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Note:

3D Total Lightning Observation Network in Tokyo Metropolitan Area (Tokyo LMA)

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The National Research Institute for Earth Science and Disaster Resilience deployed a lightning mapping array (LMA) in the Tokyo metropolitan area in March 2017. Called the "Tokyo LMA," it obtains detailed three-dimensional observations of the total lightning activity (cloud-to-ground and intracloud flashes) in storms. The network initially consisted of 8 receiving stations, expanded to 12 stations in March 2018. Real-time total lightning images were first opened on the webpage in Japan. Real-time observations from the Tokyo LMA will be used in nowcasting lightning hazards and mitigating lightning disasters. Archived data will be used to develop lightning prediction techniques and a lightning climatology for the Tokyo metropolitan area.

Keywords: 3D total lightning, Tokyo LMA, lightning detection

1. Introduction

Lightning discharges are a high-impact phenomenon associated with well-developed cumulonimbus clouds. They are not only dangerous to humans but also cause significant property damage and economic losses. There are currently many two-dimensional operational lightning detection networks in Japan (e.g., the Lightning Detection Network (LIDEN) operated by the Japan Meteorological Agency (JMA) [1] and the Japanese Lightning Detection Network (JLDN) operated by Franklin Japan Co., Ltd. [2]). The LIDEN has 30 observation sites across Japan and the JLDN has 31, both of which provide country-wide coverage. The sites detect atmospheric radio "static" (referred to as "sferics") produced by lightning in the low frequency (LF; 30–300 kHz) radio band. The observations are primarily used to determine the locations where cloud-to-ground (CG) discharges strike ground. Similarly, some electric power companies operate each lightning detection network in each region.

Most lightning discharges in storms are intracloud (IC) flashes that do not strike the ground [3]. In addition, IC discharges usually precede the onset of CG lightning in storms [4–7], making their detection important not only for issuing lightning warnings but also for the development of lightning prediction techniques. To utilize total lightning data for lightning disaster mitigation, the development of a real-time processing technique, a new product with total lightning data, and a product delivery system is expected. Three-dimensional total lightning observations have been performed in Japan (e.g., [8–12]). However, the previous 3D total lightning observations did not have any open products in real time in Japan.

To make use of total lightning observations for research on lightning disaster mitigation, the National Research Institute for Earth Science and Disaster Resilience (NIED) constructed and deployed a set of lightning mapping array (LMA) stations in the Tokyo metropolitan area (**Fig. 1**). The Tokyo LMA has been operational since March 2017 and obtains three-dimensional observations of the total lightning activity in storms, both over and around the greater metropolitan area. In the Tokyo metropolitan area, unique observations on cumulonimbus clouds have been developed. For example, there are many advanced radars such as Ka-band cloud radars [13], X-band multi-parameter (MP) radars [14, 15], a C-band MP radar [16], X-band phased array weather radars (PAWRs) [17, 18], and an X-band MP-PAWR [19]. Moreover, the JMA radars have been successively replaced with C-band MP radars. The Tokyo LMA is the first continuous 3D-total lightning observation in such a unique observation area, which helps to obtain valuable data and results regarding the research development of lightning disaster mitigation. This paper provides an overview of the Tokyo LMA and presents products opened on web pages and examples of initial observation results.

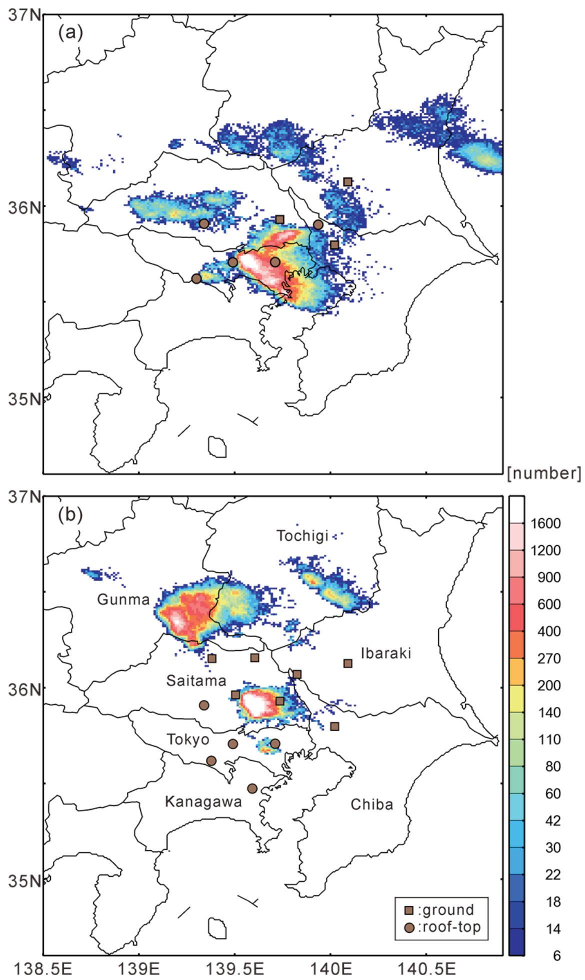

Fig. 1. Lightning data and station locations for (a) the eight-station network in 2017 and (b) the 12-station network in 2018. The colored areas show the number density of LMA sources (per square km) observed over two hours on (a) August 19, 2017, and (b) August 27, 2018, respectively. Square and circular dots show the locations of roof-top and ground installations, respectively.

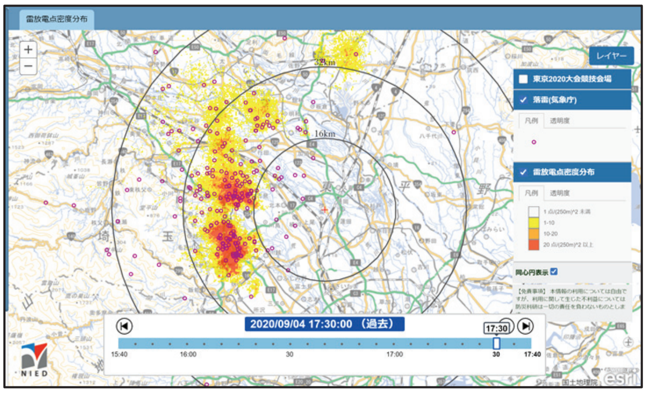

Fig. 2. Weather information system with GIS format, called "SORACHECK." It depicts the plan views of extreme weather conditions, such as lightning, rainfall, wind field, and hail. Shade colors indicate LMA source density, and the purple circles indicate CGs observed by the LIDEN.

2. Data

The LMA was developed at the New Mexico Institute of Mining and Technology (NMT) in 1998 [20] and is based on the Lightning Detection and Ranging (LDAR) system developed at the NASA Kennedy Space Center [21]. Each sensor of the LMA detects the time of arrival of impulsive very-high-frequency (VHF) radiation produced by electrical breakdown as lightning propagates through a thunderstorm [20, 22]. Peak events are detected in successive 80 μs time windows for signals above the threshold value. Decimated data from each sensor are transmitted to a central server in real time and processed on a minute-by-minute basis to generate a series of plan and vertical projection images that are posted on a web page. These include:

1. The current activity over the most recent 2 or 10-minute time period, updated every minute, showing the LMA source density on a 1 $\times$ 1 km grid or the individual LMA sources. The images of the lightning activity during successive 10-minute and hour-long intervals are archived for each day.
(https://mizu.bosai.go.jp/LMA/LMAwatching/)

2. Animation of the latest three-hour set of the 10-minute source density images updated every minute, showing the development and motion of the storms and storm systems.
(https://mizu.bosai.go.jp/LMA/LMAwatching/)

3. Plan view of 10-minute LMA source density on a 1 $\times$ 1 km grid updated every five minutes with geographic information system (GIS) format (**Fig. 2**). In the viewer, plan view images can go back by two hours and superpose the CG discharges observed by the LIDEN. On the same webpage, extreme weathers of rainfall, wind field, and hail, which are caused by the developed cumulonimbus clouds, can also be monitored.
(https://isrs.bosai.go.jp/soracheck/storymap/?entry=4)

In addition, the complete 80 μs station data are downloaded every night for the previous day and post-processed to produce archived data files.

The stations of the Tokyo LMA are spread over an area 90 km in diameter, with the urban stations operating on a locally unused television channel in the upper VHF (Japan Channel 9; 192–198 MHz). Being in a quieter RF environment, outlying rural stations operate in the lower VHF (U.S. Channel 3, 60–66 MHz) for greater sensitivity. About half of the stations are set up on the ground and the others are set up on roof-tops (**Figs. 1** and **3**). The processing typically locates tens to several hundreds of VHF sources per flash, revealing the development of individual flashes and identifying their type. The rms uncertainty in the time-of-arrival measurements is typically

Fig. 3. Typical LMA installations on the ground (left panel: Kumagaya Station) and roof-top (right panel: Toyama Station). The stations are solar powered and operate on a fully stand-alone basis, communicating their data via cellular data modems to a central processing server. The rectangular enclosure houses deep-cycle batteries and a sealed electronics box containing the VHF receiver, data processor, GPS, cellular data modem, and solid-state disk. The stations were specially designed by NIED to be rugged and low-profile to withstand typhoons.

25–30 ns rms, and corresponds to location uncertainties over the network of 6–12 m rms in the horizontal and 20–30 m rms in the vertical [22].

The LIDEN and JLDN data were used in this paper for reference. In the analysis, negative CG lightning discharge was adjudged with LIDEN or JLDN data because the return stroke of negative CG discharge could be observed with high detection efficiency. IC and positive CG discharges were judged with the lightning paths observed by the Tokyo LMA.

3. Results

In this section, we present some examples of the observations of lightning activity over the Tokyo metropolitan area. On August 30, 2017, three storm cells were developed almost simultaneously in close proximity to each other (**Fig. 4**); each lightning activity had different characteristics. Cell C2 initiated first among the three cells and produced only IC flashes for about 20 minutes before the first CG flash occurred (**Fig. 4(c)**). On the other hand, the first flash in cell C1 was a negative CG flash, and the storm alternated back and forth between −CGs and ICs (**Fig. 4(b)**). C3 started producing lightning 20 minutes after C2 and produced only IC flashes over its 17-minute lifetime (**Fig. 4(d)**). This variability is consistent with observations in other storms as reported, for example, by MacGorman and Rust [23]. MacGorman et al. [24] investigated the timing of IC flashes relative to the CG flashes using LMA, LDAR II, and U.S. National Lightning Detection Network (NLDN) observations in three regions (Oklahoma, North Texas, and the high plains) of the USA. They showed that 50% of storms produced a CG flash within 5–10 minutes after the lightning activity started, and approximately 10% did not produce a CG flash within one hour in Oklahoma and North Texas. An important study with the Tokyo LMA will be conducted to determine how often and what types of storms in the Tokyo area begin with CG flashes and how many storms do not produce CG flashes. These and other statistical studies are made possible by the essentially 100% detection efficiency for different types of lightning flashes and will help clarify the climatological characteristics of total lightning activity in Japan and develop lightning warning techniques. The JLDN provides a useful adjunct to the LMA data by confirming the occurrence of the CGs, while also indicating where the lightning actually struck ground. The JLDN detected five CGs in cell C1 and nine CGs in cell C2, and it was confirmed that the Tokyo LMA detected all of the CGs detected by the JLDN in the storms. On the other hand, the JLDN detected only 3/13, 13/113, and 3/21 IC flashes detected by the Tokyo LMA in the three cells.

Figures 5 and **6** show examples of individual lightning discharges observed by the Tokyo LMA over the Tokyo metropolitan area. The LIDEN detected one point in each event. **Fig. 5** shows an IC flash that occurred later in cell C2 on August 30, 2017. The discharge had a bilevel structure, which is typical of IC flashes. The lower and upper levels correspond to the main negative and upper positive charge regions of the storm, respectively [25]. In all, 249 radiation sources were located during the flash, with most produced by a negative polarity breakdown in the upper positive charge region and relatively few sources in the lower, negative charge region. This asymmetry in the number of sources is typical and is mainly due to the negative polarity breakdown radiating more strongly at VHF than the positive polarity breakdown [25, 26].

The top panel of **Fig. 5** shows the temporal development of the flash. The breakdown began with a negative leader propagating upward into and horizontally through the upper positive charge. Significant radiation was not

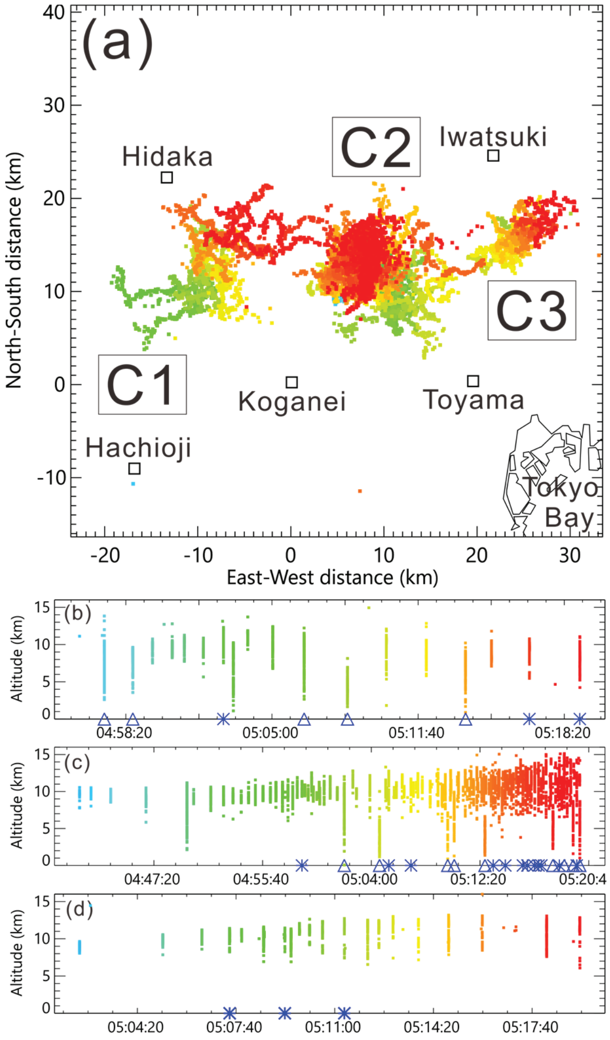

Fig. 4. Observations of lightning activity during a 40-minute time window in three storm cells on August 30, 2017. (a) Plan view of the activity colored by time progression and showing locations of Tokyo LMA stations. (b, c, d) Altitude vs. UTC time of the discharges in cells C1, C2, and C3, respectively. Triangle and star symbols indicate times and locations of −CG and IC discharges detected by the JLDN, respectively.

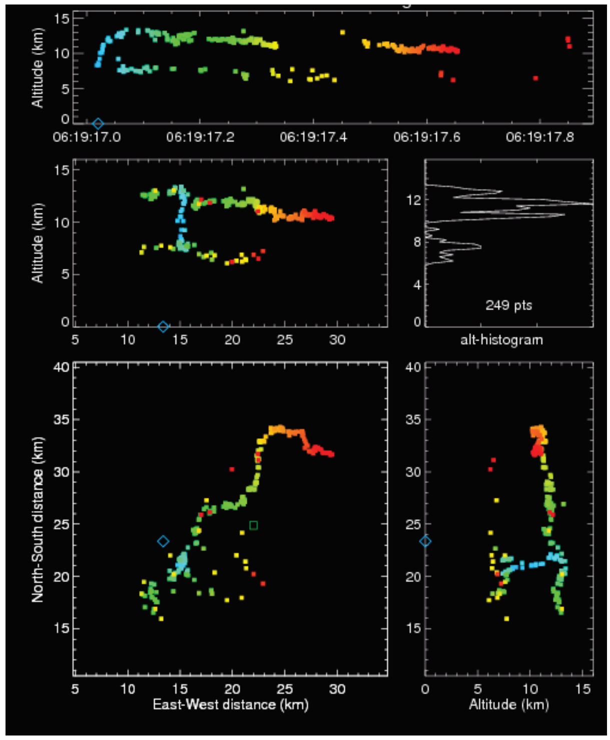

Fig. 5. Observations of an intracloud (IC) lightning discharge on August 30, 2017. The colors indicate time progression, and the different panels show altitude vs. time (top) and the threedimensional structure of flash in plan view and east-west and north-south vertical projections. A histogram of the source heights is shown in the middle right panel. The diamond indicates the time and location of the intracloud event detected by LIDEN. The squares in the plan view indicate the location of the Tokyo LMA measurement stations. The unit of time is UTC.

detected in the negative charge region until after a time delay of about 40 ms. Hereafter, the radiation was primarily associated with the negative polarity breakdown back along the path of the undetected positive leaders in the negative charge region [20, 25]. The remaining panels show the VHF sources in plan and vertical projection views, with the histogram showing the number of sources in the two levels.

There is a particularly dangerous type of CG discharge called a bolt-from-the-blue (BFB). Rather than going directly to the ground through the lower positive charge, BFBs begin with negative-polarity breakdown that initially develops upwards as an IC discharge toward or into the storm's upper positive charge region but exits from the side of the storm and goes downward to the ground at a distance from the core of the storm. Although the channel to ground often appears to emanate from the upper positive charge region, it actually discharges the lower negative charge to the ground. BFB discharges were first observed with the LMA by Rison et al. [20] and Thomas et al. [26] in New Mexico storms, and they commonly occur in such localized storms.

Figure 6 shows an example of a BFB. In this case, the discharge exited in a northwestward direction from the storm and went to the ground about 5 km to the northwest of the core. A total of six such "spider-like" BFBs occurred in cells C1 and C2 during the time interval, as depicted in **Fig. 4**. The occurrence frequency of the BFB was not known in Japan because BFBs have been reported only by photographers. The frequency of occurrence of BFBs in Japan was first investigated in this study. A statistical analysis using the Tokyo LMA data will provide the general characteristics of BFB frequency in Japan.

Figure 7 shows a similar CG discharge relative to 3D radar observations of the parent thunderstorm. The flash initiated at an altitude of 6 km near the high reflectivity core of the storm and developed horizontally away from the core for about 60 ms before turning directly downwards to the ground in a manner similar to the BFB shown in **Fig. 6**. The final source of the downward leaders was

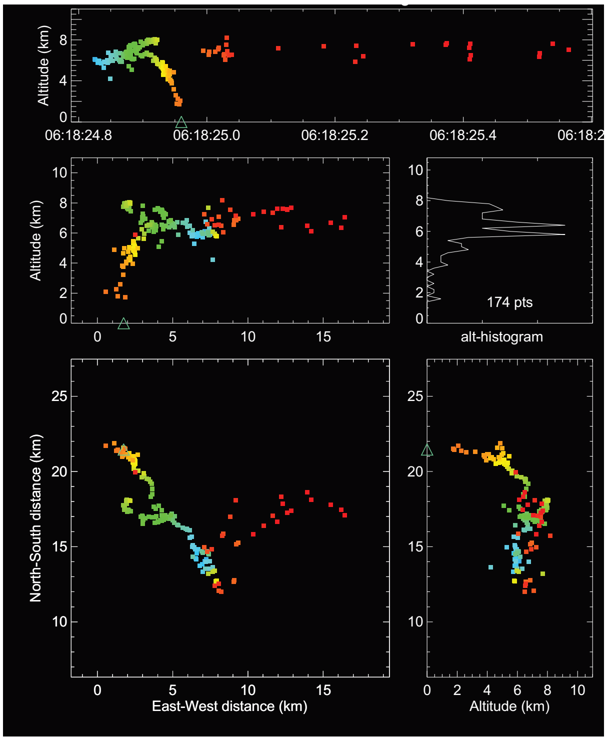

Fig. 6. Same as **Fig. 5** but for an observation of a bolt-from-the-blue CG lightning discharge later in cell C2 of **Fig. 4**.

within 400 m of the ground strike location as determined by LIDEN (**Fig. 7**). The Tokyo LMA has been accumulating data for more than three years, facilitating the development of new warning products for BFBs.

4. Summary

The Tokyo LMA was deployed in the Tokyo metropolitan area in 2017 by NIED and locates the total lightning activity in storms in three dimensions continuously in time. A 3D total lightning image that updates in real time is first available on the webpage in Japan for the purpose of research development for lightning disaster mitigation. In this paper, the initial results of the Tokyo LMA are presented: The differences between the Tokyo LMA and existing operational lightning observations are shown in the total lightning activity (**Figs. 2**, **4–7**). A particularly dangerous type of lightning discharge, BFB, was visualized with the Tokyo LMA. The observations obtained will be used to investigate the climatology of total lightning and also develop lightning prediction and warning techniques for mitigating lightning disasters. Moreover, unique radar observations for the cumulonimbus cloud have been developed in the Tokyo metropolitan area [13–19]. The Tokyo LMA is the first continuous 3D-total lightning observation in this unique observation area. It is expected that valuable data and result on the research development of lightning disaster mitigation will be obtained.

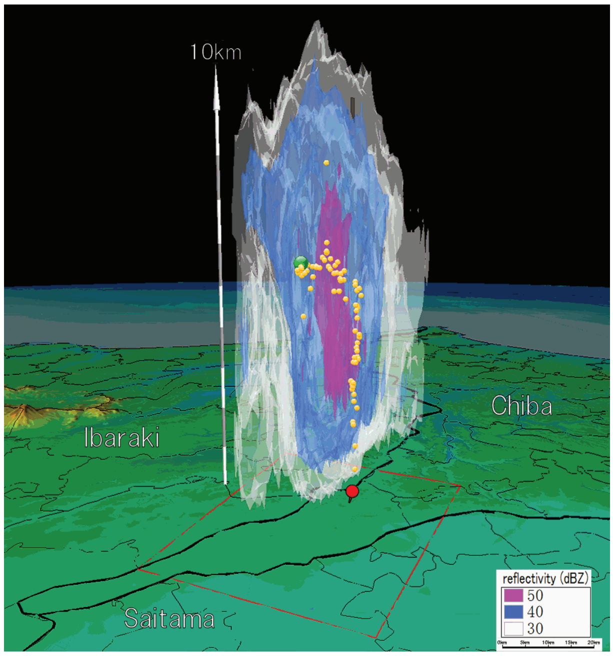

Fig. 7. 3D VHF radiation sources (dots) and radar reflectivity (shaded color) for a CG flash that occurred at 17:11 Japan Standard Time (JST = UTC + 9 hours) on June 16, 2017. The reflectivity data are from an X-band PAWR [17]. Yellow dots indicate VHF radiation sources detected by the Tokyo LMA. The green dot indicates the initial radiation source of the CG flash. The red pin indicates the location of the CG discharge determined by LIDEN. The vertical arrow indicates 10 km height. The map color indicates elevation and is published by the Geospatial Information Authority of Japan.

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References:

[1] Japan Meteorological Agency, https://www.jma.go.jp/jma/kishou/know/toppuu/thunder1-2.html (in Japanese) [accessed August 14, 2019]

[2] A. Sugita and M. Matsui, "Lightning characteristics in Japan observed by the JLDN from 2001 to 2015," The 16th Int. Conf. on Atmospheric Electricity, P-05-06, 2018.

[3] V. A. Rakov, "Fundamentals of lightning," Cambridge University Press, 248pp., 2016.

[4] E. J. Workman and S. E. Reynolds, "Electrical activity as related to thunderstorm cell growth," Bulletin of the American Meteorological Society, Vol.30, pp. 142-144, 1949.

[5] R. M. Lhermitte and P. R. Krehbiel, "Doppler radar and radio observations of thunderstorms," IEEE Trans. on Geoscience Electronics, Vol.17, No.4, pp. 162-171, 1979.

[6] E. R. Williams, M. E. Weber, and R. E. Orville, "The relationship between lightning type and convective state of thunderclouds," J. of Geophysical Research, Vol.94, No.D11, pp. 13213-13220, 1989.

[7] T. Matsui, M. Adachi, J. Onuki, Z.-I. Kawasaki, M. Wada, and K. Matsuura, "Forecasting of cloud-to-ground discharge by SAFIR," IEEJ Trans. on Power and Energy, Vol.116, No.4, pp. 438-443, 1996 (in Japanese and English abstract).

[8] M. Saito, M. Ishii, H. Kawamura, and T. Shindo, "Location of negative charge associated with continuing current of upward lightning flash in winter," IEEJ Trans. on Power and Energy, Vol.129, No.7, pp. 929-934, 2009.

[9] M. Nishihashi, K. Shimose, K. Kusunoki, S. Hayashi, K. Arai, H. Inoue, W. Mashiko, M. Kusume, and H. Morishima, "Three-dimensional VHF lightning mapping system for winter thnderstorms," J. of Atmospheric and Oceanic Technology, Vol.30, No.2, pp. 325-335, 2013.

[10] S. Yoshida, T. Wu, T. Ushio, and Y. Takayanagi, "Lightning observation in 3D using a multi LF sensor network and comparison with radar reflectivity," IEEJ Trans. on Power and Energy, Vol.134, No.4, pp. 188-196, 2014 (in Japanese).

[11] D. Shi, D. Wang, T. Wu, R. J. Thomas, H. E. Edens, W. Rison, N. Takagi, and P. R. Krehbiel, "Leader polarity-reversal feature and charge structure of three upward bipolar lightning flashes," JGR Atmospheres, Vol.123, No.17, pp. 9430-9442, 2018.

[12] T. Wu, D. Wang, and N. Takagi, "Development of fast antenna lightning mapping array (FALMA)," Proc. of 96th Society of Atmospheric Electricity of Japan, pp. 201-202, 2018.

[13] T. Maesaka, "Cloud radars," C. Andronache (Ed.), "Remote Sensing of Clouds and Precipitation," pp. 137-152, Springer, 2018.

[14] M. Maki, T. Maesaka, R. Misumi, K. Iwanami, S. Suzuki, A. Kato, S. Shimizu, K. Kieda, T. Yamada, H. Hirano, F. Kobayashi, A. Masuda, T. Moriya, Y. Suzuki, A. Takahori, D. I. Lee, D. S. Kim, and V. Chandrasekar, "X-band polarimetric radar network in the Tokyo metropolitan area," Proc. of the 5th European Conf. on Radar in Meteorology and Hydrology, 2008.

[15] S. Kuran, "X-band polarimetric (multi-parameter) radar for heavy rainfall disaster," The J. of the Institute of Electrical Installation Engineers of Japan, Vol.34, No.3, pp. 180-183, 2014.

[16] A. Adachi, T. Kobayashi, H. Yamauchi, and S. Onogi, "Detection of potentially hazardous convective clouds with a dual-polarized C-band radar," Atmospheric Measurement Techniques, Vol.6, pp. 2741-2760, 2013.

[17] T. Kashiwayanagi, K. Morotomi, O. Sato, and H. Sugawara, "Rapid 3D scanning high resolution X-band weather radar with active phased array antenna," WHO Technical Conf. on Meteorological and Environmental Instruments and Methods of Observation (CIMO TECO 2016), P2(34), 2016.

[18] T. Adachi, K. Kusunoki, U. Shimada, and J. Ito, "Three dimensional structure of typhoon Mindlle (2016) and near-surface streaks observed by phased array radar," The 38th Conf. on Radar Meteorology, 12B.2, 2017.

[19] N. Takahashi, "Analysis of a precipitation system that exists above freezing level using a multi-parameter phased array weather radar," Atmosphere, Vol.10, No.12, doi: 10.3390/atmos10120755, 2019.

[20] W. Rison, R. J. Thomas, P. R. Krehbiel, T. Hamlin, and J. Harlin, "A GPS-based three-dimensional lightning mapping system: initial observations in central New Mexico," Geophysical Research Letters, Vol.26, No.23, pp. 3573-3576, 1999.

[21] C. Lennon and L. Maier, "Lightning mapping system," Proc. of 1991 Int. Aerospace and Ground Conf. on Lightning and Static Electricity, pp. 89-1-89-10, 1991.

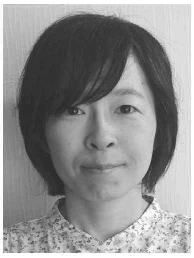
[22] R. J. Thomas, P. R. Krehbiel, W. Rison, S. J. Hunyady, W. P. Winn, T. Hamlin, and J. Harlin, "Accuracy of the lightning mapping array," JGR Atmospheres, Vol.109, No.D14, doi:10.1029/2004JD004549, 2004.

[23] D. R. MacGorman and W. D. Rust, "The electrical nature of storms," Oxford University Press, pp. 422, 1998.

[24] D. R. MacGorman, I. R. Apostolakpoulos, N. R. Lund, N. W. S. Demetriades, M. J. Murphy, and P. R. Krehbiel, "The timing of cloud-to-ground lightning relative to total lightning activity," Cover Monthly Weather Review, Vol.139, No.12, pp. 3871-3886, 2011.

[25] X. M. Shao and P. R. Krehbiel, "The spatial and temporal development of intracloud lightning," JGR Atmospheres, Vol.101, No.D21, pp. 26641-26668, 1996.

[26] R. J. Thomas, P. R. Krehbiel, W. Rison, T. Hamlin, J. Harlin, and D. Shown, "Observations of VHF source powers radiatied by lightning," Geophysical Research Letters, Vol.28, No.1, pp. 143-146, 2001.



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• N. Sakurai et al., "Relationships between Updraft Characteristics and Cloud-to-Ground Lightning Activity in Warm-Season Convective Storms in the Kanto Region, Japan," SOLA, Vol.11, pp. 177-180, 2015.

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• K. Iwanami et al., "Statistical Validation of the Predicted Amount and Start Time of Heavy Rainfall in 2015 Based on the VIL Nowcast Method," J. Disaster Res., Vol.14, pp. 248-259, 2019.

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- S. Shimizu and H. Uyeda, "Algorithm for the identification and tracking convective cells based on constant and adaptive threshold methods using a new cell-merging and -splitting scheme," J. of the Meteorological Society of Japan, Vol.90, pp. 868-889, 2012.
- S. Shimizu et al., "Structure and formation mechanism of a 24 May 2000 supercell-like storm developing in a moist environment over Kanto Plain, Japan," Monthly Weather Review, Vol.136, pp. 2389-2407, 2008.

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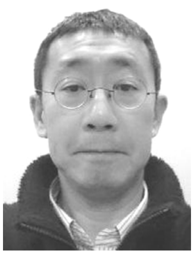

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- S. Suzuki and B. Hoskins, "The Large-Scale Circulation Change at the End of the Baiu Season in Japan as Seen in ERA40 Data," J. of the Meteorological Society of Japan, Vol.87, pp. 83-99, 2009.

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Selected Publications:
• K. Shimose et al., "Two-dimensional Variational Analysis of Near-Surface Moisture from Simulated Radar Refractivity-related Phase Change Observations," Advances in Atmospheric Sciences, Vol.30, pp. 291-305, 2013.
• K. Shimose et al., "Impact of Observation Operators on Low-Level Wind Speed Retrieved by Variational Multiple-Doppler Analysis," SOLA, Vol.12, pp. 215-219, 2016.
• K. Shimose et al., "Analysis of the 6 September 2015 Tornadic Storm Around the Tokyo Metropolitan Area Using Coupled 3DVAR and Incremental Analysis Updates," J. Disaster Res., Vol.12, pp. 956-966, 2017.

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• J. W. Belz et al., "Observations of the origin of downward terrestrial gamma-ray flashes," JGR Atmospheres, Vol.125, doi: 10.1029/2019JD031940, 2020.
• J. Tilles et al., "Fast negative breakdown in thunderstorms," Nature Communications, Vol.10, doi: 10.1038/s41467-019-09621-z, 2019.
• W. Rison et al., "Observations of narrow bipolar events reveal how lightning is initiated in thunderstorms," Nature Communications, Vol.7, doi: 10.1038/ncomms10721, 2016.
• P. R. Krehbiel et al., "Upward Electrical Discharges from Thunderstorms," Nature Geoscience, Vol.1, pp. 233-237, 2008.

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Selected Publications:
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• W. Rison et al., "A GPS-based three-dimensional lightning mapping system: Initial observations in central New Mexico," Geophysical Research Letters, Vol.26, pp. 3573-3576, 1999.

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