rate constants used in a quasi-electrostatic model in the estimation of the O(^{1}D) production will be discussed in this paper. Solving the continuity equations for O(^{1}D, ^{3}P), electron, O^-, coupled with a 2-D quasi-electrostatic model (using the Poisson's equation and the equation of charge transfer), we estimated the total O(^{1}D) production by a single sprite halo. Initial results indicated that the total O(^{1}D) production is 10^3-10^4 cm^{-3} at 70-90 km. We also examined the dependence of thundercloud charge moment and initial conditions (e.g., assuming density profiles in the daytime or nighttime) on the O(^{1}D) production and the temporal variation of O(^{1}D) during occurrence of a sprite halo. These results imply that the sprite halos become an important source of O(^{1}D) as giving rise to chemical potential changes of the mesosphere because O(^{1}D) is to initiate the oxidation of a wide variety of atmospheric long-lived tracer constituents (e.g., water vapor). We are improving our model for investigating the impact of sprite phenomena on the mesospheric HOx chemistry at their chemical equilibrium state. The effect on the HOx chemistry obtained from the improved model will be discussed.

AE42A-0786 1330h POSTER

Stratospheric Electric Field and Conductivity Measurements Above Thunderstorms: Implications for Sprite Models

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Electric fields and conductivity were measured in the stratosphere (32-34 km altitude) above thunderstorms as part of the Sprite Balloon Campaign 2002-2003 in southeastern Brazil. During the two balloon flights, the payloads measured hundreds of electric field transients, some as large as 130 V/m, correlated with lightning events. Also, conductivity variations over thunderstorms of at least a factor of two different from the fair weather values were measured. Since optical verification of sprites was not achieved during these flights and recent studies (Hu et al. 2002) have found that the probability of sprite production is proportional to the charge moment of the corresponding positive cloud-to-ground (+CG) stroke, we rely on charge moment estimates from remote ELF observations in Onagawa, Japan and Syowa, Antarctica to indicate possible sprite events. Here we present a detailed study of several nearby (< 60 km) +CG strokes indicated by the ELF charge moment estimate to be probable sprite generators. By using a quasi-static electric field model (Pasko et al. 1997), we show how these large field changes correlated with +CG strokes, along with varying conductivity over thunderstorms, may provide the necessary conditions for sprite development.

URL: http://www.ess.washington.edu/Space/AtmosElec/home.html

AE42A-0787 1330h POSTER

Role of the EMP and the QE field processes in the generation of columniform sprites

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Sprites are transient luminous events at the altitude of the mesosphere induced by cloud-to-ground lightning discharges (CGs). Recent observations revealed that sprites consist of two portions: sprite halo which is a diffuse glow occurring at the altitude from 70 to 85 km, and sprite streamers which include fine structures extending downward from the bottom of the sprite halo. It is suggested that the quasi-electrostatic (QE) field induced by CGs is an essential source for producing both the sprite halo and the sprite streamers. Recent electrodynamic models of the sprite halo have reproduced the spatial and temporal evolution of the halo obtained from optical observations. However, the evolution of the sprite streamer region has not be reproduced by computer simulation, and it is suggested that there are other important factors in addition to the QE field for their generation. To clarify the important factors related to the generation of the sprite streamers, we investigated the role of the electromagnetic pulse (EMP) radiated from parent CG. We analyzed sprite image data and ELF sferics data obtained in the wintertime sprite campaign conducted in Japan. In the campaign, we observed 51 columniform sprites of which streamer region is characterized by long vertical columns. We compared the structures of columniform sprites and the characteristics of parent +CGs obtained by Franklin Japan Corporation and Tokyo Electric Power Corporation. It is found that the peak current of +CGs is correlated to the number of sprite columns while the charge moment of +CGs is correlated to the vertical length of sprite columns. From these results, we suggest that +CGs with large peak current values make a precondition for the generation of sprite streamers by radiating strong electromagnetic pulses. On the other hand, +CGs with large charge moment values induce strong QE field above the parent thunderstorm system that can produce sprite columns with long vertical lengths.

AE42A-0788 1330h POSTER

Dynamics of Positive and Negative Streamers in Weak Uniform Electric Fields Between Thunderstorm Tops and the Lower Ionosphere

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It is well established by now that transient luminous events (TLEs) observed at different altitudes above thunderstorms commonly consist of large numbers of needle-shaped filaments of ionization, called streamers [e.g., Gerken and Inan, JASTP, 65, 567, 2003; Su et al., Nature, 423, 974, 2003; Pasko, Nature, 423, 927, 2003; and references cited therein]. One of the important questions of the current TLEs research, which directly relates to the evaluation of the total volumes of atmosphere affected by these phenomena and possible role of some of the TLEs (i.e., sprites, jets and gigantic jets) in establishing a direct path of electrical contact between the tropospheric and mesospheric/lower ionospheric regions, is related to the determination of the minimum electric fields required for the propagation of streamers in air at different pressures [Pasko and George, JGR, 107, 1458, 2002]. The minimum field required for the propagation of positive streamers in air at ground pressure has been extensively documented experimentally and usually stays close to the value 4.4 kV/cm [Allen and Ghaffar, J. Phys. D Appl. Phys., 28, 331, 1995], in agreement with recent results of numerical simulations of positive streamers [Babaeva and Naidis, IEEE Trans. Plasma Sci., 25, 375, 1997; Morrow and Lowke, J. Phys. D Appl. Phys., 30, 614, 1997]. The information about the absolute value of the similar field for the negative streamers at present is very limited. The existing sources indicate that this field is a factor of 2-3 higher than the corresponding field for the positive streamers [e.g., Raizer, Gas Discharge Physics, 1991, p. 361; Babaeva and Naidis, 1997]. We note that although from the streamer similarity laws one generally would expect the minimum fields required for streamer propagation to scale with altitude proportionally to the air neutral density N, the actual scaling for the altitude range of sprites, jets and gigantic jets has not yet been verified experimentally, and a limited amount of data currently available in the literature [Griffiths and Phelps, Q.J.R. Meteorol. Soc., 102, 419, 1976; Bazelyan and Raizer, Spark Discharge, 1998, p. 216] indicate possible deviations from the N scaling. In this talk we will discuss conditions required for the propagation of streamers in air at different pressures and will present corresponding results from a new two-dimensional model, which has recently been developed at Penn State for studies of dynamics of streamers in weak uniform electric fields, documenting the minimum electric field magnitudes required for the propagation of positive and negative streamers at TLE altitudes.

AE42A-0789 1330h POSTER

Gamma Ray Flashes due to Plasma Effects in the Stratosphere: Role of Whister Waves

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The gamma ray flashes observed by satellites are correlated with thunderstorms and can be due to the large electric fields associated with the latter. The proposed mechanism involves a number of physical processes. It starts with the creation of a beam of runaway electrons by the static electric field in the upper part of a thunder cloud. As the beam propagates upward it interacts with whistler waves generated during cloud-to-ground lightning discharges. This is followed by self-focusing of the whistler wave, producing ducts which guide the relativistic electron beam to higher altitudes. Such beams could reach altitudes in excess of 30 km so that the gamma rays generated by bremsstrahlung emission can escape the atmosphere. In this model for gamma ray generation the whistler waves play an essentila role. The whistler waves become unstable when the number density of the relativistic electron beam is high enough to overcome the damping by the population of cold electrons. The threshold conditions are studied for different ranges of the relevant atmospheric parameters. For whistler waves with large amplitudes due to the instability, the conditions for self-focusing and channel formation, and consequently the beam propagation are investigated.

AE42A-0790 1330h POSTER

Search for Terrestrial Gamma-ray Flashes With the RHESSI Spacecraft

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In 1991, NASA launched the Compton Gamma-Ray Observatory (CGRO), carrying aboard the multiple detectors of the Burst and Transient Source Exper-

iment (BATSE). BATSE's mission was to study cosmic gamma-ray bursts, but it unexpectedly detected gamma-ray flashes from our atmosphere, dubbed Terrestrial Gamma-ray Flashes (TGFs). These events may be caused by electrical discharges in the upper atmosphere related to lightning storms although there have been alternate models proposed. A relationship with high-altitude optical phenomena, namely sprites and jets, has been considered. We are searching for TGFs with the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI), in orbit since 2002. We will present the status of this search and discuss RHESSI's capabilities versus BATSE. Having a clearer understanding of these events and their origins is important for the study of Earth's upper atmosphere and particle acceleration processes, to help establish a clearer relationship with high altitude optical events, and to evaluate the potential for similar phenomena in other planets with thunderstorm activity such as Jupiter.

AE42A-0791 1330h POSTER

Stratospheric Observations of X-rays Near a Thunderstorm

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A balloon, carrying up and down-viewing x-ray spectrometers, was launched from Cachoiera Paulista, Brazil on 6-Dec-2002 to study lightning and sprites from the stratosphere (35 km altitude). Each spectrometer acquired a spectrum every millisecond in the energy range 20 keV–600 keV. Over 190 CG strokes within 50 km horizontal distance of the balloon were identified by a ground-based lightning detection network while the balloon was at ceiling. We report on the general absence of x-ray emissions specifically associated with lightning, and set observational upper limits for the sprite/lightning associated x-ray flux. We also report upon a singular x-ray event, in which the downgoing flux increased by a factor of nearly 5 for several seconds, but without nearby lightning.

AE42A-0792 1330h POSTER

Observations of transient luminous events on the ROCSAT-2 satellite using ISUAL instruments*

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ISUAL is a scientific payload of ROCSAT2 satellite, which is to be launched in November of 2003. The ISUAL instrument consists of a high-speed CCD imager, a six-channel spectrophotometer, and a red/blue band array photometer. Operating from a low-earth orbit, the instruments will facilitate long term, global survey of transient luminous events (TLES), and measure the spatial-temporal evolution of these upper atmospheric luminous phenomena. Through the ISUAL payload, we hope to learn the global distribution of TLES and to explore the possible unknown properties of TLEs from space. In this presentation, the salient characteristics of the ISUAL instruments will be introduced, as well as the observation strategy and the operation scenario. Besides devoting the majority of time towards observing TLEs, the project also will allocate a portion of time to other worthy scientific causes. International collaborations and observation proposals using ISUAL instruments are welcomed.
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AE42A-0793 1330h POSTER

ICCD imagery of oceanic sprites*

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As reported in Su et al [GRL vol. 29(4), doi 10.1029/2001GL013737, 2002] and Hsu et al [JASTP vol. 65, p561-566, 2003], the oceanic sprites tend to appear in single column, which is in sharp contrast with the clustering land sprites. In the 2003 Taiwan Sprites campaign, one of the scientific goals is to study the oceanic sprites in detail. The recorded images confirm the oceanic/land morphology disparity as reported before. Three of the ICCD cameras deployed in this campaign were equipped with R, G, B filters to obtain high spatial resolution and tri-color optical images. From the red and blue bands images, the spatial distribution and the energy of oceanic sprites could be evaluated. We will also compare the energy distribution of various types of oceanic sprites. Using stars in the star field as standard luminous gauges, the optical brightness of the oceanic sprites was estimated to exceed 5 MR. Using ICCD cameras set to different gain levels; the spatial brightness distribution of the oceanic sprites was also explored. * This work is supported in part by 92-NSPO(B)-ISUAL-FA09-01 and NSC 92-2111-M-006-002.

AE42A-0794 1330h POSTER

Optical observations of conjugate sprites in South Africa

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Theoretical studies have predicted optical emissions and ionospheric conductivity enhancements due to precipitation of relativistic electron beams, created by large positive cloud-to-ground discharges in the magnetically conjugate hemisphere. In July and August 2003, an attempt was made to detect these optical emissions, called conjugate sprites, and correlate them to sprite observations in Europe near L 1.8. In the northern region, two remote-controlled low-light CCD cameras were installed at the Observatoire Midi-Pyrenees (OMP) in France to observe sprites in southern France and northern Spain. Additionally, VLF receivers were installed in Europe to detect causative sferics and ionospheric disturbances associated with sprites. In the southern region, the Wide-angle Array for Sprite Photometry (WASP), an array of six photometers, was set up to observe conjugate sprites at the South African Astronomical Observatory (SAAO) near Sutherland, South Africa, with a field-of-view magnetically conjugate to the northern observing region. A VLF receiver was also set up at SAAO to detect ionospheric disturbances of VLF transmitter paths caused by relativistic electron beams. The team at OMP has observed over 100 sprites. Further analysis is required to determine whether conjugate sprites have been observed. We present initial analysis of optical data recorded at SAAO as well as charge-moment analysis of causative sferics to determine the likelihood of the conjugate events.

URL: http://www-star.stanford.edu/∼vlf/southafrica/southafrica.htm

AE42A-0795 1330h POSTER

Precipitation of Energetic Electrons by Magnetospherically Reflecting (MR) Whistlers

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Long enduring (10 s or more) precipitation of energetic electrons by magnetospherically reflected (MR) whistler episodes excited by individual lightning flashes have recently been reported in the form of drift-loss-cone enhancements observed on the SAMPEX satellite [Blake et al., 2001] and direct observations in the bounce-loss-cone via the associated subionospheric VLF signatures [Inan et al., 2003]. These observations indicate that the effect on the radiation belt electrons of electromagnetic energy injected by lightning may be more significant than previously believed, since each lightning may continue to drain the belts for tens of seconds as the MR whistler energy propagates back and forth between hemispheres. In this paper, we report on the results of a statistical analysis of MR whistler-induced precipitation events as observed with the Holographic Array for Lightning (HAIL), consisting of multiple observing stations configured in a north-south orientation in the mid-western United States. MR whistler-induced episodes are recognized in HAIL data in view of the long onset delays (many seconds) and event durations (many seconds).

AE42A-0796 1330h POSTER

Three-dimensional FDTD Modeling of Earth-ionosphere Cavity Resonances

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Resonance properties of the earth-ionosphere cavity were first predicted by W. O. Schumann in 1952 [Schumann, Z. Naturforsch. A, 7, 149, 1952]. Since then observations of extremely low frequency (ELF) signals in the frequency range 1-500 Hz have become a powerful tool for monitoring of global lightning activity and planetary scale variability of the lower ionosphere, as well as, in recent years, for location and remote sensing of sprites, jets and elves and associated lightning discharges [e.g., Sato et al., JASTP, 65, 607, 2003; Su et al., Nature, 423, 974, 2003; and references cited therein]. The simplicity and flexibility of finite difference time domain (FDTD) technique for finding first principles solutions of electromagnetic problems in a medium with arbitrary inhomogeneities and ever-increasing computer power make FDTD an excellent candidate to be the technique of the future in development of realistic numerical models of VLF/ELF propagation in Earth-ionosphere waveguide [Cummer, IEEE Trans. Antennas Propagat., 48, 1420, 2000], and several reports about successful application of the FDTD technique for solution of related problems have recently appeared in the literature [e.g., Thevenot et al., Ann. Telecommun., 54, 297, 1999; Cummer, 2000; Berenger, Ann. Telecommun., 57, 1059, 2002, Simpson and Taflove, IEEE Antennas Wireless Propagat. Lett., 1, 53, 2002]. In this talk we will present results from a new three-dimensional spherical FDTD model, which is designed for studies of ELF electromagnetic signals under 100 Hz in the earth-ionosphere cavity. The model accounts for a realistic latitudinal and longitudinal variation of ground conductivity (i.e., for the boundaries between oceans and continents) by employing a broadband surface impedance technique proposed in [Breggs et al., IEEE Trans. Antenna Propagat., 41, 118, 1993]. The realistic distributions of atmospheric/lower ionospheric conductivity are derived from the international reference ionosphere model (IRI) [Bilitza, Radio Sci., 36, 261, 2001] and account for the medium anisotropy due to the geomagnetic field above approximately 70 km altitude. The realistic three-dimensional geomagnetic field distributions are loaded from the international geomagnetic field model (IGRF) [Barton, J. Geomag. Geoelectr., 49, 123, 1997]. In this talk we will compare the model results with available analytical solutions for electric and magnetic field distributions in the earth-ionosphere cavity excited by a strong positive cloud-to-ground lightning discharge. We will also discuss known sources of variability in Schumann resonance frequencies and present results illustrating model response under conditions of high-energy particle precipitation events in the polar regions [e.g., Morente et al., JGR, 108, doi:10.1029/2002JA009779, 2003, and references cited therein].

AE42A-0797 1330h POSTER

Measurement of Externally Driven D Region Ionospheric Variability

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Very low frequency (VLF) electromagnetic pulses launched from lightning, which are called sferics, are almost entirely reflected by the ionosphere below 100 km altitude and thus contain information about the D region ionosphere. In this work we examine the effects of three different external sources on the D region ionosphere. The first is lightning itself. Powerful electromagnetic pulses radiated from lightning discharges can cause direct heating and ionization of the lower ionosphere. Using VLF energy radiated from lightning that occurred before and after a big lightning discharge, we can measure D region ionosphere disturbance caused by big lightning flash. Our results will be compared to theoretical predictions (e.g. Taranenko et al., GRL, 1993). With the same measurement technique, we also measure the D region ionosphere variability due to solar flares such as X-class/M-class flares and relativistic electron precipitation. The daytime ionospheric change produced by big solar flares is clear. Using SAMPEX energetic particle data we also find clear nighttime ionospheric changes when significant particle precipitation is present.

AE42A-0798 1330h POSTER

The Use of the Waveguide Cutoff Region to Monitor Ionospheric Height Through the Day-Night Boundary

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The use of electromagnetic waves to measure the height of the ionosphere is a well-known concept, as in any ionosonde. However, the use of lightning as a tool to measure the ionospheric height is less well explored. Using a wideband electric antenna in West Greenwich, Rhode Island with a flat frequency response across the ELF-to-VLF transition region, this study purports to do just that. A preliminary study for a single day has revealed that the effective ionospheric height rises from 60 km during the day to almost 90 km at night, and that this change in height occurs over a short period of time - less than 30 minutes. Given that the effects of dispersion and waveguide attenuation at VLF are different for day and night, different approaches are used at different times. The two main approaches are outlined below:
1) During nighttime, tweek sferics are prevalent and the tranverse resonances of the Earth-ionosphere waveguide are weakly damped. In this case, frequency-time spectrograms are used to determine the cutoff frequency and asymptotically, the tranverse resonance frequencies. The effective ionospheric height is easily calculated from these results.
2) During daytime, VLF attenuation is enhanced and the quality factor of the transverse resonances much reduced. Consequently, we appeal to the extraction of the waveguide cutoff frequency from simple FFT's of individual sferics waveforms. This frequency is picked in the steep rise to VLF energy out of the broader frequency region with reduced waveguide energy. Attention will also be given to the locations and characteristics of lightning flashes that provide the best estimates for effective ionospheric height, by any method.

AE42A-0799 1330h POSTER

ELF/VLF monitoring of lightning activity in Taiwan*

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Currently, there are two long-range lightning monitoring systems operating in Taiwan; one is a VLF/ELF electric field detection system and the other one is an ELF (SR) magnetic field system. The electric field system detect the electric sferics emitted by lightning in the 1 Hz to 22 kHz range. The magnetic system operates in the frequency range of 1 Hz to 100 Hz. In the 2003 Taiwan Sprites campaign, these two systems worked in parallel with a set of ICCD cameras to study oceanic sprites occurring in the South China Sea. From the ELF and optical data, the correlation between optical luminosity of sprites and amplitudes of their associate ELF emission was found. We will also discuss the possible correlation between the morphology of sprites and the waveform of their associate ELF signals. * This work was partially supported by 92-NSPO(B)-ISUAL-FA09-01 and NSC 92-2111-M-006-002

AE42A-0800 1330h POSTER

The Structure of Sporadic-E Layer Suggested by the In-situ Electron Number Density Profile Obtained During the SEEK-2 Campaign

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To understand the generation mechanism of QP echoes, the SEEK-2 campaign was carried out on August 3, 2002. It has been planned as an in-situ observation using two sounding rockets and ground-based instruments. Based on the electron number density measured by using the Impedance Probe during the rocket experiments, there have been found very similar peak structures of electron density in each profile. This similarity might be an important signature to understand the generation mechanism of QP echoes. It is also suggested that there was significant horizontal modulation of electron number density at the altitude of Es layer, suggested by comparison of Impedance Probe and Beacon observation results. The 3-D structure of Es layer is very important to understand the process of QP echoes generation, however there were few studies on the 3-D picture of Es layers. The purpose of this paper is to discuss on the possibility to realize the 3-D Es structure mentioned above. NEI(Number density of electrons by Impedance probe) was installed in S310-31 and 32 sounding rockets which were used during the SEEK-2 campaign, they launched at 23:24JST and 23:39JST respectively. The altitude profiles obtained by the measurement of electron number density showed very sharp peak due to the Es layer at the altitude of around 105km (number density is about 10^5 /cc). This feature is very similar among the four profiles, so it is possible to infer that there is very large structure horizontally expanded more than 100km. In addition, there are large modulation of electron number density in the Es layer suggested by the comparison between NEI and Beacon measurement. The estimated magnitude of the modulation is ranging from 10^5 to 10^4 /cc. Based on these facts, it becomes possible to estimate the 3-D structure of Es layer. About 3-D structure of Es layer estimated by radar observation results have already reported in several issues, as an example, [Chu, Yen-Hsyang et al., 2002]. In this paper, 3-D structure of Es layer estimated by in-situ observation result is discussed by comparing to the other results obtained during SEEK-2 or theoretical studies of QP echoes generation [R. B. Cosgrove et al., 2001], and recent progress of study on the irregular structure of Es layer.

AE51A MCC: 2000 Friday 0800h

Electrical Effects of Thunderstorms on the Middle and Upper Atmosphere III *(joint with A, SA, SM)*

Presiding: **D D Sentman,** Geophysical Institute, University of Alaska, Fairbanks**; V P Pasko,** Pennsylvania State University

AE51A-01 0800h INVITED

Strong Electric Fields from Positive Lightning Strokes in the Stratosphere: Implications for Sprites

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A balloon payload launched in Brazil has measured vector electric fields from lightning at least an order of magnitude larger than previously reported above 30 km in the stratosphere. During the flight hundreds of lightning events were recorded, including several positive cloud to ground lightning strokes. A two stroke flash, with small (15kA peak current) and moderate (53 kA) positive strokes at a horizontal range of 34 km, produced fields over 130 V/m at 34 km altitude. On-board optical lightning detection, recorded with GPS timing, coupled with ground based lightning location gives high time resolution for study of the electric field transient propagation. These measurements imply that lightning electric fields in the mesosphere over large thunderstorms may be much larger than previously measured.

URL: http://www.ess.washington.edu/Space/AtmosElec/Brazil.html

AE51A-02 0820h

Investigating sprite energetics over Brazil in association with small/frontal storms

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As part of the sprites 2002 balloon campaign, a suite of intensified CCD cameras were used to obtain novel data on the occurrence and properties of sprites over south eastern Brazil. Measurements were made from a field station at Cachoeira Paulista (23S, 45W), and from an Embraer aircraft both operated by the INPE (Instituto Nacional de Pesquisas Espaciais). A total of eighteen transient optical events were recorded, sixteen of which exhibited vertical structures typically associated with sprites, while the other two were disc-like events, characteristic of sprite halos or elves. Coordinated measurements by the ELAT Brazilian lightning network show that all but three of these transient events were associated with positive lightning discharges generated by relatively small thunderstorms, that were induced primarily in association with the passage of strong cold fronts. Furthermore, simultaneous ELF data obtained from Syowa Station, Antarctica and Onagawa, Japan, indicate that the charge moments associated with these events ranged from 240 to 1500 C.km with a predominance of 400-600 C.km. These observations provide the first quantitative measurements of sprites over Brazil. Although our data acquisition was limited by prevailing weather conditions, the results indicate that sprites occur relatively frequently over south eastern Brazil during the fall and spring time periods, mostly in association with rapidly developing small storms or with frontal systems.