NEWSLETTER ON ATMOSPHERIC ELECTRICITY

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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 **October 31, 1998.** 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.

11th International Conference on Atmospheric Electricity 7 - 11 June 1999

Lake Guntersville State Park, Guntersville, Alabama, 36976 USA

First call for papers. The International Commission on Atmospheric Electricity is pleased to announce the 11th International Conference on Atmospheric Electricity (ICAE 99) to be held from June 7 through 11 at the Lake Guntersville State Park. The Chairman of the ICAE 99 is Dr. Hugh J. Christian of the NASA Marshall Space Flight Center.

Additional information can be found at the end of this Newsletter.

MCS Electrification and Polarimetric Radar Study

The National Severe Storms Laboratory (Norman, Oklahoma) is hosting the MCS Electrification and Polarimetric Radar Study (MEaPRS) from May 15 to June 15, 1998. In the electrification portion of this project, NSSL scientists will be joined by collaborators from several universities and other research organizations. Details and participants may be found at http://www.nssl.noaa.gov/projects/meaprs/.

In Memory of Andrzej Losakiewicz

With great regret we inform you that on February 16, 1998 our coworker Andrzej Cezary Losakiewicz died unexpectedly. He received his M.Sc. degree from the Department of Physics, at the University of Warsaw, and joined our atmospheric electricity group at the Institute of Geophysics, Polish Academy of Sciences. Andrzej Losakiewicz was the author of several scientific papers in our field, published in *Acta Geophysica Polonica*, *Journal of Geophys*., and *Res. and Przeglad Geofizyczny*. They mainly involved studies of vertical air-earth current

density recorded by means of a long antenna at the polar station, Hornsund, and in Jozefoslaw, near Warsaw. He was also a contributor to the monograph: "Evolution of the Earth and Other Planetary Bodies" edited by Prof. R. Teisseyre and published by the Polish Scientific Publishers and Elsevier Company in 1992.

He was a very gifted theoretician, with deep knowledge and precision of thought and mathematical skill. He was a very good colleague and friend. We feel his loss deeply.
S. Michnowski and P. Baranski.

RESEARCH ACTIVITY BY ORGANIZATION

*AUBURN UNIVERSITY (Auburn, AL)

Auburn University is currently involved in a joint endeavor with the USMA and Eglin AFB to investigate the phenomenology of red sprites and blue jets. Much of the research has been presented at PIERS or will be forthcoming during 1998. The primary thrust of their investigations have been related to modeling the non-linear behavior of the atmosphere during the sprite event. The current participants involved include:
Dr. Michael E. Baginski, Associate Prof. of Electrical Engineering, 423 Broun Hall, Auburn Univ., Auburn, AL 36849. www.eng.auburn.edu: 80/users/mikeb/e-mail mikeb@eng.auburn.edu Personal e-mail drbauburn@mindspring.com Phone: (334) 844-1874 FAX: (334) 844-1809
Lieutenant Colonel Edward Shaffer of West Point Military Institute, Assistant Prof. of Electrical & Computer Engineering (Ph.D. Ele. Eng.) (914) 938-5584
Dr. Keith Thomas, Eglin AFB (904) 882-2005

*DEPARTMENT OF EARTH SCIENCES, METEOROLOGY (Uppsala,Sweden)

In a European Union cooperative project we plan together with Tapio Tuomi (Finland), and Sergey Anisimov and Eugene Mareev (Russia), to continue our study called "Atmospheric electrical current variations at middle and high latitudes." Any support from other countries would be welcome. The project involves the experimental, theoretical and numerical investigation of the role of the Global electrical circuit in the Earth's electric environment. Hannes Tammet (Tartu, Estonia) and Stanislaw Michnowski (Warszawa, Poland) participate as members in a Baltic area project. We have also started cooperation with the Swedish Institute of Space Physics, MRI Atmospheric Research Programme in Kiruna, Sweden. Together with them we hope to expand the measurements to northern latitudes and provide easier access to geophysical data.

Sven Israelsson, Ranjith Lelwala and Chandana Jayaratne (Colombo, SriLanka) continue to compare theoretical and experimental studies of space charge densities and currents in the lower layer of the atmosphere during variable turbulent and electric field conditions.

Together with the Physics Department (Uppsala) Sven Israelsson participates in a European project where natural radioactivity is used as a tracer of the general circulation of the atmosphere.

*SOUTH DAKOTA SCHOOL OF MINING AND TECHNOLOGY (Rapid City,SD)

Dr. Qixu Mo has joined the armored T-28 aircraft facility at the Institute of Atmospheric Sciences. He will be working on improving the airborne instrumentation and retrieval techniques for estimating ambient electric fields during thunderstorm penetrations. His email address is qmo@ias.sdsmt.edu

Planning is underway for an atmospheric electricity/convective storms program for 2000. This will build on previous plans for the recently postponed RACES field program. The goals of the program will include acquiring comprehensive observational data sets to elucidate the processes that lead to anomalous electrification and lightning polarity distribution, along with large hail, in some severe storms, and to relate electrical, dynamical, and microphysical characteristics of storms to the production of sprites/blue jets/elves. Investigators who are interested in the observations for other purposes are invited to join in the planning efforts. The favored location for the study will be in the eastern Colorado/western Kansas, southwestern Nebraska region, and the program is being planned to span the convective storm season in this region, from mid-May to mid-August, 2000. Facilities desired for the field project include a triple-Doppler radar network with 2 multiparameter radars, an LDAR system, instrumented balloons and aircraft, instrumented surface vehicles and other deployable surface observation systems, and an optical observatory for low-light observations at night. Possibilities exist for linkages to other field programs with related goals, such as TIMEX. Investigators who have already expressed an interest in the program include M. Baker, W. Beasley, V. N. Bringi, L. Carey, A. Detwiler, J. French, J. Helsdon, P. Krehbiel, W. Lyons, D. MacGorman, J. Miller, S. Rutledge, J. Stith, E. Williams, and W. Winn.

Our goal is to have a planning document prepared by this summer to circulate for review. If you have an interest in participating and are not already on the RACES distribution list, please contact Andy Detwiler (605/394-2291, andy@ias.sdsmt.edu) or John Helsdon (same phone number, jhelsdon@ias.sdsmt.edu) with your interests and input. For further information, consult the old version of the RACES planning document, available via anonymous ftp from nimbus.ias.sdsmt.edu. It is in the directory pub/races.

*FMA RESEACH Inc. (Fort Collins, CO)

FMA Research, Inc. continues planning for the upcoming SPRITES'98 campaign at the Yucca Ridge Field Station (YRFS) outside of Ft. Collins, CO. The observational program will extend from 15 May until late August. Two intensive periods are planned. The first will support the MEaPRS program (MCS Electrification and Polarimetric Radar Studies) organized by the National Severe Storms Laboratory. Dave Rust of NSSL will be hosting a wide field-of-view CCD camera system on one of the MEaPRS mobile vans. The object will be to obtain GPS-time stamped images of dendritic "spider lighting" structures on the underside of the MCS stratiform precipitation regions. Simultaneously, Walt Lyons and Tom Nelson will be monitoring for sprite and elve activity above the storm using low light imagers at YRFS. It is believed that long continuing currents and the massive charge transfers suggested by the mesoscale spider lightnings play an important role in sprite formation. In addition, simultaneous multi-spectral photometry of emissions from the transient luminous events will be made from YRFS by the Los Alamos National Laboratory team (Dave Suszcynsky and Hal Dehaven) and Mission Research Corporation (Russ Armstrong). During the course of the summer, GPS-time stamped video images of cloud-to-ground lightning discharges within about 100 km of YRFS will be obtained for Ken Cummins (Global Atmospherics, Inc.) as part of a program to evaluate performance of the upgraded National Lightning Detection Network. A companion effort will be the acquisition of broadband, high speed photometry of emissions from CG strokes for Earle Williams (MIT) in

order to better understand the relationship between continuing currents and ELF transients being recorded at the MIT Schumann resonance site in Rhode Island. The focus of the summer's activities will come in the latter half of July when a half dozen stratospheric balloon-borne sensing packages will be launched from Iowa by Gar Bering (University of Houston). The goal will be to launch the balloons so as to be within 300 km or so of sprite-generated MCS over the central and northern High Plains. Verification of sprite and elve activity will be obtained by the ground teams including those at Yucca Ridge and from the University of Alaska.

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*INDIAN INSTUTUTE OF TROPICAL METEOROLOGY (Pune, India)

Thunderstorm Activity Over India and the Indian Southwest Monsoon G.K. Manohar, S.S.Kandalgaonkar and M.I.R.Tinmaker Indian Institute of Tropical Meteorology, Pune 411 008, India

The tropical land mass of India is characterised by the seasonal occurrence of thunderstorms and rainfall during the premonsoon and monsoon seasons. In recent years atmospheric scientists have shown much concern about the pronounced differences in the precipitation yield and dynamical and electrical properties of tropical mesoscale cumulonimbus regimes embedded in the monsoonal convection; and the more vigorous but sparsely distributed thunderstorms of the premonsoon season. Although the above mentioned differences are usually common in tropical monsoonal storms, there is a need for making an assessment of similar information from the Indian region where land and warm waters are juxtaposed for the monsoon development. By using monthly data on the number of thunderstorm days, surface wet-bulb temperature and rainfall of 78 Indian stations for an 11 year period (1970-1980), a study on various aspects of thunderstorm activity over India and its association with the Indian southwest monsoon was completed. The preliminary results of this study are given below :

1. The latitudinal inter-month comparison of the thunderstorm activity during the premonsoon season (M-A-M) showed a significant increase in the number of thunderstorm days such that their activity decreased with increasing latitudes. The analysis for the four months of the monsoon season (June-September) showed a latitudinal variation in contrast with the premonsoon season such that the thunderday activity increased with increasing latitudes. An interesting result of the intra-seasonal comparison indicated that during the months of July and August, mid-monsoon season, thunderstorm activity maintained a seasonal low profile throughout the country, whereas during the months of June and September, the onset and withdrawal phase months of the monsoon season, the activity was more pronounced. The other result of the study showed that the month of January is the preferred period for minimum thunderstorm activity over the Indian region.
2. The latitude-belts associated seasonal variation of the thunderstorm activity within the four belts (8-10, 10-15, 15-20, 20-25 deg. N) indicated clear semiannual variations. These semiannual signals also showed systematic changes in amplitudes and a phase shift varying with the northward shift of these belts from the equator. These systematic changes in signals are noted to

be a function of latitude and season, and appear to be consistent with the seasonal migration of the ITCZ and the solar heating of the Indian land mass.

3. We have compared the above mentioned latitude-belt averaged seasonal thunderday activity with similar data of monthly mean maximum values of surface wet-bulb temperatures (Tw). The seasonal variation of Tw showed excellent one to one correspondence with that of the number of thunderstorm days in each latitude-belt. This comparison has shown that the occurrence of the thunderstorms per 1 C rise in Tw is nearly 3-4 times larger in the lower latitudes where the average magnitude of Tw and its range of variation is respectively higher and smaller than in the northern latitudes. This sensitive relationship between Tw and the number of thunderstorm days appears to be consistent with results relating Tw and lightning flash counts in the other regions of the tropics.

4. Using monthly rainfall data from 58 common stations, a relation between seasonal rainfall and number of thunderstorm days (RTR) was examined for the premonsoon and monsoon seasons of the 11 year period from 1970-1980. It was noted that the yearwise variation of the two quantities was highly correlated. The variation of the RTR index for the Indian region during the premonsoon and monsoon seasons of the years 1970-1980 was presented. Comparison between these seasonal mean values of the RTR indices showed that the RTR index undergoes a change from the average 9.6 in the premonsoon season to 36.5 in the monsoon season. It was observed that these seasonal values of the RTR are consistent with the previous works in the other regions of the tropics. It was noted that the premonsoon season and monsoon season rainfall is often associated respectively with lower and higher values of the RTR.

5. The lightning flash count analysis for the series of premonsoon thunderstorms for the five year period 1972-1977 (except 1976) at Pune, was made to examine the ENSO influence on the thunderstorms. This information is very much revealing and welcome to atmospheric scientists. Our results have shown that, in this part of the Indian sub-continent, the ENSO influence during the El-Nino year 1972 was not only a lowering of the thunderstorm days but also a minimization of the lightning flash rate. The results of this analysis tentatively suggest that the thunderstorm days and the the number of field changes in this region are mutually consistent measures of cloud electrification on the ENSO time-scale.

6. The monthly mean electrical conditions of the premonsoon and monsoon season thunderstorms were studied using point discharge current (PDC) data from a large number of thunderstorm days at Pune. The result of this analysis showed a pronounced difference in the magnitude of monthly average electrification of these seasonal thunderstorms. It was observed that with the advent of the monsoonal regime, the cloud electrification (magnitude of the electric field, PDC and lightning flash counts) of the monsoonal thunderstorms is diminished by about 50-70% with respect to the premonsoon season, while their rainfall yield is increased.

*INST, OF GEOPHYS., POLISH ACADEMY OF SCIENCES (Warsaw,Poland)

The research activity of the atmospheric electricity group has continued on thunderstorm observations and on a study of recordings at the polar station, Hornsund, at Spitsbergen and Swider Observatory in Poland.

Raindrop charge transport measurements by means of a new ground based instrument with an inductive ring (P. Baranski and S. Warzecha) have been carried out simultaneously with recordings of electric field and Maxwell current density. Data examination concerns the effects

of the LPCC (lower positive charge center) in thunderclouds (P. Baranski, paper submitted to Acta Geoph. Polonica).

The recordings of electric field, air-earth current density, three components of geomagnetic field, riometer and meteorological variables from Hornsund are also studied (S. Michnowski, N. Kleimenova, S. Israelsson, N. Nikiforova and M. Kubicki).

Field mills of a new type have been constructed and tested (J. Berlinski, S. Warzecha).

*LABORATOIRE D'AEROLOGIE – UPS/OMP (Toulouse, France)

A long term study on the correlations between lightning flash activity and precipitation from convective clouds is being performed by the Group of Atmospheric Electricity, involving Serge Soula, Serge Chauzy and Gilles Molinié who is achieving his PhD thesis in this area. The lightning data utilized for this study are provided by the French national CG flash detection network « Météorage », and the precipitation data are obtained either from the Météo-France radar network or from the 10 cm wavelength radar of the Laboratoire d'Aérologie based at Lannemezan (in the foothills of the Pyrénées) and managed by Henri Sauvageot. Several features have been observed and a few conclusions can be drawn from this first study :

1. There is a reasonable overall correlation between the total number of CG flashes and the total amount of precipitation produced by a convective storm. The average precipitation volume per CG flash stays within a rather constant range of an order of magnitude around 15 x 10^3 m^3.

2. The parallel evolution of lightning and precipitation reveals the existence of a time lag. The corresponding delay can be positive or negative depending essentially on the altitude where the precipitation is detected by the radar beam. The maximum surface precipitation rate occurs always prior to the maximum CG lightning frequency.

3. A case study of a flash flood on August 7th, 1996, at Biescas, in the Spanish Pyrénées, provides complementary information. This event which caused severe casualties (more than 80 people were killed) was produced by a remarkably stationary, strong and long duration thunderstorm. The detailed observation of both kinds of activity, including a volume exploration of the storm by a 10 cm Spanish radar indicates that the maximum CG lightning activity occurs when the high reflectivity regions suddenly collapse within the cloud.

The further step of this study is being conducted by Serge Soula and Stephan Defoy (a student from the Ecole Nationale de Météorologie). They are presently coupling the radar reflectivity detection and the total lightning detection (CG and IC) as it is documented by the SAFIR system intalled in the Ile-de-France region (around Paris).

A recent study on the corona charge transferred from ground to thundercloud has been performed by Serge Chauzy and Serge Soula. The introduction within the PICASSO model of the surface field data detected during several summer experiments provides the order of magnitude of the charge reaching the cloud during the lifetime of a thunderstorm. A publication is being prepared on the subject.

The participation of the group in the experimental phase of MAP (Mesoscale Alpine Programme) is being prepared. This campaign is planned to take place during the fall of 1999. A new sensor for measuring the electric field vector by free balloon has been designed for this experiment. The field data within thunderclouds will be associated with radar detection, especially polarimetric radar data related to the phase of cloud hydrometeors. The sensor will be tested in the near future.

In other work, Sylvain Coquillat, Serge Chauzy and Nicolas Gaussiat (a pre-PhD student) study the microphysical interactions between hydrometeors. A laboratory experiment is performed in a cold chamber. Charge transfers between supercooled drops, on the one hand, and between drops and icicles, on the other hand, are characterized under dynamical conditions. Falling charged drops interact with stationary hydrometeors. The corresponding current signatures are detected by a transient analyzer and the overall charge transfers are evaluated with induction rings. The temperature dependence of such transfers is characterized for both kinds of hydrometeors. In parallel, Sylvain Coquillat is modeling the influence of a horizontal electric field on a falling precipitating drop.

*LOS ALAMOS NATIONAL LABORATORY (Los Alamos, NM)

Report on the FORTE Satellite Science Activities

First sferics collected automatically

The regional sferic array (Robert Massey, Kyle Wiens) have now gathered their first sferic data from unattended operation of the Los Alamos station. The remote stations will be in the field before 1 May.

CONUS passes heating up

We are now dedicating up to 200 - 300 events per pass over the CONUS to VHF self-triggered collects there. While the event yield is still paltry compared to similar passes over the tropics, these CONUS passes are now yielding steadily more triggered events on a week-to-week basis. The purpose of these CONUS collects is to gather data which is correlatable with National Lightning Detection Nework (NLDN) geolocated strokes.

Two significant improvements in Forte rf capability, plus the coming into routine use of Forte optical sensors, have enabled an explosion of data collection and interpretation.

First, in late October 1997 the primary VHF antenna's deployment led to qualitatively more noise-free rf collects, due to there no longer being insertion of pre-amp noise from the active backup antennas. The primary antenna comprises two linear arrays, orthogonal to each other, useful over the entire VHF, boresighted at satellite nadir and forming a broadband null at the Earth's limb (as seen from the satellite).

Second, during March 1998 the University of Alaska (Fairbanks) data-downlink site came into fully routine use. This facility has both multiplied severalfold the available downlinked data volume (to approaching 1 GByte per day) and relieved CONUS passes of having to be impinged-upon by Albuquerque downlinks.

In 99+% of operations, we run two 20-MHz-passband receivers simultaneously, one centered at 38 MHz, the other at 130 MHz, to perform two-band observations of VHF emissions. From the ratio of power in the high band to the power in the low band, we can monitor the spectral roll-off of the lightning-emitted VHF. We have verified that the Blackbeard-like transionospheric pulse pairs (TIPPs) are white-spectrum over the VHF, and that they are a minority within a softer-spectrum continuum of TIPPs. The latter were not distinguishable by Blackbeard from noise, but with Forte's advanced multi-channel-coincidence trigger system, they are routinely and cleanly registered. All TIPPs have been verified to arise from ground reflections, based both on (1) direct comparison with the National Lightning Detection Network (NLDN), and (2) on correlation of trends in TIPP interpulse separation and slant-integrated electron content during collection of repeated emissions from a recurrent storm center over

hundreds of seconds. There is no longer a shred of doubt on the origin of the TIPP inter-pulse separation.

The photodiode detector (PDD) collects all visible and near-IR photons from roughly 10**6 km**2 under the satellite and samples the radiant power at 15-microsecond intervals. With typical record lengths of 1.9 milliseconds, the PDD thus provides a fast-time-response and comprehensive recording of main-stroke rise, dwell, and fall phases. The PDD "events" gathered in self-trigger ("autonomous") mode are frequently correlated in time with VHF self-triggered events. This is the first instance of routine-research mass-statistics on correlation of space-borne observations of optical and VHF transients from lightning.

Finally, the lightning-location-system (LLS), consisting of effectively a 128X128-pixel CCD imaging array, with pixel effective size 8X8 km at nadir, is now being used to locate lightning optical transients and thus to geolocate the coincident PDD and VHF transients where such a coincidence exists.

Moving to ground-support activities, two major advances to report:

First, Los Alamos is fielding a regional array of vertical-electric-field-change monitors using LINUX-based data acquisition and communication. We will monitor and geolocate sferics (sampling rate 1 Megasample/sec; record length typically 8 millisec) and record detailed waveforms for comparison with Forte collects over the region.

Second, starting 1 April 1998 we began a six-month pilot research collaboration with Global Atmospherics, Inc (GAI) to compare Forte events with coincident CONUS-based sferics as reported by the NLDN.

*M.I.T. LINCOLN LABORATORY (Lexington, MA)

Lincoln Laboratory and NASA/Marshall Space Flight Center published a final report on the NOAA/NESDIS sponsored evaluation of operational applications of satellite-derived total lightning data. This was issued as Lincoln Laboratory Project Report NOAA-18, "An Assessment of the Operational Utility of a GOES Lightning Mapping Sensor". Based on results from the LDAR-based total lightning demonstration program at Melbourne, Florida we concluded that substantive improvements to severe weather warnings (for example, greater lead times) might result if LMS data were available in real time to National Weather Service forecasters. In addition the LMS would facilitate strategic rerouting of oceanic aviation around convective weather. The associated economic value of these and other LMS operational capabilities —for example through reduced casualties, property damage and airline operating costs— was estimated to total approximately $60M per year.

Analysis of several mesocyclones cases in the tornado outbreak in Florida on February 22–23, 1998 are underway with Steve Hodanish and Dave Sharp (Melbourne NWS) and Steve Goodman, Dennis Bucchler and Ravi Ragharvan (NASA MSFC) using the LISDAD system. Substantial jumps in LDAR total flash rate (in the order of 50 flashes/minute per minute are evident well in advance of the Volusia County tornado. The radar cloud top for this case reached 17–18 km during the period of lightning jumps and intensification of the mesocyclone, presumably by updraft stretching of vertical vorticity.

Bob Boldi has recently implemented two severe storm lightning thresholds, one for total (LDAR) flash rate and one for rate of increase of flash rate (the lightning jump) in the real time LISDAD display in the Melbourne, Florida NWS office. Interaction with local personel (S.

Hodanish and D. Sharp) has been invaluable in establishing these severe storm criteria in total lightning.

Earle Williams and Bob Boldi are working with Ralph Markson (Airborne Research Associates) on the analysis of previously acquired triple Doppler radar data (Orlando) and ongoing LISDAD observations of Florida thunderstorms to identify and characterize the intracloud activity which signals weather hazardous to general aviation.

*M.I..T. PARSONS LABORATORY (Cambridge, MA)

Everest Huang has won First Prize in the Ernst A. Guillemin Thesis Awards for his thesis entitled "Electromagnetic Transients, Elves and Sprites in the Earth-Ionosphere Waveguide", concerned with the analysis of sprite and elve events using Schumann resonance observations from Rhode Island. The analysis concentrated on events from the July 24,1996 bow echo storm in Kansas/Oklahoma simultaneously documented by Walt Lyons and Tom Nelson from the Yucca Ridge observatory near Ft. collins. The inferred charge moments for positive ground flashes with accompanying elves and sprites are 5–10 times larger than values typical of ordinary ground flashes. The ELF current spectra for elve events are nearly white in the range of 3–120Hz indicating continuing currents of short duration, whereas sprites almost invariably show long (>10msec) tails. This sustained current may be essential in maintaining sprite luminosity. Calculations of the field increases at sprite altitude based on the observed lightning moment changes indicate that conventional dielectric breakdown is unlikley but that electron runaway breakdown is possible

Large transient events in Africa show modest but systematic dirurnal variations in apparent bearing as observed from Rhode Island. Vadim Mushtak is interpreting these observations in the context of a model for the Earth–ionosphere cavity with day/night asymmetry and is achieving consistency between theory and observation.

Sunnia Lin has examined the seasonal migration of lightning, temperature wet bulb potential temperature and rainfall over tropical land zones for her Master's thesis. She has also begun to examine the NASA TRMM (Tropical Rainfall Measuring Mission) Satellite radar and lightning data for January 1998 and finds excellent agreement between the global lightning distribution and the areal distribution of radar cloud top height over land.

Tommy Chang is completing a Bachelor's thesis in Physics on an algorithm to locate sprite-producing positive ground flashes in the 1996 data set from the National Lightning Dectection Network. Toward furthering the understanding of the relationship between large positive ELF transients and sprites and the background behavior of Schumann resonances on a global basis, he is examining the relationship between total ground flash production and total sprite production for several large storms in the great Plains. This work is also in collaboration with Walt Lyons and Tom Nelson at Yucca Ridge.

*NASA / MARSHALL SPACE FLIGHT CENTER (Huntsville, AL)

The Lightning Imaging Sensor (LIS) was successfully launched on 28 November 1997 as a scientific payload on the Tropical Rainfall Measuring Mission (TRMM). The LIS is a calibrated optical sensor operating at 0.7774 microns that detects, locates, and measures the radiant energy produced by lightning (intracloud and cloud-to-ground flashes, day and night) from its 350 km altitude, 35° inclination orbit with high detection efficiency (>90%), total field

of view of 600 km x 600 km, storm scale (5-10 km) spatial and 2 ms temporal resolution. The LIS mission will provide a three to four year survey of the distribution and variability of total lightning occurring over the Earth in the tropics and subtropics. Another satellite, the Optical Transient Detector (OTD), developed in-house at MSFC and launched in April 1995 as an early prototype of the LIS, has now completed three years of measurements of global lightning activity from its 735 km altitude, 70° inclination orbit.

More information about both LIS and OTD can be found on the web page at http://thunder.msfc.nasa.gov. The LIS and OTD daily browse images are available there. The first three months of LIS data from December 1997- February 1998 will be released to the general scientific community shortly and can be ordered from this web site. Global lightning data from the OTD experiment are available now.

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

The Texas phase of the TExas FLorida UNderflight (TEFLUN-A) experiment is being conducted this spring in support of validation of the TRMM sensors, data products, and retrieval (e.g., multi-sensor precipitation retrieval) algorithms. The NASA ER-2 aircraft, with an electrical measurement package (R. Blakeslee, M. Bateman, J. Bailey, and M. Stewart) and other complementary measurement systems is being flown as a key component of this experiment. This field campaign, viewed as having low risk, high payoff scientific return, is focusing on the U.S. Gulf Coast and especially on the priority TRMM ground validation sites in Texas and Florida. In the summer, we will participate in the Convection and Moisture Experiment (CAMEX-3), TEFLUN-B (with a focus on Florida), and a concurrent USWRP supported effort to study lightning relationships in Hurricanes and tropical cyclones. Plans are also underway to install (C. Weidman, N. Renno, R. Blakeslee) a four station ALDF network this summer in the Rondonia region of western Brazil to support the Tropical ``Land'' Field Campaign in January/February 1999, as well as provide long term ground-based lightning measurements for LIS and OTD validation. In addition, measures to expand the range of the lightning network at Kwajalein are being jointly pursued with Aeromet to support the Tropical “Ocean” Field Campaign to be conducted the following summer.

The Lightning Mapper Benefits Study final report has been completed. The study entitled "An Assessment of the Operational Utility of a GOES Lighting Mapper Sensor" was conducted for NESDIS by MIT Lincoln Laboratory (M. Weber, E. Williams, M. Wolfson) and MSFC (S. Goodman, H. Christian). The proposed total Lightning Mapping Sensor (LMS) in geosynchronous orbit offers significant benefits to the U.S., specifically in areas of severe convective weather warnings and aviation weather support. The LMS, conceived by NASA MSFC, is a follow-on to the LIS, featuring improved coverage and the ability to observe storms throughout their life-cycle. In geosynchronous orbit, the LMS would provide continuous, real-time surveillance of lightning activity over large portions of the North and South American continents and surrounding oceans. It would potentially enhance operational weather forecasting capabilities as well as provide data for scientific studies of convective processes on a continental scale.

*NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (Boulder, CO)

Jim Dye and Dan Breed of NCAR are continuing to work on analysis of radar, lightning and chemistry data collected during the STERAO project in 1996 which had the goals of examining redistribution of chemical species by thunderstorms and the production of NOx by lightning. A lot of the effort so far has been devoted to evaluating and understanding the lightning measurements from the ONERA lightning interferometer and also relating the lightning measurements from the interferometer to the radar reflectivity structure and evolution. This has been collaborative with Pierre Laroche and Eric Defer at ONERA and Steve Rutledge and Tim Lang of Colorado State University. Time histories of IC and CG lightning and also radar reflectivity – altitude – time histories for several storms have been prepared showing very high flash rates in excess of a 100 per minute in a couple of severe storms. Although there is a correlation between lightning activity and increases in reflectivity associated with new growth, the behavior of the lightning pattern and ratio of IC to total lightning changes from being almost 100% for some periods to as low as 60% at other times. The ratio changes appreciably during storm lifetimes of 4 or 5 hours.

Some individual flashes show interesting features such as one IC spider flash in a decaying stratiform region with embedded convection where the flash extends over 50 to 60 km and into reflectivity regions with reflectivities of 0 to – 10 dBZ. In another case one flash extends 40 to 50 km into the downwind anvil of an active storm. This kind of activity was rare though and the only one for over an hour period where the flash extended far into the anvil. For most of the flashes the VHF radiation sources are located near the storm core in reflectivities of about 20dBZ or greater.

In a separate study with Jeff Stith of the Univ. of No. Dakota large spikes of NO up to 12 ppbv were found by the UND Citation jet aircraft during some of the anvil/storm penetrations. The large NO spikes are being related to nearby lightning flashes with the hope of trying to say something about the source strength of NO_x produced by lightning.

*NATIONAL LIGHTNING SAFETY INSTITUTE (Louisville, CO)

1. NLSI conducted its standard two day intensive lightning safety workshop at Los Alamos National Laboratories (LANL) in January and at the annual US Air Force Safety Meeting in March. Future scheduled programs will be conducted at:

a. LANL, New Mexico	end April
b. NLSI, Colorado	May 14 & 15
c. NLSI, Colorado	June 18 & 19
d. NLSI, Colorado	July 23 & 24
e. NLSI, Colorado	August 13 & 14

Full description, course outline, registration form, etc. are available on the WWW at: http://www.lightningsafety.com

2. At the January AMS Phoenix meeting, a group of interested lightning safety organizations was convened to adopt personal lightning safety guidelines of a consistent and uniform description. [Much confusion exists about what is - and what is not - personal safety during lightning events.] NLSI (Kithil), NSSC (Holle, Howard, Lopez), Global Atmospherics (Cummins, Krider, Lawry, Zimmerman, Zumbusch), Univ. Chicago (Cooper), College of William & Mary (Bennett), St.

Paul Insurance (Lunning), NASA (Madura), QPS (McGee), Patrick AFB (Roeder), Secondary School Science Teachers (Vavrek), and LPT (Byerley) contributed to the meeting.

3. In February, NLSI's Rich Kithil and Dick Reehl completed a study of modification options and upgrades for the National Weather Service NEXRAD WSR-88D stations at Dulles National Airport and at a Roanoke VA site. Lightning-caused outages lead to significant downtime to approximately 30% of NEXRAD weather radar sites.

4. In March, Kithil and Reehl completed a lightning hazard mitigation study for DOE/ Kaiser-Hill at the Rocky Flats Environmental Test Site, near Golden Colorado. The Scope of Work involved a site survey with detailed attention to a large, existing lightning protection system (LPS). Recommendations were made to bring the LPS into conformance with present codes and standards.

5. Kithil presented a four hour lightning safety tutorial to approx. 75 electric utility company engineers at the Delaware Valley Regional Power Quality Assn. Meeting in Philadelphia in March.

6. NLSI has been invited to present six papers at the UK Sept. '98 ICLP meeting:

a. Grounding-Bonding-Surge and Lightning Protection for PSC Antennas.
b. Lightning Death and Injuries at a Military Airfield: A Case Study.
c. Determining the Probability of a Lightning Strike.
d. Lightning Hazard Mitigation: A Holistic Approach.
e. Lightning Codes: Confusion and Costs in the USA.
f. Why not Establish a NLSI in Your Country?

*NATIONAL SEVERE STORMS LABORATORY (Norman, OK)

NSSL is hosting the MCS Electrification and Polarimetric Radar Study (MEaPRS) from May 15 to June 15, 1998. In the electrification portion of this project, NSSL scientists will be joined by collaborators from several universities and other research organizations. Details and participants may be found at http://www.nssl.noaa.gov/projects/meaprs/.

Lightning safety and education were addressed during the American Meteorological Society's Annual Meeting in Phoenix in January 1998. The intent was to apply results of recent research to improve lightning safety education, and standardize recommendations on safety during thunderstorms. At the meeting was a group of qualified experts who are frequently involved in lightning research and safety from a variety of backgrounds; a report on the results is being prepared. Attendees from NSSL were Ron Holle, Raúl López, Ken Howard, and Don MacGorman; Ken Cummins, Bill Geitz, Lee Lawry, Lynne Shumaker, Christoph Zimmermann, and Pat Zumbusch were from Global Atmospherics, Inc. in Tucson, Leon Byerley of Lightning Protection Technology in Tucson, Brian Bennett of the College of William and Mary, in Williamsburg, Virginia, Mary Ann Cooper of the University of Illinois at Chicago, Rich Kithil of the National Lightning Safety Institute, Louisville, Colorado, E. Philip Krider of the University of Arizona, Bruce Lunning of The St. Paul Companies in Minneapolis, John Madura from Kennedy

Space Center, Marcus McGee from Quality Protection Systems, Inc. in Rochester, NY, Bill Roeder from Patrick Air Force Base in Florida, Jim Vavrek from Eggers Middle School in Hammond, Indiana, and Roger Witt of State Farm Life and Casualty Co. in Champaign, Illinois. Others who are often involved in similar studies were not able to attend.

Raúl López and Ron Holle of NSSL have started studying the distribution of the time and space separation between successive flashes from the same storm. This information is sorely needed for personal safety strategies. A person can determine, using the flash-to-bang method, how far away a flash has occurred. The question is then, is that person too close to where the lightning is happening? What is the probability that the next flash will strike at the position of the observer? The present study makes use of the National Lightning Detection Network (NLDN) database. Different regions of the country are being explored to derive statistics of the distance between successive flashes and to study clusters of subsequent flashes. Preliminary results indicate that lightning clusters tend to have an internal structure of about 10 km, which probably corresponds to lightning-producing cloud cells. A large number of consecutive flashes occur very close to each other (less than 3 or 4 km) and come from the same cell. A significant number, however, come from adjoining cells of the same cluster or in some cases up to 14 km or more from a cell, probably from the anvil region. It appears that safety rules will have to be modified to increase to 6 or 8 miles the distance from a previous flash which can be considered to be relatively safe. In the past, 3 to 4 miles was used in lightning safety education.

Ron Holle, John Cortinas, and Chris Robbins presented a paper on cold-season lightning during cold surface temperatures at the Weather Analysis and Forecasting Conference in Phoenix in January. It used 211 stations for nine years in the continental US and found the maximum to be on the plains; the highest frequency was in Amarillo, Texas. Ron and John have an expanded study in progress of about 1000 stations for 15 years over the US, Canada, and Alaska for the September AMS Severe Local Storms Conference. This paper will better identify the extent of lightning at low surface temperatures with respect to present weather, diurnal and seasonal changes, and region of occurrence.

"The Electrical Nature of Storms" by Don MacGorman and Dave Rust was published by Oxford Press this winter. An outline of the book and an errata list are available on the internet at www.nssl.noaa.gov/~elecbook. The book can be purchased directly from Oxford University Press or from most booksellers who handle technical books.

*NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY (Socorro, NM)

Bill Rison, Paul Krehbiel, and Ronald Thomas of New Mexico Tech. are putting the finishing touches on a deployable LDAR system for locating lightning radiation sources in three spatial dimensions and time. The system will initially be deployed northwest of Oklahoma City during the last part of May and during June as part of the MEaPRS program. The system consists of 10 stations deployed over an area about 60 km in diameter and uses GPS receivers to obtain accurate time-of-arrival measurements used in the locations. During MEaPRS the TOA data will be recorded locally at each site post-processed daily. Following MEaPRS the system will be set up around Langmuir Laboratory in central New Mexico using high speed wireless modems to obtain the lightning locations in real-time.

*NIOSH – PITTSBURGH RESEARCH LABORATORY

The following paper: The Calculated Risk of Experiencing a Lightning Caused Unplanned Detonation By Lon Santis was presented at the International Society of Explosives Engineers' 24th Annual Conference on Explosives and Blasting Technique, New Orleans, Louisiana, 2/8-11/98. *Abstract*

This paper presents data and a theorem which can be used to calculate the risk of experiencing undesirable lightning related events while blasting or while engaged in other lightning sensitive activities. The paper provides an overview of lightning hazards in blasting operations and a brief history of lightning related blasting accidents. Lightning continues to be the primary cause of premature initiations of explosives in mining; on average, over two such incidents are reported to the Mine Safety and Health Administration each year. The energy contained in lightning discharges and how this energy sets off explosives in mining is presented. Three categories of lightning warning methods: public media, lightning detectors, and atmospheric electrostatic field measurement are discussed. The remainder of the paper presents recently acquired data on the spatial characteristics of lightning development. These data are used to estimate the risk assumed by blasters under certain conditions. Formulae for estimating risk are presented for electric and nonelectric blasting when the blasting activity is stopped and all persons are evacuated when cloud-to-ground (c-g) lightning is within a certain distance. For example, about 10% of all c-g lightning strikes have no other c-g lightning strikes within 4 miles in the previous 30 minutes. This means that 1 in 150 blasters using nonelectric initiation could be injured by a lightning-caused unplanned detonation sometime during their career if they were to evacuate their shots for 30 minutes every time c-g lightning was 4 miles away.

Although the paper is targeted at blasters, readers may find interesting the frequency of lightning strikes which have no other lightning strikes within a certain distance in the previous 30 minutes. Analyses of 4.4 million lightning strikes which occurred roughly within the boundries of the contiguous US in 1995 revealed a strong fitting power function: $y = .56x^{-1.4}$ where y = the frequency (in %) of lone lightning strikes, and x = miles from all other lightning strikes in the previous 30 minutes

A significant difference was noticed between lightning east and west of -102 degrees longitude. The frequency of lone lightning strikes is approximately three times higher west of -102 longitude.

Look for a copy of the paper at: http://outside.cdc.gov:8000/ciss/featpub.html#conf

*ONERA (Meudon, France)

We continue STERAO-A data analyses on 3D VHF location of intra-cloud and cloud to ground lightning discharges. This work is done with NCAR (Jim Dye) and other participants in the field experiment. Up to now the UND Citation aircraft had identified a NOx spike which is attributed to a lightning flash. Richard Ramarosson, scientist of our Group, is spending a year at NCAR, in part to contribute to the analysis of the chemical transport of species for STERAO-A events.

EULINOX (European Lightning NOx production experiment) is a field experiment designed to evaluate at the local and the mesoscale production and transport of NOx by storms. The experiment will take place near Munich in Bavaria in July. It relies on ONERA's 3D VHF interferometer, the Doppler weather radar POLDIRAD of DLR and their Falcon 20 instrumented aircraft to sample the chemical composition of the storm anvil's air. In our Group, Patrice Blanchet, Pierre Laroche and Claire Thery are involved in EULINOX. DLR, ONERA, NILU and KNMI will collaborate in this program.

Modeling of the lightning leader is being improved by Anne Bondiou and Philippe Lalande. The models are used to describe the triggering of a flash by an aircraft or a rotorcraft

and to analyze the process of connection of a downward negative flash to ground. Physical models are dynamically linked to 3D field calculations on actual shapes of aircraft or buildings.

Studies of lightning flash parametrization within the University of Washington's 1.5D dynamical and microphysical model are continued by Eric Defer and Claire Thery. Bob Solomon is expected to take a one year postdoc position in our Group on that topic.

Anne Bondiou set up the ORAGES project, which consists in VHF lightning location from a microsatellite platform orbiting within the tropics. The preliminary planning for the project forecasts a launch around 2001-2002.

*PENN STATE UNIVERSITY (Univ. Park, PA)

Les Hale has been studying old rocket data concerning middle atmosphere electric fields. A feature of these data is a frequent indication of an approximately volt/meter vertical field extending above the fair weather region into the mesophere. Although many have suggested that this is an instrumental artifact, the recently developed theory of millisecond "slow tails" originating from nearly all lightning gives a plausible explanation for the existence of such a field as the superposition of many smaller wavelets of essentially constant amplitude between the Earth and the base of the ionosphere. A field of this magnitude would have a substantial effect on relevant reaction rates, particularly at higher altitudes in the mesophere. (This process apparently does not provide an explanation for the large layered fields observed by US and USSR groups, except possibly as a temporal variation in the global lightning rate.)

*TEL AVIV UNIVERSITY (Tel Aviv, Israel)

On-going research by Zev Levin and Yoav Yair is concerned with lightning characteristics in Israel and the eastern Mediterranean. During this winter lightning season we had 2 operative CGR3 counters, one in Tel-Aviv and another in Haifa (100 km to the north, by Mt. Carmel, on the coast). Both instruments were connected to a PC, enabling measurement of flash type and time. Results show a remarkable increase in lightning density near Hiafa, almost 10 times larger than Tel-Aviv values and 3 times higher than the national average. These results strengthen earlier reports, which were based on analysis of LPATS measurements. Through a cooperation with the Israeli Electrical Company, we plan to study the special increase in lightning activity in that area using cloud radar data and LPATS lightning strike locations. A correlation of the lightning data-set from the two systems will be conducted on selected events using the lightning location system and the Tel Aviv University meteorological radar.

Colin Price has started to collect data from the newly established Schumann Resonance station in the Negev desert. The data look very good. Due to data storage problems, at the moment we are collecting only 5 minutes of raw data every hour. Other new projects include analysing lightning data from Brazil, Europe and the United States and comparing them to upper tropospheric water vapour concentrations. It appears that upper tropospheric water vapour concentrations may well be linked to the intensity of the lightning activity in the storms that transport the water vapour to the upper regions of the atmosphere.

Colin Price is also working with Umran Inan on setting up a VLF station in the Negev desert. Hopefully this will be running before the 1998 Sprites Campaign. Finally, Colin Price has also started a new project in collaboration with David Rind and Drew Shindell of NASA

Goddard Institute for Space Studies to investigate the impact of lightning on tropospheric NOx and ozone concentrations. This project will start this summer and continue for 3 years.

*YORK UNIVERSITY (Toronto, Ontario,Canada)

Stephen Clodman is studying satellite detection of above-troposphere effects of thunderstorms. The WINDII limb-viewing instrument, on the UARS satellite, measures emissions at specific optical wavelengths, so that temperatures and winds can be computed along a track. A list has been made of some WINDII observation tracks passing near well-developed thunderstorms (based on NOAA severe storm data). The resulting WINDII data is being examined. Some large spatial wind fluctuations occur at these places, but it is still unknown whether this is related to the storms below. (Pasko et al. (GRL, vol 24, p 1735) suggest that the middle atmosphere above a thunderstorm may be perturbed, and that this in turn may help cause sprites.)

The feasibility of detecting sprites, jets, etc., by satellite is being investigated. Work has begun, by Stephen Clodman, Gordon Shepherd and Brian Solheim, on a project to search WINDII optical emission data for evidence of sprites. Also, using York's experience in scientific earth satellites, Ian McDade had done a design study for a very-low-cost nadir-viewing orbiting satellite (named "MESO") to measure atomic oxygen in the middle atmosphere. This satellite would use multi-wavelength CCD photometers at selected wavelengths from 270 to 760 nm, and would have
horizontal resolution of about 4 km. The team is studying whether a modified version of this satellite might also detect sprites and related phenomena.

*TEXAS A&M UNIVERSITY (College Station, Texas)

The following work is based on thesis research and is published or under review.

Changes in Measured Lightning Flash Count and Return Stroke Peak Current After the 1994 U. S. National Lightning Detection Network Upgrade; Part I: Observations Robert S. Wacker and Richard E. Orville.

Abstract A total of more than 134 million cloud-to-ground lightning flashes (127 million negative; 7 million positive) occurring during 1989-95 in the continental United States, have been studied on a monthly and yearly basis for variations in flash count, first stroke peak current, and polarity. The years 1989-93 cover a period in which similar instrumentation was used throughout the United States. In 1994 the National Lightning Detection Network (NLDN) underwent a system-wide upgrade to improve location accuracy and detection efficiency. As a result of this upgrade, we observe in the NLDN that the negative mean peak current decreased from a pre-upgrade (1989-93) mean of 37.5 kA to a 1995 value of 30.2 kA, a decrease of 3.4 standard deviations. The positive mean peak current decreased from 54.4 kA to 31.6 kA, a 5.0 standard deviation decrease. The NLDN negative flash count increased 1.2 standard deviations, from a pre-upgrade mean of 16.7 million flashes/yr to 20.6 million flashes in 1995. The positive flash count increased 6.2 standard deviations, from an average of 696,000 flashes/yr before the upgrade to 2.1 million flashes in 1995. Both the negative and positive flash count increases were predominantly at low peak currents.

Changes in Measured Lightning Flash Count and Return Stroke Peak Current After the 1994 U.S. National Lightning Detection Network Upgrade; Part II: Theory Robert S. Wacker and Richard E. Orville

A model of return stroke detection by the US National Lightning Detection Network (NLDN) sensors is used to simulate the pulse width criterion modification made to the NLDN sensors during the 1994 upgrade. Decreasing the pulse width detection criterion used by the sensors increases their effective detection range, which increases their sensitivity to weak flashes (due to NLDN sensor geometry, increasing sensitivity has little effect on detection of strong flashes). The increased detection of weak flashes accounts for the decrease in mean peak currents and the increase in flash counts observed in subsequent years to 1994.

A Study of Lightning Initiation Signatures as Indicated by Doppler Radar
By Michael S. Gremillion and Richard E. Orville

Abstract The operational potential for identifying thunderstorms for the onset of cloud-to-ground lightning is examined. WSR-88D reflectivity echoes are analyzed for 40 thunderstorms over the Kennedy Space Center to determine the best Lightning Initiation SignaTure (LIST). These storms were studied in conjunction with cloud-to-ground lightning flash locations from the National Lightning Detection Network. From a time series of radar echoes, it was found that the 30 dBZ echo detected at the +15°C temperature height is the best indicator of the beginning of CG activity. The observed median lag time between this lightning initiation signature and the beginning of CG lightning flashes was 15.5 minutes. Other lightning initiation signatures were also examined at +10°C, -15°C, and +20°C temperature heights and did not yield as successful results.

"Lightning Ground Flash Density and Thunderstorm Duration in the Continental United States: 1989-96" by Gary R. Huffines and Richard E. Orville

Abstract We analyzed the mean annual flash density, thunderstorm duration, and flashrates using 121.7 million cloud-to-ground (CG) lightning flashes in the continental United States for the period 1989-1996. Florida had flash densities over 11 flashes per km squared per year while the Midwest, Oklahoma, Texas, and the Gulf Coast had densities greater than 7 flashes per kilometer squared per year. There was a relative minimum in flash density (3 flashes per kilometer squared per year) in the Appalachian mountains and Missouri. We used lightning data to determine the duration of thunderstorms, and found more than 120 hours per year in Florida and over 105 hours per year in New Mexico, Arizona, and the Gulf Coast. The maximum annual flash rates exceeded 45 flashes per hour in the Midwest, along the Florida coasts, and along the mid-Atlantic coast with the minimum flash rates, 15 flashes per hour, over the Applachian and Rocky Mountains. The relationship between thunderstorm duration and flash density was Flash-Density = 3D 0.024 * (Flash_Hours)^1.29 producing expected flash densities that were within 30 percent of the measured densities for over 70 percent of the nation with the greatest errors, but over 80 percent, in the intermountain region of the Rockies.

*UNIVERSITY OF ELECTRO-COMMUNICATIONS (Tokyo, Japan)

As a part of collaborative work with E. R. Williams, we have completed an ELF observation site in Moshiri, Hokkaido JAPAN in May 1997 to observe Schumann resonances and ELF transients with three field components (Ez, Hns and Hew). A. Shvets, invited from the

UKRAINE, helped in the calibration of equipment and installation of the vertical electric component. The observations are going well.

N. Tsuchiya and M. Hayakawa studied ELF transients observed at Moshiri during the sprite campaign held in Australia in November 1997. They found more than 20 transient events with positive polarity highly connected with optical events detected by Kawasaki's group at Osaka.

T. Otsuyama and S. Takahashi are currently analyzing the lightning data in the optical range gathered during the ground observation in January 1998. We are conducting a study for the characteristics of winter lightnings (especially +CGs) and the associated optical phenomena around the sea of Japan.

Y. Hobara and N. Tsuchiya are continuing to analyze results from the Japan-Australia VLF/ELF campaign conducted in November, 1996. The aims of this campaign are (1) to investigate the relation between various types of lightning and radiation associated with these lightnings; (2) to study the propagation characteristics of the VLF/ELF ground-ionosphere waveguide mode; (3) to explore whistlers. During the one month campaign, we installed a fields site in Brisbane, Australia (VLF/ELF). Together with VLF data at Kagoshima (K. Ohta), Trimpi data (R. L. Dowden) and UHF lightning data (Z. Kawasaki), we are investigating the topics mentioned above.

We have been working on the analysis of Schumann resonance data recorded for 8 years by Sao in Tottori, Japan and searching for correlations between the amplitude of Schumann resonances and global warming.

Sasha Nickolaenko is visiting the University of Electro-Communications as an invited professor for one year to continue collaborative work in the field of the atmospheric electricity, and VLF/ELF radio wave propagation.

*UNIVERSITY OF FLORIDA (Gainesville, FL)

Triggered-lightning experiments will continue in Summer 1998 (for the sixth year) at Camp Blanding, Florida. A number of experiments are planned including (1) multiple-station measurements of electric and magnetic fields and acoustic radiation produced by both triggered and close natural lightning, (2) lightning testing of transmission and distribution arresters, (3) lightning testing of an airport lightning system, (4) comparison of the performance of various lightning rods, and (5) initiation and characterization of the positive lightning discharge using the rocket-and-wire technique.

Mark Fernandez, Keith Rambo, Vlad Rakov, and Martin Uman authored a paper titled "Performance of MOV Arresters During Very Close, Direct Lightning Strikes to a Power Distribution System." The paper (PE-376-PWRD-0-12-1997) has been recommended and approved by the IEEE Surge Protective Devices Committee of the IEEE Power Engineering Society for publication in the IEEE Transactions on Power Delivery.

Mark Fernandez defended his Masters Thesis titled "Responses of an Unenergized Test Power Distribution System to Direct and Nearby Lightning Strikes." He is presently with the National Security Agency.

Contribution from V.A. Rakov to the Atmospheric Electricity Newsletter (May 1998) : 13th International Zurich Symposium and Technical Exhibition on Electromagnetic Compatibility (EMC Zurich '99)

The Symposium will be held in Zurich, Switzerland on February 16-18, 1999. The program will include a special session on Lightning Physics and Effects, which covers essentially all aspects of the lightning discharge. Preliminary manuscripts (up to 6 pages) should be sent to the Technical Program Committee EMC Zurich '99, ETH Zentrum-IKT, ETF, CH-8092 Zurich, Switzerland, so that they arrive no later than July 1, 1998. Financial support for authors is available. For further information visit the EMC Zurich '99 World Wide Web page at http://www. nari.ee.ethz.ch/emc/emc99/emc99.html

*UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY (Manchester, UK)

Our visitors from Cordoba, Argentina, have been here now for 12 months with 6 months to go. Eldo Avila and Negui Castellano have been working in the cloud chamber to learn more about the heat transfer characteristics of riming graupel pellets. It seems that the negative sign of charge transfer to riming graupel, when ice crystals collide and separate, occurs when the crystals are growing by vapor diffusion faster than the rimer. The depositional growth rate of the rimer reduces when it accretes supercooled water droplets, because of the heat released to the rimer surface, and this favors negative rimers. (With an even higher rate of accretion, rimers charge positively possibly because of the high flux of vapor to the surface from freezing droplets). Last year we noted that droplet size affects the sign of charging - the accretion of larger droplets can enhance negative rimer charging. Laboratory measurements of the temperature rise of a riming rod target as a function of accreted droplet size have now shown that, for a constant rate of rime accretion, larger droplets (typically 30 μm diameter) heat the rimer more than smaller droplets (15 um diameter) and this may lead to the enhanced negative charging of the rimer. The reason for the heat retention by the rimer may be connected with the smoother surface produced by the freezing of larger droplets which reduces the effect of ventilation. The heat balance equation of Macklin and Payne has a numerical factor in the heat transfer coefficient and the present results show that this factor has increasing values, over 0.5, for smaller droplets while for the larger droplets the factor becomes independent of droplet size and tends to a value around 0.3. The above results are not in conflict with our earlier report that small droplets (around 5 μm) favor negative rimers because they can enhance the ice crystal growth rate. Both sets of results emphasise the need for laboratory measurements to use representative droplet size distributions and the need for more accurate measurements of droplet distributions in the electrically active regions of clouds.

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*UNIVERSITY OF MISSISSIPPI (University, MS)

Analysis of data collected at Kennedy Space Center in 1996 is now nearly complete. Tom Marshall and Dave Rust (NSSL) made fair-weather electric field soundings with a tethered balloon system during several weeks of "sunrise enhancements" over the KSC field mill network. The positive charge layer that accounts for electric field magnitudes in excess of 1000 V/m during the enhancement was found to be relatively dense, shallow and just above the surface at early stages. The charge depth abruptly increases and the charge density decreases 50-70 minutes after local sunrise. These and other, coincident changes are indicative of upward convective mixing of the charge through a deepening boundary layer.

Tom Marshall and Maribeth Stolzenburg will participate in MEaPRS (MCS Electrification and Polarization Radar Studies) this spring in Oklahoma. Collaborating with Dave Rust (NSSL) and many others, they will have more than 50 electric field meters with which to make balloon soundings through mesoscale convective systems. Their objective is to acquire, for several MCSs, a complete set of soundings through (1) updraft of the convective region, (2) non-updraft of the convective region, (3) the transition zone, and (4) three "downstream" locations in the stratiform region. Airborne and ground-based kinematic and microphysical data will be collected to support the study.

Tom Marshall and Maribeth Stolzenburg will also be making multiple balloon soundings in thunderstorms at Langmuir Lab in the summer of 1999. These measurements will be made in collaboration with Bill Winn (New Mexico Tech), Dave Rust (NSSL), and others. The goal of these measurements will be to study the electrical evolution of mountain thunderstorms.