NEWSLETTER ON ATMOSPHERIC ELECTRICITY

Vol. 6, No. 1 --- June, 1995

AMS COMMITTEE ON ATMOSPHERIC ELECTRICITY

AGU COMMITTEE ON ATMOSPHERIC AND SPACE ELECTRICITY

INTERNATIONAL COMMISSION ON ATMOS. ELECTRICITY

Announcements

Future Newsletter Contributions. Two issues of this Newsletter are issued each year, in November and May. In efforts to save the expense of this mailing (now to approximately 440 recipients), we are requesting contributions for the fall Newsletter to be received by **October 30, 1995.** Contributions may be mailed (E. Williams, Parsons Laboratory, Bld. 48, Cambridge, MA 02139), E-mailed (earlew@juliet.ll.mit.edu) or faxed (617-981-0632). If you missed the deadline for this issue, you are probably not reading the Newsletter Announcements. MARK YOUR CALENDARS NOW!

The 2nd International Workshop on the Physics of Lightning will be held September 18-22, 1995 in Osaka, Japan. Zen Kawasaki is the main contact, FAX 81 68 75 0506.

The 1995 International Aerospace and Ground Conference on Lightning and Static Electricity will be held on the 26-28 September 1995. Advanced registration is due before August 1995. The Conference Coordinator is Mr. Sam Frazier (301-826-3868).

Steve Rutledge is serving as the Program Chair for the 27th Conference on Radar Meteorology which will be held in Vail, CO from 9-13 October 1995. A session entitled "Cloud Electrification" will be held on Thursday, 12 October, consisting of nine oral papers covering a wide range of electricity topics.

Memorial Address for Professor Atsushi Kimpara (1902-1995)

Professor Atsushi Kimpara, Honorary Member of the Society of Atmospheric Electricity of Japan, passed away on January 1, 1995. He was one of the most prominent leaders in the research field of atmospheric electricity and radio science.

Professor Kimpara was born on March 2, 1902 in Hamamatsu, Shizuoka Prefecture. In 1925 he graduated from the Department of Electrical Engineering, the University of Tokyo. Then, he joined the Ministry of Posts and Telecommunications of Japan and worked on the development of radio engineering. In 1927, the Second URSI General Assembly was held at Washington and intensive discussion on atmospherics, the natural radio waves that disturb radio communication. After attending the Assembly, he started to engage in the investigation of atmospherics. He gathered and analyzed many atmospherics records received at several radio stations in Japan and found that the direction of atmospherics sources coincided with those of thunderstorms, with a probability higher than 90%. His first

English paper entitled "Correlation of atmospherics with thunderstorms" dealt with this result and was published in the Report of Radio Research in Japan, vol. 1, no. 1 in 1931.

From 1935 to 1937, he studied in England, France, Germany and the United States. The success of radio-photograph transmission from Berlin to Tokyo, at the time of the Berlin Olympic Games in 1936, was one of his great achievements. For the success of the radio-photograph transmission, he had to negotiate against German authorities with difficulty. In this period he attended many international conferences, e.g. CCIF and CISPR and made many intimate friends who kept cooperative relationships with him throughout his long life.

In 1941, Professor Kimpara was appointed as professor of the Department of Electrical Engineering, Nagoya University. In this year, for the prevention of lightning disaster in general, a large cooperative research project was organized in Japan. The project consisted of three groups of investigators, namely, meteorologists, electric power engineers and radio communication engineers. In this project, Professor Kimpara observed waveforms and arrival directions of atmospherics and revealed detailed relationships between atmospherics and thunderstorms.

During the Second World War, the Japanese Military adopted Professor Kimpara's work on direction finders for atmospherics and constructed equipment for the location of thunderstorms. Immediately after the War, the U.S. Air Force recognized his work and asked him to cooperate to prepare safe air-routes between U.S. and Japan.

In 1947, Professor Kimpara established the Research Institute of Atmospherics as an attachment to Nagoya University and was appointed director of the Institute. A 20 ha (about 50 acres) area of ex-U.S. Naval Arsenal in Toyokawa-city, 60 km southeast from Nagoya-City, was used as the site of the Institute. The area is favorable for receiving atmospherics. The research field of the Institute covered atmospherics over the whole frequency range, lightning discharges, whistlers, and solar radio-waves. He was not only an excellent researcher but also an able administrator and took many fine staff members. The activity of the Institute contributed very much to the development of studies in the field of atmospheric electricity and radio science. In 1990, the Institute was reorganized as Solar Terrestrial Environmental Laboratory.

In 1965, Professor Kimpara retired as director of the Research Institute of Atmospherics and moved to Chubu University. There, he coordinated the Upper Atmosphere Laboratory and continuously contributed to the development of studies in the fields of atmospheric electricity and radio science, guiding many young scientists and engineers. In 1980, he retired from Chubu University at the age of 78.

Professor Kimpara contributed extensively to the community of investigators working on atmospheric electricity and radio science. From 1963 to 1978, he served as the chairman of the Committee of Radio Science, Science Council of Japan. Professor Kimpara frequently attended the international conferences in these fields, and continuously arranged and promoted cooperative international and domestic studies. For instance, he successively attended the First to Fifth International Conferences on Atmospheric Electricity which were held every four years. He introduced the results obtained by Japanese investigators and brought back the recent world development presented at the Conferences. Professor Kimpara was awarded several high prizes for his prominent achievements.

After his retirement from Chubu University, he spent a calm life and enjoyed good health until his death. In these years, we sometimes visited him and enjoyed his talk that implied precious essence based on his long experience. Within a year's time we lost Professor Hatakeyama and Professor Kimpara who both made prominent pioneering contributions in the field of earth sciences and radio sciences. The change of generation is apparently going on in our community and the following generation is now responsible for the further development in this fields.

February 14, 1995
Masumi Takagi

Memorial Address for Professor Hisanao Hatakeyama (1905-1994)

Professor Hisanao Hatakeyama, Honorary Member of the Society of Atmpospheric Electricity of Japan, passed away on February 11, 1994. He enjoyed a long life of 89 years and died of decrepitude. He was associated with the Japanese Meteorological Agency for thirty-seven years and lastly served as a Director General of the Agency. Afterward, he served as a professor of Nishogakusha University for thirteen years. He was one of the most prominent leaders in the fields of atmospheric and terrestrial physics in Japan.

Professor Hatakeyama was born on January 20, 1905 in Shibata-shi, Niigata Prefecture. He graduated from the Physics Department, Faculty of Science, Tokyo University and joined the Central Meteorological Observatory (the precursor of the present Meteorological Agency of Japan). At this organization he worked as a forecaster and successively served as director of the following boards: Meteorological Training College, Kakioka Magnetic Observatory, Toyohara Magnetic Observatory, Forecast Division, Meteorological Research Institute, and Tokyo Meteorological Observatory. As a forecaster he brought innovative developments on the contemporary forecasting technique. He not only performed fine administrative work as director of the above boards but also accomplished many research works in the field of atmospheric and terrestrial physics.

One notable achievement he performed during his work at Central Meteorological Observatory was research work "On the Bay-Disturbance in the Terrestrial Magnetic Field." The work revealed that bay-disturbances observed at 32 geomagnetic observatories scattered over the whole globe were caused by the westward jet electric current in the auroral zone. It was epoch-making, because it contributed greatly to revealing the mechanism of the geomagnetic storm. For this work, Professor Hatakeyama was awarded the Academy Prize from the Science Acacemy of Japan.

In the field of atmospheric physics, mainly in the study of lightning and thunderstorms, fair-weather atmospheric electricity, and cloud and precipitation particles, he performed leading work to raise the activity of Japanese scientists to an internationally higher level. From 1940 to 1943, he guided a thunderstorm research project that operated surface network observation and aerological observations covering the North Kanto District, an area noted for frequent occurrence of thunderstorms. The results obtained led to the development of analysis of aerological conditions that formed thunderclouds in the area. Simultaneously, he clarified the horizontal movement of individual lightning discharges. The discharge positions exhibited a random walk within 10 km diameter circles that followed the movement of the cloud system. The result contributed not only to the study of thunderstorms but also to the renovation of safety measures against thunderbolts.

In 1954, the First International Conference on Atmospheric Electricity was held at Portsmouth, New Hampshire, U.S.A. and since then the international exchange of research work in this field has accelerated. In 1958, the Second Conference was held at the same place and Professor Hatakeyama attended it. He presented a paper on the electrical nature of thunderclouds and the movement of lightning discharge positions obtained by the network observations at North Kanto District. The reported new features of thunderclouds were appreciated at the Conference. The Third International Conference on Atmospheric Electricity was held in 1963 at Montreux, Switzerland. In this Conference, Professor Hatakeyama introduced the paper by a Japanese scientist that treated the effects of radioactive substances in the atmosphere, produced by nuclear bomb tests, on the worldwide surface electric field. This paper figured out the effects on the local electric field, observed at Kakioka Observatory and Memanbetsu Observatory. At the same Conference, this effect was reported in England. Since the accumulation of radioactive substances in the stratosphere produced by the numerous nuclear bomb tests was the serious problem in those years, his presentation provoked wide concern. In 1968, the Fourth International Conference on Atmospheric Electricity was held in Tokyo, Japan. The Japanese research activitiy on this field that had been pushed forward by Professor Hatakeyama, led to the success of the Conference.

After retirement from the Meteorological Agency, Professor Hatakeyama served as professor of Nishogakusha University for thirteen years. He continued his research work and his guiding activity in the field of atmospheric physics throughout his life. He was also interested in fire science, and contributed very much to its development in Japan, working on the relationship between fire and meteorological conditions. During this period, Professor Hatakeyama served as either a president or a committee member for the following scientific associations, efficiently promoting their activities: the Meteorological Society of Japan, the Society of Atmospheric Electricity of Japan, the Japanese Society of Snow and Ice, and the Japan Association for Fire Science and Engineering.

Especially, Professor Hatakeyama contributed a great deal to the establishment and the development of the Society of Atmospheric Electricity in Japan. The success of the Fourth International Conference on Atmospheric Electricity in Tokyo was a direct trigger for the establishment of the Society. He served as a committee member in its early period and later he continuously served as Consultant of the Society until he passed away. In 1982, the Society began to publish its English journal named "Research Letters on Atmospheric Electricity." This was enabled because Professor Hatakeyama served as the chief editor of the journal. He had brought the journal to an internationally well qualified level. In 1993, the name of the journal was changed to "Journal of Atmospheric Electricity". It is the only well qualified journal in the world that deals solely with the subject of atmospheric electricity.

Besides the award of the Academy Prize from the Science Academy of Japan, Professor Hatakeyama was awarded the Fujiwara Prize from the Meteorological Society of Japan. The prize is to be awarded to its members to commend their marked contribution toward the development of meteorology in Japan.

Reviewing the whole work of Professor Hatakeyama, what he had achieved in his life was literally the step of a giant. At the same time, Professor Hatakeyama was of a warm and amicable personality. The editors meeting for Research Letters on Atmospheric Electricity used to be held in the Professor's living room at his house. Professor Hatakeyama steered

the meeting, and all attendants of the meeting felt as if they were speaking with their gentle father, while they discussed the edition of the journal.

The recent advance of Japanese atmospheric and terrestrial physics owes very much to Professor Hatakeyama, and in 1996 the Tenth International Conference on Atmospheric Electricity is scheduled to be held in Japan. We, Japanese scientists deeply grieve to hold the Conference without his attendance.

February 12, 1995
Nobu Kitagawa

AGU CASE NEWS (from John Willett)

This section is devoted to the Committee on Atmospheric and Space Electricity of the American Geophysical Union. Thanks are due to the AGU for continuing to share the printing and mailing costs of this Newsletter with the ICAE.

In the next issue of the Newsletter, to be distributed prior to the Fall Annual Meeting of the AGU, look for a tentative agenda of the upcoming CASE meeting. Topics for the 1994 CASE meeting are hereby solicited. You will also recall from the last issue that a listing of new AE and Middle-Atmosphere databases is being printed in these pages each Fall. Please send your input on both of these subjects as soon as possible, but not later than September 30, 1995, to

John C. Willett, PL/GPAA
29 Randolph Rd.
Hanscom AFB, MA 01731-3010.
Phone: 617-377-5954
Fax: 617-377-2984
E-mail: willett@zircon.plh.af.mil

You will recall that the Annual Case Database Listing is intended to be a concise directory to new atmospheric/space electricity datasets of general interest, organized by category rather than by researcher, to facilitate interdisciplinary awareness, and collaborative use, of existing data. Last year we received and published only four listings. We are hoping for many more this time! In your submission please indicate at least the following:

(1) parameters measured,
(2) amount of data,
(3) periods covered,
(4) principal investigator, and
(5) a telephone number and/or E-mail address

The main function of this Spring edition of the AGU CASE News is to summarize the last Committee meeting, which was held at 8:00 PM on December 5, 1994, at the Cathedral Hill Hotel in San Francisco. At least 45 people attended, including 11 of the 15 CASE members. The following topics were discussed:

1. Joe Borovsky described a very interesting workshop on lightning physics that was held at the Los Alamos National Lab. last year. Dr. Borovsky reported that there was a high interest in repeating the workshop. For more information contact him (505-667-8368).

2. John Willett reported on the development by the Applied Physics Lab. at Johns Hopkins of a re-usable tethered-balloon.system designed to remain on station at an altitude of 20 km (!) carrying a payload of 1000-3000 lbs for a minimum of three days. The design is now in need of a sponsor for a demonstration. For more information, contact Glen Cameron (301-953-6949).

3. Martin Uman announced the opportunity to carry out experiments with rocket-triggered lightning this summer at Camp Blanding in central Florida. For more information, contact Prof. Uman (904-392-0940).

4. John Willett and Maj. Jim Kroll reported relatively steady funding for Atmospheric-Electrical research available from NSF (contact Ron Taylor, 703-306-1524) and from the Air Force Office of Scientific Research (contact Jim Kroll, 202-767-5026).

5. Jim Dye reported that NCAR had recently acquired a B-57 aircraft. In addition to carrying a heavier payload than the ER-2 to altitudes of 67-70 kft, the B-57 will feature a seat for a mission specialist and 40 kVA of research power. For more information, contact Jim Dye (303-497-8944).

6. Dick Goldberg reported on the completion of the Guara Campaign in Brazil, wherein numerous rockets and radars looked at the dynamics and electrodynamics of the tropical mesosphere. The contact for more information is Rob Pfaff (301-286-6328).

7. Brian Tinsley requested long-term data to test a new model of solar influences on the global circuit. He can be reached at 214-690-2838.

8. Bob Holzworth called attention to the plight of nominations for AGU Fellows (and other awards) from interdisciplinary areas such as ours. It seems that strong support from an AGU Section is required for a successful nomination and that such section-oriented support is less likely for candidates whose research spans two or more sections. Bob Holzworth (206-685-7410) volunteered to seek a solution to this problem. Martin Uman pointed out that he is currently one of 4 or 5 members of the Fellows Committee.

9. John Willett discussed the difficulty of obtaining a satisfactory session schedule at the Fall Meeting. Most of our problems arise from the AGU Program Committee's understandable lack of familiarity with our subject area. The CASE will attempt to gain more control over the schedule by the following measures:

   (A) Announcing at least two "place-holder" Special Sessions (typically "Atmospheric Electricity" and "Lightning"), in addition to any "topical" Special Sessions (e.g., "Lightning-Induced Effects in the Middle and Upper Atmospheres" -- see below) that may seem warranted, each year,

   (B) Requesting that all contributors submit their papers directly to one of these Special Sessions, so that our sessions can be organized by knowledgable convenors instead of the Program Committee, and

(C) Lobbying the Program Committee for an "appropriate schedule" of oral and poster sessions, once the number of papers submitted to each Special Session is known. Our current idea of an appropriate schedule spreads the relevant sessions over at least three consecutive days, preferably with oral and poster sessions alternating, to leave time for "networking".

Contact John Willett with further suggestions or comments.

10. In connection with (9) above, there was considerable discussion of how to make poster sessions more attractive, since they have become a fact of life for at least half of the contributors to the Fall Meeting. This discussion has continued over E-mail, and John Willett agreed to summarize the suggestions and focus further discussion. We hope to try some of these suggestions out this Fall. Meanwhile, if you are willing to give a poster paper, please request "poster" when submitting your abstract.

11. Finally, several scientists announced upcoming field programs and welcomed collaborators.

Our four Special Session abstracts for this coming Fall Meeting are as follows:

1. Lightning Induced Effects in the Middle and Upper Atmospheres

Observations have shown that intense lightning produces a number of interesting and unexpected effects in the middle and upper atmospheres above thunderstorms. These effects include induced particle precipitation from the magnetosphere, anomalous optical brightenings in the ionosphere, and "blue jets" and "red sprites" that vertically span the stratosphere and mesosphere, respectively. Gamma ray bursts and extremely intense VHF radio bursts (TIPPs) observed from low earth orbit are also thought to be associated with thunderstorms. There are presently several experimental groups actively investigating these intriguing phenomena, and a number of theorists exploring their microphysical origins and possible electrochemical effects on the middle and upper atmospheres.

This session will provide an opportunity to present new observations obtained during the 1995 observing season and new theoretical results.

Convenor: D.D. Sentman, Geophysical Institute, University of Alaska, Fairbanks, AK 99775. Tel: 907-474-6442; Fax: 907-474-7290; E-mail: dsentman@gi.alaska.edu.

2. The Optical Transient Detector

The Optical Transient Detector (OTD) is an early flight qualified version of the Lightning Imaging Sensor (LIS) developed for the NASA Earth Observing System (EOS) as a flight of opportunity aboard the Tropical Rain Measuring Mission (TRMM). OTD was launched on the MicroLab 1 satellite in April 1995. The primary mission of the OTD is to detect and locate lightning activity over large areas of the earth's surface during both daytime and nighttime. These data will be used to produce a global climatology of lightning and its variability, as well as to investigate the relationships between thunderstorm activity and

rainfall, NOx production, the occurrence of sprites, and support field campaigns. Papers in this session will present early results of the analysis of the OTD data base.

Convenors: Hugh J. Christian, NASA/MSFC Global Hydrology and Climate Center, 977 Explorer Blvd., Room B210, Huntsville, AL 35806. Tel: 205-922-5828, Fax: 205-922-5723 E-mail: hugh.christian@msfc.nasa.gov, and

Steven J. Goodman (same address and fax), Room C11 Tel: 205-922-5891 E-mail: steve.goodman@msfc.nasa.gov.

3. Atmospheric Electricity

Papers are invited on all aspects of tropospheric fields, charges, and currents. Topics of special interest include the following: thunderstorm-electrification mechanisms and observations; quasi-static ("Maxwell") current distributions around thunderstorms; and relationships among global thunderstorm activity, the atmospheric-electrical global circuit, and climate. Papers about thunderstorm effects on the middle and upper atmosphere are also welcomed.

Convenors: Thomas C. Marshall, Dept. of Physics and Astronomy, University of Mississippi, MS 38677. Tel: 601-232-5325, Fax: 601-232-5045, E-mail: marshall@sparc.NCPA.OleMiss.Edu, and

Earle R. Williams, Parsons Laboratory, 48-317, MIT, Cambridge, MA 02139, Tel: 617-253-2459, Fax: 617- 253-6208, E-mail: earlew@juliet.ll.mit.edu.

4. Lightning, Triggered and Natural

Papers are invited on all aspects of the physics, phenomenology, and effects of lightning. Rapid technological advances are being made in the geographical location of lightning, in mapping the development of individual flashes in time and space, and in the detailed study of specific discharge processes and their electromagnetic radiation. Rocket-triggered lightning has proven a valuable tool for the latter. Of special interest will be results from an ongoing triggering campaign at Camp Blanding, Florida. Papers about lightning effects on the middle and upper atmosphere are also welcomed.

Convenors: John C. Willett, PL/GPAA, 29 Randolph Rd., Hanscom AFB, MA 01731-3010, Tel: 617-377-5954, Fax: 617-377-2984, E-mail: willett@zircon.plh.af.mil, and

Vladimir Rakov, Electrical and Computer Engineering, PO Box 116200, University of Florida, Gainesville, FL 32611-6200, Tel: 904-392-0940, Fax: 904-392-8671, E-mail: MNEUF@admin.ee.ufl.edu.

AMS COMMITTEE ON ATMOSPHERIC ELECTRICITY REPORT (from Dave Rust)

As they rotate off the committee, we acknowledge and thank Dr. Robert Black of NOAA/Hurricane Research Division, and Dr. Mark Weber, Weather Sensing Group, MIT Lincoln Laboratory, for their past three years of service.

We welcome two new members of the committee: Dr. John Molinari, Dept. of Atmos. Science, State University of New York-Albany, and Mr. Steven Hunter, National Weather Service, Morristown, TN.

At its meeting at the Dallas AMS Annual Meeting in January 1995, the committee passed the following motion unanimously:

"The AMS Committee on Atmospheric Electricity commends Dr. Earle Williams for the continued excellent and valuable service to the meterological community as editor of the Newsletter on Atmospheric Electricity."
Bill Beasley is exploring an AMS Home Page for incorporation of the AE Newsletter.

Follow-on business after that meeting included our making a few revisions to the previous missions statement. The new statement follows:

1. To provide a focal point for those working in atmospheric electricity and related fields;

2. To act as a communication link for the community by publishing a newsletter and facilitating intra society and extramural communications;

3. To promote the dissemination of basic and applications research results;

4. To integrate atmospheric electricity with other disciplines in meteorology (The Committee encourages papers that include atmospheric electricity be submitted to various AMS conferences as individual research topics fit);

5. To promote the use of atmospheric electricity parameters in forecasts and warnings of hazardous and other significant weather;

6. To serve the American Meteorological Society as a reference, referee, representative, or spokesperson, as requested by the Council.

The Committee on Atmospheric Electricity includes within its area of interest all electrical processes occurring in the atmosphere of Earth and to some extent in the atmospheres of the other planets. We exclude no areas, but emphasize atmospheric electricity and its relationship to all types of weather in the troposphere. Aspects of this discipline include the study of cloud electrification and lightning, relationships between cloud microphysical processes and cloud electricity, and the role of cloud electricity in large storms and storm systems as an indicator of storm development. Another broad area of study is concerned with describing the spatial and temporal variations in the fair-weather tropospheric electric field and the understanding of the entire global circuit. A third broad area of research deals with the constituents of atmospheric electricity on a microscopic scale, i.e., the chemistry and physics of ions in the atmosphere. Interests here include ion chemistry, charged aerosols, air pollution, and other modifiers of the conductivity and net charge of air.

Stan Kriz of Resolution Displays has kindly contributed $50 toward the publication of this Newsletter. Other voluntary contributions are welcome and should be sent to the secretary

of the ICAE (E. Williams).

Research Activity by Organization

AIRBORNE RESEARCH ASSOCIATES (Weston, MA)

Ralph Markson is investigating the use of ionospheric potential measurements for observing the variation of global temperature. Electric field instrumentation has been interfaced with a standard radiosonde. Part of the payload includes a new kind of conductivity instrument developed by *Lothar Ruhnke* which will measure columnar resistance in the lower atmosphere where the traditional Gerdien tube does not work well on sounding balloons. A field program including over 20 simultaneous measurements by Markson and *Earle Williams* in Darwin, Australia and Ruhnke with other ARA personnel in Weston, was conducted during a 3 week period in May 1995. Two full diurnal cycles were measured with 3-hour temporal resolution. These data will also be compared with Schumann resonance measurements made by Williams in Rhode Island and with variations in global high clouds obtained from synchronous satellites by *Dave Martin* and *Barry Hinton* at the Space Science Center, University of Wisconsin. Data analysis is still required. This program was to demonstrate that one reliable measurement of ionospheric potential at subpolar latitudes is globally representative. One of the fundamental advantages of using the global circuit for global change studies is that one measurement at relatively little cost provides a global parameter which in some ways may be better than temperature which requires hundreds of measurements all over the world. This approach relies on the fact that thunderstorm development is very sensitive to temperature.

ARA is also developing airborne and ground-based lightning mapping technology. During 1994 *David Proctor* worked with Markson on a new airborne system which utilized the TDOA of direct signals and those reflected from the Earth's surface. A field program in Florida utilizing in part comparisons with the KSC/LDAR demonstrated the viability of this approach. Some of the ground-based systems utilize both electric field and light changes to eliminate non-lightning signals.

ASTeR Inc./MISSION RESEARCH CORP. (Ft. Collins, CO)

The SPRITES '95 field program at the Yucca Ridge Field Station northeast of Ft. Collins is planning its intensive observation program from mid-June through late July 1995. Many of the 1994 measurements will be repeated and will be substantially augmented by the concurrent observations of science teams from a number of institutions. ASTeR, Inc. (*Walt Lyons*, *Tom Nelson*) will deploy two red-sensitive Xybion ISS-255 low-light cameras, 1-10 kHz and 1-100 kHz VLF receivers, and a pointing photometer (designed by *Jack Winckler*). The video and VLF audio will be logged onto SHVS tape, with GPS time stamping. In addition, magnetometer coils provided by MIT (*Earle Williams*) will be used to detect Q-burst signatures. The photometer, ELF and VLF signals will also be digitally sampled in 1500 ms windows on an event basis (*Bob Nemzek*). The STAR Lab, Stanford University (*Umran Inan*, *Bill Trabucco*, *Alexander Slingleland*) will provide continuous narrowband VLF observations at an array of sites along the west coast, VLF broadband and narrowband

observations at Yucca Ridge and the conjugate region at Palmer Station, and narrowband observations from a narrowband receiver mobile van positioned in line with the storm. Mission Research Corp./Nashua, N.H. (*Russ Armstrong* and *Jeff Shorter*) have designed a sensitive CDD array for spectral measurements. Lawrence Livermore National Lab (*John Molitoris* and *Colin Price*) will deploy their new infrared and optical camera system (IROCS) for high temporal resolution (1 ms) sampling of sprite optical omissions. The University of Otago, New Zealand (*Richard Dowden*) will deploy dual VLF receivers in Colorado for VLF Interferometery to detect RORD phenomena. Tohoku University, Sendai, Japan (Profs. Takahashi and Fukunishi) will man four sensitive photometers monitoring two optical bands at two separate altitudes above storm tops. Plans are underway to deploy a 2-30 mHz tunable radar by SRI International (*Roland Tsunoda*). Additional low-light camera sites are being considered by the Geophysical Institute, University of Alaska (*Dave Sentman*) atop a mountain peak west of Denver and by the USAF Academy (*Perry Malcolm*, *Geoff McHarg* and *Scott Dudley*).

Coordination will be attempted with the National Severe Storms Lab (*Dave Rust, Tom Marshall*). A mobile van will be positioned beneath the anvil on the far side of a sprite-producing MCS. Video of the "anvil crawler" lightning will be matched with the sprites. Several electric field mill launches into the region above sprite-producing anvils will be made. GeoSpace Research (*Frank Djuth*, *Mathew Cox*, *Ken Williams*) will be monitoring WWV signals and 28 MHz transmissions from LaSalle, CO in central Illinois to coordinate observations with optical sprite reports. The MIT team (*Earle Williams*, *Dennis Boccippio*, *Charles Wong*) will continue to monitor Schumann resonance Q-bursts during sprite observation periods at the Rhode Island site.

Coordination with overflights of the Space Shuttle (NASA MSFC, *Otha Vaughan*), the HALOE satellite (NASA Langley, *Guy Beaver*), Alexis/Blackbeard TIPP and surface SIPP reports (LANL, *Bob Franz* and *Dave Smith*) and the NASA OTD experiment are contemplated.

A several week-long monitoring program during August 1995 is planned for KSC using the image-intensified cameras to conduct a "sprite inventory" above east central Florida. The ASTeR group will be joined by the LLNL group and their IROCS imager. These measurements will be made in conjunction with the LDAR system (*Carl Lennon*, *Launa Maier*).

Parties interested in making cooperative measurements in 1995 should contact *Walt Lyons* at ASTeR --- Tel: 970-568-7664; Fax: 970-482-86827; E-mail: lyonsccm@csn.org.

CLOUD PHYSICS LABORATORY (Tel-Aviv University, Israel)

The cloud physics group at the Department of Gophysics and Planetary Sciences at Tel Aviv University, led by *Prof. Zev Levin*, is involved in seveal research topics concerning measurements and theoretical studies of atmospheric electricity. In early January, *Yoav Yair* submitted his Ph.D. thesis, titled "Jupiter's water clouds - a detailed numerical model of cloud growth, charge separation and lightning formation". Thesis supervisors were *Zev Levin* and *Shalva Tivion*. The research studied the conditions for development of large convective water clouds in Jupiter's atmosphere, and evaluated the efficiency of the non-

inductive ice-ice charging mechanism for cloud electrificiation. The location, frequency, and energies of the lightning discharges in Jupiter's clouds were calculated, and the results agreed with the available data obtained during the encounters of the Voyager spacecrafts with the planet. The description of the numerical model, the microphysical schemes used and the formulation of the charging process may be found in the coming issues of *Icarus* (vol. 114 and 115).

Zev Levin, *Yoav Yair* and *Baruch Ziv* are completing an analysis of the lightning data obtained from the CGR-3 (SN5) instrument, that has been operating in Tel-Aviv operating in Tel-Aviv from 1987 as part of the world-wide net organized by Dave Mackerras and Matt Darvoniza (University of St. Lucia, Australia). The lightning data are augmented by radar images, obtained from the WR-100-5 Enterprise radar that is being operated by our group. The results show that thunderstorms with a relatively large fraction of positive ground flashes are associated with a strong wind shear between the freezing level and the altitude of the -25 C isotherm. A paper which relates the results to synoptic conditions in the eastern Mediterranean is now in preparation for submission to JGR.

COLORADO STATE UNIVERSITY (Ft. Collins, CO)

The Radar Meteorology group in the Department of Atmospheric Sciences at CSU continues to devote a substantial portion of its research effort to atmospheric electricity issues. This summer finds us busy with a field program centered around the CSU-CHILL multiparameter facility. Within the vicinity of CHILL we have located three corona points, a slow antenna (for measuring total lightning flash rates within a range of 40 km) and a NASA field mill (courtesy of our colleagues at NASA/MSFC). The purpose of the field effort is to identify mechanisms within severe, hail-producing storms that lead to high percentages of positive cloud-to-ground flashes. This field effort is being led by *Steven Rutledge* and *Larry Carey*. Several other students in our group are also involved. The CHILL radar, with its recent upgrade to a dual-transmitter, dual-receiver configuration, provides a full suite of multiparameter variables which we use to infer the microphysical state of the storm including hail size and the presence of mixed-phase conditions. Several excellent cases have already been obtained. *Jim Metcalf* from the Phillips Laboratory visited us in early June to collect specific differential phase (KDP) data with CHILL in the upper portions of thunderstorms. Numerous negative KDP shifts (indicating the presence of vertically-oriented ice particles in strong electric fields) were noted.

Walt Petersen's ongoing research is concentrating on tropical oceanic, continental and island thunderstorms. Recently, Walt has been examining the large scale controls involved in the develoment of electrified convection over the western Pacific warm-pool (TOGA COARE). Using ALDF network data collected during TOGA COARE (in collaboration with *Dick Orville* at Texas A&M) a strong diurnal cycle in cloud-to-ground lightning was found to exist over the tropical ocean with peaks in CG frequency near 1-3 AM local time, and a trough in activity near local noon. The peak in CG activity seems to follow a broad, but well defined peak in CAPE that occurs near midnight local time (1970 J/kg). GMS brightness temperatures for the same area indicate that a peak in cold cloud area (temperatures < 208 K) lags the CG lignting peak by several hours, but the cold cloud convective rainflux. When thermal buoyancy profiles associated with intense convection located in other regions such as the maritime continent were compared to those collected over the tropical

ocean, it was found that "active" thermal buouancy profiles (i.e., high CAPE environments which support electrified convection) over the warm pool approached the structure of buoyancy proifles observed over electrically active regions such as Bathurst and Melville Islands located off the tip of tropical northern Australia. In the near future a 2-D modelling study will commence in an effort to examine the sensitivity of convetive dynamics, micxrophysics and electrification to small changes in the thermal buoyancy structure of the troposphere.

Terry Schuur is investigating the electrical structure and development of two mesoscale convective systems observrd during the COPS91 experiment through a combination of a detailed observational analysis of in-situ electrical and microphysical data and numerical simulations with a 2-dimensional, dynamical, bulk microphysical model. The model is configured to allow for an investigation of both local charge generation through a variety of microphysical processes and advection of charge from theconvective line. Parameterizations are included in the model for charge generation due to non-inductive charge transfer during ice/ice collisions and vapor growth. Preliminary results indicate that non-inductive charging is effective in developing charge density magnitudes of up to 5 nC/m3 once model liquid water contents reach observed values of approximately 0.2 g/m3. The model also suggests that, once these charge densities are achieved, the sink of charge resulting from fallspeed divergence becomes approximately equal to the rate of charge generation, which might lead to the quasi-steady layered structure that is commonly seen in the observations.

Recently, *Steve Rutledge* and *Walt Petersen* have examined lightning statistics over Melville and Bathurst Islands which lie approximately 100 km north of Darwin. Over the islands, a mid-morning peak in flash rate is followed by a major late afternoon peak. In mid-morning, lightning locations outline the island boundaries, where first convection forms associated with frictional convergence of the seabreeze. In the late afternoon, major clusters of lightning are aligned meridionally with the organized convection. Unlike the tropical continental and middle latitude cases we studied in the past, we do not observe a period of enhanced positive lightning immediately after the peak in negative lightning (End of Storm Oscillation). We attribute this finding to the relatively small fraction of stratiform precipitation over the islands (as shown by recent water budget studies), consistent with the lck of a mesoscale charge generator that could produce an inverted dipole and hence positive lightning. We plan to collect detailed electrical observations in these island storms during Nov-Dec, 1995.

GEOPHYSICS DIRECTORATE, PHILLIPS LAB (Bedford, Massachusetts)

John Willett is taking a respite from field work this Summer to build more electric-field sounding-rocket payloads and to analyze triggered-lightning data from 1987 in collaboration with *Dave Le Vine* (NASA/GSFC) and *Vince Idone* (SUNY Albany).

LAWRENCE LIVERMORE NATIONAL LABORATORY (Livermore, CA)

Colin Price and *Joyce Penner* from Lawrence Livermore National Laboratory (LLNL) and *Michael Prather* from the University of California, Irvine, have completed a two part study quantifying the amount of nitrogen oxides (NOx = NO+NO2) produced globally by lightning. The first part of the study uses simulated global lightning distributions together with lightning physics to arrive at the global NOx production by lightning. The results provide the first global maps of lightning-produced NOx on daily, monthly, seasonal and interannual time scales. The global data sets will be made available to other researchers interested in modeling the effects of NOx on tropospheric chemistry. The second study uses the global atmospheric electric circuit to quantify the integrated effect of lightning on global NOx production. The two methods provide independent means of arriving at the same result, and the results greatly improve the current estimates of the contribution of lightning to the global NOx budget. A third part to this study will involve placing the newly derived global distributions of lightning-produced NOx into a global chemical tracer model to understand the redistribution of NOx in the atmosphere and the potential effect on tropospheric ozone concentrations.

We are also involved in a study to investigate the effect of subsonic aircraft on tropospheric chemistry. Aircraft emit large amounts of NOx into the upper troposphere, although these emissions occur in well defined flight corridors. We intend to investigate the contribution of lightning-produced NOx to the background NOx concentrations in these flight corridors, to see whether the aircraft are affecting the background levels of NOx in the upper troposphere.

Britton Chang and *Colin Price* have a paper in press (Geophysical Research Letters) discussing the possibility of gamma ray production above thunderstorms, as reported by Fishman et al. (Science, 1994). We have used a theoretical model of runaway elecrons to show that under certain rare conditions, it is possible to obtain large enough electric field above large thunderstorms to produce conditions favorable for runaway electrons to occur, resulting in the production of gamma radiation. These conditions are determined by a combination of high electric fields (100's V.m) together with low atmospheric density. Due to these competing factors we find that gamma ray production above intense thunderstorms can occur only above altitudes of approximately 70 km, approximately the altitude of the upper atmospheric discharges (sprites) recently observed by *Lyons* et al. and *Sentman* et al.

John Molitoris and *Colin Price* of LLNL together with *Eric Arens* of UC, Berkeley, will be fielding some new imaging instrumentation as part of the SPRITES '95 campaign this summer at the ranch (Yucca Ridge) of *Walt Lyons* in Ft. Collins, Colorado. We plan to bring both optical and infrared imagers that will be able to observe the sprites at speeds of 2000 frames per second (0.5 msec resolution). We hope to determine if the sprites propagate either up or downward, and to see how they vary temporally in structure and brightness. We also hope to be able to determine whether the sprites have a specific IR signature, which may supply information as to the mechanism that produces sprites.

From August 1, 1995, *Colin Price* will no longer be at LLNL. He is joining the faculty of Tel Aviv University in Israel. His new address from this date will be: Dr. Colin Price, Department of Geophysics and Planetary Sciences, Tel Aviv University, Ramat Aviv, Tel Aviv 69978, ISRAEL.

MIT WEATHER RADAR LABORATORY (Cambridge, Mass.)

Dennis Boccippio, *Stan Heckman*, *Bob Boldi*, and *Earle Williams* continue their investigation of Schumann resonance Q-bursts and sprites initiated last summer with *Walt Lyons*. A comparison of amplitudes of ELF transients from ground flashes identified by the National Lightning Detection Network shows a pronounced asymmetry between positive and negative polarity, with the positives showing systematically stronger ELF amplitudes for the entire range of peak currents. The ELF amplitudes for negative ground flashes in the 10-30 kA range are of the same order as the background CW resonances, suggesting that these events make an important contribution to the latter phenomenon. *Stan Heckman* continues to work on the Schumann resonance inverse problem in his spare time at Philipps Laboratory. *Charles Wong* has begun to explore the impedance method for locating the origins of the large amplitude Q-bursts (from the West Greenwich, Rhode Island field site) which have been shown to be associated with sprites. This work will help to understand the relationships between the continuous and transient Schumann resonances and will continue this summer during the Sprites '95 campaign.

Bob Boldi has fit Lorentzian line shapes for 17 months of continuous Schumann resonance observations from Rhode Island. These results show a strong annual signal with maximum in the Northern Hemisphere summer and a weaker semi-annual signal. The long term trend does not show an increase. The amplitudes in January 1995 are slightly weaker than in January 1994. Comparisons of these signals with simultaneous recordings at the U.S. Navy submarine base in New London, Connecticut, 40 miles distant (in collaboration with *Bob Hall* and *Rob Aiksnoras*), show excellent agreement on the diurnal time scale, indicating that cultural noise is not a problem at either site and that the signals have global representativeness. Africa and South America have strong and often distinct manifestations in the diurnal signals; the contribution from Asia/Australia is significantly weaker probably due to ELF attenuation.

Work continues with *Joel Susskind* and *Ebby Anyamba* at NASA Goddard Space Flight Center on the global analysis of deep convection and surface air temperature with TOVS satellite data. This study continues to focus on the geographical origin of the annual and semi-annual signals for comparison with global circuit Schumann resonance measurements. The tentative conclusion is that a relative minimum in cloud-to-ground lightning in the equatorial zone is necessary to explain the predominance of the annual signal over the semi-annual signal at ELF. We are requesting information on ground flash density at low latitude stations to follow up on these findings. Any interested collaborators?

Collaborative work with *Steve Goodman* at NASA/MSFC has led to a merging of Dennis Boccippio's wet bulb potential temperature data set and global maps of deep convection from geostationary satellite, with 3 hourly resolution. This information will be very helpful in understanding global circuit response to temperature.

Earle Williams worked with *Ralph Markson* and *Lothar Ruhnke* in May on Ralph's project to measure ionospheric potential simultaneously in Darwin, Australia and western Massachusetts in late May and early June. These measurements will be compared with Schumann resonance observations in Rhode Island and electric field measurements on Mt. Washington (using a field mill specially designed by *Mike Stewart*).

Earle Williams will move 100 meters north from the Department of Earth, Atmospheric and Planetary Sciences to the Parsons Laboratory in the Department of Civil Engineering, beginning in July. He will have a split appointment with *Mark Weber's* Weather Sensing Group at MIT Lincoln Laboratory.

MOSCOW POWER ENGINEERING INSTITUTE, TECHNICAL UNIVERSITY (Moscow, Russia)

The Moscow High Voltage Engineering Seminar was organized in MPEI some years ago. The aim of the seminar is to discuss problems of high voltage engineering and atmospheric electricity. Four meetings were organized in 1994. The fourth meeting was held on 20th of December, 1994. The items of discussions were: "Lightning electrodynamical characteristics of strokes to grounded objects with multiwires lines" presented by academician *M.V. Kostenko* of RAN and "Spatial-temporal characteristics of lightning main discharge development: transmission line model with nonlinear parameters" presented by scientist *B.N. Gorin* of the Krzhizhanovsky Power Institute. Many specialists from different institutes and universities in Russia take part in these meetings.

Scientists of the High Voltage Engineering Department (*Prof. I.P. Verseshohagin* is the head of the HVED) investigate the physics of discharges produced by artificially charged aerosol clouds. We pay attention to upward leaders which develop from grounded electrodes. Many other aspects of electrified cloud and electric fields can be studied.

Alexander V. Orlov began studying radio noise from discharges generated by artificially charged aerosol clouds.

The scientific journal "Electrichestvo" published articles by *A.V. Orlov* and *V.S. Petukhov* on the estimation of cloud electrical structure in issues N2 and N8, 1994.

MSFC ATMOSPHERIC ELECTRICITY GROUP (Huntsville, Alabama)

A new and innovative satellite for detecting lightning called the Optical Transient Detector (OTD) was launched on a Pegasus rocket on April 3 in a 785 km, 70 inclination orbit with a planned mission lifetime of 2 years. OTD is the engineering flight model of the NASA Lightning Imaging Sensor (LIS) which will be included on the Tropical Rainfall Measurement Mission (TRMM) planned for launch in 1997. The sensor detects lightning events with a time resolution of 2 ms to within 8 km over a 1300 x 1300 km region. It employs a 128 x 128 CCD detector array which also provides high quality images of cloud formations. The initial results are very exciting and have validated that OTD is able to easily detect lightning during the day time as well as night. Initial evaluation and analysis of the data is underway. We will compare the OTD lightning data with both ground measurements and observations from other satellites. We will also begin the process of building and archiving a global lightning data base using OTD data. Information about the MSFC electricity program, instrument descriptions, and recent results from OTD can be found on our World Wide Web home page at URL http://wwwghcc.msfc.nasa.gov:5678.

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

A LIS/OTD science meeting was held at the Global Hydrology and Climate Center in Huntsville on June 6-7. First results from the OTD were presented by H. Christian. Presentations were given by outside scientists interested in using the OTD data in their own research and break-out sessions were held to discuss instrument on-orbit calibration, validation, and geolocation. A special session on the OTD results will be held at the Fall meeting of the AGU in San Francisco. *H. Christian* (oral presentation) and *S. Goodman* (poster presentation) will be presenting OTD results at the IUGG meeting in Boulder.

The LIS for the TRMM satellite is now undergoing laboratory calibration (*H. Christian, W. Koshak, J. Bergstrom, M. Stewart, J. Hall*). A full radiometric calibration is being performed and includes: DC linearity analyses, AC response testing, FOV coverage, and narrow-band filter testing. In addition, performance tests of the sensor are being performed using an externally modulated laser light and conditioning optics.

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Plans continue for participation in the Maritime Continent Thunderstorm Experiment (McTEX) planned for Melville Island in November 1995 (*R. Blakeslee, H. Christian, J. Bailey, S. Goodman, R. Raghavan*). Prior to McTEX a 3 station Advanced Lightning Direction Finder (ALDF) will be installed in Darwin to support long term Tropical Rainfall Measurement Mission (TRMM) ground truth studies. During McTEX a fourth ALDF site will be installed at the radar site on Melville Island. Plans to deploy a 9 station field mill network have been cancelled, although observations with 1-2 field mills and a wideband E-field sensor may be collected. *D. Boccippio*, a MIT doctoral student of *Earle Williams,* will be joining the MSFC science team as a NASA co-op employee beginning at the end of June.

National images of cloud-to-ground lightning frequency (derived from GDS network) and precipitation rate (derived from the U.S. National Radar Network composite reflectivity data from WSI) are being generated every 15 min at 8 km spatial resolution. These images are available to the NASA Earth Observing System research community and participants in the Tropical Rain Measuring Mission (TRMM) through the EOS Data and Information System (EOSDIS) node for hydrologic cycle studies located at MSFC. For more information contact the Distributed Active Archive Center (DAAC) user services group at e-mail: msfc@eos.nasa.gov (205-922-5813). The images are produced in real-time (ready in about 10 minutes after the observations are taken) and are available on the World Wide Web at URL http://wwwdaac.msfc.nasa.gov. There is also a movie loop (mpeg) for both lightning and precipitation of the previous 24 hour period composed of the individual 15 min images. In addition, daily composite images of accumulated precipitation and lightning are available. The images are restricted to certain users. For more information contact *S. Goodman*.

The MSFC Atmpspheric Electricity group is located at the Global Hydrology and Climate Center in Huntsville, Alabama. The mailing address is: 977 Explorer Blvd., Huntsville, AL 35806. The Fax number is 205-922-5723.

NATIONAL SEVERE STORMS LABORATORY (Norman, Oklahoma)

Conrad Ziegler is employing ground strike data from GDS to locate regions of deep convection relative to cloud areas and dryline position in a mesoscale modeling study of convective initiation on four days during the COPS-91 experiment in the Oklahoma-Texas-Kansas region. The location and timing of explicitly simulated deep convection is being evaluated against concentrations of ground strikes. Additionally, lightning activity on larger scales is being correlated to regions of parameterized subgrid-scale convection in the model.

Ken Howard and *Ron Holle* printed the poster Lightning Danger! of lightning striking a tree. This poster warns people not to take shelter under trees during thunderstorms, and is oriented toward schools. To date, 6350 copies have been distributed, mainly to schools and National Weather Service staff involved in education and warning activities. Raúl Lopez and his wife translated the poster into a Spanish version "Peligro de Rayos!" whose first printing of 3000 recently arrived. Contact us at 1313 Halley Circle, Norman, OK 73069 (405-366-0500/0516) about obtaining copies.

Don MacGorman of NSSL and *Ken Crawford* and *Xia Huan-Qing* of the Oklahoma Climatological Survey are completing work on a 7-year lightning strike climatology of Oklahoma to study geographic, diurnal, seasonal, and interannual variations in flash counts. Ground flashes have been tabulated each day by hour of day and flash polarity on a grid with 12 km x 12 km resolution. During spring and fall, ground flash production in much of Oklahoma is dominated by large storm systems, which often form in the lee of the Rocky Mountains and move through Oklahoma during the night. This results in a prominent late-evening peak in flash counts. During summer, the diurnal variation in flash counts has a strong peak in late afternoon, consistent with storms driven by late afternoon heating. Although rainfall and severe weather climatologies of Oklahoma have shown pronounced peaks in spring and fall, with a relative minimum in summer, flash counts and the number of days in which ground flashes occur somewhere in the state both peak in June and July. Lightning statistics should provide a more accurate indication of regional thunderstorm climatology than is provided by rainfall and severe weather statistics.

Between May 15 and June 15, *Tom Marshall* (University of Mississippi), *Dave Rust* (NSSL) and *Maribeth Stolzenburg* (NSSL/CIMMS) will make electric field soundings in supercell thunderstorms as part of the VORTEX experiment. Througout May and June we will collaborate with *Bill Beasley* and *Ken Each* of the University of Oklahoma to make X-ray and electric field soundings in mesoscale convective systems (MCSs) and with *Walt Lyons* of ASTeR to look at electric fields above MCSs when sprites occur.

NEW MEXICO TECH (Socorro, New Mexico)

Paul Krehbiel and graduate students *Mark Stanley* and *Richard Scott* have made initial comparisons of individual lightning discharges in storms over Langmuir Laboratory with vertical cross-sections of the storm structure using Tech's dual-polarization radar. The results indicate that the vertical channel of intracloud lightning discharges coincides with the main precipitation shaft of the storm and extrnds upward into regions of strong electrical alignment prior to the discharge. Horizontal development of the IC discharges at their upper level has been shown to extend into the storm anvil, as expected. Separate comparisons have also been made of LDAR lightning observations from *Launa Maier* at NASA/KSC with horizontal cross-sections of storm structure from the Melbourne NEXRAD radar. The entire sequence of lightning activity in a multicellular storm system was found to be closely correlated with the precipitation cores of the cells. Both sets of results will be reported at the upcoming Radar Meteorology Conference in Vail this October. Work will be continuing both at Langmuir Laboratory and at KSC this summer to extend the comparisons. The latter will incorporate observations from NCAR's CP2 radar, which is deployed at KSC this summer as part of the Small Cumulus Microphysics Study (SCMS).

RESOLUTION DISPLAYS, INC. (Fairfax, Virginia)

RDI was recently awarded a contract by NASA to devleop a global lightning detection network, emphasizing long-range detection of over-ocean lightning for the Tropical Rainfall Measuring Mission. Locating will be done by reception of VLF sferics using both time-of-arrival and magnetic-direction-finding techniques. This fall four receivers are scheduled for installation along the U.S. east coast to monitor most of the Atlantic.

The electric and magnetic receivers have sensitivity below the natural background noise over the frequency range from 5 Hz to 18 KHz. RDI is interested in collaborating on research projects where this data would be useful. A project newsletter is available from *Stan Kriz* at RDI (703-591-8902).

SCIENTIFIC APPLICATIONS AND RESEARCH ASSOCIATES
(Huntington Beach, CA)

Under a Phase II Small Business Innovation Research contract with the NASA, SARA, Inc. has developed a workstation that will track storm centers based on electric field data, animate the storm tracks, establish system errors, and predict the onset of lightning strikes. The workstation performs and displays the results of two analyses of the electric field mill data. One analysis, based on Multiple Signal Characterization (MUSIC) eigenanalysis, utilizes a model of the thunderstorm and calculates model parameters while efficiently searching the entire parameter space. The other analysis, in which a least squares algorithm has been implemented, utilizes the same thunderstorm model as the MUSIC algorithm but only searches a subset of the model space. The storm centers are displayed in color and looped to depict storm movement and charge locations.

In a poster paper to be presented at the 1995 International Aerospace & Ground Conference on Lightning and Static Electricity, the analysis techniques will be discussed briefly and the results of the analyses using data from electric field mills installed at the

KSC will be presented on a workstation display. Also, comparisons of MUSIC products and LDAR products will be presented for several thunderstorms. These comparisons confirm the reliability of the analytical techniques incorporated in the workstation. In fact, for a few case studies, MUSIC product predicts where lightning activity will occur. The presence of lightning is confirmed by the LDAR data.

Texas A&M University (College Station, Texas)

The mesoscale group in the Department of Meteorology remains active with a number of master's projects nearing completion. Approximately 12 master's research programs involve the use of the lightning information from the National Lightning Detection Network. The faculty advisors include *Ed Zipser, Dick Orville,* and *Mike Biggerstaff*. Much of the research was reported at the recent Annual Meeting of the AMS (Dallas, January 1995) and is available in reprints from this meeting.

A collaborative agreement was signed in April between the Voeikov Main Geophysical Observatory, St. Petersburg, Russia, and Texas A&M University. Professor *G. Shchukin* signed for the MGO Research Center for Atmospheric Remote Sensing and *Dick Orville* signed for the Cooperative Institute for Applied Meteorological Studies. The collaborative research involves, among other things, a cooperative study at the Turgosh field site approximately 300 km east of St. Petersburg. The Turgosh site is the home of the multi-wavelength radar facility with radars spanning the range from 0.8 to 200 cm. Lightning location equipment is also in operation at this site. Colleagues interested in more information should write *Dick Orville* (orville@ariel.tamu.edu) or phone, 409-845-9244.

UNIVERSITY OF FLORIDA (Gainesville, Florida)

Doug Jordan, Vlad Rakov, and *Martin Uman* in collaboration with *Vince Idone* (SUNYA), and *Dick Orville* (Texas A&M University) analyzed a high-speed streak photograph of a natural cloud-to-ground lightning return stroke followed by two M-components. As opposed to the return-stroke light pulse whose amplitude and waveshape vary markedly with height, the amplitude and waveshape of one M-component light pulse is essentially invariant with height between the cloud base (about 1 km) and ground, while the other M-component has a relatively constant light waveshape and light amplitude that varies somewhat with height. This behavior of M-components is consistent with the M-component mechanism recently proposed by the University of Florida group.

Rajeev Thottappillil, Jon Goldberg, Vlad Rakov, and *Martin Uman* in collaboration with *Dick Fisher* and *George Schnetzer* (Sandia) analyzed various properties of M-components using currents measured at triggered-lightning channel base. A typical M-component in triggered lightning is characterized by a more or less symmetrical current pulse having an amplitude of 100-200 A (two orders of magnitude lower than for a typical subsequent return stroke), a 10 to 90% rise time of 300-500 ms (three orders of magnitude larger than for a typical return stroke), and a charge transfer to ground of the order of 0.1 to 0.2C (one order of magnitude smaller than for a typical return-stroke pulse). About one third of M components transferred charge greater than the minimum charge reported by Berger et al.

(1975) for subsequent leader-return storke sequences. It appears from the analysis that the M component is a necessary feature of the continuing-current mode of charge transfer to ground.

Vlad Rakov, Martin Uman, and *Glen Hoffman* in collaboration with *Marx Brook* (NMIMT) analyzed regular burst of electric field radiation pulses in natural lightning discharges recorded in 1991 at KSC. The bursts are similar in the number of pulses per burst and inter-pulse intervals to the "multiple burst" component (so-called component H) of the standard lightning environment for the design and testing of aerospace vehicles. Preliminary results of this study were reported at the International Symposium on EMC in Zurich (EMC Zurich '95).

Rajeev Thottappillil has joined the High Voltage Research Institute at the University of Uppsala, Sweden.

A full program of triggered-lightning research at Camp Blanding is planned for summer 1995 with primary funding from EPRI, NSF, and Florida Power Corporation. Participants include researchers from the U.S., France, Switzerland, Norway, Sweden, and Italy.

The University of Mississippi (Oxford, Mississippi)

Tom Marshall, Dan Breed (NCAR), and *Jim Dye* (NCAR) are continuing their analysis of the charge, size, and type of precipitation particles found in CaPE thunderstorms. The data were collected with the NCAR sailplane.