NEWSLETTER ON ATMOSPHERIC ELECTRICITY

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INTERNATIONAL COMMISSION ON ATMOSPHERIC ELECTRICITY (IAMAS/IUGG)

AMS COMMITTEE ON ATMOSPHERIC ELECTRICITY

AGU COMMITTEE ON ATMOSPHERIC AND SPACE ELECTRICITY

EUROPEAN GEOPHYSICAL SOCIETY

SOCIETY OF ATMOSPHERIC ELECTRICITY OF JAPAN

ANNOUNCEMENTS

The Newsletter on Atmospheric Electricity is now sent by e-mail. We remind all our colleagues that it is also routinely provided on the web (http://ae.atmos.uah.edu), thanks to Monte Bateman's help. Those individuals needing a mail version should contact Serge Chauzy: (chas@aero.obs-mip.fr) or Pierre Laroche: (laroche@onera.fr). They will receive the Newsletter in its paper version. Those knowing anybody who needs such a paper version are also welcome to contact us. On the other hand, the easiest way to communicate being now electronic mail, we would be grateful to all of those who can help us complete the "atmospheric electricity" list of email addresses already available.

Contributions to the next issue of this Newsletter (May 2001) will be welcome and should be submitted to Serge Chauzy or Pierre Laroche before April 30, 2001, preferably under word attached documents. A reminder will be sent to all colleagues whose e-mail addresses are presently listed.

BOOKS

RESEARCH NOTEBOOKS OF C.T.R. WILSON

Earle Williams reports:

The AGU Committee on Atmospheric and Space Electricity is continuing efforts to secure general access to the 50 volumes of C.T.R. Wilson laboratory notebooks, currently in the library of the Royal Society in London. Ms. Jessie Wilson, daughter of C.T.R. Wilson, has kindly written to the Royal Society in support of this access. Academic Microforms, at the recommendation of the archivist at the Royal Society, has provided estimates for both microfilming and digitizing this material. Requests have been submitted to the American Geophysical Union (Dr. John Dickey) and the Center for the History of Physics (Dr. Spencer Weart) at the American Institute of Physics (AIP) to cover these costs. The AGU has approved this request, contingent on approval to place the material on the AGU website. This request is currently being considered by the Library Committee of the Royal Society. The AIP has approved funds for microfilming but according to policy, do not support digitizing tasks.

LIGHTNING PHYSICS AND LIGHTNING PROTECTION

by E M Bazelyan, Krzhizhanovsky Power Engineering Institute, Moscow and Y P Raizer, The Institute for Problems in Mechanics, Moscow. Released in Aug 2000 234 x 156mm 325 pages, illustrated, hardback 0750304774 £75.00/$120.00.
Dr John Navas, Senior Commissioning Editor, Books, Institute of Physics Publishing, Dirac House, Temple Back, Bristol, BS1 6BE, UK reports on the publication of this book:

In Lightning Physics and Lightning Protection the authors provide a comprehensive and up-to-date review of lightning, including its hazards and protection techniques. The book considers:
The mechanisms of lightning discharge processes: the initiation of a leader, return stroke and subsequent components, using experimental data and theory.
The effects of large aircraft, high-voltage lines and other high-altitude constructions on lightning trajectory and leader attraction.
The action of lightning's electrical and magnetic fields and the lightning current on industrial premises, power transmission lines, underground communications, aircraft and their electrical circuits and the induction of a dangerous overvoltage.
Effectiveness of conventional protective measures, and gives technical advice and practical recommendations.
The prospects for the preventive control of a lightning leader.

Introduction. Lightning, its destructive effects and protection. The streamer-leader process in a long spark. Available lightning data. Physical processes in a lightning discharge. Lightning attraction by objects. Dangerous lightning effects of modern structures. Index.

CONFERENCES

ICOLSE 2001

The 2001 International Conference on Lightning and Static Electricity (ICOLSE) will take place September 11-13, 2001, in Seattle, Washington, as part of the Aerospace Congress and Exhibition (ACE). For more information visit http://www.sae.org/calendar/ico/cfp.htm.

IAGA 2001

The International Association of Geomagnetism and Aeronomy Conference will be held in Hanoi, Vietnam, August 19-31, 2001. Two sessions of special interest to Newsletter readers are planned, one treating sprites and other middle atmosphere electrical phenomena (Dave Sentman and H. Fukunishi, Co-Convenors) and one concerned with giant positive discharges

(Earle Williams and Martin Fullekrug, Co-Convenors). The abstract deadline is February 1, 2001. Abstracts should also be submitted to the Convenors listed above. Invited talks are also planned. Excellent opportunities here for direct interaction with tropical thunderstorms in Southeast Asia!

Web site: www.ngdc.noaa.gov/IAGA/

The details on the two Special Sessions are as follows:

GAII 1: Transient Effects of Lightning on the Middle and Upper Atmosphere: Sprites and Other Effects

With the recent unexpected discovery of red sprites, blue jets, ELVES, and other optical lightning after-effects in the middle and upper atmosphere above very active thunderstorms, there has occurred an explosion of research activity to investigate their significance within the context of the larger terrestrial machine. Investigators of middle and upper atmosphere effects of lightning are invited to submit abstracts on all aspects of this new discipline, including relationship to the global electrical circuit, global distribution, underlying meteorology, microphysics and transport dynamics, spectroscopy, electromagnetic signatures, electrochemistry and atmospheric chemistry effects, ionospheric and magnetospheric effects, possible extraterrestrial equivalents, and methods and problems of remote sensing. Of special interest are papers devoted to the study of these new phenomena associated with active thunderstorm regions of South and Southeast Asia, Japan, the Malay Archipelago, and the Western Pacific.

Convenor: D.D. Sentman (Physics Department and Geophysical Institute, University of Alaska, Fairbanks, AK 99775, U.S.A.; Tel: +1-907-474-6442; Fax: +1-907-474-7290, E-mail: dsentman@gi.alaska.edu. Co-Convenor: H. Fukunishi.

GAII 2: Physics and Global Behavior of Giant Lightning Discharges

Scientific interest in a class of exceptionally energetic lightning discharges has greatly intensified in recent years. Cloud-to-ground flashes with positive polarity stand out in this category. These events are clearly identified with the largest single excitations ('Q' bursts) of the Schumann resonances in the Earth-ionosphere cavity. Many such events are causal to sprites, elves and trolls with a polarity bias that is currently not well understood. These discharges exhibit large continuing currents whose role in sprite initiation and maintenance is only now being explored. Many giant discharges are associated with a special phase of mesoscale convection characterized by modest vertical air motion (<1 m/s), large horizontal extent (>50 km) and radar bright band, whose ice microphysics is still poorly understood. The vertical channels to ground are linked aloft with laterally extensive 'spider' lightnings, structures only now being mapped with RF time-of-arrival methods. The charge transfers by these discharges are 1-2 orders of magnitude larger than ordinary lightnings. Positive charge transfers to Earth appear to discharge the DC global circuit. This Symposium seeks contributions on all aspects of giant discharges: their physical origin and microphysical basis, their mesoscale meteorological context, their characterization by the National Lightning Detection Network and particularly by lightning networks in the Eastern Hemisphere, their 3D structure as disclosed by RF analysis, their global distribution and land/ocean contrast, their relationship with mesospheric sprites, elves and trolls, their relationship with the background Schumann resonances, with ELF 'slow tails' and with ordinary lightning activity, their use as a diagnostic for the D-region of the Earth-ionosphere waveguide, their global variation on various time scales, and their possible links with giant lightning in the Jovian atmosphere.

Convenors: E.R. Williams (Parsons Laboratory, Massachusetts Institute of Technology, Cambridge, MA 02139 USA; Tel: +1-617-253-2459, Fax:+1-781-981-0632, E-mail: earlew@ll.mit.edu. Co-Convenor: M. Fullekrug.

IWPL'2001

The 5th International Workshop on Physics of Lightning will take place September 10-13, 2001, in Nagoya-Japan. The main subjects of interest are:

1. Thunderstorm Electrification and Atmospheric Electricity
2. Lightning phenomenology and meteorology
3. Lightning discharge physics
4. Lightning detection and protection
5. Lightning and Human Beings
6. Lightning and Atmospheric Environment

The deadline for abstracts submission is December 1st, 2000. More details on the web site: http://eism.elcom.nitech.ac.jp/~iwpl/index.html

EGS 26th GENERAL ASSEMBLY

The 26th General Assembly of the EUROPEAN GEOPHYSICAL SOCIETY will be held at the Acropolis Congress Centre, Nice, FRANCE, 25-30 March 2001. The deadline for abstracts submission is 01 December 2000. For further details see web site: www.copernicus.org/EGS/EGS.html

AGU 2000 FALL MEETING

The 2000 Fall Meeting of the American Geophysical Union will take place in San Francisco, USA, December 15–19, 2000. The abstracts submission deadline was September 1, 2000. More details on the web site: www.agu.org/meetings. Vlad Rakov (CASE chair) reports:
Following a long-established tradition, AGU's Committee on Atmospheric and Space Electricity (CASE) will meet at the 2000 Fall AGU Meeting in San Francisco on Monday December 18, 5:30-7:30, room 272 at Moscone Center. The CASE meeting is open to all who attend the Fall AGU Meeting. Please let me know if you have items (particularly those related to upcoming opportunities for collaboration) to place on the agenda for the CASE meeting.

AGU 2001 SPRING MEETING

The 2001 Spring Meeting of the American Geophysical Union will take place in Boston, USA, May 29 – June 2, 2001. The abstracts submission deadline is March 1, 2001. More information on the web site: www.agu.org/meetings.

IAMAS 2001

The next assembly of the International Association of Meteorology and Atmospheric Sciences will be held in Innsbruck, Austria, 10 - 18 July, 2001. The abstracts submission deadline is February 16, 2001. One session of special interest to Newsletter readers is cosponsored by ICAE: Symposium 7.6: The global effect of thunderstorm-produced NOx on tropospheric ozone; ICACGP, ICAE IOC-ICAE, ICCP.
Convenors: James Dye, Mesoscale and Macroscale Meteorology Division, National Center for Atmospheric Research, Boulder, CO, USA, e-mail: dye@ncar.ucar.edu. Hartmut Hoeller, Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany; e-mail: hartmut.hoeller@dlr.ge. Kenneth Pickering, University of Maryland, USA, e-mail: pickerin@metosrv2.umd.edu.
More information is available on the web site: http://iamas.org/

RESEARCH ACTIVITY BY ORGANIZATION

* LABORATOIRE D'AEROLOGIE, UNIVERSITE PAUL SABATIER (Toulouse, France)

The analysis of the data collected during the MAP (Mesoscale Alpine Programme) field experiment continues by Serge Soula (sous@aero.obs-mip.fr), Sylvain Coquillat (coqs@aero.obs-mip.fr), Serge Chauzy (chas@aero.obs-mip.fr), and Jean-François Georgis (geof@aero.obs-mip.fr). It gives rise to characterize the precipitation current produced by convective rains. One case of deeply convective thundercell and several cases of weakly convective events have been documented. These analyses concern the local measurements on two close surface sites of the electric field, of the precipitation current density, of the individual raindrop charges and of the rain microphysics. The dynamical characteristics of the thunderclouds are obtained from the observations of a triple Doppler radar system. The scientific questions approached here are (i) the interpretation of the mirror image effect connecting electric field and precipitation current, (ii) the characteristics and the origin of the charge carried down by the precipitation, and (iii) the role of the vertical development and dynamics of the cloud in the electrification processes. Two articles are in preparation on this subject.

Based on other data collected during MAP, a study is also conducted in order to better understand the relation between lightning activity and thundercloud characteristics. Yann Seity (an engineer from Météo-France) starts his thesis work on this topic, in cooperation with Serge Soula and the radar group of the Laboratoire d'Aérologie, Frank Roux (rouf@aero.obs-mip.fr) and Jean-François Georgis. The questions approached in this study will specially be the characterization of the events producing large amounts of positive cloud-to-ground flashes. As a matter of fact, during MAP experiment, such cases of storms occurred within the area covered by the radar observation.

A station for continuously measuring the electric field, the precipitation current density, and the rain microphysics is installed at the site of the laboratory Centre de Recherches Atmosphériques of Campistrous (Hautes-Pyrénées) since August 2000, by Serge Soula and Yves Meyerfeld (meyy@aero.obs-mip.fr). These data are collected in order to systematically study the characteristics of the precipitation current under various meteorological and seasonal conditions. They will be associated with radar observations from the operational network of Météo-France.

Sylvain Coquillat, Serge Chauzy, and Fabrice Gangneron (ganf@aero.obs-mip.fr) are developing a new balloon-borne system for in situ measurements in thunderclouds. This system gathers a radiosonde that provides thermodynamical characteristics and gives the position of the balloon via a GPS, a field mill that measures the three components of the electric field, and a new microphysics sensor. Equipped with a video camera and an induction ring, this sensor is designed to detect the nature, the shape, the size, and the electric charge of precipitating hydrometeors. The minimum detected charge will be ±2 pC and the maximum about ±400 pC. A particular care is devoted to the teletransmission of the data to the ground. The different signals will be sent separately and the bandwidth of the video signal will be reduced by filtering to ensure a good transmission without spoiling the hydrometeor pictures. This system is planned to be used in a forthcoming campaign in Lannemezan at the Pyrénées foothills, France. For this, radar coverage provided by Henri Sauvageot (sauh@aero.obs-mip.fr), from the radar group of the Laboratoire d'Aérologie, will be available. It involves a polarimetric and a double wavelength radars.

* THE UNIVERSITY OF ARIZONA (Tucson, Arizona, USA)

Natalie Murray has recently begun a new study of the space charge produced by splashing in the surf zone at the NASA Kennedy Space Center (KSC). Scott Handel has found that the surface electric field just before and during the onset of isolated storms at KSC is dominated by the appearance of a lower positive charge center (LPCC) at measuring sites that are close to or directly under the storm, before the negative charge at higher altitudes dominates the pattern. Bruce Gungle has examined relationships between cloud-to-ground (CG) lightning and surface rainfall (measured with gages) in 9 storms at KSC and has found that there are about 1.5 x 10**4 cubic meters of convective rainfall per CG flash in both small and large storms. By analyzing the development of 386 CG flashes recorded on video tape, William Valine has determined that Arizona storms produce an average of 1.45 strike points per CG flash. W. J. Koshak and E. P. Krider are continuing to study the response of the NASA Lightning Imaging Sensor (LIS) when lightning occurs over or near the KSC and are within the LIS field of view. An effort is also being made to determine if the total light output from IC or CG discharges, as measured by LIS, is proportional to the total charge in the flash or any other electrical parameter. As part of the Thunderstorm Observation and Research (ThOR) initiative at the NASA-GHCC and the UAH, C. D. Weidman is developing methods for validating the performance of satellite lightning sensors that can be implemented by elementary, high school, and college students.

* CENTRE FOR EARTH SCIENCE STUDIES (Thiruvananthapuram, India)

(Address: PB No. 7250, Thuruvikkal PO, Thiruvananthapuram 695031, India)

Atmospheric electricity was one of the thrust areas identified for research in the Atmospheric Sciences Division in 1978 when our institution was started. Initially, we decided to generate data for our region, which was very meagre. We concentrated on making measurements of ion concentration, ion mobility and electrical polar conductivities. Quite a bit of time was spent on the development of the instrument, the Gerdien condenser, for rocket and balloon-borne measurements. We participated in the Indian Middle Atmosphere Programme and carried out four measurements in the region from 60 to 90 km using rockets and four measurements in the region from surface to 33 km using high altitude balloons. Of the latter, two used self-aspirated instruments and two force-aspirated ones. Subsequently we were involved in a study of the influence of the rich deposits of monazite in the coastal sands of our state on the electrical structure of the atmosphere above the region. This involved continuous measurement of polar conductivities at the surface at three sites and surveys using airborne and jeep-borne instruments. The conductivity data from surface monitoring showed that the diurnal pattern at the radioactive site changed from one season to another, which is rather unusual. The data also prompted us to take a look at the causes behind the diurnal variation. It is this aspect that we are looking at now, through a new project. Our aerial surveys showed that they could detect the presence of deposits of radioactive minerals in the soil, providing a simple technique for the purpose. Our work so far has thus been confined to fair weather studies.

Our present work is in two areas. One is the study of the causes for the diurnal variation of electrical conductivity. This involves setting up Gerdien condensers for monitoring positive and negative polar conductivities, a radioactive potential equaliser probe for monitoring the vertical electric field, and a weather station for monitoring temperature, humidity, pressure, wind and rainfall. In addition, the Space Physics Division of the Vikram Sarabhai Space Centre here will collaborate with us to provide aerosol data. The weather station has been set up and the fabrication of the Gerdien condenser is nearing completion. We hope to complete setting up the entire system within a month or so.

We have taken up studies related to lightning accidents in the state. As a pilot study, an area that is reported to have had a high incidence was selected. Data regarding lightning accidents were collected from the local people, official records and the press. This data were used to determine the number of lightning incidences in different panchayats (a small administrative entity). We also conducted awareness camps for the public in two of the panchayats which had more incidences compared to other nearby areas. A pamphlet prepared in local language on how to protect oneself during lightning activity was also distributed during the camps. The reasons for high incidence in a given area are being now studied from the point of view of terrain and other geophysical factors. A related study is the mapping of lightning hazard in the state. The aim of this study is to collect data on lightning strikes from different sources, including the press, local people and official revenue records, and prepare a lightning activity map of the state.

Publications:

Murali Das, S., V. Sasi Kumar and S. Sampath: Measurements of electrical conductivities, ion densities and mobilities in the middle atmosphere over India, Indian J Radio Space Phys, 16, 215-220, 1987.

Sampath, S., S. Murali Das and V. Sasi Kumar: Electrical conductivities, ion densities and mobilities in the middle atmosphere over India - balloon measurements, J Atmos Terr Phys, 51, 533-540, 1989.

Murali Das, S., S. Sampath and V. Sasi Kumar: Effect of surface radioactivity on the vertical distribution of atmospheric electrical conductivities, Indian J Radio Space Phys, 20, 444-445, 1991.

Sampath, S., V. Sasi Kumar and S. Murali Das: Positive and negative ion densities and mobilities in the middle atmosphere over India - rocket measurements, J Atmos Terr Phys, 54, 347-354, 1991.

Sampath, S. and V. Sasi Kumar: Electricity in the atmosphere, Phys Education, 8, 135-147, 1991.

Sasi Kumar, V., S. Murali Das and S. Sampath: Atmospheric electrical conductivities over a region of high radioactivity, Indian J Radio Space Phys, 23, 253-258, 1994.

Murali Das, S., V. Sasi Kumar, S. Sampath, T.K. Krishnachandran Nair, and M. Ismail: Aerial survey of atmospheric electrical conductivity over a radioactive region using a Pushpak aircraft, Indian J Radio Space Phys, 23, 380-386, 1994.

Sampath, S., V. Sasi Kumar, and S. Murali Das: Airborne measurements of atmospheric electrical conductivities, Pure Appl. Geophys., 143, 713-727, 1994.

Sasi Kumar, V., S. Sampath, S. Murali Das and K. Vijaya Kumar: Atmospheric electrical conductivity variations over different environments, Geophys J. Int., 122, 89-96, 1995.

* COLORADO STATE UNIVERSITY (Fort Collins, Colorado, USA)

1. RADAR METEOROLOGY GROUP

- Contribution to STEPS 2000

The Severe Thunderstorm, Electrification and Precipitation Study (STEPS) field project was conducted from 22 May through 15 July 2000 in eastern Colorado and western Kansas along the climatological position of the dry line. The broad goal of STEPS was to achieve a better understanding of the interactions between kinematics, precipitation production, and electrification in severe thunderstorms on the High Plains. Several fundamental processes are still not well understood, but can now be investigated due to technological advances in instrumentation. STEPS focused on supercell thunderstorms, including addressing why some supercells produce markedly little precipitation (LP supercells) while others produce large amounts of precipitation (HP supercells). STEPS was also interested in examining the lightning behavior across this spectrum of storms, and sought answers to why some severe storms produce anomalously large amounts of positive cloud-to-ground lightning. STEPS deployed the following observing systems to perform coordinated measurements of environmental wind and thermodynamic vertical profiles, storm windfields, hydrometeor contents, electric fields, particle charge and lightning. The deployment of this particular suite of instruments was unprecedented.

- Two S-band polarimetric radars, CHILL from Colorado State University (CHILL also served as the Operations Center for the field campaign) and S-Pol from the National Center for Atmospheric Research,
- The South Dakota School of Mines and Technology armored T-28 aircraft,
- A 10 station lightning mapping system from the New Mexico Institute of Mining and Technology,
- Two mobile environmental sounding systems (MGLASS) from NCAR,
- Two mobile sounding systems from NOAA/NSSL to collect balloon-borne measurements of electric fields,
- Six mobile mesonet stations from OU and NSSL to observe the meteorological conditions and precipitation types beneath storms,
- The Yucca Ridge Field Station (YRFS) for monitoring sprite activity above the storms sampled in the STEPS domain,

The STEPS observational platforms were deployed in the context of the National Lightning Detection Network, which provided data on CG lightning locations, polarity and peak currents, and the NWS NEXRAD network which provided larger scale context for the research radars. Additionally, the CHILL, S-Pol and Goodland KS NEXRAD radars formed a triple-Doppler network. STEPS worked closely on a daily basis with the Goodland KS NWS Weather Forecast Office. Three NWS personnel produced detailed forecasts for STEPS and worked closely with STEPS personnel in all aspects of the project. Their insights regarding the local climatology were particularly helpful to the project. In this paper we will present the network design and discuss preliminary results from multiple platform observations of selected case studies. One particular interesting aspect of the observations suggested that a good number of the cases sampled, whether severe or not, contained inverted charge structures with positive charge situated below negative charge. Many storms sampled produced large fractions of positive cloud-to-ground lightning, including the tornadic supercell sampled on the evening of 29 June 2000.

- "Wet-season" vertical structures of tropical precipitation

In a recent paper submitted to J. Climate, Walt Petersen and Steven Rutledge have combined TRMM Precipitation Radar (PR) and Lightning Imaging Sensor (LIS) data to examine "wet-season" vertical structures of tropical precipitation, including ice water content, across a broad spectrum of locations in the global tropics.

Analysis of reflectivity vertical structure histograms, and lightning flash density data reveal that: 1) relative to tropical continental locations, wet-season isolated tropical oceanic locations exhibit relatively little spatial (and in some instances seasonal) variability in vertical convective structure across the global tropics; 2) coastal locations and areas located within 500-1000 km of a continent exhibit considerable seasonal and spatial variability in mean vertical structure, often resembling "continental" profiles or falling intermediate to that of tropical continental and isolated oceanic regimes; and 3)interior tropical continental locations exhibit marked variability in vertical structure both spatially and seasonally, exhibiting a continuum of characteristics ranging from a near isolated oceanic profile observed over the central Amazon and India, to a more robust continental profile observed over regions of high lightning flash density such as the Congo and Florida. Examination of regional and seasonal mean conditional instability for a small, but representative subset of the geographic locations suggests that tropospheric thermodynamic structure (as opposed to aerosol loading) likely plays a significant role in the regional characteristics of precipitation vertical structure and associated lightning flash density. In general, the largest systematic variability in precipitation vertical structure observed between all of the locations examined occurred above the freezing level. Importantly, sub-freezing temperature variability in the vertical reflectivity structures was well reflected in the seasonal mean lightning flash densities and ice water contents diagnosed for each location. In turn, systematically larger rainfall rates were observed on a pixel-by-pixel basis in locations with larger precipitation ice water content and lightning flash density. These results delineate, in a regional sense, the relative importance of mixed phase precipitation production across the global tropics.

- Positive cloud-to-ground lightning

In collaboration with Walter A. Petersen and Steven A. Rutledge, Lawrence D. Carey will present a poster analyzing the positive cloud -to-ground lightning associated with the Spencer F4 Tornado at the upcoming Fall 2000 AGU meeting.

On 30 May 1998, a supercell storm spawned five tornadoes, one of which was rated F4 on the Fujita Damage Scale. The tornadic storm devastated Spencer, South Dakota, killing 6 people, injuring more than 150 persons, and destroying nearly 90% of the structures in the community. This supercell produced over 65% positive cloud-to-ground (CG) lightning and a peak positive CG flash rate in excess of 16 min^{-1} (5-minute average). Earlier studies have reported anomalous positive CG lightning activity in some supercell storms producing violent tornadoes.

What makes the CG lightning activity in this tornadic storm unique is the timing of the positive groundstrokes relative to the F4 tornado. In previous studies, a supercell dominated by positive CG lightning produced its most violent tornado after it attains its maximum positive ground flash rate, whenever the rate is in excess of 1.5 min^{-1}. Often, tornado genesis occurs during a lull in CG lightning activity and sometimes during a reversal from positive to negative polarity CG lightning. Contrary to these findings, the positive CG lightning flash rate and percentage of positive CG lightning in the Spencer supercell began to increase dramatically *during* genesis of the tornado and continued to rise while the storm was wreaking F4 damage on Spencer. The positive CG flash rate finally peaked above 16 min^{-1} as the tornado exited Spencer and began to weaken, producing F1 – F2 damage.

These results have very important implications for the use of CG lightning in the Nowcasting of tornadoes and for the understanding of cloud electrification in these unusual storms.

2. COOPERATIVE INSTITUTE FOR RESEARCH IN THE ATMOSPHERE (CIRA)

– NSW/VISIT Lightning Training

The U.S. National Weather Service (NWS) is offering forecasters training on lightning developed at the Virtual Institute for Satellite Integration Training (VISIT). VISIT member Bard Zajac is the producer and instructor of lightning training. To date, one training session has been offered entitled "CONUS CG Lightning Activity." The session covers the operation and performance of the National Lightning Detection Network and the climatology of cloud-to-ground lightning (CG) over the contiguous U.S. (CONUS). This session has been delivered to over half of the 114 NWS local offices using an distance learning application called VISITview.

The second lightning session entitled "Lightning Meteorology" will be released before the end of the year. The session will cover thunderstorm electrification and lightning-thunderstorm behavior using a number of case studies from AWIPS, the NWS's new platform for viewing weather data and products. The session emphasizes forecast applications including 1) the environmental factors and storm characteristics necessary to produce lightning and 2) lightning activity (-CGs and +CGs) as indicators of storm lifecycle stage and convective and stratiform rainfall location and intensity. A follow-up session is planned and will focus on relationships between lightning and severe weather.

More information on VISIT, VISITview, and lightning training can be found at: www.cira.colostate.edu/visit. The point-of-contact for VISIT lightning training is Bard Zajac at: zajac@cira.colostate.edu.

- Contribution to STEPS 2000

CIRA supported STEPS (Severe Thunderstorm, Electrification and Precipitation Study) by providing real-time satellite loops from RAMSDIS On-Line, including imagery from GOES Rapid Scan Operations. In addition, digital McIDAS satellite data was archived from six days. These data can be used for research and training purposes.

The STEPS home page is located at: www.mmm.ucar.edu/community/steps.html. RAMSDIS On-Line is located at: www.cira.colostate.edu/ramm/rmsdsol/main.html. Bard Zajac is the point-of-contact for the satellite data just described.

* COMMUNICATION AND SPACE SCIENCE LABORATORY, PENN STATE UNIVERSITY (University Park, Pennsylvania, USA)

Les Hale (LesW3LH@aol.com) reports:

In retirement I have been reviewing over 50 years of lightning and other electromagnetic observations, data, and theory. In the 50's the AE community and myself tended to believe electromagnetic transients were mainly of the "relaxation time" variety. ater, people realized this was not always the case, and that complete solutions of Maxwell's equations, including a time-varying magnetic field, were necessary to explain the atmospheric data. This eventually led to things like "FDTD" computer codes, which will not yield any transient solution without a time varying magnetic field.

It now appears that this viewpoint is also not always correct, as measurements in the conducting boundary regions show that simple polarization of the earth and ionosphere boundaries, both by electrostatic fields and travelling "TEM" waves, and both with large electric fields perpendicular to the boundaries, penetrate the boundaries much more deeply than "skin depth" concepts would allow. A frequently valid approximation is in fact the one dimensional "relaxation time" solution, which far from facilitating "shielding," simply transmits the field more deeply into the conducting medium, without attenuation. This solution cannot be generated by "FDTD" codes, which generally yield answers that are incorrect by many orders of magnitude, although their proprietors seem to be blissfully ignorant of this.

In the case of the ionospheric boundary, the problem is actually simplified by the earth's magnetic field, which one-dimensionalizes the field and results in the polarization of the magnetosphere, with charge deposited at the base of the magnetically conjugate ionosphere, mainly by the travelling ELF "slow tails" associated with lightning. This can explain the large mesospheric electric fields observed by Russian and US groups, and their differences, which can be explained by the "tilt" of the magnetic field with respect to the axis of rotation. (Paper presented by L. C. Hale at COSPAR in Warsaw, July, 2000, submitted to Adv. In Space Res.) A definitive experiment remains to be done involving simultaneous measurements in magnetically conjugate regions, such as S. Africa and Central Europe.

This "polarization" concept can also explain the strong underground current transients measured by our Penn State group and others, much greater than allowed by "skin depth" concepts or "FDTD" computer models. It may also explain the large number of unexpected "blasting accidents" during the construction of new tunnels through the Alps after WW2 reported by Prof. K. Berger (in Golde's "Lightning," vol.2). The current poor understanding of such phenomena, institutionalized in "FDTD" computer codes, may constitute a serious hazard to public safety in the area of mine and pipeline explosions, etc…

* LABORATORY OF CONVECTIVE STORM AND LIGHTNING PHYSICS, COLD AND ARID REGIONS ENVIRONMENTAL AND ENGINEERING RESEARCH INSTITUTE, CHINESE ACADEMY OF SCIENCES (LANZHOU, China)

(former filiation: Lanzhou Institute of Plateau Atmospheric Physics, Chinese Academy of Sciences) (From Xiushu QIE qiex@ns.lzb.ac.cn)

Altitude triggered-lightning experiments by using an underground rocket-launching facility technique were continuously conducted in Summer 2000 at Guangzhou area, southeastern China (xliu@ns.lzb.ac.zn). The experiments included (1) continued studies of the interaction of lightning discharges with ground-based objectives, including lightning rod and Semi-conductor Lightning Eliminator, in collaboration with Chinese Electrical Power Company. (2) continued studies of the initiation and propagation of bi-directional leader system by using high speed video camera, current measurement and two-station measurements of electric and magnetic fields. This experiment started in summer 1998, and the total number of flashes triggered in the last three years was 12. The data are being analyzed.

The development of positive leader of an artificially triggered lightning has been analyzed based on the data of electric field change, location of radiation source and frequency spectrum obtained by a broadband interferometer system. The results indicate that radiation from positive leader could be detected within close distance. Positive leader developed with few branches, and the initial progression velocity was of the order of 10^5m/s. A paper titled «Broadband Interferometer Observations of A Triggered Lightning» by DONG Wansheng (dongw@ns.lzb.ac.cn), LIU Xinsheng, YU Ye and Zhang Yijun (zhangyj@ns.lzb.ac.cn). has been accepted by the Chinese Science Bulletin.

The unusual charge structure of thunderstorms in Chinese inland plateau, located in the verge of Qinghai-Tibetan Plateau, has been continuously studied by using the data achieved in the last few years. One paper titled «K-type Breakdown Process of Intracloud Discharge in

Chinese Inland Plateau» by QIE Xiushu (qiex@ns.lzb.ac.cn), YU Ye, LIU Xinsheng et al. has been published in the Journal of Progress in Natural Science, 2000, Vol.10, No.8, 607-611. Another paper titled «Charge Analysis on Lightning Discharges to the Ground in Chinese Inland Plateau(Verge of Tibet)» by Xiushu QIE, Yu YU, Xinsheng LIU et al. has been accepted by Annales Geophysicae. It has been verified that a great positive charge region is widely distributed at the base of the thundercloud. The analysis also found that the intracloud discharges and positive discharges usually relate to this charge region. As to why such a large amount of positive charges exists at the base of the cloud and why lower positive charges seems to be more effective in discharge processes in Chinese Inland Plateau remain unanswered. To answer these questions, we plan to organize a big experiment program during 2001-2003 under the support of NSFC and Chinese Academy of Sciences.

The interaction between microphysics dynamics and thunderstorm electrification is continuously studied within the group. Correlation studies between lightning and precipitation activities have been studied by using the data of weather radar, meteorological sounding and lightning location system. We find the regression equation between the rainfall rate (R) and the CG lightning flash rate (F) is R=1.692lnF 0.273, and the correlation coefficient r is 0.8641. A paper titled «A Study of the Relationship between Cloud-to-ground Lightning and Precipitation in the Convective Weather System in China» by Yunjun Zhou (Zhouyj@ns.lzb.ac.cn), Xiushu Qie and Serge Soula (sous@aero.obs-mip.fr) has been submitted to Annales Geophysicae.

* UNIVERSITY OF FLORIDA (Gainesville, Florida, USA)

A total of 29 lightning flashes were initiated from June 12 to September 6, 2000 at the International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida. Of these 29, 26 contained downward leader/upward return stroke sequences, and 3 were composed of the initial stage only. All triggered flashes effectively transported negative charge to ground.

Seventeen flashes were triggered from an underground rocket-launching facility surrounded by a 70 x 70 m^2 buried metallic grid. Direct return stroke current derivative measurements and associated electric and magnetic field derivative measurements at 15 and 30 m were obtained. Further, electric fields at three distances (5, 15, and 30 m) and magnetic fields at two distances (15 and 30 m) for lightning M components were simultaneously measured. Electric fields were also recorded using Pockels sensors installed at a radial distance of 10 cm and at a height of 10 cm from the tip of the lightning strike rod, the closest lightning electric field measurements ever obtained. The position of the lightning channel with respect to the sensor varied for different events from 10 cm or less (in one case the channel was in contact with the sensor) to a few meters. This latter experiment was performed in collaboration with Megumu Miki of CRIEPI, Japan. Acoustic shock waves were recorded at about 2, 15, and 30 m from the lightning channel. It appears that all impulsive processes in the lightning discharge, including M-component type processes, produce acoustic shock waves. Triggered-lightning return stroke shock waves resemble those produced by the 4-m laboratory sparks studied by Uman et al. (1970). Preliminary results of the experiments conducted using the underground rocket launcher will be presented at the Fall 2000 AGU Meeting.

Twelve flashes were triggered using the tower rocket launcher. Lightning current was directed to a phase conductor (at mid-span or at a pole) near the center of a three-phase test distribution line. The line had a length of 829 m and was protected by six lightning arresters. The results of this experiment are found in Ph.D. dissertation “Interaction of Lightning with Power Distribution Lines” by Carlos Mata.

David Crawford, Vladimir Rakov, Martin Uman, George Schnetzer, Keith Rambo, and Michael Stapleton authored a paper, submitted to the JGR, titled “The Close Lightning Electromagnetic Environment: Leader Electric Field Change vs. Distance”. Leader electric field changes due to triggered-lightning strokes from experiments conducted in 1997, 1998, and 1999 at the ICLRT at Camp Blanding, Florida are analyzed and compared to similar data obtained in 1993 at Camp Blanding and at Fort McClellan, Alabama. In 1997-1999, the fields were measured at 2 to 10 stations with distances from the lightning channel ranging from 10 to 621 m, while in 1993, the fields were measured at three distances (30, 50 and 110 m) in Florida and at two distances (about 10 and 20 m) in Alabama. With a few exceptions, the 1997-1999 data indicate that the distance dependence of the leader field change is close to an inverse proportionality (r^{-1}), in contrast with the 1993 data in which a somewhat weaker distance dependence was observed. The observed r^{-1} dependence is consistent with a more or less uniform distribution of leader charge along the bottom kilometer or so of the channel.
Rouzbeh Moini, Behzad Kordi, G.Z. Rafi (Amirkabir University of Technology, Iran), and Vladimir Rakov authored a paper, accepted for publication in the JGR, titled “A New Lightning Return-Stroke Model Based on Antenna Theory”. A new approach based on antenna theory is presented to describe the lightning return-stroke process. The lightning channel is approximated by a straight and vertical monopole antenna with distributed resistance (a so-called lossy antenna) above a perfectly conducting ground. The antenna is fed at its lower end by a voltage source such that the antenna input current, which represents the lightning return-stroke current at the lightning channel base, can be specified. An electric field integral equation (EFIE) in the time domain is employed to describe the electromagnetic behavior of this lossy monopole antenna. The numerical solution of EFIE by the method of moments (MOM) provides the time-space distribution of the current and line charge density along the antenna. This new antenna-theory (or electromagnetic) model with specified current at the channel base requires only two adjustable parameters: the return-stoke propagation speed for a nonresistive channel and the channel resistance per unit length, each assumed to be constant (independent of time and height). The new model is compared to four of the most commonly used “engineering” return-stroke models in terms of the temporal-spatial distribution of channel current, the line charge density distribution, and the predicted electromagnetic fields at different distances. A reasonably good agreement is found with the modified transmission line model with linear current decay with height (MTLL) and with the Diendorfer-Uman (DU) model.
The following three papers were presented by the UF group at the 25th International Conference on Lightning Protection:

1. “Lightning Properties from Triggered-Lightning Experiments at Camp Blanding, Florida (1997-1999)”, in Proc. of the 25th Int. Conf. on Lightning Protection, Rhodes, Greece, September 18-22, 2000, pp. 54-59, V.A. Rakov, M.A. Uman, D. Wang, K.J. Rambo, D.E. Crawford, and G.H. Schnetzer.
2. “Triggered Lightning Testing of an Airport Runway Lighting System”, in Proc. of the 25th Int. Conf. on Lightning Protection, Rhodes, Greece, September 18-22, 2000, pp. 825-830, M. Bejleri, V.A. Rakov, M.A. Uman, K.J. Rambo, C.T. Mata, and M.I. Fernandez.
3. “Positive and Bipolar Lightning Discharges: A Review”, in Proc. of the 25th Int. Conf. on Lightning Protection, Rhodes, Greece, September 18-22, 2000, pp. 103-108, V.A. Rakov.

* INDIAN INSTITUTE OF TROPICAL METEOROLOGY (IITM) (Pune, India)

The Indian Institute of Tropical Meteorology (IITM) functions as a national centre for basic and applied research in monsoon meteorology of the tropics in general with special reference to monsoon meteorology of India and neighbourhood. Its primary functions are to promote, guide and conduct research in the field of meteorology in all its aspects. IITM has made significant contributions in the challenging areas of the Meteorology and Atmospheric Sciences like Weather Forecasting, Monsoon, Cloud Physics, Weather Modification, Atmospheric Chemistry, Atmospheric Electricity, Climatology and Global Change, Hydrometeorology, Monsoon, Climate Modelling.

Studies in Atmospheric Electricity is one of the projects of Physical Meteorology and Aerology Division of the IITM. Under this project the continuous observations of different electrical parameters such as electric field, point discharge current, drop charge etc. were taken since the 1970 at this station (Pune) and also in different environmental conditions. The present study deals with the behavior of one of the above mentioned electrical parameters.

Dr. S.S. Kandalgaonkar, Dr. M.I.R. Tinmaker, and Dr. M.K. Kulkarni, report about their findings on "**Time evaluation and frequency distribution of point discharge current over Pune region":**

One minute interval data of Point discharge Current (PDC) collected for a total of 65 thunderstorm days occurred during 6 years period (1972-1977) at Pune (18°32'N, 73°51'E, 559 m asl) forms the data set for the present study. This data has been analysed to study its time variation and also analyzed statistically to study its frequency distribution. For this purpose the total diurnal period (0000 - 2359 IST) is divided into 3 distinct time intervals i.e. afternoon (1400-2100 IST); night time (2100-0759 IST) and day time (0800-1400 IST). The number of data points for positive and negative polarity in each of the above time interval were 5649 & 4399; 1289 & 1091 and 479 & 411 respectively. These data points for each time interval were subjected to their frequency distribution. For each category, the data has been divided into 24 class intervals (i.e. 13 for negative polarity and 11 for positive polarity) ranging from -6.5 to 5.5 μA with uniform class width of 0.5 μA. The percentage occurrence of PDC of either polarity for total diurnal period and also for the above 3 categories of time interval for individual class interval were obtained. The computed values were evaluated by applying Gaussian Model, which suggests that the distribution is normal and the chi-square value obtained (5.2008) is less than the standard table value (9.542) for 22 degrees of freedom. From this it is seen that the hypothesis applied to the above data holds good. Since it is a normal distribution the data has been further tested by using Fischer's test for the skewness and kurtosis. The results thus obtained suggests that the distribution is found to be normal with negative skewness and exhibits the property of leptokurtic distribution. Temporal analysis of this data suggests that the behaviour of PDC of either polarity in the first category of time interval (i.e. 0800-1400 IST) is found to be identical (contribution of positive and negative PDC is nearly same) with the overall contribution of PDC during the total diurnal period (0000-2359 IST), whereas for second and third category the contribution of PDC of either polarity is observed to be in the opposite sense. This result is curious. The sustained occurrence of negative and positive PDC at the end of the storm day in second and third category of time interval may be due to the presence of excess positive and negative space charges in the corresponding category of time interval, and their concentrations also increases with increasing instability (for second category of time interval) and stability (for third category of time interval) respectively during that time intervals (Law, 1962).

* INSTITUTE OF ATMOSPHERIC SCIENCES, SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY (Rapid City, South Dakota 57701, USA)

At the South Dakota School of Mines and Technology (SDSMT) efforts continue in the areas of modelling of lightning and electrification in convective storms, and the analysis of field observations of convective storms. On the observations side, John Helsdon, Andy Detwiler, Qixu Mo, Donna Kliche, and Jessica Irvin, are beginning to analyse observations obtained with the SDSMT armored aircraft during the Severe Thunderstorm Electrification and Precipitation Study (STEPS) field program during May-July, 2000, in eastern Colorado/western Kansas. The analysis of airborne observations will be combined with observations from multiparameter Doppler radars, the NMIMT lightning mapper array, NSSL/OU electrical soundings, and other STEPS observations for several very interesting cases of both normal polarity and inverted-polarity convective storms.

On the modeling side, Helsdon, Dick Farley and Xingjun Zhang continue their efforts to model the production of NOx compounds by lightning in convective storms. Helsdon, Farley, and Inna Suz are continuing work on the simulation of lightning in 3D cloud models, including cloud-to-ground strokes. Both Mr. Zhang and Ms. Sus expect to finish their graduate work this year.

The SDSMT armored T-28 suffered a major engine failure late in the STEPS field program. A replacement engine is currently being outfitted and we expect to have the aircraft flying again by early next year. We are lookingfor new projects during the next few years in which the aircraft can make a contribution. As most of you know, the aircraft has base support from the US National Science Foundation (NSF), and funding for participation in field projects is also available from the NSF, through a formal request and panel-review process. If you have a project to which the aircraft can contribute, please contact Andy Detwiler at andy@ias.sdsmt.edu, or 605-394-2291.

At this time, the NSF is also evaluating several candidate aircraft with superior performance characteristics to take over storm penetration work from the T-28 and provide in situ observations at higher altitudes and for longer periods than are possible with the T-28. One example of a viable candidate is the US Air Force A-10 fighter/bomber. If you have ideas or comments concerning suitable aircraft and/or instrumentation issues, pleasecontact Jim Huning, Lower Atmospheric Observing Facilities program manager at the NSF (jhuning@nsf.gov)

* MASSACHUSETTS INSTITUTE OF TECHNOLOGY (Lincoln Laboratory, Lexington, Massachusetts, USA)

Upsurges in total lightning activity 5-20 minutes prior to tornadoes have now been observed for numerous case studies in Florida with the operational LISDAD (Lightning Imaging Sensor Data Application Demonstration) system, in collaboration with Steve Goodman and Dennis Buechler at NASA MSFC. Traditional Doppler radar observations of tornadogenesis make use of time-height plots of rotational velocity, vorticity, and the operational tornado vortex signature (TVS). We are making use of a quasi-conservative angular momentum density which is the product of local air density, rotational velocity and the radius of the velocity couplet. In several cases (including the August 1998 tornado in Salt Lake City), this quantity shows a pronounced enhancement aloft (3-8km) followed by a substantial decrease aloft at the time the tornado is reported on the ground. These observations support the traditional view that the angular momentum in the tornado is drawn from a reservoir aloft. The apparent descent of angular momentum is consistent with the notable diminishments in total lightning rate at the time of the tornado.

* MASSACHUSETTS INSTITUTE OF TECHNOLOGY (Parsons Laboratory, Cambridge, Massachusetts 02139, USA)

Recent examination of long-term recordings of the Earth's Schumann resonances in Hungary (G. Satori), Antarctica (M. Fullekrug and A. Fraser-Smith) and Rhode Island (R. Boldi, V. Mushtak and E. Williams) has revealed a systematic variation in the resonant frequency of the Earth-ionosphere cavity over the 11-year solar cycle. These frequency variations are distinguishable from more routine variations associated with source-receiver distance variability on the basis that all resonant frequencies at all three sites change in the same sense. The frequency increase toward solar maximum is interpreted as an increase in the phase velocity of cavity waves associated with an increased conductivity in the upper dissipation layer of the D-region, induced by solar x-ray enhancement.

Observations of sprites continue to show a diffuse quasi-uniform structure at high altitudes and a channeled structure at lower altitudes (and higher air density). A simple explanation for these observations has been constructed based solely on geometry and on values of two parameters: the electron mean free path and the mean distance between free electrons. The former quantity increases with altitude and the latter quantity decreases with altitude. Free electrons are nucleation sites for dielectric breakdown. When breakdown sites are closed spaced relative to the scale of breakdown (the mean free path), the discharge is guaranteed to be homogeneous. When the breakdown sites are relatively isolated, one has the possibility for local avalanching to the streamer state and subsequent propagation by concentration of the electric field at the periphery of the conductive plasma, resulting in a very heterogeneous structure. The crossover altitude between mean free path and mean distance between free electrons is 70-75 km, in reasonable agreement with the observations on the altitude of structure change. Elves and haloes above this level are diffuse, whereas sprites tendrils, blue jets and lightning itself at lower levels of the atmosphere are structured.

* UNIVERSITY OF MISSISSIPPI (University, Mississippi, USA)

Tom Marshall, Maribeth Stolzenburg, and physics graduate student Lee Coleman are continuing analyses of balloon, radar, and lightning data from two recent field experiments: MEaPRS (MCS Electrification and Polarimetric Radar Studies, May and June 1998, in the southern Great Plains) and SEET (Study of Electrical Evolution in Thunderstorms, July and August 1999, at Langmuir Lab in New Mexico).

One MEaPRS study (with co-authors Dave Rust, Earle Williams, and Bob Boldi) includes a balloon sounding of electric field through the trailing stratiform cloud of a bow echo mesoscale convective system. The sounding showed only two substantial in-cloud positive charge regions, at 5.1-5.6 km and 6.4-6.8 km altitude. Based on Schumann resonance Q-burst data acquired by Earle Williams and Bob Boldi, the amount of charge transferred by three positive CG flashes with large peak currents that occurred within 60 km of the balloon during its flight was in the range of 97-196 C. Another MEaPRS case (with co-author Dave Rust) includes five partial balloon soundings in an updraft and outside the updrafts of the convective region, in the transition zone, and in the stratiform cloud region of an MCS. Both these studies have been submitted for publication in the Journal of Geophysical Research.

Data from SEET are currently being used for three evolution studies on (a) early electrification, (b) the end-of-storm oscillation, and (c) a detailed comparison of charge location inferred from balloon soundings to lightning paths from New Mexico Tech's

Lightning Mapping Array. These analyses are in collaboration with numerous colleagues at New Mexico Tech.
Tom and Maribeth are also collaborating with Eugene Mareev and Stanislav Davydenko at the Institute of Applied Physics in Nizhny Novogorod on the contribution of MCSs to the global electric circuit.

* NATIONAL LIGHTNING SAFETY INSTITUTE (NLSI), (Louisville, Colorado, USA)

(www.lightningsafety.com)

1. NLSI is serving as a contributing member of the Department of Defense Explosive Safety Board (DDESB) Lightning Committee. We are re-writing the military lightning protection guideline, document 6055.9 to conform to latest information, taking into account NATO and other science-based standards. In previous renderings 6055.9 emphasized the NFPA 780 approach. Since 780 was downgraded in 1999, together with the present indecisiveness of that organization, it is no longer prudent to recommend only the installation of air terminals as a lightning defense.
2. At this writing, NLSI has graduated about 90 students from the intensive two day Lightning Safety Workshop during the year so far. Seminars were conducted in: Washington DC; Los Alamos New Mexico; Cuidad del Carmen, Mexico; and Louisville Colorado. Graduates of the workshop were employed by FAA, NASA, EPA, DOE, US Air Force, US Navy, Defense Threat Reduction Agency, US Coast Guard, electric power utility companies, park and recreation districts from local governments, insurance companies, explosives manufacturing companies, amusement parks and lightning protection companies.
3. Interesting site review and consulting assignments have included:
a. Explosives chemical manufacturing factory, Arizona. With 1000 employees and buildings over a 1.5 km sq. area, lightning visited three times over the past 18 months. NLSI recommended upgrades to the lightning detection system, attention to bonding detail in electrostatic environments; and a complete characterization of the NFPA 780 lightning protection system to bring it into compliance.
b. Wind turbine farm, New York. This is a new installation. NLSI recommended compliance with the IEC standards for wind turbines, plus lightning detection.
c. Department of Energy storage of low level nuclear waste, Colorado. NLSI reviewed the exiting LPS and suggested improvements, including installation of surge protection devices conforming to IEEE Std. 1100.
d. Denver International Airport and Dulles International Airport. We reviewed safety procedures for ramp workers and suggested more conservative policies based upon improved lightning detection, notification and resumption of activities. Lightning has injured one worker in Denver and seven workers in Atlanta at respective airports in 2000.
e. Ski area, Utah. Working for an insurance firm which insures 160 USA/Canadian Ski areas, NLSI prepared a comprehensive Lightning Safety Protocol for the Client. Included here were recommendation for attention to grounding, bonding, shielding, surge protection to protect electronic equipments. This Protocol will be a guideline document for winter and summer ski are operations. Summer operations include considerable tourism, mountain biking, and hiking activities. (At Vail Ski Area in Colorado a skier was killed by winter lightning in 1993.)
4. NLSI's research project on air terminal tip geometry has yielded no results so far. Details of this project at our High Altitude Lightning Observation Station (HALOS), with

photographs, can be seen at:

http://www.lightningsafety.com/nlsi_info/research/installation.html

* NATIONAL SEVERE STORMS LABORATORY, NOAA (Norman, Oklahoma, USA)

Dave Rust and Don MacGorman of the National Severe Storms Laboratory participated with a team of students and colleagues to fly instrumented balloons into severe storms during the Severe Thunderstorm Electrification and Precipitation Study (STEPS) during the spring and early summer in the region of northwest Kansas. Even with a drought in place for much of the project, several interesting profiles of the electric field were obtained. These data are being analyzed and combined with radar and lightning mapping array data. Thirty flights were made, and a few were into the mesocyclones of tornadic storms. A major goal will be to look at the electric structure in strong updrafts and to look for charge structures during normal and inverted-polarity intracloud discharges found to be numerous during STEPS.
Sites are being selected in central Oklahoma for the installation of a New Mexico Tech built lightning mapping array. We anticipate this system being operational for this spring for coordinated data acquisition with it, instrumented balloons for electric field profiles, and two new mobile C-band Doppler radars (being built by Texas A&M, Oklahoma University, Texas Tech University, and the National Severe Storms Laboratory). This will likely be a small field project, designed as a shake down of these and other new facilities.

OFFICE NATIONAL D'ETUDES ET DE RECHERCHES AEROSPATIALES Atmospheric Environment Research Group (Paris, France)

Pierre Laroche (laroche@onera.fr) www.onera.fr

Anne Bondiou-Clergerie (bondiou@onera.fr), Alain Delannoy (alain.delannoy@onera.fr) Philippe Lalande (lalande@onera.fr), and Patrice Blanchet (blanchet@onera.fr) proceed with the preparation of a prototype of the payload of the future ORAGES mission. ORAGES consists in the location of lightning flashes from a microsatellite, using interferometer in VHF band. A flight of the prototype on a stratospheric balloon is planned for mid 2001. Preparation of this project is supported by analyses of data from the Los Alamos FORTE mission (Abe Jacobson ajacobson@lanl.gov). Serge Chauzy, Serge Soula and Franck Roux from the Laboratoire d'Aérologie de Toulouse contribute to this preparation. ORAGES preliminary studies are funded by CNES, the French Space Agency.
Total lightning activity data collected in various areas of the world with Onera's 3D VHF interferometric system are currently used by Claire Thery (thery@onera.fr) and Eric Defer (eric.defer@ucar.edu) at NCAR to perform analyses of relation between convective activity and lightning activity. Both Claire and Eric made some comparison between the interferometer and other mapping systems. Collaboration with Harmut Hoeller (Hartmut.Hoeller@dlr.de) at DLR carries on to derive a parameterization of lightning activity within storms.
Anne Bondiou-Clergerie and Philippe Lalande continue their modelling effort to describe the sweeping of a lightning flash on an aircraft with the participation of Anders Larson of Lundt University in Sweden. They achieved a fruitful study of aircraft radom lightning protection

based on modeling and experiment realized with Alain Ulmann at CEAT (Centre d'Essais Aeronautiques de Toulouse) ceat.foudre@wanadoo.fr.

* POLISH ACADEMY OF SCIENCES (Warsaw, Poland)

The atmospheric electricity research group at the Institute of Geophysics reports:

The electric charge on the precipitation particles transported to the earth's surface and other electrical parameters (electric field, space charge density, electric currents) were measured in Warsaw for the cases of nearby thunderstorms monitored by radar (P. Baranski; baranski@igf.edu.pl)

The data from the Siemens Central European Lightning Detection Network (CELDN) were used for detection and location of cloud-to-ground discharges in surrounding region of Warsaw. A comparison of those data with the corresponding electric field recordings in Warsaw station is applied to eliminate the false identifications of the CELDN network. The corrected CELDN data overlapped on the thundercloud radar pictures are analyzed to find, if any, a regularity of appearance of clusters of positive flashes in special area of the radar echo (P. Baranski).

The study on initiation of lightning discharge is continued (Nguyen Manh Duc, S. Michnowski; smichn@igf.edu.pl).

The atmospheric electricity recordings since 1956 are continued on the background of meteorological, aerosol, radioactive and chemical pollution observations at Swider Geophysical Observatory (M. Kubicki; swider@igf.edu.pl). The results are being published and exchanged (M. Kubicki).

The electric field and vertical air-earth current recordings accompanied by the meteorological observations and geomagnetic, riometer and other geophysical measurements are carried on at the polar station at Hornsund, Spitsbergen (M. Kubicki).

Works on developing new designs of electric field, air-earth and space charge density sensors are under way (M. Kubicki, J. Drzewiecki, J. Berlinski).

The local effects at Hornsund and Swider on the electric field and air-earth current variations are studied (M. Kubicki, S. Warzecha).

The effects of interplanetary magnetic field on the electrical variation at the ground in Hornsund are being examined (S. Michnowski, N. Kleimenova, S. Israelsson, N. Nikiforova, J. Drzewiecki and M. Kubicki).

* TEL AVIV UNIVERSITY, DEPARTMENT OF GEOPHYSICS AND PLANETARY SCIENCES (Tel Aviv, Israël)

The team led by Prof. Zev Levin, Dr. Colin Price and Dr. Yoav Yair will try and obtain high-resolution images of sprites from space during the MEDIEX campaign, and correlate them with ground-based ELF-VLF measurements. The present launch date for STS-107 (the space shuttle Columbia) is summer 2001, for a 16 day mission at 39 degrees inclination. The payload consists of a multi-spectral Xybion IMC201 camera that will be operated by an Israeli astronaut in cooperation with a ground team located at NASA/GSFC. Images will be recorded on digital VCRs in the crew-cabin and downlinked to the ground. Observational runs would consist of continuous recording of the Earth's limb from the direction of the dusk terminator towards the night side, preferably before midnight local time at the observed area. In order to enhance the success probability, as many thunderstorms as possible would be targeted. The observation areas would cover an area that extends from 39S to 39N, along the shuttle orbit. The most (active) desired areas will be tropical South America, North-Australia and Indonesia, South-East Asia, China, Sea of Japan, Continental USA and the Gulf of Mexico. Several groups have expressed interest in the MEDIEX-Sprite campaign and will collect electromagnetic and optical data during the mission. These include Earle Williams (MIT), Umran Inan (Stanford), Walt Lyons (FMA Research Inc.), Marcelo Saba (Brazil), Zen Kawasaki (University of Osaka, Japan) and Martin Fullekrug (Frankfurt, Germany).

Orit Altaratz, Prof. Zev Levin and Dr. Yoav Yair continue the study of the properties of winter thunderstorms along the coast of Israel, with special emphasis on the differences between the areas near Tel-Aviv and Haifa. The objective is to understand the role of different parameters, such as topography, sea-land temperature difference and aerosol particles concentration in affecting the dynamical and microphysical characteristics of thunderclouds in this region. Part of this study is carried out by analyzing data from lightning detection systems (LPATS, CGR3 and LIS) and data from the Tel Aviv University radar. In addition, a numerical study is being carried out by using the RAMS model to simulate the evolution of clouds, including electrical charge separation and electric field build-up, as they move from the Mediterranean Sea toward the coast.

Mustafa Asfur, under the guidance of Dr. Colin Price, completed his M.Sc. thesis on ELF sprite detection. Analysis of ELF data collected in Israel during the SPRITES ’99 field campaign show that we were able to temporally and spatially locate the majority of the optically-observed sprites imaged by Dr. Walt Lyons in Colorado, 11,500 km away. We detected 3 times more ELF transients originating from the storm of 18 August, 1999, than were observed visibly by Walt Lyons. Whether all these transients were related to sprites is presently under investigation.

Moshe Blum and Dr. Colin Price are studying the VLF pulses produced by meteors entering the atmosphere. We have found a close link between the frequency of meteors during the Leonid ’99 meteor shower and the frequency of VLF pulses identified with the meteors. We have found a unique spectrum related to the meteors, very different to the normal lightning discharge spectrum, hence allowing us to differentiate between the two.

Dr. Colin Price continues his research on Schumann resonances related to climate change. A recent paper relating global lightning activity to upper tropospheric water vapor appeared in Nature this summer (Nature, Vol. 406, pp. 290-293). In addition, Colin Price and Sasha Nickolaenko (Ukraine) have published a paper recently looking at the statistical properties of the background Schumann resonance signals using the Hurst exponent (GRL, Vol. 27, pp. 3185-3188).

* TEXAS A&M UNIVERSITY, DEPARTMENT OF ATMOSPHERIC SCIENCES (College Station, Texas 77843-3150, USA)

Dick Orville reports:

1. We have completed an initial mapping project to analyze the flash density, positive flash density, and the percentage of positive lightning flashes for 115 sites in the continental United States. The 345 maps have a spatial resolution of 5 km and covers eleven years, 1989-1999. These initial maps are pointing the direction for some of our future research and represent a first look at the cloud-to-ground lightning characteristics in the USA with relatively high spatial resolution. Access to the maps is obtained by going to the site: http://www.met.tamu.edu/ciams.html and clicking on NOAA/NWS Regional Lightning Maps. When you are asked for a name and password, use the following:

Name: nws
Password: ciams

If there are any problems, you can contact me at rorville@tamu.edu.

2. We have recently published a paper in Geophysical Research Letters detailing the effects of the smoke intrusion into the USA in the spring of 1998. The citation is: Murray, N. D., R. E. Orville, and G. R. Huffines, 2000, "Effect of pollution from Central American fires on cloud-to-ground lightning," Geophys. Res. Lett., 27, (15), August 1, 2000, 2249-2252. The published version of our paper, in pdf format, is available at the following site: http://www.met.tamu.edu/personnel/faculty/orville/Recent.htm

3. A paper summarizing the first ten years of the NLDN cloud-to-ground lightning data is now in press for the Monthly Weather Review. The citation is: Orville, R. E. and G. R. Huffines, 2001, "Cloud-to-ground lightning in the USA: NLDN results in the first decade 1989-1998," Mon. Wea. Rev., 129, (In press). Electronic pdf copies of the paper can be obtained by emailing either one of the authors (rorville@tamu.edu or Gary1 Huffines thunderbolt@erinet.com)

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Ed Zipser (ezipser@met.utah.edu) moved from Texas A&M University to the University of Utah in March 1999, but as recently as the last week in October 2000, his last two students at Texas A&M successfully defended their dissertations there. Both deal with the question of land vs. oceanic lightning using LIS, radar, and passive microwave data from the TRMM (Tropical Rain Measuring Mission) satelllite. Rick Toracinta's work contrasts properties of precipitation features (PFs) over large areas of the tropical Pacific Ocean, tropical South America, and tropical Africa. It has been known for some time that Africa is the champion lightning producer, followed by South America and with oceanic lightning scarce. Rick carefully normalizes the PFs by strength of the ice scattering signature at 37 and 85 GHz, and finds that for the same brightness temperature that the probability of LIS-detected lightning is still an order of magnitude greater over land than ocean. Even more startling, when normalizing fo! r radar reflectivity at any level, probability of lightning is still much greater over land. Dan Cecil uses the same database as a reference, and does the same type of analysis for tropical cyclones, separating the eyewall, inner rainbands, and outer rainbands. For a far larger database, he finds that the outer bands are more likely to have lightning than the other regions of the hurricane, in agreement with Molinari. When normalized by brightness temperature or radar profiles, the lightning probabilities are less than over continents but greater than over oceans outside of hurricanes.

Depending on the outcome of pending proposals, Zipser plans to continue field studies on tropical convection in the NASA and U.S. Weather Research Program supported Convection and Moisture Experiment (CAMEX-4) in August-September 2001. In the meantime, his research group in Utah has ample data from TRMM and from several of the TRMM validation field programs held in 1998 and 1999.