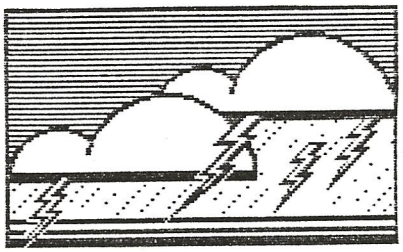
NEWSLETTER ON ATMOSPHERIC ELECTRICITY

Vol. 2, No. 1
May 28, 1991



AMS COMMITTEE ON
ATMOSPHERIC ELECTRICITY

ANNOUNCEMENTS

25th International Conference on Radar Meteorology, Paris, France. June 24-28, 1991. Contacts: Anthony Illingworth and Earle Williams. Session on Storm and MCS Electrification, Friday, June 28.

International Union of Geodesy and Geophysics, Vienna, Austria. August 11-24, 1991. Contacts: Anthony Illingworth and Michel Kuhn. Session M1, August 13-14, Lightning Location and Its Applications to Forecasting of Meteorological Phenomena and the Global Circuit. Session M2, August 15-16, Properties of Thunderstorms.

The Ninth International Conference on Atmospheric Electricity of the ICAE was originally scheduled to be held in Tbilisi, Georgia, USSR, on June 12-15, 1992. Unfortunately, the Academy of Sciences of Georgia retracted their offer to host the conference because of the difficult political and economic situation there. Instead, an offer was made to shift the conference to Leningrad. A decision on the location will be made by May 31, and Prof. John Latham and Dr. J. Shvarts (Program Chairmen) will annouce details of abstract submission and conference organization soon after.

RESEARCH ACTIVITIES BY ORGANIZATION

AIRBORNE RESEARCH ASSOCIATES (Weston, MA)

Ralph Markson conducted the first ionospheric potential (V_I) soundings over the Pacific Ocean away from continental influences at Hawaii and Christmas Island using free balloons. He found it was essentially unchanged at about 260 kV compared to previous measurements and that the clean air provided unusually noise-free data. While the classic Carnegie Curve was observed in the V_I data,

meteorological factors caused it not to be present in surface electric field data. Future studies of the global circuit are planned.

UNIVERSITY OF ARIZONA (Tucson, AZ)

William J. Koshak has completed his Ph.D. dissertation on a new, linear method for analyzing lightning field changes subject to various constraints. Bill is now employed at the NASA Marshall Space Flight Center, Code ES43.

Capt. Timothy D. Oram is finishing his M.S. thesis on a comparison of LLP lightning flash locations (ground strike points), field mill locations (change in cloud charge), and cloud radar reflectivity. In June, Tim will return to active duty with the Air Weather Service.

ATMOSPHERIC RESEARCH SYSTEMS, INC. (Palm Bay, FL)

Atmospheric Research Systems, Inc., announces its U.S.A. national lightning network, which is a private venture investment in conjunction with Zephyr Weather Information Service. There are 11 Lightning Position and Tracking Systems (LPATS) installed to cover the U.S.A. including the coastal waters. The data is distributed by either dedicated telephone line, dial-up service, or satellite ground stations. The system is unique as it uses a patented time-of-arrival technique which is far more accurate than a direction-finding system.

The U.S. Geological Survey has procured an LPATS for installation in Alaska. The system will be installed so as to cover the majority of the Cook Inlet with highly accurate data. This data will be used to study lightning which occurs in volcanoes such as Redoubt. Once the system becomes operational, the data will be available at the U.S.G.S. facility in Fairbanks. Dave Murry and Rick Hobblet are working on this project.

The Swiss Post and Telecommunications has installed a national LPATS to cover Switzerland. The primary purpose of the network is to collect data for research with consideration to the propagation of lightning signatures related to high mountains. The system has waveform digitizers fitted at six remote sites, and each site transmits the data to the central site for archiving and analysis. Some very exciting information has already been collected on lightning strokes occurring outside their borders and is being detected at various sites either directly or over a number of mountainous regions. The effects of propagation of the waveforms over these mountains is readily discernible from the waveform plots.

For more information contact Bill Highlands.

COLORADO STATE UNIVERSITY (Ft. Collins, CO)

Atmospheric electricity research at Colorado State University directed by Steve Rutledge focuses on two areas, thunderstorm electrification modelling studies in collaboration with John Heldson and Dick Farley at SDSMT, and analysis of DUNDEE data in collaboration with Earle Williams. The modelling studies employ the SDSMT cloud-electricity model to investigate the observed relationship between lightning flash rate and CAPE (Convective Avalable Potential Energy) as revealed in their DUNDEE (Darwin, Australia) field studies. Charging parameterizations based on both Takahashi (1978) and Jayaratne and Saunders (1986) will be used in the modelling studies. They are conducting simulations of both "break" period continental convection (high CAPE and large flash rates) and monsoon convection (low CAPE and low flash rates) to investigate the relationships between cloud dynamics, microphysics and electrification. Analysis of data from a 4-station LLP network used in DUNDEE, along with surface DC electric field measurements are also underway. One Mesoscale Convective System case analyzed to date (12/5/89) showed negative charge overhead (and negative CG's) associated with the passage of a leading line of convection followed by a one hour period of positive charge overhead associated with the trailing stratiform region, within which a few high current positive CG's were recorded. Evidence for an inverted dipole in the trailing stratiform region is seen in this case associated with positive charging of large ice particles in low supercooled water contents.

CSU will be participating in the COPS (Cooperative Oklahoma P-3/Profiler Studies) during May and June 1991. Airborne microphysical measurements, electric field meter profiles, and LLP data will be collected in MCSs in Oklahoma to further examine the in-situ electrification of stratiform precipitation associated with these storms in order to explain the bipolar lightning patterns.

DIMENSIONS (St. Aubin, France)

Dimensions is presently developing, under contract with ONERA, a 3D version of the SAFIR system to be used by ONERA this summer in Orlando, Florida, in a joint experiment with MIT Lincoln Laboratory.

This system gives 3D mapping of VHF sources associated with lightning discharges; its temporal resolution is 20 microseconds and typical spatial resolution is 100m. The objective of the experiment is to analyse the relationship between VHF activity and thunderstorm morphology and dynamics obtained with Doppler weather radars. Application of the research is considered for the operational early

detection of microburst producing thunderstorm cells.

DIMENSIONS will conduct this summer an evaluation of the SAFIR system lightning monitoring and early warning functions in Japan in collaboration with Osaka University and with a local Electric Power Co. Investigators for this experiment are Dr. Kawasaki (Osaka Univ.) and P. Richard from DIMENSIONS.

DEPARTMENT OF TRANSPORTATION (Cambridge, MA)

The FAA has investigated the use of network lightning data for three years, primarily for the application of thunderstorm detection for AWOS (Automated Weather Observing System). Recently, other FAA organizations have shown interest in this same data for different applications, reports John Canniff.

The source of data is the EPRI/SUNY network of direction-finders which cover the contiguous 48 states, thorugh a cooperative network with Federal Agencies. The FAA and NWS are currently issuing a competitive contract to obtain network lightning data for the next several years.

Network lightning data is only cloud-to-ground, with position errors of approximately 5 miles. More accurate data is desirable, including intracloud flashes, but the current system is more than adequate to meet the FAA mission needs for applications. Costs for the current system data are reasonable; enhanced performance would demand a greater price, and a cost/benefit analysis would be needed to justify the enhancements.

The key to widespread use of network lightning data is the number of critical locations where data is available. Each of the 20 Air Route Traffic Control Centers (ARTCC's) can service all the AWOS and ASOS (the NWS version of AWOS) units under its domain, as well as the Central Weather Service Unit (CWSU). Data at the Central Flow Facility (CFCF) will assist at the national level. Data at the regional level will support Flight Service Station and terminal area applicaitons. For AWOS/ASOS, network data will be the sole means of detecting thunderstorms; for other applications, network data will be combined with weather radar and other data sets to provide a complementary profile of thunderstorms and other hazards to aviation.

The pilot and ATC system will then have access to thunderstorm identification and tracking at several levels: voice broadcasts to pilots via AWOS/ASOS; graphics for the CWSU staff to brief controllers; alphanumerics/graphics for tower and FSS personnel to brief pilots; and graphics for the CFCF staff to assess the impact of hazardous weather on a national scale.

UNIVERSITY OF FLORIDA (Gainesville, FL)

Ewen Thomson, Pedro Medulius and Yosev Yariv from the University of Florida will be measuring wideband (80 Hz-8MHz) vertical electric fields at five stations during CaPE 91 at Kennedy Space Center this summer. They plan to locate the sources of microsecond-duration pulses and determine their velocity-current vector. These sources occur both during and between lightnings.

UNIVERSITY OF KALYANI (West Bengal, India)

A. Bhattacharya reports on a 'Study of Atmospheric Radio Noise Field Strength in the Tropics': Instruments used for the measurement of atmospheric radio noise are mainly quasi peak metre, peak metre, average and rms metre, noise burst generator, pulse rate counter, lightning flash counter, etc. All these instruments have been widely used for investigating the noise characteristics, particularly in tropical countries like India.

From the various observations, it has been noted that the atmospheric radio noise field strength can be specified in terms of average, rms, peak value or the amplitude probability distribution of the noise envelope. Of these, the average value of the noise envelope voltage provides most extensive information. In our investigation over Calcutta (Lat. 22 34'N, Long. 88 24'E), the same method has been applied in the VLF band.

Tuned VLF receivers have been used to amplify the input signals at 10, 20 and 30 KHz. The original design of the receiver by Ellison used to obtain the solar flare effect was modified slightly to have a large dynamic range required to accommodate a wide range of field intensities due to local sources.

LAWRENCE LIVERMORE NATIONAL LABORATORY (Livermore, CA)

The charter and objectives of the Range Commanders Council recently formed Lightning Prediction and Detection Committee are as follows: (Charter) Identify mutual problems, share knowledge and techniques, and serve as the focal point for issues associated with the prediction and detection of lightning.

The objectives are to suggest and/or recommend equipment and procedures that can 1. enhance safety, 2. reduce down time for "at risk" activities, and 3. provide timely and credible information to duty weather forecasters. The LPDC will seek to: 1) identify and coordinate common range problems and solutions, 2) periodically conduct lightning prediction and detection workshops, 3) track new technology, develop methods to facilitate technology transfer and communicate needs to the scientific

community or industry, as appropriate, 4) identify and recommend criteria for selection, siting and management.

The LPDC has recently conducted a survey; they plan to issue an 'RCC Directory of Lightning Instrumentation Users' with the results. Contact Richard Hasbrouck for additional information.

LIGHTNING LOCATION AND PROTECTION, INC. (Tucson, AZ)

LLP is continuing its research program aimed at improving detection efficiency and location accuracy in lightning detection networks. An improved site-error correction method, based on the procedure developed by Passi and Lopez at NSSL/Boulder, is in the final stages of evaluation. We are also analyzing cloud lightning waveforms collected and archived over the past two southwestern USA monsoon seasons, with the intent of investigating the use of magnetic direction finding methods for "locating" inter- and intra-cloud lightning.

In addition, a research project aimed at developing an omnidirectional electrical storm identification device (ESID) is nearing completion. This device is based on the coincidence of optical and electric field signals, and is capable of identifying cloud and cloud-to-ground (C-G) lightning and determining the range to C-G lightning within 25 miles of the sensor. The signal processing methods employed in this device allow us to operate it in electrically noisy environments and to place it near large structures such as towers and on top of buildings. For further information please contact Kenneth Cummins or Burt Pifer.

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

Clive Saunders reports that UMIST laboratory studies of thunderstorm electrification continue, but in a new direction, or rather, in an old direction revisited. B.J. Mason proposed that the inductive theory may still have life in it. He suggests that small, low density graupel falls slowly enough for supercooled water droplets to bounce off the underside well away from the neutral zone. He estimates the number of droplets required to separate in order to provide sufficient charge transfer to account for the observed field growth.

We have our doubts about the mechanism in that charged particles have been found in thunderstorms at times when the field is inadequate to account for them by the inductive process. Also, the number of droplets separating, is not well established. So, our cold room cloud chamber now has field electrodes and charge detectors for ice spheres falling through the supercooled droplet cloud. At present the charge sensitivity is hampered by the vibrational effects of passing trucks and buses in the street outside.

MIT LINCOLN LABORATORY (Lexington, MA)

A joint experiment to study the impact of hazardous weather (including lightning) on traffic safety and efficiency was conducted last summer at Orlando's McCoy International airport. The collaboration was between MIT Lincoln Laboratory's (LL) Weather Sensing Group (sponsored by the FAA) and the French government laboratory ONERA (sponsored by DRET (similar to U.S. DoD) and DGAC (similar to the U.S. FAA). The experiment will be continued this summer with the participation of Earle Williams (MIT EAPS) and enhanced observational capabilities.

The experimental network will consist of interferometers, radars, mesonet stations, and soundings. A two-station SAFIR interferometer system with 3D localization capability and 20 microsecond resolution will be installed using a 50 km baseline. The area of coverage was chosen to minimize triangulation errors over the airport which is centered in the 'sweet spot' of the triple Doppler network of three C-band radars: LL testbed Terminal Doppler Weather Radar, MIT EAPS meteorological field radar, and Univ. N. Dakota meteorological radar (contracted by LL). Continuous surface thermodynamic and wind soundings will be performed at the discretion of LL site staff. The experiment is scheduled to run from August 1 through September 30, 1991.

MIT WEATHER RADAR LABORATORY (Cambridge, MA)

In continuing analysis of electrical observations during DUNDEE in Darwin, Australia (In collaboration with Steve Rutledge (CSU)), the local diurnal variation in cloud-to-ground lightning, obtained with a 4-station LLP network, has been convolved with the global distribution of lightning at midnight (from Orville and Henderson, (1986)) to obtain a 'Carnegie Curve' for global lightning. The result shows the same phase as the classical Carnegie Curve but the amplitude variation is markedly greater. The NOAA 50MHz profiler in Darwin, located 26 km from the MIT Doppler radar, has been used to investigate the vertical air and particle motions in the trailing stratiform region of a tropical squall line for which electrical measurements were also obtained. The MIT C-band Doppler radar was used to 'calibrate' the profiler on the precipitation so that quantitative C_N^2 values could be obtained for both the deep convection and the trailing stratiform region.

Stan Heckman is refining an instability mechanism in long arcs as an explanation for multiple strokes in lightning. Motivated by Don Latham's claim that all laboratory measurements of long arcs have imposed some form of confinement not representative of lightning, a large DC power supply has been obtained to produce free vertical arcs of 20-80 centimeter length. In this geometry, the arcs exhibit negative

differential resistance which is an essential part of the long arc instability.

A major thunderstorm field program is planned for Orlando, Florida this summer with Mark Weber, Cindy Engholm and Valerie Coel of Lincoln Laboratory and with investigators from ONERA and Dimensions in France. A network of twenty corona point sensors will be operated within the 'sweet spot' of the triple Doppler network established last summer. Special emphasis will be given to coordinated scanning from early stages in determining the fall speeds of ice particles aloft at the time of both initial electrification and initial lightning. Rapid update Doppler RHI's will also be conducted to study the evolution of cloud microphysics and the development of thunderstorm outflows. Field change measurements will also be carried out at the MIT radar site to determine CG lightning currents on a continuous basis in distant isolated storms. All interested parties are invited to participate in the Orlando study which will run from June through September.

UNIVERSITY OF MISSISSIPPI (Oxford, MS)

During the summer of 1991 Tom Marshall will be working with Dave Rust studying electricity in mesoscale convective systems (MCS's) in an experiment called COPS '91, which will run from April 24th to June 12th. They have upgraded their balloon-borne electric field meters (based on the design developed by Winn and Byerley) to send down electric field data digitized in the instrument with a 12 bit A/D converter. This should make a substantial improvement in their ability to detect the horizontal component of the electric field. They have several different telemetry frequencies and several receiving stations, so they plan to fly instrumented balloons simultaneously through different parts of each MCS.

Tom Marshall will be on sabbatical leave during the 1991-92 academic year and will be spending time at both New Mexico Tech and the National Severe Storms Lab working on papers and COPS '91 data.

NASA-AMES RESEARCH CENTER (Moffett Field, CA)

Bill Borucki and Julio Magalhaes have found a second narrow band of lightning activity on Jupiter. Almost all lightning activity on Jupiter occurs in these two, very narrow latitude bands. The bands are found at 49 and 14 degrees N. latitude. No lightning has been observed in the southern hemisphere, but the coverage of this hemisphere is poorer than that of the northern hemisphere. Work is in progress to associate the lightning activity with particular cloud features. Because of instrument limitations, lightning is seen only on the nightside of the planet where cloud features cannot be seen. Therefore it is necessary to obtain latitude and longitude locations for the lightning features, find these locations at

other times when the locations are in daylight and were imaged by the Voyager spacecraft, and then compensate for wind motions before any associations can be made.

NASA-GODDARD INSTITUTE FOR SPACE STUDIES (New York, NY)

Colin Price and David Rind are studying how global lightning activity may be affected by climate change. To accomplish this they have introduced a lightning parameterization into the Goddard Institute for Space Studies (GISS) General Circulation Model. Good agreement exists between the models' control run and the available lightning data from satellites. Initial results show that for a doubled CO_2 climate, representing a 4 C global warming in our model, global lightning activity may increase by 25%.

NASA-KENNEDY SPACE CENTER (JFK Space Center, FL)

The Atmospheric Science field Laboratory will operate three major projects this year: Rocket Triggered Lightning, Electromagnetic Radiation Hazard Detection System and Test and Evaluation of Facility Lightning Protection Systems. The first two projects will also support the Convective area Precipitation Experiment (CaPE) and NASA Airborne Field Mill (ABFM) programs. Each of these projects will be supported by data acquisition vans and the high voltage calibration facility. All data collected during these projects will be archived for future analysis. Experimenters are expected to prepare a report of their results for an early Spring 1992 KSC Workshop.

The need exists for the simultaneous measurement of the entire electric field and visual characteristics of triggered/natural lightning processes. The Vertical Electric field soundings both prior to and during a rocket triggered lightning are very important in understanding triggered lightning processes. Other significant benefits are interpretation of data from both LDAR (Lightning Detection and Ranging) II and the Electromagnetic Radiation Hazard Detection System and development of a complete theoretical model of the physical processes involved in a triggered lightning event. It should be noted that validation of the above systems and model will lead to better warnings of adverse weather and launch criteria.

This year's Rocket Triggered Lightning Program will be conducted from July 15 through the end of August and will measure the vertical profile of the electric field intensity during triggered events using the classical French Ruggieri (1 KM alt) and the USA Army 2.75 FFAR (7 KM alt) rockets. These launches will be supported by a NRL 25,000 cubic feet Aerostat, tethered at 1.5 KM. The aerostat will support eight electric

(1991) deployment have produced data of excellent quality that are currently being analysed. The next ABFM deployment is scheduled to coincide with the CaPE program this summer.

Hugh Christian is coordinating the upgrade of the electric field mill network at KSC. Installation of the new network is planned to begin this fall.

Rich Blakeslee, Hugh Christian, and graduate students will make optical and electrical storm measurements during CaPE using the high altitude ER-2 aircraft. These will include measurements of the air conductivity and electric field for the determination of the electric currents over the tops of clouds, an experiment initiated during COHMEX in collaboration with Bernard Vonnegut of SUNYA. Plans are being made for participation in STORM-FEST (March 1992) and discussions are underway for possible ER-2 storm observations during TOGA-COARE in the Western Pacific Ocean. Rich Blakeslee and Hugh Christian in collaboration with Doug Davis of Georgia Tech will also be making electric field (field mill) and sferics (3M Stormscope) measurements on the DC-8 to support the Pacific Exploratory Mission (REM) tropospheric chemistry experiment. The objective is to better quantify NO_X production by lightning. The DC-8 is also under consideration for storm observations during TOGA-COARE.

Bill Boeck, Rich Blakeslee, and Skeet Vaughan continue to analyse shuttle lightning videos. A number of vertical lightning discharges have been identified and analysed. Efforts to coordinate the acquisition of shuttle lightning videos with ground based sferics measurements will be implemented on selected missions (first attempt was mission STS-37, April 5-11). Bill Boeck is at MSFC on a sabbatical visit from Niagara University.

Steve Goodman continues work with the DMSP Optical Linescan System (OLS) data. The DMSP archive data availability survey has been completed and plans are being made to start a digital archive by summer. The archive data set over Florida will be compared with LDAR and French interferometer data collected at KSC to understand the source and structure of the lightning streaks observed on the DMSP visible channel.

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR) (Boulder, CO)

Dan Breed and Jim Dye report that the NCAR sailplane will be participating in the CaPE project from 15 July through 11 August, 1991. During the months of May and June, flights will be made near Boulder for instrument check-out. The sailplane has been outfitted with a new data recording system, additional electric field mills, and a slightly modified particle charge (induction) ring. The data system changes will allow for better instrumentation diagnostics on the ground and improved post-flight

data analysis in the field. The new field mills, mounted around the mid-section of the fuselage, allow the determination of all three electric field components with some redundancy. The sailplane now has a complement of eight electric field mills. A new induction ring, which mounts on a PMS 2DC gray-scale probe, has been designed and built with improved deicing and near-probe airflow characteristics.

The sailplane will be operated out of Patrick Air Force Base during CaPE, allowing for close collaboration with the NASA Learjet and the Airborne Field Mill project. In addition, Dan Jones from NMIMT will be assisting with test flights out of Boulder and in the field during CaPE.

NOAA-HURRICANE RESEARCH DIVISION (Miami, FL)

In cooperation with John Hallett (DRI), NOAA/Hurricane Research Division will continue its efforts to obtain electric field and particle charge measurements in hurricanes and tropical oceanic cumuli, reports Robert Black. Two additional field mills for measuring E_y, the horizontal component of the electric field parallel with the wings, have been installed for the 1991 field season. Also, a controllable high-voltage supply has been installed on the NOAA P-3. They will use this device to attempt to neutralize the accumulated charge on the aircraft.

NATIONAL SEVERE STORMS LABORATORY (NSSL) (Norman, OK)

Activities for the Storm Electricity and Cloud Physics Research Group were given in detail in the last Newsletter. They consist of two categories: (1) measurements on intracloud lightning and (2) in situ measurements with balloons to determine the electric field, thermodynamics, wind, and precipitation charge and size inside mesoscale convective systems and isolated severe storms. As part of the Cooperative Oklahoma Profiler Studies (COPS-91), we will use two mobile laboratories for mobile ballooning and NSSL's nearly modified "Cimarron" Doppler radar that is coming on line with dual polarization capability. We will have microphysics and Doppler radar data from a NOAA P3 research aircraft. We also anticipate collaborative flights with the T-28 to investigate the electrical structure of severe storms. The lightning studies will be in collaboration with Bill Beasley (Univ. of Oklahoma), Marx Brook (NMIMT), and Zen Kawasaki (Osaka Univ.). The ballooning will be done in collaboration with Tom Marshall (Univ. of Mississippi). There are other university collaborators with whom we will work in various phases of COPS-91.

Vlad Mazur participated in the Int'l Aerospace and Ground Conf. on Lightning and Static Electricity and plans to participate in CaPE in Florida.

NSSL participated in the STORMFEST planning meeting held in Boulder, April 17-19, 1991 to explore the possibilities of measuring electric fields in winter storms. They propose to evaluate their mobile ballooning facilities and techniques in winter conditions.

Charles Doswell and Michael Branick have recently reported observations of the relationship between supercell structure and lightning ground strike polarity. Tornadic thunderstorms were widespread from southern Oklahoma northward through eastern Kansas and Nebraska during the afternoon and evening of March 13, 1990. Visual data from eyewitness photographers, supported by some Doppler radar observations, indicate a distinct difference in structure between the storms in central and southern Oklahoma and those from northern Oklahoma on into Kansas and Nebraska. The northern storms displayed a distinct separation between the mesocyclones and the precipitation cascade region, whereas the southern storms had significant precipitation within the mesocyclones. Based on the visual evidence, the southern storms were high-precipitation (HP) supercells, while those to the north were either low-precipitation or classical supercells. The vertical wind shear structure on this day was such that the storms northward from northern Oklahoma were in an environment with much stronger mid- and upper-level winds aloft than those in central and southern Oklahoma.

Cloud-to-ground lightning strike data collected during this event reveal a notable difference between the southern and northern storms. Whereas the northern storms (either classical or LP supercells) produced a predominance of flashes delivering positive charge to ground (+CG), the southern storms showed a majority of flashes lowering negative charge to ground (-CG). Several studies have noted an apparent connection between wind shear and +CG flash dominance. Our observations tend to support this and also suggest that the wind shear environment can affect storm structure as well as CG polarity. Put another way, the data indicate a possible connection between CG polarity and storm structure.

NATIONAL SEVERE STORMS LABORATORY (NSSL) (Boulder, CO)

Raul Lopez, Ron Holle and Bob Ortiz have been studying relationships between C-G lightning and radar activity for thunderstorms in northeastern Colorado as a function of their growth cycle and structure. In addition, they studied the distribution of flashes of both polarities in relation to the radar echo and satellite configuration of a thunderstorm cluster over Colorado as it became organized and grew into an MCS. Considerable work also has been devoted to the comparison of the signal strength distributions of positive and negative flashes. Finally, they studied the relationships between lightning activity and rainfall

distribution and intensity, as a finction of the convective available potential energy (CAPE) of the environment, the dynamic forcing provided by the sea-breeze in its interaction with the large scale flow, the energy picked up from the surface under different wind conditions, and the existence of disturbed or suppressed synoptic conditions.

Terry Schuur (NSSL in Boulder), Dave Rust and Steve Hunter (NSSL in Norman), and Tom Marshall (Univ. of Mississippi) are continuing investigations into the charge structure and possible processes involved in the electrification of MCS's over central Oklahoma. The analyses include examinations of balloon-borne electric field meter (EFM) data, dual-Doppler derived wind fields, in situ cloud microphysical data, and C-G lightning collected during NSSL's 1989 COPS program. Two EFM profiles from 1989 show marked similarities in overall charge structure, and are also quite similar to two previously-published profiles that were obtained immediately behind lines of intense convection. Other stratiform charge structure features that appear to be repetitive are regions of negative charge near the level of the radar bright band. They plan on collecting more data during NSSL's COPS program to be held from late April to June of 1991.

Irv Watson has obtained C-G flash data from the western U.S. in order to examine the Southwest U.S. monsoon in detail. Irv will be looking at the relationship of C-G flashes to upper-air and satellite information using BLM lightning data for the period 1985 to 1990. Irv, Ron Holle, Raul Lopez, and Bob Ortiz will also start to study MCSs over the region, as well as comparisons to radar data, and other operational and research topics pertinent to the meteorology and climate of the area, using flash data from the SWAMP program that was held in southern Arizona and northwestern Mexico in July and August of 1990.

NATIONAL WEATHER SERVICE (NOAA-NWS) (Silver Spring, MD)

The NOAA/NWS issued a Request for Proposals to industry on Feb. 22, 1991 for operational lightning data. The NWS is seeking data covering the conterminous 48 states and adjacent areas. In addition, as options, the NWS is interested in (1) data covering other areas where it has forecast responsibility, and (2) a data archive. Other federal agencies may eventually participate in the resulting contract. The award of a contract is expected in late 1991 reports Henry Newhouse.

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

Marx Brook will operate two wideband electric field sensors (with possible auxiliary optical channels) in Florida during CaPE. One of these sensors will be installed near the rocket triggered lightning site for purposes of correlating the electric field structure with UV pictures of

lightning obtained by Vince Idone of SUNYA.

Paul Krehbiel's main news at this point is the preparation to participate in the CaPE program with both dual-polarization radar and lightning interferometer. The primary goal of CaPE studies with radar is to further investigate the ability of radar to remotely sense electrical effects in storms at different stages of their life cycle. Observations during Summer 1990 with the radar in Socorro showed that electrical particle alignment occurs essentially thorughout the full horizontal extent of a dissipating storm above the brightband. This was detected by observing the cross-polar return from linearly-polarized transmissions, which changed every time a lightning discharge occurred in the storm, and was regenerated between lightning discharges. A passive radiometer experiment with the radar to detect changes in the radiation temperature of an electrically active storm at the time of lightning gave negative results, indicating that radiation from particles in corona discharge is not strong enough to be detected at 3 cm wavelength. A real-time processor is being developed for the radar using PC-cased digital signal processing cards and the PC monitor for graphical display, to aid in the radar studies. The processor is relatively inexpensive and has good capability.

Concerning the lightning interferometer, we have developed a very nice set of analysis routines for the data using a commercial software package, and graduate student Xuan-Min Shao has used this to analyze several flashes. A paper detailing some results was presented at the recent ICOLSE conference in Florida and will appear in the proceedings.

STATE UNIVERSITY OF NEW YORK AT ALBANY (Albany, NY)

Bernard Vonnegut and Anton Seimon have recently examined the intriguing relationship found between the polarity of lightning and its temporal evolution in several severe storms with F5 tornadoes. A paper on this topic is presently in preparation for submission to the reviewed literature.

Bernard Vonnegut also is looking for an aircraft to drop chaff during the CaPE experiment this coming summer at KSC. (If anyone knows of an aircraft that could be used, please contact Prof. Vonnegut!) The disposition of the chaff as observed by several of the highly specialized radars to be deployed should provide basic data on the motion of air in and around convective clouds. This, in turn, should allow a more stringent examination of various aspects of the convective theory of thunderstorm electrification.

The recent shuttle observations of lightning analyzed by Christine Breslawski-Skubis have been summarized in a NASA Technical Report, "Size, Duration, and Rate of Growth of Nocturnal Lightning Events

Appearing on Space Shuttle Video Tapes", (NASA CR-4313). Ricardo Lopez-Torrijos recently completed a Master's thesis titled "Production of Electrically Atomized, Monodisperse, Sub-Micron Liquid Aerosols".

Ken Demerjian continues as Director of the Thunderstorm Analysis Center and Project Director of the SUNYA-EPRI Lightning Detection Network. The network has recently expanded to include coverage of Arizona and New Mexico. Ron Henderson and Rich Pyle continue to develop operational aspects of the network. Ron has enhanced the stroke processing and waveform capture capabilities of the network. Peter Manousous is nearing completion of his Master's thesis on a study of ground flash characteristics for the Northeast as related to the local topography and different meteorological regimes. Scott Jacobs continues his thesis work on the relation of various meteorological parameters and the polarity of lightning ground strikes. Michael Brock recently completed a Master's thesis entitled "The Observation and Implications of a Storm Dominated by Positive Lightning".

Vince Idone, Ron Henderson, and Rich Pyle are analyzing the performance characteristics of the SUNYA-EPRI LDN with respect to stroke peak current, flash multiplicity, flash location and detection efficiency as verified through the triggered lightning observations at KSC from 1985 through 1990. This analysis has been ongoing but limited because of the number of events obtained for '85 through '88. However, with the advent of the stroke processing capability for '89 and '90 triggered flashes, the dataset has increased dramatically. This will allow the kind of stringent analysis that was previously impossible.

Vince Idone has recently received NSF funding to continue analysis of the photographic lightning data obtained in recent triggered lightning campaigns and to participate in the next two field programs at KSC. Various integrated and time-resolved photographic observations will be made, including highly time-resolved recordings (3-5 us time resolution) of the variation of the lightning channel diameter (near ground) throughout the course of a flash. The observations will be made in coordination with the measurements of Pierre Laroche (ONERA), John Willett (AFGL), and Marx Brook (NMIMT).

ONERA (Meudon, FR)

Anne Bondiou and Pierre Larouche are conducting a program of theoretical modelling of positive and negative leaders, in collaboration with Professor Gallimberti (Univ. of Padua).

The analysis of the basic phenomenology of the positive leader has been oriented in two directions: a general analysis of the physical processes involved in the development of a positive leader in long air-gaps in the laboratory and an experimental and theoretical study of the positive

leader of triggered lightning.

A complete and self-consistent model of the successive stages of the laboratory positive leader has been developed based on the classical plasma models of the streamer and leader phases. The simulation has been tested under a wide set of laboratory conditions and is in excellent agreement with experimental data. The simulation of the development of the triggered lightning positive leader has been performed using the same basic model, taking into account the specific plasma processes due to higher currents involved. The results of the simulation are consistent with experimental data especially as concerns the leader onset, the current's shape and peak values, and the leader velocity. Further work is needed to improve the calculation of field distribution which includes the ambient external field and local fields due to the leader and corona space charge.

The modelling of the negative stepped leader process is currently under investigation, also based on the analysis of the laboratory negative discharge mechanisms. Particular attention is devoted to the interstep processes in order to simulate correctly the stepping period.

OFFICE OF NAVAL RESEARCH - EUROPE (London, England)

The WMO Data Centre on Atmospheric Electricity in Leningrad routinely publishes every month (since January 1964) hourly averages of atmospheric electricity data (field, conductivity, current, and related meteorological information) from 12 stations, up to 744 data per parameter per station per month. Several issues with aerological data have been released. At present, work is underway to transform all these data for computer use. About 60 papers, mostly in Russian, have been published based on data from this collection. Discussions are now underway concerning the potential use of this collection for the monitoring of global change reports Hans Dolezalek.

RICHARD E. ORVILLE (Schenectady, NY)

Dick Orville has completed two papers on the SUNYA national lightning detection network. The first (Monthly Weather Review, 119,2,February 1991,573-577) reports the first measurement of the annual lightning ground flash density in the contiguous U.S. Using LLP sensors from the BLM, NSSL and SUNYA networks, it is found that the peak value occurs near Tampa, Florida with secondary maxima off the Carolina coast and in central Kansas. A second paper in press, (Journal of Geophysical Research, 1991) is entitled, "Calibration of a magnetic direction finding network using measured triggered lightning return stroke peak currents." In this paper, it is shown that (1) peak currents can be derived from LLP high gain units, (2) the magnetic radiation field in

Florida decays as $D^{-1.13}$, and (3) an evaluation of the error in the mean range-normalized signal strength amplitude caused by lightning location errors reveals that the mean amplitude is typically in error by less than 2%.

THE SOUTH DAKOTA SCHOOL OF MINES (Rapid City, SD)

Three papers concerning thunderstorm modeling are in various stages of preparation for JGR-Atmospheres. One concerns their lightning parameterization scheme, another is regarding ion injection into clouds, and the third, a part of their series involving the simulation of the 19 July CCOPE storm.

On the experimental side, an investigation is continuing of the 28 June 1989 outbreak of severe storms during the North Dakota Thunderstorm Project (NDTP) which produced a high percentage of positive flashes to ground. Also an analysis of T-28 electric field data from the 17 July 1989 NDTP decaying squall line case is proceeding. Preliminary results from both of these studies were presented at the Severe Storms Conference in Kananaskis Park. We are also preparing for the deployment of the T-28 research aircraft for both COPS-91 and CaPE. From an electrical standpoint, the T-28 will be making electric field measurements within these two very different environments.

UNIVERSITY OF TOYKO (Toyko, Japan)

Masaru Ishii is preparing to conduct EM field observations in Indonesia. Also, he has begun evaluation of an LPATS system owned by an electric power company, and finished calibration of the sensitivity of each remote receiver.

U.S. DEPT. OF AGRICULTURE (Intermountain Fire Sciences Lab) (Missoula, MT)

Don Latham is currently running some investigative tests on charge release by wind-driven fire in their wind-tunnel facility. Preliminary indications are that there is significant charge released, even in a field free space, and that the charge release is not associated with the flaming part of the combustion. In fact there are indications that the charging has some resemblance to triboelectric effects (like blowing snow).

UNIVERSITY OF WASHINGTON (Seattle, WA)

Bob Holzworth reports that a new thunderstorm rocket and balloon program is underway. The project is titled 'Middle atmosphere electrodynamics during a thunderstorm' and Charles Broskey (Penn State) is the PI; John Mitchell, Leslie Hale (Penn State) and R. Holzworth (Univ. of

Washington) are co-PI's. The stated goals of the program are 1. investigation of thunderstorm effects on middle atmospheric electrical structure, 2. characterization of the electric field transients and the associated energy deposited at various altitudes, 3. evaluation of the vertical Maxwell current density over a thunderstorm and 4. investigation of the coupling of electrical energy to the ionosphere and current to the 'global circuit'. The program involves the launch of two middle atmosphere rockets and some balloons over a thunderstorm within range of the Wallops Flight Facility impact zone off the Atlantic coast. The program is now planned to be launched in July 1992 and will involve extensive coordination with ground based thunderstorm instrumentation such as the NLDN (National Lightning Detection Network) and the SPANDAR radar. Anyone with East Coast thunderstorm research plans for next summer is encourgaged to discuss the possibility of coordinated observations with C. Croskey (814) 865-2357 or R. Holzworth (206) 685-7410.

ELBBO Update: The Extended Life Balloon Borne Observatories (ELBBO) program has gotten underway with a successful test flight in November 1990 from New Mexico and a prototype superpressure balloon payload from Christchurch, New Zealand in February 1991. The test flight also included a comparison between Maxwell current density detected with a split Langmuir probe, and the current density determined by separate electric field and conductivity measurements. The prototype flight was launched successfully and obtained good data for about a day before a power system failure resulted in loss of telemetry. The Main Sequence ELBBO flights are tenatively planned to begin in November 1991 from Christchurch, New Zealand. Attempts to get NASA to allow the Main Sequence flights to be launced in the northern hemisphere have failed.

Robert Solomon and Marcia Baker will examine radar and aircraft data from several New Mexico storms as we develop our thunderstorm model. Our plan is to use the radar derived winds as direct inputs to the microphysical/electrical model. We will attempt to identify those parameters of low level soundings that promote thunderstorm electrification as a first step in developing a thunderstorm climatology.

Robert Solomon will participate in CaPE this summer working with both Jim Dye and Hugh Christian and their groups.