NEWSLETTER ON ATMOSPHERIC ELECTRICITY

Vol. 7, No. 2 --- November, 1996

AMS COMMITTEE ON ATMOSPHERIC ELECTRICITY

AGU COMMITTEE ON ATMOSPHERIC AND SPACE ELECTRICITY

INTERNATIONAL COMMISSION ON ATMOS. ELECTRICITY

Announcements

Contributions to the next edition of this Newsletter are welcome and should be submitted to Earle Williams, Secretary of the ICAE, by e-mail (preferably) (EARLEW@JULIET.LL.MIT.EDU) or by fax (617-253-6208) any time before April 15, 1997. Mark your calendars!

This newsletter is now routinely provided on the World Wide Web (http://hawk.nmt.edu/bateman/ae-home.html). Those individuals not needing the mailed version should contact Earle Williams toward reducing distribution expenses.

AGU CASE News (From Don MacGorman)

The American Geophysical Union's annual fall meeting is once again approaching. The program will include four special sessions requested by the AGU Committee on Atmospheric and Space Electricity (CASE): (1) Thunderstorm Electrical Effects on the Middle and Upper Atmosphere and Ionosphere, (2) Global Electrical Circuit, (3) Thunderstorm Electrification, and (4) Lightning: Triggered and Natural. The first of these sessions will begin Sunday morning, December 15, and the last will end Tuesday afternoon, December 17.

CASE will have its annual evening committee meeting on Monday, December 16, at 8:00 in Room 131 of Moscone Center. The meeting is open to all conference attendees. As most of you know, CASE is chartered by AGU to promote interdisciplinary collaboration among meteorologists, atmospheric electricians, middle- and upper-atmospheric electrodynamicists, space physicists, and others interested in electrical processes in atmospheres. All who are involved in any aspect of research on this topic are encouraged to attend the CASE meeting.

You are invited to submit agenda items for the meeting. Possibilities include policy issues for the CASE community and upcoming opportunities for collaboration. In the interest of time, particularly because of the evening setting, we will not include brief reports of past field and research programsQthese should be reserved for the sessions and for this newsletter, as in recent years. One agenda item will be possible interdisciplinary or historical sessions for the 1997 AGU fall meeting. If you have other suggestions, please send them to me at the address below.

Below is a list of the names, addresses, and telephone numbers of current CASE members. If you have concerns that you would like brought to CASE's attention, please feel free to contact any of us.

Thanks to the AGU for continuing to share the printing and mailing costs of this Newsletter with the ICAE and the AMS.

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SPECIAL SECTION in JGR for IUGG Meeting

The Special Section of JGR with the papers from the IUGG meeting in Boulder (July 1995) will be out in December 1996. As usual these things take longer than planned, but I think it was worth waiting for the papers which took a little longer to finish the review process. There will be a Reprint Volume generated which should be available in January 97. If you are interested in a copy, please contact Robert Holzworth (bobholz@geophys.washington.edu) or 206-685-7410.

AMS Radar Conference

The next radar conference will be in early September 1997 in Austin, Texas. An announcement appears in the most recent Bulletin of the AMS. A special session is planned for atmospheric electricity and radar papers. Abstracts will be sent to Mike Biggerstaff, Department of Meteorology, Texas A&M University. Dick Orville is on the Program Committee. Please send a courtesy copy of your atmospheric electricity/radar abstract to him. (Dept. of Meteorology, Texas A&M University, College Station, TX 77843-3150).

RACES

The Radar and Aircraft Cloud Electrification Studies (RACES) project has been postponed until 1998. The goal of the project is to test physical hypotheses linking hail and positive cloud-to-ground lightning in severe storms. It was to have been carried out in May- June-July, 1997 in eastern Colorado. It is hoped additional facilities can be gained for the project by delaying one year. For 1997 we had proposed using the following NSF-sponsored facilities: CSU-CHILL multiparameter S-band Doppler radar, the armored SDSMT T-28, the U. of Wyoming King Air with its airborne mm-radar, a CLASS (radiosonde system), and SPOL, a second multiparameter Doppler radar. We plan on requesting the same NSF-sponsored facilities in 1998, and hope in addition that Paul Krehbiel will be able to participate with his new lightning mapping system along with Bill Winn with his deployable field meter network. Our goal is to obtain comprehensive datasets on all aspects of behavior of storms occurring in the area during the project. Additional investigators are welcome to collaborate. Please contact program managers at potential funding agencies as early as possible to inform them of your interest.

IAGA Conference, Uppsala, Sweden, August 4-9, 1997

Symposium (2.19) is entitled "Electrodynamic Upward Coupling in the Middle Atmosphere and Ionosphere (Sprites, Jets, etc.)". Convenors are Dick Goldberg (goldberg@nssdca.gsfc.nasa.gov) and Dave Sentman (dsentman@gi.alaska.edu).

IAMAS (International Association of Meteorology and Atmospheric Sciences) Meeting

This meeting is planned for July 1-9, 1997, in Melbourne, Australia. For further information contact mscarlet@peg.apc.org.

24th International Conference on Lightning Protection (ICLP)

The call for papers will be distributed during February, 1997. Abstracts will be due September 15, 1997. For further information please contact Sue Hardman, Staffordshire University, Stafford ST 180DF, U.K. E-mail: s.hardman@staffs.ac.uk

ICAE '96 OSAKA CONFERENCE PUBLICATION

Bill Beasley has received more than 50 manuscripts of full papers submitted to JGR from the 10th ICAE held in Osaka, Japan in June 1996. The JGR editorial office will be sending them out for review very soon. Don'tbe surprised to be asked to review one or more manuscripts. If you receive one of these papers to review, please try to respond as quickly as you can so that we might meet the goal of publication of a special issue of JGR at about the time of the first anniversary of the Osaka conference. For more information, to comment, or to volunteer to review, please contact Bill by e-mail at wbeasley@ou.edu.

Research Activity by Organization

Atmospheric Environment Service (Toronto, Ontario, Canada)

The work done by Stephen Clodman in collaboration with Earle Williams (M.I.T.) has covered additional cases. The recent emphasis is on finding the criteria for initiation of both positive and negative flashes in a number of structurally different storms. In moderate to strongly convective storms, good development is needed for positive flashes; this can be related to a cloud water content versus temperature charging diagram. We have studied two extreme cases. In one, about 1500-2000 negative CG flashes occur before the first positive CG flash. At the other extreme, certain storms with little vertical development have 70-90% of CG flashes positive. These cases provide insight into charge separation and flash production theory.

University of Arizona (Tucson, AZ)

M. J. Murphy and E. P. Krider are continuing their analyses of field mill data at the NASA Kennedy Space Center (KSC). Particular attention is being placed on how the locations and magnitudes of lightning-caused changes in the cloud charge distribution relate to the LDAR radiation sources obtained by L. M. Maier. The average currents into lightning charge centers are being compared to estimates of the cloud generator currents derived from displacement currents at the ground.

During the summer of 1996, the Arizona group continued to investigate the causes of anomalously high electric fields (> 1000 V/m) that sometimes occur at KSC under fair weather conditions. Space charge concentrations that approach 1.0 nanoCoulomb per cubic meter were measured at the ground just before local sunrise, but the source of this charge is still not understood.

University of Botswana (Gaborone, Botswana)

In the Department of Physics, Rohan Jayaratne and V. Ramachandran continue their studies of thunderstorm electrification and lightning.

Universidad Nacional de Colombia (Columbia, South America)

Horatio Torres reports that the National University of Colombia has been working for 16 years on the analysis and interpretation of lightning parameters under a spatial-temporal perspective. This approach considers lightning activity on several scales of time (day, month, seasonal, multiannual) and space (local, regional, global). Within this conceptual frame, the comparison of levels of activity between different regions, for instance temperate and tropical countries where the nature of thunderstorms seem to be very different, is possible. Additionally, this viewpoint provides criteria for verification, comparison and a more meaningful use of statistical information obtained by different lightning detection and measurement systems, in order to apply them for engineering purposes. As part of the spatial analysis, the hypothesis that lightning parameters are a function of latitudinal and geographical (topography and winds) variations is formulated.

In December 1994 ISA and EEPPM (Colombian utilities) and the National University of Colombia installed the Colombian Lightning Detection Network (RECMA). This is a ten sensors system based on time-of-arrival (six sensors) and detection finding (four sensors) techniques, that extends along a significant portion of Colombia's National Interconnection Grid. Lightning parameters provided by RECMA system are being used for operation, maintenance and design purposes. Therefore, it is important to ensure the highest confidence in the parameter estimation.

As a first part of the validation a process of calibration for amplitude of peak current was carried out. The calibration was performed by using measurements of electric field waveforms obtained with a plate-plate antenna, in order to assess the enhancement factors for each LPATS antenna and modify their gains accordingly to achieve more reliable current magnitudes.

Additionally, electric field measurements, combined with location data reported by the LPATS system, were used to compare the estimation of peak current provided by different return stroke models. For more information, contact htorres@bacata.usc.unal.edu.co

Colorado State University (Ft. Collins, CO)

Walt Petersen and Steve Rutledge have been using the 1-D, time dependent, bulk microphysical model developed by Brad Ferrier (four class ice scheme), along with a recently added non-inductive electrical parameterization to explore the relationship between cloud electrical, microphysical, and kinematic development as a function of forcing tropical oceanic and continental environments. To accomplish this task, composited soundings for the model environment were constructed from data collected over the Maritime Continent region of northern Australia and over the western Pacific Ocean.

The model has been used to simulate three distinct types of tropical convection: (1) lightning-producing oceanic; (2) non-lightning producing oceanic; and (3) lightning producing Maritime Continental convection. The simulated vertical velocity and reflectivity fields are in broad agreement with observationally based hypotheses that suggest certain thresholds in hydrometeor mass and vertical velocity must be met prior to tropical convection becoming significantly electrified. The degree to which a given storm meets these thresholds appears to be a sensitive function of both the initial forcing and the thermal buoyancy supplied to the storm by the environment. For example, if the soundings for the two oceanic cases are simulated with the same degree of gust front forcing, the sounding not associated with lightning produces only weakly electrified oceanic convection with cloud tops of 10 km, 35 dBZ reflectivities to 6.5 km, and peak rainfall rates of 40 mm/hr. The sounding representative of conditions when lightning was observed produces deep convection with tops of 16 km, 35 dBZ reflectivities to 8 km, and peak rainfall rates of 50 mm/hr; electric field breakdown is achieved approximately 15 minutes after the initial formation of radar echoes. Significant differences existed between the cases with regard to rainfall processes and the structure of the diabatic heating profiles. Currently, the model simulations are being used to suggest methods by which lightning observations could be used to infer differences in the vertical microphysical and diabatic heating structures of deep tropical convection.

One other aspect of the modeling studies being investigated is the method of representing non-inductive charging processes. More specifically, the laboratory results from Takahashi (1978) or Saunders et al. (1991) can be used in the model. Preliminary results using each parameterization show that when the modeled charge transfer is limited to less than 250 fC/collision, both Takahashi and Saunders et al. laboratory results produce a tripolar charge structure (we have included velocity and diameter dependencies on charge separation in the Takahashi parameterization to make it more parallel to the Saunders et al. parameterization). However, if the charge transfer is not limited, the Saunders et al. parameterization produces an inverted dipole. The need to limit charge transfer in the model may be associated with the choice of microphysical representation (i.e., bulk vs explicit scheme) and the lack of an explicitly modeled cloud water droplet size distribution which is a crucial parameter when considering the collection efficiency between graupel/frozen drops and cloud water.

Terry Schuur and Steve Rutledge have been using a two-dimensional, dynamical model with bulk microphysics to investigate electrification of stratiform regions associated with symmetric mesoscale convective systems. The model is set up to use the laboratory results for non-inductive charging from either Takahashi or Saunders et al. Charge densities produced by the model are similar to those indicated by balloon-borne electric field meter data when both the advection of charge from the convective line and in-situ charging by stratiform microphysics are activated. Charge density values are most similar to observations when the Takahashi laboratory data are used (charge densities are considerably lower when using the Saunders et al. results). A charge budget analysis shows that in situ charge generation can account for as much as 70% of the charge in the stratiform precipitation region, with the remaining charge contributed by advection from the convective region. This result is consistent with the contribution that mesoscale ascent (in situ condensate production) makes to the total stratiform precipitation. Several charge layers were produced by the model with the lower charge layers produced by in-situ charging and upper most layers owing to charge advection. However the model was not capable of producing the five layer charge structure observed by Rust and Marshall in these types of systems. Terry is currently completing work on his Ph.D. dissertation and plans to graduate in December of 1996.

CSIR (Pretoria, South Africa)

As part of a range of measurement technologies and tools developed at the Power Vision Programme of the CSIR, R.K. Fricker and G. Bourn are working on a Lightning Storm Monitor for protection of electronic devices.

University of Cote D'Ivoire

In the Department of Physics,J S. Mamadou is involved in a project dealing with the equatorial electrojet and the ionosphere. Details may be obtained from their WWW home page at http://www.ci.refer.org/educ.accueil.htm.

ESKOM (Johannesburg, South Africa)

EKSOM operates a six-receiver site LPATS system which has been logging data since October 1993. Results are being compared with lightning distribution maps produced from flash counter readings. Applications include verification of strikes to transmission lines.

University of Florida (Gainesville, FL)

During the summer of 1996, the International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida continued experiments involving triggered and natural lightning. The following researchers participated in the program:

M. A. Uman, K. J. Rambo, M. I. Fernandez, V. A. Rakov (Department of Electrical and Computer Engineering, University of Florida, Gainesville, FL 32611)

G. H. Schnetzer, R. J. Fisher (Consultants to the University of Florida, Gainesville, FL 32611)

D. M. Jordan (Department of Electrical Engineering, University of West Florida, Pensacola, FL 32514)

M. Darveniza (Department of Electrical and Computer Engineering, University of Queensland, Brisbane, Qld 4072, Australia)

R. Moini (Department of Electrical Engineering, Amir Kabir University of Technology, No 424, Hafez Ave., Tehran, Iran)

C. D. Wiedman (Institute of Atmospheric Physics, University of Arizona, Tucson, AZ 85721)

G. Diendorfer, M. Mair (Austrian Lightning Detection and Information System, Kahlenberger St. 2B, 1190 Vienna, Austria)

Presented below is a list of the 1996 projects:

1. Study of the interaction of nearby and direct lightning strikes with an unenergized test power distribution system and of the performance characteristics of various lightning protection devices (UF, UQ);

2. Measurement of lightning-induced ground surface arcing with a view toward minimization (UF);
3. Measurement of lightning-induced upward streamer emission with views toward both suppression and stimulation (UF);
4. Measurement of electric and magnetic fields from lightning at near (10-100 m) distances and electric fields at intermediate (20-40 km) and far (100-200 km) distances (UF, UWF, AKUT);
5. Measurement of lightning channel temperature from the NI(1) and NI(18) spectral lines and return stroke velocity in the bottom 200 m of the channel (UA);
6. Measurement of lightning electric fields for comparison with similar measurements in Austria (ALDIS).

Two launchers and four types of triggering rockets were used. Twenty "classical" flashes, initiated by upward positive leaders, and five "altitude" flashes, initiated by bi- directional leaders (upward positive leader from tip of rocket and downward negative leader from bottom of ungrounded wire) were triggered. One altitude flash struck the test overhead distribution line, and four altitude flashes terminated on ground. Fulgurites produced by two of the altitude flashes have been excavated and examined. Additionally, five natural lightning strikes occurred on the facility or nearby and were recorded by the instrumentation. Some results will be presented at the 1996 Fall AGU Meeting in San Francisco (December 15-19, 1996).

Doug Jordan (University of West Florida), Vlad Rakov, Bill Beasley (University of Oklahoma), and Martin Uman have analyzed luminosity characteristics of dart leaders and return strokes in natural lightning. The data base includes streak-camera photographs obtained in daylight for 23 subsequent strokes in 5 Florida negative cloud-to-ground flashes. One subsequent stroke created a new channel to ground and, therefore, must have been initiated by a stepped leader, although this leader was not detected. Only 10 dart leaders and 1 dart-stepped leader were detected with 5 of them (including the dart-stepped leader) being very faint, while 12 subsequent leaders (including the one that created a new channel to ground) failed to produce luminosity above the daylight background level. Three dart leader/return stroke sequences from two flashes have been examined for relative light intensity as a function of time and height. Dart-leader light waveforms appear as sharp pulses with 20-to-80% risetimes of about 0.5-1 s and widths of 2-6 s followed by a more or less constant light level (plateau). The plateau continues until it is overridden by the return-stroke light waveform, suggesting that a steady leader current flows through any channel section behind the downward-moving leader tip before, and perhaps for some time after, the return-stroke front has passed that channel section. There is a tendency, although weak, for the dart-leader light plateau to be higher as the leader tip approaches ground. Return-stroke light waveforms near ground exhibit 20-to-80% risetimes of about 1-2 s, appreciably longer than the dart-leader light waveforms. The return-stroke light pulses decay more slowly than the dart-leader light pulses. The amplitudes of the return-stroke light pulses near ground are a factor of 2 to 3 greater than those of the dart-leader light pulses. There is a significant difference between return strokes and dart leaders in terms of the variation of luminosity along the channel: The 20-to-80% risetime of the return-stroke light pulses increases from 1.5 to 4.0 s (mean values) and in 3 out of 4 cases the pulse peak decays up to 50% of the initial value as the return-stroke front propagates from ground to the cloud base at about 1.4 km, whereas the risetime of the dart-leader light pulses is essentially constant with height, and the pulse peak is either more or less constant or increases as the leader front approaches ground. Brighter dart leaders generally produce brighter return strokes. It appears that relatively- high current (as inferred from the distance-normalized initial electric field peaks) subsequent return strokes are initiated by brighter dart leaders. No correlation was found between the leader speed and either leader or return-stroke luminosity. Further, no correlation was observed between the leader luminosity and the previous interstroke interval. The six brightest leaders occurred about 30 to 50 ms after the preceding stroke and had a relatively small total duration of about 1 ms or less, as determined from electric field records. If we view both the dart leader and the return stroke as traveling wave phenomena, the electric field intensity across the dart-leader front, inferred from measured light-pulse risetimes and propagation speed to be of the order of 10 m, should be at least an order of magnitude greater than the electric field intensity across the return-stroke front, inferred to be of the order of 100 m.

FMA Research Inc. (formerly ASTeR, Inc.) (Ft. Collins, CO)

The SPRITES'96 Campaign was hosted by Walt Lyons and Tom Nelson and FMA Research, Inc. (formerly ASTeR, Inc.) at the Yucca Ridge Field Station (YRFS) near Ft. Collins, Colorado during July and early August 1996. SPRITES'96, partially sponsored by the U.S. Air Force Phillips Laboratory, involved about 50 scientists and support staff representing 16 organizations from three countries. The objective was to coordinate various optical and RF measurements of individual lightning-induced middle atmospheric luminous phenomena above large mesoscale convective systems. At least 1127 sprites and elves were observed from YRFS on 19 nights of observations. Detailed results from a number of investigators will be presented at the Fall AGU meeting in San Francisco. Participating and cooperating organizations included Philips Laboratory, Mission Research Corporation, Geophysical Institute/University of Alaska, STAR Lab/Stanford University, Massachusetts Institute of Technology/Lincoln Lab, Space Dynamics Laboratory (Utah State), Tohoku University (Japan), University of Otago (New Zealand), UC- Berkeley, Lockheed Space and Missile Corp., Sandia and Los Alamos National Laboratories, New Mexico Institute of Mining and Technology, NASA Marshall and NASA Goddard. SPRITES'96 also inaugurated a new 2500 sq. ft. climate controlled laboratory and permanent viewing platform which accommodated a suite of LLTVs, spectrometers, broad and narrow band photometers and fast imagers.

As many as twelve low light television systems (LLTVs), located at YRFS, Wyoming and New Mexico, simultaneously imaged individual sprites and elves. Fast imagers (1000 fps) and photometer arrays were deployed to examine the horizontal and vertical propagation of sprites and elves. Several blue sensitive LLTV systems and spectrographs were operated, along with a number of broad band (blue and red sensitive) and narrow band photometers (4278 A, 3914 A, 3390 A). A variety of VLF and ELF experiments concentrated on detection and ultimately, location, of sprites and elves. Radar measurements were taken from nearby LaSalle, CO by Phillips Laboratory. Distinct differences between sprites and elves in both optical and RF signatures are emerging. Events were routinely detected optically for ranges from 500 to 1000 km. Evidence continues accumulating that High Plains mesoscale convective systems need to be larger than about 20,000 km2 in order to produce frequent sprites and elves, which are in turn associated with extremely complex, high peak current positive cloud-to-ground flashes (probably) exhibiting long continuing currents. Close-up images of sprite structure reveals that dendritic tendrils can both be downward and upward branching.

During the past four summer observation campaigns conducted from the Yucca Ridge Field Station, evidence strongly indicates that sprites and elves are related (perhaps uniquely) to large peak current positive polarity cloud-to-ground (+CG) lightning flashes from parent mesoscale convective systems (MCSs) comprised largely of stratiform precipitation regions. A climatology of large peak current CGs was developed by Walt Lyons, Marek Uliasz and Tom Nelson. They examined 58.8 million flashes measured by the National Lightning Detection Network during 14 summer months (1991-1995). CG density maps of large peak current (>75 kA) -CGs and +CGs revealed significant geographical differences. Large amplitude -CGs (1.21 million flashes) clearly cluster over the southeastern U.S., especially in coastal areas and over open water. By contrast, the 197,000 large +CG flashes are strongly concentrated in and near the U.S. High Plains especially from Kansas north into North Dakota and eastward into Minnesota. This corresponds to the region where a majority of optical sprite observations have been made. A new web site with information on sprites will be launched by FMA Research during the upcoming quarter (http://www.FMA-Research.com).

High-Mountain Geophysical Institute (Nalchik, Russia)

Jouri Kouznetsov, a radio engineer, reports: "For more than 30 years I have worked at the High-Mountain Geophysical Institute on problems connected with the application of radar in meteorology. Generalizing many years of experience in this field I succeeded in decoding from the echo-signal a parameter unambiguously characterizing the microstructrue of the cloud medium. On this basis I developed a method, without other analogue, of coherent processing of the signals from a pulsed non-coherent radar, allowing an increase in the resolution and accuracy of radar measurements as well as an extension of the functional possibilities of radar."

Langmuir Laboratory (Socorro, NM)

Bill Winn reports on anticipated activities at Langmuir Laboratory during summer 1997:

1. Studies of electric field and particle charges and shapes in thunderclouds using instruments on airplanes and balloons. These measurements will be supported by a vertically scanning Doppler radar, a polarization-diverse radar, an interferometer for mapping lightning channels inside thunderclouds. and ground-based measurments of electric field.
2. Studies of the responses of lightning rods to triggered and natural lightning.
3. Studies of x-ray emission accompanying lightning.

M.I.T. Lincoln Laboratory (Lexington, MA)

Bob Boldi, Anne Matlin, Mark Weber and Earle Williams have been collaborating with Steve Goodman and Ravi Raghavan at the NASA MSFC and Steve Hodanish and Dave Sharp at the Melbourne, FL NWS Office in the development of an operational lightning/radar system in central Florida. LISDAD (Lightning Imaging Sensor Data Acquisition and Display) integrates Lincoln Laboratory's ITWS (Integrated Terminal Weather System) with the

Kennedy Space Center LDAR (Lightning Detection and Ranging) system for total lightning detection, the NLDN (National Lightning Detection Network) for ground flashes, and the NEXRAD radar in Melbourne for storm structure. Individual thunderstorm cells can be selected for detailed examination in a Tpop-upU box that displays the complete history of cell development including radar cloud top height, total lightning and cloud-to-ground lightning. Results for a large number of thunderstorms corroborate findings in earlier case studies: intracloud lightning leads the first ground flash on average by 11 minutes, the IC/CG ratio can easily exceed 10:1 during short episodes of strong vertical development, and storms in the 'severe' category can exhibit flash rates of several per second. Comparisons between lightning observed by LDAR and by the Optical Transient Detector in space are currently underway.

M.I.T. Parsons Laboratory (Cambridge, MA)

Dennis Boccippio completed and defended his PhD thesis entitled "The Electrification of Stratiform Anvils" in September. In between chapter writings, he also completed a study comparing bright lightning events seen from NASA's Optical Transient Detector in space and corresponding large amplitude ELF events recorded at MIT's Schumann resonance station in Rhode Island. He is currently working with the data from the Optical Transient Detector at Marshall Space Flight Center.

Global maps of ELF transient source locations have been assembled by Bob Boldi using Rhode Island observations. These results have been used to examine the meteorological conditions necessary for the special subset of SR transientsQthe classical Q-bursts. Examination of ELF events from a large hailstorm on August 1 in Colorado studied by Steve Rutledge and Larry Carey (and "chased" by Anton Seimon) showed no classical Q-bursts for the clustered positive ground flashes, in strong contrast with a sprite-producing MSC on August 4 observed by Walt Lyons and Tom Nelson from Yucca Ridge Observatory in Ft. Collins. NLDN data supplied by Ken Cummins has been very valuable in testing ideas and ground-truthing the ELF measurements. Single stroke negative flashes likewise produced no classical Q-bursts, as expected, if unaccompanied by any long continuing current. Ken Morrison has identified positive ground flash events on a local network in Bogota, Columbia operated by Horacio Torres which correspond with transients in R.I.. These locations provide error estimates for the single station locations which are of the order of 0.1-0.3 Mm. Additional network data for these comparisons have been provided by Yoav Yair and Zev Levin in Israel and Masaru Ishii and Syarif Hidayat for both Japan and Indonesia.

ELF comparisons with 'slow tail' measurements by Marx Brook in New Mexico for a Nebraska storm on July 16 from last summer are currently underway with Dwayne Free (AFTAC) and Emily Glass (Sandia).

Sasha Nickolaenko has provided a very insightful review of Charles Wong's Master's thesis completed last March. He has also applied his own clever methods to the single station analysis of transient events.

International collaboration grants have been awarded to Gabriella Sartori (Hungary) and Colin Price (Israel) for further investigations of Schumann resonances with Earle Williams.

Stimulated by observations by Martin Fullekrug of 20-25 day correlated variations in SR amplitude in 1989-1990, Ebby Anyamba and Joel Susskind (NASA GSFC) and Earle Williams have examined the variation of a global convective index based on TOVS satellite observations for the same period. These two signals are highly correlated for many months, with intensifications in SR associated with enhanced global convective index, suggesting that the origin of the global circuit variations lies within the troposphere.

University of Mississippi (Oxford, MI)

Maribeth Stolzenburg recently completed her Ph.D. in Meteorology at the University of Oklahoma. She has taken a position as a post-doctoral research associate at the University of Mississippi, where she will be working with Tom Marshall on analysis of microphysical data from CaPE thunderstorms.

Tom and Maribeth are also working with Dave Rust of NSSL to study the relatively large fair weather electric fields that sometimes occur just after sunrise at Kennedy Space Center.

NASA / Marshall Space Flight Center (Huntsville, AL)

The Optical Transient Detector (OTD) has now completed one and a half years of observations of global lightning from space after being launched on 3 April 1995 into a 750 km inclination orbit. The sensor detects lightning events during both day and night with a time resolution of 2 ms to within 8 km over a 1300 x 1300 km region. OTD is the engineering flight model of the NASA Lightning Imaging Sensor (LIS) which is included on the Tropical Rainfall Measurement Mission (TRMM) planned for launch in 1997.

The Lightning Imaging Sensor (LIS) science team and MSFC DAAC are pleased to announce the availability of global lightning data sets from the OTD experiment. The current data release contains 15 months (April 1995--June 1996) of reprocessed data. You can learn more about this data set at: http://wwwdaac.msfc.nasa.gov:/userservices/whatsnew.html. The LIS science team (H. Christian, K. Driscoll, D. Boccippio, D. Mach, J. Hall, W. Boeck, D. Buechler, W. Koshak, S. Goodman, R. Blakeslee) continues to make good progress in the processing, analysis and validation of the OTD data. Recent results indicate a global flash rate maximum in the northern hemisphere summer of about 55 flashes/second and a minimum in the northern hemisphere winter of about 30 flashes/second. Although a strong annual signal is obviously present, there is little evidence in the OTD data for a semi-annual signal. In the latitude belt from 30°S to 30°N the summed flash rate is fairly constant throughout the year (the contribution from each hemisphere does vary in a sinusoidal manner as expected).

An OTD home page is located on the World Wide Web at URL http://wwwghcc.msfc.nasa.gov/otd.html. This home page will be updated regularly to keep the science community abreast of our progress. Other information about the MSFC electricity program can be found at this site.

We continue to have an interest in lightning data sets that could contribute to a global lightning climatology and/or to our ground truth activities for OTD (e.g. regional lightning detection networks, etc). Any individual or group interested in such a collaboration is encouraged to contact S. Goodman (e-mail: steven.goodman @msfc.nasa.gov) or H. Christian (hugh.christian@msfc.nasa.gov).

A study was initiated this past summer (S. Goodman, R. Raghaven, E. Williams) to determine how future geostationary orbit lightning measurements might assist a forecaster in the determination and identification of severe thunderstorms in real-time. The Melbourne, Florida weather office was selected as a preliminary site to conduct this study because it serves as an experimental forecast office for the National Weather Service (NWS) and as an Applied Meteorology Office for NASA. The demonstration system is based on the Integrated Terminal Weather System (ITWS) and currently displays a suite of products in real-time that includes data from the Melbourne WSR-88D radar, Lightning Detection and Ranging (LDAR) network at NASA/Kennedy Space Center, and the National Lightning Detection Network (NLDN).

Incremental forecast skill accrued through utilization of the lightning data will be assessed quantitatively for the first time through scoring of products generated with and without total lightning data and through interviews with Melbourne Weather Forecast Office personnel. This will demonstrate the incremental value of using total lightning observations to identify and track severe storms. The results from this experiment will be used to derive a quantitative estimate of the benefits that would be possible on a national basis from the use of data from an operational geostationary lightning sensor. Lastly, the integrated database acquired through this experiment will be used to validate and calibrate total lightning measurements acquired from OTD and LIS.

National Center for Atmospheric Research (Boulder, CO)

The STERAO Deep Convection Experiment was conducted in NE Colorado this past summer to examine the effect of thunderstorms and deep convection on the chemical composition of the troposphere and lower stratosphere. Major goals were to examine the production of NOx by lightning and its transport by deep convection. The experiment was unique in combining detailed chemical, air motion and electrical measurements. Jim Dye of NCAR/MMM was one of the main coordinators of the experiment along with Steve Rutledge of Colorado State University and Adrian Tuck of the NOAA Aeronomy Laboratory. The NOAA P3 made comprehensive chemical measurements from near the surface to 8 km along with tail Doppler radar coverage to deduce air motion within the storms. The Univ. of North Dakota Citation aircraft under the direction of Jeff Stith made microphysical and some chemical measurements in and near the anvil of the storms. The CSU-CHILL radar made multi-parameter and Doppler measurements to characterize the microphysical structure and help with airflow studies.

There was a substantial electrical component to the experiment with the French ONERA 3D lightning interferometer under Pierre Laroche's direction, two fixed and one mobile field change meters (a joint project between Steve Rutledge at CSU and Jim Dye at NCAR with the instruments from Bill Rison of New Mexico Tech), and results from the National Lightning Detection Network in collaboration with NASA Marshall (Hugh Christian and Rich Blakeslee) for the satellite-borne Optical Transient Detector. Analysis is now under way and promises to yield some interesting comparisons of lightning as seen from the various techniques. For more information contact Jim Dye via email (dye@ucar.edu) or by phone (303-497-8944).

National Lightning Safety Institute (NLSI) (Louisville, CO)

Rich Kithil reports on the following items:

1. The National Oceanic and Atmospheric Administration (NOAA) Next Generation Radar site at Lajes, Terceira, Azores, Portugal was investigated by NLSI. A three day site analysis and review of "best available technology" for lightning mitigation focused on grounding issues. This NEXRAD-Azores operation provides critical weather information to the nearby US Air Force aviation facility.
2. NLSI was retained by Voyager Outward Bound, Ely, NM to investigate a lightning fatality which occurred this past summer. NLSI used StrikeFax and Faultfinder data provided by Global Atmospherics Inc. in its consulting work.
3. The National Renewable Energy Laboratory (NREL), a part of US DOE, in Golden CO, has asked NLSI to prepare a Scope of Work proposal for Lightning Safety Guidelines for USA wind turbine designs and siting. In Europe, where the industry is mature, lightning is a major problem. The German industry, for example, reports that 80% of insurance claims filed by wind farms are lightning related. Are there "lessons learned" elsewhere that can be transferred to the USA wind industry?
4. NLSI has received a request from a small impoverished educational college in Masvingo, Zimbabwe (Africa) for articles, books, and other publications relating to lightning and lightning safety. We ask all readers to send any such lightning data surplus to their needs to us for onward shipment to our friends in Zimbabwe. This is a worthy project. Let us know if you wish to receive a receipt for tax purposes.
5. NLSI has been invited to present a paper "Lightning Safety: A risk Management Approach" at the Dec. 3-5 Natural Disaster Reduction Conference in Washington DC. This meeting is sponsored by the American Society of Civil Engineers.
6. NLSI conducted a two day Certified Lightning Safety Professional training program in Washington DC on Nov. 19-20. Attendees included USEPA, NOAA, Sasktel, Norfolk Southern Corp., US Navy, and Cinergy. The intent of this periodic course is to develop in-house lightning safety expertise for organizations. This was NLSI's second such training program offered since July.
7. NLSI's WWW page (http://www.lightningsafety.com) soon will feature a "subscribe" service, as well as an unattended Lightning Bulletin Board, where readers may conduct monologs/dialogs on lightning subjects of their interest. In addition short technical papers by Board of Advisor members, with a direct e-mail link to them are planned. New members have been added to NLSI's Board of Advisors. They include:

   a. Dick Setchell, Wisconsin Electric Power, Milwaukee, WI.
   b. Rajeev Thottappilli, High Voltage Lab., Uppsala University, Sweden.
   c. Stan Grzybowski, High Voltage Lab., U. Miss., MS.

Members of the lightning study community interested in affiliation with NLSI should contact us by email at rkithil@ix.netcom.com.

National Severe Storms Laboratory (Norman, OK)

Mary Ann Cooper of the Dept. of Emergency Medicine at the University of Illinois- Chicago organized a session on lightning at the 16th Annual Meeting of the Society for Physical Regulation in Biology and Medicine in Chicago on 12 October. Other speakers were Margaret Primeau of the Dept. of Psychology at The Chicago Medical School, Ron Holle and Raul Lopez of the National Severe Storms Laboratory in Norman, OK, Michael Cherington of the Lightning Data Center of Provenant St. Anthony Hospital in Denver, and Henk-Jan ten Duis of the Dept. of Surgery of the University Hospital in Groningen, Sweden.

Dave Rust and Les Showell (NSSL), Tom Marshall (Univ. of Mississippi), and Jim Fitzgibbon (National Weather Service, Sensor Test Section) spent about two weeks at Langmuir Laboratory for Atmospheric Research in New Mexico to make balloon-borne electric field measurements in thunderstorms and to compare the performance of a Global Positioning System radiosonde with a LORAN sonde. Both in-storm flights and high voltage lab tests were conducted. Analysis of the data is beginning.

Dave Rust (NSSL) and Tom Marshall (Univ. of Mississippi) obtained vertical profiles of the electric field at Kennedy Space Center in August and September using a NSSL mobile laboratory and a deployable tethered balloon system. The data were gathered to document a phenomenon locally called the "sunrise surprise" during which shortly after sunrise the field at the ground can exceed 1 kV/m. Such a field can cause a launch hold under existing space shuttle and unmanned vehicle launch rules. We were joined in the field by Paul Krehbiel (New Mexico Tech) and in the analysis to date by Maribeth Stolzenburg (Univ. of Mississippi) and Charles Moore (New Mexico Tech emeritus). Preliminary findings, which are in agreement with limited information in the literature, suggest this is an electrode effect that occurs often (although 1 kV/m is not often exceeded). Furthermore, the magnitude of the electric field decreases above the ground.

NIOSH CDC MSHR
(National Institute of Occupational Safety and Health, Center for Disease Control, Mining Safety and Health Research [formerly US Bureau of Mines], Pittsburgh, PA)

Lightning location data is being analyzed to identify the first c-g strikes from thunderclouds. Individual lightning strikes to the mainland United States with no other lightning strikes within 8, 25, 50, 200, and 500 miles in the previous 30 minutes are being identified. Increased understanding of the nature of first strikes will allow more accurate risk analyses to those using lightning detection as a lightning warning technique. So far, analysis of about 2.5 million strikes over 19 days in July and August of 1995 have revealed the following. Between 4.9% to 1.6% of strikes in a day met the 8 mile criteria, 1.4% to .3% met the 25 mile criteria, .7% to .12% met the 50 mile criteria, .28% to .04% met the 100 mile criteria, .1% to .01% met the 200 mile criteria, and .02% to .001% met the 500 mile criteria. For example, on 8/1/95, 395 lightning strikes were detected with no other strikes within 50 miles in the previous 30 minutes.

There is currently a great deal of interest in the behavior of current deep in the earth near a c-g lightning strike. In the last six years, circumstantial evidence points to lightning as the energy source in six explosions of methane gas in underground coal mines. Although a long history of unplanned detonations of explosives in underground and surface mines exists, these are the first incidents where lightning has been held responsible for a mine explosion in the U.S. We are unaware of work in this area except for that of Hendri Geldenhuis in South Africa, researchers at Sandia, and Berger's text in "Lightning". Anyone with input to this problem or the lightning data analysis mentioned above can contact Lon Santis at (412) 892-6117 or lns4@niosh5.em.cdc.gov.

University of Oklahoma (Norman, OK)

Ken Eack, Ph.D. Student in Physics, and Bill Beasley, Professor, School of Meteorology, have received funding from AFOSR to participate in the Summer Sprites Campaign, 1997. They will be launching balloon-borne electric-field-change antennas in Sprite-producing storms in the western Great Plains to obtain observations of field changes at altitudes of 15 km and greater for comparison with the Sprite observations. Another Physics Ph.D. student, Heidi Morris, will be beginning her dissertation research as part of the observational program.

Phillips Laboratory (Hanscom AFB, MA)

Stan Heckman, Bob Boldi, and Earle Williams released a dataset containing 2 years of absolutely calibrated electric and magnetic power spectral densities from 5 to 55 Hertz. The data are freely available at http://cirrus.plh.af.mil:7789/schumann.

Politechnic University (Tomsk, Russia)

Abstract of a paper by E.T. Protasevich: "Cooling Effect of Gaseous Discharge Plasma and Long-Lived Glowing Phenomena in the Atmosphere"

Abstract. There is the possibility to regulate the temperatures of charged and neutral particles in a gaseous discharge plasma by changes in air humidity (absolute and relative) subjected to ionization.

1. Introduction: In the period from 1982 till 1985 it was shown for the first time that cold nonequilibrium plasma can be produced in a high-frequency gas discharge if humid air (with a certain concentration of water vapor molecules) is used as a working medium. Further investigations carried out in the period 1986-1996 revealed regularities in the plasma cooling and variations of its properties during this process which explained the observed decrease of the plasma recombination rate.

2. Results and Discussion: Physico-chemical processes which occur when humid air is ionized by HF radiation are considered. Results of experimental investigations and numerical simulations are discussed. A range of parameters is shown to exist for which it is possible to obtain a plasma with very low electron temperature. This phenomenon is connected with the decomposition of water. Areas of practical application of overcooled plasma are discussed. The reasons for the appearance of glowing plasma formations in the real atmosphere are discussed. The results of laboratory modeling of these formations, in which the relative humidity of the air was varied, are reported. There exists a certain optimum concentration of water vapor, which leads to the formation of a cool, nonequilibrium plasma whose decay time is several seconds. Such atmospheric-electricity phenomena as St. Elmo's fire, ball lightning and bead lightning are discussed as examples. The properties of the cool, nonequilibrium plasma are analyzed as a function of the concentration of water vapor molecules.

Russia State Hydro-Meteorology Institute
National Commission on Atmospheric Electricity,
subsection "Electromagnetic Field of the Atmosphere" (St. Petersburg, Russia)

The seminar "Radiometeorology and atmospheric electricity" was held during the 14th All-Russia symposium "Radar investigation of natural media". The reports included the following:

L.G. Kachurin, V.V. Lobatchev, A.V. Trillis. (Russia State Hydro-Meteorological Institute, RSHMI). Special features of an interaction of electromagnetic emission with the substance in their passage through metastable media.

L.I. Divinskiy. (RSHMI). Algorithms for the detection of regions which bring a potential lightning threat to aircraft.

E.I. Dubovoy. (The Academician A.L.Mints Radiotechnical Institute, Russia Ac.Sci.). Theoretical and radar investigations of 1990-1995 for the determination of the lightning discharge physical characteristics electrical currents and released energy.

M.S. Aleksandrov. (Institute of Radio Electronics, Russia Ac.Sc., IRE). Influence of an uncertainty in the earth- ionosphere waveguide features upon the accuracy of the localization of atmospherics sources.

B.A. Khaji. (IRE). The arrangement for a multichannel recording of atmospherics electromagnetic field at VLF.

V.A. Epanetchnikov. (IRE). On one method for cluster analysis of the thunderstorm activity.

L.V. Oguryaeva, A.V.Snegurov, V.S.Snegurov. (A.I.Voeikov MGO RC ARS). Results of monitoring of thunderstorm activity in the Leningradskaya oblast.

The 15th symposium will be held in the Spring of 1997 in St. Petersburg. A seminar "Radiometeorology and atmospheric electricity" will be held during the symposium. A scientific and technical seminar "Detection of electrically active clouds which bring a potential lightning threat to aircraft" will be held at the Russia State Hydro-Meteorological Institute in December, 1997. Address: Prof. Leonid I. Divinskiy, Russia State Hydro-Meteorological Institute, Malookhtinskiy 98. St.Petersburg, 195196. RUSSIA. Tel. (812)2214163.

Stanford University: StarLab (Stanford, California)

The VLF Group at Stanford Starlab continues experimental and theoretical work on troposphere-mesosphere-ionosphere coupling, most clearly evidenced by sprites, jets, elves and gamma rays of terrestrial origin.

In the experimental area, our group launched three efforts during the Sprites '96 summer campaign, principally hosted by Walter Lyons (ASTeR, Inc.) at Yucca Ridge, Colorado. First, a new Stanford-designed and built ELF/VLF broadband (20 Hz to 22 kHz) sferic receiver was deployed by Bill Trabucco at Yucca Ridge to measure characteristics of lightning discharges at close range (~200-800 km). The expanded frequency range and location of this receiver extends the study of sferics received at Palmer Station, Antarctica, (~12,000 km range) by Steve Reising, Umran Inan, Tim Bell and Walter Lyons (GRL, in press, 1996). The study found that radio atmospherics launched by sprite-producing positive cloud-to-ground (+CG) lightning have large ELF slow tails following the initial VLF portion, indicating the presence of continuing currents on the time scale of a few ms. The arrival azimuth of the radio atmospherics was determined to +/- 1° at 12,000 km range.

The Holographic Array for Ionospheric Lightning research (HAIL) was deployed by Mike Johnson and Steve Reising, with the installation of four narrowband VLF receivers spanning the N-S extent of Colorado. Each receiver records the amplitude and phase of at least three VLF transmitters. Amplitude and phase changes in the measured VLF signals simultaneous (<20 ms) with lightning discharges near the transmitter-receiver path are used to determine the shape and size of heating/density enhancements in the D-region ionosphere due to lightning. The HAIL data are transmitted to Stanford daily over the Internet and are available for intercomparison studies at http://hail.stanford.edu.

The third Sprites '96 experiment is the Fly's Eye, a high-speed photometer array designed, built and deployed by Umran Inan, Christopher Barrington-Leigh, Sean Hansen, and Rick Rairden (of Lockheed-Martin). This instrument was designed to investigate theoretical predictions (Inan et al., GRL, Jan. 15, 1996) describing the sub-millisecond dynamics of diffuse optical emissions due to heating and ionization caused by the interaction of electromagnetic pulses due to lightning with the lower ionosphere. These emissions, dubbed "elves", are short (300 microsecond) and diffuse optical flashes observed at ~90 km altitude within ~300 microseconds of the onset of cloud-to-ground discharges (Fukunishi et al., GRL, Aug. 1, 1996). Preliminary results from the Fly's Eye photometer array show excellent confirmation of the predictions, including apparent horizontal expansion faster than the speed of light.

In the theoretical area, Vyacheslav Glukhov (Center for Space Science and Astrophysics, Stanford University) and Umran Inan studied (Aug. 1, 1996, GRL) the interaction with the lower ionosphere of rapidly varying electromagnetic pulses produced by lightning. The nonlinear heating, ionization and optical emission production are modeled using the Monte Carlo technique which allows for consideration of realistic electromagnetic pulses with rise times of a few microseconds. The peak optical emissions intensities are found to be highly dependent upon the pulse waveform, while the altitude range at which the emissions occur is relatively independent of pulse shape.

Nikolai Lehtinen, Martin Walt, Umran Inan, Tim Bell, and Victor Pasko assessed the possibility (Sept. 15, 1996, GRL) that high energy photons of atmospheric origin, measured by Fishman et al. (Science, 264, 1313, 1994) may be bremsstrahlung produced by relativistic (>1 MeV) runaway electron beams accelerated in an avalanche process by quasi-electrostatic thundercloud fields. The predicted fluxes at the satellite altitude and at horizontal distances of up to 500 km from the source are found to be comparable to the experimental data.

Stanford University (Stanford, California)

Martin Fullekrug is happy to anounce the grand opening of the first public Schumann resonance observatory.

Frank Morrison of the departement of Materials Science and Mineral Engineering at UC Berkeley runs observatory-type electromagnetic measurements in the frequency range from 1E-4 to 10 Hz in close collaboration with the seismographic station Berkeley. In April 1996, a Schumann Resonance Symposium was held at UC Berkeley to discuss the data processing for public purposes. The suggestion was made to meet standard criteria of time series analysis and to characterize the considered frequency range by use of Magnetic Activity indices on a half- hourly basis. The parameters of the first Schumann resonance (amplitude, damping and frequency) are calculated by use of the complex exponential algorithm with a time resolution of 15 minutes. Both sets of numbers are derived from two observatories in California on a daily basis since November 10, 1996.

The data are ready to use at: http://quake.geo.berkeley.edu/ncedc/em.intro.html

Tel Aviv University Dept. of Geophysics and Planetary Sciences (Tel Aviv, Israel)

On-going research in the Cloud Physics Group dealing with the relationship between meteorological conditions and the properties of lightning storms in Israel is being conducted by Orit Altaratz, a M.Sc. student, under the supervision of Zev Levin. The research utilizes LPATS strike data, combined with weather radar images and radiosonde data. Results show that peak intra-cloud flash rates are well correlated with the rise in the altitude of the 40 dBz radar echo, and the height of cloud top (determined from radar). The predominant ground flash type is negative. The research will focus on well-defined, small cells with high radar reflectivities, which are embedded in a larger matrix of precipitating clouds. We plan to use satellite images to accurately determine cloud top height and temperatures, and to investigate the relation between the intensity of the wind shear and the occurrence of positive ground flashes (results from an earlier study were published in GRL, August 1996).

Yoav Yair and Zev Levin continue to participate in the survey of global lightning characteristics conducted by Dave Mackerras (University of Queensland, AU). We plan to install a new CGR-3 detector near Mt. Carmel, in the northern part of Israel. This will enhance our coverage of the eastern shore of the Mediterranean sea, which is known to be a major contributor to the lightning activity in the region. We plan to upgrade the CGR-3 to allow for time resolution. The data can then be used for correlation with LPATS data in these areas.

A study of lightning generation in the atmospheres of the outer planets is being continued by Yoav Yair and Zev Levin. New calculations, based on the atmospheric data transmitted by the Galileo entry probe, showed that the entry site near Jupiter's equator had a very small probability to produce lightning. The clouds that are produced in the stable, dry conditions prevailing in that region, were not capable of separating enough electrical charge to generate lightning. Our calculations show that at higher latitudes, where the atmosphere may be less stable, and contains a larger fraction of water vapor, large convective clouds can develop, leading to lightning discharges. (A paper containing these calculations was submitted to JGR).

Colin Price has initiated a few projects to measure ELF/VLF signals from global lightning. A joint project with Earle Williams of MIT has started to monitor Schumann Resonances in the Negev Desert of Israel. The magnetometers were recently set up and checked at the desert site (Tel Aviv University's Astronomy Observatory in Mitzpe Ramon). The site is very remote and with very little electromagnetic noise in the ELF/VLF range. The initial tests were very successful, with very clear ELF (1-50Hz) signals observed.

Colin Price has also started a collaborative project with Umran Inan of Stanford University to set up a VLF recording station at the Negev desert site. With the two VLF stations that already exists at Palmer Station, Antarctica, and Stanford University, California, the three station network should be able to provide continuous global lightning distributions and frequencies. This would be useful for ground-truthing satellite data (OTD, LIS/TRMM) as well as supplying data during periods when the satellite is not observing. Comparisons between the ELF and VLF measurements will obviously be made in the future.

Colin Price continues to study the connection between global temperatures, global lightning activity and ELF signatures measured at different locations around the globe. Results from some of this research will be presented at the AGU meeting in December '96 in San Francisco. In addition, a two-part paper dealing with lightning production if nitrogen oxides (NOx) will soon appear in JGR-Atmospheres.

Texas A&M University (College Station, TX)

Papers published or in press in the last six months:

1. Orville, R. E. and A. C. Silver: 1997, "Lightning Ground Flash Density in the Contiguous United States: 1992-1995," Monthly Weather Review, in Press (February 1997).

2. Livingston, E. R., J. W. Nielsen-Gammon, and R. E. Orville, 1996, "A Climatology, Synoptic Assessment, and Thermodynamic Evaluation for Cloud-to-Ground Lightning in Georgia: A Study for the 1996 Summer Olympics," Bull. Amer. Meteor. Soc., 77, 7,1483-1495.

3. Toracinta R., K. Mohr, E. J. Zipser, and R. E. Orville, 1996: "A Comparison of WSR-88D Reflectivities, SSM/I Brightness Temperatures, and Lightning for Mesoscale Convective Systems in Texas, Part I: Radar Reflectivity and Lightning," Jour. of Applied Meteorology, 35, 6, 902-918.

4. Mohr, K. I., E. R. Toracinta, E. J. Zipser, and R. E. Orville, 1996: "A Comparison of WSR-88D Reflectivities, SSM/I Brightness Temperatures, and Lightning for Mesoscale Convective Systems in Texas, Part II: SSM/I Brightness Temperatures and Lightning," Jour. of Applied Meteorology, 35, 6, 919-931.

5. Lucas, C. and R. E. Orville, 1996: "TOGA COARE: Oceanic Lightning," Monthly Weather Review, 124, 9, 2077-2082.

6. Petersen, W. A., S. A. Rutledge and R. E. Orville, 1996: "Cloud-to-Ground Lightning Observations from TOGA COARE: Selected Results and Lightning Location Algorithms," Monthly Weather Review, 124, 4, 602-620.

Reprints have been mailed. If you would like your name added our reprint mailing list please send a message to orville@ariel.tamu.edu or write to Dick Orville, Dept of Meteorology, Texas A&M University, College Station, TX, 77843-3150.

Glossary: Approximately 220 words (160 old; 60 new) in the atmospheric electricity field are being redefined, dropped, or added to the next edition of the Glossary of Meteorology. Many colleagues and some graduate students have contributed to this effort. The new list of words and their definitions will be on the Internet as soon as I can find the time.

University of Toulouse (Toulouse, France)

The study of the slow charge transfer between cloud and ground proceeds through field and modeling work at the Laboratoire d'Aérologie. A field experiment was carried out in Lannemezan (Pyrénées foothill) during the summer of 1996, by Serge Chauzy, Serge Soula and Gilles Molinié (a PhD student), from the Group of Atmospheric Electricity, in cooperation with the Radar Group headed by Henri Sauvageot. The main issue of this work is characterizing the precipitation current density related to the structure of the thundercell (observed by a 10 cm meteorological radar), to the spectral distribution of the rain (measured by a disdrometer), and to the electrostatic field signature (detected at ground level and at various heights above ground, up to 100 m). Several severe storms were documented, including events producing high precipitation rates (up to 112 mm/h at the ground) and flash floods. A good correlation appears between flash rate, precipitation rate, and vertical extension of the cells. On the other hand, the PICASSO model is being used to evaluate the part played on the precipitation current by the rain space charge scavenging. On the other hand, the relations between the local electric field conditions and the cloud structure over a mountain peak are routinely observed at the Pic du Midi (2860 m), in the Pyrénées mountains, by Serge Soula and Gilles Molinié.

Various investigations are also undertaken on the interactions between cloud microphysics and discharge initiation. Jean-Fran ois Georgis completed his PhD thesis on the interactions between two raindrops and their consequences on the discharge initiation. A laboratory experiment is being conducted in order to determine the conditions for initiating discharges form precipitating drops falling at their terminal velocity in a horizontal electric field. The fine structure of the initial corona discharge is also being observed. An original modeling has been started on the asymmetrical distortion undergone by a drop under the previous conditions, in order to establish theoretically the field onsets leading to disruption/discharge process. Sylvain Coquillat and Bruno Combal (a pre-PhD student) started the study.

The Group of Atmospheric Electricity is also involved in the preparation of the Mesoscale Alpine Programme (MAP), an international project on the overall interaction mechanisms between convection, precipitation, atmospheric circulation, and orography. The field experiment is planned to be carried out in 1998 or 1999. Along with the ground study of the precipitation current the Group plans to perform electric field soundings through thundercells of different types in order to observe the interactions between electrical activity and microphysical population of the cloud.

UMIST (Manchester, England)

This has been a busy year. Clive Saunders visited Giorgio Caranti in Cordoba and worked with Eldo Avila in their cloud chamber in order to compare the UMIST charge transfer results with Cordoba. UMIST investigates multiple collisions of ice crystals with a riming graupel pellet while Cordoba bounce a 100 micron diameter ice sphere off a riming graupel pellet. In general Cordoba finds more positive graupel than UMIST. When two particles interact, UMIST finds that the particle growing faster by vapor diffusion charges positively, so the idea was to see whether the growth rate of the Cordoba ice sphere could be enhanced to give more negative charge transfer as occurs with the faster growing ice crystals in UMIST. There was limited evidence of more negative charging particularly when the rime was just starting to accrete but three weeks is not enough to gather a data set. Clive will be re-visiting Cordoba in 1997 to continue the work.

We presented results in Japan showing that not only is the LWC, temperature, ice crystal size and graupel/crystal relative velocity important in controlling the sign and magnitude of the charge transfer when ice crystals rebound from riming graupel pellets, but that the rate of rime accretion must be taken into account. Su Ling Peck has also found that the droplet size distribution is important because small droplets can freeze fast on the rimer releasing only little vapor so that, relatively, the ice crystals grow faster which favors negative rimers. Also, division of the LWC into many smaller water droplets increases the ice crystals' growth rate leading to more negative graupel. The conclusion is that experiments that measure ice crystal/graupel charge transfers must have cloud conditions that are absolutely representative of thunderstorm cloud conditions. To this end much more data are needed on thunderstorm droplet size distributions in regions of electrical interest. Su Ling also pushed the experiments to the highest temperature yet in the cloud chamber and confirmed that graupel can charge negatively even at -2.5C; as usual the sign is also controlled by the LWC.

In July, Giorgio Caranti, Eldo Avila and Negui Castellano from Cordoba visited UMIST. Investigations with large droplets (50 microns diameter) confirmed that positive graupel is favored, but in the presence of small droplets there was tentative evidence that large droplets could be associated with negative graupel possibly because the small droplets favor crystal growth. This promising line of research for real thunderstorm conditions needs to be continued.

Uppsala University (Uppsala, Sweden)

Project: "Studies of global and local currents in the atmosphere".

In cooperation with Tapio Tuomi, Finnish Meteorological Institute, FIN-00100 Helsinki, Finland; S.V. Anisimov, Institute of Earth Physics, Geophysical Observatory, Geoelectromagn. Monit. Lab.,Yroslavskaya obl. Nekouzsky reg, BOROK 152742, Russia; E. Mareev, Inst. of Applied Physics and High Power Electronics, Ulynov Str. 46 Nizhninovgorod, Russia; Hannes Tammet, Department of Environmental Physics, Tartu University,Tartu, Estonia; Stanislaw Michnowski, Polish Academy of Science, Warsaw, Poland.

Project: Space charge formation in the electrode layer in a stable atmosphere. Co-workers: K.P.J.S. Jayaratne and J. Lelwala, Colombo University, Colombo, SriLanka.

A workshop was held in Uppsala during November 4 - 8, 1996, in "studies of global and local currents in the atmosphere". In a one day seminar at the High Voltage Institut in Uppsala, 21 scientists in this field participated. The titles of the seminars were:

S.V.Anisimov: Local and global aeroelectrical structures in global electric circuit.

T. Tuomi: A summary of the Finnish lightning summer of this year and plans for a future replacement by possible new LLP system.

E.A.Mareev: Turbulence and space charge formation in the atmosphere.

S. Michnowski: Measurements with long wire antenna in the Sptitzbergwen area.

H. Tammet: Problems of interpretation of long wire antenna measurements.

R. Lelwala: Measurement of space charge density over flat ground in a nearly neutral stratified atmospheric surface layer.

A.I. Voeikov MGO Research Center for Atmospheric Remote Sensing (St. Petersburg, Russia)

The collection "Experimental Meteorology" edited by Prof. G.G.Shchukin was published in 1996 (Trudy GGO, 1995, n 545). This collection includes two articles on atmospheric electricity: a) L.G. Makhotkin. On the relation between air electrical conductivity and aerosol, b) G.P.Vayushina, G.V.Kupovych a.o. Results of atmospheric electric measurements at the mountain station "Peak Cheget" in the Elbrus country.

The first proceedings of RC ARS "Applied Meteorology" are in preparation. The collection includes the following papers on atmospheric electricity. Statistics of atmospheric and industrial radio noises, L.G.Makhotkin. Centenary of Popov's thunderstorm indicator, L.G.Makhotkin. General characteristic of the annual course of local thunderstorm activity, V.S.Snegurov. Conception of a thunderstorm direction finding network, L.G.Sokolenko. On the possible use of electrical conductivity data in the short-term forecast of fog.

L.V.Oguryaeva and Ya.M.Shvarts prepared a catalog of ground atmospheric electricity data which is available at the WDC/AE. The catalog contains 39 ASCII-files: "descrip.txt", "list.txt" and information files. Each information file pertains to one station. The total volume of the catalog is approximately 100 kilobytes.

The Turgosh field experiment has been continued during July-August of 1996 aimed at multiwave active-passive sounding of thunderstorms. As it was introduced at the ICAE'96 Conference in Osaka, the microphysical interpretation of the processes taking place in the upper part of a thundercloud is of interest to find an appropriate explanation for unusually high flash rates (up to 40-60 per minute) and continuous reflection detected by the 2 m wavelength radar.

A new Interactive Radar Informational System underwent a successful field test allowing a concurrent signal processing of four radars with different wavelengths. With kind assistance from Dr. R. Orville and Global Atmospherics, Inc. one IMPACT thunderstorm sensor has been transported to Turgosh and operated for a 20 day period in August. The processing of an experimental data set is underway.

For further details, please contact V.Stasenko and G.Shchukin at: fax: 812-247-8661 and e-mail: valery@rcars.spb.su.

University of Washington (Seattle, WA)

Together with Prof. George Parks we will be launching a rocket from Poker Flat, Alaska in February, 1997 to study pulsating Aurora. Robert Holzworth's instrument will include a full 3-D electric field instrument from DC to VLF. The instrument design has been modified, with the help of graduate student Andrew Johnson and engineer John Chin to have a lower noise threshold than previous auroral electric field double-probe instruments.

Analysis of the Thunderstorm-III rocket (launched in September 1995 from Wallops Island, Virginia over an active thunderstorm, with apogee near 400 km altitude) is actively underway in conjunction with Prof. M. C. Kelley and student Steve Baker (at Cornell University) and with Robert Holzworth and student Benjamin Barnum at the University of Washington. A recent paper was submitted to GRL describing an upgoing "nose" whistler with the nose frequency near 100 kHz - an order of magnitude higher than the usual nose frequency seen by ground observers.

Yaroslavl State University (Yaroslavl, Russia)

Every even year since 1986 a conference entitled "Ball Lightning and Long-Lived Plasmic Formations" is held at Yaroslavl State University. A regular (sixth) conference organized jointly by Yaroslavl State University, Yaroslavl Institute for Qualification Improvement and the Institute for Basic Research (Molise, Italy) was held in Yaroslavl in June 1996. This conference, chaired by Professor A.I. Grigor'ev (Yaroslavl State University), brought together the leading Russian specialists in the field. At the "Experimental Modelling of Ball Lightning" workshop the most interesting reports were presented by L.V. Furov from Vladimir Technical University and by S.E. Emelin from St. Petersburg State University. L.V. Furov reported results on experimental modelling of stable long-lived toroidal formations. S.E. Emelin presented results on obtaining ball lightning type objects through capillary discharge. At the "Ball Lightning Theoretical Modelling" workshop several presentations on new theoretical ball lightning models and methods for statistical processing of data on ball lightning observations in natural conditions were made.

University of Zimbabwe

In the Department of Electrical Engineering M. Elmissiry, B. Gotchev and T. Zvomnya are using CSIR down strobe counters to study the lightning flash distribution over Zimbabwe. They intend to relate their findings to altitude and properties of the soil.