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

HTT08-P01 Room:Convention Hall Time:May 20 14:45-15:45

Comparing of lightning activities and climatic reanalysis parameters

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The atmospheric convection is activated by the updraft associated with the heating of the surface by solar insolation. This activity carries water vapor and heat to higher altitudes. Maritime Continent (MC) is one of the most important regions for convection and lightning activity in the world, which is related to the global climatic phenomena including El Nino, Madden-Julian oscillation (MJO) and Asian monsoon. Therefore, detail research in this area leads to better understandings of the global climate change.

Until now only a few statistical studies on the lightning activity with energy information of individual discharge have been made for global scale since there have been no lightning observation network with uniform sensitivity. GEON, Global ELF observation Network, constructed and operated by Hokkaido University, provides information including energy of individual lightning stroke which occur anywhere in the world. GEON consists of four observation sites and detects electromagnetic waves in the frequency range of 1-100 Hz, radiated from cloud-to-ground lightning discharges, with a detection threshold of 950 C-km. The estimated average error in geolocation is about 600 km.

We compared GEON data with Outgoing Longwave Radiation (OLR) as a kind of proxy of cloud amount or strength of atmospheric convection. In the initial analysis areas of MC, Western Pacific Warm Pool (WPWP) and Eastern Indian Ocean (EIO) are examined from August 2003 to July 2004. It is found based on frequency analysis that lightning activities shows ˜30 day periodicity while convective activities ˜40 day periodicity. And cross spectrum of these data have ˜30 day periodicity. At the presentation, we will show these results.

Keywords: lightning, Maritime Continent, climate change, ELF, reanalysis data

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Estimation of Lightning stroke locations and Charge Moment Changes in Tohoku region, Japan

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Recent studies have offered some practical ways to use lightning data as an index of heavy convective rainfall and in-cloud convective activities. For example, Price and Federmesser (2006) investigated the relationships among lightning and several meteorological elements using the datasets obtained by TRMM satellite. They found a strong positive correlation (R=0.81-0.98) between lightning and convective rainfall, which strongly indicates that lightning can be used as a good proxy to measure heavy rainfall, especially over regions where meteorological radar observations are difficult to perform. Unlike rainfall observations, lightning observations can be implemented from greater distances by using low frequency electromagnetic waves emitted from lightning discharges. Other recent studies, such as Pessi and Businger(2009), have tried to assimilate lightning data into meteorological forecast models in order to improve the accuracy of heavy rainfall predictions over ocean areas.

As lightning data is expected to have a great impact on severe weather forecasts, it is extremely important to understand the relationships among lightning discharges, in-cloud structures and local meteorological fields. However, many studies concerning the relationships between lightning and meteorological fields have mainly focused on the "frequency" of lightning, while the "magnitude" of each lightning discharge has not been taken into consideration.

In this report, a newly developed method will be introduced to estimate the lightning locations (frequency) and charge moment change (CMC; equivalent to the magnitude of lightning) of each lightning stroke. This technique is based on the combination of two different lightning observation networks; Lightning Location System (LLS) operated by Tohoku Electric Power Company Inc. and Global ELF Observation Network (GEON) operated by Tohoku University and Hokkaido University.

LLS consists of 9 IMPACT sensors in Tohoku region of Japan that have been continuously monitoring lightning discharges in Tohoku, Kanto and surrounding ocean areas (parts of North Pacific Ocean and Sea of Japan). Although LLS has the lightning location accuracy of several kilometers (Honma et al., 1998), the estimation of CMC based on LLS data is still considerably difficult.

On the other hand, GEON consists of 4 observation sites across the globe (Syowa, Onagawa, Esrange and Santa Cruz), which have been measuring horizontal magnetic fields in the frequency range of 1-100Hz. According to past research, while CMC can easily be calculated from ELF transients detected by GEON (Sato et al., 2008, Yamashita et al., 2011), GEON systems cannot determine the lightning location as accurately as LLS.

By combining these two observation networks, we are able to determine the accurate lightning location using LLS and estimate CMC from ELF transients recorded at GEON.

Keywords: Lightning, Electromagnetic wave obserbation, Meteorology