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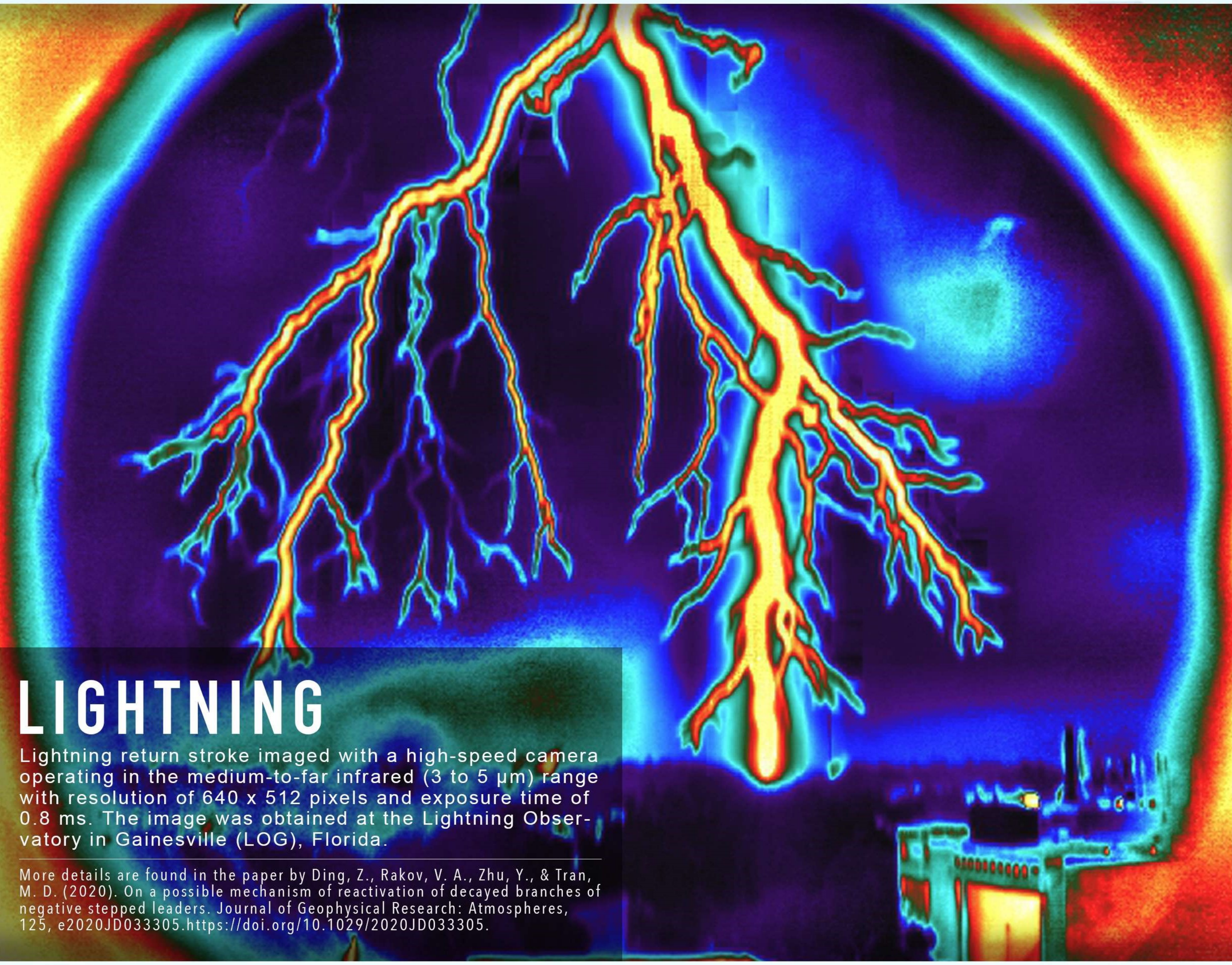

LIGHTNING

Lightning return stroke imaged with a high-speed camera operating in the medium-to-far infrared (3 to 5 μm) range with resolution of 640 x 512 pixels and exposure time of 0.8 ms. The image was obtained at the Lightning Observatory in Gainesville (LOG), Florida.

More details are found in the paper by Ding, Z., Rakov, V. A., Zhu, Y., & Tran, M. D. (2020). On a possible mechanism of reactivation of decayed branches of negative stepped leaders. Journal of Geophysical Research: Atmospheres, 125, e2020JD033305.https://doi.org/10.1029/2020JD033305.

INTERNATIONAL COMMISSION ON
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Save the date for ICAE 2022

Save the Date!!

ICAE 2022 Tel Aviv, Israel
18-24 June 2022

LOC: Colin Price and Yoav Yair

The Legacy of Irving Langmuir (1881-1957)

Earle Williams, MIT

Irving Langmuir won the Nobel Prize in Chemistry in 1932. As a leading proponent of weather modification and as a mentor to Bernard Vonnegut, Vincent Schaefer, and Duncan Blanchard at the General Electric Company in the 1940s, Langmuir had a pervasive influence on the study of atmospheric electricity. The magical substance "Ice Nine" in Kurt Vonnegut's novel "Cat's Cradle" is a product of the Vonnegut interaction with Langmuir at GE. The Langmuir Laboratory for atmospheric research in the Magdalena Mountains of New Mexico was named after him. Langmuir's grandson, Roger Summerhayes (now 64), produced an excellent, award-winning tribute to his grandfather in "Langmuir's World" in 1998, in which he conducts personal interviews with the Vonnegut brothers, Vince Schaefer, and Dunc Blanchard at the Langmuir cottage on Crown Island in Lake George, New York. This interesting work has largely escaped the attention of much of the atmospheric electricity community, but fortunately DVD copies of "Langmuir's World" can be obtained directly from Roger Summerhayes at rrsummerhayes@gmail.com or through Amazon.

*N*ew AGU Fellows

Hugh Christian and George Parks were elected to be Fellows of the American Geophysical Union on November 18.

The Citation for Hugh's award: *For pioneering space-based lightning mapping instruments and advancing knowledge of atmospheric and space electricity.*
The Citation for George's award: *For breakthrough discoveries in diverse areas spanning space plasma physics from its very beginning, atmospheric electricity, and solar physics.*

Congratulations to the new Fellows!

*N*ew Book

Below is a link to the just published book titled "Lightning-Induced Effects in Electrical and Telecommunication Systems":

https://shop.theiet.org/lightning-induced-effects-in-electrical-and-telecommunication-systems.

The book is written by Dr. Yoshihiro Baba of Doshisha University, Japan, and V.A. Rakov. The bibliographical description is as follows:
"Lightning-Induced Effects in Electrical and Telecommunication Systems", IET, ISBN-13: 978-1-78561-353-1, 264 p., 2020, Y. Baba and V.A. Rakov.

*v*EGU2021 General Assembly

On behalf of the co-conveners of session NH1.6: "Atmospheric Electricity, Thunderstorms, Lightning and their effect", I would like to extend a warm invitation to submit an abstract to our session in the vEGU2021 General Assembly. The meeting will be fully virtual this year, as explained here: https://egu21.eu/ and will take place on-line between 19-20 April 2021. Please submit your abstract here: https://meetingorganizer.copernicus.org/EGU21/sessionprogramme#NH1 and choose NH1.6. The session description details the background and the topics for the 2021 session.

The deadline for submission is January 13th 2021 at 13:00 Central European Time.

I would like to wish you all good health and please stay safe!

Looking forward to meeting online in spring, for a great session.

Best regards,
Yoav Yair

Special Issue "Atmospheric Electricity" of MDPI Atmosphere (ISSN 2073-4433)

Guest Editors: Prof. Dr. Masashi Kamogawa and Prof. Dr. Yoav Yair.

A Special Issue on atmospheric electricity of MDPI Atmosphere is open to the multi-disciplinary and various studies from a conventional research field such as global electric circuit, lightning physics, aerosol and cloud microphysics, and thunderstorm electrification, to a modern research field such as lightning/thunderstorm-generated energetic radiation, transient luminous events, and the evolution of the Earth's climate.

We welcome contributions of various article types such as original research and reviews.

https://www.mdpi.com/journal/atmosphere/special_issues/atmospheric_electricity
Deadline for manuscript submissions: 30 June 2021.

Special Issue "History of Geo- and Space Sciences"

The open access journal History of Geo- and Space Sciences has a special issue about atmospheric electrical observatories edited by Dr Karen Aplin, available here:

https://hgss.copernicus.org/articles/special_issue1042.html.

Congratulations to the Hungarian team for preparing the first paper. Submissions both to the special issue and to the ongoing compilation of historical observations (see link in the introductory article) are welcomed! The issue will remain open indefinitely.

Update on the International Space Station Lightning Imaging Sensor (ISS LIS)

Timothy Lang (timothy.j.lang@nasa.gov) and Dennis Buechler

ISS LIS has been operating on orbit for more than 3.5 years, and has received recent approval from NASA to operate through at least the end of US Fiscal Year (FY) 2023 (30 September 2023). The instrument is in good health, and results from the first three years of observations have been recently published in Blakeslee et al. (2020). The global climatology of lightning from ISS LIS (Figure 1) is consistent with past studies, but also extends the long-term Tropical Rainfall Measuring Mission (TRMM) LIS climatology to +/- 55° latitude. This enables new observations of notable mid-latitude lightning hotspots such as the northern US Great Plains, mountainous regions of Europe, and northern China (Manchuria).

Near-realtime and post-processed ISS LIS data are available from the Global Hydrology Resource Center (GHRC; https://ghrc.nsstc.nasa.gov/lightning/data/data_lis_iss.html). Current research is focused on exploiting scientific synergies enabled by combining ISS LIS observations with other existing Earth science missions, such as Global Precipitation Measurement (GPM), Geostationary Lightning Mapper (GLM), Geostationary Environment Monitoring Spectrometer (GEMS), and the Atmosphere-Space Interactions Monitor (ASIM). ISS LIS is also being used to support development of future missions, such as Meteosat Third Generation Lightning Imager (MTG-LI) and Aerosol, Clouds, Convection and Precipitation (ACCP).

ISS LIS is part of the 5th US Department of Defense (DoD) Space Test Program Houston mission (STP-H5). Within the next 1-2 years, STP-H5 (with ISS LIS) will be relocated on the ISS to accommodate another Earth science instrument. STP-H5 and ISS LIS are then scheduled to be permanently displaced from the new site (and their mission subsequently ended) after FY23. The ISS LIS team, led by Dr. Timothy Lang of NASA Marshall Space Flight Center (who assumed the role in early 2020 after the retirement of Dr. Rich Blakeslee) is working with STP to identify another available ISS site for potential operations past FY23.

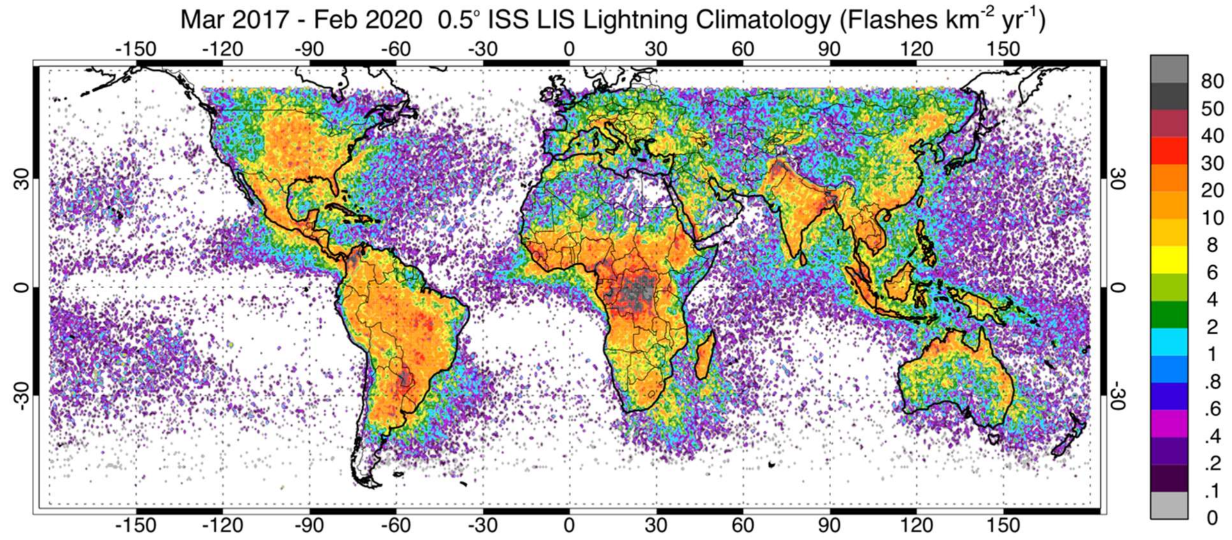

Figure 1. Three-year global climatology of lightning from ISS LIS.

The Atmospheric Electricity Research & Training (AERT) group at the University of Maryland employs tools developed by the science community to maximize the value of AE observations to society. A priority activity is the design and implementation of training material/programs to educate weather forecasters across the Americas on the use of space/ground-based lightning observations. Advancement of techniques to monitor the quality of data from the Geostationary Lightning Mapper (GLM) are ongoing.

The group manages the Mid-Atlantic Lightning Mapping Array (MALMA), a state-of-the-art VHF network used for research and operational product generation/validation. Explorative research is being conducted on the topics of multi-sensor data fusion, use of machine learning for enhanced data quality, data assimilation, and virtual reality data visualization. Resources provided by the Proving Ground and Training Center (PGTC) at the Cooperative Institute for Satellite Earth System Studies (CISESS) College Park facility enable synergy of AERT activities with broad atmospheric science research-to-operations activities in coordination with NOAA/NESDIS, NASA, and private vendors. https://lightning.umd.edu/glm/

Currently, the group includes 6 scientists, 2 technical staffs, and 3 undergraduate interns.

Scott Rudlosky - GLM science team lead working to validate GLM products and promote their operational application. https://twitter.com/goesglm

Mason Quick - MALMA management, instrument performance analysis, lightning physics research. https://cisess.umd.edu/meet-our-scientists/mason-quick/

Daile Zhang – GLM and LIS evaluation, validation and application. https://twitter.com/nesecond

Jonathan Smith - Liaison between GLM gridded product liaison research and National Weather Service forecasters. https://twitter.com/j_wynn_smith

Feng Zhang - On lightning data assimilation by using a virtual dataset created from GLM products and other lightning observations. https://cisess.umd.edu/meet-our-scientists/feng-zhang/

Joseph Patton - Developed training materials for the GLM for operational meteorologists. https://twitter.com/JosephPattonWx

Idris Akala - Developed a query website to ease access to GLM information and promote broader use.

Ayyub Abdulrezak - Developed new data processing and visualization tools to help access the value of GLM observations.

Jason Chen - Visualized MALMA data and built a website to provide access to real-time and archived imagery.

Contact: Daile Zhang (dlzhang@umd.edu)

DAVID EDWIN PROCTOR B.Sc(Eng), PhD
(1932 – 2020)

Dr David Proctor died in Johannesburg on 26th September 2020 of complications following surgery. He was 88. He had spent his career at the National Institute for Telecommunications Research (NITR) of the CSIR based, initially, on the campus of the University of the Witwatersrand ("Wits"), in Johannesburg and then at the former Observatory site in the city. Born in Johannesburg and educated at Kearsney College, a private boarding school near Durban, the young Proctor moved around the country, depending on where his father, a Methodist minister, happened to be serving at the time.

After leaving school David Proctor's interest in radio and electronics led him to work as a technician at the NITR but it was clear that he had the academic ability to attend university. However, money was tight. Fortunately, the Faculty of Engineering at Wits had the foresight to set up a part-time process by which ex-servicemen, returning from the war, were able to complete their degrees over six years. And so, after spreading the first two years of the degree over four, while continuing to work at the NITR, he graduated with a degree in electrical engineering in 1962 and immediately became a research officer at the NITR.

In 1967, at the instigation of the NITR Director Dr Frank Hewitt, who had detected UHF emissions from lightning during his own research in the early 1950s, Proctor established a new research programme with the purpose of measuring and characterising such radio emissions that occur during lightning activity. In doing this he was following in the footsteps of Basil Schonland and D. J. Malan who had made fundamentally important discoveries in the field of lightning research when based at the Bernard Price Institute of Geophysical Research at Wits many years before. Proctor's dedicated and almost single-handed research programme was to become his life's work and over the following thirty and more years he established himself as one of the leading authorities in the world in the field of lightning investigation using both radio and radar techniques.

The test site was situated north of Johannesburg at Nietgedacht. It consisted of two intersecting baselines, roughly 30 and 40 km long, at the ends of which were situated VHF (253 MHz) radio receivers with an additional one at their point of intersection. The network's purpose was to receive the sferics (lightning-induced radio noise) produced by the lightning stroke processes and from them to determine the position and other features of the emitting sources in three dimensions. The fifth receiver provided redundancy to confirm the adequacy of the locating system. Proctor pioneered this intermediate baseline, time-of-arrival (TOA) technique, which included dedicated microwave links to feed the data directly from each receiver to the "home" station at the intersection of the two baselines. Subsequently, for operational reasons, the observing frequency was moved up to UHF (355 MHz). The accuracy of the method depended on knowing the positions of the five radio receivers very precisely and for this purpose Proctor used a Tellurometer, the microwave distance-measuring instrument invented by Dr Trevor Wadley, also at the NITR, to fix those positions to within 10 cm.

The radio receivers, as well as most of the ancillary equipment, were designed and even constructed by David Proctor himself. In doing this he displayed his prodigious talent as an electronics engineer who was also more than a little handy with a soldering iron. At the home station, the output of each channel was displayed on two cathode ray tubes (CRTs) that operated alternately to accommodate the "flyback" at the end of each horizontal sweep. All the screens were photographed by two rotating drum cameras on a common shaft. Accurate timing was provided by a 1 MHz crystal-controlled clock. Thus, twelve CRTs were involved, two of which were spares. As Proctor rather laconically remarked many years later, "Even those who enjoy reading records that can be deciphered easily, found that reading the more complicated variety was a mild form of torture …". He estimated that it took about one man-month's effort to locate 100 sources accurately.

A measure of the value of any research is its publication in the international scientific literature. Proctor published his first paper in the U.S. *Journal of Geophysical Research* in 1971. It was not to be his last. Between 1971 and 1997 he published twelve papers, all involving detailed analysis of the results obtained from that time-of-arrival network as well as from the radar system that augmented it. The radar experiments followed on from the work of Hewitt when Proctor, in the mid-1970s, pressed into service three synchronised radar transmitters, their respective receivers and their associated antennas that operated on wavelengths of 5.5, 50 and

111 cm. Their purpose was to locate the source of lightning and to measure how its properties changed according to the probing radar wavelengths. In addition, two other radars, operating at very much shorter wavelengths of 3 and 5.5 cm, were also used. On purely theoretical grounds the longer wavelength radars were expected to receive reflections from the lightning strokes which were invisible at the very much shorter wavelengths. This proved to be the case and it confirmed that intervening precipitation was shielding the lightning emissions at that shortest wavelength. Of particular interest were the estimates Proctor was able to make of a parameter called the radar cross-section of the lightning stroke. He concluded that the radar echoes received were caused by many reflectors distributed throughout the volume of a cloud. This work, along with that carried out in New Mexico at about the same time, is regarded as the most thorough conducted to date.

In 1986 the CSIR experienced a convulsion - and an ensuing crisis - when it was decided that all its research had to have some definable commercial objective and, even more alarmingly, that it had to be self-funding. Pure science, whose applications were undefined - and in many justifiable cases was impossible to define in those terms - was essentially doomed. As a result, the NITR ceased to exist and David Proctor was summarily transferred to a unit carrying the uninformative title of EMATEK ("Division of Earth, Marine and Atmospheric Science and Technology"; there, his project was Integrated into the "Programme for Atmospheric Processes and Management Advice", together with the radar engineer Merry Hodson, also of NITR and involved with rainfall quantification, as well as the radar meteorology group under Gerhard Held, responsible for a triple Doppler radar system which was abandoned at the beginning of 1991; signalling the premature end of these valuable research projects !) where he soon saw his research come to a precipitate end. However, he managed to persuade the Water Research Commission to support him and his miniscule team in a project with the objective of determining how lightning was related to precipitation while also considering lightning phenomena in their own right. In the subsequent internal CSIR report that was never published in the scientific literature because Proctor himself was required to bear the costs of publication, he was able to show, from the 773 lightning flashes measured with his TOA network, that lightning exhibited peaks of activity at two altitudes, nominally 5.3 and 9.2 km above sea-level, but with their characteristics being markedly different. In addition, his radar network mapped 658 flashes and from those results it emerged that lightning begins in regions with the highest electrical charge which is where the smallest raindrops were to be found. It was intended that an aircraft be used to fly into those parts of a cloud where lightning flashes begin in order to discover what characteristics were peculiar to that relatively small region. Though Proctor designed the necessary equipment to do this, the six flights that were undertaken all took place on days when there were no storms! Since the aircraft was not dedicated to this project other more pressing needs always took priority when, as luck would have it, suitable meteorological conditions were just waiting to be exploited. In his closing comments to that 1993 report to the Water Research Commission, Proctor paid particular tribute to his technician, Dick Uytenbogaardt, "for his wisdom and for many hours of diligent and intelligent labour".

Whilst out in the scientific wilderness Proctor received an invitation to contribute to a book called "Handbook of Atmospheric Electrodynamics" which was published in 1995. He wrote the chapter entitled *Radio noise above 300 kHz due to natural causes*.

He was awarded the PhD degree from Wits in 1977 based on a thesis entitled "A radio study of lightning". His last two papers were published in the *Journal of Geophysical Research* in 1997. In one, he collaborated with four U.S.- based authors in comparing time-of-arrival techniques with another powerful method that used an instrument known as an interferometer to determine the features of lightning. It transpired that the two methods mapped two distinctly different aspects of the complex lightning stroke process and so were complementary. Thus, as is so often the case in scientific research, new avenues immediately opened up for exploration. Both papers bore Proctor's home address of Honeydew, South Africa, because his lifelong affiliation with the CSIR had, by then, come to an end. He had retired in 1992 while his two colleagues, who had assisted him for so long, had been retrenched by the CSIR the year before.

David Proctor was an extremely nice man. As is so often the case with people who don't set out to beat their own drum, his remarkable achievements in the fields of radio science and geophysics went unsung almost everywhere except in the closest confines of the NITR and among those scientists around the world whose fields of research overlapped with his. Within the wider South African community, including both the CSIR and, sadly, even at his *alma mater,* his contributions to our understanding of the mechanisms of lightning were, essentially, unacknowledged despite the prestige which his research had brought to South Africa and to its institutions.

David Proctor married Judy Stone in 1963. They had four sons, all engineers.

--Dr B.A. Austin 26.11.2020

(first published by the South African Institute of Electrical Engineers)

ZHENGCAI FU Ph.D., PROFESSOR
(1965 – 2020)

Prof. Zhengcai Fu died in Shanghai on Aug. 18th, 2020. He was born in July 1965, Quzhou, Zhejiang Province, China and passed away at the age of 55. Educated at Shanghai Jiao Tong University (SJTU), one of the China's oldest universities with a world-renowned reputation, he had a career as a professor of electrical engineering in SJTU. Prof. Fu is a respected scientist focusing in the high voltage engineering and lightning protection. Fu married Hongmei Cao in 1995. They had one daughter, studying in Massachusetts Institute of Technology (MIT).

In memory of Prof. Zhengcai Fu

It is with deep regret and profound sadness that we received the news of passing away of Zhengcai Fu, Ph.D., professor of electrical engineering in Shanghai Jiao Tong University, on Aug. 18th, 2020. He was born in July 1965.

Prof. Fu is a respected scientist in the high voltage engineering and lightning protection. He served the lightning community for more than 20 years and has made an indelible contribution to the advancement of the high voltage technology. He organized the 32nd International Conference on Lightning Protection (ICLP 2014) as a co-president, also worked as a Steering Committee member in the Asia-Pacific International Conference on Lightning Protection (APL) since 2016. The field of high voltage testing and lightning protection has recognized the outstanding contributions from Prof. Fu.

Prof. Fu was a thoughtful and just person glad to help others. Many young scientists in the lightning community benefited from his generous advices. He was a dependable friend, a person you can truly trusted and would share everything he knew. He was a nice friend, a person who always held a positive attitude to life and brings happy memories to friends.

The best blessings to Prof. Fu and his family. Rest in Peace our Dear Friend Prof. Fu.

A nice memory from ICLP 2014 with Dr. Lian Duan, Prof. Rachidi, Prof. Zhengcai Fu and Prof. Jinliang He.

Prof. Zhengcai Fu co-chaired the ICLP 2014 in Shanghai

--Prof. Jinliang He, Dr. Gerhard Diendorfer, Prof. Carlo Alberto Nucci, Prof. Vernon Cooray and rest of the ICLP scientific committee.

Remembering Prof. Zhengcai Fu

I am deeply saddened by the news in August 2020 from Dr. Yakun Liu that Prof. Zhengcai Fu has died, and would like to share my profound condolences. I twice had opportunity to interact closely with Prof. Fu, once in Portugal at a conference on lightning protection, and then later in Weihai, China where he joined Prof. Hai Yan Yu (a scientist at Harbin Institute of Technology) and me for breakfast at my hotel to address issues pertaining to the measurement of the Earth's Schumann resonances, and the possibility to find sites in China suitable for this purpose. He was always very positive and supportive on this issue. I know from my long-standing interaction with his graduate student Yakun Liu that he was involved with many interesting and valuable projects in high voltage engineering and lightning protection, and his expertise will be greatly missed by many others with whom he has interacted. His generous “loan” of Yakun to MIT enabled valuable work on in the instability of arc channels in air that has now continued in Shanghai. Prof. Fu’s death at such an early age makes this event much more difficult to accept, and I wish his family and colleagues all the strength needed to overcome this loss.

--Earle Williams, MIT

In Memoriam of Prof. Zhengcai Fu

It is with great sadness that I was informed about the demise of our good friend and colleague Professor Zhengcai Fu of Shanghai Jiaotong University.

I had the privilege of knowing personally Zhengcai from about 2012. At that time, we started to work closely together on the organization of the 2014 edition of the ICLP in Shanghai. This was the second time ICLP was organized in Asia, and the first time in China. Zhengcai did an outstanding job as Chairperson with another friend and colleague, Prof. Jinliang He. Their leadership and dedication made ICLP 2014 a great success with a record number of delegates.

Zhengcai was one of the top world scientists in the field of high voltage testing, insulation coordination and lightning protection. I personally had the opportunity of visiting him and his laboratory in Shanghai and get familiar with his outstanding research activities.

Zhengcai was also a very good friend, a person you could always rely on. He was personable, extremely kind and generous. I have very fond memories of the time spent with him.

Zhengcai’s early passing away is certainly a great loss for the high voltage and lightning protection community.

I would like to express my deepest sympathy to his grieving family and my heartfelt condolences to all the members of his group, his colleagues, and all his friends.

A nice memory from ICLP 2014 in Shanghai with the late Prof. Zhengcai Fu and Prof. Jinliang He.

--Farhad Rachidi, Swiss Federal Institute of Technology

In memory of Prof. Zhengcai Fu

I was deeply saddened to learn of the passing of Prof. Zhengcai Fu, a long-time friend. I first met Zhengcai back in 1994 at the 22th International Conference on Lightning Protection (ICLP), which was held in Budapest, Hungary. At that conference since only two of us were from China, it was quite natural we got known each other. Back then, not only because both of us were students, but Budapest's trip was our first time to visit a western country, I remembered we walked a lot around the city and enjoyed the trip very much. Since then we have maintained our friendship for 26 years, though mostly privately for our research interests are quite different (his research interest is in the engineering part of lightning and my research interest is in the observation or physics part of lightning). Zhengcai was a very kind person. Each time when I visited Shanghai, he would ask me what help he can do for me. He guided me at least twice to tour his high voltage laboratory in Shanghai Jiaotong University. Once, nearly 20 years ago, he show me every high voltage facility of his lab, and I was particularly astonished by his lab's spatial scale. Another time, in 2014 after the 32th ICLP co-chaired by him in Shanghai, he showed me a very powerful pulse generator developed by him. Zhengcai was very talkative. From his talking, I know he felt very proud of the pulse generator developed by him. I also benefited through several discussions with him. One such discussion happened in 2015, at a small workshop on lightning organized by me in our university. At the workshop, I claimed that an upward return stroke wave from the meeting point of a downward leader and an upward connecting leader should already be the reflection wave of the attachment process, so when the downward return stroke wave reaches to the ground, there will not be additional reflection any more. He said there should be another reflection and we discussed a lot. Although I forgot his specific reasons, we did agree a direct measurement was needed. The last time I met him was at the 11th Asia-Pacific International Conference on Lightning in Hongkong in 2019. Given his young age, I never thought this would be our last meeting. I will miss Zhengcai, a generous and a gracious friend.

--Daohong Wang, Gifu University, Japan

In memory of Prof. Zhengcai Fu

I am very saddened by the news of Professor Zhengcai Fu passed away.

Professor Fu was a reference on lightning protection and high voltage technology. He was one of the few engineers able to understand the generation of very high currents to simulate lightning. I am proud to have had the opportunity to work with Dr. Yakun Liu and Professor Fu on a publication about high current tests to investigate lightning effects on conductors.

The contributions of Professor Zhengcai Fu will be a legacy for academy and industry.

My sympathies to Professor Fu family and all his collaborators.

--Joan Montanyà, Universitat Politècnica de Catalunya, Barcelona, SPAIN

African Centres for Lightning and Electromagnetics (ACLENet.org)

ACLENet continues to work with lightning safety advocates across Africa and Asia, participating in international virtual conferences on lightning protection, safety and injury prevention, attracting hundreds of attendees from dozens of countries across four continents. The next conference is planned for November 20-21 with the topic of research opportunities and funding primarily aimed at graduate students and other researchers.

ACLENet has investigated lightning mass casualty incidents at Mongoyo Primary School (three children killed, 72 injured, October 2018) and the deaths of ten boys at Arua (August 2020), Uganda, examining the scene, speaking with officials, witnesses, survivors, and their families and teachers to learn more about lightning injury in rural Africa. The findings will be submitted both to lightning and medical venues to give as much coverage as possible and promote lightning safety, injury prevention and victim care across Africa and other developing countries with similar incidents.

ACLENet's Lightning Protection Working Group (LPWG) continues to be active in designing lightning protection for schools in Uganda, addressing issues such as protection of thatched buildings and other scenarios not well addressed in most international standards. Many LPWG members serve on international standards committees, so we expect these issues will precipitate broadening of the standards to include threats common in developing countries. Members of the LPWG are:

Alexis Barwise, South Africa
Anna Candela Garolera, Denmark
Mary Ann Cooper, USA
Mitchel Guthrie, USA
Ronald Holle, USA
Steve Humeniuk, USA
Trevor Manas, South Africa
Mark Morgan, USA
Taufeeq Nsamba, Uganda
Kenneth Roets, South Africa
Simone Striani, Denmark
Scott Sweeney, USA
Isaac Tumuhimbise, Uganda
Richard Tushemereirwe, Ugand

Special Technical Advisory subcommittee
Hugh Hunt, Ian Jandrell, and Ken Nixon, University of Witwatersrand, South Africa
The LPWG is currently planning lightning protection for Mongoyo Primary School.

ACLENet maintains the most complete and extensive record of lightning injuries and property damage across Africa, currently reporting on 33 of the 55 African nations https://aclenet.org/news-publications/country-news/.

There is more news in The African Flash, ACLENet's monthly newsletter (see past issues at https://aclenet.org/news-publications/newsletters/). To subscribe, contact Dr. Mary Ann Cooper at macooper@uic.edu or subscribe at https://aclenet.org/news-publications/mailing-list.html.

*I*nstitute of Atmospheric Physics, Chinese Academy of Sciences (IAP, CAS), Beijing, China

Understanding the dynamical-microphysical-electrical processes associated with severe thunderstorms over the Beijing metropolitan region. The dynamical-microphysical-electrical processes in severe thunderstorms and lightning hazards (STORM973) conducted coordinated comprehensive field observations of thunderstorms in the Beijing metropolitan region (BMR) during the warm season from 2014 to 2018. The aim of the project was to understand how dynamical, microphysical and electrical processes interact in severe thunderstorms in the BMR, and how to assimilate lightning data in numerical weather prediction models to improve severe thunderstorm forecasts. The platforms used in the field campaign included the Beijing Lightning Network (BLNET), 2 X-band dual linear polarimetric Doppler radars, and 4 laser raindrop spectrometers and so on. A total of 220 thunderstorms passed BMR were documented, it was found that squall lines and multicell storms were the two major categories of severe thunderstorms in the central urban area. The connection between lightning activity and the thermodynamic and microphysical processes of the thunderstorms were explored, and lightning data were assimilated into numerical weather prediction models to help improve the forecasting at the cloud-resolved scale (Qie et al., 2020, Sci. China Earth Sci.).

A low frequency 3D lightning mapping network in north China. A 3D low-frequency lightning mapping network with eight stations is deployed in the SHAndong Triggering Lightning Experiment (SHATLE) in north China. The ABA (A, B double time base) data acquisition system based on first input first output memory is adopted. According to the error distribution obtained by Monte Carlo estimation, the horizontal location errors are <200 m in the coverage area of the network. The ground truth calibration based on six return strokes of a triggered lightning flash gives an average horizontal error of 104.9 m. The details of development of both the cloud-to-ground lightning flash and the intracloud lightning flash can be clearly mapped in the 3D location (Ma et al., 2021, AR).

Characteristical structures for the intermittent positive and negative leaders of triggered lightning. The intermittent propagation of upward positive and negative leaders in rocket-triggered lightning were identified based on comprehensive observations of fine time-resolved optical, current, and electromagnetic fields. For both leaders, an abrupt luminous crown blooming appears due to the achievement of a step, after which the channel weakens and the head degrades. During the positive leader pausing, residual structure is recognized at area of previous luminous crown blooming, in the form of a faintly floating segment. Our observation point to a possible mechanism that it connects with the positive leader head, causing a forward-step and a sharp current pulse. This is to some extent similar to negative leader stepping, in which the space leader emerges and connection between the space leader and the channel head occurs. The generation of clustered space leaders give rise to negative channel branching, but the residual structure in positive leader generally leads to individual step (Jiang et al., 2020, GRL).

A method to update model kinematic states by assimilating satellite-observed total lightning data to improve convective analysis and forecasting. Based on the relationships, a lightning DA scheme to update model kinematic states was implemented in the Weather Research and Forecasting Data Assimilation (WRFDA) three-dimensional variational (3DVar) system. This scheme combines total lightning observations with model-based prescribed vertical velocity profiles to retrieve kinematic information through a DA scheme. The space-borne total lightning observations from the Lightning Mapping Imager (LMI) were assimilated in combination with radar DA. The assimilation of LMI data provides added benefits to the assimilation of radar radial winds by reducing wind errors and strengthening convergence along the squall line in the analysis. Although the microphysical states are identical due to the assimilation of reflectivity, the lightning DA scheme helps in promoting updraft developments at lightning observation locations, which improves the representation of mixed-phase convection. The quantitative verification of short-term convective forecasts indicated that the lightning DA adds value to the radar DA by improving the precipitation forecast skill (Chen et al., 2020, JGR).

A triggered flash with two current polarity reversals. Characteristics of a triggered bipolar lightning flash obtained in SHATLE are analyzed. The flash lasts about 315 ms with only the initial continuous current (ICC). The polarity of charge transferred to the ground varies from negative to positive and then to negative. During the first negative ICC stage, the upward positive leader (UPL) initiated from the top of the wire. The UPL develops into the cloud and multiple positive branches develop in the form of small-scale recoil leaders. Then a negative leader (NL) initiates on a previously ionized positive branch and develops into the virgin air horizontally as a floating channel. After the NL develops, a negative pulse is detected in the fast electric field change, caused by a negative-polarity breakdown discharge from the grounding trunk channel to the floating channel. Then the polarity of the channel-base current changes from negative to positive. Subsequently, with the positive ICC decreasing, the negative leader gradually terminates, and then the polarity of channel-base current slowly changes to negative (Figure 1). (Tang et al., 2020, Acta Phys., in Chinese)

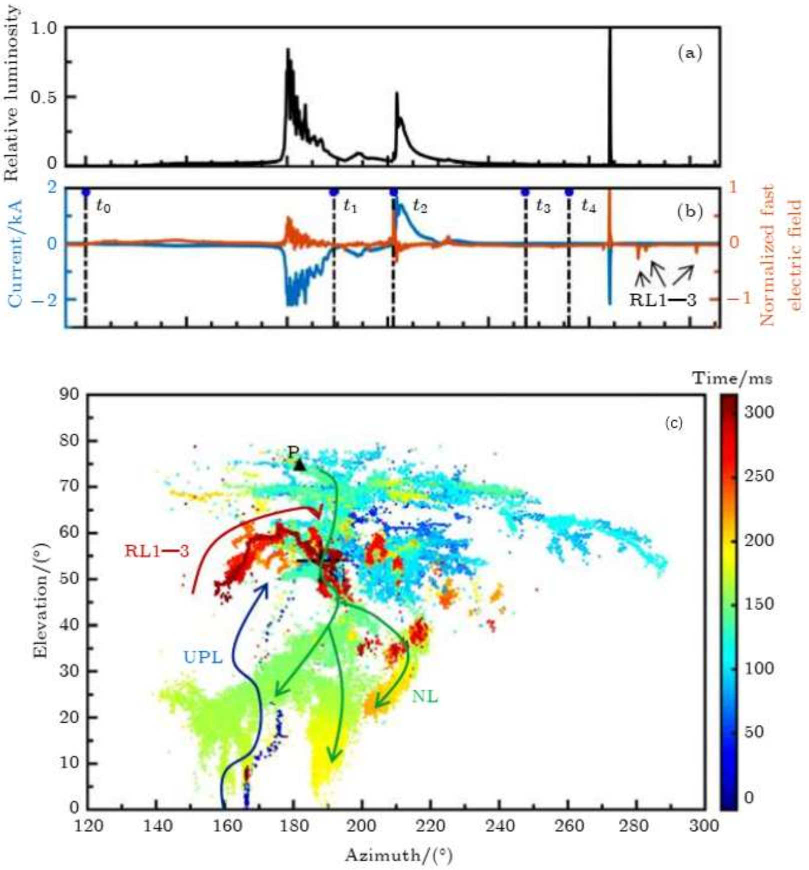

Figure 1. Simultaneous observations of the lightning discharge process: (a) relative luminosity for natural channel from high-speed optical images; (b) channel-base current and normalized fast electric field change; (c) azimuth-elevation of VHF 2D map, color of radiation sources change from blue to red with time.

Electrical evolution of a rapidly developing MCS during its vigorous vertical growth phase. The coevolution of storm structure and electrical behavior of a rapidly developing mesoscale convective system (MCS) over Beijing metropolitan region during its vigorous growth phase is examined based on observations and model simulations. During the vigorous growth phase, the lightning production increased much faster than storm volume growth. Differential growth and several distribution peaks of lightning radiation pulses were observed in the convective cell members, suggesting the overall complicated charge distribution inside the MCS. Given the decreased distances among cells during the upscale growth, it is hypothesized that such complicated charge distributions are more conducive to local high electric field for lightning initiations and hence increased lightning production rates. The electrification-coupled WRF simulations show that the MCS evolves from two layered charge regions to more complicated charge distributions. When some convective cells consisting of the MCS develop toward maturity, the precipitation particles descend to low levels and give rise to a lower positive charge region embedded inside a deep-layer negative charge region. A peak of electric field magnitude is generated at lower levels due to the approaching charge regions with opposite polarities, such that more lightning flashes are produced (Chen et al., 2020, AR).

Increasing trend of lightning activity in the South Asia region. The lightning activity in the South Asia region shows a significant increasing trend during 1996-2013 with a rate of 0.096 fl·km^{-2}·a^{-1} based on the OTD/LIS observations. Multiple linear regression analysis is adopted to identify the main influencing factors among ten potential thermodynamic or microphysical factors and the crucial areas contributing to the increases in lightning. The surface latent heat flux along the west coast of the Indian subcontinent is the largest contributor, explaining 52% of the lightning variance and contributing to a 0.025 fl·km^{-2}·a^{-1} increase. The sea surface temperature in the Arabian Sea, the CAPE over the northwestern Indian subcontinent, and the wind shear along the northwestern coast also make important contributions to the lightning increase, indicating that the thermodynamic effect overwhelms the microphysical effects on lightning activity over the South Asia region (Qie et al., 2020, Sci. Bull.).

Analysis of a gigantic jet in Southern China: morphology, meteorology, storm evolution, lightning, and narrow bipolar events. At about 22:43:30 BJT (UTC+8) on 13 August 2016, two amateur astronomers in Shikengkong, Guangdong province, and Jiahe County, Hunan province, respectively, fortuitously captured a gigantic jet (GJ) event simultaneously, and the GJ exact location could be triangulated. The parent thunderstorm was in a very humid environment (Precipitable Water [PWAT] in excess of 60 mm), featuring high convective available potential energy (CAPE of 2,428 J/kg). The GJ occurred in the region with the coldest cloud top brightness temperature of −64 °C, suggesting the GJ was associated with strong vertical development of the thunderstorm. The vertical cross sections of radar reflectivity also show that the GJ occurred near the thunderstorm strong convection region (overshooting top). The negative cloud to ground flashes dominated during the thunderstorm evolution. Three positive narrow bipolar events (NBEs) were detected within 30 s before and after the GJ. It indicates that the NBEs were occurred in the upper and middle layers of the thunderstorm (altitude of 11–13 km) with radar reflectivity of 30–35 dBZ. (Yang et al., 2020, JGR).

First measurements of low-frequency sferics associated with Terrestrial Gamma-Ray Flashes produced by equatorial thunderstorms. The low-frequency (LF) lightning sferics associated with TGFs detected by Fermi Gamma-ray Burst Monitor over equatorial thunderstorms have been recorded at a station in Melaka, Malaysia since 2017. We examine the LF sferics of two Fermi TGFs, including one TGF-associated lightning discharge at only about 28 km range. Both TGFs are related to the strongest pulse during the initial stage of their parent intra-cloud (IC) lightning, while in both cases the light curve of gamma-ray photon lags the major lightning pulse by approximately 100 µs. TGF occurred about 3 ms after the lightning initiation when the initial upward negative leader has ascended for about 2 km to reach the height of 10-11 km. Our analyses on a statistical basis show that TGF-related lightning is mostly located in the strong convection of equatorial thunderstorms at the mature stage, and near half TGFs are not produced in the strongest convection region (Zhang et al., 2020, GRL).

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How does the melting impact charge separation in squall line? A bin microphysics simulation study. A new electrification and discharge model was developed based on a two-moment bin microphysical scheme coupled with the Weather and Forecasting (WRF) model. Based on the electrical model, the role of the noninductive charging mechanism associated with the melting processes of both snow and graupel (rimed particles) in the charge structure formation in the stratiform region of an organized convective system was examined. Our results showed that the snow melting charging mechanism forms a substantial positive charge layer near and below 0°C isotherm in the stratiform region of a squall line. It was also found that the graupel melting charging process mostly enhanced the positive charge layer in the convective region with little impact in the stratiform region. The in-situ charging of noninductive collisional and melting processes, and the charge transportation from the convective core all contribute to the charge structure formation in the stratiform region of a squall line.

Lightning activity and its associations with cloud structures in a rainstorm dominated by warm precipitation. Lightning activity and its associations with cloud structures during a rainstorm dominated by warm cloud precipitation were studied in Guangdong, China on May 7, 2017, using three-dimensional lightning location and polarimetric radar data. The overall convection and lightning activities of the rainstorm were weak. The rainstorm generally showed a typical tripolar charge structure with the main negative charge core located between the −15 and −8 °C environmental isotherms in the first 4 h. The height of the charge regions clearly decreased after this period, with the main negative charge core being below the –8 °C isotherm. Lightning discharges were more concentrated in areas featuring relatively weak convection and relatively low precipitation intensity. Most of the locations with lightning discharges were dominated by dry aggregated snow and weak updrafts and downdrafts. This investigation demonstrated that the lightning discharges were spatially separated from the area of origin of charging in this rainstorm. It is proposed that, with weak convection in the rainstorm, the charging rate was lower than the speed of charge transfer from the area of origin, causing a relatively low charge density and a low frequency of lightning in the area of origin of charging. Meanwhile, the aggregation of small charged particles in regions away from the area of origin of charging might be conducive to the formation of a relatively high charge density and therefore relatively frequent lightning flashes. This situation is different from a typical thunderstorm with strong convection.

Characterizing radio frequency magnetic radiation of initial upward leader stepping in triggered lightning with interferometric lightning mapping. In summer of 2019, the bandwidth of magnetic field sensor with relatively high sensitivity was extended to 1.2 MHz during the triggered lightning experiment of Field Experiment Base on Lightning Sciences, China Meteorological Administration (CMA-FEBLS) in Conghua, Guangdong Province. The measurements with the new magnetic fields reveal the presence of microsecond-scale magnetic pulses during the entire duration of upward positive leader (UPL), including the quiet stage when only few signals can be discerned in previous observations, which indicates that the UPL generally propagates in a step-wise manner during the initial stage of triggered lightning. Synchronous mapping observations from the broadband VHF interferometer shows that the VHF radiation corresponds to the onset of individual magnetic pulses, indicating that the VHF signals are radiated by the breakdown processes of individual stepping, and these breakdown events launch the meter-scale current pulses as the radiation source of individual magnetic pulses.

Preliminary observations from the China Fengyun-4A lightning mapping imager and its optical radiation characteristics. The Fengyun-4A (FY-4A) Lightning Mapping Imager (LMI) is the first satellite-borne lightning imager developed in China, which can detect lightning over China and its neighbouring regions based on a geostationary satellite platform. In this study, the spatial distribution and temporal variation characteristics of lightning activity over China and its neighbouring regions were analysed in detail based on 2018 LMI observations. The observation characteristics of the LMI were revealed through a comparison with Tropical Rainfall Measuring Mission (TRMM)-Lightning Imaging Sensor (LIS) and World Wide Lightning Location Network (WWLLN) observations. Moreover, the optical radiation characteristics of lightning signals detected by the LMI were examined. Factors that may affect LMI detection were discussed by analysing the differences in optical radiation characteristics between LMI and LIS flashes. The results are as follows. Spatially, the flash density distribution pattern detected by the LMI was similar to those detected by the LIS and WWLLN. High-flash density regions were mainly concentrated over southeastern China and northeastern India. Temporally, LMI flashes exhibited notable seasonal and diurnal variation characteristics. The LMI detected a concentrated lightning outbreak over northeastern Indian in the pre-monsoon season and over southeastern China in the monsoon season, which was consistent with LIS and WWLLN observations. LMI-observed diurnal peak flash rates occurred in the afternoon over most of the regions. There was a “stepwise” decrease in the LMI-observed optical radiance, footprint size, duration, and number of groups per flash, from the ocean to the coastal regions to the inland regions. LMI flashes exhibited higher optical radiance but lasted for shorter durations than LIS flashes. LMI observations are not only related to instrument performance but are also closely linked to onboard and ground data processing. In future, targeted improvements can be made to the data processing algorithm for the LMI to further enhance its detection capability. This study has been published in Remote Sensing by Hui et al. (2020).

Lightning Research Group of Gifu University (Gifu, Japan)

A comparison on the e-change pulses occurring in the bi-level polarity-opposite charge regions of the intra-cloud lightning flashes. A normal intra-cloud (IC) lightning flash usually exhibits a bi-level channel structure, indicating the leader progressions in the upper positive charge region (UPCR) and middle negative charge region (MNCR). Comparison on the E-change pulses of bi-level polarity-opposite charge regions are still rare. Recently, we have made such a comparison on the E-change pulses occurring in UPCR and MNCR of 41 normal IC flashes recorded by Fast Antenna Lightning Mapping Array (FALMA). E-change pulses in both charge regions are roughly grouped into isolated pulses and pulse trains with both positive and negative polarities. Based on the characteristics of pulse locations and pulse parameters, we think that isolated pulses in UPCR are most likely produced by negative stepped leaders in virgin air, while pulse trains in both UPCR and MNCR are produced by negative dart-stepped leaders. Furthermore, one interesting phenomenon is found that in the same charge region, either UPCR or MNCR, not only the total counts but also the parameters of positive and negative pulses are similar, implying that each leader in the two respective charge regions will fluctuate in progression direction and height as shown in Figure 1. This study has been published in JGR (doi: 10.1029/2020JD032996).

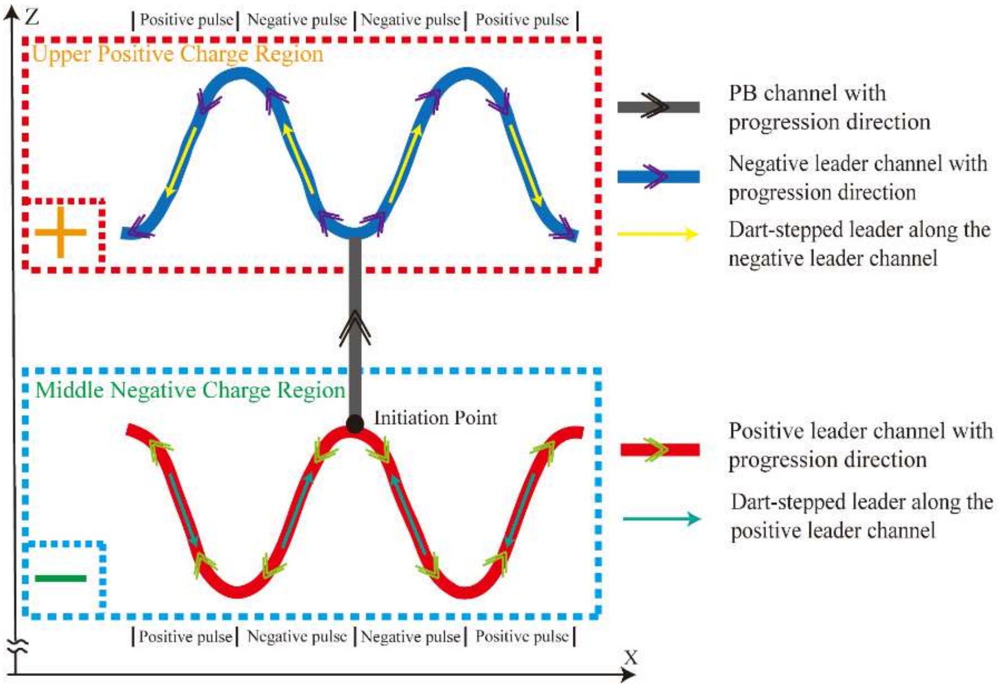

Figure 1. Illustration of fluctuating behavior in the X-Z vertical view of the leader progression in two hypothetical charge regions.

Upward negative leaders from high objects in winter observed by the FALMA. Upward negative leaders (UNLs) in positive upward lightning are rarely observed. In this study, 24 UNLs observed by the Fast Antenna Lightning Mapping Array during winter thunderstorms in Japan are analyzed. Figure 2 shows one example. Three-dimensional velocities of UNLs are calculated, and it is found that velocities during the upward propagation stage range from 1.8 to 27.9×10^5 m/s with a mean value of 10.4×10^5 m/s, and they are always larger than velocities during the following horizontal propagation stage. UNLs produce distinctive electric field change waveforms with V-shaped overall change trend, with small pulses at the beginning when UNLs start, large pulses during upward propagations and small pulses again when UNLs turn into horizontal directions (Figure 2b). Pulses produced by UNLs are mainly unipolar but sometimes also bipolar. Pulse interval, pulse width, rise time and fall time are calculated for waveforms produced by five UNLs. Pulse intervals range from 13.7 to 18.9 µs. Pulse width, rise time and fall time are on average 5.8 µs, 3.3 µs and 2.4 µs, respectively. All UNLs are preceded by other discharges. Strong negative strokes including some special types of strokes usually precede initiations of UNLs by tens of ms. As an example, a large pulse can be seen before the UNL in Figure 2a. These negative strokes are usually found only a few kilometers away from UNLs. It is speculated that these negative strokes along with following in-cloud positive leaders contribute to the depletion of negative charges in thunderclouds, which result in positive electric field changes (atmospheric electricity sign convention) large enough for initiations of UNLs. This study has been published in JGR (doi: 10.1029/2020JD032851).

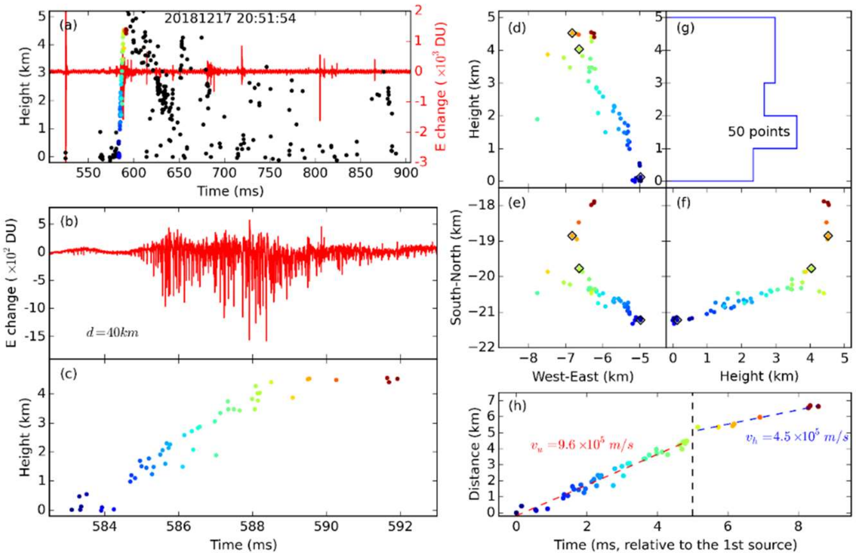

Figure 2. An example of an upward positive lightning flash.

Positive cloud-to-ground lightning flashes containing multiple strokes in winter. Multiple-stroke (MS) positive cloud-to-ground (+CG) lightning flashes are rarely reported, especially those with high-quality location information. In this study, we report 47 MS +CG flashes observed in winter thunderstorms in Japan with a 14-site Fast Antenna Lightning Mapping Array. MS +CG flashes account for 18% of +CG flashes. The mean multiplicity of all +CG flashes is 1.24, and the maximum multiplicity is five (Figure 3). Interstroke intervals have a very large range from 1.0 to 1320.6 ms with the geometric mean (GM) of 64.4 ms. In three flashes, interstroke intervals smaller than 2 ms are observed and corresponding positive strokes are inferred to be produced by two branches of the same positive leader. Horizontal distances between sequential positive strokes range from 1.1 to 37.3 km with the GM of 9.7 km. No subsequent strokes struck at the same location as a previous stroke. Distances between sequential strokes are generally much larger than distances between first strokes and lightning initiation locations. Subsequent stroke peak amplitudes are on average 0.45 of first stroke peak amplitudes. In 39 flashes (83%), the first stroke is stronger than the largest subsequent stroke in the same flash. Subsequent stroke amplitudes are weakly correlated with the time difference from the previous stroke. Origination mechanisms of positive leaders initiating first and subsequent positive strokes are discussed. It is very likely that positive leaders for most subsequent strokes originate from in-cloud negative leader channels, but origination mechanisms for positive leaders initiating first strokes are more varied. This study has been published in JGR (doi: 10.1029/2020JD033039).

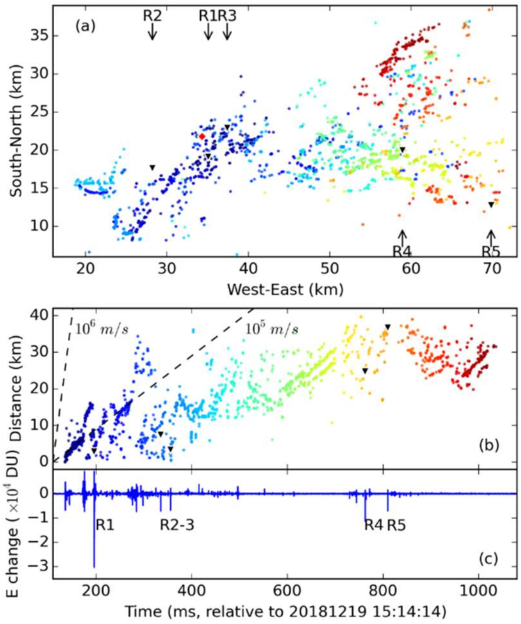

Figure 3. A MS +CG flash containing five strokes.

Massachusetts Institute of Technology

Work has now been completed during the CV-19 confinement period (and accepted for publication in JGR) on the two Super El Nino events (1996/97 and 2014/15) and their impact on global lighting activity. Six different ELF receivers were used to quantify the regional lightning activity in this international collaboration (China, Hungary, India, Israel, Poland, Scotland, and United States). Contrary to the traditional thinking that lightning activity is maximum in the warm El Nino phase and minimum in the cold La Nina phase, this study has found the greatest activity in the transition period from cold to warm phase for both events. Consistent with other studies, the lightning chimney with the strongest ENSO response is SE Asia and the Maritime Continent. Convective Available Potential Energy (CAPE) is playing a key role as a measure of the departure from convective equilibrium in the transition phase, resulting in stronger updrafts that invigorate the mixed-phase microphysical origin of storm electrification.

Research continues informally with Armenian nuclear physicists Hripsime Mkrtchyan, Ashot Chilingarian and Suren Hovakimyan on S-band radar studies of reflectivity structure over the Aragats Mountain surface observations (electric field and gamma ray detectors at 3200 m MSL), documenting an abundance of Thunderstorm Ground Enhancement (TGEs) (aka gamma ray glows) in the presence of strong (>10 kV.m) electric fields of both polarities. The observations continue to show positive TGEs (positive charge overhead) in the presence of weak vertical extent of reflectivity and negative TGEs in the presence of stronger vertical development. This behavior is consistent with electron runaway beneath the main negative charge region in a general tripole storm structure. Very compact reflectivity features (<2 km in diameter) are sufficient to establish a runaway condition.

Yakun Liu continues to explore the exceptional Australian bushfire season of 2019/20 with Earth Networks lightning data, together with a host of satellite observations. The densest distribution of fire and aerosol production occurred along the SE coast of the continent in New South Wales, with extensive smoke advected eastward over the Tasman Sea. Evidence has accrued for a role for the aerosol in invigorating oceanic lightning in this domain. The unprecedented Atlantic hurricane season this year has revived interest in research left unpublished about a decade ago showing a strong connection between Atlantic hurricanes and drought in the Amazon basin to the south of the Atlantic storm track. Use has been made of the river gage in Manaus Harbor to represent rainfall over the entire drainage basin of the upper Amazon River. Particularly conspicuous years showing this connection have been 2005 (the Katrina year), 2010 and 2020. The physical picture here involves the local Hadley circulation: strong upwelling in the Atlantic storm track is linked with strong subsidence, suppressed convection and drought over the Amazon. This expectation will be checked with the 3D wind field of ECMWF ERA5 reanalysis, in collaboration with Guilherme Martins, currently researching fire incidence in the Amazon basin of Brazil.

University of Florida

Z. Ding, V. A. Rakov, Y. Zhu, and M. D. Tran authored a paper titled "On a possible mechanism of reactivation of decayed branches of negative stepped leaders". Using visible-range and medium-to-far infrared (3 -5 μm) high-speed video cameras, they observed luminosity transients that re-illuminated decayed branches of two close (2 to 4 km) negative stepped leaders in Florida. Leader branches were energized via stepping at their tips and, as a result, were most heated near their lower ends, with the hotter sections being connected via cooler sections to the trunk. In the modeling of lightning leaders, usually a single tip is considered. In contrast, in this study, many (up to 30 per major branch) tips were active at the same time, forming a network-like structure with a descending multi-tip "ionization front" whose transverse dimensions were of the order of hundreds of meters. The front exhibited alternating stepping, with each step necessarily generating a positive charge wave traveling from the leader tip up along the channel, like a mini return stroke. It was inferred that the step-related waves can cause luminosity transients in the remnants of decayed negative branches at higher altitudes. Such reactivated branches, in turn, may facilitate further leader stepping at lower altitudes, as first reported by Stolzenburg et al. (2015). The reactivation process is likely to involve multiple steps, as evidenced by a large number of active tips (some tens per 50-μs frame) and corresponding electric field pulses occurring at time intervals of 2 μs or less. Additionally, it appears that a transient in one decayed branch can trigger (or assist with triggering of) a transient in another branch. The paper is published in the Journal of Geophysical Research - Atmospheres.

A.F.R. Leal (Federal University of Para (UFPA), Belém, Brazil) and V.A. Rakov authored a paper titled "Comparison of ionospheric reflection heights for LEMPs produced by lightning return strokes of different polarity". Apparent ionospheric reflection heights estimated using electric field waveforms of negative and positive cloud-to-ground lightning return strokes (-CGs and +CGs) that occurred during the same thunderstorms have been compared. The authors analyzed electric field waveforms of 101 -CGs and 74 +CGs that were recorded in August 2016 in Florida. For daytime conditions, the mean ionospheric reflection height for lightning electromagnetic pulses (LEMPs) produced by +CGs was larger than that for LEMPs produced by -CGs for either first or subsequent strokes, although the difference was statistically significant only for subsequent strokes. For nighttime conditions, the trend was the same, but the sample sizes were too small to draw meaningful conclusions. NLDN-reported peak currents of positive strokes tended to be higher than those of negative strokes, which could be the reason for larger reflection heights for +CGs. For daytime conditions, the mean ionospheric reflection height for subsequent strokes in -CGs is smaller than that for first strokes, while for +CGs the mean reflection heights for first and subsequent strokes are essentially the same. This disparity is related to the fact that subsequent strokes in –CGs usually develop in the channel of the first stroke, while subsequent strokes in +CGs usually form new terminations on ground and, hence, are similar to first strokes. The paper is published in the Journal of Atmospheric and Solar-Terrestrial Physics.

Vaisala

Patent issued number 10,782,448. Short-term thunderstorm forecast and severe weather alert system and method. Systems and methods are disclosed to determine the severity of a thunderstorm and/or track the path of a thunderstorm. For instance, multiple thunderstorms may be tracked by assigning detected lightning flashes to thunderstorm objects based on a number of previous lightning flashes assigned to each of the thunderstorm objects and a distance between each of the lightning flashes and each of the thunderstorm objects. In addition, an updated position may be determined for each of the thunderstorm objects based on positions and ages of lightning flashes assigned to each of the thunderstorm objects. The severity of a given thunderstorm may be determined based on lightning rates, types, and/or polarities of lightning flashes and/or lightning pulses of the thunderstorm object.

Lightning threat zone API released by Vaisala. The patent “Short-term thunderstorm forecast and severe weather alert system and method” has been converted by Vaisala into a product called Lightning Threat Zone (LTZ). The LTZ method has been part of Vaisala’s Thunderstorm Manager display for several years. In it, users can see real-time in-cloud and cloud-to-ground lightning, manage alarms and lightning threats, and visualize the projected thunderstorm path for up to an hour into the future. In September 2020, Vaisala opened up these localized lightning nowcasts for customers to incorporate into their situational awareness platforms by using a new API. With the Lightning Threat Zone API, software developers can build this functionality into their software applications to continuously monitor lightning nowcasts at a specific location.

Thunderstorm nowcasting often relies on extrapolating the current radar pattern into the future. But new radar updates can take minutes to arrive, and many regions around the world have poor or no radar coverage. In contrast, lightning data updates near real-time and have seamless global coverage.

The LTZ algorithm takes precisely-located lightning in real time from Vaisala's NLDN and GLD360 lightning networks, and accurately distinguishes cloud-to-ground from in-cloud lightning. The LTZ algorithm then calculates the storm's lightning density and change in lightning activity. This information feeds the LTZ output, a 60-minute nowcast shown in ten-minute increments that updates in near real-time. Two examples are shown below (Figure 1):

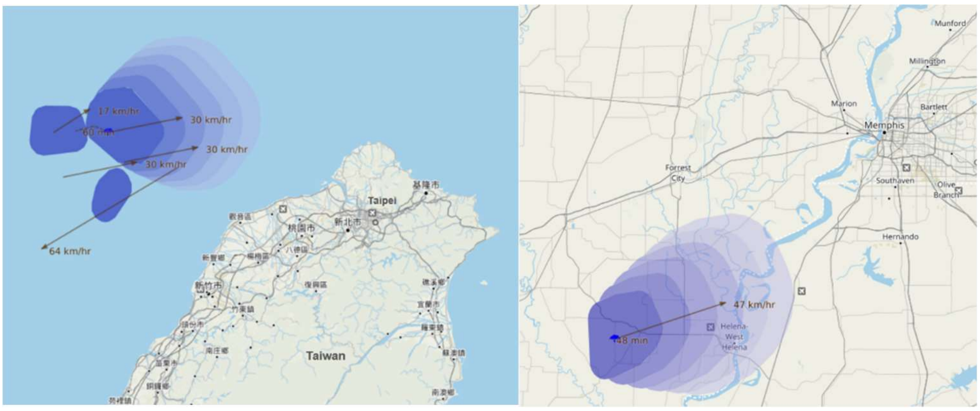

Figure 1. Examples of Lightning Threat Zone (LTZ) for storms near Taipei (left) and Memphis, Tennessee (right). Colors indicate projected storm paths in ten-minute increments.

Recent history of upgrades to the U.S. National Lightning Detection Network. The U.S. National Lightning Detection Network (NLDN) underwent a complete sensor upgrade in 2013 followed by a central processor upgrade in 2015. These upgrades produced about a factor-of-five improvement in the detection efficiency of cloud lightning flashes and about one additional cloud pulse geo-located per flash. However, they also re-aggravated a historical problem with the tendency to misclassify a population of low-current positive discharges as cloud-to-ground strokes when, in fact, most are probably cloud pulses. Furthermore, less than 0.1% of events were poorly geo-located because the contributing sensor data were either improperly associated or simply under-utilized by the geo-location algorithm. To address these issues, Vaisala developed additional improvements to the central processing system, which became operational on November 7, 2018. The following paper describes updates to the NLDN between 2013-2018 and then focuses on the effects of classification algorithm changes and a simple means to normalize classification across upgrades. Murphy, M.J., J.A. Cramer, and R.K. Said, 2020: Recent History of Upgrades to the U.S. National Lightning Detection Network. J. Atmos. Ocean. Tech.

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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.

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 Weitao Lyu (wtlu@ustc.edu) preferably by e-mail as an attached word document.

The deadline for **2021 spring issue** of the newsletter is **May 15, 2021**.

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