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Newsletter on Atmospheric Electricity

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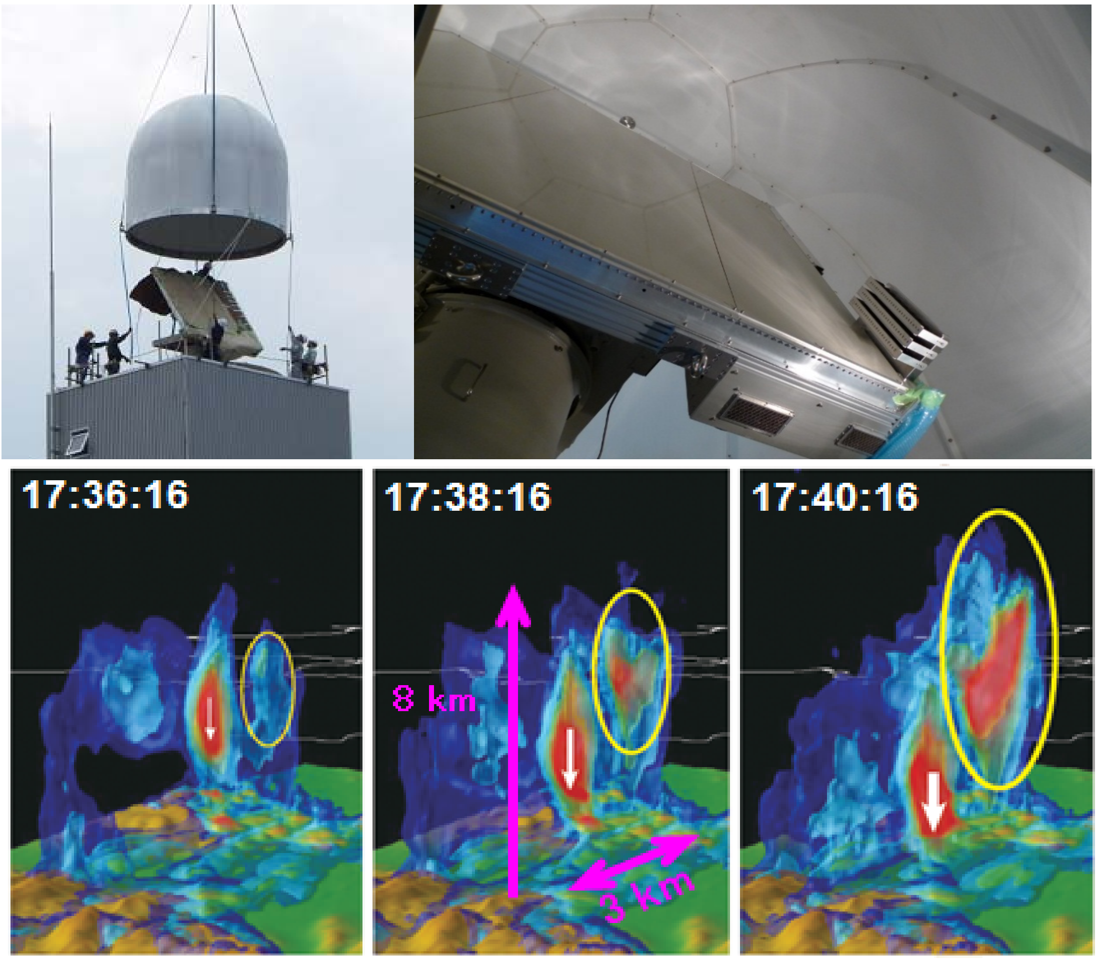
INTERNATIONAL COMMISSION ON ATMOSPHERIC ELECTRICITY (IAMAS/IUGG)

AMS COMMITTEE ON ATMOSPHERIC ELECTRICITY

AGU COMMITTEE ON ATMOSPHERIC AND SPACE ELECTRICITY

EUROPEAN GEOSCIENCES UNION

SOCIETY OF ATMOSPHERIC ELECTRICITY OF JAPAN



Comment on the photo above: **X-band Phased Array Radar (PAR) installed at the top of a building in Suita Campus, Osaka University, Osaka, Japan, and time series of the 3 dimensional thunderstorm structure captured by the PAR system in every 2 minutes, showing how the thunderstorm structure changes in a short time. Actual temporal resolution of the PAR system is 10 to 30 seconds for 60 km range and the continuous images of the evolution of the thunderstorm can be obtained with the developed system. One of the scientific results using the PAR with lightning location system appears in Wu et al. GRL, 2013.**

ANNOUNCEMENTS

New Books

A collection of papers devoted to lightning interaction with aircraft as shown in the following can be downloaded from http://www.aerospacelab-journal.org/al5/downloading, an online journal called Aerospace Lab Journal (ALJ) which edits twice a year scientific papers and tutorials on selected aerospace topic.

Lightning Hazards to Aircraft and Launchers

AL05-00 - Overview of Lightning Hazards to Aircraft
P. Laroche

AL05-01 - Electrical Environment in a Storm Cloud
S. Soula

AL05-02 - Airborne Measurements of the Charge of Precipitating Particles Related to Radar Reflectivity and Temperature within two Different Convective Clouds
A. Delannoy, P. Gondot

AL05-03 - Review of the Location of VHF Pulses Associated with Lightning Discharge
Z. Kawasaki

AL05-04 - Polarity Asymmetry in Lightning Leaders: the Evolution of Ideas on Lightning Behavior from Strikes to Aircraft
E. Williams, S. Heckman

AL05-05 - Triggering Lightning Experiments: an Effective Approach to the Research of Lightning Physics
X. Qie, R. Jiang, P. Laroche

AL05-06 - Experimental Studies of Lightning Strikes to Aircraft
P. Laroche, P. Blanchet, A. Delannoy, F. Issac

AL05-07 - A Physical Model of Branching in Upward Leaders
P. Lalande, V. Mazur

AL05-08 - Numerical Methods for Zoning Computation
P. Lalande, A. Delannoy

AL05-09 - Direct Effects of Lightning on Aircraft Structure: Analysis of the Thermal, Electrical and Mechanical Constraints
L. Chemartin, P. Lalande, B. Peyrou, A. Chazottes, P.Q. Elias, C. Delalondre, B.G. Cheron, F. Lago

AL05-10 - Indirect Effects of Lightning on Aircraft and Rotorcraft
J.P. Parmantier, F. Issac, V. Gobin

AL05-11 - The Interaction of Lightning with Aircraft and the Challenges of Lightning Testing
D. Morgan, J. Hardwick, S. Haigh, A. Meakins

AL05-12 - Space Launching Site Protection against Lightning Hazards
F. Issac, E. Bachelier, D. Prost, V. Enjalbert, L. Mohedano

Special_Issue

Twenty papers have been accepted for publication in the Special Issue of Atmospheric Research following the International Conference on Atmospheric Electricity in Rio de Janeiro, Brazil in August

2011. The Guest Editors have approved the following list:

First author surname	Title
Koehn	Angular distribution of Bremsstrahlung photons and of positrons for calculations of terrestrial gamma-ray flashes and positron beams
Zhang	Experiments of artificially triggering lightning and its application in Conghua, Guangzhou, China
Petersen	Microwave radio emissions of negative cloud-to-ground lightning flashes
Anisimov	Space charge and aeroelectric flows in the exchange layer: An experimental and numerical study.
Anisimov	Intermittency of turbulent aeroelectric field
Zepka	Lightning forecasting in southeastern Brazil using the WRF model
Koshak	The NASA Lightning Nitrogen Oxides Model (LNOM): Application to air quality modeling
Campos	High-speed video observations of natural cloud-to-ground lightning leaders-A statistical analysis
Cardoso	Lightning casualty demographics in Brazil and their implications for safety rules
Qie	Characteristics of current pulses in rocket-triggered lightning
Petrova	Summer-time lightning activity and its relation with precipitation: Diurnal variation over Maritime, Coastal and Continental Areas
Bruning	Continuous variability in thunderstorm primary electrification and an evaluation of inverted-polarity terminology
Soula	Multi-instrumental analysis of large sprite events and their producing storm in southern France
Blakeslee	Seasonal variations in the lightning diurnal cycle and implications for the global electric circuit
Tammet	Intermediate ions in the atmosphere
Buechler	Assessing the performance of the Lightning Imaging Sensor (LIS) using deep convective clouds
Farias	The influence of urban effect on lightning activity: Evidence of weekly cycle
Mallick	On remote measurements of lightning return stroke peak currents
Pineda	Characteristics of lightning related to wildfire ignitions in Catalonia

CONFERENCES

15th International Conference on Atmospheric Electricity (ICAE 2014)

15th International Conference on Atmospheric Electricity (ICAE 2014) will be held in Norman, Oklahoma, USA, 14-19 June 2014. Historically, the ICAE has brought together scientists from all over the world every 4 years to discuss the latest research on atmospheric electricity. However, ICAE 2014 will be held only 3 years after the Brazilian conference, to restore the timing of ICAE to a place in the IUGG schedule that avoids conflicting with other IUGG conferences.

ANNOUNCEMENTS

Co-hosts for ICAE 2014 will be the NOAA/National Severe Storms Laboratory and the College of Atmospheric and Geographic Sciences of the University of Oklahoma. Both are housed in the National Weather Center in Norman, Oklahoma. The conference hotel will be the nearby National Center for Employee Development (http://cc.nced.com/, operated by Marriott), which provides excellent meeting facilities for conferences and resort-like recreational facilities for visitors. Oklahoma is home to more Native American tribes than any other state in the USA and provides visitors many opportunities to sample the heritage of both its Native American and cowboy roots.

A call for papers will be issued in May and abstracts may be submitted June 1 – October 31, 2013 to be considered for presentation at ICAE 2014. Any topic related to atmospheric or near-space electricity may be submitted and will be considered, but papers are particularly solicited on the following topics:

Fair-Weather Electrical Properties of the Atmosphere
Atmospheric Ions, Clusters, and Nanoparticles
Non-Thunderstorm Electrified Clouds
Global Electrical Circuit
Thunderstorm Electrification Processes
Thunderstorm Charges and Currents
Electrical Effects on Microphysics
Energetic Radiation from Thunderstorms and Lightning
Lightning Physics
Lightning Occurrence Relative to Meteorology
Lightning Effects on the Middle and Upper Atmosphere (including TLEs)
Distant Electromagnetic Environment Produced by Lightning
Lightning and Climate
Lightning Effects on Atmospheric Chemistry
Lightning Hazards
Meteorological Applications of Lightning Data
Lightning Detection Technologies

A website will be available by June 1 with more information about the conference, instructions for submitting abstracts, and links to the conference hotel and Oklahoma tourism.

If you wish to ensure that you receive all upcoming information about the conference, please send an e-mail to icae2014@nwc.ou.edu.

ANNOUNCEMENTS

International Lightning Detection and International Lightning Meteorology Conferences 2014

The 23rd International Lightning Detection Conference and 5th International Lightning Meteorology Conference will be held from 18 to 21 March, 2014 in Tucson, Arizona, USA. The conferences will be hosted by Vaisala at the Hilton El Conquistador Hotel. Organized every other year, these conferences bring together global participants to present new advancements in lightning detection technologies, research findings in atmospheric electricity, and new applications of lightning data in a variety of fields including electric power transmission and distribution, telecommunications, and meteorology.

The tentative list of topics for the 2014 conferences includes the following:

Lightning Physics and Chemistry
Lightning Occurrence Characteristics
Lightning and Upper Atmospheric Discharges
Use of Lightning Data by the Power Industry
Lightning Interaction with Tall Objects
Lightning Detection Technology
Winter Lightning
Lightning Data Use in Protection of Structures and Systems
Lightning Warning, Nowcasting, and Forecasting
Meteorological Applications of Lightning Data
Lightning Safety, Medicine, and Education
Lightning Data Applications in Forestry and Fire

Further information will be posted at www.vaisala.com/ILDC.

2011-2012 CHVUA-GLM VALE Field Campaign

During the period of 8th and 10th of May of 2013, the University of São Paulo hosted the 1st International Workshop of CHUVA (Cloud processes of tHe main precipitation systems in Brazil: A contribUtion to cloud resolVing modeling and to the GPM (GlobAl Precipitation Measurement)): http://chuvaproject.cptec.inpe.br/portal/workshop/index.html.

This workshop had the participation of 70 scientists from Brazil, Argentina, USA, Italy, France and Germany where it was presented results from the 5 field campaigns (Alcantara, Fortaleza, Belém, Vale do Paraiba and Santa Maria).

The workshop hosted also two specific sessions called "Electrification Processes" and "Lightning Detection Systems" where 21 studies were presented. The studies vary from thunderstorm characteristics as observed by auxiliary datasets (weather radar, field mills and lightning detection systems) to lightning characteristics as observed by 10 different types of lightning detection systems, the Lightning Imaging Sensor (LIS) on board TRMM, high-speed cameras (up to 10,000 fps), fast plate antennas and field mills that were deployed during the CHUVA-Geostationary Lightning Mapper (GLM) Vale do Paraiba field experiment that occurred during the period of November of 2011 – March of 2012.

Among the lightning detection systems deployed in CHUVA-GLM-VALE experiment we had total lightning and cloud-to-ground systems, Figure 1. The total lightning systems were: Lightning Mappinger Array (VHF) from MSFC/NASA, LINET (VLF) from DLR, BRASILDAT-EarthNetworks (VLF/LF/HF), and TLS200 (VHF) from Vaisala. For cloud-to-ground measurements we had: ATDNet from Meteo-Office UK, GLD360 (VLF) from Vaisala, RINDAT (VLF/LF – Impact/LPATS/LS7000) from a Brazilian consortium, STARNET (VLF) from University of São Paulo, TLS200 (VLF/LF) from Vaisala, and WWLLN from University of Washington. Such combined measurements, Figure 2, show how important is to understand the principles of lightning detection systems since each technology is measuring different segments of a lightning discharge. Despite being a preliminary result, Figure 2 presents an inter-comparison among the 10 different lightning networks and a LIS overpass. It is possible to know that not all the LMA sources have coincident measurements in the total lightning networks and the cloud-to-ground systems present different observations. Finally, some of the events measured by 10 different networks were not measured by LIS, showing that optical systems are dependent of the type of lightning as well as the cloud opacity and instrument buffer.

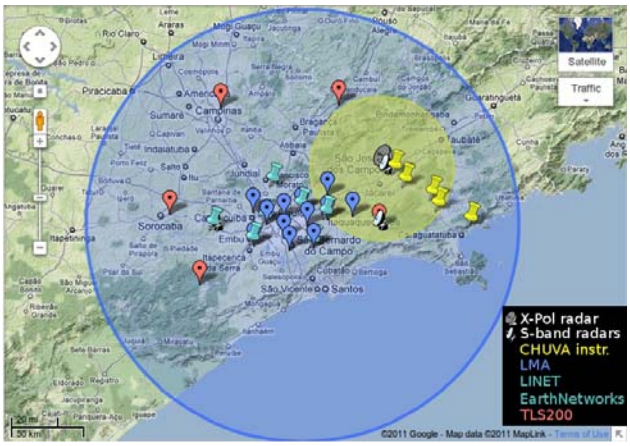


Fig. 1 CHUVA-GLM Vale do Paraíba deployed sensors location.

During the meeting it was decided that all the lightning datasets collected during the CHUVA-GLM-VALE campaign will be public released to the scientific community on January 2014 (expected date). Until then, an effort will be made by the lightning detection system coordinators to release the best quality control data sets including the receiver status. Nonetheless, interested scientists can contact individually the coordinators to have access to their dataset. For more information, the readers can access the CHUVA website at http://chuvaproject.cptec.inpe.br or contact Dr. Rachel Albrecht from INPE (rachel.albrecht@cptec.inpe.br) or Dr. Carlos A. Morales from USP (morales@model.iag.usp.br).

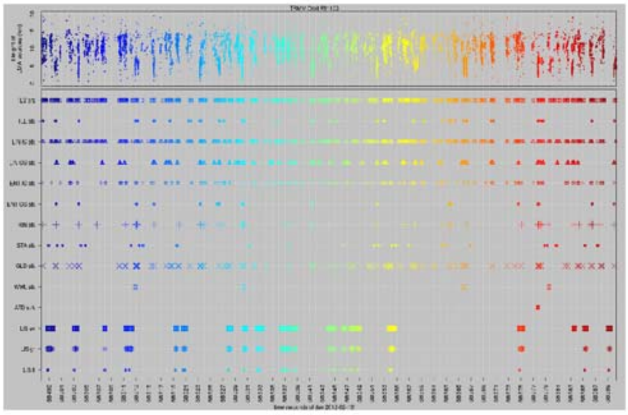


Fig. 2 Coincident measurements between LMA, TLS200 VHF, TLS200 LF, LINET intra-cloud and cloud-to-ground, EarthNetwork intra-cloud and cloud-to-ground, RINDAT, STARNET, GLD360, WWLLN, ATDNet and LIS events, groups and flashes during February 10th 2012 on TRMM orbit 81108.

Atmospheric Electricity Research Group at the Institute of Geophysics, Polish Academy of Sciences (Warsaw, Poland)

Marek Kubicki (swider@igf.edu.pl)
Piotr Baranski (baranski@igf.edu.pl)
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In 2012 our group started two research projects, funded by the Polish National Science Centre.

In one of the projects we run and use observations to analyse diurnal variations of the fair-weather geoelectric field and aerosol at ground-level, at different locations on the globe, from middle latitudes in central Europe to the Arctic and Antarctic. The project is aimed at better understanding of processes and phenomena operating in the Earth's electric atmosphere and ionosphere, including the coupling with the magnetospheric current system at polar regions, and the role of aerosol and atmospheric turbulence at mid-latitude regions. Another goal is the systematisation and standarisation of Polish atmospheric electricity observations by strengthening and extending current observations and transforming it into a professional scientific observation network monitoring the Earth's atmospheric electricity and, potentially, starting a new, modern, international network of atmospheric electricity monitoring. The improvements concern the mid-latitude observation site at the Geophysical Observatory in Swider (SWI), Poland (21.25°E, 52.12°N), and at Polish Polar Station in Hornsund (HRN), Svalbard, Norway (15.50°E, 77.00°N). Most importantly, atmospheric electricity observations have been established at Henryk Arctowski Polish Antarctic Station (ARC), South Shetland Islands, (58.47°W, 62.16°S) and run from January 2013.

The second project concerns the electricity of low-level stratiform clouds for the purpose of modelling their electric structure, and their role in the global circuit in mid-latitude regions. The project consists of an experimental and modelling part. The experimental part involves comprehensive measurements of meteorological and atmospheric electricity parameters, and analysis of historical ground-level data from the Geophysical Observatory in Swider.

In the summer of 2012 we started TLE observations at the Swider observatory, with a view to installing a remotely controlled system in 2013. Observed events are reported to the Eurosprite database.

Fig. 1 Measurements of the atmospheric electric field at Arctowski station.

Institute of Physics, Jagiellonian University, Cracow, Poland

Zenon Nieckarz (zenon.nieckarz@uj.edu.pl)

Two topics regarding thunderstorm activity have been investigated. The first concerns comparisons of the results of standard meteorological observation of thunderstorm activity (days with thunderstorm) and indices of lightning activity. This was studied previously on global (Nieckarz et. al., Monthly Weather Review, 2009) and, currently, on regional scale: Poland and central Europe. In addition, the size of thunderstorm area as a potential hazard has been investigated (Nieckarz and Zięba, 2013). This research project has been funded by Polish National Science Centre.

The second topic is a study of the long-time variability of frequency of lightning observed in ELF measurements. A special method for identification of lightning signature occurring in ELF measurements has been developed.

Key Laboratory of Land Surface Process and Climate Change in Cold and Arid Regions(LPCC), Cold and Arid Regions Environmental and Engineering Research Institute(CAREERI), Chinese Academy of Sciences(CAS), Lanzhou, China

Using a 3D lightning mapping system working at VHF passband (267-273MHz) and auxiliary instruments, comprehensive observation on natural lightning discharge has been conducted in the summer of 2007-12. Two experimental areas were established and the associated lightning discharges in thunderstorms were analyzed during this period. The areas of study were east of Pohai Gulf (center station: Hengdian; 37.83°N, 118.08°E) in 2007--08 and the northeastern edge of the Qinghai-Tibet Plateau (center station: Mingde; 37.01°N, 101.62°E) in 2009-11 (in atmospheric electricity sign convention, a negative electric field change indicates positive charge reduce over-head).

A time-gap in time-altitude plot of the VHF-mapping image corresponding to E-field change, and a space-gap in 3D plots of the VHF-mapping image (Fig.1), were both employed to separate associated lightning discharges into two distinct lightning discharges. Using these two criterions, some radiation pulses during time-gap could be proven to correspond to the other branch of the first lightning discharge, which was located far from the starting point of the second lightning discharges. It would be considered as two independent lightning discharges if the time-gap exceeded 60 ms or the space-gap exceeded 2 km with no apparent discharge channel connecting the two parts of the associated lightning discharge (these two values were chosen arbitrarily). Three pairs of associated lightning discharges (including two lightning discharges at least, and following an arbitrary rule that the space-gap was less than 10 km and the time-gap was less than 800 ms between two adjacent lightning discharges) were observed, and the interaction between associated lightning discharges was analyzed. All these three pairs of associated lightning discharges were found to involve three or more charge regions (the ground was considered as a special charge region in the present study). Moreover, at least one charge region involved two lightning discharges per pair of associated lightning discharges. Identified from electric field changes, the subsequent lightning discharges were suppressed by the prior lightning discharges. However, it is possible that the prior lightning discharge provided a remaining discharge channel to facilitate the subsequent lightning discharge. The third case provided evidence of this possibility. Together, the results suggested that, if the charges in the main negative charge region can be consumed using artificial lightning above the main negative charge regions, lightning accidents on the ground could be greatly reduced, on the condition that the height of the main negative charge region and the charge intensity of the lower positive charge region are suitable.

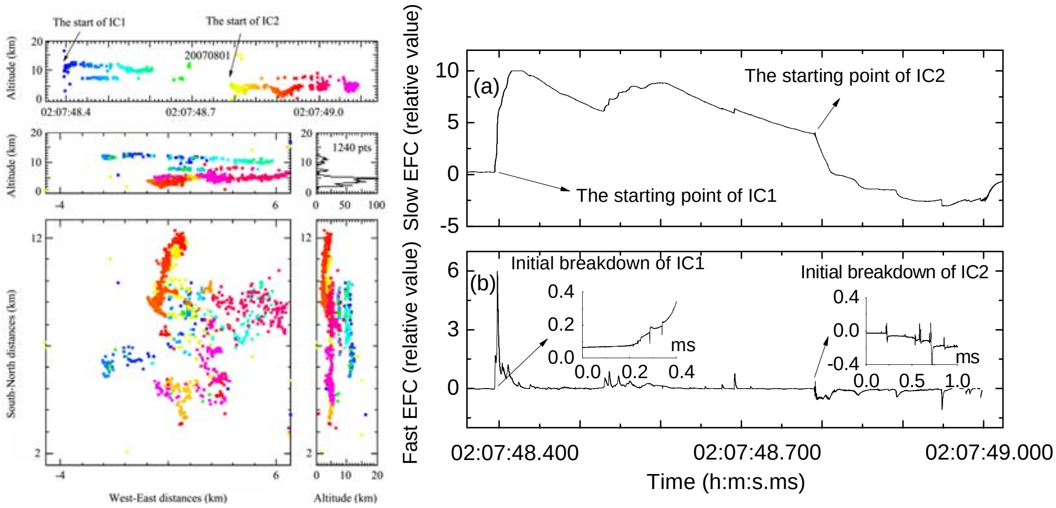


Fig. 1 The VHF mapping of an associated lightning discharge, which included one normal-polarity IC and one inverted-polarity IC. And the corresponding slow electric field change (a) and fast electric field change (b) waveforms.

Key Laboratory of Middle Atmosphere and Global Environment Observation (LAGEO), Institute of Atmospheric Physics, Chinese Academy of Sciences (CAS), Beijing

The current research of LAGEO mainly focuses on following parts:

Propagating properties of upward positive leader in negative triggered lightning were analyzed by using high speed camera and electric field data. The electric field change waveforms were roughly stepped during the initial stage of the leader development, with the interval of 28 E-field steps ranging from 14 μs to 39 μs The expanded images of the leader tip were carefully checked, and some images were found to exhibit weak luminous segments ahead of the positive leader tip, which were somehow similar to those "space stem" that generally occurred ahead of the negative stepped leader tip.

A lightning VHF radiation location system based on short-baseline time-difference of arrival (TDOA) technology has been developed and tested in artificially triggered lightning. A general correlation time delay estimation algorithm based on direct correlation method and wavelet transform is proposed to reduce the noise and to improve estimation accuracy of time delay. Moreover, parabolic interpolation algorithm used in the fractional delay estimation was used to improve the time resolution of the positioning system. Testing results by triggered flashes indicate that the TDOA location system could effectively map the lightning radiation sources in 2 dimensions and are in a good agreement with the high-speed video camera images.

A regional thunderstorm model (RAMS V6.0) coupled with two primary non-inductive electrification mechanisms (Takahashi, 1978 and Saunders, 1991) is developed. The results show that the total charge distribution is tripolar in both schemes when the electric field reaches breakdown value. However, the results of Takahashi's (1978) scheme produces a tripolar charge distribution in the cloud before the first lightning. The Saunders' (1991) scheme produces a transform from inverted dipole distribution to tripolar distribution. The results from both schemes show that the positive charge carrier at a low level of thunderstorm is rain droplet, the aggregates and graupels are located in high level of thunderstorm, and the charge center distribution of graupels is similar to the distribution of total charge in thunderstorm cloud.

A gigantic jet event was observed over a storm near the Huanghai Sea in 2010. Different from results in other countries that positive CGs dominated during a time period centered at GJ, negative CGs dominated during a time period centered at the GJ event and during most of the time in the storm life. It is interesting that GJ-producing storm only produced this GJ event during its lifetime and five sprites were produced over another storm, different from other study that sprites and GJs were produced by the same storm.

RESEARCH ACTIVITY BY INSTITUTIONS

Laboratory of Lightning Physics and Protection Engineering (LiP&P), Chinese Academy of Meteorological Sciences (CAMS), Beijing, China

Coupling of Electrification and Discharge Processes with WRF Model and Its Preliminary Verification

The processes of cloud electrification and lightning parameterization are introduced into the Advanced Weather Research and Forecasting (ARW-WRF) model, in which the ideal supercell and real squall line are simulated. The numerical formulation of the electrical processes includes the non-inductive graupel-ice, hail-ice, hail-snow and inductive graupel-cloud, hail-cloud charge separation mechanisms coupled with the Milbrandt two-moment microphysical scheme. In the meantime, a bulk lightning parameterization is considered in the model. The 3-dimensional charge structure and vertical electric field of the storms can be simulated by the coupled model.

On the one hand, the simulation of supercell produced a normal tripolar charge structure, consisting of a main negative charge region (-10℃ to -30℃) with an upper main positive charge region (-40℃ to -60℃) and a lower positive charge region (near 0℃). The maximum total charge density is approximately 2nC/m3. The majority of hail and graupel charge negatively and most of the ice and snow charge positively. In the whole charging process, the non-inductive charge separation mechanism between graupel (hail) and ice plays a vital role, while the effect of the inductive charge separation mechanism is very weak in the simulation. The simulated vertical profile of charge structure is in accordance with the previous classical structure observed in the severe convective weather. On the other hand, the simulation of the squall line showed the inverted dipolar charge structure with the negative charge region above the positive charge region in some cells and the maximum total charge density is smaller than that of the supercell. The inverted charge structure is due to high temperature near the melting level during the particle collisions, inducing hail particles to charge positively and ice particles to charge negatively. Moreover, the simulated distribution of lightning density is similar with observed cloud-to-ground (CG) lightning density in the mature stage of the squall line, but the simulated value of lightning density is bigger than the observation (Fig. 1).

Optical and electrical observations of an abnormal triggered lightning event with two upward propagations

We investigate an abnormal artificially triggered lightning that produced two times positive upward propagations: one during the initial stage (i.e., the upward leader (UL)) and another after a negative downward aborted leader (DAL). The triggered lightning was performed in a weak thunderstorm over the experiment site and didn't produce return stroke process. All the intracloud lightning around the experiment site produce positive electric field changes. The initial stage was of weak discharge process. After that, a downward dart leader propagated along the original channel produced by the 1st UL and ended at a height of about 453 m, forming a DAL. Influenced by the DAL, the electric field at a point located 78 m from the rod showed a steady reduction by about 6.8 kV m^{-1} over 5.24 ms before the initiation of a new upward channel (i.e., the 2nd upward propagation (UP)). The 2nd UP, which started at about 4.1 ms after termination of the DAL and propagated along the original channel, was triggered by the DAL and sustained for about 2.95 ms according to the current record. Two current pulses were superimposed on the current of the 2nd UP. The first pulse, related to the sudden initiation of the 2nd UP, showed a more rapid increase and decrease, and large peak value, than did the second pulse, related to the development of the 2nd UP into the area where the DAL had propagated. The 2nd UP contained the similar-to-leader process and the following neutralization process. This study represents a new type of triggering leader, in which a new upward discharge is triggered in an established channel by the aborted leader propagating along the same channel with opposite polarity and propagation direction (Fig. 2).

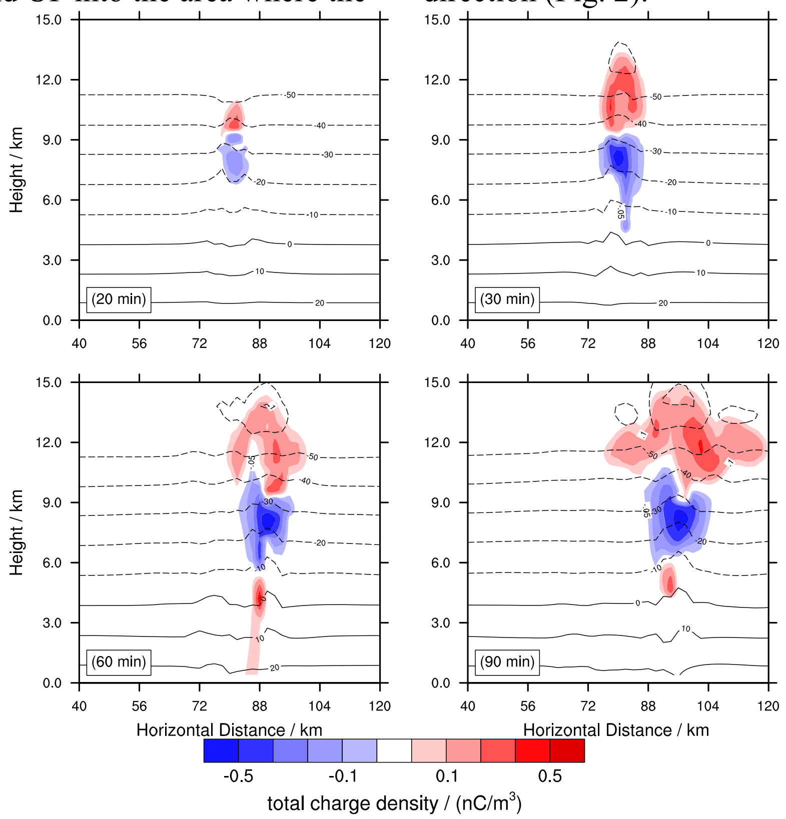
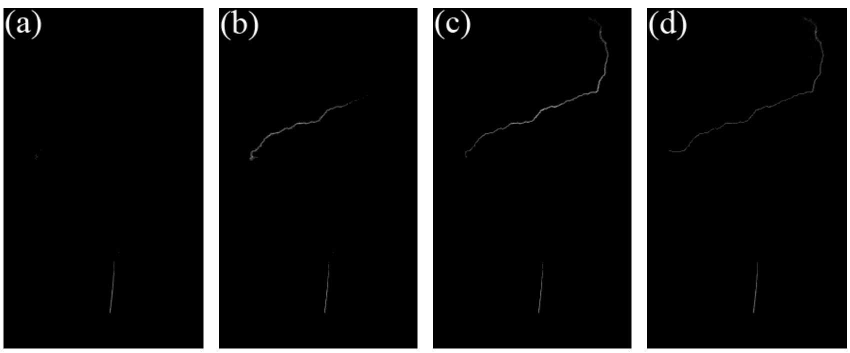


Fig. 1 The distributions of simulated total charge density in different time: (a) 20th minute, (b) 30th minute, (c) 60th minute, (d) 90th minute. The contour lines are isotherms (unit: ℃).



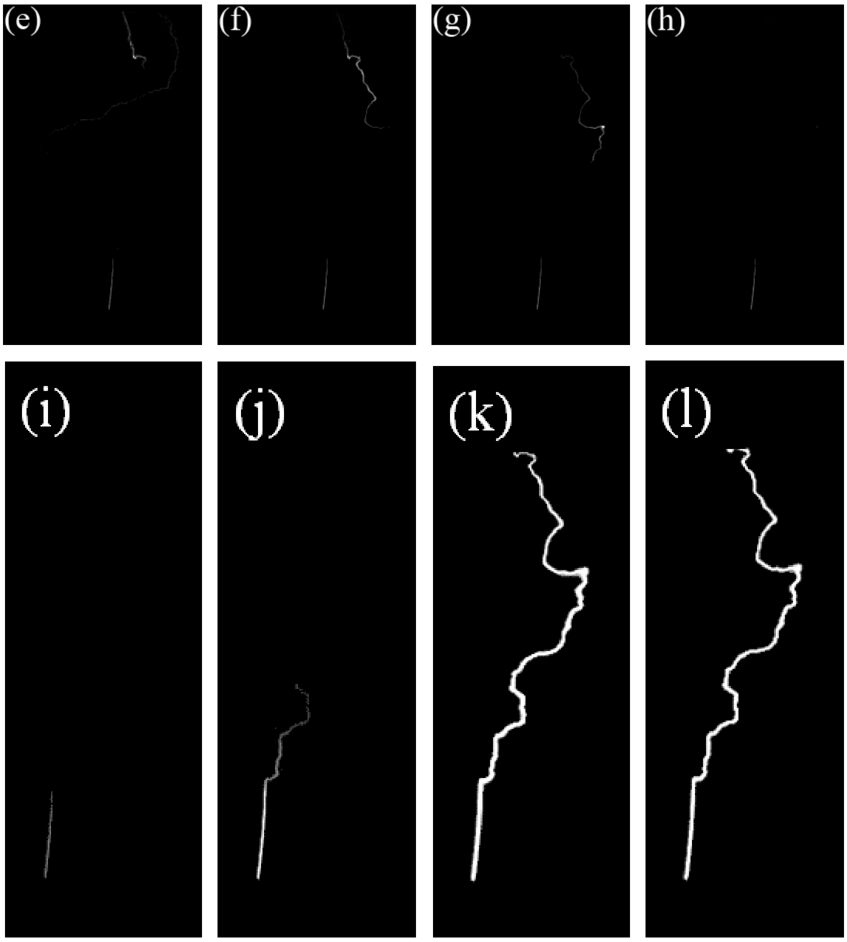


Fig. 2 Negative downward aborted leader ((a) - (h)) and the subsequent second positive upward propagation ((i) - (l)) (There is a 4.1-ms interval between (i) and (h)).

Performance Evaluation for a Lightning Location System Based on Observation of Artificially Triggered Lightning and Natural Lightning Flashes

Performance evaluation for the lightning location system (LLS) of the power grid in Guangdong Province, China, was conducted based on observation data of the triggered lightning flashes obtained in Conghua, Guangzhou, during 2007–11 and natural lightning flashes to tall structures obtained in Guangzhou during 2009–11. The results show that:

(1) For 28 artificially triggered lightning flashes (each of them contains one or more return strokes), the LLS's flash detection efficiency and stroke detection efficiency are approximately 92% (25/28) and 46% (37/81), respectively. The location accuracy of LLS's reports is analyzed for those location retrieval results by using more than two sensors. For 33 return strokes occurring in classical triggered lightning flashes, the arithmetic mean and median values of the LLS's location error are estimated to be approximately 759 and 649 m, respectively; and for 13 return strokes occurring in altitude triggered lightning flashes, the arithmetic mean and median values of the distances between the LLS's records and the rocket launcher are approximately 675 and 646 m, respectively. When the absolute peak current of a return stroke is greater than 15 kA, the detection efficiency was 100% (15/15), but decreased to 50% (7/14) when the peak current was less

than 15 kA, and only 33% (1/ 3) in cases where the peak current was less than 10 kA. There is a strong positive linear relationship between the directly and LLS estimated and directly measured peak currents, with the correlation coefficient being of 0.92 (samples: 21).

(2) For 34 natural lightning flashes to tall structures in Guangzhou, the LLS's flash detection efficiency is approximately 97% (33/34). For the 81 return strokes included in these flashes, the LLS's stroke detection efficiency is approximately 74% (60/81). If more than two reporting sensors are involved in the location retrieval, the arithmetic mean and median values for location error are estimated to be approximately 633 and 453 m, respectively, when more than two reporting sensors are involved in the location retrieval (samples: 54).

Totally, the LLS's flash detection efficiency and stroke detection efficiency are approximately 94% (58/62) and 60% (97/162), respectively. The arithmetic mean and median values for location error are estimated to be approximately 710 and 489 m, respectively, when more than two reporting sensors are involved in the location retrieval (samples: 87). After eliminating one obviously abnormal sample, the absolute percentage errors of peak current estimation are within 0.4%–42%, with arithmetic mean and median values of approximately 16.3% and 19.1%, respectively (samples: 21).

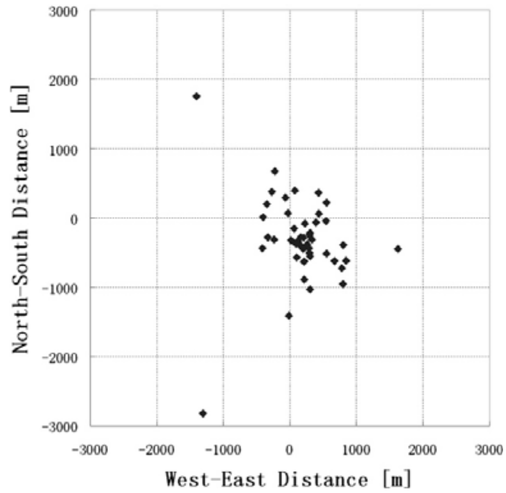


Fig. 3 Location errors of LLS reports for 54 return strokes on tall structures. The origin corresponds to the ground strike point.

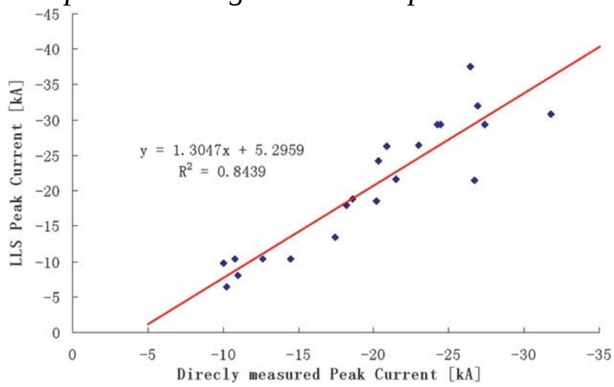


Fig. 4 LLS-reported and directly measured peak currents in the triggered lightning experiment.

Lightning Research at National Space Science and Technology Center -NASA Marshall Space Flight Center (MSFC), University of Alabama in Huntsville (UAH), National Weather Service Weather Forecast Office (WFO) - in Huntsville, Al

In April, NASA approved the Lightning Imaging Sensor (LIS) flight spare as an attached payload on the International Space Station (ISS). The tentative launch will be on Space X 10 in January, 2016 for a nominal 2 year mission (with the possibility of additional years beyond that). The first LIS flight model, developed for the NASA Earth Observing System, is still operating at full capability on the Tropical Rainfall Measuring Mission satellite after 15 years on orbit. The ISS LIS will take advantage of the high inclination, or the ability to "look" far further toward Earth's poles than the original LIS could do aboard the TRMM satellite. Once on station, LIS will monitor global lightning for Earth and space science studies, provide cross-sensor calibration and validation for several space-borne payloads (e.g., Geostationary Lightning Mapper or GLM) and ground-based lightning networks, and supply real time lightning data over data-sparse regions, such as the oceans, to support operational weather forecasting and warning. MSFC (R. Blakeslee, W. Koshak, D. Cecil) and UAH (H. Christian, M. Stewart, D. Mach, D. Buechler, J. Hall) will prepare the spare LIS for flight.

A fully updated OTD-LIS Gridded Lightning Climatology through 2011 (Cecil, Buechler, Blakeslee) is now accessible in HDF files or through a Google Earth interface at http://thunder.nsstc.nasa.gov/data/data_lis-otd-climatology.html. Also, a paper (Atmos. Res.) fully describing the gridded lightning climatology dataset from TRMM-LIS and OTD is available via open access from http://dx.doi.org/10.1016/j.atmosres.2012.06.028.

T. Lang, who recently joined the NSSTC lightning group, is using lightning, radar, satellite, and other meteorological data from the Deep Convective Clouds and Chemistry (DC3) project to study the electrification of wildfire smoke plumes. The electrification leads to small intracloud discharges at high altitudes, and occurs after rapid wildfire growth causes vertical growth of the plumes and the development of a mixture of ice and ash particles in the pyrocumulus cloud cap.

A study (Buechler, Koshak, Christian, S. Goodman) looking at the stability of the LIS onboard the TRMM satellite has been accepted for publication in the Special Issue of Atmospheric Research on the 14th International Conference on Atmospheric Electricity (ICAE). This study used LIS observations of Deep Convective Clouds (DCCs) and showed that the LIS background radiance of DCCs have not changed from 1998-2010. Since the Geostationary Lightning Mapper (GLM) on the GOES-R is of a similar design, it too should provide stable performance. The DCC method can also be used to monitor GLM performance once in orbit.

MSFC continues supporting the National Climate Assessment (NCA, http://www.globalchange.gov/what-we-do/assessment) by monitoring and analyzing US National Lightning Detection NetworkTM (NLDN) data, and several databases associated with the harmful impacts of lightning (i.e., fatalities, injuries, property/crop damage, wildfires) in order to generate insightful assessment products that contain analyses, trends, and alerts pertinent to a warming climate. The primary focus is to produce assessment products using MSFC visualization tools that are useful in monitoring key long-term changes in lightning, and that can be used to monitor and potentially help predict the impact of these changes on the US. Most recently, the effort is employing LIS data to inter-compare with the ground-based national lightning data analyses. A journal article (Koshak, Blakeslee, K. Cummins, Buechler) providing the details and results of this effort will be submitted within about 2 months to the AMS Journal of Applied Meteorology and Climatology.

The most significant activity here at the Huntsville WFO (K. White, C. Darden, B. Carcione, G. Stano) was the introduction of North Alabama LMA data in the new AWIPS II platform beginning in early March. Since then, these data have been used primarily for situational awareness, monitoring for total lightning activity (as a potential precursor to cloud-to-ground lightning) for outdoor events. Collaboration for a journal article is currently underway regarding the use of the LMA data during the March 2nd, 2012 severe weather outbreak.

From the NASA NSSTC Short-term Prediction Research and Transition (SPoRT) center perspective (Stano) with total lightning, besides the operational implementation of the LMA plug-in in AWIPS II in the Huntsville WFO, this tool is now also being used at the Houston WFO and the Spaceflight Meteorology Group. Additionally, via the GOES-R Visiting Scientist Program, SPoRT is collaborating with S. Rutledge to incorporate the Colorado LMA data into the pseudo-GLM for GOES-R Proving Ground activities as well as SPoRT transitioning these data to the WFOs in Boulder, Colorado and Cheyenne, Wyoming. Another exciting activity is the development of the total lightning tracking tool, which is evolving into a SPoRT/ NOAA Meteorology Development Laboratory (MDL) collaboration. This tool is being tested at the Hazardous Weather Testbed and has been accepted, via a proposal, to be evaluated at the Operations Proving Ground later this summer. Lastly, SPoRT is now collaborating with seven LMA networks to produce pseudo-GLM data (PGLM). This has been used to create the PGLM Mosaic which is now being demonstrated at the Aviation Weather Center and Storm Prediction Center. This effort began late last spring.

NASA (Schultz), UAH (Carey), and SPoRT (Stano) are providing leading support for the National Lightning Jump Demonstration in which the National Weather Service (NWS) is attempting to evaluate the operational utility and readiness of the lightning jump algorithm in its current form. The primary focus of the NSSTC investigators in this joint venture is to help the NWS personnel conducting the experiment to work through challenge as they arise. The demonstration program is now beginning its second year of operation. Several challenges that have arisen have been resolved or are in the process of being resolved.

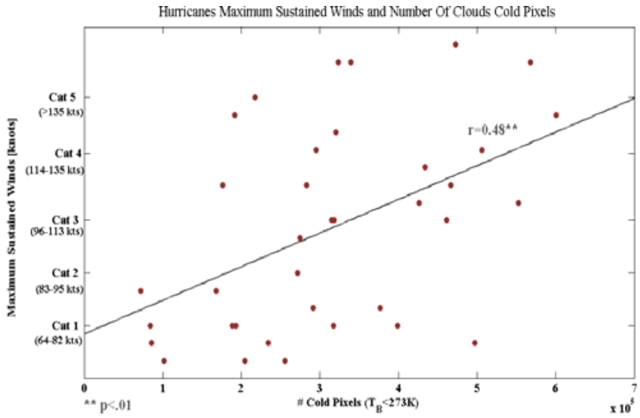
Lightning Research in Israel

Yoav Yair (The Open University), Colin Price (Tel-Aviv University) and their students completed the 7th winter ILAN sprite campaign (http://www.ilanteam.com/). This year two cameras were operated remotely in parallel, in order to enable triangulation and reconstruction of the spatial arrangement of TLE elements: a new Watec902H at the Wise Astronomical Observatory in Mitzpe-Ramon, and the other on the Geophysics building at the Tel-Aviv University campus. The combined coverage area of the two cameras is almost 800 km around central Israel, offering coverage to neighboring regions in Syria, Jordan, Saudi-Arabia and Egypt. The winter season 2012/2013 showed a relatively low amount of convective thunderstorms with only ~50 sprites recorded, mostly over the Mediterranean Sea. Unfortunately, not a single synchronous observation was successful. Better luck next year!

Gal Elhal, Yoav Yair and Colin Price are collaborating with Giles Harrison and Keri Nicole (U. of Reading, UK) in analysis of the fair weather current data recorded at the Wise Astronomical Observatory. The GDACCS instrument was installed at Wise 2 years ago (Bennet and Harrison, 2008) and has been used for monitoring changes in Jz in relation with the arrival of Coronal Mass Ejection (CMEs) from the sun. Results show a marked increase (an order of magnitude) in the variability of Jz around the time of disturbances to the interplanetary geomagnetic field (IMF), lasting for several hours, implying a response of the Global Electrical Circuit.

Na'ama Reicher, Colin Price and Yoav Yair completed an analysis of the lightning activity and cloud top temperatures in African Easterly Waves preceding the onset of tropical disturbances in the Atlantic Ocean, developing (or not) into hurricanes. Results for 63 tropical storms show that the area coverage of cold cloud pixels in West Africa (taken from the METEOSAT geostationary satellite images) is positively correlated with the maximum sustained winds observed in the future tropical storms or hurricanes. These tropical storms develop from African Easterly Waves (AEWs) that can be studied using infrared cloud images and lightning data.

Israel Silber and Colin Price, together with Christos Haldoupis and Craig Rodger have being investigating the link between mesopause temperatures, and VLF narrowband ground-based measurements. Using VLF transmitters normally used for navigation of submarines by various navies around the world, the VLF signals between the transmitters and the receiving antennas are influenced by the properties of the lower ionosphere (D-region). Temperature changes in the D-region due to solar radiation, gravity waves, tides and even climate change influence the D-region reflection height, and hence the VLF amplitudes detected on the ground. A JGR paper is in press on this topic.



Keren Mezuman and Colin Price have been using the WWLLN data to try to estimate the number of thunderstorms active at any moment across the globe. The acceptable number in the literature is 2000, based on an estimate by Brooks in 1925! More recent estimates have ranges from 1800-3600 storms around the globe. In our research we have found that the number of thunderstorms is likely closer to 1000, about half the acceptable number. Our analysis also shows that the diurnal variations in the number of thunderstorms around the globe matches nicely the Carnegie Curve of potential gradient at the surface obtained in the 1920s.

MIT (Cambridge, MA, USA)

Work continues with Anirban Guha (a Post-Doc from India) on the variation of Schumann resonance parameters in the Rhode Island archive from 1994 to present. The modal intensities are varying by ~15% over the 11-year solar cycle, in anti-phase, and so in-phase with the galactic cosmic rays, consistent with like observations in Hungary by Gabriella Satori. We have still not succeeded in establishing to what extent these variations can be explained solely on the basis of changes in the Earth-ionosphere cavity, and to what extent changes in global lightning are also involved. A recent publication in JASTP by Pinto, Pinto and Pinto showing 11-year variations (also anti-phase) in thunder day time series in Brazil has considerable relevance here. Discussion with NASA MSFC has been underway to verify the presence of an 11-year variation in LIS lightning flashes.

Anirban is also organizing ELF observations and editing ELF time series from multiple stations worldwide for use in Vadim Mushtak's latest-and-greatest iterative inversions for global lightning activity. Key contributions to this study have been made by: X. Shen, X. Zhang, H. Yu (China), A. Ondraskova (Czech Republic), G. Satori, J. Bor and T. Nagy (Hungary), B.M. Pathan , A. Sinha, R. Rawat and J. Krishnamurthy (India), C. Price (Israel), Y. Hobara and M. Hayakawa (Japan), M. Sato and Y. Takahashi (Japan), M. Neska (Poland), A. Kulak and M. Ostrowski (Poland), Y. Bashkuev and D. Buyanova (Siberia), P. Ortega (Tahiti), H.-T Su and A. Chen (Taiwan), T. Whitely and M. Fullekrug (UK), Y. Yampolski and A. Koloskov (Ukraine) , S. Cummer (USA), R. Moore and A. Fraser-Smith (USA).

Spare time work continues (with R. Golka and M. Valente) on the resurrection of a large (+/- 65 kV, 5 ampere) DC power supply intended for making long arcs in air, with main goal to shed further light on the stability of continuing current in lightning.

Earle Williams participated in the recent (May 8-10) CHUVA Workshop in Sao Paulo where results were presented for a sequence of field experiments at a number of locations in Brazil over the past three years. An X-band polarimetric radar and wide variety of lightning location systems (LMA, Brasildat, Vaisala, LINET, RINDAT) were used in the vicinity of Sao Jose dos Campos to study 20 incipient isolated thunderstorms from first radar echo to initial ground flash. In all cases the evolutionary behavior matched that of northern hemisphere thunderstorms: first radar echo followed by initial intracloud flash (in 26 min, mean) followed by first ground flash (44 min, mean). Single stroke flashes dominated the initial CG multiplicity. The differential reflectivity (ZDR) in the mixed phase region prior to the first intracloud flash was negative, with typical positive values in the lower warm part of the storm. The negative ZDR values aloft can be interpreted as conical graupel, or alternatively as ice particles aligned in predominantly vertical electric field. These two interpretations are difficult to distinguish with scanning radar data alone.

MIT Lincoln Laboratory (Lexington, MA, USA)

Collaboration with Mengistu Wolde and Alexei Korolev with the Canadian National Research Council (NRC) CONVAIR 580 aircraft (with full suite of cloud microphysical measurements) has been undertaken to verify polarimetric radar observations with NEXRAD radars in Cleveland and Buffalo. Targeted regions in snowstorms are those with icing hazard to aircraft. Coordination among Lincoln Lab, ground-based radars and aircraft has been achieved with email 'chat' sessions. Earle Williams flew three missions in snowstorms in February. A highlight of the flight on February 28 was the finding of large numbers of hexagonal flat plate crystals in regions characterized by radar with large differential reflectivity +5-8 dB. Hexagonal plates are of particular interest as they are the most anisotropic target known (among hydrometeors) for dual pol radar, and because they have been quite scarce in earlier aircraft microphysical measurements. Abstracts have been submitted to the upcoming AMS Radar Conference in Colorado on this work.

National Severe Storms Laboratory (NSSL), Norman, Oklahoma

The National Severe Storms Laboratory (NSSL) in Norman, Oklahoma has participated in several experiments this past year:

In May – June 2012, NSSL joined several other government agencies, the National Center for Atmospheric Research, and several universities to carry out the Deep Convective Clouds and Chemistry Experiment. Among its goals were to improve understanding of lightning's contribution to the chemistry of the upper troposphere and to improve understanding of correlations between lightning flash rates and other storm parameters and particularly of conditions that produce inverted-polarity thunderstorm charge distributions. Observations were obtained from three venues, northern Alabama, Oklahoma - west Texas, and northeast Colorado. Each venue had a Lightning Mapping Array, one or more polarimetric radars, and environmental soundings. In all three venues, *in situ* chemical species were observed in anvils by the NCAR G-V, the NASA DC-8, and the German Falcon aircraft. NSSL, the University of Oklahoma, and Texas Tech University also made balloon-borne soundings with an electric field meter and a particle imager for storms in Oklahoma and west Texas. Oklahoma-Texas storms were observed on thirteen days, and very good data sets were obtained for seven storms.

In May 2012 and 2013, NSSL has been conducting the Hazardous Weather Testbed Experiment to examine how weather service forecasters can use new observing technologies and computer algorithms to improve severe weather warnings. Among the new types of data being examined is the total lightning observed by Lightning Mapping Arrays, which are being used to produce a proxy for data from the Geosynchronous Lightning Mapper planned for launch by the United States on the GOES-R satellite. A related experiment at NSSL and NASA Marshall Space Flight Center (MSFC) in Alabama is evaluating the performance of an automated lightning jump algorithm in warning of severe weather. The lightning jump algorithm was developed by scientists at MSFC using data from their Lightning Mapping Array.

Over the past year, scientists at NSSL and the University of Oklahoma have been refining a technique for assimilating total lightning data into a numerical weather forecast model (the WRF-ARW model) to improve the environment input into the model at the beginning of the forecast period. A quasi-operational test of this lightning data assimilation scheme is being included as part of a broader forecasting experiment at NSSL this spring. These scientists also have been developing a scheme for predicting lightning activity directly from explicit parameterizations of storm electrification and lightning which they added to WRF-ARW.

ONERA Plasma and Lightning Physics Research Group

Philippe Lalande (philippe.lalande@onera.fr)

The group is doing experimental and theoretical studies on interaction between lightning channel and the surface of an aircraft. Bruno Peyrou, under the supervision and the assistance of Laurent Chemartin and Philippe Lalande, finished a PhD on a MHD modelling of a lightning channel http://ovh.to/um3qYrJ . Laurent Chemartin is achieving the design and the setup of GRIFON, a Laboratory Lightning Research Facility. GRIFON will develop current pulses going up to 200 kA, superimposed on a continuing current of few hundreds of A and 200 Coulombs. The facility, associated with a small wind tunnel will be devoted to the study of the phenomenology of the lightning attachment and of the arc sweeping.

Patrice Blanchet, Magalie Buguet and Aurélie Bouchard are involved in the preparation of a large dynamical range atmospheric electric field measurement (few V/m to 100 kV/m) on an aircraft instrumented with a 8 field mills network. The aircraft will be flown at the vicinity of convective clouds and will survey early electrification.

Radar Meteorology Group, Colorado State University

Doug Stolz and **Steven Rutledge** are studying the roles of thermodynamics and aerosols to examine tropical lightning. Many studies have documented marked regional and temporal variability in the frequency and occurrence of lightning within the tropics and researchers have postulated that aerosols and thermodynamics play key roles in modulating the degree to which clouds become electrified. We hypothesize that lightning is most strongly influenced by the properties of the underlying surface and thermodynamic profile of the overlying atmosphere, with aerosols having a secondary role in controlling convective vigor and electrification. A suite of lightning (satellite and ground based), aerosol, thermodynamic, and radar data are being analyzed across twelve areas in the tropics (based on previous lightning climatology) to attempt to quantify the relative contributions of thermodynamics and aerosols to lightning variability. Specifically, this research aims to assess the potential importance of mid- level inflow, the "shape of the CAPE", and aerosol size (and composition) in driving regional and temporal variations in lightning. Vertical profiles of radar reflectivity from the TRMM precipitation radar are being used to characterize the microphysical structure of clouds affected by varying thermodynamic and aerosol properties on the global scale.

Brett Basarab and **Steven Rutledge** are investigating relationships between lightning and storm parameters based on observations from the Deep Convective Clouds and Chemistry (DC3) experiment. These relationships can serve as lightning parameterizations in cloud-resolving models. Many numerical models rely on storm parameters, such as maximum updraft velocity and cloud top height, to estimate lightning flash rates. It is therefore important to develop lightning parameterizations from storm observations to possibly improve the representation of lightning in models. For this study, we focus on three storms that occurred in the DC3 Colorado domain, all of which exhibited vigorous lightning. This work will also investigate how well the derived parameterizations represent the production of nitrogen oxides by lightning.

Nick Beavis and **Steven Rutledge**, in collaboration with **Timothy Lang** (NASA/MSFC) and **Walt Lyons** (FMA Research) have been analyzing impulse charge moment change (iCMC; from Duke University). As is well established, a large iCMC (> 300 C km) is likely to produce a mesospheric sprite. A two-year climatology of iCMC events reveals significant regional and seasonal variations in both polarity and frequency. A clear diurnal cycle is evident in the warm season, with the occurence of afternoon cellular convection yielding to organized, nocturnal mesoscale convective systems. Over nearby oceanic regions, iCMC events are maximum in early morning. The analysis of the meteorological environments that support a large iCMC (defined here as exceeding 100 C km) along with radar data, has led to conclusions that, not surprisingly, larger systems tend to produce more large iCMCs in their stratiform-identified regions, while smaller systems tend to produce more large iCMCs in their convective-identified regions. Comparison of iCMC data with NLDN yields a larger fraction of large iCMCs to NLDN strokes in stratiform regions than convective regions, possibly indicating the "tapping" of a larger charge reservoir. The iCMC dataset provides an excellent means to better understand the challenge of electrification in storms.

Brody Fuchs and **Steven Rutledge** along with **Timothy Lang** are using the CSU Lightning, Environmental, Aerosol and Radar (CLEAR) framework to analyze all isolated convective storms in regions with Lightning Mapping Arrays (LMAs) during the 2011 warm season. The regions of study are Alabama, Colorado, Oklahoma and Washington, D.C. which all experience different modes of storms, allowing for a regional comparison of storms. With the large suite of data incorporated in this study, the goal is to understand what factors determine the electrical characteristics in thunderstorms. One of the characteristics we're interested in is the occurrence of positive cloud-to-ground lightning and its dependence on electrical structure. IC:CG ratio is also of interest because it may be more indicative of a storm's vigor. With the LMA data we are able to construct intra-cloud flashes with high accuracy which has not been done on this size scale before. Compiling statistics on a large number of storms' lightning behavior along with their radar structures, environmental variables, and aerosol information will hopefully illuminate the controls on thunderstorm charging.

Special Laboratory of Physics, University of Shkodra, Albania

Florian Mandija (f_mandija@yahoo.com)

Our laboratory realizes continuous monitoring campaigns on atmospheric particles on the lower part of the troposphere. The focus is set mainly on cluster ions (air ions) and aerosol particles of sub-micron and micron size range. These monitoring campaigns were carried out since 2006 till nowadays. During this six month period our working group was focused on the study of two primary problems;

- Continuous presentation of monitoring results of aerosol number concentrations.
- The theoretical interpretation of some of the monitoring results.

The first goal was realized through the presentation in the several conferences, like ICTFSD, (Shkoder, Albania), 4th International Workshop on Air Quality Forecasting Research (Geneva, Switzerland), Electrostatics 2013 (Budapest, Hungary), etc. In the ICTFSD we theoretically simulate the altitude profiles of the ion production rate and aerosol concentrations (Fig. 1).

The second goal was realized through the publications in the impact factor journals. In the Journal of Electrostatics we have presented a new classification of charged atmospheric particles. This paper includes charged ultrafine aerosols into the cluster ion group. This new categorization gives a net help on the discussion of atmospheric electricity, especially in the determination of the attachment and recombination coefficients. The paper in IET Science, Measurement & Technology presents two methods on the determination of the coefficients of the power law functions of aerosol size spectrum using the data from aerosol spectrometers. Figure 2 presents the comparison between the models for the evaluation of the power law coefficients.

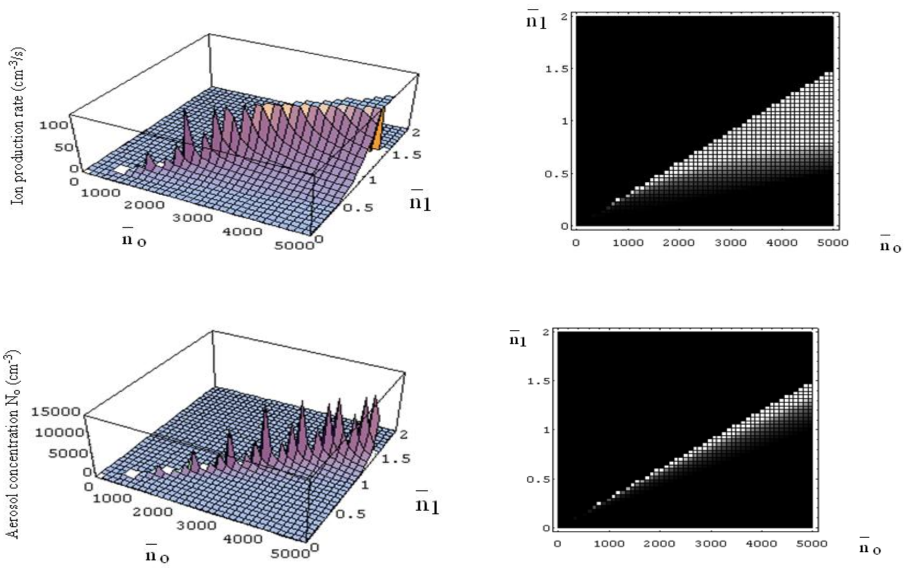


Fig. 1 The altitude profiles of the ion production rate and aerosol concentrations.

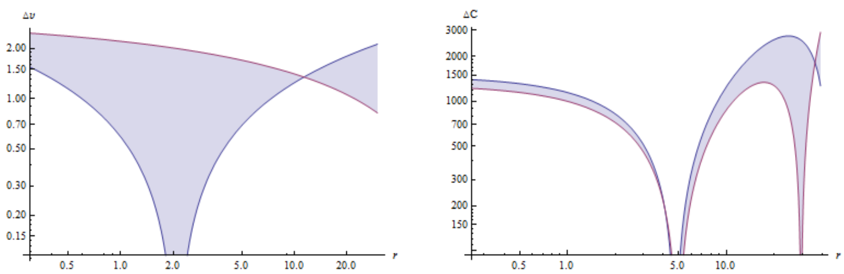


Fig. 2 Comparison between the models for the evaluation of the power law coefficients.

University of Florida (Gainesville, FL, USA)

Lightning experiments and observations will continue in Summer 2013 at Camp Blanding, Florida (for the 20th year), as well as at the Lightning Observatory in Gainesville (LOG), located at a distance of about 45 km from Camp Blanding. The two facilities are linked by a dedicated phone line. Additionally, coordinated field measurements will be performed at the Golf Course site, located at a distance of 3 km from the Camp Blanding facility. A Lightning Mapping Array (LMA) will be operated (for the third summer) in the Camp Blanding area. Among the visiting researchers scheduled to perform experiments in the summer campaign from the new optical building are Dr. Vince Idone and a grad student from SUNYA, Dr. Hugh Christian and a grad student from the University of Alabama Huntsville, and Dr. Daohong Wang from Gifu University, Japan.

W.R. Gamerota, M.A. Uman, J.D. Hill (now at Stinger Ghaffarian Technologies), J. Pilkey, T. Ngin, and D.M. Jordan in collaboration with C.T. Mata of Stinger Ghaffarian Technologies authored a paper titled "An "anomalous" triggered lightning flash in Florida". An "anomalous" rocket-and-wire triggered lightning flash, a flash whose downward leaders do not follow the triggering-wire remnants to ground, is characterized via high-speed video images at 10 and 300 kilo-frames per second, still camera images, 66–72 MHz source locations from a Lightning Mapping Array, channel-base current, and electric field and electric field derivative (dE/dt) measurements. This is the first well-documented anomalous flash of about 410 classically triggered flashes in north-central Florida. The flash began with an upward positively charged leader (UPL) initiating from the tip of the upward-moving triggering wire, about 280 m above ground level. All but the bottom 17 m of wire exploded 37.6 ms after UPL initiation, making the upper part of the UPL plasma channel floating (disconnected from ground). A downward stepped leader initiated, likely from the bottom of the floating plasma channel, 282 m above ground level and about 1.3 ms after the wire explosion, and propagated for 2.1 ms, attaching to the top of a grounded utility pole 117 m from the launching facility. The line charge density on the stepped leader is estimated to be of the order of 10^{-3} C m^{-1}. In the presented event, contrary to previously reported "anomalous" flashes in France and New Mexico (roughly 16% and 31%, respectively, of their triggered flashes), there was no tens of milliseconds long zero-current period preceding the stepped leader, there was no observed downward dart leader in the floating UPL channel prior to the stepped leader to ground (the floating channel remained luminous at all times), and there was a failed attempt to reestablish current between the floating UPL channel and ground. The paper is published in the JGR - Atmospheres.

V.A. Rakov wrote a review paper titled "The Physics of Lightning". An overview of the physics of cloud-to-ground lightning is given, including its initiation, propagation, and attachment to ground. Discharges artificially initiated (triggered) from natural thunderclouds using the rocket-and-wire technique are discussed with a view toward studying properties of natural lightning. Both conventional and runaway breakdown mechanisms of lightning initiation in thunderclouds are reviewed, as is the role of the lower positive charge region in facilitating different types of lightning. New observations of negative-leader stepping and its attachment to ground are compared to similar processes in long laboratory sparks. The mechanism and parameters of compact intracloud lightning discharges that are thought to be the most intense natural producers of HF-VHF (3–300 MHz) radiation on Earth are reviewed. The M-component mode of charge transfer to ground and its difference from the leader/return-stroke mode are discussed. Lightning interaction with the ionosphere and the production of energetic radiation (X-rays and gamma radiation) by cloud-to-ground leaders are considered. Some aspects of lightning physics are still poorly understood or are a subject of debate. These include the dominant lightning initiation mechanism, the role of cosmic rays and energetic radiation in electrical breakdown processes in different parts of the atmosphere, properties of positive and bipolar lightning, and details of the breakthrough phase of the lightning attachment process, to name a few. The paper is published in the Surveys in Geophysics.

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Reminder

Newsletter on Atmospheric Electricity presents twice a year (May and November) to the members of our community with the following information:

- announcements concerning people from atmospheric electricity community, especially awards, new books...,
- announcements about conferences, meetings, symposia, workshops in our field of interest,
- brief synthetic reports about the research activities conducted by the various organizations working in atmospheric electricity throughout the world, and presented by the groups where this research is performed, and
- a list of recent publications. In this last item will be listed the references of the papers published in our field of interest during the past six months by the research groups, or to be published very soon, that wish to release this information, but we do not include the contributions in the proceedings of the Conferences.

No publication of scientific paper is done in this Newsletter. We urge all the groups interested to submit a short text (one page maximum with photos eventually) on their research, their results or their projects, along with a list of references of their papers published during the past six months. This list will appear in the last item. Any information about meetings, conferences or others which we would not be aware of will be welcome.

Newsletter on Atmospheric Electricity is now routinely provided on the web site of ICAE (http://www.icae.jp), and on the web site maintained by Monte Bateman http://ae.nsstc.uah.edu/.

In order to make our news letter more attractive and informative, it will be appreciated if you could include up to two photos or figures in your contribution!

Call for contributions to the newsletter

All issues of this newsletter are open for general contributions. If you would like to contribute any science highlight or workshop report, please contact Daohong Wang (wang@gifu-u.ac.jp) preferably by e-mail as an attached word document.

The deadline for **2013 winter** issue of the newsletter is **Nov 15, 2013**.

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