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Newsletter on Atmospheric Electricity

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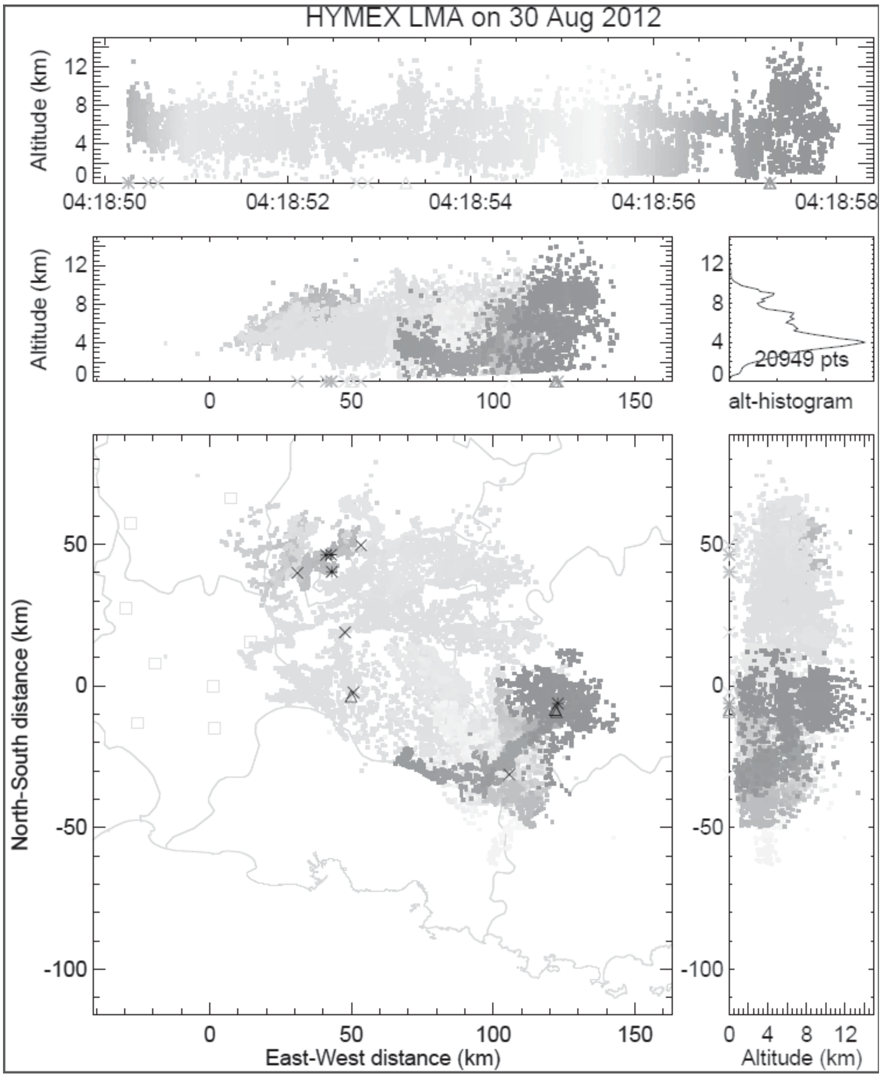
INTERNATIONAL COMMISSION ON ATMOSPHERIC ELECTRICITY (IAMAS/IUGG)

AMS COMMITTEE ON ATMOSPHERIC ELECTRICITY

AGU COMMITTEE ON ATMOSPHERIC AND SPACE ELECTRICITY

EUROPEAN GEOSCIENCES UNION

SOCIETY OF ATMOSPHERIC ELECTRICITY OF JAPAN



Comment on the photo above: **A lightning flash that lasted 7.74 seconds. You can watch its animation at http://lightning.nmt.edu/ICAE/France_Flash.gif. In the figure, an "X" is a +CG stroke located by the EUCLID lightning detection network; a "Δ" is a EUCLID detected -CG (This was a +CG flash, so there were probably no -CG strokes. The "Δ"s were probably mis-classified cloud pulses.); a "*" is a EUCLID detected +IC pulse. The figure and the animation were provided by Bill Rison, New Mexico Tech with support from Eric Defer of LERMA, Observatoire de Paris, Paris, France, who was the one who worked to get the LMA to France, and Stephane Pedeboy of Météorage, Pau, France, who provided the EUCLID data.**

ANNOUNCEMENTS

Announcement of ICAE

During the 15th ICAE conference at Norman, USA, the following 9 members have retired from their beloved commission (ICAE):

Zen Kawasaki (Japan)
Pierre Laroche (France)
Clive Saunders (UK)
Sergey Anisimov (Rusia)
Osmar Pinto (Brazil)
Stanislaw Michnowski (Poland)
Earle Williams (USA)
Masaru Ishii (Japan)
Dave Rust (USA)

Also during this conference, two new Officers, 8 new members and 4 honorary members as listed in the following, have been elected.

New ICAE officers:
President: Daohong Wang (China, Associate professor of Gifu University of Japan)
Secretary: Tomoo Ushio (Japan, Associate professor of Osaka University of Japan)

New ICAE members:

Eric Defer (France)
Eldo Avila (Argentina)
Evgeny Mareev (Rusia)
Marcelo Saba (Brazil)
Joan Montanyà (Spain)
Donald R. MacGorman (USA)
Maribeth Stolzenburg (USA)
David Smith (USA)

New honorary members:

Pierre Laroche (France)
Hugh Christian (USA)
Stanislaw Michnowski (Poland)
Earle Williams (USA)

Due to the above changes, the composition of new ICAE committee is as follows:

Officers:
President: Daohong Wang (China, Associate Professor of Gifu University of Japan)
Secretary: Tomoo Ushio (Japan, Associate professor of Osaka University of Japan)

ANNOUNCEMENTS

Committee Members:
Eldo Avila (Argentina), V. Cooray (Sweden), Eric Defer (France), James E. Dye (USA), Paul Krebhiel (USA), Donald R. MacGorman (USA), Evgeny Mareev (Rusia), Joan Montanyà (Spain), Colin Price (Israel), Xiushu Qie (China), Vladimir A. Rakov (USA), Marcelo Saba (Brazil), David Smith (USA), Serge Soula (France), Maribeth Stolzenburg (USA), Tomoo Ushio (Japan), Daohong Wang (China)

Honorary Members:
Hugh Christian (USA), Nobuichiro Kitagawa (Japan), E. Philip Krider (USA), Pierre Laroche (France), John Latham (UK), Stanislaw Michnowski (Poland), Lothar H. Runhke (USA), Hannes Tammet (Estonia), Earle Williams (USA)

After a series of procedures, **Nara, Japan** has been chosen as the venue of the next ICAE conference (16^{th} conference), which will be held in **2018**.

Awards

At the 32nd International Conference on Lightning Protection (Oct. 13-17, 2014, Shanghai, China) **Berger award** was awarded to Dr. Gerhard Diendorfer and Prof. Joseph Dwyer; **Golde award** was awarded to Prof. Shigeru Yokoyama and Prof. Fridolin Heidler.

New Books

The Lightning Flash (second Edition, updated with nine more chapters), Editor: V. Cooray, IET publishers, London, 2014.

Introduction to Lightning, V. Cooray, Springer Publishers, 2014.

Conferences

26th General Assembly of the International Union of Geodesy and Geophysics (IUGG)

The 26th General Assembly of the International Union of Geodesy and Geophysics which will be held at Prague, Czech Republic, 22 June - 2 July 2015. The title of the symposium is “Electrical Charging and Discharging in Thunderclouds” and the deadline for abstract submission is January 31th, 2015.

For detail, please visit first http://www.iugg2015prague.com/,
and then http://www.iugg2015prague.com/iamas-symposia.htm.

ANNOUNCEMENTS

The Ninth Asia-Pacific International Conference on Lightning (APL 2015)

The deadline of the paper submission to this conference is Nov.30, 2014. For detail, please visit http://apl2015.jp/.

European Geosciences Union General Assembly 2015
Vienna | Austria | 12 – 17 April 2015

We invite you to submit abstracts to the session: NH1.4/SSS0.29 - **Atmospheric Electricity, Thunderstorms, Lightning and their effects.**

This session seeks contributions from research in atmospheric electricity on:

Cloud microphysics, charge separation and lightning discharge physics
Atmospheric electricity in fair weather and the global electrical circuit
Atmospheric chemical effects of lightning and the contribution of LtNOx
Middle atmospheric Transient Luminous Events
Global lightning patterns in an era of climate change
Thunderstorms in hurricanes and typhoons
Urban effects on lightning distributions
Modeling of thunderstorms, lightning
Now-casting and forecasting of thunderstorms, flash floods and severe weather
Lightning detection networks and sensors from ground and space

You can submit at: http://meetingorganizer.copernicus.org/EGU2015/abstractsubmission/18799

The deadline for Abstract submission is 7th of January 2015, 13:00 CET

Young scientists are encouraged to apply for the Young Scientist's Travel Award (YSTA). The deadline to apply for EGU support is 28 November 2014.
Please visit http://www.egu2015.eu/support_and_distinction.html

Note that there will be a related session at EGU 2015: "High Energy Radiation from Thunderstorms and Lightning" (AS4.12) convened by Sebastien Celestin, Thomas Gjesteland, and Martino Marisaldi.

Jointly, our sessions have been growing steadily in the last couple of years, making the EGU a great venue for the Atmospheric Electricity community to meet, present new science and advance collaboration in Europe and beyond.

We look forward to seeing you in Vienna!

With warm regards,

Yoav Yair
on behalf of: Serge Soula, Yukihiro Takahashi, Giles Harrison, Colin Price and Hans-Dieter Betz

SPECIAL TOPICS

STANDARDIZING THE SIGN CONVENTION FOR ATMOSPHERIC ELECTRIC FIELD MEASUREMENTS

Paul Krehbiel, Vlad Mazur, William Rison

Papers concerned with atmospheric electricity typically need to declare if the ‘Physics’ or ‘Atmospheric Electricity’ sign convention is used for the electric field *E*. The difference between the two is they assign opposite polarities to ground-based electric field measurements. As discussed at the 2014 International Conference in Norman, the fact that there are two conventions confuses matters, and the community needs to standardize on the so-called ‘Physics’ convention.

The historical basis for the Atmospheric Electricity convention is that an early technique for measuring atmospheric electric fields determined the potential difference ΔV of a long horizontal wire mounted on insulators a distance Δz above ground, relative to ground. Attaching a radioactive source (polonium) to the wire maintained it in local equilibrium with the atmospheric potential at the same height, thereby not perturbing the field lines and allowing *E* to be determined from the uniform field relation $E = \Delta V / \Delta z$. The polarity of *E* was considered to be the same as that of ΔV, even though the electric field vector would be vertically downward for a positive ΔV between the wire and ground.

In a vector sense, the Atmospheric Electricity convention corresponds to a coordinate system in which the unit $\hat{z}$ vector is downward rather than upward. The convention is therefore not incorrect or unphysical, as $\vec{E} = -\vec{\nabla} V$ applies equally well in either coordinate system. However, because $\hat{z}$ is chosen to be upward, the polarity of electric field measurements needs to be standardized and consistent with that system. The issue is simply resolved by having researchers who work in the atmospheric electric convention (or refer to studies made with that convention) identify the results as ‘potential gradient’ or ‘grad V’ (∇V) measurements, as opposed to electric field (*E*) measurements (e.g., MacGorman and Rust, 1998, p. 29). At the same time, we need do away with both the ‘atmospheric electricity’ and ‘physics’ terminology.

In fair weather conditions, the atmospheric electrostatic field is vertically downward, i.e., negative. This results from the atmosphere being positively charged and the earth having an opposite-polarity negative charge. Normally-electrified storms having main mid-level negative and upper positive charge regions reverse the direction of the electric field beneath the storm to upward (positive) values due to the dominant charge overhead being negative (see diagram). This simplified description of the effect of thunderstorms on the atmospheric electric field is straightforwardly extended to account for the presence of other storm charges, such as lower positive charge, screening charges, and inverted or other anomalous charge structures, as well as the vector nature of *E*.

A related issue that adds to the confusion concerns the polarities of lightning electric field changes ΔE. The field changes have three components (e.g., Uman 1987, p. 329), commonly called the electrostatic, induction and radiation components. The components behave differently with range and with the type of discharge. The electrostatic and induction components of ΔE for dipolar intracloud (IC) discharges reverse polarity with distance from the event, whereas monopolar changes associated with cloud-to-ground (CG) flashes do not change polarity with distance. In contrast, the radiation component does not reverse polarity with distance, either for dipolar or monopolar discharges. Rather, the radiation changes are bipolar versus time, with the polarity of the initial excursion indicating the upward or downward direction of vertical lightning currents. Additional complications are that one can have normal- and inverted-polarity discharges, and that one needs to know or assume something about the discharge orientation.

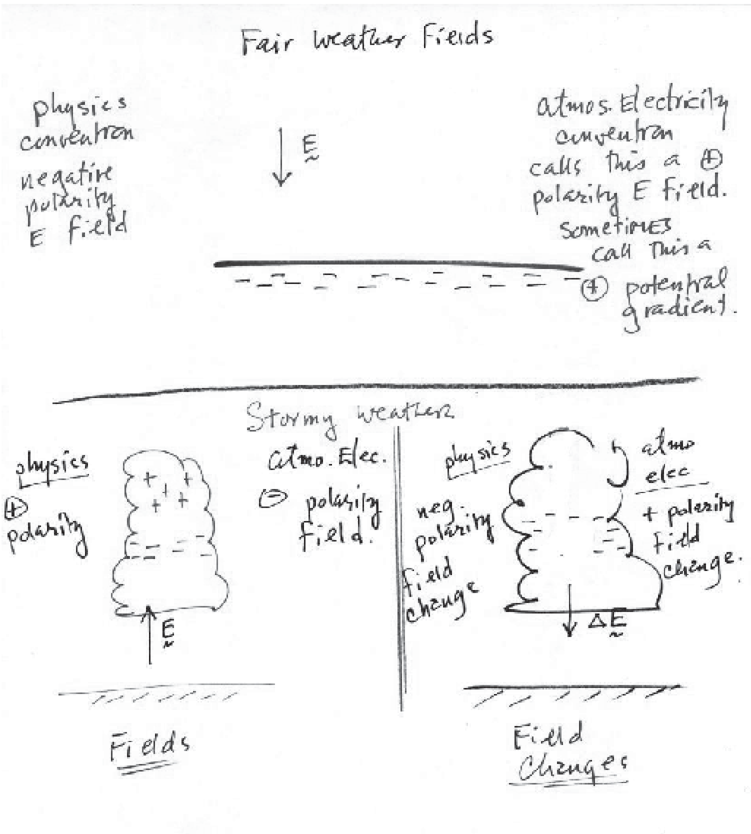


Fig. An early sketch used to illustrate the 'Atmospheric Electricity' and 'Physics' sign conventions at the University of Arizona.

Even when the sign convention is clear, sorting out and understanding the ΔE polarities requires careful thought. In the following we summarize the basic results for ground-based lightning field changes of normal-polarity, vertically-oriented IC and CG discharges.

Beneath and nearby normally electrified storms, negative CG flashes and normal-polarity IC flashes have the dominant effect of reducing the negative charge overhead (or equivalently, adding positive charge). Therefore both produce negative electrostatic field changes ΔE, as indicated in the diagram. Because CG strokes are monopolar, their electrostatic field changes are relatively strong and remain negative with increasing distance from the storm. Being dipolar, ΔE values for IC flashes tend to be weaker and reverse polarity to positive values with increasing distance. The polarity reversal occurs typically at 10-15 km plan distance and results from the field change due to negative charge being deposited in the upper positive charge region exceeding that of positive charge deposited at lower altitude in the main negative charge region. Beyond the reversal distance, one can distinguish between CG and vertical IC flashes by virtue of their polarity.

The 'induction' component is directly related to the discharge current, $I(t)$. At close and intermediate distances, the component is important for high-current events such as CG return strokes, intracloud K-events, and energetic NBEs. The polarities of the inductive changes behave exactly the same as those of their corresponding electrostatic component, namely negative at all distances for negative CG return strokes and negative reversing to positive values for IC events. This is indicative of the two components being similarly produced, as discussed below.

We note that the term 'induction' is a substantial misnomer (Chalmers, 1965). Induction refers to the fact that a changing magnetic field generates ('induces') an electric field, as per Faraday's Law, $\nabla \times E = -\partial B / \partial t$. But this effect is responsible for the radiation component, not the induction component. A better alternative name for the latter is the 'intermediate' component. Whereas the electrostatic component is related to the charge transfer $q = q(t)$ of the discharge (and therefore is not static in of itself), the intermediate component is related to the time rate of change of charge, $dq / dt = I$. The two components have different range dependencies, decreasing as $1/R^3$ and $1/R^2$, respectively. Otherwise, both result from the same basic effect, namely the effect of the lightning current altering the storm's charge structure, and hence E, through Gauss's law $\nabla \cdot E = \rho / \varepsilon_0$.

The radiation component of ΔE is caused by the acceleration of charge, d^2q / dt^2, or equivalently by a time rate of change of current dI / dt. The result is an electromagnetic wave that radiates energy away from the discharge. The resulting field change $\Delta E(t)$ is bipolar and transient as the current turns on and off, and decreases with range as $1/R$. For negative return strokes the current *I* is upward or positive, due to negative charge being lowered to ground. For energy to be propagated away from the discharge, ΔE is in the negative $\hat{z}$ direction, at all ranges. Negative CG strokes therefore produce negative initial radiation field changes, and can be detected out to large distances by sferics detection networks. Normal-polarity IC flashes transport negative charge upward in storms and therefore produce downward or negative currents, causing electric field sferics that are initially positive. Unlike the electrostatic and intermediate components of ΔE, which are determined by Gauss's law, IC radiation sferics do *not* reverse polarity with distance, owing to the magnetic and electric field directions being determined at all ranges only by the direction of the lightning current I.

Because the radiation component decreases more slowly with range, it becomes the dominant component for distant measurements. Large-area sferics location networks such as the U.S. NLDN primarily detect the far-field radiation component and classify the events according to the polarity of the sferic, namely as −CGs and +ICs, respectively for normal-polarity discharges. Sferics for positive CG strokes (+CGs) have the same polarity as +ICs, while inverted-polarity IC events (−ICs) have the same polarity as −CGs. For each polarity, the two possibilities are differentiated on the basis of the waveform characteristics. But this can be difficult to do, leading for example to commonly-occurring +IC events in normally-electrified storms often being misclassified as weak or moderate +CGs.

References

Chalmers, J. A., The so-called induction component in the electric field of a lightning discharge, J. Atmos. Terrestrial Physics, 27, 1027-1028, 1965.

MacGorman, D. R. and W. D. Rust, *The Electrical Nature of Thunderstorms*, 422 pp., Oxford University Press, New York, 1998.

Uman, M. A., *The Lightning Discharge*, 377 pp., Academic Press, San Diego, 1987.

RESEARCH ACTIVITY BY INSTITUTIONS

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

Brett Basarab and Steven Rutledge: A component of our group's lightning research focuses on development of lightning parameterizations to improve prediction of lightning flash rate. Accurate flash rate parameterizations are important to reduce uncertainty in lightning NO_x production in cloud models, and potentially on the global scale. Numerous flash rate parameterizations exist in the literature; most parameterizations are based on observed relationships between flash rate and macroscopic quantities such as precipitating ice mass. Several existing flash rate parameterizations were tested against observations of thunderstorms from the recent Deep Convective Clouds and Chemistry (DC3) field campaign. These relationships were found to inadequately predict flash rate for a number of DC3 storms. We have therefore focused recently on improving flash rate parameterization schemes using the Colorado DC3 dataset. From this dataset, we have found robust relationships ($R^2 \sim 0.8$) between lightning flash rate and bulk storm parameters including the graupel echo volume, 30-dBZ volume, and precipitating ice mass. When these relationships are applied as flash rate parameterization schemes, observed flash rate trends are generally predicted very well. We also investigated measures of updraft intensity as predictors of flash rate, but found these parameters to correlate less well to flash rate than the bulk storm volume quantities. To improve these results, multiple storm parameters were used to predict flash rate. A simple approach was found to be most effective: storm-total graupel and dBZ volumes were split into representative area and height dimensions and regressed against flash rate. This approach is unique, and the combined quantities were slightly better correlated to flash rate and predicted flash rate variability for individual cases better than single-parameter flash rate schemes. We also tested the flash rate schemes developed against observations of Alabama thunderstorms, but found that the schemes more successfully predicted flash rate for Colorado storms. This important finding suggests that different parameterization coefficients may be necessary for different regions or different thermodynamic environments. Finally, we have observed a strong, consistent relationship between total flash rate and the sum of all lightning flash channel lengths. Since NO_x production may depend most strongly on the size of flash channels, we advocate this relationship as a potential component in an improved lightning NO_x parameterization.

Brody Fuchs and Steven Rutledge: Convective vertical motions are strongly linked to lightning flash rates. Therefore, a study of the environmental impacts on lightning is also a study of vertical motions. Our recent work has focused on relating storm intensity to its thermodynamic and aerosol environments. In multiple regions of the United States possessing Lightning Mapping Array (LMA) networks, a large sample of isolated convective storms for one warm season was analyzed to investigate regional differences in radar reflectivity structure, total lightning flash rate and vertical charge structure. LMAs were used for their ability to detect the three-dimensional structure of both cloud and ground flashes and can produce total lightning flash rates with the new flash clustering algorithm implemented in this study. It was found that thermodynamic environments with large instability and shallow warm cloud depths are most likely to produce storms with high flash rates and anomalous mid-level positive charge. These environments are most common in northeast Colorado relative to the other regions of study in Oklahoma, Alabama and Washington, D. C. This is also a preferred region for production of large fractions of positive ground flashes believed to be correlated to anomalous mid-level positive charge.

To a lesser degree, flash rate and radar reflectivity structures can be influenced by model derived cloud condensation nuclei (CCN) concentrations and the sign of the effect is concentration dependent in this study. The paucity of clean (~ 100 cm^{-3} CCN concentrations) cases limits the investigation into aerosol invigoration in this study, however a decrease in flash rates is observed for large CCN concentrations above 1000 cm^{-3}, consistent with a previous study. This phenomenon may be the result of aerosol radiative effects increasing the near-surface stability or modification of size distributions resulting in increased condensate loading and slower updrafts. These aerosol effects appear to be most prevalent when the thermodynamic environments are not particularly favorable in these continental regions.

The electrical characteristics of storms in northeast Colorado warrant further investigation into the processes that make these storms unique. To that end, we are currently developing methods to infer microphysical processes with polarimetric and dual-Doppler radar data as well as charge layer inference methods using LMA data. Storms from the Deep Clouds and Convective Chemistry (DC3) field project in 2012 and the CHILL Microphysical Investigation of Electrification (CHILL-MIE) project in 2013 provide rich radar and lightning datasets on which to develop these techniques. With the potential combination of microphysical processes and identification of charge structures, we hope to identify the processes that produce the anomalous charge structures and flash rates observed predominantly in the Colorado region.

Doug Stolz and Steven Rutledge: An analysis of deep convective clouds and lightning observed by the TRMM precipitation radar and lightning imaging sensor during 8 years in the Tropics is on going. The objective is to quantify the relative contributions of thermodynamics and boundary layer aerosol concentrations to variability of convective intensity and lightning between continental and oceanic regions. The results illustrate that vertical precipitation structure and lightning associated with deep convective clouds are sensitive to normalized convective available potential energy (NCAPE), aerosol concentrations, and warm cloud depth, consistent with hypotheses established in the literature. When simultaneously stratified by the three aforementioned independent variables, enhanced radar reflectivity within a cloud's mixed phase region and higher total lightning density are noted for high NCAPE, intermediate warm cloud depth, and high aerosol concentrations over both land and ocean. We speculate that while NCAPE exerts significant influence on the vigor of updrafts, warm cloud depth and aerosols influence the development of precipitation within a cloud's warm phase and subsequent transport of cloud liquid water above the freezing level (at which point riming/freezing may contribute to invigorating updrafts further). Overall, the findings of this study suggest that thermodynamics and aerosols modulate the variability of deep convection in the Tropics simultaneously. The next step is to carry out a statistical decomposition of the relative influence of these variables between continents and oceans as well as seasonally.

As a related study, we have been investigating the potential influence of aerosols on the development and evolution of the Madden Julian Oscillation. Three specific MJOs documented during the DYNAMO field campaign (September 2011 – March 2012; central equatorial Indian Ocean region) were examined. GEOS Chem simulated aerosol concentrations reveal that aerosol concentrations in the DYNAMO region are significantly higher north of equator (~100-300 cm^{-3}) in this compared to the southern Indian Ocean (where background aerosol concentrations are < 100 cm^{-3}). We hypothesize that circulations associated with the MJO are in part responsible for elevated aerosol concentrations in the northern hemisphere compared to the southern hemisphere. Analysis of horizontal winds derived from reanalysis shows that off-equatorial cyclonic gyre circulations, surges in the northeasterly winter monsoon flow, and local meridional flows lead to enhanced aerosol concentrations in this region. While cold cloud features (IR brightness temperatures < 208 K) are equally represented in both DYNAMO domains north and south of the equator, cloud-to-ground lightning occurs far more frequently in the northern portion, suggesting a role for aerosol invigoration since NCAPE is essentially the same in both domains. These results motivate the next stage of the study that will employ the long-term TRMM climatology to investigate whether high aerosol concentrations and frequent lightning in the northern hemisphere are associated with more vertically developed reflectivity profiles. In this way we can more fully investigate the coupling between aerosols and deep convection central to development of the MJO.

Finnish Meteorological Institute (FMI)

Finnish Meteorological Institute (FMI) has been sharing the expertise on lightning location data and systems in various developing countries in 2014. The Consultancy Service Unit of FMI is coordinating and involved in projects for example in Nepal, Vietnam, and in the South Pacific Ocean with the aim to enhance the meteorological readiness of these developing countries and regions. In each project, one component is to provide the basic knowledge of lightning location and its applicability in operational forecasting and in climate and commercial services, respectively. The training has been noted to be of extremely useful so that the countries have the basic skills to use lightning location data, and even to determine their future needs for e.g. national lightning location systems. The workshops and hands-on trainings have been a success. Also, the projects have made possible the joined investigations and peer-reviewed publications on the local occurrence of thunderstorms (for Nepal, see Mäkelä et al. 2013. Thunderstorm characteristics in Nepal during the pre-monsoon season 2012. Atmos. Res., 137, 91-99). Figure 1 shows an example of cheerful participants and experts in one of the most recent workshops.

The European Meteorological Satellite Organization (EUMETSAT) is launching the Third Generation Geostationary Satellites (MTG) at the end of this decade. One of the novel instruments in the payload is an optical Lightning Imager (LI), with the capability to continuously detect total lightning over Europe, Africa and Atlantic Ocean. To ensure the fluent use and understanding of the data after the launch of the instrument, EUMETSAT has been coordinating the generation of proxy data. -"The proxy data enables this new data to be tested by the operational forecasters at the meteorological services. The feedback from the forecasters is important for understanding the end-user needs and expectations", says Dr. Jochen Grandell, the PI of the Lightning Imager Science Advisory Group at EUMETSAT. At the moment, FMI together with IMGW (Poland), RMI (Belgium) and DWD (Germany) are conducting a user survey for the LI. Besides the user survey, the project consists of proxy data generation from LF and VHF ground-based lightning location data, and the proxy data assimilation into Local Analysis and Prediction System (LAPS). The project outcomes will be published in 2015.

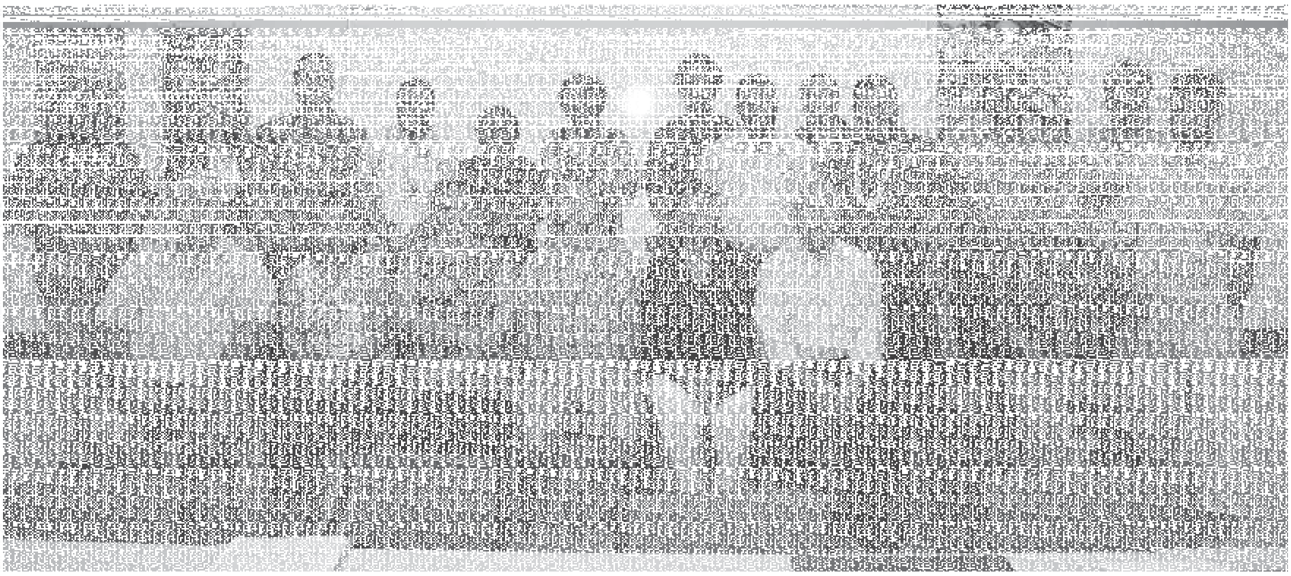


Fig. 1. *The participants and FMI experts of the Lightning Location Workshop in Apia (Samoa) in October 2014 in the Finnish-Pacific (FINPAC) Project. Workshop participants were from Niue, Tuvalu, Fiji, Palau, Solomon Islands, Papua New-Guinea, Vanuatu, Kiribati, Cook Islands, Marshall Islands and Samoa.*

Israel Atmospheric Electricity Research

Profs. Colin Price (Tel Aviv University) and Yoav Yair (Interdisciplinary Center, Herzliya) continue with their joint research in Atmospheric Electricity. Together with PhD student Roy Yaniv we are studying the fair weather currents and electric fields in the Negev Desert. In a recent field experiment in collaboration with the University of Reading, we have launched a number of balloons carrying sensors to measure the conductivity and ionization up to 40km. Simultaneous measurements were carried out in Israel, UK, Russia, Antarctica and Spain (with a slight delay). We are interested in studying how the cosmic radiation ionization profile changes as a function of geomagnetic latitude, and also during solar storms. For movie of launch in Spain with go-pro camera see: https://www.youtube.com/watch?v=xOe2KtSWRKU.

Prof. Yair continues the ILAN sprite observation campaign for the 8th year, together with Prof. Colin Price and students from Tel-Aviv

University. Winter thunderstorms over the Mediterranean Sea produce sprites and they are being observed from Tel-Aviv and Mitzpe-Ramon. A paper summarizing the results of previous seasons had been submitted to Atmospheric Research, presenting over 500 sprites observed through the years. An upgrade for faster cameras will be attempted in early 2015, with cameras borrowed from industrial optical firms.

PhD student Israel Silber continues to study the narrow band VLF data collected in Israel. We have detected an interesting semi-annual cycle in the narrowband VLF data that appears to be linked to gravity waves that propagate upwards from the troposphere. The semi-annual cycle is also seen in the local OH temperatures at 87km, and in the global airglow characteristics. A paper on this topic is in preparation.

PhD student Gal Elhalel is working on the impact of weak ELF fields on cardiac cells of mice. In collaboration with researchers from Bar Ilan University in Israel, we have found some interesting impacts of weak ELF fields on the Calcium ion transfer accompanied with the spontaneous contractions of cardiac cells. Three independent experiments have been performed, all showing similar results.

PhD student David Shai Applbaum is working on infrasound signatures from sprites in Israel. Using the infrasound stations in Israel, he has detected signatures related to sprites observed by the ILAN campaign that continues every winter in Israel. In addition, David has found some interesting infrasound signatures in Israel related to the eruptions of Mt. Etna in Italy.

PhD student Daria Dubrovin has completed her thesis, which is now in review. Her thesis titled "Laboratory and theoretical study of extra-terrestrial sprites" is available to anyone on request.

***Fig.** Prof. Yoav Yair with radiosonde ready for launch at the Wise Astronomy observatory of Tel Aviv University in Mitzpe Ramon, Israel.*

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

With support from the Storm973 Project (Dynamic-microphysical-electrical processes in severe thunderstorms and lightning hazards) as the key basic research program of China, LAGEO conducted the field experiments on thunderstorm and lightning during summer of 2014, including Beijing Lightning NETwork (BLNET) and Shandong Artificially Triggering Lightning Experiment (SHATLE).

The BLNET is consisted of 15 stations equipped with fast/slow antennas and VHF antenna, forming a regional lightning detection network with capability of multi-band integrated observations of lightning, including VLF, LF, HF, and VHF frequency band. Theoretical simulations showed that the 2-D location error of this network is less than 200 m within the network and 3 km at the range of 100 km outside. Preliminary results of lightning location show a good performance of the system and more improvement will be made to obtain high-quality 3-D location results.

During SHATLE2014, nine negative flashes were triggered with the classical rocket-and-wire technique. The experiment also concerns general observation on natural lightning with different detection means and remote detection of Transient Luminous Events with low-light level cameras.

1. The bidirectional development of a dart leader

The bidirectional propagation of a dart leader developing through the preconditioned channel was observed by high-speed video camera operated at 10,000 fps. The leader initially propagated downward through the upper channel with decreasing luminosity and speed and terminated at an altitude of about 2200 m. Subsequently, it restarted the development with both upward and downward channel extensions. The 2-D speed of the leader was in the 10^6m/s range, and the upward positive portion extended faster than the downward negative portion.

2. VHF radiation locations of a rocket-triggered lightning flash with a total of 16 strokes

A negative lightning flash with 16 leader-return stroke sequences triggered with the classical rocket-and-wire technique was observed. Using a short-baseline VHF lightning location system with continuous data recording capability, the upward positive leader was mapped immediately from the tip of metal wire during the initial stage, developing at a speed of about 10^4 m/s. The upward positive leader and all the negative leaders propagated along the same channel with few branches inside the cloud, which might be the reason for the relatively small charge transfer despite a large number of stroke sequences. The 2D imaging results also show that dart leaders may transform into dart-stepped leaders after a long time interval between successive strokes.

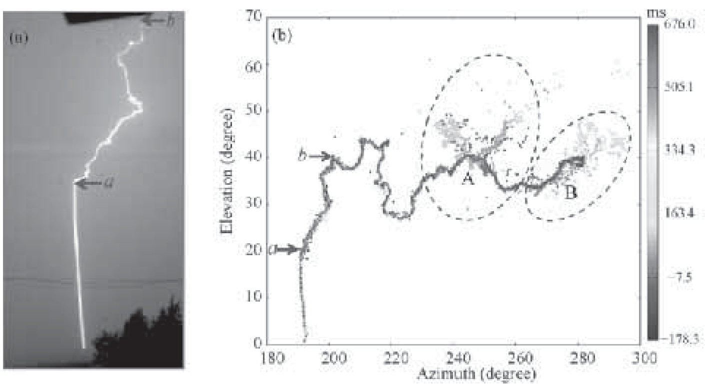


Figure 1 *Discharge channel of the triggered lightning flash as shown by (a) one frame from high high-speed video images, and (b) 2-D VHF radiation source locations.*

3. Application of total-lightning data assimilation based on the WRF model

A total lightning data assimilation method was proposed and applied in a mesoscale convective system (MCS) simulation with the Weather Research and Forecasting (WRF) model.

Empirical formulas between total lightning flash rate and ice-phase particle mixing ratio were constructed. The constructed nudging functions were then added into the WSM6 microphysical scheme of WRF to adjust the mixing ratio of ice-phase particles within a temperature layer from 0°C to -20°C isotherms. The method was examined and the result showed that the representation of convection was significantly improved one hour after the lightning data assimilation. The precipitation center, amount and coverage were all much closer to the observation in the sensitivity run with lightning data assimilation than in the control run without lightning data assimilation.

4. Simulation of thunderstorm charge structure using a RAMS model

Electrification and simple discharge schemes are coupled into a 3D Regional Atmospheric Model System (RAMS) as microphysical parameterizations, in accordance with electrical experiment results. The dynamics, microphysics, and electrification components are fully integrated into the model with inductive and non-inductive electrification mechanisms being considered in the charging process. The simulated charge structure and lightning frequency are basically consistent with observations of the lightning radiation source distribution. Non-inductive charging mechanism contributed to the electrification during the whole lifetime of the thunderstorm, while the inductive electrification mechanism played a significant role in the development period and the mature stage when the electric field reached a large value. The charge density in the convective region was twice that in the rearward region.

5. Comprehensive Pattern of Deep Convective Systems over the Tibetan Plateau–South Asian Monsoon Region

The spatio-temporal variation and convective properties of deep convective systems (DCS) over the Tibetan Plateau–South Asian monsoon region are investigated using 14-yr TRMM data. About 23% of total DCSs develop into intense DCSs (IDCSs; with 40-dBZ echo tops exceeding 10 km) in the southern Himalayan front (SHF), followed by the TP (21%) and the least over the ocean (2%). The average 20-dBZ echo-top height of IDCSs exceeds 16 km and 9% of them even exceed 18 km. DCSs and IDCSs are the most frequent over the SHF, especially in the westernmost SHF, where the intensity is the strongest. DCSs over the TP are relatively weak in convective intensity and small in size but occur frequently. Oceanic DCSs possess the tallest cloud top and the largest size with markedly weaker convective intensity. Both DCSs and IDCSs mainly occur in the afternoon. DCS has a peak in August, whereas IDCS peaks in May.

6. Unusual Atmospheric Light Emissions

Unusual atmospheric light emissions were observed from a station located in Shandong Province of East China. The main morphology of these events includes a bright glowing spot, which differs distinctly from any type of transient luminous events (TLEs) recognized in literature (such as sprites, halos, elves, gigantic jets, blue jets, and blue starters). The comparison of four observations of such light emission events with the data from lightning detection networks does not reveal any correlation between these events and the intense lightning activity in the adjacent area.

RESEARCH ACTIVITY BY INSTITUTIONS

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

Three-dimensional propagation characteristics of the upward connecting leader

To study the process of lightning flashes striking tall structures, a field experiment has been conducted in Guangzhou, Guangdong Province, China, a metropolis that contains many tall structures. The Tall-Object Lightning Observatory in Guangzhou (TOLOG) was established. Two observation stations are included in our experiment. The main observation station is located on a ~100 m building and the sub-station is located on a ~70 m building.

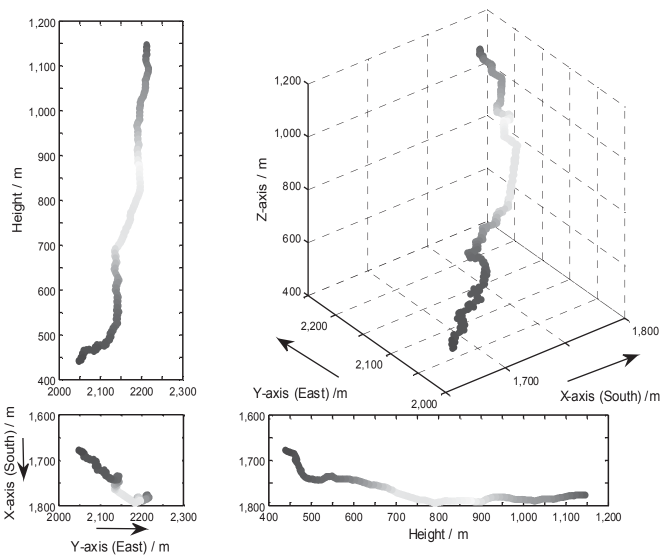


Fig. 1. The 3-D reconstruction results of the UCL for F1215. It contains the 3-D reconstruction channel of the UCL (top right), the projection of the 3-D reconstruction channel in the Y-Z plane (top left), the X-Y plane (bottom left) and the X-Z plane (bottom right). The colors indicate height increase.

Six downward negative flashes are analyzed. The three-dimensional (3-D) lightning channels are reconstructed from dual-station optical observations. Figure 1 shows the 3-D reconstruction results of the upward connecting leader (UCL) in the flash numbered F1215. For each reconstructed 3-D UCL channel, its 3-D length and speed are calculated. The 3-D length values of the six positive UCLs range from 180 to 818 m. There are 38 3-D speed values which are calculated combining the 3-D UCL channel and the high-speed images for the six UCLs. The 3-D speed values range from 0.8 to 14.3×10^5 $m\cdot s^{-1}$ and four of them (11%, 4/38) are on the order of 10^6 $m\cdot s^{-1}$. For comparison, the corresponding two-dimensional (2-D) parameters are calculated using the single-station high-speed images. The values of the 2-D length and 2-D speed range from 147 to 610 m and 0.3 to 10.6×10^5 $m\cdot s^{-1}$, respectively. From the statistical analysis, we determine that the average value of the 3-D speed can be 1.3 times the 2-D speed. When the time is approaching the return stroke (RS), the propagation speed of the UCL is increasing. All of the four 3-D speed values on the order of 10^6 $m \cdot s^{-1}$ occur less than 0.2 ms prior to the RS. When the 3-D length is shorter than 300 m, 77% (20/26) of the corresponding 3-D speed values are smaller than 5×10^5 $m \cdot s^{-1}$. When the 3-D length is longer than 300 m or the UCL tip height is higher than 650 m, all of the corresponding 3-D speed values are faster than 5×10^5 $m \cdot s^{-1}$.

Lightning Research Group of Gifu University (Gifu, Japan)

With the support from the lightning research group of University of Florida (UF), we have been continuing our high speed optical observation experiments at The International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida by using two LAPOSs (Lightning Attachment Process Observation System). During 2014, we have re-configured one of our LAPOSs to study the detailed progression of an individual step of dart-stepped leaders. The data are under analysis.

At the ICAE2014 held at Norman, USA, Wang et al. reported the lightning attachment processes of five natural lightning with 3 of them occurring on site of ICLRT. All the first return strokes are found to initiate at a height above the ground. Return strokes with larger peak current tend to initiate higher, similar to the results previously obtained for rocket triggered strokes.

At the ICLP2014, Wang et al. reported that the height-dependent attenuation characteristics of return stroke peak light intensities within the lowest tens of meters of the lightning channel. All return strokes studied follow a similar height-dependent attenuation tendency (decrease in light intensity peak amplitude and increase in rise time) in their upward propagation from their initiation heights. While in their downward propagation, although 10 out of 11 return strokes decreased their light intensity amplitudes, only 3 out of 11 return strokes have exhibited an increased rise time. The attenuation within the lowest tens of meters of the lightning channel tends to be much stronger than that over the remaining propagation.

Dr. Mi Zhou, from Wuhan University of China, is currently working in our group. Although he has just been here for 10 months, he has finished 3 scientific papers with one of them having been accepted by JGR. The following is the abstract of his JGR paper. Correlation between channel-bottom light intensity and channel-base current of all discharge processes of a rocket triggered lightning flash, including ICC pulses, ICC pulse background continuing current (IBCC), return strokes, M-components and M-component background continuing currents (MBCC), has been analyzed in detail. A rough linear correlation has been found between the current squared and the light intensity for ICC pulses (including peaks of different ICC pulses), IBCC, initial rising stage (IRS) of return strokes (including current peaks of different strokes), and MBCC. The slopes of the correlation regression lines for the current squared versus light intensity of ICC pulses and IBCC are similar, but they are about 2~3 times smaller than the slopes of MBCC and 5~7 times smaller than the slopes of the IRS of return strokes. In contrast, a rough linear correlation has been found between the current and the light intensity for the later slow decay stage (LSDS) of return strokes and for the M-components. The slopes of the correlation regression lines of the current versus the light intensity for these two processes are found to be similar. No simple correlation has been found between the current and the light intensity for the initial fast decay stage (IFDS) of return strokes. These IFDS of return strokes generally last from several microseconds to several tens of microseconds and are more or less directly proportional to the corresponding peak return-stroke current squared. A time delay ranging from 12 μs to 300 μs has been found between the current and the light intensity of all ICC pulses and M-components. The time delay decreases as the corresponding peak current increases.

Our observation on lightning that strike on a rotating windmill and its nearby lightning protection tower during winter seasons has being continued for 10 years. In this winter, we are hosting a 9 station LMA from New Mexico tech. Dr. Thomas and Dr. Edens have stayed at our observation site for two weeks and got all the LMA set up as planned.

Los Alamos National Laboratory (LANL)

Elise Pusateri and Heidi Morris

An electron swarm model has been developed to study the time evolution of low-energy conduction electrons produced by photoelectron ionization of air observed in an Electromagnetic Pulse. This environment is characterized by electric field and pressure and is assumed to be composed of 78% N_2, 21% O_2, and 1% Ar. The code developed for this model uses an adaptive time step and solves a system of coupled differential equations for electric field, electron temperature, swarm electron number density, drift velocity, and positive and negative ion density. Collision frequencies and rate coefficients, including the momentum and energy transfer collision frequency, ionization rate, and 2- and 3-body attachment rate to oxygen, are calculated using an updated set of cross sections taken from the Phelps database on the LXcat website. The electron distribution function is calculated using BOLSIG+, a two-term Boltzmann solver and is described by the electron temperature. We are working to fully include recombination to N_2^+ and O_2^+, along with mutual neutralization in the swarm model in order to properly track the electron, positive, and negative ion densities. For this analysis, the equilibrium temperature, which refers to the steady state value reached when the energy gained from the electric field balances the energy lost through various scattering collisions, is determined for atmospheric heights up to 40 km. The equilibrium time, which corresponds to the time it takes to reach this steady state temperature, is also found. This is compared to the results obtained by Longmire (1978) using a single equation for the electron temperature. The results are shown in the table below.

We can see that the results for equilibrium temperature are within 20% of each other. The swarm calculated equilibrium times can be 2-6 times greater than the Longmire calculated equilibrium times. The changes represented in the newly calculated values may be attributed to the use of a full set of swarm equations and also differences in the calculated energy and momentum transfer collision frequencies. The other processes can be neglected for the values of E/N that were used here. Future work lies in including water vapor content in the model and studying how that affects calculations.

Table 1. Equilibrium temperatures, U_e, and times, t_{eq}, versus altitude found by Longmire (Longmire, 1978) and calculated using the swarm model with updated collision frequencies and reaction rates from BOLSIG+.

Altitude [km]	U_e (Longmire) [eV]	U_e (BOLSIG+) [eV]	t_{eq} (Longmire) [s]	t_{eq} (BOLSIG+) [s]
0	0.17	0.191	7.00E-10	1.63E-09
10	0.35	0.43	9.00E-10	2.98E-09
20	1	1.049	3.00E-10	7.64E-10
30	1.6	1.5	3.00E-10	1.13E-09
40	5	4.48	1.00E-10	3.32E-10

MIT Parsons Laboratory (Cambridge, MA, USA)

Earle Williams has received a Visiting Fellowship from the Hungarian Academy of Sciences, and is currently interacting with Gabriella Sátori's Schumann resonance group (József Bór, Tamás Nagy, Veronika Barta, István Lemperger, Ernő Prácser) in Sopron, Hungary. The interaction at the Geodetic and Geophysical Institute there has also expanded to Eötvös University in Budapest, where some preliminary whistler comparisons have been undertaken with Janos Lichtenberger on lightning flashes parent to elves in the ISUAL data set of Yen-Jung Wu. Sátori and Williams recently traveled to Krakow, Poland to visit with the Schumann resonance group of Andrzej Kulak at Jagiellonien University. This meeting has led to a joint study of the relative merits of symmetrical and asymmetrical Lorentzian modal fits on Schumann resonance spectra and the impact of the source receiver proximity on the asymmetry parameter. These considerations are important in obtaining the most accurate inputs to multi-station inversion of the Schumann background observations for global lightning activity. Bob Boldi and Anirban Guha have been major players in these comparisons. At MIT, Yen-Jung Wu's work continues to focus on the chemistry-related linkages between elves and the OH airglow layer. A one-year satellite database of ISUAL elves has been compared with the Vaisala NLDN/GLD360 archive (with generous assistance from Ryan Said in improving the hit rate) to improve on the geolocation/height estimates for elves. Haiyan Yu is extending the earlier Nelson (1967) PhD thesis work on treating the forward problem for Schumann resonances in absolute units, and in implementing an accurate day-night model for the Earth-ionosphere cavity.

RESEARCH ACTIVITY BY INSTITUTIONS

Texas A&M University，Dept. of Atmospheric Sciences

Richard E. Orville and Gary Huffines. Insights into Lightning Climatology Derived from Twenty-Five Years of USA National Lightning Detection Network (NLDN) Maps: 1989-2013.

Cloud-to-ground lightning data from the NLDN are summarized in annual maps, 1989-2013, for the continental United States. We have not altered the recorded data in any way with the exception of deleting all positive lightning reports with peak currents less than 15 kA. All data were analyzed with a spatial resolution of 20-km. We analyze total (negative and positive) flashes for ground flash density, the percentage of positive lightning, the negative and positive first stroke peak currents and the flash multiplicity. The Gulf Stream is "outlined" by higher flash densities off the East Coast of the United States. The annual percentage of positive lightning to ground varies from less than 2% over Florida to values exceeding 25% off the West Coast. There is a relatively sharp transition from low to high median negative peak currents along the Gulf and Atlantic coasts of the USA. No sharp transitions are observed for median positive peak currents. Relatively lower positive peak currents occur throughout the southeastern USA. Over the twenty-five year period, we note that the latitude of maximum flash density has apparently increased from 28 degrees to 33 degrees latitude.

Richard E. Orville, Tom Warner and John Helsdon. UPLIGHTS Lightning Spectra: -CG from Horizontally Extensive IC Flash.

A horizontally extensive intracloud flash had positive leaders travel along cloud base while corresponding negative leaders traveled incloud. Branches of the visible positive leaders decayed and produced numerous recoil leaders. In one case, the negative end of the recoil leader transitioned to stepping in virgin air and traveled down to the ground initiating a negative cloud-to-ground return stroke. The return stroke traveled back up and out the path formed by the preceding recoil leader and to the tip of the decayed positive leader branch. Luminosity faded in the channel path formed by the recoil-to-stepped leader/ return stroke sequence and numerous other recoil leaders initiated along the same path and traveled to ground initiating subsequent negative return strokes. This flash was captured at 1,000 ips without spectra and at 11,001 ips with spectra. The spectra of the negative end of the recoil leader as it steps downward in virgin air is well resolved. Some of the subsequent dart leaders as well as resulting return strokes are also well resolved with spectra. The return strokes show typical channel cooling from the first frame of the return stroke sequence.

University of Florida (Gainesville, FL, USA)

A total of 27 full-fledged lightning flashes were triggered in 2014 at Camp Blanding (CB), Florida. Nineteen flashes contained leader/return stroke sequences (a total of 79) and eight were composed of the initial stage only. Eighteen triggered flashes with return strokes, besides being recorded at CB, were recorded at the Lightning Observatory in Gainesville (LOG) and fourteen also at the Golf Course station in Starke, at distances of 45 and 3 km, respectively. The University of Oklahoma team used two radars to guide the triggering effort at Camp Blanding and the NSSL team flew balloons though the local storms.

William Gamerota defended his Ph.D. Dissertation titled "The Dart-Stepped Leader in Rocket-Triggered Lightning". John Pilkey defended his Ph.D. Dissertation titled "The Physics of Lightning Studied Using Lightning Mapping Array, Electric Field, and Optical Measurements". Terry Ngin defended his Ph.D. Dissertation titled "Channel-Base Current and Ground-Level Electric Fields of Rocket-and-Wire Triggered Lightning".

M.D. Tran, V.A. Rakov, and S. Mallick wrote a paper titled "A negative cloud-to-ground flash showing a number of new and rarely observed features". An unusual natural lightning flash containing two branched negative strokes to ground was recorded at the Lightning Observatory in Gainesville, Florida, on 8 June 2013. The flash was apparently a bolt from the blue, whose first-stroke leader emerged from the side of the cloud at a height of about 3.5 km above ground level. The first leader showed profuse branching and what appears to be corona-like formations with spatial extent of 100 to 200 m (probably an intensified portion of radial corona sheath) at the upper part of the channel. Leader branching process facilitated by two simultaneous space stems was observed. The corresponding step lengths were estimated to be 14 and 15 m. The first-stroke attachment process involved a streamer zone about 50 m in length. One of the ungrounded second-leader branches appeared to abruptly change its direction at the beginning of return stroke process. The paper is published in the Geophysical Research Letters.

T. Ngin, M.A. Uman, J.D. Hill, R.C. Olsen III, J.T. Pilkey, W.R. Gamerota, and D.M. Jordan, authored a paper titled "Does the lightning current go to zero between ground strokes? Is there a current "cutoff"?". At the end of 120 prereturn stroke intervals in 27 lightning flashes triggered by rocket-and-wire in Florida, residual currents with an arithmetic mean of 5.3 mA (standard derivation 2.8 mA) were recorded. Average time constants of the current decay following return strokes were found to vary between 160 μs and 550 μs, increasing with decreasing current magnitude. These results represent the most sensitive measurements of interstroke lightning current to date, 2 to 3 orders of magnitude more sensitive than previously reported measurements, and contradict the common view found in the literature that there is a no current interval. Possible sources of the residual current are discussed. The paper is published in the Geophysical Research Letters.

University of Mississippi, Oxford, MS USA

We continue to examine the lightning data that we collected around the NASA Kennedy Space Center region in Florida during the summers of 2010 and 2011. In conjunction with operational 3-D VHF mapping data (LDAR2), VLF/LF return stroke locations (CGLSS), and electric field mill (LPLWS) data acquired at KSC, we deployed ten slow and fast E-change antennas and a high-speed video camera, along with VLF/LF stroke locations from a LINET system deployed in 2010. Some of our recent results from these analyses include the following:

Karunarathne et al. (2014) modeled six "classic" Initial Breakdown Pulses (IBPs) using three modified transmission line models called MTLL, MTLE, and MTLK. Locations of the six

IBPs were obtained using time-of-arrival and used as model input, while recorded IBP waveforms from six to eight E-change sensor sites were used as model constraints. All three models were able to reasonably fit the measured IBP waveforms; the best fit was most often given by the MTLE model. For each individual IBP, there was good agreement between the three models on several physical parameters of the IBPs: current rise-time, current fall-time, current propagation speed, and total charge moment change. Currents in the MTLL and MTLE models moved a negative charge downward and deposited an equivalent positive charge along their paths; the mean Q values were 0.35 C for MTLL and 0.71 C for MTLE. MTLK model deposited negative charge along its lower path and positive charge along its upper path, with mean values of 0.27 C.

Stolzenburg et al. (2014) examined luminosity and leader propagation during the initial breakdown stage of a single CG flash. The video data, beginning at 6.06 km altitude and 31.86 ms before the return stroke, show multiple branch ends advancing concurrently in the first 6 ms of the flash. Each branch began with IBPs, and the burst intensity in the video data was directly related to the IBP amplitude in the E-change data. Each initial leader branch end transitioned into a stepped leader branch end at a different time, resulting in a complex E-change waveform including relatively narrow step-type pulses during the IB stage and no apparent Intermediate stage prior to the Leader stage in this case. Radar and time-of-arrival lightning source data indicated that the IB luminosity detected by the video camera came from about 6 km deep within the thundercloud echo. The main 1276 m-long initial leader transitioned to a stepped leader at about 5.0 km, near the altitude of the radar bright band. There was no visible evidence of an upward propagating leader end above the initial IB sources prior to the RS.

Marshall et al. (2014) describe an Initial E-Change (IEC) found immediately before the first initial breakdown pulse in both CG and IC flashes. The IECs are detected only when nearby E-change data are available, i.e., a sensor within 80% of the reversal distance of the IEC. For 18 CG flashes the IECs had an average point dipole moment of 23 C-m and an average duration of 0.18 ms; these parameters for 18 IC flashes were -170 C-m and 1.53 ms. The IECs of CG flashes began with a change in slope of the E-change (with respect to time) from zero to a positive slope. For IECs of IC flashes the beginning slope change was from zero to a negative slope. In 14 of 36 cases, the IEC beginning was coincident with a discrete, impulsive source of VHF radiation; another 13 cases had at least one VHF source during the IEC or the first IB pulse. Before the IECs, there were no preliminary variations detected in the 36 flashes. It is hypothesized that lightning initiation begins with an ionizing event that causes the IEC and that the IEC enhances the ambient electric field to produce the first IB pulse.

Vaisala, U.S.A.

The following papers were published by Vaisala in the areas of lightning locating system behavior, lightning climatology, lightning physics, characteristics, and modeling.

RESEARCH ACTIVITY BY INSTITUTIONS

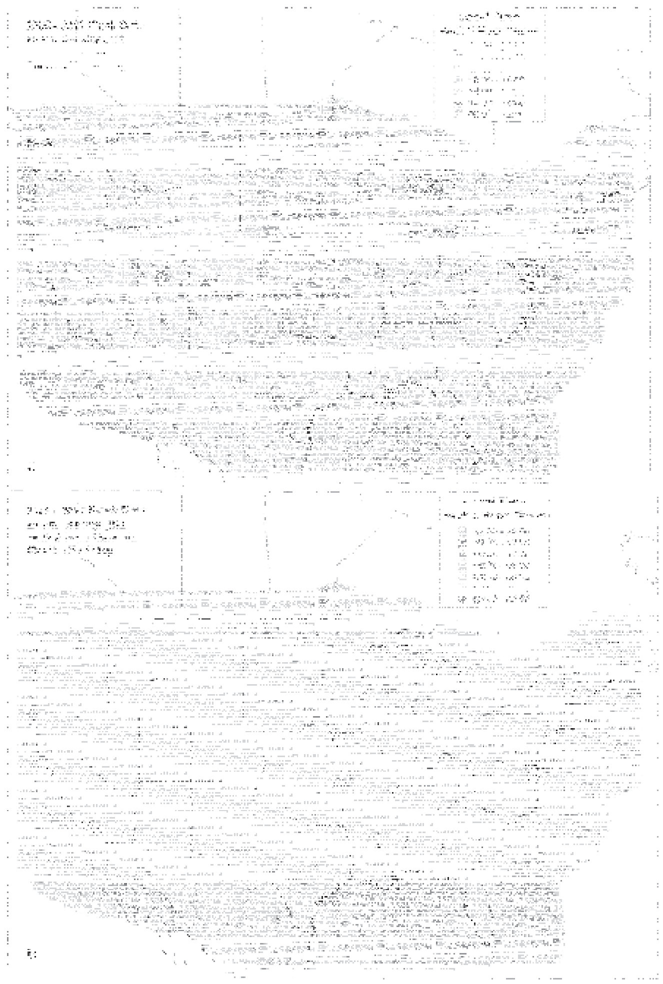
Nag, A., V.A. Rakov, and K.L. Cummins, 2014: Positive Lightning Peak Currents Reported by the U.S. National Lightning Detection Network. IEEE T. Electromagn. C., 56, 2.

Abstract—We infer peak currents from radiation electric field peaks of 48 positive return strokes acquired in Gainesville, FL, USA, from 2007 to 2008. In doing so, we use the transmission line model, National Lightning Detection Network (NLDN) –reported distances, and assumed return-stroke speed. From a similar analysis of negative subsequent strokes, it appears that the implied return-stroke speed in the NLDN field-to-current conversion equation is 1.8×10^8 m/s (the NLDN peak current estimation algorithm is calibrated for negative subsequent strokes). The NLDN uses the same field-to-current conversion procedure (and hence the same implied return-stroke speed) for positive return strokes. However, NLDN-reported peak currents for positive return strokes differ from peak currents predicted by the transmission line model with an assumed return-stroke speed of 1.8×10^8 m/s. The discrepancy between regression equations for negative and positive return strokes suggests that the NLDN procedure to compensate for field propagation effects and find the average range-normalized signal strength (RNSS) works differently for these two groups of strokes. We find that the difference can be explained by the bias toward NLDN sensor reports from larger distances for positive strokes combined with the higher relative sensor gain (the ratio of sensor's peak current estimate to the NLDN-reported peak current) at larger distances.

Holle, R.L., 2014: Diurnal variations of NLDN-reported cloud-to-ground lightning in the United States. *Mon. Wea. Rev.*, 142, 1037-1052.

Abstract—National maps of cloud-to-ground lightning flash density in flashes•km^{-2}•yr^{-1} for one or more years have been produced since the National Lightning Detection Network (NLDN) was first deployed across the contiguous 48 U.S. states in 1989. However, no single publication includes maps of cloud-to-ground flash density across the domain and adjacent areas during the entire diurnal cycle. Cloud-to-ground lightning has strong and variable diurnal changes across the United States that should be taken into account for outdoor lightning-vulnerable activities, particularly those involving human safety. For this study, NLDN cloud-to-ground flash data were compiled in 20 by 20 km grid squares from 2005 to 2012 for the lower 48 states. A unique feature of this study is that maps were prepared to coincide with local time, not time zones. NLDN flashes were assigned to two-hour time periods in five-degree longitude bands. Composite maps of the two-hour periods with the most lightning in each grid square were also prepared. The afternoon from 1200 to 1800 LMT provides two-thirds of the day's lightning. However, lightning activity starts before noon over western mountains and onshore along Atlantic and Gulf of Mexico coasts. These areas are where recurring lightning-vulnerable recreation and workplace activities should expect the threat at these times, rather than view them as an anomaly. An additional result of the study is the mid-day beginning of lightning over higher terrain of western states, then maximum activity moves steadily eastward. These storms pose a threat to late afternoon and evening recreation. In some Midwest and plains locations, lightning is most frequent after midnight.

RESEARCH ACTIVITY BY INSTITUTIONS



Nag, A., and V.A. Rakov, 2014, Parameters of Electric Field Waveforms Produced by Positive Lightning Return Strokes, IEEE Transactions on Electromagnetic Compatibility, 56, 4.

Abstract—In 2007–2008, 52 positive cloud-to-ground flashes containing 63 return strokes (52 first, 10 second, and 1 third) were recorded at the Lightning Observatory in Gainesville, Florida. The U.S. National Lightning Detection Network located 51 (96%) of the positive return strokes at distances of 7.8–157 km from the field measuring station and correctly identified 48 (91%) of them as cloud-to-ground discharges. In this study, parameters of positive return-stroke electric field and electric field derivative waveforms are examined. The geometric mean (GM) value of initial electric field peak normalized to 100 km for 48 strokes is 18 V/m. The GM peak electric field derivative normalized to 100 km for 27 strokes is 9.0 V/m/µs. The GM zero-to-peak risetime and 10-to-90% risetime for 62 strokes are 6.9 µs and 3.4 µs, respectively, and the GM slow front duration is 5.0 µs. The GM zero-crossing time for 42 strokes is 45 µs and the GM opposite polarity overshoot for 33 strokes is 13% of the peak. These characteristics are compared with those of negative return strokes in Florida found in the literature.

Nag, A., and V.A. Rakov, 2015, A transmission-line-type model for lightning return strokes with branches, Electric Power Systems Research, 118 (2015), pp. 3-7.

Abstract—We examine the effect of channel branching on electric field waveforms produced by first return strokes in negative cloud-to-ground lightning using a modified transmission line model. From computed return stroke electric field waveforms it is found that the presence of an ungrounded branch results in sharper initial peak and a secondary peak in the falling part of the return stroke waveform. The time interval between the primary and secondary peaks depends upon the height of the branching point above ground and the speed at which the incident current wave moves upward from the ground. The presence of branch serves to slightly decrease the magnitude of the opposite polarity overshoot. The effects of the height of the branching point above ground, fraction of total channel current flowing to the branch, and current reflections from the branch unconnected end are illustrated.

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Reminder

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

✧ announcements concerning people from atmospheric electricity community, especially awards, new books...,

✧ announcements about conferences, meetings, symposia, workshops in our field of interest,

✧ brief synthetic reports about the research activities conducted by the various organizations working in atmospheric electricity throughout the world, and presented by the groups where this research is performed, and

✧ a list of recent publications. In this last item will be listed the references of the papers published in our field of interest during the past six months by the research groups, or to be published very soon, that wish to release this information, but we do not include the contributions in the proceedings of the Conferences.

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

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

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

Call for contributions to the newsletter

All issues of this newsletter are open for general contributions. If you would like to contribute any science highlight or workshop report, please contact Daohong Wang (wang@gifu-u.ac.jp) preferably by e-mail as an attached word document. The deadline for **2015 spring** issue of the newsletter is **May 15, 2015**.

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