MIS29-01 Room:101A Time:May 22 09:00-09:15

Anomalous large amplitude geomagnetic sudden commencement (SC)

Tohru Araki[1]*

[1]Polar Research Institute of China

The CRRES satellite detected instantaneous formation of the inner radiation belt near the equator in L=2.6Re and 2.5h local time at 0341 UT, March 24, 1991 [Blake et al., 1992]. At this time ground geomagnetic observatories globally observed an SC preceded by a large amplitude pulse of short duration [Araki et al., 1997]. The H-component amplitude and duration of the pulse was measured as 202 nT and 1 min, respectively by 1 sec values at Kakioka observatory. The 1 min values of routine geomagnetic observations can not record such a rapid variation accurately. Since the SC amplitude at Kakioka is usually less than 50 nT and the rise time is mostly 3-4 min, the amplitude of this pulse is anomalously large and the duration is anomalously short. A computer simulation by Liu et al. [1993] shows that an electromagnetic pulse due to the magnetospheric compression accelerated magnetospheric partcles to form the inner radiation belt. The data of EXOS-D (Akebono) satellite indicates that this radiation belt lasted more than one year [Yukimatsu et al, 1996]. Although it is interesting to see the corresponding solar wind variations, there is no data of the solar wind.

Being stimulated by this SC, we checked the SSC list publicized by Kakioka observatory since 1924.
It shows that the 1991 SC mentioned above is the second largest. The largest SC occurred on March 24, 1940. Referring to the SC list by Mayaud [1973] this seems to be the largest since 1868. If we include SI (Sudden Impulse) for which Kakioka observatory publicizes the list separately, the 1991 SC is the third largest. The second largest is an SI (220nT) occurred on November 13, 1960.

The currents induced in the earth depend upon the time variation rate of the SC. It is known that the SC amplitude correlates positively with its time variation rate [Araki et al., 2004] and so larger SCs induce stronger induction currents. Usually a linear relationship is assumed between the SC amplitude dH and jump in the square root of Pd, d(Pd**0.5) as dH=A*d(Pd**0.5) and A is experimentally estimated as about 15 nT/[Pd(nPa)]**0.5. If this A is used for SC with 200nT amplitude, Pd should be increased from 2nPa (quiet time value) to 210 nPa , but the non-linear effect will require a larger Pd.

In the estimation of A the induction effect is usually assumed to be 1.5 (i.e. SC is amplified 1.5 times on the earth). For more accurate considerations of SC, however, the induction effect should be estimated taking the time variation rate of each SC into account.

Prof. Rikitake said ; Although researchers of the upper atmosphere use observed amplitude of SCs, it is important to consider the effects of induction currents.

Keywords: geomagnetic sudden commencement(SC), historically largest SC, radiation belt, particle acceleration, induced earth current

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-02 Room:101A Time:May 22 09:15-09:30

Introduction of Network-MT method - toward elucidating nation-wide deep electrical conductivity structure -

Makoto Uyeshima[1*], Research Group of Network-MT method[2]

[1]Earthquake Research Institute, the University of Tokyo, [2]Respective Universities and Research Institutes

To determine a nation-wide 3-D deep electrical conductivity structure e.g. of several hundreds times several hundreds km² scale, electric field had better be measured with a typical dipole length of 10km or more. In order to estimate spatial variation of the structure in this scale, all the electrodes ideally mutually connected by the observation network. Then, referring to the pioneering works in employing telephone lines for electric dipoles (e.g., Mori, 1985, 1987), Uyeshima et al. (2001) developed an observation technique named Network- MT method. In this method, the telephone line network is fully used to determine horizontal distribution of voltage differences with long electrode spacings. The dipoles in the method are telephone lines connected to electrodes, which are either earths installed for telecommunications facilities by the telephone company, or electrodes purpose built for the experiment. Dipole lengths range from ten to several tens of kilometers. As a reference magnetic field, magnetic records obtained by three component magnetometers at geomagnetic observatories or at purpose built stations are used. Data loggers are often installed at the central telephone station. If we deploy long dipoles, the S/N ratio of electrical records will be enhanced. This enhancement will enable us to extend the experiment both in space and frequency domain (especially toward the lower frequency range). We also obtain responses relatively free from the static effect.

After the telluric voltage difference records are obtained, response functions in the frequency domain between each voltage difference and 2 component horizontal magnetic fields are estimated. Period range is from several s to 10⁵⁻⁶ s. If all the electrode points are connected by the observation network, virtual voltage difference between any pairs of electrodes can be estimated by linear combination of the response functions for real (or measured) dipoles. In this way, after selecting three electrode points in the observation area, voltage differences along two sides of the triangle made by the selected electrode points can be estimated, and then, average 2 component electric fields in the triangle, when a unit magnetic variation occurs in the x- or y-direction at the reference site, can be estimated by linear combination of the response functions. Thus the average impedance tensor for the triangle can be estimated and will be inverted to yield the electrical conductivity structure. At the same time, the response functions or the impedance tensors can be used to evaluate spatial distribution of GIC at large geomagnetic storms.

In order to obtain regional 2-D or 3-D structures from the Network-MT data, several methods were developed. One way is to first compose averaged impedance tensors for triangles made by three electrode points, as mentioned above, and then, conventional inversion schemes are applied to those impedance tensors (Yamaguchi et al., 1999; Shiozaki et al., 1999; Satoh et al., 2001). In Uyeshima et al. (2001, 2002), the response functions between respective voltage difference and magnetic field are directly reproduced in the 2-D or 3-D forward calculations. This method is adopted in a subsequent 3-D inversion scheme by Siripunvaraporn et al. (2004), which is based on a 2-D and 3-D data space Occam's inversions designed for inverting conventional MT datasets (Siripunvaraporn and Egbert, 2000; Siripunvaraporn et al., 2005). Recently, a new 2-D inversion technique for combining conventional and Network MT response functions was developed (Usui, 2010). The technique will be extended for the 3-D problem.

Keywords: Network-MT method, nation wide deep electrical conductivity structure, spatial distribution of induced currents

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-03 Room:101A Time:May 22 09:30-09:45

Mid latitude GIC as the ground surface currents carried by the TM0 mode waves in the Earth-ionosphere waveguide

Takashi Kikuchi[1*], Shinichi Watari[2], Kumiko Hashimoto[3]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]National Institute of Information and Communications Technology, [3]Kibi International University

The geomagnetically induced current (GIC) has been attributed to the time change in the Bx component of the ground magnetic field. However, the GIC was found to be well correlated with By component [e.g., Watari et al., Space Weather 2009]. Recently, it was reported that the GIC has diurnal and seasonal variations, which suggests that the GIC could be a return current of the ionospheric currents since the ionospheric conductivity is affected by the solar radiation [Braendlein et al., JGR 2012]. To explain the close relationship between the GIC and ionospheric currents, the authors used the Earth-ionosphere waveguide model proposed by Kikuchi et al. [Nature 1978]. In this model, the TM0 mode wave propagates at the speed of light with accompanying the ionospheric and ground surface currents connected by the displacement currents flowing on the wave front. In the present talk, we review the Earth-ionosphere waveguide model and explains the close relationship by applying the Earth-ionosphere waveguide model.

Keywords: Geomagnetically induced current, Earth-ionosphere waveguide, ionospheric current, polar-equatorial propagation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-04 Room:101A Time:May 22 09:45-10:00

Three-dimensional analysis technique for marine magnetotelluric method

Noriko Tada[1]*

[1]JAMSTEC

Magnetotelluric (MT) sounding is a powerful geophysical method to explore electrical conductivity structure in the Earth's interior. The electrical conductivity of Earth material is known to be strongly dependent on physical conditions such as temperature, water content, and degree of partial melting which control their mechanical properties. Especially in oceanic areas, therefore, a number of efforts have been made to obtain accurate images of the electrical conductivity distribution in the upper mantle since the pioneering work by Filloux's (1973).

However, topographic effect makes difficult to obtain accurate electrical conductivity images. The electric and magnetic (EM) fields observed on the seafloor are generally distorted by rugged seafloor topography. The effect of seafloor topography is more significant than that of land topography (e.g., Nam et al., 2008) because seawater, which has extremely high conductivity, produces strong conductivity contrast at the seafloor (Schwalenberg and Edwards, 2004).

In recent years, several works have attempted to solve the problem of topographic effects on the seafloor MT data. Baba and Seama (2002) proposed a three-dimensional (3-D) forward modeling called FS3D which can incorporate precise 3-D topography over arbitrary subsurface structure. Tada et al. (2012) introduced a practical 3-D inversion scheme called WSINV3DMT with approximate treatment of topography (ATT) which expresses conductivity using volumetric averaging in order to describe seafloor, which treats large-scale topographic effect. Furthermore, Baba et al. (submitted) combined the FS3D method with the WSINV3DMT with ATT in order to treat both small-scale and large-scale topographic effects. These techniques allow us to estimate detailed 3-D electrical conductivity structures beneath the seafloor. Now we can perform 3-D inversion analysis for a data set of seafloor EM survey in the Philippine Sea and in the western edge of the Pacific Ocean in order to reveal upper mantle electrical conductivity distribution.

Keywords: Marine magnetotelluric method, Topographic effect, Three-dimensional, Forward modeling, Inversion analysis

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-05 Room:101A Time:May 22 10:00-10:15

Development of measurement equipment for effects of GIC(Geomagnetically-Induced Currents)

OOSATO, Kenichi[1], NAKATANI, Hideyuki[2], YAMAMOTO, Yasuhiro[2], Sadayuki Ishikura[2*], TAMAKI, Hajime[2]

[1]Tokyo Electric Power Company, [2]Nissin Electric Co.,Ltd

We developed the GIC which could measure the geomagnetically-induced currents to occur to an electric power system by influence of the magnetic storm. This device can grasp the influence of the electric power system by the magnetic storm for stable supply and use of the electricity in real time. In addition, this device resembled a base at the record unit of a record device for unit type electricity that I developed in 2007 that I cost-cut it in what I developed and was able to realize high reliability.

Keywords: Geomagnetically induced currentsunit, Measurement, Electric power

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-06 Room:101A Time:May 22 10:15-10:30

A general introduction of magnetotellurics and of electrical conductivity distribution beneath Japan for the GIC study

Masahiro Ichiki[1]*

[1]Graduate School of Science, Tohoku University

Electrical conductivity distribution in the earth is one of the most fundamental parameter to estimate geomagnetic induced current (GIC). The electrical conductivity distribution deeper than a few km depth is usually inferred by using magnetotellurics. In this presentation, I introduce the magnetotelluric principle and a general view of the conductivity model in the crust and uppermost mantle beneath the Japan Island Arc for the GIC researchers.

MIS29-07 Room:101A Time:May 22 11:00-11:15

Toward Construction of iES Database (Database for Information on Electromagnetic Surveys) for Conductivity Structure ben

Naoto Oshiman[1*], Satoru Yamaguchi[2], Makoto Uyeshima[3], Tada-nori Goto[4], Hiroaki TOH[5], Ryokei Yoshimura[1], Hideki Murakami[6], Yasuo Ogawa[7], Takeshi Hashimoto[8], Shinichi Takakura[9]

[1]DPRI, Kyoto Univ., [2]Graduate School of Science, Osaka City University, [3]ERI, The University of Tokyo, [4]Graduate School of Engineering, Kyoto University, [5]Graduate School of Science, Kyoto University, [6]Faculty of Science, Kochi University, [7]Volcanic Fluid Research Center, Tokyo Institute of Technology, [8]Graduate School of Science, Hokkaido University, [9]National Institute of Advanced Industrial Science and Technology

The Japan Arc, where many large earthquakes and volcanic eruptions have occurred, is formed by the Philippine Sea and Pacific plates subducting beneath the Eurasian and North American plates. Moreover, these two different aged plates are subducting with overlapped geometry in the central part of Japan. Therefore, subsurface structure beneath the Japan Arc up to deeper part is highly three-dimensional. Recently, three-dimensional seismic velocity structure models beneath the Japan Arc have been presented, and displacement fields are monitored in real time with the Japanese Archipelago scale using very high density GPS observation network (GEONET). Electrical conductivity provides us very important physical quantity suggesting condition beneath the Japan Arc, which is independent from density, seismic velocity, etc. Therefore, construction of a three-dimensional conductivity model beneath the whole Japan Arc is very important issue in geosciences, because conductivity models give constraint to the thermal structure and/or fluid distribution in the crust and mantle of the earth. In order to achieve the scientific goal, we made a research plan composed of the following three phases;

Phase I: We collect all information on electromagnetic surveys, which were carried out in and around Japan, among scientific community in Japan to form the iES Database (Database for Information on Electromagnetic Surveys). Then, we will chose suitable data sets among the iES Database to construct the database of observed electromagnetic data at 50km interval mesh covering the whole Japan Arc (50km Interval Mesh Database), which will be used for construction of 3D conductivity structure model beneath the Japan Arc at the final phase (Phase III).

Phase II: In addition to the data set chosen from the iES Database in Phase I, new observations will be made to infill gap regions over the Japan Arc to obtain full set of data covering the whole Japan Arc.

Phase III: A three-dimensional conductivity model beneath the Japan Arc will be inverted based on data set in the 50km Interval Mesh Database.

The overall research plan from Phase I to Phase III above is called JEMINI (Japan Electro-Magnetic Imaging with Network observation In-depth) project. In our presentation, we will introduce the details of Phase I in the JEMINI project, especially about the iES Database, which is the main component in Phase I.

Keywords: resistivity structure, conductivity structure, geo-electromagnetic survey, database

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-08 Room:101A Time:May 22 11:15-11:30

Superflares on solar-type stars

Hiroyuki Maehara[1*], Takuya Shibayama[2], Yuta Notsu[2], Shota Notsu[2], Takashi Nagao[2], Satoshi Honda[3], Daisaku Nogami[2], Kazunari Shibata[2]

[1]University of Tokyo, [2]Kyoto University, [3]University of Hyogo

We will present our recent research on superflares on solar-type stars (G-type main sequence stars).
Superflares are eruptive events mainly seen in rapidly-rotating stars like young stars and close binary stars, and have a total energy of 10^{33}-10^{38} ergs, 10-10^{6} times larger than that of the largest solar-flares observed so far.
We searched for superflares from the data of 90,000 solar-type stars observed by the Kepler space telescope between 2009 April and 2010 August. We found more than 1,500 superflares on 279 solar-type stars, including 60 superflares on 25 Sun-like stars (solar-type stars with a rotation period longer than 10 days and with the surface temperature of 5600-6000 K). Most of these stars show quasi-periodic light variations with the amplitude of 0.1-10% which suggest the existence of large starspots on rotating stars.
The energy-frequency distribution of superflares are similar to that of solar-flares and can be fitted by a power-law function with the index of -1.6 - -2.0 in the energy range between 10^{34} and 10^{36} erg.
Although the flare occurrence frequency decreases as the rotation period increases, the maximum energy of superflares does not depend on the rotation period of stars. These results suggest that superflares can occur on the slowly rotating stars like our Sun.
The average occurrence frequency of superflares which release 10^{35} erg of energy (1,000 times larger than that of the largest solar-flares) on Sun-like stars is estimated to be once in a few thousand years.

Keywords: solar flares, superflares, extreme space weather events

MIS29-09 Room:101A Time:May 22 11:30-11:45

Concentration of magnetotelluric current caused by local 3-D resistivity heterogeneities

Hiroshi Ichihara[1]*

[1]Japan Agency for Marine-Earth Science and Technology

Geomagnetic variation originated from solar activities induces telluric current in the earth. The telluric current largely depends on the resistivity heterogeneity. Recent progression on magnetotelluric method enabled us to model 3-D resistivity distribution and revealed complicated resistivity structure of subsurface. In this presentation, I introduce the phenomena that complex conductive body composed from seawater and sediment induces local concentration of telluric current (e.g. Ichihara and Mogi, 2009). These phenomena are reported especially in Japan such as northeastern Hokkaido (Ichihara et al., in rev) and Kitakami area.

Keywords: magnetotelluric, current channeling, out-of-quadrant-phase, 3-D resistivity structure

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-10 Room:101A Time:May 22 11:45-12:00

On GIC associated with past intense geomagnetic storms

Shinichi Watari[1]*, Takashi Watanabe[1]

[1]NICT

Geomagnetically Induced Current (GIC) of the electric power grid was measured in Memanbetsu, Hokkaido between 2005 and 2007 by cooperation with the Hokkaido Electric Power Co., Inc. However, few intense geomagnetic storms occurred in this period because of low solar activity near minimum. It is usually difficult to obtain GIC data at the moment of past intense geomagnetic storms. It is known that the maximum value of GIC is given with the value of electric field along the power line divided by power line resistance per unit length considering a single power line. Geoelectric data by earth current measurement in Memanbetsu, Kakioka, and Kanoya are provided from the Kakioka Geomagnetic Observatory of Japanese Meteorological Agency (JMA). Using those data, we estimate GICs at the moment of past intense geomagnetic storms such as the March 1989 storm associated with the electric power blackout in Canada and the October 2003 storm associated with the blackout in southern Sweden. The result of our analysis will be presented.

Keywords: Geomagnetically Induced Current (GIC), geomagnetic storm, earth current, power grids, space weather

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-11 Room:101A Time:May 22 12:00-12:15

Inhomogeneity of the shallow resistivity structure inferred from EM surveys and resistivity logging data in Kanto Plain

Shinichi Takakura[1]*

[1]Geological Survey of Japan, AIST

It is worried that huge geomagnetically induced currents (GICs) associated with sudden changes of the geomagnetic field affect society's infrastructures such as a power line and a communication network. Although the damage caused by GIC mainly happens in the area of higher geomagnetic latitudes, they may occur also in Japan if the greatest geomagnetism sudden change takes place. For the prediction of GIC, it is effective to carry out the simulation of the induced electric field on the surface of the Earth and GIC by using 3D resistivity structure (conductivity distribution of the Earth). Resistivity structures of many areas except urban areas have been clarified by electromagnetic (EM) methods for scientific research and resource investigation. In the city plains where the damage caused by GIC will concentrate, however, the resistivity structures are not clarified because the application of the EM methods is difficult due to a severe electromagnetic noise. Earth crust is generally heterogeneous as compared with a mantle. Especially the resistivity structure above a pre-Tertiary basement has high heterogeneity because various geologic formations from which solid state, water content, and salinity differ are distributed intricately. This suggests that GIC flows intricately there. Since the density of the electric current induced by the magnetic field variation is the largest near surface of the earth, it is important for prediction of GIC to know the sallow resistivity structure. So, I tried to estimate the resistivity structure of the thick Neogene and Quaternary sedimentary layers in Kanto Plain where population is concentrating most in Japan. In this research, the some results of EM surveys were used to estimate the resistivity structure in the circumference of urban areas. The resistivity logging of the wells excavated by investigation of urban disaster prevention or engineering works were referred to estimate the resistivity structure of the urban areas where no EM surveys were carried out.

Keywords: geomagnetically induced currents (GIC), sudden changes of the geomagnetic field, Kanto Plain, electromagnetic (EM) method, resistivity logging, shallow resistivity structure

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-12 Room:101A Time:May 22 12:15-12:30

Super magnetic storms and geomagnetically induced currents in Japan

Ryuho Kataoka[1]*

[1]Tokyo Tech

Geomagnetically induced currents (GIC) flowing in ground-based conductor systems during large geomagnetic storms are one of the most important space weather phenomena that affect our ground-based infrastructures. Former research showed that GIC activity in subauroral latitudes depends on the storm phase and on the interplanetary drivers, such as coronal mass ejections (CMEs) and corotating interacting regions (CIRs). Despite of the differences between CME and CIR storms, the relationship between GIC and the time derivative of the horizontal ground magnetic field is always the same. However, Japan is located at lower latitude, and because of its distinctive ground conductivity structure, it is not obvious how large GICs flow in Japan during super storms. Further, ionospheric current system itself of super storms is not obvious. I will discuss the methodology how to study the GICs in Japan during super storms using our limited observations.

Keywords: magnetic storms, geomagnetically induced currents, ground conductivity

MIS29-P01 Room:Convention Hall Time:May 22 18:15-19:30

Importance of estimating the extremely large GIC in Japan

Shigeru Fujita[1]*

[1]Meteorological College

The geomagnetically induced currents (GICs) happen to cause power line failure in the high-latitude countries. Meanwhile, there are no researches about extremes of GICs in Japan with heterogeneous profiles of the underground conductivity. Therefore, to evaluate extremes of the GIC in Japan is not only important for Japanese society but also significant for the scientists. Namely, estimation of extremes of the GIC is a challenging interdisciplinary research from the magnetosphere-ionosphere physics for estimation of the extremely large storms and related phenomena to the solid Earth geomagnetism for electromagnetic response under three-dimensionally heterogeneous conductivity profiles. We also need information from the solar physics for extremely large flares and the interplanetary physics for propagation of the disturbances from the sun to the Earth. This session is a kick-off meeting for investigating the extremely large GIC expected in Japan. By sharing present status of the researches related to evaluation of the extreme GIC, we will discuss future collaborating research among scientists from space science, solid-earth geomagnetism, and related fields toward evaluation of the extremes of GICs.

Keywords: Geomagnetically Induced Current, Extreme space waether condition, nonuniform ground electric conductivity, modelling, statistical analysis

MIS29-P02 Room:Convention Hall Time:May 22 18:15-19:30

Science and Operational Activity of Space Weather in NICT

Mamoru Ishii[1]*

[1]NICT

We, NICT has been providing space weather forecast information for keeping secure and safe operation of telecommunication, broadcast and satellite positioning, etc. We need to study very wide area, from the sun to the earth's ionosphere and/or ground for studying space weather. In addition we still have unknown mechanism in this field. We are now constructing forecasting system with observation network, empirical model and numerical simulation in such limited condition. And we use informatics technique for high-performance observation and building large computing field. GIC is one of the big topics in space weather and we will discuss how to collaborate their expert community to improve this scientific field.

Keywords: Space Weather, satellite positioning, solar flare

MIS29-P03 Room:Convention Hall Time:May 22 18:15-19:30

Numerical solver of EM induction equation in 3-D anomalous sphere by using integral equation method

Takao Koyama[1*], Hisayoshi Shimizu[1], Hisashi Utada[1]

[1]Earthquake Research Institute, Univ. Tokyo

We developed a forward modeling solver of EM induction equation in 3-D anomalous Earth by using the integral equation method. The integral equation method use a semi-analytic Green's function for 1-D background structure so that the numerical solution can be more accurate, but Green's function requires a lot of computational memory and time.

To reduce them, we performed a spherical harmonics expansion in lateral direction and variable separation in vertical direction. Further, we adapted a modified IDM to accelerate the solver, which is well known that the condition number of discrete integral equation is drastically reduced.

We introduce the details of this method.

Keywords: 3-D forward modeling, integral equation method, modified IDM, Green's function, spherical harmonic expansion, variable separation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-P04 Room:Convention Hall Time:May 22 18:15-19:30

Development of the ionospheric conductivity model

Yukinobu Koyama[1*], Atsuki Shinbori[2], Tomoaki Hori[3], Masahito Nose[1], Yoshimasa Tanaka[4]

[1]Graduate School of Science, Kyoto University, [2]Research Institute for Sustainable Humanosphere (RISH), Kyoto University, [3]Nagoya University Solar Terrestrial Environment Laboratory Geospace Research Center, [4]National Institute of Polar Research

To estimate the ionospheric current quantitatively, we implemented the ionospheric conductivity model on Interactive Data Language (IDL) by using IRI-2012, NRMSISE-00, and IGRF-11. In this presentation, we don't mention about Geomagnetically induced current itself which is the theme of this session. We explain about the ionospheric conductivity model implementation, the calculation example, and the current situation of the software distribution preparation.

Keywords: ionosphere, conductivity, numerical model, IDL, IUGONET

MIS29-P05 Room:Convention Hall Time:May 22 18:15-19:30

Estimation of the extreme geomagnetic storm level by utilizing extreme value statistics

Ken Tsubouchi[1*]

[1]The University of Tokyo

Extreme GIC events, hazardous to some technological systems in our current society, must be associated closely with a large disturbance in the geomagnetic field. The typical prominent phenomenon is the geomagnetic storm, which is defined by the time variation of the Dst-index. The interest of the present study is the statistical assessment of the occurrence of severe storms, characterized by the large negative depression of Dst less than -100 nT. The largest storm in the recorded history is known as the Carrington event of 1859, whose Dst was estimated to be -1750 nT. In the published Dst since 1957, the largest value is -589 nT on March 1989. Using the whole Dst database is inadequate for drawing the precise statistics of the occurrence of such "superstorms" due to its rareness. In the present study, we utilize extreme value statistics, which focuses on the statistical behavior only in the tail of the distribution. We extract the Dst data less than -280 nT and determine the form of the generalized Pareto distribution by fitting this subset to it. This enables us to estimate the imaginable largest storm level, as well as the occurrence probability for the specific level in several decades ~ centurial scale.

MIS29-P06 Room:Convention Hall Time:May 22 18:15-19:30

Seafloor electromagnetic observation and recent application for imaging sub-seafloor structure

Tada-nori Goto[1*]

[1]Graduate School of Engineering, Kyoto University

Abrupt changes of geomagnetic field can yield damages to pipelines, cables and other architectures. For understanding the phenomena and future risks, geomagnetic observations and exploration of sub-surface resistivity structure are necessary. Here, I introduce the seafloor electromagnetic observations: the observation techniques and recent examples of the application for evaluating sub-seafloor resistivity structure.

Mainly, the seafloor observation was conducted by using OBEMs: ocean-bottom electromagnetometers. OBEM can records the fluctuations of geomagnetic and induced electric field on the seafloor. Although the high frequency components could not be recorded due to high attenuation in the conductive sea layer, the low frequency components (e.g., less than 0.1 Hz typically) can be observed on the seafloor with water depth of several thousand meters. The obtained electromagnetic field can be analyzed for imaging sub-seafloor resistivity structure. In addition to the natural electromagnetic field, a controlled artificial electromagnetic signal can be used for imaging shallow sub-seafloor structures. The survey is now expanded to various fields: for finding energy and mineral resources, imaging active faults and submarine magmatic activities, etc.

In my talk, I review the techniques to observe electromagnetic field on seafloor, and recent topics related to sub-seafloor resistivity explorations briefly.

Keywords: ocean bottom, sub-seafloor structure, electromagnetic observation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS29-P07 Room:Convention Hall Time:May 22 18:15-19:30

A statistical study of geomagnetic events in Japan

Yasuhiro Minamoto[1*], Shigeru Fujita[2]

[1]Kakioka Magnetic Observatory, JMA, [2]Meteorological College, JMA

Japan Meteorological Agency has reported geomagnetic events at Kakioka, Memambetsu and Kanoya. Lists of geomagnetic events at Kakioka and Memambetsu are since July 1957, and the list of Kanoya is since January 1958. Furthermore, lists of older events at Kakioka are in preparation to publish.
In this presentation, we will show characteristics of geomagnetic events at these three observatories with those databases of events. And we will predict scales of "once in 1,000 years event" boldly.

Keywords: geomagnetic, database, magnetic storm, si, ssc

MIS29-P08 Room:Convention Hall Time:May 22 18:15-19:30

Responses of Geomagnetic Storm and Magnetosperic convection to the extreme solar wind conditions

Tsutomu Nagatsuma[1*], Manabu Kunitake[1]

[1]NICT

To estimate the extreme value of the geomagnetically induced current (GIC), estimation for the extreme value of geomagenetic disturbances and its time variations are essential. It is well known that geomagnetic disturbances are produced from the magnetospheric current systems driven by the interaction between the solar wind and the magnetosphere. So, it is important to understand the response of the magnetospheric current systems to the extreme solar wind conditions. Magnetospheric convection and geomagnetic storm are parts of the important elements for the magnetospheric current systems. The geomagnetic storm is believed to be developed by the enhancement of the magnetospheric convection. However, both phenomenon show different behavior to the extreme conditions of the solar wind electric field. In the case of magnetospheric convection, its development is saturated by the extreme conditions of the solar wind. On the contrary, in the case of geomagnetic storm, its development is linearly growth depending on the intensity of the solar wind electric field. Based on the data analysis of the previous great geomagnetic storm events, we will show the difference for the responses of magnetospheric convection and geomagnetic storm, and will discuss about the responses of geomagnetic disturbances to the various kinds of extreme solar wind conditions.

Keywords: Geomagnetic Disturbances, Magnetospheric Convection, Geomagnetic Storm, Magnetospheric Current System, Solar wind - Magnetosphere Interaction

MIS29-P09 Room:Convention Hall Time:May 22 18:15-19:30

Geoelectric Potential difference observation conducted by Kakioka Magnetic Observatory

Ikuko Fujii[1*]

[1]Kakioka Magnetic Observatory, Japan Meteorological Agency

Kakioka Magnetic Observatory, Japan Meteorological Agency, has measured the geoelectric potential difference continuously since 1930's at Kakioka amd 1950's at Memambetsu and Kanoya. The measurement is sometimes addressed as an Earth current measurement, however what has been measured is a voltage difference between two electrodes at the Earth's surface. The electrodes and their locations were changed several times. At present, we use a pair of cupper plates or carbon rods as the electrodes and separate them 100 - 300m each other. Two pairs of electrodes are placed in the north-south and east-west directions at each observatory and the two horizontal components of the voltage difference are measured every 0.1 second.

The geoelectric potential difference measurement for a long term is rather rare. In addition, the geomagnetic field is simultaneously measured in our case, which makes investigations of conductivity structures, geomagnetic sudden changes, and crustal activity possible. Use of the geoelecric potential difference data is expected to be boomed because a data download service through the observatory HP started in the end of 2012 and data accessibility has been improved.

I will introduce observation systems and characteristics of our geoelectric potential difference measurement in my presentation. Site differences among Kakioka, Memambetsu, and Kanoya will be focused and the relationship with the local conductivity structure will be speculated. For instance, a heterogeneity of the voltage difference at Kakioka, which has been known for years, will be considered if a modern spectral analysis technique and a modeling method may add new information.

Keywords: geoelectric potential difference, long term observation, Kakioka Magnetic Observatory

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Evaluation of the earth-induced current contribution for a precise prediction of the Dst index

Masahito Nose[1]*

[1]Graduate School of Science, Kyoto Univeristy

A precise prediction of the Dst index is one of the important issues in space weather forecasting. The Dst index was developed by Sugiura [1964] to measure the magnitude of the axially symmetric geomagnetic field variations. The field variations during geomagnetic storms are produced by various currents in the magnetosphere, such as, the ring current, the tail current, the magnetopause current, and the field-aligned current. Since the Earth can be considered as a conductor, these magnetospheric currents generate the induced currents inside the Earth, which also contribute to the Dst index. Previous studies have reported that the magnetic field variations due to the induced currents are about 20-30% of the Dst index [Rikitake and Sato, 1957; Anderssen and Seneta, 1969; Langel and Estes, 1985; Hakkinen et al., 2002].

In order to predict the Dst index precisely, we need a more proper evaluation of the contribution of the Earth-induced current. From the property of induction, we expect that the percentage of the Earth-induced current contribution may depend on the rate of change of the disturbance field. Thus, using the magnetic field data obtained at 70-80 ground observatories, we examine how the Earth-induced current contribution changes during magnetic storms. The magnetic field variations are decomposed into portions of the external (i.e., magnetospheric current) origin and the internal (i.e., Earth-induced current) origin by using the spherical harmonic expansion. It is found that the Earth-induced current contribution varies between ~30% and ~50%. We will derive an empirical equation relating the Earth-induced current contribution to the rate of change of the disturbance field.

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A modeling of Geomagnetically Induced Currents in Midlatitude Regions

Kimura Aoi[1], Yusuke Ebihara[1*], Yoshiharu Omura[1], Toshiaki Kikuchi[1]

[1]Kyoto University Electrical and Electronic

We have simulated an electromagnetic field to reproduce Geomagnetically Induced Currents (GIC). GIC are induced along an electrical conductor on the ground from electric fields generated by an ionospheric current, and are serious threat to a power grid system. The generation of GIC depends on the geomagnetic latitude, the current system, and the structure of a stratum and the topology of the electrical conductor. We usethe exact method offered by Hakkinen et al., which can take into accountthe above-mentioned factors, for the sake of reproducing GIC at a transmission network.By this method, the intensity of GIC is calculated as a function of the parametersof the ionospheric currents and the earth, i.e. height, density, frequency of theionospheric currents, as well as magnetic inclination, magnetic declination and itsdistribution. We calculate an electromagnetic field for GIC by various parametersof the ionospheric current, and clarify which parameters affect the intensity of GIC.As a result, we find that the height and the frequency of the ionospheric currentsgreatly influence the intensity of the electromagnetic field and GIC. We also find that the magnetic declinationand the magnetic inclination and declination because of the field aligned currents.In the presentation, we discuss the factors that affect GIC and adversely affect infrastructure systems at mid-latitudes including Japan.