Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS02-P01 Room:Convention Hall Time:May 22 17:15-18:30

Analysis of Narrow Bipolar Pulse by VLF/LF broadband digital interferometer

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Recent studies of radio frequency emissions from thunderstorms have noted a distinct class of very energetic pulses emitted from the upper troposphere. This pulse called narrow bipolar pulse (NBP) can be associated with a narrow bipolar event (NBE). This event is a large scale discharge of intracloud charge structures occurring in 10us.

We have been designing and developing a 3D lightning location system based on broadband digital interferometry technique in VLF/LF bands. The VLF/LF broadband digital interferometer (VLF/LF DITF) consists of four or more observation stations which detect electromagnetic (EM) waves in a wide frequency range from 400 Hz to 500 kHz associated with lightning discharges. The VLF/LF DITF is able to locate lightning discharges such as return strokes, K events, and NBP, which are energetic breakdowns within thunderclouds several hundred kilometers away from the VLF/LF DITF.

During the summer season in 2009, we had conducted lightning observation campaign with a use of a prototype of the VLF/LF DITF, which consisted of four stations in Darwin, Australia, to validate the system.

The observation results are compared with Doppler radar data operated by the Bureau of Meteorology (BOM) and the observations of VHF broadband digital interferometers (VHF DITF) which enable us to visualize leader developments associated with lightning discharges.

In this paper, we focus on the statistical altitude distribution of narrow positive bipolar pulses (NPBPs) and narrow negative bipolar pulses (NNBPs) in tropical regions.

Keywords: Narrow Bipolar Pulse, Lightning Discharge, Electromagnetic Source Location, Broadband Interferometry

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Three-dimensional distribution of VHF lightning radiation sources

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We have conducted a field observation, ”the Shonai area railroad weather project”. This project has investigated fine-scale structure of wind gust using two X-band Doppler radars and the network of 26 surface weather stations since 2007, in order to develop an automatic strong gust detection system for railroad. We focus on total lightning (both intra-cloud (IC) and cloud-to-ground (CG) lightning) activity in winter to investigate the mechanism of winter lightning discharge process and the application to strong gust prediction. Thus, we have developed a three-dimensional (3D) lightning mapping system utilizing arrival time differences of VHF broadband pulses radiated by leader progression

We investigate 3D distribution of VHF lightning radiation sources. In particular, the vertical distribution of VHF sources is compared with -10 degree C level. We analyze 3D lightning data observed in the Shonai area on November 30, 2010. The vertical distribution of the number of VHF sources exhibits a single maximum at 2.5-3.0 km altitude. The -10 degree C level retrieved from JMA-MANAL was 2.8 km at the same time. Hence, the vertical distribution of VHF sources is related to the atmospheric temperature level. In this presentation, we will also show the relationship between VHF source distribution and X-band radar reflectivity.

Keywords: Winter lightning, VHF observation, 3D mapping

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MIS02-P03 Room:Convention Hall Time:May 22 17:15-18:30

Energetic radiation associated with thunderstorm activity at the top of Mt. Fuji on 2011.

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Gradual energetic radiations probably caused by a summer thunderstorm have been observed at the top of Mt. Fuji, Japan on Aug. 8, 2011. The variation lasted for a few minutes, and was found to be high-energy gamma rays having a continuous energy spectrum up to around 10 MeV. The origin of variations might be the bremsstrahlung photons generated by the energetic electrons produced continuously with an intense electric field in the thundercloud.

Keywords: Energetic radiation, Thunder storm, Mt. Fuji

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Concentration of small ions measured at the center of Tokyo and at the summit of Mt. Fuji

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It has been proposed that climate could be affected by changes in cloudiness caused by variations in the intensity of galactic cosmic rays in the atmosphere. The cause of it is considered as a new particle formation with ion induced nucleation. The ion induced nucleation is occurred under the low concentration of particles and high concentration of ions, but there are a few reports. Then we observed small ions, aerosol size distributions, radon concentrations, and intensity of cosmic rays at the summit of Mt. Fuji simultaneously. We also observed the similar elements at Tarobo, the base of Mt. Fuji and Kagurazaka, the center of Tokyo.

Observation periods were from 29th July to 25th August 2010 and 5th to 23th August 2011 at the summit (3776m ASL) and from 9 to 23 August 2011 at Tarobo (1290m ASL) and from 30th October to 31st to 6th June 2011 at Kagurazaka. Small ions were measured with the Gerdien type meter (COM-3400). The critical mobility was set 0.7 cm2/V/s and we measured positive and negative ions alternately. Size distributions from 4.4 to 5000 nm in diameter were measured with a scanning mobility particle sizer (SMPS, TSI 3936N25 or 3936L22) and an optical particle counter (OPC, RION KR12 or KC01D). Radon concentration was calculated from concentration of radioactive aerosols collected on a filter.

Small ions are generated with ionization of air by cosmic rays or radiation from radioactive substances. Small ions are lost by various mechanisms such as ion-ion recombination and ion-aerosol attachment.
dn/dt=q-an2 -bnN
where n : small ion concentration, N : aerosol concentration, q : ion pair production rate (ionization rate), a : recombination coefficient, b : attachment coefficient. As the second term can be neglected because of small n compared with N in large city, dn/dt goes to q - bnN. Under the equilibrium conditions, the left-hand side is zero, q = bnN. If q is constant, n is inversely proportional to N. However, aerosol concentration is low and the ionization rate by cosmic ray is high in mountain atmosphere.

Hourly averaged concentration showed often the diurnal pattern of high in the early morning and low in the evening at Kagurazaka, Tarobo, and the summit in 2010. However, the different pattern of low in the early morning and high in the evening was often observed at the summit in 2011. This pattern had observed at the summit of Mt. Fuji by Sekikawa (1960) and Himaraya by Venzac et al. (2008). New particle formation with ion induced nucleation was observed once at night. There is a possibility of descending of stratosphere air mass and low concentration of particles during the period.

Ion concentration measured at Kagurazaka on mid-March showed high values. Its variation was well accorded with that of dose measured in the Tokyo Metropolitan Institute of Public Health 4km far from the observation site. Then we regarded this event was the transport of radioactive substances from the Fukushima Daiichi Nuclear Power Station. We estimated the scale of transported radioactive air mass and the deposition around the site.

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Keywords: small ions, Mt. Fuji, radon, dose, new particle formation, ion-induced nucleation

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3-D tomographic approach to investigate the ionospheric disturbance prior to the 2011 Tohoku Earthquake

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In this paper, neural network based tomography using GEONET data has been performed to investigate the fine structure possibly associated with the 2011 off the pacific coast of Tohoku Earthquake (Mw9.0). Although the possible ionospheric anomalies preceding large earthquakes have been reported by many researchers, a physical mechanism of the anomalies has not been clarified yet. To understand the mechanism, monitoring of three-dimensional distributions of ionospheric electron density is considered to be effective.

At first, the Total Electron Content (TEC) anomaly associated with the earthquake using the Global Ionosphere Maps (GIM) published by the Center for Orbit Determination in Europe (CODE) has been investigated. To detect the anomalous TEC changes, the normalized GIM-TEC (GIM-TEC$*$), which is computed based on 15 days backward running mean of GIM-TEC, have been investigated. As for the 2011 off the Pacific coast of Tohoku Earthquake, the significant enhancements are found in GIM-TEC investigation, 1, 3-4 days prior to the earthquake. Especially, TEC increase of 3 days prior to the earthquake was remarkable. Then the tomography has been performed. As a result, the reconstructed distribution of electron density was enhanced around F-region in comparison with 15 days backward median distribution, the region was found to be located over the epicenter and extended farther southward. Additionally, we found the enhanced region at lower ionosphere over the Japan Sea and it seems to be developed toward the upper ionosphere along with magnetic field lines. In our presentation, the difference in the character of pre-seismic disturbance and other periods will be shown.