

DEDICATION

Toshio Ogawa (1927-2014), Father of Lightning Q-bursts

Earle Williams

Toshio Ogawa, world class researcher in atmospheric electricity and deep thinker, died on March 10, 2014 at age 87. Ogawa worked virtually every domain in this field and beyond: the physics of lightning, charge on precipitation, the DC global circuit, stratospheric electric fields, Schumann resonances, ionospheric conductivity, atmospheric pollution, negative ions in the troposphere, electromagnetic effects of earthquakes, EM emission from stressed rocks in the laboratory, auroral electric fields, magnetic substorms and solar flares. This year marks the 50th anniversary of his classical paper with Marx Brook in JGR on “The Mechanism of the Intracloud Discharge”, a study still discussed and debated today with the growing use of LMA technology to follow lightning behavior within the cloud. Ogawa felt a special kinship with Marx Brook because ‘Ogawa’ in Japanese is ‘brook’ in English. Ogawa is probably best known in atmospheric electricity for electromagnetic Q-bursts—the global manifestation of extraordinarily energetic lightning flashes within the Earth-ionosphere cavity. Ogawa’s apt name for them came from ‘Quiet’ bursts—transient waveforms largely devoid of frequencies higher than the fundamental mode of Schumann resonances (8 Hz). Ogawa’s work in the 1960s on this phenomenon with narrow band filters raised questions about whether lightning flashes were sufficiently energetic to produce such a large amplitude global disturbance. When several decades later the same events were linked with sprites in the mesosphere, his curiosity was piqued again after a lapse of nearly four decades. In 2002 he explored the polarity of Q-bursts worldwide, and on the occasion of the ICAE in Beijing in 2007, expanded the bandwidth of his ELF receiver by nearly three orders of magnitude (to extend from the Schumann resonance region to the waveguide cutoff), and then developed some simple ‘by eye’ analyses on the interfering waveforms coming round two sides of the Earth to estimate the distances to these special discharges. With his ‘ball antenna’ in Japan he located many Q-bursts in the vicinity of Argentina in South America, a location now recognized as being a conjugate region for the large mesoscale convective systems in North America, with similar conducive physical environment (high mountain range to the west and warm ocean at low levels). Like his Q-bursts, Ogawa was quiet—modest and unassuming—but all the while intensely engaged. He will be missed. By good fortune, much of his research work (through 1990) was collected in a single volume entitled “The Earth’s Electric Fields” on the occasion of his 63rd birthday by the Department of Physics of Kochi University (Tosa Shuppan, Inc., Kochi, Japan, 1990).

ANNOUNCEMENTS

NEW TECHNICAL BROCHURE

CIGRE TB 549, Lightning Parameters for Engineering Applications, WG C4.407, V.A. Rakov, Convener (US), A. Borghetti, Secretary (IT), C. Bouquegneau (BE), W.A. Chisholm (CA), V. Cooray (SE), K. Cummins (US), G. Diendorfer (AT), F. Heidler (DE), A. Hussein (CA), M. Ishii (JP), C.A. Nucci (IT), A. Piantini (BR), O. Pinto, Jr. (BR), X. Qie (CN), F. Rachidi (CH), M.M.F. Saba (BR), T. Shindo (JP), W. Schulz (AT), R. Thottappillil (SE), S. Visacro (BR), W. Zischank (DE), 117 p., August 2013.

In April 2008, CIGRE (International Council on Large Electric Systems) formed a Working Group C4.407, named “Lightning Parameters for Engineering Applications”. The WG C4.407 was composed of 21 members from North and South America, Europe, and Asia. It was tasked to prepare a CIGRE Reference Document (Technical Brochure) on lightning parameters needed for engineering applications. CIGRE WG C4.407 has completed its work on the Technical Brochure in May 2013. This Brochure (CIGRE TB 549, 2013), published in August 2013, can be viewed as an update on previous CIGRE documents on the subject published in *Electra* more than three decades ago: Berger et al. (1975) and Anderson and Eriksson (1980).

References

Anderson R B, A J Eriksson. 1980. Lightning parameters for engineering application. *Electra*, 69: 65-102.
Berger K, R B Anderson, H Kroninger. 1975. Parameters of lightning flashes. *Electra*, 41: 23-37.

Open call for nominations for the prestigious ICLP Berger and Golde awards

Based on the decision of the ICLP scientific committee made on the 8th of May, 2014, we are pleased to announce that the call for nominations for the prestigious ICLP Berger and Golde awards is now open. Each year the scientific committee of the ICLP bestows these awards upon four scientists for distinguished achievements in the science and engineering of lightning research, developing new fields in theory and practice, modelling and measurements.

Once the nominations are in, a distinguished panel of judges consisting of the previous recipients of these awards will rank the nominees according to their standing in the research community and for their contributions to the field. Based on this ranking, the award committee will select the recipients of the two awards.

Please send in your nomination before the 31st of July, 2014, with a short description of the achievements of the nominee including a short CV and the proposed citation. The nominations can be forwarded to any member of the Awards Committee whose names and emails are given below. In order to keep the nomination process fair and just, please do not make any personal contact with your nominee concerning your nomination.

ANNOUNCEMENTS

Award Committee of the ICLP

Prof. Istvan Berta (berta@shock.hu)

Prof. Marcos Rubinstein (marocs.rubinstein@heig-vd.ch)

Prof. Vernon Cooray (vernon.cooray@angstrom.uu.se)

Call for papers Special issue of the Journal of Atmospheric and Solar Terrestrial Physics dedicated to Lightning Research

A special issue of the Journal of Atmospheric and Solar Terrestrial Physics dedicated to lightning research is planned to be published in the spring of 2015. This special issue aims to gather research works in the area of Lightning and related topics to present the latest results obtained and the efforts of the lightning research community to address and solve various problems related to lightning. The title of the special issue will be: Recent Advances in Lightning Research.

Some of the papers for the special issue will be selected from the papers that will be presented at the International Conference on Lightning Protection to be held in Shanghai in October 2014 and the rest will be selected from the response to this open call for submissions.

We will open up the submission portal for this special issue in October, 2014 and the dead line for the submissions will be the end of December, 2014. If you plan to submit a paper to this special issue please indicate your interest and the possible topic to one of us by email.

Prof. Vernon Cooray (Vernon.Cooray@angstrom.uu.se)

Prof. Farhad Rachidi (Farhad.Rachidi@epfl.ch)

CONFERENCES

2014 AGU Fall Meeting



The fall meeting of AGU will be held on 15-19 December 2014, at the Moscone Center West, 800 Howard Street, San Francisco. There will be several sessions associated with atmospheric electricity. For detail, please visit <http://fallmeeting.agu.org/2014/>.

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Atmospheric Electricity Group (ELAT), Brazil

During the last summer in Brazil, 22 upward lightning flashes have been recorded by high-speed cameras and electric field sensors. Most of these flashes were triggered by nearby +CG flashes. A few were triggered by IC discharges. They initiated from telecommunication towers located in Sao Paulo, Brazil. All processes of the upward flashes were identified using a *Phantom v711* high-speed video camera located at a distance of 5 km from the towers. The frame rate used was 20,000 images per second.

An electric field sensor was placed 27 m away from the tallest tower and managed to record the waveforms of several recoil leaders that occur

during the flash. Some are very similar to those of return strokes and can be detected by the lightning location system that covers the region.

During June and July 2014, part of our equipment will be used to record upward flashes in Rapid City, SD where a lightning mapping array (LMA), a few high-speed cameras and electric field sensors will operate simultaneously.

The figure below shows two upward flashes that were triggered by +CG flashes that struck ground more than 40 km away from the tower. The digital still images were obtained by a Nikon D800 camera (ISO, 100; aperture, f/8; focal length, 20 mm; exposure time, 18.2 s).



Colorado State University, Department of Atmospheric Science, Radar Meteorology Group

Doug Stolz and S. A. Rutledge

To date, our work has been focused on developing a scheme to attribute environmental aerosol (from a transport model) and thermodynamic characteristics to electrified convective features in

the Tropics. The goal from early on has been to investigate the relative contributions of aerosol microphysical processes and instability to the intensity/electrical properties of convection. Preliminary results point to the

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simultaneous importance of boundary layer aerosol concentrations and thermodynamics in explaining a significant portion of the variance of lightning in the Tropics. The next step is to quantify the relative importance of independent "predictors" regionally and seasonally.

The second subject of interest is convection occurring during various phases of the Madden Julian Oscillation, which was observed in great detail during the DYNAMO field campaign in the year 2011. Observations from DYNAMO illustrate drastically different low-level aerosol characteristics in the equatorial Indian Ocean depending on background, large-scale circulation (related to the changing phase of the Asian Monsoon). We have also found coherent eastward-propagating lightning signals associated with the pre-onset phase of MJO convection, using Vaisala GLD 360 lightning data. We are now investigating role of both CAPE and aerosol variability in contributing to documented variability in MJO related convection.

Brett Basarab and S. A. Rutledge

We continue to investigate the relationship between lightning behavior and storm structure, dynamics, and microphysics in several Colorado case studies from the DC3 (Deep Convective Clouds and Chemistry) experiment. Simultaneous radar, lightning, and storm chemistry measurements during DC3 afford the opportunity to better quantify nitrogen oxide ($\text{NO} + \text{NO}_2 = \text{NO}_x$) production by lightning. We have been able to develop new relationships between lightning flash rate and storm parameters, which can be used to parameterize flash rate in cloud models. We have found that graupel echo volume, 30-dBZ echo volume, and precipitation ice mass are particularly well correlated to flash rate for Colorado storms. Multiple Doppler radar coverage of some of our case studies has allowed for investigation of the

relationship between flash rate and updraft parameters as well. One particular goal is to determine those updraft parameters that are most physically related to flash rate, such as updraft volume greater than 15 m/s (representative of the updraft core) and large differential vertical motion (important in storm-scale charge separation). Despite the robust correlations between flash rates and storm parameters, we have found mixed results in terms of the successful prediction of flash rate for Colorado storms. We therefore wish to test the relationships we have developed on storms outside of the Colorado DC3 domain. Additionally, since the amount of NO_x produced per flash likely depends on the flash size (channel length), we have investigated flash size trends with the goal of working toward a more physical NO_x parameterization. Based on electrostatic theory (motivated by E. Bruning's work), it is hypothesized that trends in flash sizes and flash rate are generally opposed, and we have observed this qualitative relationship in our case studies. We plan to determine a more rigorous, quantitative relationship between flash rate and total flash size. Since the amount of NO_x produced per channel length has been investigated in laboratory studies, and with the potential to successfully predict flash rate from storm parameters, then a flash rate-total flash channel length relationship could be used to better parameterize NO_x production in cloud-resolving chemical transport models.

Brody Fuchs and S. A. Rutledge

Our work has been focused on using an objective analysis method to determine environmental controls on storm flash rates and charge structures. Flash rates are produced by a novel flash clustering algorithm that groups sources detected by Lightning Mapping Array (LMA) networks in space and time to determine each flash within in thunderstorm. A novel method of determining the

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strongest positive charge within a storm has also been implemented in this study using LMA information. Using four LMA networks in the United States, we were able to determine that the northeast Colorado region has higher flash rates per storm than the Oklahoma, Alabama and Washington DC regions. We have also found that specific environmental variables are well correlated with storm flash rates in a median sense. The strongest flash rate relationships were found with normalized CAPE (NCAPE), a measure of the “shape of the CAPE”, and cloud base height. The highest flash rate storms occur when these variables are coincident which is typically

produced by high surface dry-bulb temperatures. These results support previous claims that updraft width scales with cloud base height, indicating storms with high cloud bases have broad updrafts less prone to entrainment and dilution of buoyancy. This is the same result found in a study of the tropics with different data and provides evidence for the robustness of these relationships. Lightning is strongly linked to vertical air motions so lightning can be used to diagnose vertical motions. This study can then be thought of as an investigation of environmental effects on vertical motions.

Equatorial Geophysical Research Laboratory, Indian Institute of Geomagnetism, India

The Indian Institute of Geomagnetism (IIG), Mumbai is a leading institute of the country, actively engaged in basic and applied research in Geomagnetism and allied areas of Geophysics, Atmospheric and Space Physics. Indian scientists got the unique opportunity to study the near Earth environment during a long Annular Solar Eclipse (ASE) at the end of the last long deep solar minimum, on 15 January 2010. Continuous high time resolution records of the atmospheric electric parameters and meteorological parameters were made at Tirunelveli (8.70°N, 77.80°E, 35 m AMSL) and Braemore Hill (8.41°N, 76.59°E, 460 m AMSL) stations where the eclipse was during

11:07:57-15:06:52 IST with maximum obscuration (~90%) at 13:17:09 IST. The recorded values of the parameters show marked deviations from those normally observed on control fair-weather days. The ambient electric field underwent a large drop by up to 65% during the eclipse, and potential gradient showed epochs of enhancements during and after the eclipse until post-sunset. The data also seem to reveal the long lasting paradox of conductivity enhancement during eclipse, which may be due to the eclipse induced upsurge of low winds or waves that brings high density of free space charges embedded in air parcels.

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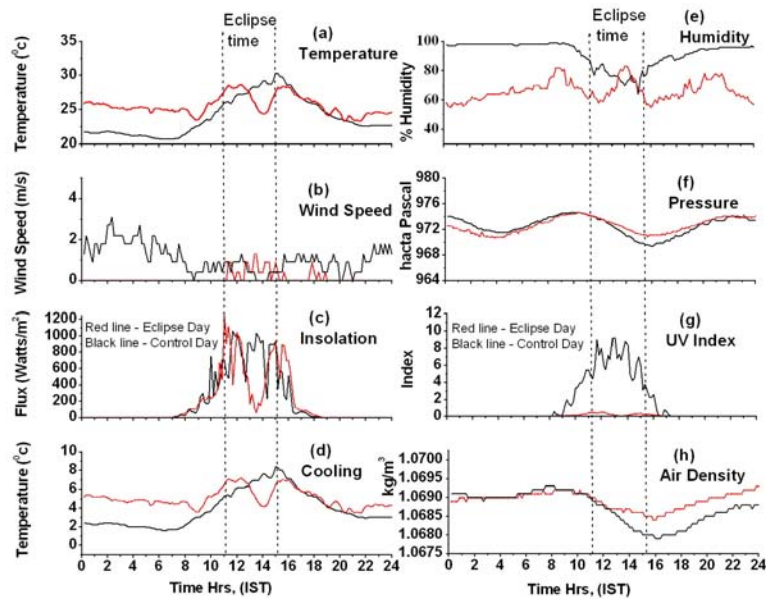


Figure 1. Red curves in the panels show the surface temperature (a), wind speed (b), insolation (c), rate of cooling (d), humidity (e), air pressure (f), UV flux (g) and air density (h) measured on the solar eclipse day on 15 January 2010; vertical dotted lines show the eclipse window. Black curves show the corresponding parameters on control days.

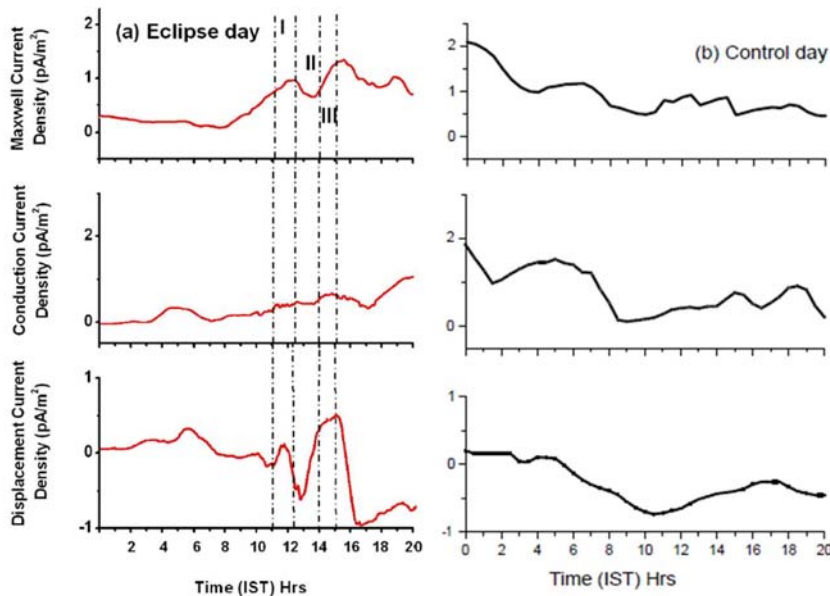


Figure 2. (a) Tracings of the original digital records of atmospheric currents during the solar eclipse on 15 January, 2010; top panel - Maxwell current (or total current), middle panel - conduction current, and bottom panel - displacement current. Stages I, II and III illustrate the durations from first contact to annularity, 2nd contact to 3rd contact, and 4th contact to the end of the eclipse. At Tirunelveli eclipse started at 11:07:57 IST (05:37:57 UT), annularity was for about 8.5 minutes during 13:17:02-13:25:28 IST with maximum at 13:17:09 IST, and eclipse ended at 15:06:52 IST (09:36:52 UT); (b) Similar to (a) but for control days.

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MIT Parsons Laboratory- Massachusetts Institute of Technology

Now that several long-term records of the Earth's Schumann resonances are available (Arrival Heights and Vernadsky in Antarctica, Nagycentk in Hungary, and Rhode Island, USA) efforts continue to understand the variations in the modal frequency and intensity that are linked with changes in the ionosphere, induced by variations of energetic particles and radiation over the 11 year solar cycle, and on shorter time scales as well. Collaborators in this effort are Anirban Guha in India, Robert Boldi in the UAE, Gabriella Satori in Hungary, Alexander Koloskov and Yuri Yampolski in the Ukraine, and Pascal Ortega in Tahiti.

The Antarctica records show evidence for a substantial lowering of the effective ionospheric height in polar regions near solar maximum. The so-called auroral power, measured by polar-orbiting satellites, also follows the solar cycle but the physical origin of this inferred height change remains puzzling. Solar protons appear to be too sporadic to explain this sustained change despite evidence for this behavior on much shorter time scales in other studies. Energetic electrons following the magnetic field lines and more steady

in time may not achieve sufficient energy to modify the height. Solar X-radiation, also varying in phase with the solar cycle, is not expected to ionize deeply in polar regions because of the oblique incidence there in their origin from the Sun.

Dr. Haiyan Yu arrived at MIT in March from the Harbin Institute of Technology in China. Interested in both electromagnetic methods for earthquake prediction and the global lightning activity, she is pursuing a Green's function approach and the 2D transmission line method toward understanding both ionospheric perturbations and the variability of global lightning.

Continued interaction with the ISUAL satellite group in Taiwan has been concerned with the possible detection of solar cycle variations in elves and the D-region heights at which they occur. Ongoing discussions with Joanne Wu, who will visit MIT beginning this summer for part of her PhD thesis, have raised questions about the stability of the airglow layer (to which elves appear to be 'glued') over the solar cycle.

ONERA Plasma and Lightning Physics Research Group

Philippe Lalande (philippe.lalande@onera.fr)

Modern fast video camera provides detailed observations of the propagation of positive and negative lightning leaders. A field experiment devoted to observation of lightning activity over Paris city, has been realized by Magalie Buguet (magalie.buguet@onera.fr) and Patrice Blanchet

(patrice.blanchet@onera.fr). 191 Positive and negative lightning flashes have been observed during the summer season 2013. Positions of return stroke at ground are indicated by the French NLDN run by Meteorage (sp@meteorage.com). Stepping process of negative leaders has been

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observed and velocity of positive and negative leader has been evaluated.

ONERA was also involved in the HAIC/HIWC International field campaign (High Altitude Ice crystals/ High Ice Water Content) www.haic.eu. This campaign, which was supported by Europe, North America and Australia, was conducted in the frame of a large-scale integrated project which aims at enhancing aircraft safety when flying in mixed phase and solid icing conditions. The HAIC Consortium brings together 34 partners from 11 European countries and 5 partners from Australia, Canada and the United States. This first HAIC/HIWC campaign, organized in Darwin Australia, was devoted to observation of microphysical and electrical properties of deep convective clouds and of cirrus cloud generated by storms. The SAFIRE (INSU)

instrumented Falcon 20 aircraft was flown nearby and inside cirrus cloud: a part of the ice crystal PMS measurement was conducted by LAMP, onboard weather radar RASTA was installed and run by LATMOS (alain.protat@latmos.ipsl.fr); Onera realized measurements with a 6 sensors ABFM network. Data analyses will focus on the relation between the properties of ice crystals, the ambient atmospheric electric field and the electrical potential of the aircraft.

A campaign of atmospheric electrical field measurement over sea was realized by Philippe Lalande and Patrice Blanchet during fall 2013 and winter 2014. A buoy, instrumented with 2 field mills, was anchored 20 km offshore in the Atlantic Ocean. Atmospheric field value exceeding 30 kV m^{-1} was observed under weakly convective clouds.



Downward CG negative stepped leader June 17 2013 7:33:57.110 GMT

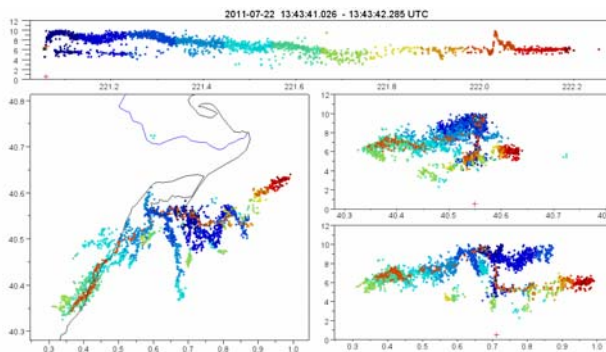
The Universitat Politecnica de Catalunya group (UPC, Barcelona, Spain)

Van der Velde, O. A., and J. Montanyà authored a paper titled “Asymmetries in bidirectional leader development of lightning flashes”. We have summarized the characteristics of bidirectional

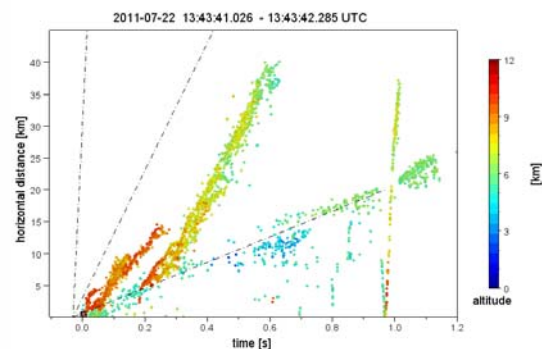
leader development of various lightning flashes registered by the Ebro 3-D Lightning Mapping Array at the east coast of Spain, supplemented by high-speed camera records. In order to follow the

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horizontal development of positive and negative leaders over time, a time-distance-altitude graph was designed, using the flash origin or a cloud-to-ground stroke as reference. The examples confirm that negative and positive leaders propagate at characteristic horizontal speeds (10^5 and $2 \cdot 10^4 \text{ ms}^{-1}$). The positive leader's low apparent speed corresponds to the phase when recoil processes are active. Very fast negative leaders (up to $8 \cdot 10^5 \text{ ms}^{-1}$) are detected in association with positive cloud-to-ground strokes. Negative leaders respawn repeatedly from the



origin or as a retrograde negative leader at the positive branch. Positive leaders remain propagating throughout the flash or until reaching ground. We show that the velocity difference shifts the potential of the leader, increasing the gradient with cloud charge at the positive end while reducing it at the negative end. The positive section lowers its potential through retrograde negative leaders, eventually making it possible to emit a new negative leader into the upper positive potential well.



Montanyà, J., O. van der Velde, and E. R. Williams authored a paper titled “Lightning discharges produced by wind turbines”. In the paper, new observations with a 3-D Lightning Mapping Array and high-speed video are presented and discussed. The first set of observations shows that under certain thunderstorm conditions, wind turbine blades can produce electric discharges at regular intervals of ~ 3 s in relation to its rotation, over periods of time that range from a few minutes up to hours. This periodic effect has not been observed in static towers indicating that the effect of rotation is playing a critical role. The repeated discharges can occur tens of kilometers away from electrically active thunderstorm areas and may or may not precede a fully developed upward lightning discharge from the turbine. Similar to rockets used for triggering lightning, the fast movement of the

blade tip plays an important role on the initiation of the discharge. The movement of the rotor blades allows the tip to “runaway” from the generated corona charge. The second observation is an uncommon upward/downward flash triggered by a wind turbine. In that flash, a negative upward leader was initiated from a wind turbine without preceding lightning activity. The flash produced a negative cloud-to-ground stroke

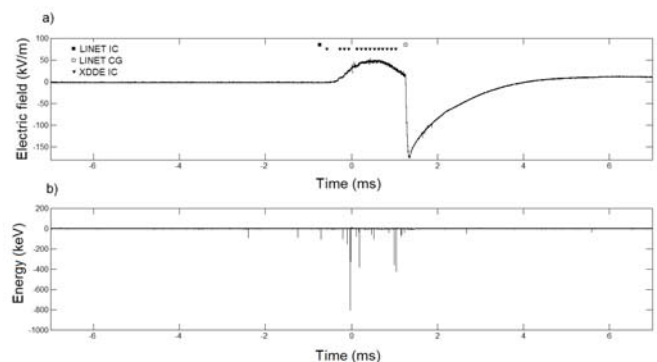


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several kilometers from the initiation point. The third observation corresponds to a high-speed video record showing simultaneous upward positive leaders from a group of wind turbines triggered by a preceding intracloud flash. The fact that multiple leaders develop simultaneously indicates a poor shielding effect among them. All these observations provide some special features on the initiation of lightning by nonstatic and complex tall structures.

Montanyà, J., F. Fabró, O. van der Velde, D. Romero, G. Solà, J. R. Hermoso, S. Soula, E. R. Williams, and N. Pineda (2014) authored a paper titled “Registration of X-rays at 2500 m altitude in association with lightning flashes and thunderstorms”. Electric fields and high-energy radiation of natural lightning measured at close range from a mountain top tower are discussed. In none of the 12 negative cloud-to-ground upward flashes were X-rays observed. Also no energetic radiation was found in one negative upward leader at close range (20 m). In the first of two consecutive negative cloud-to-ground flashes, X-rays were detected during the last ~ 1.75 ms of the leader. During the time of energetic radiation in the flash an intense burst of intracloud VHF sources was located by the interferometers. The X-ray production is attributed to the high electric field runaway electron mechanism during leader stepping. Even though the second flash struck closer than the previous one, no X-rays were detected. The absence of energetic radiation is attributed to being outside of the beam of X-ray photons from the leader tip or to the stepping process not allowing sufficiently intense electric fields ahead of the leader tip. High-speed video of downward negative leaders at the time when X-rays are commonly detected on the ground revealed the increase of speed and luminosity of the leader. Both phenomena allow higher electric fields at the leader front favoring energetic

radiation. Background radiation was also measured during thunderstorms. The count rate of a particular day is presented and discussed. The increases in the radiation count rate are more coincident with radar reflectivity levels above ~ 30 dBZ than with the total lightning activity close to the site. The increases of dose are attributed to radon daughter-ion precipitation.



Ongoing Research

- Observations of TLE from San Andrés (Colombia): During September 2013 we observed four gigantic jets. Results will be presented at the ICAE 2014 conference.
- Observations of TLE from Curaçao: At the beginning of May we set up a camera in Curaçao observing in the southwest direction over Lake Maracaibo and surrounding areas, including Catatumbo.
- Measurement of corona currents in vertical conductive long wires trailed by a kite under fair-weather. The project is carried out by two students: Roger Gutierrez (Aeronautics) and Pol Cirera (Electronics). The project is supervised by Earle Williams (MIT).
- Study of X-ray emission from long sparks in laboratory and RF emission. Some results will be presented at the ICAE 2014 conference.
- Study of all AGILE passes over South America and the meteorological and lightning conditions of those passes with and without TGF detected.

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- Analysis of 31 sprite-producing +CG flashes in the Ebro Lightning Mapping Array region. The study uses the time-distance-altitude projection to find the bidirectional origins of positive leaders to ground and negative leaders in the positive charge region. There is a large variation in negative and positive leader speeds. An interferometer system provided complementary data and appears to produce many detections during very fast negative leader expansion ($>4105 \text{ m s}^{-1}$). The study was submitted to JGR.
- Analysis of optically recorded leaders emerging from thundercloud tops. These 1-3 km protruding leaders occur often in cold airmass thunderstorms developing over the Mediterranean.



University of Florida (Gainesville, FL, USA)

Lightning experiments and observations will continue in Summer 2014 at Camp Blanding, Florida (for the 21st 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 4th 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 and Dr. Daohong Wang from Gifu University, Japan.

T. Ngin, M. A. Uman, J. D. Hill (now at Stinger Ghaffarian Technologies), J. Pilkey, W. R. Gamerota, D. M. Jordan, and R. C. Olsen III (now at Stinger Ghaffarian Technologies) authored a

paper titled “Measurement and analysis of ground-level electric fields and wire-base current during the rocket-and-wire lightning triggering process”. They presented ground-level electric field intensity and trigger-wire-base current measurements in Florida during 33 successful rocket-and-wire triggered lightning attempts, those which initiated a sustained upward leader, and 20 unsuccessful attempts. The electric field changes during wire ascent were measured at eight stations between 35 m and 208 m from the launch site while the electric fields produced by precursor discharges at the ascending wire tip were measured at 120 m and 220 m. Both relatively steady trigger wire currents in the milliamperere-range and fast precursor currents in the ampere to hundred-ampere range were measured at the wire base. A total of 2196 individual precursors were measured in 45 launches with negative charge overhead, with 0 to 225 precursors per launch and each precursor

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depositing 1 to 157 μC of charge at the wire tip. With negative charge overhead, slowly varying currents measured during the wire ascent increased to a maximum value between 3 mA and 10 mA. Positive line charge densities on the wire were inferred from both the wire-base current and the ground-level electric field reduction during wire ascent for 38 launches, ranging from 1 $\mu\text{C m}^{-1}$ near ground to about 100 $\mu\text{C m}^{-1}$ at 200 to 300 m aloft. Successful launches tend to have larger trigger wire line charge densities and larger precursor charge magnitudes, implying larger electric fields aloft. Three unsuccessful triggering attempts were made with positive charge overhead. The paper is published in the JGR - Atmospheres.

S. Mallick, V.A. Rakov, J.D. Hill, T. Ngin, W.R. Gamera, J.T. Pilkey, C.J. Biagi, D.M. Jordan, and M.A. Uman in collaboration with J.A. Cramer and A. Nag of Vaisala wrote a paper titled "Performance characteristics of the NLDN for return strokes and pulses superimposed on steady currents, based on rocket-triggered lightning data acquired in Florida in 2004–2012". The overall data set includes 78 flashes containing both the initial stage and leader/return-stroke sequences and 2 flashes composed of the initial stage only. In these 80 flashes, there are a total of 326 return

strokes (directly measured channel-base currents are available for 290 of them) and 173 kiloampere-scale (≥ 1 kA) superimposed pulses, including 58 initial continuous current pulses and 115 M components. All these events transported negative charge to the ground. The NLDN detected 245 return strokes and 9 superimposed pulses. The resultant NLDN flash detection efficiency is 94%, return-stroke detection efficiency is 75%, and detection efficiency for superimposed pulses is 5% for peak currents ≥ 1 kA and 32% for peak currents ≥ 5 kA. For return strokes, the median location error is 334 m and the median value of absolute peak current estimation error is 14%. The percentage of misclassified events is 4%, all of them being return strokes. The median value of absolute event-time mismatch (the difference in times at which the event is reported to occur by the NLDN and recorded at the lightning triggering facility) for return strokes is 2.8 μs . For two out of the nine superimposed pulses detected by the NLDN, they found optical evidence of a reilluminated branch (recoil leader) coming in contact with the existing grounded channel at an altitude of a few hundred meters above ground. The paper is published in the JGR - Atmospheres.

University of Toulouse (Toulouse, France)

In September 2013, a low-light video camera has been installed at the observatory of Maito (2200 m) in la Réunion by Serge Soula and Jean-Michel Martin (LA) with help from Laçy at the University of la Réunion. Thanks to a fast internet connection, the camera can be remotely controlled from

Toulouse. The camera is located at the Maito observatory in Indian Ocean (55.23E; 21.4S) which will allow TLE observations during the months of November to March, and possibly Gigantic Jets over tropical storms.

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The camera at Maido (2200 m) at sunset (left), its pan/tilt system (middle) and the first sprite captured on December 1st, 2013.

An observation made on August 16, 2013 could confirm the hypothesis that the existence of electron density irregularities in the mesosphere could favor the onset of sprites. In this case, it is a large electron density irregularity with a volume of about 5 km³ at an altitude of 80 to 85 km located above a large thunderstorm (200 km × 200 km) that developed above the Pyrénées mountain range. The analysis of all available information related to this case was conducted by Martin Füllekrug from the University of Bath (UK) and included Andrew Mezentsev and Adrian Evans from the University of Bath, Oscar van der Velde from the University of Terrassa, and Serge Soula from the University of Toulouse. During the event, at first a group of four sprite elements was observed after a positive CG stroke, by using a video camera located in Clermont-Ferrand (450 km to the north of the storm). These four simultaneous sprite elements were observed within 17 ms after the parent stroke. They had a very rapid development over a vertical distance of about 40 km. One element of the sprite was observed a few kilometers away from this group, but it was much less bright. This element then re-appeared in the form of a column with a delay of at least 40 ms and horizontally displaced by at least 15 km. The radiated electric field recorded in a wide range of low frequencies (1 Hz to 2 kHz) at several stations in France and England confirmed the correspondence between the positive lightning

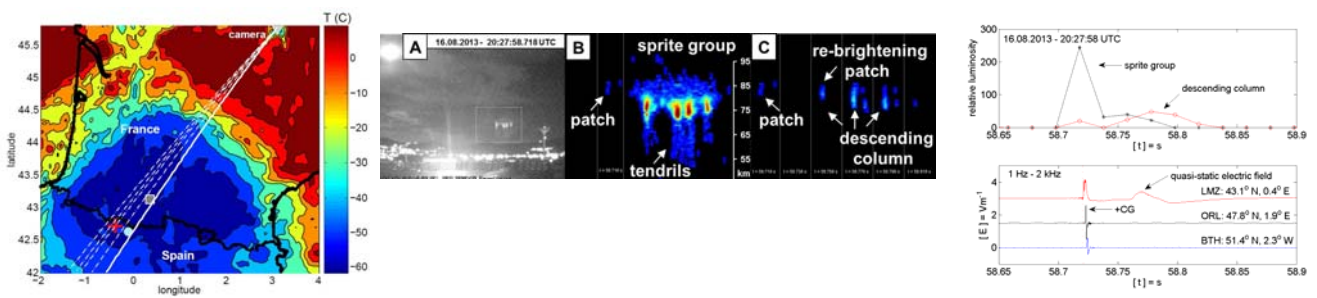
CG flash and the first group of sprites. For the illumination of the second sprite element, only the station located near the storm (80 km from the location of the positive lightning flash) recorded a signal in this frequency range. The first group of sprites is clearly due to the positive discharge and can be explained because the breakdown threshold of air at that altitude is reached under these conditions. The second progressive illumination is not associated with a positive discharge; it is possibly due to the existence of an environment with local conductive irregularity and subject to a strengthening of the quasi-static electric field produced by the gradual reorganization of residual charge within the cloud after the initial positive lightning flash.

During the SOP1 (Special Observation Period) of the HyMeX (Hydrology cycle in the Mediterranean eXperiment) campaign (September-November 2012), optical observations of sprite events were performed thanks to low light video cameras located in southern France. During the night of October 22nd – 23rd, a storm developed along the coastline in south-eastern France, moved westward while producing a moderate lightning activity for about 4 hours, with a maximum cloud to ground (CG) flash rate of about 2 min⁻¹. A study of this case of a sprite-producing storm (leading to a stratiform Mesoscale Convective System type storm) is conducted by Serge Soula from the University of

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Toulouse. Twelve sprite events were observed over this storm during the second half of its lifetime, while it was located in the area covered by a Lightning Mapping Array. The storm was located at a distance of 360 km and 230 km from camera 1 and camera 2, respectively. Each sprite event was associated with a positive CG stroke detected in the stratiform region, by the operational lightning detection network. The delay between the parent stroke and the sprite allows classifying the events within two categories, i.e., short delay ($\sim < 20$ ms) and long delay ($\sim > 20$ ms). Some of the sprite events were recorded by

two cameras and can be triangulated to determine a precise location of sprite elements. Observations of broadband ELF/VLF activity were performed during this storm. The 3D locations of the VHF sources allow describing leader paths and their correlation with the timing and the location of sprite elements. The location of the sprite elements coincide with the last VHF activity before the sprite occurrence, characterized by scattered sources within the stratiform region. These scattered sources are generally located remotely from the primary VHF source of the flash sequence.



Left: Configuration of the storm (cloud top temperature) and the TLE observation (lines of sight of the four sprite elements with dashed line and the sprite re-illumination with solid line) on August 16, 2013 in south-western France. Middle: Image from the video camera and spatial distribution of the luminosity at two stages of the phenomenon. Right: Evolution of the luminosity (upper graph) and radiated electric field (lower graph) detected at 80 km (red) at 1000 km roughly (blue) and at 600 km (black).

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