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Newsletter on Atmospheric Electricity

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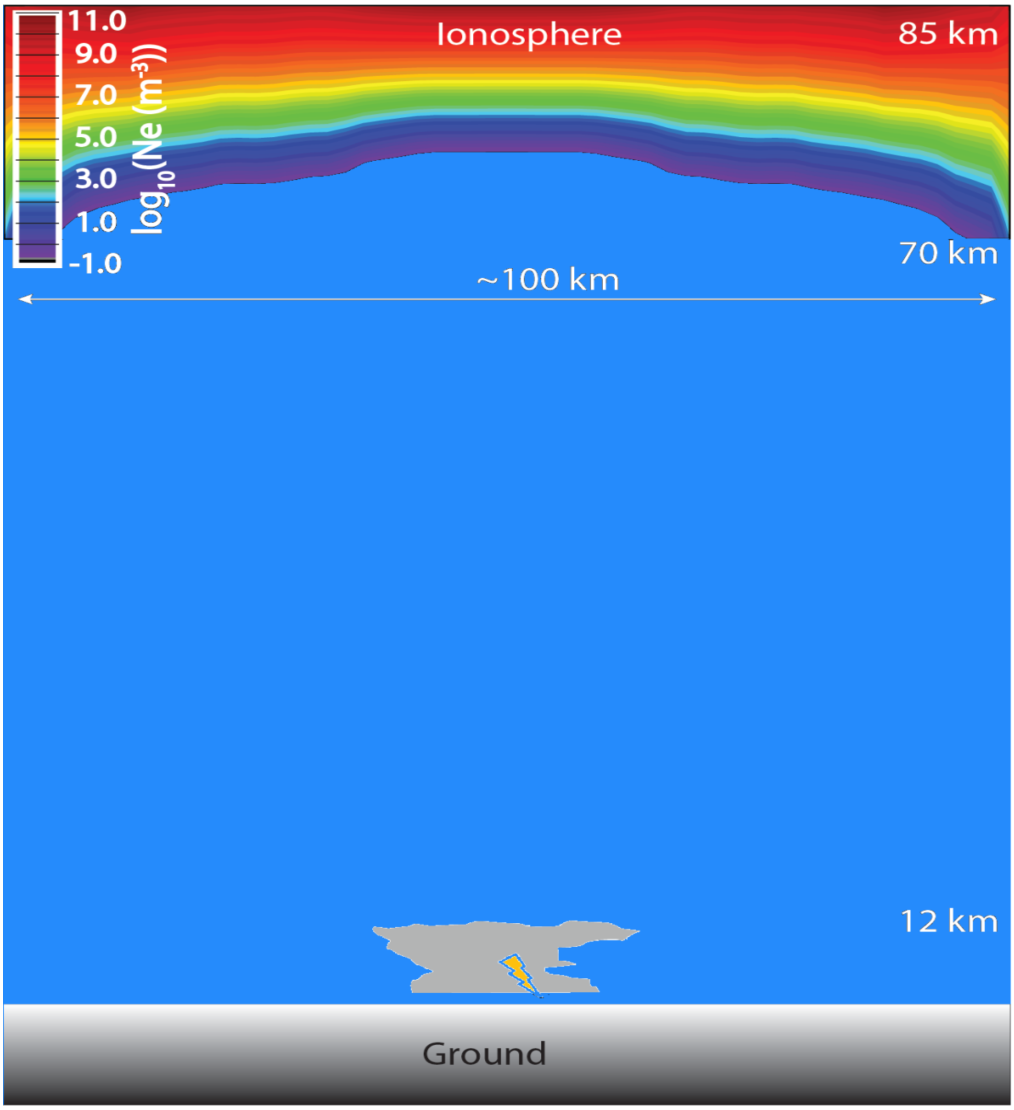
INTERNATIONAL COMMISSION ON ATMOSPHERIC ELECTRICITY (IAMAS/IUGG)

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 recent study by Shao, Lay and Jacobson *(Nature-Geoscience, 6, 2013)* shows that lightning flashes in a small thunderstorm reduces electron density in the nighttime ionospheric D-region. This plot shows a snapshot of the affected D-region electron density profiles atop the storm, at a time when the underlying storm was at its most lightning active stage. The rainbow colors represent electron densities in a logarithmic scale, as shown by the color bar.**

ANNOUNCEMENTS

Two major researchers in Schumann resonances work, Theodore Madden, 88, and Vadim Mushtak, 65, have both died since the last edition of this Newsletter, Madden on November 11 after a long illness in Bedford, Massachusetts and Mushtak on September 25 in a tragic automobile accident in Walker Valley, New York. Their work was highly interconnected by their common use of transmission line methods to treat ELF propagation in the Earth-ionosphere cavity, including the recognized importance of the day-night asymmetry of the ionosphere for an accurate global analysis. The review article by Madden and Thompson (1965) remains one of the most detailed and insightful treatments of Schumann resonances to date, and also introduced the idea about two special layers of energy dissipation in the ionosphere that Mushtak's work had recently put into practice in the inversion problem for the background resonances.

New Books

For a collection of work done by Kasemir (See the 2012 fall issue of ICAE newsletter), please visit
http://onlinelibrary.wiley.com/book/10.1029/SP066;jsessionid=B7C2D97A2BDD3BC2386B09339B20D31A.d01t03.
The printed copy can be purchased:
http://www.wiley.com/WileyCDA/WileyTitle/productCd-0875907377.html.

Conferences

EGU General Assembly 2014

The meeting will be held in Vienna, Austria, from 27 April to 02 May 2014 (http://www.egu2014.eu) and the deadline for Abstract Submission is January 16th, 2014. There are two sessions related to atmospheric electricity.

(1) NH1.4 "Atmospheric Electricity, Thunderstorms, Lightning and their effects"
This session seeks contributions from research in atmospheric electricity on:

1. Cloud microphysics, charge separation and lightning discharge physics
2. Atmospheric electricity in fair weather and the global electrical circuit
3. Atmospheric chemical effects of lightning and the contribution of LtNOx
4. Middle atmospheric Transient Luminous Events
5. Global lightning patterns in an era of climate change
6. Thunderstorms in hurricanes and typhoons
7. Urban effects on lightning distributions
8. Modeling of thunderstorms, lightning

9. Now-casting and forecasting of thunderstorms, flash floods and severe weather
10. Lightning detection networks and sensors from ground and space

(2) AS4.8/NH1.5: "High Energy Radiation from Thunderstorms and Lightning."

During recent years, high energy radiation from lightning and thunderclouds has been measured from space, aircraft, and ground level.

Thunderclouds emit energetic gamma radiation, electrons, and antimatter into space. They also produce continuous energetic radiation, which has been measured at ground level and by aircraft. High energy radiation has also been detected in association with lightning leaders and laboratory sparks. The physical processes associated with these phenomena are not well established yet, neither are the effects of this radiation on the upper atmosphere and the near space environment.

In this session, we welcome contributions regarding experimental observations and theoretical studies related to the production of energetic particles from thunderclouds and lightning discharges.

Especially, phenomena such as terrestrial gamma ray flashes (TGFs), terrestrial electron beams, thunderstorm ground enhancements, and X-ray observations from lightning and laboratory discharges, as well as their relationships to one another are of great interest.

It is possible for young scientist to apply for financial support. This deadline is 29 November 2013. For more information visit the EGU 2014 financial support web page
http://www.mmsend61.com/link.cfm?tid=18769123716&trk=yes&r=1021858767&sid=27875897&m=3110197&u=AGU_&j=15620031&s=http://www.egu2014.eu/support_and_distinction.html.

More information about the EGU General Assembly 2014, visit the EGU 2014 website
http://www.mmsend61.com/link.cfm?tid=18769123716&trk=yes&r=1021858767&sid=27875898&m=3110197&u=AGU_&j=15620031&s=http://www.egu2014.eu/.

International Lightning Detection and International Lightning Meteorology Conferences 2014

The 23rd International Lightning Detection Conference and 5th International Lightning Meteorology Conference will be held from 18 to 21 March, 2014 in Tucson, Arizona, USA. The conferences will be hosted by Vaisala at the Hilton El Conquistador Hotel.

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

- Lightning Physics and Chemistry

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

The conference keynote speech entitled “From Frogs to a National Network” will be given by the distinguished Dr. E. Philip Krider of the University of Arizona.

In addition, the following lectures will be given by invited speakers:
Dr. Steven A. Cummer, Duke University
“Response of the Middle Atmosphere to Lightning Transients”
Dr. Steven J. Goodman, NOAA
“Global Total Lightning Detection: Contributions of the Next Generation Geostationary Weather Satellite Constellations”
Dr. Douglas M. Jordan, University of Florida
“Lightning Experiments at Camp Blanding”
Dr. Carlo Alberto Nucci, University of Bologna, Italy
“Lightning Interactions with Power Systems”
Dr. Farhad Rachidi, Swiss Federal Institute of Technology
” Lightning Experiments on the SANTIS Tower”
Dr. Vladimir A. Rakov, University of Florida
“Parameters Needed for Lightning Protection”
Dr. Steven A. Rutledge, Colorado State University
” Radar Studies of Lightning-Producing Clouds”
Dr. Marcelo M. F. Saba, INPE, Brazil
” Lightning Research with High-Speed Video in Brazil”
Dr. Daohong Wang, Gifu University, Japan
“Lightning Attachment Processes”

The registration and final paper submission deadlines are on 01 February 2013. For more information, visit www.vaisala.com/ildc.

ANNOUNCEMENTS

32nd International Conference on Lightning Protection

The 32nd International Conference on Lightning Protection will be held at Crowne Plaza Shanghai, Oct. 13-17, 2014, Shanghai, China. The ICLP 2014 conference continues the tradition of the preceding ICLP conferences by offering a platform for the exchange of scientific and technical information related to lightning phenomena. Contributions are sought on all topics related to the study of lightning physics, characterization, protection of buildings, electric power systems, electronic systems as well as methods for improving protection of people, animals and property against the effects of lightning. Prospective authors are invited to submit original papers on their latest research results. We also solicit proposals for special sessions, industrial forums, workshops and tutorials. This conference will provide authoritative reviews and papers on the progress and state of lightning research and lightning protection, as well as opportunities for personal contacts between the international community of lightning researchers and lightning protection engineers.

The two page abstract submission deadline is March 1st, 2014.
For details, please visit http://iclp2014.net/.

Status report for ICAE2014, 15-20 June 2014

A total of 324 abstracts have been submitted to the 15th International Conference on Atmospheric Electricity (ICAE2014) spanning the whole range of topics in the call for papers. A local group of scientists at the National Weather Center in Norman, Oklahoma, USA is in the process of organizing the abstracts by topic. The IUGG/IAMAS/International Commission on Atmospheric Electricity will then develop the ICAE2014 program at its December meeting. Authors will be notified of the status of their papers in January, and authors of accepted papers will be requested to submit an extended abstract or a short paper in April. Many excellent papers were submitted, so the program for ICAE2014 promises to give attendees an excellent overview of the present state of atmospheric electricity research.

An ICAE2014 registration form and a link to make lodging reservations at the conference hotel will be available on the conference website (icae2014.nwc.ou.edu) by 3 February 2014. Keep checking the website for updates concerning the ICAE2014 program, local tours, requests for the invitations needed for visas, and activities for spouses. Questions concerning the conference may be sent to icae2014@nwc.ou.edu.

We look forward to welcoming you to Norman, Oklahoma, USA in June for the conference.

The TEA-IS Summer School 2014, in Collioure, France

The goal of the summer school is to provide high-level lectures and training on Atmospheric Electricity. Prominent scholars in the field have agreed upon giving extensive tutorial talks and more focused topical lectures about relevant topics such as lightning, Transient Luminous events, Terrestrial Gamma Flashes, thunderstorms and their role in the atmosphere-ionosphere-magnetosphere system. Contributions from students will be emphasized in special sessions with oral and poster presentations.

The general provisional program is below.

2014 TEA-IS Summer School Collioure, 23-27 June 2014, France

Monday 23: Physics of atmospheric electricity.
Tuesday 24: Lightning induced perturbations of the atmosphere-ionosphere.
Wednesday 25: High Energy Atmospheric Electricity.
Thursday 26: Perturbations of the atmosphere-ionosphere induced by thunderstorms.
Friday 27: Current and future space projects: objectives, instrumentation and expected impacts.

Information about practical issues such as registration, venue, and housing will be communicated in a subsequent announcement.

** Important Deadlines **
Registration starts: February 1st, 2014
Deadline to apply for Funding: February 15, 2014
Abstract Submission: March 15, 2014

The TEA-IS Summer School Local Organizing Committee:
Elisabeth Blanc and Thomas Farges,
Atomic Energy and Alternative Energies Commission (CEA), France.
Sebastien Celestin and Jean Louis Pinçon,
Laboratory of Physics and Chemistry of the Environment and Space (LPC2E), University of Orleans, CNRS, France

http://lpc2e.cnrs-orleans.fr/~scelesti

RESEARCH PROJECT

Storm-penetrating A-10 research aircraft

Haflidi Jonsson
CIRPAS
3200 Imjin Rd.
Marina, CA 93933

Andrew Detwiler
Dept. Atmospheric Sciences
SDSMT
Rapid City, SD 57701

A storm-penetrating research aircraft is being developed for use by the atmospheric science research community. The project is funded by the U. S. National Science Foundation Division of Atmospheric and Geospace Sciences. The Center for Interdisciplinary Remotely-piloted Aircraft Studies (CIRPAS) at the U. S. Naval Postgraduate School is directing the project. Other partners in the project include Zivco Aeronautics, in Guthrie, Oklahoma, and the South Dakota School of Mines and Technology, in Rapid City, South Dakota. Once ready for use, the aircraft will be operated by CIRPAS as part of the NSF Lower Atmospheric Observing Facility program. The project has been underway for two years. An A-10 aircraft has been brought up-to-date and also demilitarized by the U.S. Air Force and transferred to CIRPAS for modifications. ZIvco Aeronautics has been modifying the aircraft for research use, including retrofitting with civilian flight instrumentation, rebalancing after removal of main anti-tank gun, and addition of alternators for research electric power production, research wiring, a data acquisition system, and hardpoints and connectors for instrumentation and pod-mounted instrument suites mounted underwing. Basic instrumentation initially will include a collection of state-of-the-art aerosol and cloud physics probes currently in the CIRPAS inventory, an air-motion sensing system, and a suite of electric field meters. There will be ample payload and power capacity to carry user-supplied instrumentation.

RESEARCH ACTIVITY BY INSTITUTIONS

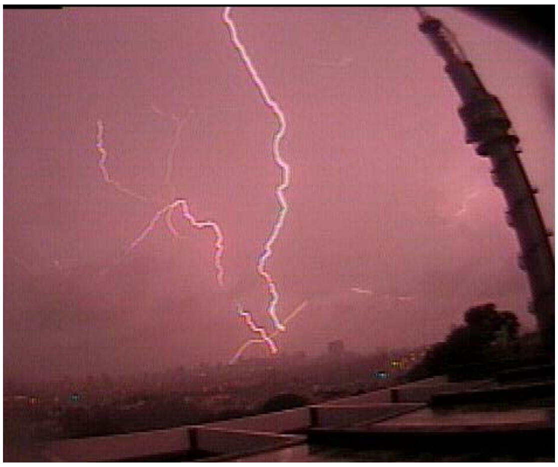
Atmospheric Electricity Group (ELAT), Brazil

Tens of upward lightning flashes have been recorded by high-speed cameras and electric field sensors in Sao Paulo, Brazil, since January 2012. Some of the upward lightning flashes were also recorded with a lightning mapping array (LMA) installed in Brazil during the summer of 2012. The simultaneous and combined observations of upward lightning flashes with different techniques helped us to understand the physical processes that occur during an upward flash.

The analyzed characteristics of upward flashes were: total duration, presence of subsequent return stroke, previous lightning events, M-component and recoil leader presence.

The detection accuracy of upward flashes by different lightning detection networks present in Brazil is under analysis.

The figure below shows some upward flashes that were triggered by the same positive cloud-to-ground flash even though they were initiated in towers 11km apart from each other.



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

Dr. Gaopeng Lu joined the research team as a talent of "One Hundred Person Project of the Chinese Academy of Sciences" in July, 2013. He earned the Ph. D. degree in physics at New Mexico Institute of Mining and Technology, USA, and proceeded on his postdoctoral study at Duke University.

Storm973 (Dynamic-microphysical-electrical processes in severe thunderstorms and lightning hazards) Project, committed to the research of 1) Interaction of dynamic, microphysical, and electrical processes in severe thunderstorm, 2) Mechanism of lightning initiation and propagation, and hazards causality, and 3) Assimilation of special observation data and the associated incorporation into forecasting model of severe thunderstorms, will be launched in 2014 with a joint effort of several institutes from Chinese Acadamy of Sciences, China Meteorological Administration and 4 universities. Comprehensive detection on thunderstrom in Beijing and rocket-triggering-lightning experiments in Shandong and Guangdong will be conducted in coordinance during the project execution in 2014-2018.

To detect severe thunderstorms around Beijing, Storm973 will use 2 C-band multi-parameter radars, Beijing Lightning Network (BLNet) covering 3 frequency band and disdrometers. The campaign will also incorporate the meteorological operational networks of S-band Doppler radar, CG lightning, rain gauge and automatic meteorological station. The BLNet was set up since 2009 and consists of 10 stations that cover over an area of about 50 km in diameter. Fast and slow electric field antennas and very high frequency (VHF) sensors are equipped at each station for the observation of detail physical processes of lightning. The ongoing efforts of BLNet aim to achieve a real-time imaging and monitoring of the lightning activity in Beijing.

Shandong Artificially Triggering Lightning Experiment continued to conduct in the summer of 2013, and the experiment also concerns general observation on natural lightning and remote detection of Transient Luminous Events with low light level cameras (at different sites). Analysis of a triggered flash with more-than-usual dart leader-return strokes is in progress.

The current research findings of LAGEO focus on following:

1. Characteristics of lightning activity and charge structure of squall lines

The characteristics of lightning activity and charge structure of squall lines were analyzed based on the data of SAFIR3000 lightning detection network and Doppler radar. The lightning radiation sources were found to mostly distribute in the convective leading region with a high reflectivity in front of the squall line. A good correlation was found between the total lightning and the convective precipitation, indicated an influence of the dynamical and microphysical process of squall line on the lightning occurrence. As the system developed, the vertical distribution of the lightning radiation sources evolved from two layers into three layers.

2. Climatological features of deep convections

Using 12 years TRMM data and NCEP reanalysis data, climatological features of deep convective systems (DCSs, with 20 dBZ echo-top extending 14 km) over the Asian monsoon region were analyzed. DCSs occur frequently in mid-latitude regions especially in southern slope of the Himalayas during monsoon season. DCSs over the Tibetan Plateau are weak in convective intensity and small in horizontal scale, but occur and approach the tropopause frequently, which is usually not possible in other lower regions. DCSs in central-eastern China have more robust updrafts and generate more lightning flashes than in other Asian monsoon regions.

3. Processes of -CG flash observed by short-baseline VHF radiation location system

A negative CG flash with multiple strokes observed by short-baseline lightning VHF radiation location system was analyzed in detail. The preliminary breakdown with bi-directional propagations, stepped leader with two main channels, and dart leaders exhibited average speeds in the orders of 10^4 m/s, 10^5 m/s and 10^6 m/s, respectively. Intensive VHF radiation was produced during the intermission between return strokes and after the last return stroke, in form of channel extension in cloud. K processes after the return stroke were found to be caused by negative streamers propagating backwards along the positive electrified channel.

4. Discussion of M-component mechanism based on triggered lightning

The characteristics and mechanism of M-component were analyzed based the current and E-field data obtain in SHATLE. A modified model based on Rakov's "two-wave" theory is proposed and confirms that the evolution of M-component involves a downward wave transferring negative charge from the upper to the lower channel and an upward wave draining the charge transported by the downward wave. The upward wave serves to deplete the negative charge by the downward wave at its interface and makes the charge density of the channel beneath the interface layer to be roughly zero. The calculated and the measured E-field waveforms showed a good agreement.

5. Characteristics of +CG flashes in Da Hinggan Ling, China

185 +CG flashes occurred at DaHinggan Ling of Northeastern China were analyzed based on the multi-station observation with fast and slow antennas. It was found that most of the +CG flashes contained continuing current, with relatively short average duration. The vast majority of +CG flashes was characterized by a single stroke. The average charge transferred by positive stroke and continuing current was +5.2 C at a height of 6.0 km (above ground) and +10.2 C at a height of 6.4 km, respectively. The preliminary breakdown process in +CG can be classified into three types, namely type-S (same), type-D (different) and type-C (chaotic) according to the disparities in the initial polarity of bipolar pulses from the return stroke.

6. Comparative analysis of storms with or without sprites

Three summer thunderstorms were analyzed in detail using multiple data, including Doppler radar, lightning location network, TRMM, MTSAT images, NCEP Reanalysis, and radiosonde. Two of them were sprite-producing and the other was not. The results showed that the storm with strongest convection produced the largest number of sprites, with the precipitation ice, cloud ice and cloud water content in the convective regions being larger than the other storms. The storm microphysical properties along lines through parent CG locations showed no special characteristics related to sprites. The flash rate evolution in the severe storm provided additional confirmation that major sprite activity coincides with a rapid decrease in the negative CG flash rate.

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

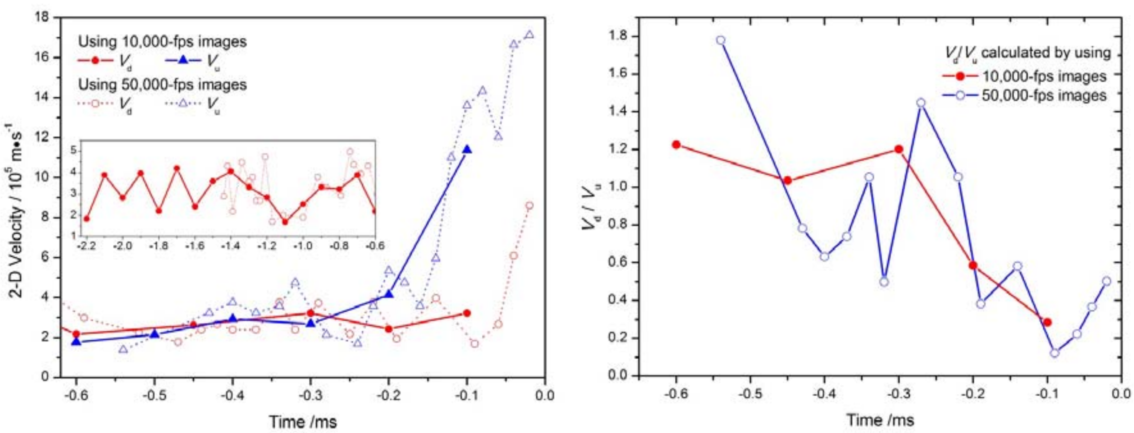
Experiments on Lightning Protection for Automatic Weather Stations Using Artificially Triggered Lightning

The automatic weather station (AWS) is integrated with numerous electronic devices (sensors, data acquisition unit, digital communication device) that are vulnerable to the electromagnetic pulses generated by lightning. Because the field environments in which AWSs are installed are subjected to adverse conditions, they are easily damaged by lightning in actual operation. We used an artificially triggered lightning technique to examine and analyze induced voltage on low-power lines and vertical signal lines, as well as the characteristics of AWS protection devices, to provide a technical basis for perfecting and revising current standards for lightning protection of AWSs. The results indicated that pulses of voltage on the overhead power line corresponding to the return strokes with the peak currents ranging from -6.67 to -26.47 kA showed bipolar features. Sub-peaks and main peaks ranged from 0.99 to 4.47 kV and from –4.98 to –10.31 kV, respectively. The voltage waveforms corresponding to the return strokes on the vertical signal line of wind speed were of two types: with and without a sub-peak after the main peak. All the main peaks, with the peak value from -0.41 to -3.10 kV, were "V" shaped. A significant relationship existed between the peak currents of the return strokes and the 10-90% average gradients of the voltages. The peaks of currents through the SPD ranged from –0.22 to –1.64 kA. The durations of residual voltages ranged from 0.6 ms to 5.9 ms, average value being 2.1 ms.

Variations of leaders' propagation speeds during the attachment process

A field experiment, mainly focusing on the observation of lightning flashes terminating on tall structures, has been conducted since 2009 in Guangzhou, Guangdong, China. The Tall-Object Lightning Observatory in Guangzhou (TOLOG) was established. Here, we analyze a downward negative lightning flash that occurred at 07:13:32 (UT) on 18 July 2011 and struck the 440 m high Guangzhou International Finance Center (GIFC). This flash is labeled F1111 in our database.

The two-dimensional (2-D) propagation speeds of the downward leader (DL) and the upward connecting leader (UCL) during the attachment process of F1111 are calculated by using high-speed images with sampling rates of 10,000 frames per second (fps) and 50,000 fps. The initial 83 m and 96 m of the UCL channel cannot be discerned from the 10,000-fps and 50,000-fps images, respectively, due to the low luminosity of the UCL. The final length of the UCL in F1111 exceeds 400 m. Figure 1a shows the variations of V_d (speed of the DL) and Vu (speed of the UCL). It can be seen that both the DL and the UCL have speeds mainly on the order of 105 m s-1. From the 10,000-fps images, V_d ranges from 1.7 × 105 to 4.2 × 105 m s^{-1} (with an average value of 3.0 × 105 m s^{-1}) between the heights of 700 m and 1320 m AGL, and Vu ranges from 1.8 × 105 to 11.3 × 105 m s^{-1} (average: 4.2 × 105 m s^{-1}) between 490 m and 720 m. From the 50,000-fps images, V_d ranges from 1.7 × 105 to 8.6 × 105 m s^{-1} (average: 3.0 × 105 m s^{-1}) between the heights of 700 m and 1070 m, and V_u ranges from 1.4 × 105 to 17.1 × 105 m s^{-1} (average: 5.0 × 105 m s^{-1}) between 500 m and 790 m.



(a) *(b)*

Figure 1. (a) Variations of 2-D speeds of the DL and the UCL, V_d and V_u. (b) Variation of V_d/V_u.

The ratio of the speeds of the DL and the UCL (V_d/V_u) versus time is shown in Figure 1b. The V_d/V_u calculated by using the 10,000-fps and 50,000-fps images range from 1.2 to 0.28 and from 1.8 to 0.12, respectively. Overall, V_d/V_u exhibits a decreasing trend because V_d shows no clear change, except for the final 80 μs prior to the beginning of the return stroke, while V_u tends to generally increase, as shown in Figure 1a. During the final 160 μs, V_u sharply increases from 3.6 × 105 to 17.1 × 105 m s^{-1}. During the final 80 μs, although both V_d and V_u increase sharply, the former increases faster, so that V_d / V_u increases from 0.12 to 0.50.

Lightning Activity and Precipitation Characteristics of Typhoon Molave (2009) Around Its Landfall

Cloud-to-ground (CG) lightning data and storm intensity and track data are combined with the data from a Doppler radar and the Tropical Rainfall Measuring Mission (TRMM) satellite to analyze the temporal and spatial characteristics of lightning activity in Typhoon Molave (0906) during different periods of its landfall (pre-landfall, landfall, and post-landfall). Parameters retrieved from the radar and the satellite are used to compare precipitation structures of the inner and outer rainbands of the typhoon, and to investigate possible causes of the different lightning characteristics.

The results indicated that lightning activity was stronger in the outer rainbands than in the eyewall and inner rainbands. Lightning mainly occurred to the left (rather than “right” as in previous studies of US cases) of the moving typhoon, indicating a significant spatial asymmetry. The maximum lightning frequency in the tropical cyclone (TC) eyewall region was ahead of that in the whole TC region, and the outbreaks of eyewall lightning might indicate deepening of the cyclone. Stronger lightning in the outer rainbands was found to be associated with stronger updraft, higher concentrations of rain droplets and large ice particles at elevated mixed-phase levels (Figure 2), and the higher and broader convective clouds in the outer rainbands. Due to the contribution of large cloud nuclei, lightning intensity in the outer rainbands had a strong positive correlation with radar reflectivity (Figure 3).

The ratio of positive CG lightning in the outer rainbands reached its maximum 1 h prior to occurrence of the maximum typhoon intensity at 2000 Beijing Time (BT) 18 July 2009. During the pre-landfall period (0300 BT 18 July—0050 BT 19 July), the typhoon gradually weakened, but strong lightning still appeared. After the typhoon made landfall at 0050 BT 19 July, CG lightning density rapidly decreased, but the ratio of positive lightning increased. Notably, after the landfall of the outer rainbands at 2325 BT 18 July (approximately 1.5 h prior to the landfall of the TC), significantly higher ice particle density derived from the TRMM data was observed in the outer rainbands, which, together with strengthened convection resulted from the local surface roughness effect, might have caused the enhanced lightning in the outer rainbands around the landfall of Molave.

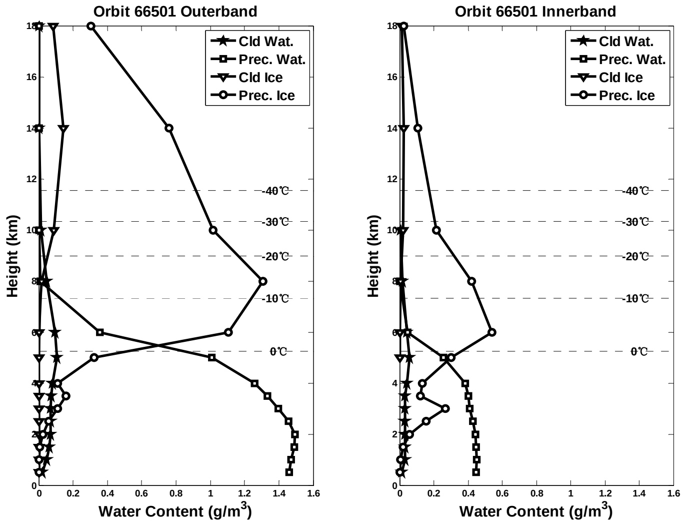


Figure 2. Vertical profiles of averaged particle density of cloud water, precipitable water (PW), cloud ice, and precipitable ice (PI) in clouds over the inner and outer rainbands, retrieved from TRMM/TMI-2A12. The height of each temperature layer is calculated by the temperature-altitude linear relationship with sounding data from Yangjiang Station at 2000 BT 18 July 2009.

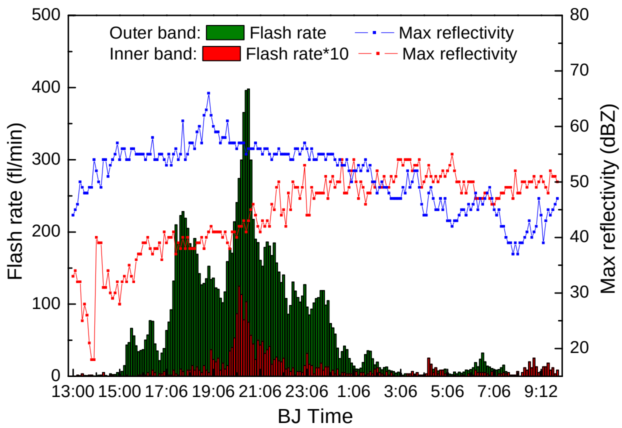


Figure 3. Temporal evolution of radar maximum reflectivity and lightning frequency in the inner and outer rainbands.

Lightning Research Group of Gifu University (Gifu, Japan)

With the support from the lightning research group of University of Florida (UF), we have being continued our high speed optical observation experiments at The International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida by using three LAPOSs (Lightning Attachment Process Observation System). Using the data obtained in 2011 and 2012, D. Wang and N. Takagi, in collaboration with scientists of UF, authored two papers. One paper titled "Initiation processes of return strokes in rocket-triggered lightning". Using a high speed optical imaging system operated at a time resolution of either 10 ns or 100 ns, we have documented the initiation process of 14 return strokes in 4 rocket-triggered lightning flashes. Of the 14 strokes, 9 occurred following dart leaders and 5 following dart-stepped leaders. The return strokes are found to initiate at heights ranging from 7.2±1.4 m to 21.0±4.6 m above the lightning termination point. Return strokes with larger peak current tend to initiate higher. All the return strokes show initial bidirectional (upward and downward from their initiation height) propagation. We have been able to estimate the initial upward propagation speeds below 60 m for all of the return strokes. The resultant speeds range from 0.4×10^8 m/s to 2.5×10^8 m/s. For the downward propagation speeds, only six strokes among the 14 strokes allow us to perform a reasonable estimation. Those downward speeds range from 0.6×10^8 m/s to 1.9×10^8 m/s. Another paper titled "Lightning Attachment Processes of an "Anomalous" Triggered Lightning Discharge".

Using a high-speed optical imaging system specifically designed for observing the lightning attachment process, we have documented the process for stepped, dart, and dart-stepped leaders in an "anomalous" rocket-triggered lightning flash that terminated on a 10 m grounded utility pole. The initiation of the first return stroke was found to occur at a height of 23±3 m above the top of the utility pole and was associated with three "slow-front" dE/dt pulses. A time of 1.5 s later, a fast rise in luminosity at 18±2 m was associated with a "fast-transition" dE/dt pulse. The first return stroke propagated bi-directionally from its initiation height, as did subsequent return strokes from their initiation heights of 8±1 m to 16±2 m above the top of the utility pole. The initial upward speed of the first return stroke was 1.4×10^8 m/s, while its initial downward speed was 2.2×10^7 m/s. The channel-bottom luminosity of the first return stroke rose more slowly to a two-or-more-times larger amplitude than that of the subsequent stroke luminosities. In contrast, the NLDN-derived first-return-stroke peak current is smaller than that of the second and the third strokes, and our electric field records at 45 km show similar behavior for the initial field peaks of the first and subsequent strokes. In the summer of 2013, we have moved two LAPOSs very close (about 20 m) to the rocket launcher intending to obtain better data on upward connecting leader. The data analysis is underway. We have being also analyzed the attachment processes of natural lightning recorded at ICLRT and the results are going to be reported at 2014 ICAE in Norman, Oklahoma, USA, 15-20 June 2014. In addition, D. Wang is going to give a review talk on the lightning attachment process at The 23rd International Lightning Detection Conference to be held from 18 to 21 March, 2014 in Tucson, Arizona, USA.

Our observation on lightning that strike on a rotating windmill and its nearby lightning protection tower during winter seasons has being continued for 9 years. In 2013, we have added two high speed video cameras. Fortunately, we have recorded two positive dart leaders and are going to report them in the coming AGU fall meeting in San Francisco in December, 2013.

MIT Parsons Laboratory (Cambridge, MA, USA)

Anirban Guha from Tripura University in India completed a one-year Fulbright Post-Doc Fellowship at MIT in September. Guha and Bob Boldi (Sayed University, Dubai, UAE) devoted much time to organizing the 20-year data set of calibrated Schumann resonance (SR) observations from the MIT field station in West Greenwich, Rhode Island. Extensive comparisons were made between the variation of SR parameters peak frequency, Q-factor and magnetic intensity. Based on a comparison of these new data with other long-term SR observations in Hungary and Antarctica, the tentative conclusion is that changes in the medium are playing the major role in the variations in all parameters, including the intensity, on the 11-year solar cycle time scale. Further discussion on this issue is planned for the upcoming ICAE in Norman, Oklahoma.

Enrique Mattos, a PhD candidate with Luiz Machado in Brazil, is currently working with Earle Williams on X-band dual pol radar and lightning observations from the CHUVA field experiment in Sao Jose dos Campos. The main goal at present is to distinguish two mechanisms for systematic negative differential reflectivity in the mixed phase region prior to the first lightning flash. The two working hypotheses are the gravity alignment of conical graupel particles and the electric field alignment of ice particles.

Haiyan Yu from the Harbin Institute of Technology has been selected to visit MIT for one year beginning in 2014 to work on ELF inversion methods, aimed at the problem of earthquake prediction in China.

Earle Williams visited Pascal Ortega at the University of French Polynesia in Tahiti in November to discuss the ongoing Schumann resonance measurements there, initiated by Ortega and enabled by the earlier provision of magnetometer coils from Anirban Guha. High quality observations are obtained there day after day, with lightning centers in the Maritime Continent and in the Americas showing up in the NS-oriented magnetic coil and the most prominent lightning center in Africa appearing in the EW-oriented coil. One problem of current mutual interest is the evidence for a fourth tropical lightning 'chimney' near Tahiti, diametrically opposite Africa and roughly 90 degrees of longitude from both the Maritime Continent and South America. This feature may be crucial for the wavenumber-4 structure that is now well documented in the E and F regions of the ionosphere. The ongoing discussion and the new Tahiti measurements will provide valuable new input to the ongoing effort to invert the multi-station background Schumann resonances for global lightning activity.

MIT Lincoln Laboratory (Lexington, MA, USA)

Work continues with the analysis of Convair-580 aircraft observations (from Mengistu Wolde at Canada's National Research Council) in three winter storms in February 2013. Dual pol radar information from the NEXRAD radar in Buffalo, New York was used to guide the aircraft to regions of interest. In one gentle snowstorm on February 28, a predominance of needle crystals was encountered near -6 C, a predominance of hexagonal flat plate crystals at -11 C and a predominance of dendrite crystals at -15 C, with all three crystal types accompanied by supercooled water. These results are consistent with laboratory diffusion chamber measurements by John Hallett and colleagues in which both temperature and humidity are carefully controlled variables. The observed crystal shapes in situ were also broadly consistent with theoretical predictions for radar-measured differential reflectivity, with the hexagonal flat plates showing the largest values (up to +7 dB). These results were presented at the AMS Radar Conference in Breckenridge, Colorado in September.

Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, Geodetic and Geophysical Institute, Sopron, Hungary

The former Geodetic and Geophysical Research Institute has become the part of RCAES since January 1, 2013. One of the Research Groups (former Dept. of Aeronomy) deals with thunderstorm related phenomena as follows: background Schumann resonances (SR), SR transients, transient luminous events (TLEs) and thunderstorm –ionosphere coupling mechanisms by ionograms. TLEs are captured from the top of the Institute above thunderstorms in Central Europe. The other observations are carried out at the Nagycenk (NCK) Observatory near Sopron. Areal variation of global lightning has been found in the 11-year solar cycle deduced from the variations of the daily frequency range of SR. A northward shift of global lightning has been identified attributed to the more intense global warming in the Northern hemisphere since 1993 based on SR frequency observations (Sátori et al., 2013). Morphological classification of sprites observed from Sopron was published this year (Bór, 2013). Decrease of the critical frequency of ionospheric sporadic E-layer has been found after local thunderstorms in the Mediterranean region in the vicinity of the ionosonde station at Rome (Barta et al., 2013). Veronika Barta, PhD student, spent six months in Rome in the frame of ERASMUS program. Our group is participant of the TEA-IS network sponsored by the European Science Foundation. V Barta has also got a grant award of two weeks (TEA-IS) to visit the Geophysical Institute of Prague and study ionograms there when sprites were observed above that region from Sopron. József Bór, PhD, spent one week in the Institute of Physics of the Earth, RAS in Moscow to discuss a new collaboration for studying the origin of oscillation in the SR frequency range observed on the board of CHAMP satellite. We also joined the international SR inversion project conducted by Earle Williams, MIT.

Storm electricity research group at the National Severe Storms Laboratory

The Storm Electricity Team at the National Severe Storms Laboratory launched instrumented balloons in the vicinity of Camp Blanding, Florida, USA during an eighteen-day period in June - July 2013. The balloons measured either the vector electric field or precipitation size spectra for comparison with C-band polarimetric radar measurements by Dr. Mike Biggerstaff at the University of Oklahoma and with triggered lightning measurements by the International

Center for Lightning Research and Testing (ICLRT) at Camp Blanding. One balloon carrying an electric field meter flew through a decaying storm over Camp Blanding during a period in which three lightning strikes were triggered by the ICLRT. The electric field meter showed that the triggered flashes propagated horizontally through a layer of negative charge just above the 0°C isotherm. This was the first vertical sounding of the electric field during a flash triggered by the ICLRT and was the first in a Florida storm. Subsequent balloon flights were made elsewhere in northern Florida, but provided additional electric field soundings and provided precipitation size spectra in two Florida storms.

University of Florida (Gainesville, FL, USA)

A total of 20 full-fledged lightning flashes and 6 attempted upward leaders (events with precursor pulses only) were triggered in 2013 at Camp Blanding (CB), Florida. Twelve flashes contained leader/return stroke sequences (a total of 62) and eight were composed of the initial stage only. Eleven triggered flashes with return strokes, besides being recorded at CB, were recorded at the Lightning Observatory in Gainesville (LOG) and four 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, one such balloon flight measuring the electric field vs. height just before a triggered lightning.

V.A. Rakov wrote a review paper titled “Electromagnetic Methods of Lightning Detection”. Both cloud-to-ground and cloud lightning discharges involve a number of processes that produce electromagnetic field signatures in different regions of the spectrum. Salient characteristics of measured wideband electric and magnetic fields generated by various lightning processes at distances ranging from tens to a few hundreds of kilometers (when at least the initial part of the signal is essentially radiation while being not influenced by ionospheric reflections) are reviewed. An overview of the various lightning locating techniques, including magnetic direction finding, time-of-arrival technique, and interferometry, is given. Lightning location on global scale, when radio-frequency electromagnetic signals are dominated by ionospheric reflections, is also considered. Lightning locating system performance characteristics, including flash and stroke detection efficiencies, percentage of misclassified events, location accuracy, and peak current estimation errors, are discussed. Both cloud and cloud-to-ground flashes are considered. Representative examples of modern lightning locating systems (LMA, NLDN, LINET, USPLN, ENTLN, WWLLN, and GLD360) are reviewed. Besides general characterization of each system, the available information on its performance characteristics is given with emphasis on those based on formal ground-truth studies published in the peer-reviewed literature. The paper is published in Surveys in Geophysics (Springer).

J.D. Hill (now at Stinger Ghaffarian Technologies), J. Pilkey, M.A. Uman, and D.M. Jordan, in collaboration with W. Rison and P.R. Krehbiel of New Mexico Tech, M.I. Biggerstaff and P. Hyland of the University of Oklahoma, and R. Blakeslee of NASA Marshall Space Flight Center, authored a paper titled “Correlated lightning mapping array and radar observations of the initial stages of three sequentially triggered Florida lightning discharges". Correlated Lightning Mapping Array and vertical-scan radar images are presented for three rocket-and-wire triggered lightning flashes that occurred sequentially within 17 min in the presence of a decaying multicellular convective storm system over north-central Florida. The initial stage (IS) of each flash propagated generally vertically to the altitude of the 0°C melting level, about 5 km, and then subsequently propagated for many kilometers horizontally along the melting level contour. Radar images suggest that the propagation paths of the IS channels below and above the melting level were heavily influenced by precipitation gradients. Flash UF 11-24 exhibited a 12.6 km unbranched IS channel, the longest unbranched channel observed in the study by a factor of three. During flash UF 11-25 (119 ms following the cessation of the measured IS current at ground and prior to the first return stroke), a natural cloud-to-ground discharge, perhaps induced by the IS, initiated between 2.5 and 4 km altitude and struck ground 5 to 7 km from the launching facility. The IS of flash UF 11-26 propagated upward through a descending precipitation packet and apparently induced a naturally appearing bi-level intracloud discharge via an upward negative leader that initiated within the IS breakdown region 3.5 km from the launching facility. The upward-negative leader propagated from 5.6 to 9.3 km altitude in a time of 11 ms. The electrical current measured at ground during the IS of flash UF 11-26 exhibited a 57 ms polarity reversal, transferring 19 C of positive charge to ground. The paper is published in the JGR - Atmospheres.

Vaisala, U.S.A.

Holle, R.L., Diurnal variations of NLDN-reported cloud-to-ground lightning in the United States. *Monthly Weather Review*, American Meteorological Society, accepted, 2013.

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.

A. Nag, V. A. Rakov, and K. L. Cummins, Positive lightning peak currents reported by the U.S. National Lightning Detection Network, IEEE Transactions on EMC, doi: 10.1109/TEMC.2013.2280000, in press, 2013.

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 1.8×10^8m/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

Said, R. K., M. B. Cohen, and U. S. Inan (2013), Highly intense lightning over the oceans: Estimated peak currents from global GLD360 observations, *J. Geophys. Res. Atmos., 118*, doi:10.1002/jgrd.50508.

We present the first global distribution of the average estimated peak currents in negative lightning flashes using 1 year of continuous data from the Vaisala global lightning data set GLD360. The data set, composed of 353 million flashes, was compared with the National Lightning Detection Network^{TM} for peak current accuracy, location accuracy, and detection efficiency. The validation results demonstrated a mean (geometric mean) peak current magnitude error of 21% (6%), a median location accuracy of 2.5 km, and a relative ground flash detection efficiency of 57% averaged over all positive and negative reference flashes, and 67% for all reference flashes above 15 kA. The distribution of peak currents for negative flashes shifts to higher magnitudes over the ocean. Three case study 10° x10° regions are analyzed, in which the peak current enhancement is extremely sharp at the coastline, suggesting that the higher peak currents for oceanic lightning cannot be solely attributable to network artifacts such as detection efficiency and peak current estimation error. In these regions, the geometric mean and 95th percentile of the peak current distribution for negative cloud to ocean flashes is 22%–88% and 65%–121% higher, respectively, compared to cloud to ground flashes in nearby land regions. Globally, the majority of all negative flashes with estimated peak current magnitude above 75 kA occur over the ocean.

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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 **2014 spring** issue of the newsletter is **May 15, 2014**.

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