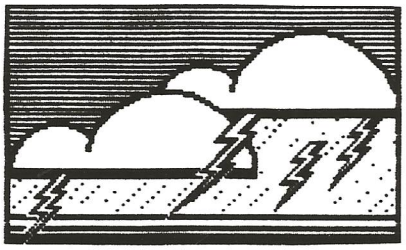
# NEWSLETTER ON ATMOSPHERIC ELECTRICITY

**VOL. 2 NO. 2**
**NOVEMBER 8, 1991**

**AMS COMMITTEE ON**
**ATMOSPHERIC ELECTRICITY**



## ANNOUNCEMENTS

The deadline for abstracts for the **Cloud Physics Conference** in **Montreal** in **August 1992** has been extended to **November 15th.**

The Annual **CASE/AMS Meeting** will be held at the **AGU MEETING** in **SAN FRANCISCO** on **Tuesday, December 10th. (Embarcadero Room, Cathedral Hill Hotel, 7:00 to 9:00 p.m.)** This meeting could not be scheduled on Wednesday evening (the day of the main Atmospheric Electricity sessions at AGU) because of a conflict with the AGU banquet. Topics for discussion include CaPE results, NLC-91, ELBBO, Antartica measurements, Christmas Island kites, National Network, Satellite Lightning Mapping, triggered lightning and future meetings. Other suggested topics should be communicated to **Bob Holzworth** or **Earle Williams**.

Abstracts for the **9th International Conference on Atmospheric Electricity (St. Petersburg, U.S.S.R.)** were due on **October 20th.** Final selection is by **November 20th.** Contacts are **John Latham (FAX: 44 61 2003941) and Ya.M. Shvarts (FAX: 7-812-247-8661).**

**Bill Beasley** is preparing a review article for **Nature** on recent developments in atmospheric electricity and is soliciting suggestions and contributions. Contact him at:

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For additional information, see Bill's entry under the **University of Oklahoma (page 11).**

**Phil Krider**, currently Editor of the **Journal of the Atmospheric Sciences**, has suggested the possibility of a special issue of **J.A.S.** to cover results from the St. Petersburg Conference. This suggestion will be up for discussion at the **CASE/AMS** meeting in **San Francisco** on **December 10th.**

**This newsletter is currently received by about 300 people in 20 different countries. The response to request for contributions has increased steadily with each issue.**

## RESEARCH BY ORGANIZATION

**ASTeR, Inc. (Fort Collins, CO)**

Walter Lyons, Robert Walko, Melville Nicholls, Roger Pielke, William Cotton, and Cecil Keen, and Andrew Watson (NSSL, Boulder, CO) have completed a climatological study of the Merritt Island Effect (MIE) and a test of a new interactive grid model with explicit microphysics to simulate MIEs. They are planning further evaluations of the model with CaPE data, and hope the atmospheric electricians can provide a robust relationship between parameters the model can simulate (bulk microphysical water and ice properties) and lightning to provide for the inclusion of "lightning potential" in the model.

**Airborne Research Associates (Weston, MA)**

Ralph Markson has continued development of the M-10 hand-held lightning detector which contains independent optical and electrostatic field change sections. These can be operated separately or in coincidence to eliminate false signals. The instrument is being marketed in numerous areas including golf, boating, government labs and outdoor activities.

**University of Arizona (Tucson, AZ)**

Capt. Timothy Oram completed a comparison of lightning locations, LLP and field mill, with cloud radar reflectivities at the NASA Kennedy Space Center (KSC). A manuscript describing this work is planned for Weather and Forecasting. Tim is now on active duty with the USAF Air Weather Service in Las Vegas, NV.

During the summer of 1991, Lori Tyahla worked an analyses of cloud-to-ground lightning data with R. Lopez and R. Holle at the NOAA National Severe Storms Laboratory in Boulder, CO. E. Philip Krider participated in the CaPE experiments and plans to analyze data derived from the KSC field mill network together with CP-2 weather radar data. The radar data analyses will be a collaboration with Art Jameson of the Applied Research Corporation.

On November 18-21, there will be a joint U.S.-Japan Workshop on the Physics of Lightning in Nagoya, Japan. The U.S. participants will be M. Brook, V. Idone, E.P. Krider, V.Mazur, J.A. Plumer, M.A. Uman and J.C. Willett.

**Colorado State University (Fort Collins, CO)**

Terry Schuur and Steve Rutledge of CSU, in collaboration with Dave Rust of NSSL and Tom Marshall of the University of Mississippi, will be investigating the charge structure and electrification processes of midlatitude mesoscale convective systems (MCSs). This will be accomplished by examining a combined data set consisting of multiple electric field meter (EFM) profiles, Doppler radar data from both ground-based and airborne platforms, and in situ microphysical data collected during the COPS91 program. Possible relationships between MCS kinematic, microphysical and in situ electrical properties will be examined with the results being compared to microphysical charging mechanisms suggested in the literature and observed cloud-to-ground lightning flash rates and distributings. Future work may also include modelling efforts in an attempt to replicate observed charge features.

Walt Peterson and Steve Rutledge are conducting research on data collected from DUNDEE (Down Under Doppler Electricity Experiment) conducted in Tropical North Central Australia during the Australian summers of 1988-89 and 1989-90. The data set includes radar, profiler, lightning (4LLP DF antennas) and electric field mill data. The LLP and field mill data are being used concomitantly with the radar and profiler data to investigate possible mechanisms for the development of cloud-to-ground lightning in the trailing stratiform regions of tropical mesoscale convective systems (MCSs). We have also compiled statistics on 4976 flashes taken from eight different tropical MCSs to evaluate parameters such as average peak currents, flash rates, and flash polarity percentages. The peak current statistics have allowed them to correlate the position of maximum and minimum positive peak currents to type of precipitation, (convective or stratiform) in six mature MCSs. The results show a tendency for maximum positive peak currents to occur in stratiform precipitation 70 percent of the time, while the minimum positive peak currents are found in the convective precipitation 89 percent of the time. This may indicate that a larger charge volume is being tapped by flashes occurring in the region away from the main convection.

Scot Randell and Steve Rutledge, together with Dick Farley and John Heldson are conducting numerical modelling studies of the electrification of tropical convection using the South Dakota School of Mines SEM (Storm Electrification Model). Simulations of convection in continental tropical (high Convective Avaliable Potential Energy) and maritime tropical (low CAPE) have been completed. These simulations aid in the understanding of how the microphysics and dynamics of these types of tropical convection influence the effectiveness of the non-inductive charging mechanism. Results indicate that the continental tropical storm develops a deep mixed phase region at temperatures well below the charge reversal temperature, thereby effectively producing a normal polarity dipole (consistent with high obser ved lightning flash rates). The maritime tropical case also produces a deep mixed phase region, but it is centered near the charge reversal temperature. This prevents ice particles from acquiring and accumulating charge of one sign, and no organized charge structure develops (consistent with the low observed flash rates). Currently, it is hypothesized that the low CAPE storms, although they have deep mixed phase regions, lack the energy to carry the ice mass to
sufficiently low temperatures to produce a dipole structure as in the case of the high CAPE continental tropical storms.

**Consulting Bureau Reiter (Garmisch-Partenkirchen, Germany)**

Reinhold Reiter operates two stations for atmospheric electricity. The station at 1780 m a.s.l. on the Wank peak has now been expanded with an electronic data processing system with an automatic telemetry device which fills the data in the main computer (150 MB hard disc) in the nearby valley station at 740 m a.s.l. (Garmish). The computer on the Wank station operates with a 40 MB hard disc and can store the data for about 60 days. The data are sampled with a frequency of 1 tp 10 seconds (optional). The data are: electric field, air-earth current, point discharge current, air conductivity, air temperature and humidity, precipitation and brightness

of the sky (as cloud indicator). The same parameters are recorded at the valley station.

Dr. Reiter has just published a book, Phenomena in Atmospheric and Environmental Electricity, which presents, defines and explains the main phenomena of atmospheric electricity found in the lower atmosphere, with emphasis on the troposphere and the stratosphere/mesosphere up to 60-70 km. The book also deals with electric phenomena in the biosphere. It is available from Elsevier Science Publishers.

**Desert Research Institute (Reno, NV)**

John Hallett of DRI, in collaboration with Clive Saunders of the University of Manchester Institute of Science and Technology, Bob Black and Paul Willis of the Hurricane Research Division has taken part in the CaPE experiment over the Kennedy Space Center in Florida. Equipment to measure electrical properties of clouds (vertical, horizontal electric field, particle charge, and ice particle size and concentration), designed and built at DRI by Rick Purcell and Harold Faretto from DRI, was flown in the NOAA P3 Orion during penetration through developing and mature thunderstorms in August 1991.

The purpose of the study was to relate the evolution of the ice phase as the storm developed to the build-up of electric field and the electrical charges acquired by individual particles as they grow. Sequential aircraft penetrations were made as clouds grew at speeds up to 25 m $s^{-1}$ through the O C to -10 C level; data from other aircraft will be integrated with the P3 data as the analysis proceeds.

The aircraft results will be interpreted in terms of laboratory studies carried out by Ya-Yi Dong on simulation of ice crystal and soft hail particles in the laboratory. In this work ice crystals and graupel particles are grown in a specially designed chamber in which conditions can be controlled to simulate the atmosphere. These particles become charged under quite specific conditions and charge separation occurs during collision and separation because of different fall speeds of the particles.

**Dimensions (St. Aubin Cedex, France)**

Dimensions has developed, under contract with ONERA, a 3D version of the SAFIR system to be used in a research program conducted by ONERA in collaboration with MIT Lincoln Laboratory. The system was tested in September in Orlando, Florida and analysis ofpreliminary data is currently underway.

A tornado-producing thunderstorm occurred in the Paris area on August 22, 1991. This storm propagated for 4 hours over a distance of 250 kilometers. The tornado formed after one hour and 45 minutes of electrical activity and was followed by very intense precipitation and hail. Observations with the SAFIR system used in the Paris area by the French National Weather Service revealed very intense intra-cloud activity. The ratio of total activity detected by the SAFIR system and cloud-to-ground activity detected by a cloud-to-ground lightning location system was 100 to 1.

Philippe Richard and Zen Kawasaki from Osaka University are currently conducting statistical comparisons between radar data and SAFIR data. This study is performed on a large number of thunderstorms observed last summer in Japan with the SAFIR system operated by Osaka University. Results of this study will be presented at the St. Petersburg conference.

**University of Florida (Gainesville, FL)**

Ewen Thomson, Pedro Medelius and Yosev Yariv obtained multiple station wideband (600 Hz-3.5MHz) electric field measurements from lightning at Kennedy Space Center (KSC) this summer. The data are presently being analyzed for the locations and physical characteristics of the sources, which include processes other than typical lightning.

D. Jordan, (Univ. of North Florida), V.A. Rakov, M.A. Uman, and W.M. Beasley (Univ. of Oklahoma) have found a total of twenty one daylight streak-camera records of subsequent strokes, ten of which had visible dart leaders, from 1979 and 1982 data. Correlated vertical electric field measurements were available for all the strokes. They suggest that previously reported distributions of dart leader speeds are likely skewed toward the higher speeds.

R.J. Fisher, G.H. Schnetzer (Sandia National Labs), R. Thottappillil, A. Rakov and M.A. Uman are reviewing data obtained when Sandia National Laboratories measured triggered lightning currents at Kennedy Space Center during the Summer of 1990, and from Alabama in July 1991. Among the results, obtained from a preliminary analysis, are that the return stroke peak current decreases with an increase in the 10 to 90% rise time of the return stroke current wave front (correlation coefficient = -0.53, statistically significant at 0.01 significance level), an observation which is not in agreement with previous studies.

M. Rubinstein, F. Rachidi (Lausanne, Switzerland), M.A. Uman, D.M. Jordan, A. Aka (Cote d'Ivoire, Africa), A. Eybert-Berard and L. Barret (Grenoble, France) conducted measurements of the channel-base current simultaneous with the vertical and horizontal components of the electric field 30 m from artificially initiated lightning at Kennedy Space Center during the Summer of 1991. Results from this, and the other studies mentioned above from Martin Uman's group, will be presented at the fall AGU meeting.

**Geomet Data Services (Tucson, AZ)**

In May 1991, Geomet Data Services, Inc. (GDS) was formed to operate and manage the National Lightning Detection Network (NLDN), formerly operated by the State University of New York at Albany (SUNYA). Under terms of the agreement, GDS will continue to supply data for research to the Electric Power Research Institute (EPRI) through the year 2001. GDS's goal is the expansion of user services and detection capabilities to the broader industrial marketplace. Additionally, continuing the NLDN's role as provider to the national lightning experiment, GDS will be exploring ways of supporting the research community's growing application-oriented studies. Key initial SUNYA developers Ron Henderson and Rich Pyle are under contract to GDS to build a new Network Control Center that will eventually transfer to Tucson, Arizona, home of sister company LLP.

**Lawrence Livermore National Laboratory (Livermore, CA)**

Livermore Lab reports they have overcome a recurring problem with the atmospheric potential probe (Airborne Research Associates--ARA--model P-1) in use at the U.S.D.O.E. Nevada Test Site (NTS). Apparently, extremely high electric fields had been causing some of the probe's very high voltage components (rated on the order of 400 kV) to breakdown. Lowering the probe tip to approximately 10 m, and adding a spark gap and capacitor to limit transients, has allowed the system to survive and produce data during a number of local thunderstorms. Several of ARA's M-10 optical intracloud lightning detectors are being evaluated, as safety instruments, by field personnel at the NTS and their high-explosives test site near Livermore, CA.

Richard Hasbrouck, Chairman of the (DoD) Range Commanders Council (RCC)/Meteorology Group/Lightning Prediction and Detection Committee (LPDC) reports that the RCC will publish the "Proceedings of the 1990 Lightning Seminar" (hosted by White Sands Missile Range, Feb. 1990) in early 1992. Also, a one-day Lightning Prediction and Detection Workshop will be held on 8/14/92 in Salt Lake City, UT in conjunction with the 72nd Meteorology Group meeting (hosted by Dugway Proving Grounds). Results of the 1991 lightning survey are being analyzed with assistance from the Office of the Federal Coordinator for Meteorological Services (OFCM); survey results will be made available to interested parties. H. Newhouse, Chairman the the OFCM Lightning Working Group, gave a detailed briefing, the essence of which was the 60% (overall) of the NWS forecasters surveyed believed that lightning

mapping was a useful adjunct to other climatological data; a liaison has been established between the OFCM Working Group for Lightning Detection Systems (WG/LDS) and the LPDC.

**Lightning Location and Protection (LLP)(Tucson, AZ)**

LLP has developed a single station device capable of detecting cloud and cloud-to-ground discharges. The technology uses optical and electric fields emitted by lightning to detect and range cloud-to-ground activity occurring out to 20 nautical miles, and separately reports cloud discharges out to a range of approximately 10 miles. User programmable relays are available to provide automated warnings or to isolate sensitive equipment from electrical noise. To remove the danger of power transients, the device is self-powered using a photo voltaic panel and an optical fiber link to an LED display. Siting requirements are very flexible and allow the unit to be adapted to harsh environments. Shipment began in July of this year; international sales begin in December.

A study of LLP network performance was conducted by Computer Sciences Raytheon Corporation for the ESMC complex. Their report concluded that: "the distribution of expected locating errors for all flashes detected by three or more ALDFs within 10 km of SLC 41 (Launch pad) during 1990 was found to be consistent with the ground truth results after application of the bias error corrections. With the corrections applied, 10% of all flashes near SLC 41 are located within 100 m, 50% are located within 300 m, and 90% are located within 600 m."

**University of Manchester Institute of Science and Technology (UMIST) (Manchester, UK)**

John Latham reports that a series of laboratory experiments involving both real and simulated hydrometeors has been conducted into the threshold conditions for corona emission possibly leading to the onset of lightning. These studies have been carried out in collaboration with Alan Blyth of New Mexico Tech.

The critical electric field $E_c$ required to induce corona when pairs of raindrops of radii R and r collide with relative velocity V was found to decrease with increasing values of R, r, V and impact parameter X. In circumstances representative of those occurring in a thunderstorm, values of $E_c$ as low as 1.5 - 2.0 KV/cm were found, which are less than those required for subsequent propagation of a discharge. These lowest values of $E_c$ occurred when the liquid 'spike' produced during the initiation of the drops was of maximum length.

Collisions between 'cold' hydrometeors of precipitation dimensions produced corona emission in electric fields as low as 2.5 - 3.0 KV/cm. Corona threshold experiments involving supercooled raindrops and melting ice particles are in progress. Also, data from major airborne investigations of thunderclouds are being analyzed in an attempt to establish the possible roles of each of these corona emission processes in lightning initiation; and to account for the differences between summer and winter thunderstorms.

**MIT Lincoln Laboratory (Lexington, MA)**

Mark Weber reports that a cooperative experiment involving an FAA-supported triple Doppler radar network and various thundercloud electrical measurements took place at the Orlando, Florida airport during June-September, 1991. Lincoln Lab's TDWR testbed (FL-2), University of North Dakota's C-band radar and the MIT Weather Radar Lab's C-band radar were deployed in a short-baseline (15 km) configuration around the Orlando airport. A network of corona point sensors, an electric field mill and a slow antenna documented electric field evolution at the ground. During September, a two-station interferometric lightning mapping system (SAFIR) with 20 microsecond time resolution and 3-dimensional localization capability was deployed by ONERA. New Mexico Tech deployed a single-station interferometric lightning

mapper with 1 microsecond time resolution.

Frequent thunderstorm activity during the June-August time period produced an excellent data set of multiple-Doppler radar and surface electric field measurements. Unfortunately, September was relatively quiet. Simultaneous documentation of thunderclouds with the radars and interferometers was obtained on eight days during September. Data analysis is underway.

**MIT Weather Radar Laboratory (Cambridge, MA 02139)**

As a further test of the sensitivity of tropical lightning to temperature change, Phillippe Richard of Dimensions has provided Earle Williams with daily lightning counts from the SAFIR interferometer system in Kourou, French Guyana for all of 1989. Comparisons with wet bulb temperature records for the same period show a 20-fold change in lightning activity for a 1.3 C change in temperature. This sensitivity is attributed to modest changes in potential buoyant energy which cause large changes in the amount of ice phase condensate aloft in deep convection, as noted earlier in DUNDEE (Darwin, Australia).

The sensitivity of lightning to temperature change begs the use of the global circuit as a global 'thermometer'. Recent analysis of the diurnal variation of cloud electrification and comparisons with the amplitude variaiton of the Carnegie Curve with Stan Heckman supports the older idea that lightning is not a major player in maintaining ionospheric potential. We are therefore quite interested in the use of Schuman resonance amplitudes as a potentially sensitive global thermometer.

MIcrophysical calculations by Renyi Zhang and observations of lightning in stratiform precipitation in Orlando with Dennis Boccippio and collaborators from Lincoln Laboratory continue to support the association of sublimation with negative graupel charging and deposition with positive graupel charging. We are presently seeking in situ measurements of temperature, liquid water content and graupel size so that the microphysical state of the rimed particles can be identified at various levels in electrified clouds. We have already received valuable data of this kind from Andy Heymsfield and Jim Dye for a New Mexico thunderstorm and from Rob Black for the eyewall convection in Hurricane Emily.

Igor Gonta is constructing a calibrated Franklin Chimes for operation in both fair and disturbed weather. The elevated electrode is on the 100 m tall Green Building on the MIT campus. Its high potential will drive the oscillation of metal spheres suspended between parallel plates in the building below.

**University of Mississippi (Oxford, MS)**

Tom Marshall (on sabbatical for the 1991-92 academic year) is spending the fall semester as a Visiting Research Scientist at the Univ. of Oklahoma/CIMMS/NSSL working with NSSL scientists on data taken during COPS-91. During COPS-91, Tom and Dave Rust launched balloons carrying electric field meters into mesoscale convective systems. For the first time they made multiple launches from two locations into the same storm; on the best days 6 instruments (3 from each site) traversed a storm. Several soundings through the trailing stratiform cloud of an MCS were remarkably similar despite being separated by 50 km and 1 or 2 hours. These results will be presented at the fall AGU meeting. Tom will spend the spring semester as a Visiting Scientist at NCAR working with Jim Dye on particle charge measurements taken in CaPE.

**NASA Ames Research Center (Moffett Field, CA)**

A special session on planetary lightning, chaired by W.J. Borucki and C.T. Russell, was held at the AGU Spring Meeting 1991 in Baltimore. Ten papers on planetary lightning were presented. The first paper, by W.L. Boeck, presented a video tape of Space Shuttle observations of a newly discovered type of lightning discharge that is diffuse and propagates upward from terrestrial

clouds. A paper by W.J. Borucki and colleagues discussed the results of a recent search for optical pulses from lightning on the nightside of Venus. These results indicated that optical flashes from lightning are weak or absent on the nightside and are consistent with the radio results if the lightning detected by the electric field detectors is produced only on the dayside. D.A. Gurnett and colleagues examined the results of the Galileo spacecraft encounter with Venus and found evidence for lightning from the plasma wave receiver. V.S. Sonwalker, R.J. Strangeway, C.T. Russell and C-M Ho presented papers on the anlysis of VLF measurements of Venusian radio signals. These analyses imply that some of the VLF waves are not caused by lightning, but that a substantial fraction have the properties expected for lightning generated waves. Further work is in progress to develop techniques to distinguish between lightning and non-lightning events. M. Dubin discussed the VLF signals generated by meteors entering the Earth's atmosphere. D.A. Gurnett and colleagues advanced evidence for lightning generated whistlers in the atmosphere of Neptune. They concluded that the space plasma needed to cause the observed dispersion must be at a much higher density and at a lower temperature than expected to be present near Neptune. J.D. Menietti and colleagues presented a ray tracing program to investigate the propagation and dispersion of whistlers in Neptune's magnetosphere. Their calculations support the conclusion that the signals observed by the Voyager spacecraft during its encounter with Neptune were generated by lightning discharges.

**NASA Goddard Institute for Space Studies (New York, NY)**

Colin Price and David Rind are continuing their work on developing a simple lightning parameterization to be used in general circulation models (GCMs), for modeling global lightning activity. The parameterization relates convective cloud top height to lightning activity, with different formulations for continental and marine thunderstorms. To validate the parameterization, extensive work has been done with the international satellite cloud climatology project (ISCCP) data set. Convective cloud heights from this data set have been used with the parameterization to simulate global lightning frequencies. The calculated values were then compared with available DMSP lightning data. Various statistical tests show the correlation between the simulated and observed lightning data sets is highly significant.

**National Center for Atmospheric Research (NCAR) (Boulder, CO)**

Dan Breed of the Mesoscale and Microscale Meteorology Division reports that the NCAR sailplane took part in the CaPE project, making 24 flights between July 16th and August 11th. Twelve flights were made in electrified clouds and measurements above the -5 C level were obtained on six of those flights. Copious amounts of data were obtained from the 2D probe with induction ring, although the sensitivity of the charge data appear to be no better than 2-3 pC due to noise.

Several early electrification cases exist with multiple penetrations by the NCAR and Wyoming King Airs. Preliminary analysis indicates that the E-field measurements from the NCAR King Air are of good quality, and work is continuing at NCAR and New Mexico Tech (Dan Jones) on calibrating the field mill system and assessing these measurements.

Extensive efforts were made in CaPE to intercompare E-filed measurements from the various aircraft. Results of these intercomparisons will be valuable in combining the data in case studies. Of greatest interest are the early electrification cases studies by both NCAR aircraft, with particular focus on the in situ microphysical development and multiparameter (CP-2) radar data.

**NOAA Hurricane Research Division (Miami, FL)**

Robert Black reports that the first useable ice particle charge data obtained from the NOAAP-3 were obtained during 6 flights in support of CaPE. Simultaneous measurements of PMS 2-D particle size distributions, FORMVAR replica and the vertical and horizontal components of
the electric field were also obtained. Similar data were collected in Hurricane Claudette on 8 Sept. 1991 as part of the Hurricane Research Division's (HRD) Hurricane Electrification experiment. Claudette is also the first hurricane in which particle charge data were collected.

**NOAA/National Severe Storms Laboratory (NSSL) (Norman, OK and Boulder, CO)**

During the 1991 Spring season, NSSL was involved in the Cooperative Oklahoma Profiler Studies field program (COPS-91) that included a major component to obtain in situ measurements of electrical parameters of mesoscale convective complexes (MCSs). Visiting investigators from several institutions joined, and some of their activities are found elsewhere in this newsletter. Facilities and instrumentation used in COPS-91 included the NOAA P3 with Doppler radar, dropsondes, and microphysical probes, balloon-borne electric field meters (EFMs) and particle charge and size (q-d) measuring instruments, NSSL's newly upgraded polarization diversity Doppler radar (CIM), two mobile laboratories, lightning ground strike location network, the SDSMT T-28 measuring electric fields and microphysics, new wind profilers, and other ground-based Doppler radars.

Most of the EFMs we flew were a new higher resolution (12 bit) version designed by engineer John Carter. This allows more accurate computation of the horizontal electric field and increased dynamic range (54 V $m^{-1}$ to 220 kV $m^{-1}$). The q-d instruments flown were those first described at the last AGU fall meeting by Ph.D. candidate, Monte Bateman.

Collaborating on the studies of the charge structure and its relationship to MCS dynamics are Tom Marshall (on sabbatical from University of Mississippi), Brad Smull and Dave Jorgensen (NSSL, Boulder), Don MacGorman and Dave Rust (NSSL, Norman), and Terry Schuur (CSU). Other student participants in mobile ballooning and data analysis are Bateman, and Maribeth Stolzenburg and Tom Shepherd. We are focusing on data collected during three MCS events: 8 May (6 EFMs released in the convective line, transition zone, and stratiform rain region of a large bow echo MCS); 24 May (5 EFMs released in transition zone and stratiform rain band of a strong squall line); and 2 June (7 EFMs released in stratiform region of bow echo MCS). The EFM data are unique in that many of the soundings were simultaneous releases by both mobile labs separated by 50 km. An interesting preliminary result is the similarity of the profiles from the bow echo cases, while the profiles from the squall line case closely resemble earlier profiles taken in a 1987 squall line. Research plans include relating charge regions to dual-Doppler derived flow features and hydrometeor characteristics. Several abstracts have been submitted to the AGU fall meeting.

Vlad Mazur made lightning measurements that included high-resolution field change, high-speed and regular video, optical pulses and magnetic field at two sites (NSSL and OU) in collaboration with Bill Beasley (Univ. of Oklahoma) and Zen Kawasaki (Osaka Univ.). Vlad continued these measurements plus radiation fields on natural and rocket-triggered lightning at two sites in CaPE. Vlad will travel to Japan in November as an invited participant in a joint U.S.-Japan seminar on lightning.

Don MacGorman and Don Burgess have been examining severe storms in which almost all cloud-to-ground lightning lowers positive charge to ground for periods ranging from one to several hours. Cloud-to-ground flash rates and densities are often comparable to those of negative cloud-to-ground lightning in normal storms. Most storms with unusual numbers of positive cloud-to-ground lightning flashes produce tornadoes, and all produce large hail.

**NOAA/National Severe Storms Laboratory (NSSL) (Boulder, CO)**

Irv Watson is currently examing the Southwest Monsoon in a lightning context. Using 6 years of BLM cloud-to-ground lightning data, and sounding data from the U.S. and Mexico, Irv is investigating the regimes that bring high thunderstorm activity (high CG counts) as well as periods of little or no thunderstorm activity to Arizona.

Raul Lopez, Lin Li, and Ron Holle have completed processing the CG lightning data from 1983 to 1990 for Kennedy Space Center, including determination of site errors and computing final flash positions. Together with Bob Ortiz, a lightning climatology has been started for central Florida with this data set, emphasizing stratification of the spatial and temporal patterns of flashes in terms of the large-scale synoptic flow, and moisture and convective instability.

Raul Lopez, Lori Torikai (at NSSL/MRD this summer during graduate studies at the Univ. of Denver), and Ron Holle have started to investigate the connection between lightning activity and forest and range fires in the western U.S. In addition to the CG lightning data sets, an archive of lightning-initiated fires is being developed with data from the Bureau of Land Management, U.S. Fish and Wildlife Service, the Forest Service, and the State of Colorado. Initial analyses of the lightning activity, forest fire patterns and meteorological conditions have been performed for the Pike and Roosevelt National Forests in northeastern Colorado.

Ron Holle, Raul Lopez, Bob Ortiz and Irv Watson have begun a study of the effect of the Santa Catalina Mountains near Tucson on the frequency of flashes relative to the surrounding desert. There are up to 40% more flashes over the mountainous area. This result comes from a short-baseline low-gain network operated by LLP in the immediate Tucson area, which detects 67% more flashes than the long-baseline high-gain BLM network for identical uses.

Raul Lopez, Ron Holle, Bob Ortiz and Lori Tyahla (a graduate student at NSSL/MRD this summer from the University of Arizona) have examined the detection efficiency of CG flash direction-finder networks, and developed a methodology to correct for reduced detection efficiency as a function of distance from direction finders. This methodology is to be applied to data sets from different networks before climatological complications are finalized.

A paper by Raul Lopez and Ranjit Passi, "Simulations in site error estimation for direction finders" was published in the August 20 issue of JGR. Another paper by Raul Lopez, Mike Maier and Ron Holle, "Comparison of the signal strength of positive and negative cloud-to-ground lightning flashes in northeastern Colorado" has been conditionally accepted for publication in JGR. The latter paper summarizes signal strength distributions of positive and negative flashes detected by NOAA's medium-gain lightning detection network in Colorado. The different detection biases of this network, and their effects on the resulting signal strenth distributions are considered.

**NOAA - National Weather Service (Rockville, MD)**

An experiment designed to improve thunderstorm probability forecasts over Florida is underway and Ron Reap of the Techniques Development Laboratory, NWS, is conducting reserach to establish the patterns of convection associated with specific synoptic regimes. The regimes were identified by pattern classification of "map typing" of NGM initial and 18 h forecast sea-level pressure fields. Pattern classification was done by correlating grid point values for each day with corresponding values for every other day in the developmental sample for the Florida region. Map types were selected from the resulting correlation matrix by means of a variable correlation threshold. Lightning location data for the 1987-90 warm seasons were subsequently analyzed to determine the thunderstorm climatology for each of the predetermined map types. At present, Ron is combining selected NGM forecast fields with lightning frequencies in order to develop separate thunderstorm probability equations for each map type in an attempt to account for the effects of persistent small-scale features over Florida such as land-sea breeze convergence zones.

**New Mexico Institute of Mining and Technology (Socorro, N.M.)**

Paul Krehbiel reports that dual-polarization observations of electrified storms, near Kennedy Space Center in Florida this past summer with Stephen McCrary, Tiehan Chen, William Rison, Grant Gray, Thomas Blackman and Marx Brook, have provided dramatic evidence of the buildup and collapse of strong electrification as lightning discharges occur in the storm, by detecting the presence of electrically aligned particles. Regions of electrical alignment are readily identified by scanning through the storm and can be either widespread or localized. Localized strong correlations in the upper part of a storm appear to be primarily affected by intracloud discharges; lower correlation regions appear to be affected both by intracloud and cloud-to-ground discharges. The altitude of electical correlation has been observed to decrease as the storm dissipates, down to just above the melting level. In these (and other) cases the alignment structure can be horizontally stratified. Paul will report on the results at the AGU meeting in San Francisco.

**ONERA (Meudon, France)**

ONERA has been involved in two experiments during the summer of 1991. The first was ORLANDO 1991, the continuation of the 1990 experiment in Florida, and consisted of comparisons between electrical activity and dynamical and microphysical properties of convective cells. This experiment was conducted in collaboration with MIT's Lincoln Laboratory, the University of North Dakota and the MIT Weather Radar Group. ONERA set up a 3D VHF interferometer developed by DIMENSIONS as a follow-up to a low time resolution (100 microsecond) 2D SAFIR system in 1990.

The rocket triggered lightning program was held at Kennedy Space Center (KSC) as in previous years. Measurements and observations of positive leaders and of bidirectional triggered discharges have been realized; this experimental work is supported and complemented by modelling work underway at Padova University in Italy.

**University of Oklahoma (Norman, OK)**

As briefly reported in the **Annoucements**, Bill Beasley has been asked to write a review article on atmospheric electricity for Nature. Though he feels there are others who could do a better job, he appreciates the opportunity and is committed to producing a balanced, critical and informative review. Bill is soliciting help from the greater atmospheric electricity community. If you have a candidate you feel should be included under the heading of significant recent development, you can increase its chances of being included if you send him a one-page description of, and a list of principal references on, the subject. The article is a chance to inform a broad-based audience about the existing opportunities in research in atmospheric electricity; he would like everyone to have a fair chance at informing his judgement.

Bill's preliminary thoughts about what to include fall into two categories: recent developments in instrumentation and techniques, and recent significant scientific results. Under the first category, interferometers and toa systems, lightning location networks, the satellite lightning mapper, rocket-triggered lightning, M-CLASS, fast-scanning radars, superpressure balloon systems and rockets for middle-atmosphere electrodynamics most likely will be included. Under the second category, some of the recent results of attempts to develop numerical models for cloud microphysics and electrification, some of the preliminary results of locations of discharge channels within clouds, meteorological applications of lightning ground-strike location data, new observations of charge structure in thunderstorms and new results on electrical coupling in the middle and upper atmosphere would tend to be included.

AGU will provide opportunities for informal discussions, and Bill hopes to have an outline or perhaps a rough draft by that meeting. To contact Bill, please consult the information on the first page of this newsletter.

**University of Peradeniya (Peradeniya, Sri Lanka)**

Paul Hoole reports that his atmospheric electricity-related work includes a study of tropical lightning frequency, an investigation of lightning attachment, and a characterization of triggered lightning, studies of natural lightning and laboratory sparks and research into the electrical nature of the tropical environment. In the latter study he has set up monitoring and data logging systems to observe long term changes in electrical activity in the tropics.

**University of Roorkee (Roorkee, India)**

Renu Rani Agarwal is charting the atmospheric electrical fields and currents calculated theoretically, as should occur over the Indian sub-continent considering realistic conditions in two typical seasons, the monsoon and the winter season. The contours at first would be plotted assuming the base values of the conductivity and ionospheric potential. Gradually then the perturbing factors like solar activity and pollution, etc. will be introduced to see how the charting is affected. This would help in the interpretation of the atmospheric electric parameters measured at different places over the Indian sub-continent.

N.C. Varshneya is working on the nature and degree of inter-relationships that are obtained in the Global Electric Circuit (GEC). Since the GEC is an open system, the factors which influence it are not local and may extend to interplanetory regions. Furthermore, the system never remains in equilibrium. The electromagnetic field pervades the whole atmosphere which affects and is affected by several global and non-global factors and therefore has been taken as one of the bases for the inter-relations; a substratum over which all perturbations are united in their interplay.

**SRI International (Menlo Park, CA)**

In the summer of 1989, SRI teamed with Aeromet, Inc. (Tulsa, OK), to instrument Aeromet's Learjet 36A with an airborne field mill (ABFM) system. The Learjet was already instrumented with multiple hydrometeor probes including a 1D-C, 1D-P, 2D-C, 2D-P, and FSSP. The ABFM system included eight electric field mills to resolve, in redundant fashion, the ambient electric field vector with increased accuracy. The Learjet was flown near Cape Canaveral, FL from mid-August to early September (1989) to gather data to support system calibration and the study of clouds pertinent to the Launch Commit Criteria. The flight tests and subsequent analyses and reports were supported by the Air Force as part of the joint NASA/USAF ABFM program. Three SRI reports have been published in 1991 as a result of the program: "Airborne Field Mill System Calibration Report", "Electrification Aspects of the Launch Commit Criteria : Case Studies", and "Airborne Field Mill Special Studies." Primary researchers included Kathy Giori, Joel Kositsky, Robert Maffione and Joseph Nanevicz of SRI; and Ray Harris-Hobbs of Aeromet. Contact Kathy Giori at (415) 859-3138 for more information or to receive copies of any of the reports.

Surprisingly, Aeromet's Learjet 36A had significantly different engine charging characteristics than those of a NASA/Ames Learjet 24 previously instrumented by SRI in 1978-88. In an attempt to better understand the effects of engine charging, triboelectric charging, induction charging, etc. on field mill measurements, Kathy Giori instrumented a discharge wick and a charging patch on the T-28 (operated by South Dakota School of Mines and Technology) during the last two weeks of the CaPE project in Florida. She will collaborate with Andrew Detwiler of SDSMT to compare the T-28's charging and discharging characteristics with field mill and other particle probe data.

**Sandia National Laboratories (Albuquerque, N.M.)**

A two-phased rocket-triggered lightning program has been carried out. During 1990, a self-contained transportable triggered lightning facility was designed, built and fielded at the Kennedy Space Center. This shakedown trial for the facility also provided an opportunity to acquire a set of direct-strike damage data spots produced by measured lightning currents incident on aluminum and ferrous steel disk samples. Data were acquired on nine triggered flashes, during which 30 individual return stroke and continuing currents were recorded with 2.1-MHz and d.c. to 500-kHz bandwidths, respectively. The amplitude resolution of the latter channel was 2 A. Correlation of individual damage spots with the incident return stroke/continuing current combinations that produced them was established for nine of the spots with the aid of 5-ms resolution movies of each flash. These data are being used as benchmarks against which to quanify the fidelity of laboratory burnthrough simulation techniques. Details of the triggered lightning facility and the materials experiment are available in the Proceedings of the 1991 International Aerospace Conference on Lightning and Static Electricity. Results of an analysis of the flash currents, including an examination of the characteristics of M current pulses recorded during continuing currents, will be presented at the 1991 Fall Meeting of the AGU.

During July 1991, tests of an earth-covered munitions storage bunker located at Ft. McClellan, Alabama were conducted using the SNL facility. Nine flashes (35 return strokes) were initiated to designated attachment points on the test structure. The incident channel current was measured with a 6-MHz bandwidth ( 60-ns risetime) for resolving return strokes as well as with a d.c. to 500 kHz bandwidth for continuing and other long-duration current components. Twenty-three test points located throughout the bunker were simultaneously monitored during each flash. The response measurements included currents in the structure's concrete rebar, common interior ground bus, and buried lightning protection system counterpoise cables; interior electric and magnetic fields; and voltages between various structural members. Additional direct-strike damage data points were obtained for stainless steel, copper and titanium samples.

**State University of N.Y. at Albany (SUNY) (Albany, N.Y.)**

During this past summer, Vince Idone participated in the triggered lightning experiments at KSC. The main objectives were 1) to obtain time-resolved streak recordings simultaneously with electric field recordings made by Marx Brook of N.M. Tech, and 2) to attempt a new experiment on measuring lightning channel cross-sections continuously with spatial and temporal resolutions of 5 mm and 3 microseconds, respectively. Although Mother Nature provided relatively few opportunities this summer, both these objectives were realized as a small but excellent set of recordings were obtained. In the coming months, these new recordings as well as those of several previous campaigns will be analyzed. Henry Jurenka has recently joined our group and will be adding his considerable and complementary expertise in helping to interpret the photographic recordings in terms of basic channel physics.

Pete Manousous is presently finishing his master's thesis on a study of lightning ground flash density and other flash characteristics as related to topography and differing meteorological regimes in the northeastern U.S. Pete will be taking a full time position with Weather Services Corporation in Bedford, MA this November 1.

Anton Seimon is preparing a revised manuscript for publication in MWR showing that the thunderstorm that produced the devasting tornado of 28 August 1990 in Plainfield, IL, had unusual cloud-to-ground lightning activity. Data from the National Lightning Network showed that, in contrast to the usual thunderstorms, the 65K-ft cloud was giving preponderantly positive cloud-to-ground flashes for two hours prior to the tornado. During the 20-minute period that the tornado took place the cloud-to-ground lightning almost ceased and then resumed, although now with nearly all flashes depositing the usual negative charge.

Bernard Vonnegut and Richard Moore (Charlie's brother) made a VHS recording of interviews with eyewitnesses along the tornado track. This recording will be furnished upon request.

There are reasons to believe that the dynamics, the formation of precipitation, and the production of lightning in clouds may be influenced by the population of aerosol particles present in the air-mass from which the cloud is growing. Accordingly, during the CaPE experiment during the period 7/27 to 8/26 Thomas Kirchstetter and Eric Zalewsky, seniors at SUNYA, carried out order-of-magnitude determinations of the concentrations of condensation and ice forming nuclei by the use of a Schaefer cold box. Their results show that most of the time the air was quite clean, with low concentrations of condensation nuclei and no detectable ice forming nuclei. The results suggest that when the CaPE results are compared with those obtained in other situations in which the aerosol concentrations may be much higher, allowances should be made for this difference.

One of the greatest barriers to a satisfactory understanding of thunderstorms is our poor knowledge of the air motions in the upper portion of the cloud. With the development of polarizing radar it is now possible to determine these motions by following the trajectories of chaff released from an airplane flying over the penetrative top of the storm. The multiple radars participating in CaPE provided an ideal experimental opportunity. Vonnegut located a suitable aircraft with chaff dispensing capability, but the experiment could not be carried out because of lack of the necessary funds. The experiment is of such importance, plans should be made to carry it out in the future.

**Texas A&M University (College Station, TX)**

A mesoscale research group is developing at Texas A & M Univ. with a strong interest in atmospheric electricity and related meteorological phenomena. Ed Zipser, Head of the Dept. of Meteorology, arrived at Texas A&M in 1990 and has been studying high precipitation, no-thunderstorms and their dominance of tropical oceanic rainfall. Zipser has been joined in the past year by Mike Biggerstaff (From Univ. of Washington), John Nielsen (from MIT via SUNYA), and Dick Orville (from SUNYA), who are all interacting on mesoscale storms and the lightning characteristcs associated with these phenomena. Texas A&M Univ. has an expanding observational capability with a Doppler radar and a recent connection to the EPRI-SUNYA National Lightning Detection Network. Research is performed in the Cooperative Institute for Applied Meteorological Studies (CIAMS), one of NOAA's nine cooperative institutes. Both Zipser and Orville will be reporting on their recent research at the December AGU Fall meeting in San Francisco. All scientists can be reached through CIAMS/Dept. of Meteorology, Texas A&M Univ., College Station, Texas 77843-3150, (Tel: 409-845-7671; FAX 409-845-6331).

**Uppsala University (Uppsala, Sweden)**

Sven Israelsson and Edgar Knudsen are collaborating on several projects. Included in their completed experimental studies are an investigation of space charge generation caused by evaporation of water, mobility of ions in space charge cells where the mobility spectrum remains very much in the ordinary small ion spectrum, conductivity profiles in the lowest atmosphere, and the electrode effect when influenced by radioactive emanation from the ground. Their profiles differ from the classical case. A theoretical study on the mechanism for charge production due to temperature gradients in the different states of water is also finished but not yet published.

Studies in progress or planned for the future include experiments on the thermochemical process in the atmosphere, a study of the existence of ions with mobilities higher than $5\text{-}10^{-4}m^2s^{-1}V^{-1}$, the influence of the global events on the Maxwell current (GAEM), participation in the global atmospheric electric measuring project "Global Change Monitoring", and studying the effects of radioactive fallout on the electrical parameters.

**U.S. Dept. of Agriculture/Intermountain Fire Sciences Lab. (Missoula, MT)**

Don Latham is presently running experiments on wind-tunnel fires and looking at charging mechanisms. A JGR paper on lightning from fire-generated clouds has recently been published.

**U.S. Dept. of Transportation (Cambridge, MA)**

John Caniff reports that on September 24-25, 1991, the FAA hosted an "FAA LIGHTNING WORKSHOP" at Arlington, VA. The purpose was to assess the state of science, using lightning data, for detecting and forecasting convective hazards to meet potential user needs. About 65 experts and program officials from the FAA, NWS and other agencies, as well as academic and research institutions, were in attendance.

The findings included an assessment that the Lightning Detection Network data can match or exceed the human observer beyond eight miles from the airport, but that within eight miles the human observer can match or exceed the current network. A possible R&D activity to enhance the network performance within eight miles was discussed. Recommendations included that the FAA Air Traffic should require integration of lightning data with ASOS/AWOS systems as soon as ADAS (AWOS Data Acquisition System) is implemented. A possible redefinition of 'severe thunderstorm' based on new criteria was discussed.

**University of Washington (Seattle, WA)**

Robert Solomon participated in the CaPE project, working with both Jim Dye and Hugh Christian's group. He will use CaPE data in the study of thunderstorm climatology he and Marcia Baker have underway. The idea of the study is to examine constraints on soundings that produce electrification, using a numerical model. The model is an improved version of that of G. Taylor, used subsequently by Norville et al (1991).

Recent Theoretical results (Elbaum and Schick, 1991) reconcile earlier laboratory evidence that droplets form on ice just below 0 C (Hobbs, 1974) with evidence for surface melting on ice (e.g. Golecki and Jaccard, 1978). The theory shows there is partial wetting on ice near the triple point, consistent with recent laboratory measurements (Elbaum, 1991). These new results support the starting assumptions of the Baker and Dash charge transfer model (Baker and Dash, 1989).

Bob Holzworth is involved with the ELBBO (Extended Life Balloon Borne Observations) and reports that during the last few months they have successfully conducted a payload test flight and a prototype test of the superpressure balloon. They expect full up integration to be complete by late fall and the launch of up to 5 balloons from Christchurch, New Zealand to commence in February 1992. Bob is also working with C. Croskey (Penn State) on a thunderstorm upcoupling experiment slated for July 1992. The experiment is funded to include two Penn State rockets and a balloon from Univ. of Washington for launchover a thunderstorm at Wallops Island. Electric fields, conductivity, current density and other related parameters will be measured. They are looking for interested parties to participate in the ground-based component of the experiment (including ground based current density and field measurements, radar data and related observations). Contact C. Croskey (814) 865-2357 or Bob Holzworth (206) 685-7410.