Characterization of Regional Earth Magnetic Activity Based On MAGDAS Data

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Abstract—**Earth magnetic data can be measured by magnetometer, Magnetic Data Acquisition System and other devices. MAGDAS is a realtime system magnetometers that are being deployed by Kyushu Sangyo University of Fukuoka, Japan. The earth magnetic data from the MAGDAS can be used as part of earth magnetic data monitoring, mainly for earth events such as earthquake and space events such as geomagnetic storm. For this project, data from stations at the north, equatorial and south region are considered as monitored data to be analyzed. The analyses are based on the different biases of MAGDAS data at different region. From the analysis, the earth magnetic polar at different region can be mapped and defined. The results are useful to give the regional of magnetic format data.**

Keywords— **Magnetic Data Acquisition System (MAGDAS), Global Positioning System (GPS), Planetary index (*Kp* index)**

1.0 INTRODUCTION

Magnetic Data Acquisition System (MAGDAS) is a system of 50 realtime magnetometers that are being deployed by Kyushu Sangyo University of Fukuoka, Japan. On the April 2007 the deployment was concentrated along the 210 magnetic meridian. However, during the current stage of expansion, units are also being deployed along the geomagnetic equator, in places such as Malaysia, Ethiopia, Nigeria, Ivory Coast, and also Brazil. The overview of study is this project will focus on evaluating MAGDAS data at the north, centre and south region of the world. We chose to study this because we want to identify study and evaluate the different earth magnetic field located at the north, centre and south stations of the world. The problem statement for this project is there is no clear characterization of the earth magnetic activity based on MAGDAS data. Therefore, this project is focus on the characterization of earth magnetic field. Data are taken from the north, centre and south of the world to identify the characterization of the earth magnetic field.

2.0 MAGDAS DATA AND EARTH MAGNETIC FIELD

Magnetic field digital data such as H+δ H, D+δ D, Z+δ Z, F+δ F are obtained at the sampling rate of 1/16 seconds, and then the averaged data are transferred from overseas stations to SERC. The ambient magnetic field which is expressed by horizontal (H), declination (D), and vertical (Z) components, are digitized by using the field-canceling coils for the dynamic range of ±64,000nT/16bit. Next, the total field (F+δ F) is estimated from the H+δ H, D+δ D, and Z+δ Z components. For the resolution, resolution of MAGDAS data are 0.061 nT/LSB and 0.031nT/LSB for ±2,000 nT and ±1,000 nT range. For further information, the estimated noise level of the MAGDAS magnetometers is 0.02nTp-p, the long-term inclinations denoted as I of the sensor axes are measured by two tiltmeters with 0.2 arc-sec resolution. The temperature, denoted as T inside the sensor head is also measured. The GPS signals are received to adjust the standard time inside the data logger/transfer unit. These data are logged into the Compact Flash Memory Card and the total weight of the compact MAGDAS magnetometer system is less than 15 kg. Below is the calculation on the earth magnetic field. The x, y and z are the coordinate.

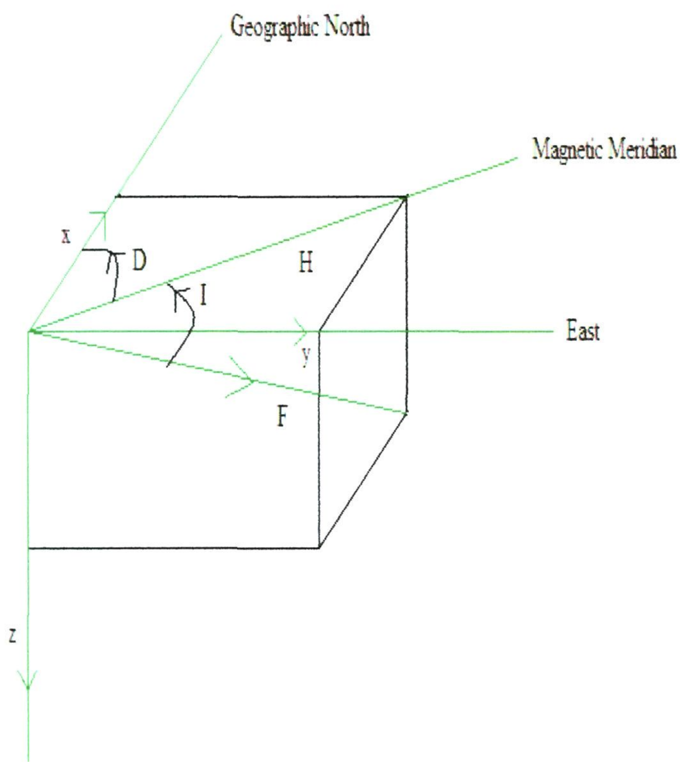

Fig. 1. Earth Magnetic Field

To get F,

$$F = \sqrt{x^2 + y^2 + z^2} \qquad (1)$$

To get H,

$$H = \sqrt{x^2 + y^2} \qquad (2)$$

To get angle I,

$$I = Tan^{-1}\, z/H \qquad (3)$$

To get angle D,

$$D = Cos^{-1}\, x/H \qquad (4)$$

The definition of the MAGDAS parameter is explained here. The declination (D) indicates the difference, in degrees, between the headings of true north and magnetic north. For inclination, inclination (I) is the angle, in degrees, of the magnetic field above or below horizontal. Next, horizontal Intensity (H) defines the horizontal component of the total field intensity and vertical Intensity (Z) defines the vertical component of the total field intensity. Last is the total Intensity (F) is the strength of the magnetic field.

3.0 METHODOLOGY

In specific methodology, the first process is to select the station to be analyzed. The station to be analyzed can be at Langkawi, Malaysia, Onagawa, Japan and Cooktown, Australia. After selecting the station, MAGDAS data is extract from MGD file to text document and also save in folder work. After selecting the station, insert the file name for example ONW_MIN_200609090000.mgd into the read_1M.m. Next, if the data is not available in the command window, the MAGDAS data is extract again from MGD file to text document and read by using read_1M.m again. If the data is available, the data is shown in the command window. Afterward, choose which bias to be plotted and don't forget to insert the time in the workspace. The time can be in 24 hour depending on the location. Next, click New variable in the Workspace, rename it with a suitable name and plot the bias with time. Type, for example plot (time,Bias_H) on the command window. The graph is then plotted and analyze.

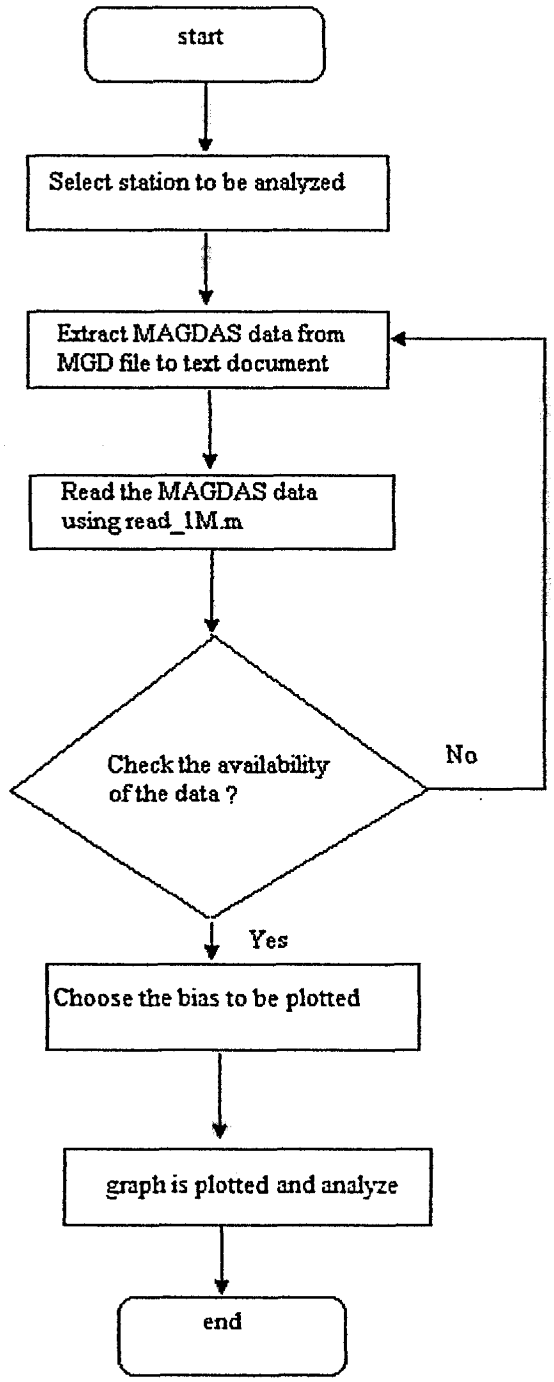

Fig. 2. Methodology

TABLE I
THE CHARACTERIZATION OF EARTH MAGNETIC ACTIVITY BASED ON DATE AND LOCATION

Region	Station	Date
Northern	Onagawa, Japan	9th September 2006 and 10th September 2006
Equatorial	Langkawi, Malaysia	9th September 2006 and 10th September 2006
Southern	Cooktown, Australia	9th September 2006 and 10th September 2006

4.0 RESULTS

The results show bias_F at Onagawa, Japan, Langkawi, Malaysia and Cooktown, Australia. Bias_F is use to show the strength of the magnetic field.

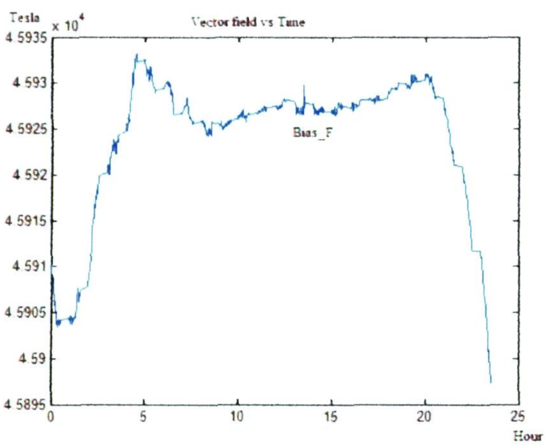

Fig 3. Bias_F for Onagawa, Japan on 9th September 2006

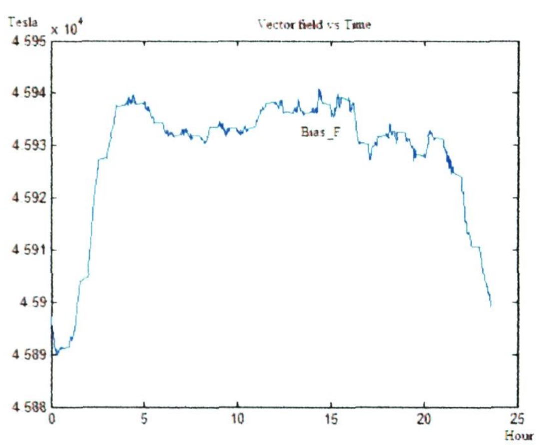

Fig 4. Bias_F for Onagawa, Japan on 10th September 2006

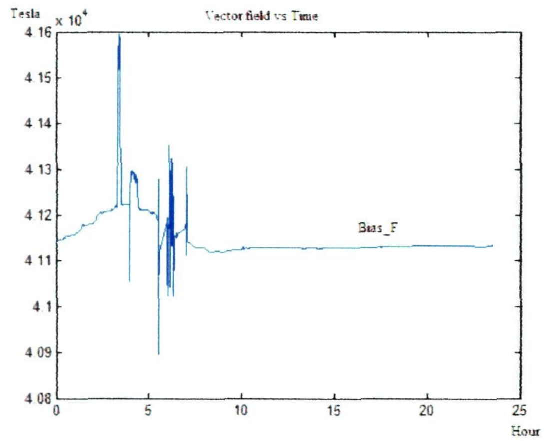

Fig 5. Bias_F for Langkawi, Malaysia on 9th September 2006

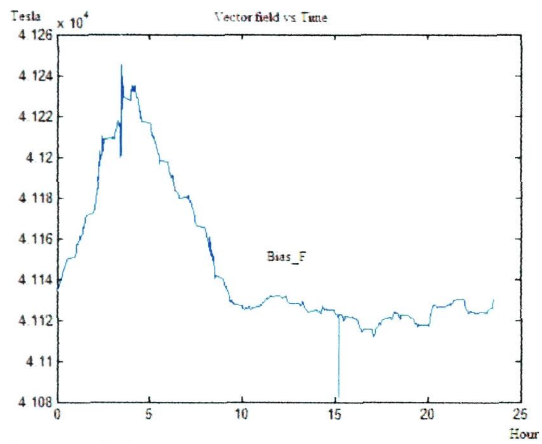

Fig 6. Bias_F for Langkawi, Malaysia on the 10th September 2006

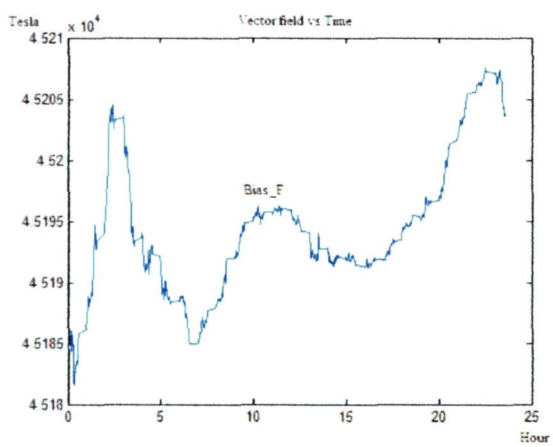

Fig 7. Bias_F for Cooktown, Australia on the 9th September 2006

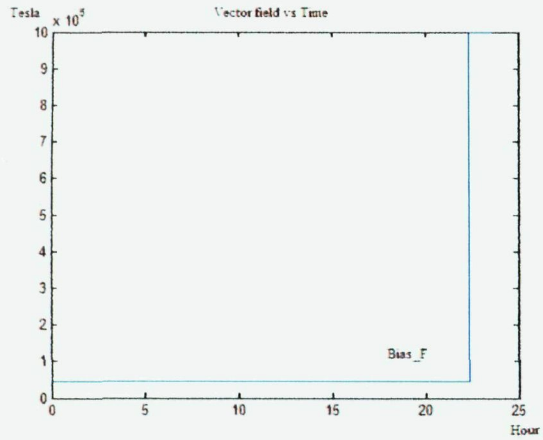

Fig 8. Bias_F for Cooktown, Australia on the 10 September 2006

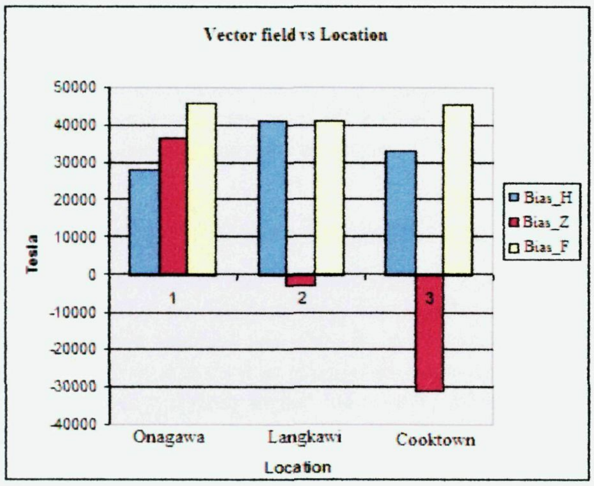

Fig 9. The average data for bias_H, bias_Z and bias_F on 9th September 2006

TABLE 2
THE AVERAGE DATA FOR EARTH MAGNETIC FIELD ON 9th SEPTEMBER 2006

Station	The average data for bias_H	The average data for bias_D	The average data for bias_Z	The average data for bias_F
Onagawa, Japan	28005T	-7.81^0	36405T	45916.60T
Langkawi, Malaysia	41100T	-145^0	-2802.77T	41150T
Cooktown, Australia	32985T	-7.81^0	-30905T	45201.75T

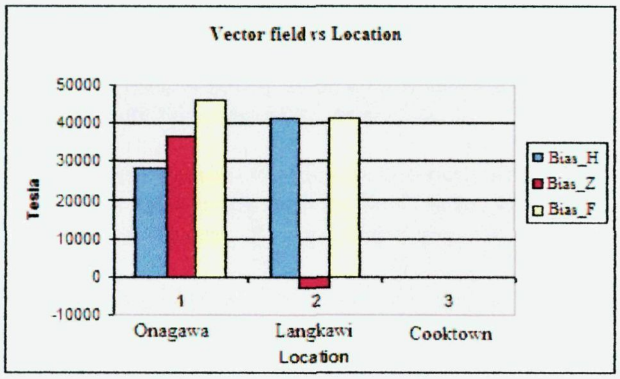

Fig 10. The average data for bias_H, bias_Z and bias_F on 10th September 2006

TABLE 3
THE AVERAGE DATA FOR EARTH MAGNETIC FIELD ON 10 SEPTEMBER 2006

Station	The average data for bias_H	The average data for bias_D	The average data for bias_Z	The average data for bias_F
Onagawa, Japan	28005T	-7.81^0	36410T	45916.60T
Langkawi, Malaysia	41050T	3.0^0	-2802.77T	41130T
Cooktown, Australia	No Measurement	No Measurement	No Measurement	No Measurement

5.0 DISCUSSION

The Earth's magnetic field is generated within its molten iron core through a combination of thermal movement, the Earth's daily rotation, and electrical forces within the core. These elements form a dynamo that sustains a magnetic field that is similar to that of a bar magnet slightly inclined to a line that joins the North and South Geographic Poles. Based on the result, we can see the characterization of the earth magnetic field. The total intensity (F) which shows the strength of magnetic field is larger at the north and south of the world compare to the center of the world since most of the earth magnetic activity concentrate at the North and South Geographic Poles. Table 1 and table 2 shows the average data for the earth magnetic field on 9th and 10th September 2006. It shows the average data for bias_F is larger at the north and south compare to the center of the world.

On the 9th to 10th September 2006, the k-Index shows there is no geomagnetic storm occurs since the value of the k-index is not greater than 5.

After researching, the most important bias is bias_H since bias_H can be used to the detect magnetic storm. In the website http://swdcwww.kugi.kyoto-u.ac.jp/dstdir/dst2/onDstindex.html , it state 'the onset of a magnetic storm is often characterized by a global sudden increase in H, which is referred to as the storm sudden commencement and denoted by ssc. Following the ssc, the H component typically remains above its average level for a few hours; this phase is called the initial phase of the storm. Then a large global decrease in H begins, indicating the development of the main phase of the storm. The magnitude of the decrease in H represents the severity of disturbance'.

The parameter of the earth magnetic field for example horizontal intensity (H) is most directly influenced by the external field contributions. Variations in vertical intensity (Z) are strongly influenced by the electrical conductivity of the subsurface and contain information on the field contributions induced in the Earth by the external variations.

The graph for Bias_H, figure 14 for Cooktown, Australia on the 10th September 2006 shows a horizontal line and a vertical line. On that day, there was no *measurement being made which explain why the graph was* a horizontal line and vertical line.

The geomagnetic variations are usually caused by 3 factors which are core field variations, solar variations and solar wind-magnetosphere interaction. For Bias_F at Langkawi, Malaysia, Onagawa, Japan and Cooktown, *Australia from figure 3 to figure 8 are affected by solar* radiation and core field variation. Solar radiations are changes in the amount of solar radiation emitted by the sun. Interaction of solar particles, the solar magnetic field, and the earth's magnetic field, cause variations in the particle and electromagnetic fields at the surface of the planet. The peak in the geomagnetic variation for figure 5 is causes by core field variation which consists of reverse, westward drift and secular variation.

6.0 CONCLUSION

For the conclusion, the characterization of the earth magnetic field has been seen. The earth magnetic field is greater at the north and south compare to the center of the world. The study in the characterization of the earth magnetic activity using MAGDAS data have made us realize the character of earth magnetic field at the north, center and south of the world. In the end, this project is important since the study in the characterization of the earth *magnetic field can provide information on the earth* magnetic field located at the south, north and centre region of the world. Beside, the variation of earth magnetic field could detect major events such as geomagnetic storm. The information gain can be use to minimize the cost of destruction cause by geomagnetic storm.

7.0 FUTURE RECOMMENDATION

Future research should be conducted to cover a more detail study about this project. They are as follow, take more data at different stations and analyze it, research based on the other earth events such as earthquake, volcano, flood and seasonal events and study higher value of KP-index to detect geomagnetic storm.

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