

AEM002-01

会場:201A

時間:5月27日 08:30-08:45

Observation, Modelling of Lightning Activity in Hurricanes Observation, Modelling of Lightning Activity in Hurricanes

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Modern global lightning detection networks enable us to monitor and investigate the lightning activity in areas where there is little or no coverage by local lightning location systems, such as the remote regions or the oceans. Hence, we are now better able to track and understand the complex connection between hurricane development and electrical activity in these dangerous storms. In a recent study (Price et al., 2009) it was shown that in category 4-5 hurricanes (typhoons), there is a clear increase of lightning activity approximately one day before the maximum intensity (lowest pressure, strongest winds) of the storm. Additional analysis confirms this initial finding, possibly allowing us to use real-time lightning observations to forecast the time of hurricane intensification. We have also started modeling lightning activity in hurricanes using the WRF mesoscale meteorological model. Numerical simulations of the electrical activity in hurricanes, employing microphysical parameterization of the charging potential (using the Lightning Potential Index, LPI; Yair et al., 2010) show a reasonable agreement with the observations of lightning for the few case studies we have analyzed thus far. Both observations and modeling results will be presented.

Price, C., M. Asfur and Y. Yair, 2009: Maximum hurricane intensity preceded by increase in lightning frequency, *Nature Geoscience*, doi:10.1038/NGEO477, 2, 329-332.

Y. Yair, B. Lynn, C. Price, V. Kotroni, K. Lagouvardos, E. Morin, A. Mugnai, and M. d. C. Llasat (2010). Predicting the potential for lightning activity in Mediterranean storms based on the Weather Research and Forecasting (WRF) model dynamic and microphysical fields, *J. Geophys. Res.*, 115, D04205, doi:10.1029/2008JD010868.

キーワード: Lightning, Hurricanes, Storm Intensity, Detection Networks, Modelling, WRF

Keywords: Lightning, Hurricanes, Storm Intensity, Detection Networks, Modelling, WRF

AEM002-02

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ELF/VLF 帯空電観測に基づいた全球・アジア域における落雷活動の導出 Estimation of the global and Asian lightning activity based on the observation of ELF/VLF sferics

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In the recent decade, many researchers have been attracted to the investigation of global lightning activity. One of the reasons is the progresses in the observation of global lightning discharges. Measurements of electromagnetic waves radiated from CGs with ground-based systems have been developed drastically.

Electromagnetic wave radiated from cloud-to-ground (CG) lightning discharge is observed as transient waveform called as atmospherics or sferics. Sferics in the Very Low Frequency (VLF: 3-30 kHz) and Extremely Low Frequency (ELF: 3-3000 Hz) bands can be detected at a receiver which is several mega-meters from CGs due to the propagation with quite low attenuation. This long propagation enables us to monitor the global CGs activity only with single or few receivers. Using observed waveform in ELF or VLF range, information not only about the location but also about the electrical properties such as polarity, peak current and charge moment (Qdl) of individual lightning stroke can be derived.

In this study, we developed new algorithm to estimate location and charge moments for relatively small Qdl events ($|Qdl| > 950$ C-km). This method is applied to the magnetic fields data observed in 1-100 Hz range obtained by global ELF observation network (GEON), Syowa station in Antarctica, Onagawa station in Japan, Esrange in Sweden, and Santa Cruz in U.S.A. Making use of the time-of-arrival method, the accuracy of geolocation and detection sensitivity is greatly modified. Thanks to this new algorithm, about a millions of CGs can be analyzed with one month (during January 2004). Global CGs distribution is derived with annual data (from October 2003 to July 2004) and about a million CGs whose Qdl are larger than 950 C-km are obtained. The results show the monthly and seasonal variation of global CGs distribution.

Furthermore, a new VLF observation network (Asian VLF observation network: AVON) is developed to monitor the activity of CGs in Southeast Asia. Observation sites of this system are located at Tainan in Taiwan, Saraburi in Thailand, and Pontianak in Indonesia. In this study, data observed at Tainan station and Pontianak station during three days (from October 13th, 2010 to October 15th, 2010) is used for the initial analysis. Using the waveforms obtained by this network, 1-3 sferics per seconds are geolocated. Median of geolocation error is estimated as 93 km comparing with WWLLN data using about 400 CGs located in the Maritime Continents. Furthermore, charge moment distribution for the CGs of > 200 C-km in the Maritime Continents is derived with a combination of CG locations obtained by AVON and the transient waveform observed by GEON.

In this presentation, we introduce the speculation of new observation network to monitor the lightning activity in Southeast Asia and demonstrate the efficiency of combination of the measurement of ELF sferics and that of VLF ones.

キーワード: 雷, 空電, ELF, VLF

Keywords: lightning, sferics, ELF, VLF

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AEM002-03

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The characteristics of global lightning activities observed by ISUAL experiment The characteristics of global lightning activities observed by ISUAL experiment

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Lightnings serve as an important charge transporter between cloud and ground, and emit sferics that propagate in the ground-ionosphere cavity. During the six-year observation of ISUAL/FORMOSAT-2, besides surveying upper atmospheric transient luminous events, more than 110,000 lightnings which exceeded the ISUAL trigger threshold were recorded. In this presentation, the distribution, the occurrence rate, distribution and seasonal variation of these lightnings at local time between 22:30 and 23:00 are reported and compared with those of the LIS experiment (Christian et al., 2003). The ocean-to-land ratio and geographic distributions suggests that the lighting recorded by ISUAL is averagely more energetic than the ones registered by LIS mission and intense lightning is more frequent over oceans. The anomaly of occurrence between warm and cold phases of ENSO will also be discussed in this presentation.

キーワード: Lightning, ENSO, ISUAL

Keywords: Lightning, ENSO, ISUAL

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AEM002-04

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Energetic radiation associated with thunderstorm activity Energetic radiation associated with thunderstorm activity

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Intense gamma rays likely associated with lightning and/or thunderstorm activities have been detected in recent years, at various altitudes ranging from the ground level to the ionosphere. However, neither the source of this radiation nor its nature has been clarified. We report gamma rays lasting for several minutes attributed to both winter and summer thunderstorms in Japan. Our findings in winter thunderstorm indicate that the gamma rays were emitted continuously from a downward hemispherical surface, the bottom of which was about 300 m above sea level, and this source of gamma rays moved from north to south above the observation site at a speed of about 7 m/s. The radiation source probably moved along with the charged region of the cloud at a height of around 1 km, because the estimated migration of the radiation source was consistent with the observed movement of atmospheric electric field variation between ground-based observation sites and with the wind speed and direction at about 1 km altitude. This movement implies that the intense electric field produced by the charged region in the thundercloud generated a radiation source beneath the charged region. On the other hand, gradual energetic radiations probably caused by a summer thunderstorm have been observed at the top of Mt. Fuji, Japan. The largest of such variation was gradual and lasted for about 20 minutes, and was found to be high-energy gamma rays having a continuous energy spectrum up to 10 MeV or more. Both the observations help explain probably the lightning initiation urged by the radiation.

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AEM002-05

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ISUAL recorded halos brightness and their parent lightning emission ISUAL recorded halos brightness and their parent lightning emission

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Halo, another type of transient luminous event, is a bright disk at altitude 80-85 km above the thunderstorm. Unlikely the fact that almost exclusively +CG triggered sprites, most of halos were induced by -CG that occurred exclusively over the open water [Frey et al., 2007]. In this presentation, we analyzed total 185 ISUAL recorded pure halo events from July 2004 to Dec 2007. Using 1PN2-filter Imager, the average brightness of halos is ~ 0.25 MR. We also derived the current moment using the 777.4 lighting emission of their parent lightning to [Adachi et al., 2009]. It is found that a relatively strong linear relationship between lightning peak current and lightning-induced halo emission. In total recognized 121 events by ELF radio emission at Nagycenk Observatory (NCK), Hungary, the polarities of their parent lightning for 23 halos are identified as +CG while 98 halos are for ?CG associated with NCK recorded ELF data. From NCK estimating CMC, we found a relatively weak correlation between NCK CMC and halo brightness. Furthermore, the extremely brightest halos over ocean were also found, and their lightning polarities were dominated by ?CG. The finding reflects the nature of intense peak current for oceanic lightning [Fullekrug et al., 2002]. It seems that lighting current may have more important effect on halos generation than charge moment.

キーワード: ISUAL, Halo

Keywords: ISUAL, Halo

AEM002-06

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航空撮像されたエルブスの高速度画像 High-speed imagery of elves from airplane

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エルブスとは、雷放電に伴って起こる高高度過渡発光現象の一つである。高度約 90 km の電離圏下部で発生し、水平方向約 300-600 km の広がりを持ちパンケーキ状に発光する。またその発光継続時間は約 0.1 ms で、約 2 ms の間に光速を越えるような位相速度で全体に広がる、極めて高速な現象である。

これまでは、鉛直方向に並んだマルチアノードフォトメーターを用いた観測 [Fukunishi et al., 1996] や、垂直方向に視野を持つフォトメーターを用いた観測 [Barrington-Leigh et al., 2001] によってエルブス発光の時間・空間的变化を観ていたが、その構造の変化を二次元画像によって捉えられたものはなかった。

今回 NHK の協力のもとで高度約 13 km を飛行するジェット航空機から、世界で初めて高速度カメラでのエルブスの撮像に成功した。カメラは航空機の窓に進行方向と水平に設置され、約 8000 コマ/秒のフレーム数でパングロマトミック撮影を行った。

2010 年 11 月 28 日 18 時頃から千葉県東方沖約 400 km で雷放電が群発しており、本講演で示すデータはその雷放電によって引き起こされたエルブスを撮像したものである。この日航空機は 20 時半頃関東沖を目指して飛び立ち、21 時 48 分から 22 時 45 分までの約 1 時間撮像を行い、21 イベントの過渡発光現象を捉えた。そのうち、初期解析の段階で少なくとも 3 イベントのエルブスが検出されている。

本研究では、撮影されたエルブス構造の時間変化とそれを引き起こす親雷放電の特質との関係を調べていく。