Dear MAGDAS Hosts :

Our illustrious visitor from Nigeria, Dr B. Rabiu, has compiled a great information package on MAGDAS ---- I attach it to this email. It is about 4 MB in size, in total.

It has several components, but his cover letter (READ ME FIRST) is worth a read. It is only two pages long. It nails down the key points about MAGDAS installations.
This info package was created by Dr Rabiu to assist us in getting good locations in Africa for MAGDAS II.

If you have any questions, please ask me.

I would like to remind you that if you send to us any email regarding MAGDAS, please write to cpmn@denji102.geo.kyushu-u.ac.jp

-------- this is an email mailing list that consists of all relevant parties at our side (Prof. Yumoto, Dr Abe, myself, and many others). Doing this will insure that you get a reply from the MAGDAS Team. In a way, this is the "team email address". Please avoid any personal email addresses.

George Maeda
Editor-In-Chief.

............................................end of MAGDAS newsletter.
MAGDAS is a state of art facility for geomagnetic field observation. It is a project of the Space Environment Research Centre of the Kyushu University. The Principal Investigator PI of MAGDAS is the renowned Professor K. Yumoto, Director of the Space Environment Research Centre SERC, Kyushu University www.serc.kyushu-u.ac.jp/index_e.html. It has wide application in Space weather monitoring as well as ionospheric studies. It provides real-time monitoring of the geomagnetic field on ground. It comprises of 3-axial ring-core (amorphous metallic alloys) sensors, fluxgate-type magnetometer, data logging/transferring unit, and power unit. Magnetic field digital data (H+δH, D+δD, Z+δZ, F+δF) are obtained with the sampling rate of 1/16 seconds, and then the averaged data are transferred from the overseas stations to the SERC, Japan in real time. A MAGDAS unit comes with necessary software as the installation is carried out at overseas stations by professionals from SERC. Detail information on MAGDAS is found in a paper by K. Yumoto and the MAGDAS group (2007) attached herewith as Attachment# 1 in PDF and available at http://www.ncra.tifr.res.in/~basi/07December/355112007.PDF

This equipment comes as a long term loan of about 10 years to the host Institution as a cooperation under the ongoing IHY program. Details of IHY activities are found in www.ihy2007.org. IHY facilitates contribution of ground based scientific facilities for space experiments by instrument providers to willing host institutions mainly in developing countries. IHY does not provide fund to the providers or the hosts. The main goals of IHY are to:

- Develop the basic science of heliophysics through cross-disciplinary studies of universal processes.
- Determine the response of terrestrial and planetary magnetospheres and atmospheres to external drivers.
- Promote research on the Sun-heliosphere system outward to the local interstellar medium - the new frontier.
- Foster international scientific cooperation in the study of heliophysical phenomena now and in the future.
- Preserve the history and legacy of the IGY on its 50th Anniversary.
- Demonstrate the Beauty, Relevance and Significance of Space and Earth Science to the World and Inspire our Future Explorers

A number of African countries are presently benefiting from IHY program as indicated in the attachment # 2. MAGDAS is currently operational at the stations indicated in the attachment #3. In Africa, we have MAGDAS in Egypt (Cairo), Ethiopia (Addis Ababa), Nigeria (Ilorin), South Africa (Hermanus, Cape Town) and Cote D’ivoire (Abidjan).

The next phase of MAGDAS is tagged MAGDAS II. This phase includes installation of MAGDAS along a specific meridian which crosses Cairo through Nairobi to Durban.
Report of the MAGDAS installation at Ilorin is attached as attachment #4. Installation requirements for MAGDAS are:
- Sufficiently noise free region around the sensor
- 20 W of electric power (sporadic interruptions are OK)
- Connection to the internet
- Good security (no issues of theft)

As a member of the African Steering committee for IHY, I implore the host institution to make available for MAGDAS installation includes the following
1. A conducive atmosphere for the team
2. A suitable site for MAGDAS facility, a low noise environment with an office space for the data acquisition unit of MAGADAS, the sensor building is constructed with blocks within 6 hours or thereabout to specification. (See attachment #5 & #6)
3. A hospitality which includes boarding, lodging and transportation during the installation period

The host Department can also organize a public lectures by the leader of the team, a cordial visit to the University President/Vice Chancellor. At Ilorin, Nigeria, the media – both electronic and printed - were attracted to the public lectures (e.g. See attachment #7).

It is a research cooperation and not a money making venture. The host is not expected to pay any money to the installation team. It is better to have MAGDAS installed under the management of Department of Physics or Earth Sciences of any University/institution as the cases of MAGDAS I in Africa has been.

The potentials of MAGDAS include the following:
- Knowledge transfer
- Positive collaboration
- Availability of Research facilities for internationally competitive research.
- Windows of postgraduate opportunities
- Control of brain drain
- Development of Research in Basic Space Science
- Manpower developments

It is a viable tool for advanced research which can stimulate minds of undergraduate and graduate students. The host University takes proper advantage by ensuring that data collection is progressive and assign a proper team to handle the facility. The IHY facilities in Nigerian are handled by academics, technologists and graduate students. It is not left for a single individual.

The Host Department is expected to get the management of the University informed and duly involved in the collaboration. By hosting a MAGDAS unit, you come under the broad umbrella of MAGDAS group.

8 units of MAGDAS II are presently being planned for Installation in July 2008 in Africa. The countries where contacts have been identified are Kenya, Uganda, Mozambique, Sudan, Zambia, South Africa and Tanzania.

SERC, Kyushu University, Fukuoka, May 6, 2008
MAGDAS project and its application for space weather

K. Yumoto and the MAGDAS Group
Space Environment Research Center, Kyushu University, Japan

Abstract. We introduce a real-time MAGnetic Data Acquisition System of Circum-pan Pacific Magnetometer Network, i.e. MAGDAS/CPMN for space weather study and application, and its preliminary results. By using this system, we will conduct real-time monitoring and modeling of (1) global 3-dimensional current system, (2) plasma mass density, and (3) penetrating process of polar electric fields into the equatorial ionosphere, in order to understand electromagnetic and plasma environment changes in the geospace during the period of ILWS/CAWSES/IHY.

Index Terms. Space weather, MAGDAS, electromagnetic and plasma environment, geospace.

1. Introduction

One purpose of the Solar Terrestrial Physics (STP) research in the twenty-first century is to support human activities from an aspect of fundamental study. The scientific new aim for the STP society is a creation of new physics; (1) couplings of the complex and composite systems and (2) multi-scale couplings in the Sun-Earth system. The goals for the attainment of the purpose are to construct Network Stations for observations and Modeling Stations for simulation/ empirical modeling. In order to understand the Sun-Earth system and its effects to human lives, the international LWS (Living With a Star) and CAWSES (Climate and Weather of Sun-Earth System) programs started from 2004. The International Heliophysical Year (IHY) program is also planned to start in 2007.

For space weather study on the complexity in the Sun-Earth system, the Space Environment Research Center (SERC), Kyushu University started to construct a new ground-based magnetometer network, in cooperation with about 30 organizations in the world from 2004. The SERC will conduct the MAGDAS (MAGnetic Data Acquisition System) observations at 50 stations in the CPMN (Circum-pan Pacific Magnetometer Network) region, and the FM-CW radar observations along the 210° magnetic meridian (see Fig. 1), in order to understand dynamics of plasmaspheric changes during space storms, responses of magnetosphere-ionosphere-thermosphere to various solar wind changes, and penetration mechanisms of DP2-ULF range disturbances from the solar wind region into the equatorial ionosphere.

On the other hand, electromagnetic phenomena, e.g., ULF, ELF and VLF waves are recognized as useful diagnostic probes of the solar wind-magnetosphere-ionosphere-atmosphere coupled system for space weather studies. These waves convey information about the dynamics and morphology of the coupled system.

In the present paper, at the first we will introduce our real-time data acquisition and analysis system of MAGDAS/CPMN, and preliminary results obtained by this system; (1) monitoring of the global 3-dimensional current system to know the electromagnetic coupling of high-latitude and Sq current systems, and (2) monitoring of the plasma mass density in geo-space to understand plasma environment change during storms. In the second, we will show the FM-CW radar system at L=1.26 to deduce electric field from the ionospheric plasma Doppler velocity. From 24hr monitoring of the ionospheric drift velocity with 10-sec sampling rate by the FM-CW radar observation, (3) we can understand how the polar electric field penetrates into the equatorial ionosphere.

2. MAGDAS/CPMN system

The Circum-pan Pacific Magnetometer Network (CPMN) was constructed by Kyushu University in collaborations with about 30 international organizations along the 210° magnetic meridian and the magnetic equator during the international Solar Terrestrial Energy Program (STEP) period (1990-1997) (see Yumoto and CPMN group, 2001). The 1-sec magnetic field data from the coordinated ground-based network made it possible to (1) study magnetospheric processes by distinguishing between temporal changes and spatial variations in the phenomena, (2) clarify global structures and propagation characteristics of magnetospheric variations from higher to equatorial latitudes, and (3) understand global generation mechanisms of the Solar-Terrestrial phenomena (see Yumoto, 2004, Yumoto and 210° MM group, 1995 and 1996).
For space weather study and application, the Kyushu University group is now re-constructing a new real-time MAGDAS (MAGnetic Data Acquisition System) in the CPMN region, and the FM-CW radar network along the 210° magnetic meridian. New 50 fluxgate-type magnetometers as shown in Fig. 2 and their data acquisition system from overseas sites to Japan are being deployed by the SERC, Kyushu University from 2005. The new magnetometer system consists of 3-axial ring-core (amorphous metallic alloys) sensors, fluxgate-type magnetometer, data logging/transferring unit, and power unit. Magnetic field digital data \( H + \delta H, D + \delta D, Z + \delta Z, F + \delta F \) are obtained with the sampling rate of 1/16 seconds, and then the averaged data are transferred from the overseas stations to the SERC, Japan in real time. The ambient magnetic field, expressed by horizontal (H), declination (D), and vertical (Z) components, are digitized by using the field-canceling coils for the dynamic range of \( \pm 64,000\text{nT}/16\text{bit} \). The magnetic variations \( \delta H, \delta D, \delta Z \) subtracted from the ambient field components (H, D, Z) are further digitized by a 16-bit A/D converter. Three observation ranges of \( \pm 2,000\text{nT}, \pm 1,000\text{nT}, \pm 300\text{nT} \) can be selected for high, middle, and low-latitude stations, respectively. The total field \( F + \delta F \) is estimated from the \( H + \delta H, D + \delta D, Z + \delta Z \) components. The resolutions of MAGDAS data are \( 0.061\text{nT}/\text{LSB}, 0.031\text{nT}/\text{LSB}, \) and \( 0.0091\text{nT}/\text{LSB} \) for \( \pm 2,000\text{nT}, \pm 1,000\text{nT}, \pm 300\text{nT} \) range, respectively. The estimated noise level of the MAGDAS magnetometers is 0.02 nTp-p. The long-term inclinations (I) of the sensor axes can be measured by using two tiltmeters with 0.2 arc-sec resolution. The temperature (T) inside the sensor bloc is also measured. The GPS signals are received to adjust the standard time inside the data logger/transfer unit. These data are logging in the Compact Flash Memory Card of 1 GB. The total weight of the MAGDAS magnetometer system is less than 15 kg. The sensitivity, efficiency, capacity, and performance of the MAGDAS systems are tested until the end of March, 2005.

Every day, the data logger at an overseas site generates a file containing averaged 1-sec magnetic data \( (H, D, Z, F) \) and a file containing the averaged 1-min magnetic data and inclination and temperature data \( (I, T) \) of the magnetometer sensor. The file size of the 1-sec data is less than 1MB. The file size of the 1-min data is less than 50KB. If the communication line at the site does not allow a fast-enough connection, the data logger sends only the 1-min file to the SERC every day; if the connection is fast enough, the data logger sends both the 1-min file and the 1-sec file to the SERC every day. In fact, the data transfer does not have to be on a daily basis: That is, the data-transfer interval can be set to any value between 10 minutes and 1 day, depending on the condition of the following communication lines. The MAGDAS data can be transferred from the overseas stations to the SERC, Japan, by using three possible ways:

A) Special line for INTERNET
If the data logger of MAGDAS at overseas sites can be connected to a special line for INTERNET (via a Switch, HUB, or Router of INTERNET), the data logger uses software called “SSH client” or “FTP client” to automatically establish an INTERNET connection to the SERC, Kyushu University, Japan. Then, the data logger at the sites automatically transfers the MAGDAS magnetometer data to the SERC.

B) Telephone line
If the above A) is impossible but if the data logger of MAGDAS at overseas sites can be connected to a telephone line, the data logger uses it, automatically dials up to a PPP server at the SERC, establishes a connection, and sends the data to the SERC.

C) Satellite telephone line
If the above A) and B) are both impossible, the data logger of MAGDAS at overseas sites uses a satellite-mobile-phone system, automatically dials up to a PPP server at the SERC, establishes a connection, and sends the data to the SERC.
3. Scientific objectives and preliminary results

In order to establish the space weather studies, we have to clarify dynamics of geospace plasma changes during magnetic storms and auroral substorms, the electro-magnetic response of iono-magnetosphere to various solar wind changes, and the penetration and propagation mechanisms of DP2-ULF range disturbances from the solar wind region into the equatorial ionosphere. Figure 3 shows one example of amplitude-time records of 3-component ordinary (upper) and induction-type (bottom) magnetograms observed at the Kujyu station in Oita, Japan, during 24 hrs. The ordinary data (i.e. MAGDAS data (1)) can be used for studies of long-term variations, e.g. magnetic storm, auroral substorms, Sq, etc., while the induction-type data (i.e. MAGDAS data (2)) will be useful for studies of ULF waves, transient and impulsive phenomena. By using these new MAGDAS data, we can conduct a real-time monitoring and modeling of (1) the global 3-dimensional current system and (2) the ambient plasma density for understanding the electromagnetic and plasma environment changes in the geospace.

Fig. 3. An example of amplitude-time records of ordinary (upper; MAGDAS data (1)) and induction-type (bottom; MAGDAS data (2)) variations observed at the Kujyu station.

In 2005, MAGDAS magnetometers were installed at 20 stations along the 210° magnetic meridian. After 2005, 30 MAGDAS magnetometers will be installed along the magnetic equator and in Siberia. Figure 4 shows one example of H-component amplitude-time records observed at the MAGDAS stations (ASB, ONW KUI, AMA in Japan, HLN in Taiwan, MUT, CEB, DAV in Philippines, MND, and PRP in Indonesia, DAW, CGR, CMD, HOB in Australia) during two days of November 10-11, 2005. We can see clear equatorial enhancements near the magnetic equator at DAV, and global nature of si, DP-2, and substorm-associated variations.

3.1. Global 3-D current system

The left panel of Figure 5 indicates the ionospheric equivalent current pattern obtained from the CPMN stations along the 210° magnetic meridian during a northern summer. Each ionospheric current vector was estimated by the horizontal magnetic fields observed at each CPMN station at every hour. We will make the ionospheric equivalent current pattern every day using the MAGDAS data (1) as shown in Figs. 3 and 4. The right panel of Fig. 5 shows the global 3-dimensional currents and electric potential, with the currents illustrated by ribbons and the potential with + and – (Richmond and Thayer, 2000). At high latitudes the ionospheric currents are joined with field-aligned currents (FAC) from the solar wind region into the magnetosphere, and the electro-dynamics is dominated by the influences of solar wind-magnetosphere interaction processes. The total current flows is of the order of $10^7$ A. On the other hand, the ionospheric current at middle and low latitudes is generated by the ionospheric wind dynamo, which produces global current vortices on the dayside ionosphere, i.e., counterclockwise in the northern hemisphere and clockwise in the southern hemisphere. The total current flow in each vortex is order of $10^5$ A.

![Fig. 5.](image)

There are strong electric fields at high latitudes, on the order of several tens of millivolts per meter or more depending on the magnetic activity. At middle and low latitudes electric fields are considerably smaller, typically a
few millivolts per meter during magnetically quiet periods. During magnetic active periods the part of strong electric fields at high latitude can penetrate into middle and low latitudes, and then the global ionospheric current pattern must be re-organized strongly. In reality the current and electric fields at all latitudes are coupled, although those at high, and middle and low latitudes have been often considered separately. By using the MAGDAS ionospheric current pattern as shown in the left panel of Figure 5, the global electromagnetic coupling processes at all latitudes will be clarified during the ILWS/CAWSES/ IHY period (see Yoshikawa et al., 2003).

Fig. 6(A) shows equivalent ionospheric current patterns obtained from the MAGDAS Data (1) on September 25, 2005 (Kohta et al., 2005). The vertical axis indicates magnetic latitudes of the MAGDAS stations, and the horizontal axis is the local time of the 210° magnetic meridian stations. The arrows indicate the current vectors obtained from the H and D components, and the color code indicates the negative and positive magnetic Z component. The equatorial electrojet can be seen at the dayside dip equator. There are twin vortices of Sq current, i.e., counterclockwise and clockwise in the northern and southern hemisphere, respectively. The centers of Sq current patterns are sometime not consistent with the maximum and minimum points of the Z component. Fig. 6(B) is one example of Sq equivalent current pattern obtained by the CPMN data on July 15, 2000, during a disturbed day. The vertical axis indicates geographic latitudes of the CPMN stations, and the horizontal axis is the local time of the 210° magnetic meridian stations. A clear Sq current vortex, equatorial electrojet, auroral electrojet, and ring current patterns can be identified in the figure. It is newly found a current flowing from the northern hemisphere into the southern hemisphere around 06 hr local time during magnetic storm.

3.2. Plasma mass density

The field line resonance (FLR) oscillations in the Earth's magnetosphere are excited by external source waves, and are so-called as ultra low frequency (ULF) waves (cf. Yumoto, 1988). The amplitude of H-component magnetic variations observed at the ground stations reaches a maximum at the resonant point, and that its phase jumps by 180 degrees across the resonant point (see Yumoto, 1985). The eigen-frequency of FLR oscillations is dependent upon the ambient plasma density and the magnetic field intensity in the region of geospace threaded by the field line, and the length of the line of force as shown in Figure 7. When we observe the eigen-frequency of FLR and assume models for the latitude profiles of the magnetic field and the plasma density (with the equatorial density as a free parameter), we can estimate the plasma mass density in the magnetosphere. Therefore, the FLR oscillations are useful for monitoring temporal and spatial variations in the magnetospheric plasma density. By using ground-based network observations, we can identify the FLR phenomena and measure the fundamental field-line eigen-frequency by applying the dual-station H-power ratio method (Baransky et al., 1989, Waters et al., 1991), which have been established to identify the FLR properties.

We will install new MAGDAS magnetometers at several pair stations along the 210° magnetic meridian, and observe magnetic FLR pulsations. Each pair stations are separated in latitude by ~100 km. The MAGDAS data (2) as shown in Fig. 3 will be analyzed by using the two methods, i.e., the amplitude-ratio method and the cross-phase method. As a result, we can identify the FLR events and measure their eigen-frequencies, providing the plasma mass density varying with time.

By using these methods, Takasaki et al. (2006) discussed temporary variations of the plasma mass density during magnetic storm. From ground-based observations at L~1.4 they found a significant decrease in the FLR frequency at during a large magnetic storm as shown in Fig. 8. During 28 - 31 October, 2003, a series of coronal mass ejections hit the magnetosphere and triggered two consecutive large storms. Three ground magnetometers at L = 1.32~1.41 recorded field-line resonances (FLRs) during this interval. The FLR frequencies decreased from 0600 LT on 31 October 2003 during in the main phase of the second storm until 12 LT
when the recovery phase of this storm began. After the decrease, the FLR frequencies increased to its value before the storm started at 0600 LT on 31 October in a few hours.

Fig. 7. Plasma mass density \( \rho = \sum n_i m_i \) can be estimated from the eigen-frequency \( T = 2L/V_A \) of the field-line resonance (FLR) oscillations identified by using the gradient methods of amplitude-ratio and cross-phase at dual stations.

The measured decrease in FLR frequency might indicate a relative increase in mass density along the field lines during the magnetic storm. On the other hand, the plasma number density in the ionosphere estimated from TEC values was similar in magnitude taken during quiet time. A possible explanation for the increase in mass density would be an outflow of the heavy ions (e.g., O\(^+\)) from the ionosphere to the plasmasphere.

Abe et al. (2006) have applied the dual-station H-component power ratio method, which identifies the field-line eigen-frequency, to eleven-months magnetometer data obtained at two ground stations TIK (L=5.98) and CHD (L=5.55) that belong to the Circum-pacifc Pacific Magnetometer Network (CPMN). As a result, they have identified two patterns in the frequency dependence of the power ratio (TIK/CHD); one is an increase-then-decrease pattern (named Type 1), and the other is a decrease-then-increase pattern (named Type 2). Type 1 is observed where the Alfvén velocity \( V_A \) decreases with increasing L, and it has often been reported in literature. In the paper, they mainly studied the Type 2 events which have rarely been reported for the area near L=5.7 (midpoint of TIK and CHD);

Type 2 is expected to be observed where \( V_A \) drastically increases with increasing L. Their statistical analysis shows that the Type 2 events were observed more frequently in the afternoon sector (especially in 15~18 hr LT) than in the morning sector as shown in Fig. 9. The geomagnetic condition was usually quiet when the Type 2 events were observed. These features are consistent with the interpretation that their Type 2 events were observed at the footpoint of the plasmapause layer, as follows. The plasmapause is the only location around L=5.7 where \( V_A \) drastically increases with increasing L, leading to Type 2. L of the plasmapause is smaller than 5.7 at all LT during geomagnetically active times (meaning Type 1 at L=5.7) while it is larger than 5.7 only on the late-afternoon sector during quiet times.

3.3. Ionospheric electric fields

Geomagnetic variations generated by DP2 type current systems coherently appear at the auroral and equatorial latitudes in daytime, and these amplitudes sharply decrease with decrease of latitudes but were enhanced at the dip equator. Equatorial enhancement had been understood as manifestation of Cowling effect for penetration of electric field from polar to the equatorial ionosphere. Furthermore, preliminary reverse impulse (PRI) and main impulse (MI) of geomagnetic sudden commencement (SC) are caused by the
DP2 type current systems, and some type of Pc5 magnetic pulsations are also generated by this current system.

In order to investigate penetration mechanisms of the ionospheric electric fields from the polar to the equatorial ionosphere, we have built a FM-CW radar (HF radar of 2~42 MHz) system at Sasaguri, Fukuoka (geomagnetic latitude $\theta=23.2^\circ$, geomagnetic longitude $\lambda=199.6^\circ$) as shown in Fig. 10. The height of dipole antenna is 26 m. HF radio wave of 2~30 MHz is emitted in the vertical direction with 20 W power for ionosonde mode, while radio waves of central frequencies ($f_0$: 2.5 and 8 MHz) for Doppler mode are emitted during night (09 – 21 UT=18 – 06 LT) and day time, respectively. The speed of sweep frequency and the sampling frequency are 100~1000 kHz/sec and 2000~20,000Hz/sec, respectively. This system can measure the Doppler frequency ($\Delta f$) of reflected radio wave from the ionized layer and the height of reflection layer with 10-sec sampling rate. From the observed vertical plasma drift velocity ($v = -c\Delta f/2f_0$), we can deduce east-west component of electric field ($E$) in the ionosphere, i.e. $E = -v \times B_o$, where $B_o$ is the ambient magnetic field at Sasaguri.

We have performed correlation analysis between ionospheric Doppler data obtained at the Sasaguri station and geomagnetic variations observed at the CPMN stations, and focus on DP2 type current systems associated with SC and Pc5, which show equatorial enhancements of magnetic field variations at the dip equator. The ionospheric electric field and its intensity during at the time of SC are estimated as shown in Figure 11. From top to bottom, the number density measured by the ACE satellite in the solar wind region, the H-component magnetic field variations at the CPMN station at Cebu near magnetic equator, and the Doppler frequency of FM-CW radar at Sasaguri during 90 minute on November 4, 2003.

At the onset time of SC preceded by PRI on November 4, 2003, the initial change in the ionosphere was observed simultaneous with the geomagnetic initial change in the accuracy of $\pm$6.4s at 0625UT as shown in Figure 11. This result is in agreement with the event at 0519UT on May 9, 2003. Simultaneous observations of the initial changes are not contradictory to the result of the past report, and approve of the instantaneous penetration of the electric fields to the equatorial latitude. At the same time, it proves the quality of the FM-CW radar as an useful tool for detection of ionospheric electric fields.

The electric field variations (period of about 5 min) associated with Pc5 magnetic pulsations were also observed at the low-latitude ionosphere at Sasaguri (geomagnetic latitude $\theta=23.2^\circ$) during the recovery phase of severe magnetic storm on October 30 - 31, 2003 as shown in Figure 12. The top and bottom panel show amplitude-time records...
4. Conclusion

Until the end of December, 2005, the SERC, Kyushu University have deployed a new real-time MAGDAS/CPMN system at 20 stations along the 210° magnetic meridian for space weather study and application. In 2006-07, 30 MAGDAS magnetometers will be installed along the magnetic equator and in the Siberian region. By using the MAGDAS/CPMN system, we will conduct the real-time monitoring and modeling of (1) the global 3-dimensional current system and (2) the plasma mass density variations for understanding electromagnetic and plasma environment changes in the geospace, especially, during the solar flare, coronal mass ejection, magnetic storms, and auroral substorms. Using FM-CW radar chain, we also investigate (3) how solar-wind electric fields and polar electric fields of SC, DP-2, Pc 5 and other disturbances can penetrate into the equatorial ionosphere.

A group of several organizations for geospace environment science in Japan will conduct a coordination of simulation/modeling, ground-based observations and satellite observations to understand couplings of complex, compound Sun-Earth system and generation mechanisms of high energetic particles in the inner magnetosphere during magnetic.

Acknowledgements. Our sincere thanks go to all members of the MAGDAS/CPMN project for their ceaseless support. The MAGDAS/CPMN project is financially supported by the Ministry of Education, Science and Culture of Japan (and Japan Society for the Promotion of science) as the Grant-in Aid for Overseas Scientific Survey (15253005, 18253005).

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MAGDAS/CPMN
(MAGnetic Data Acquisition System/Circum-pan Pacific Magnetometer Network)

Planned Magnetometer

FM-CW radar

Installed Magnetometer

MAGDAS II (Planning)
REPORT ON THE INSTALLATION OF MAGNETIC DATA ACQUISITION
SYSTEM, MAGDAS, AT THE UNIVERSITY OF ILORIN, NIGERIA. 20th-27th
AUGUST, 2006.

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At about 12:00 noon local time (1100 GMT) on Sunday 20th August 2006, a team of
Japanese from the Space Environment Research Centre of the Kyushu University led by
Prof Kiyohumi YUMOTO arrived Nigeria via the Murtala Mohammed International
Airport, Ikeja, Lagos on board Ethiopian Airline ET 901 for MAGDAS installation.
Other members of the team were Mr. Joji MAEDA and Dr. Yoshihiro KAKINAMI. They
were received by IHY Nigeria team which comprised of Akin Adeniyi (representing
University of Ilorin), O. S. Bolaji, T. F. Olanubi, C. P. Ogbuka, and Dr. A. Babatunde
Rabiu (National Coordinator IHY Nigeria). A symbolic presentation of bouquet by T. F.
Olanubi on behalf of IHY Nigeria was observed at the Airport just by the arrival gate.

Professor Kiyohumi Yumoto the scientist in charge of MAGDAS is a very senior
Professor and the Director of the Space Environment Research Centre at the Kyushu
University. He also functions as the National Coordinator of IHY Japan. He is the
executive advisor to the President of the Kyushu University, Fukuoka, Japan. Mr. Joji
Maeda and Dr. Yoshihiro KAKINAMI are staff of the Space Environment Research
Centre. The selection of Ilorin was based on its nearness to the dip equator.

We had lunch at a Chinese restaurant within Lagos Metropolis before embarking on the
journey by road to Ilorin in a Peugeot 504 station wagon made available by the hosting
University.

At Ilorin, the visiting team and the IHY Nigeria team now comprising of Dr. E. O.
Joshua, Olanubi, T. F., and A. Babatunde Rabiu, henceforth referred to as MAGDAS
team, were lodged at a guest house close to the University campus between 20th and 26th
August 2006.

The installation of MAGDAS was perfected between 20th and 25th August 2006.
Appendix I indicates the schedule of duty while at the University.

The MAGDAS team left Ilorin for Lagos by road on Saturday 26th August, 2006. The
team was joined at Lagos by O. S. Bolaji and A. H. Agbeniga. We passed the night at
Lagos in order to catch up with flight scheduled for 7.00 am the next day.

The University of Ilorin provided the hospitality, lodging and logistics at Ilorin, while the
Secretariat of the IHY Nigeria assisted with the necessary protocols at Lagos and Ilorin.
By 6.00 am on Sunday 27th August 2006; the IHY Nigerian team was at the Murtala Mohammed International Airport to ensure smooth departure and to bid farewell to the MAGDAS heroes. It was a parting with mixed feelings. Installation of MAGDAS at Ilorin, Nigeria has come to remain a memorable event in the annals of our science.

ACKNOWLEDGEMENTS
A lot of kudos is deserved by the UN Office for Outer Space Affairs and the International Secretariat of International Heliophysical Year at NASA. Prof Hans J. Haubold, J. Davila, Barbara Thompson and Gopalswamy Nat are greatly appreciated for their leadership role in IHY campaign. Great appreciation goes to Professor E. E. Balogun, Chair, National Organising Committee of IHY Nigeria for his great foresight and encouragement that has brought us this far.
APPENDIX 1: SUMMARY OF DAY TO DAY ACTIVITIES WITH RESPECT TO MAGDAS INSTALLATION IN NIGERIA.

Sunday 20th August 2006.
Murtala Mohammed International Airport, Lagos.
✓ Professor Kiyohumi YUMOTO and his team members, Mr. Joji MAEDA and Dr. Yoshihiro KAKINAMI, were received by the IHY Nigeria representatives. There was a presentation of bouquet to the Visiting team.
✓ Lunch time at Chinese Restaurant, Ikeja, Lagos.
✓ Traveled by road to Ilorin enroute Ibadan, Iwo.
✓ Arrived Ilorin at about 8:30pm.
✓ Received by the Ag Head of Department of Physics, University of Ilorin, Dr. I. A. Adimula and another IHY representative in Nigeria, Dr E. O. Joshua of the University of Ibadan.

Monday 21st August 2006.
University of Ilorin
✓ Reception at the office of the Dean faculty of Science, University of Ilorin, Professor O. B. Oloyede.
✓ Courtesy call on the Vice chancellor Prof. S. O. O. Amali, represented by the Deputy Vice chancellor, Academic, Prof. L. E. Edungbola.
✓ Decoration of the Deputy Vice chancellor, Academic, Prof. L. E. Edungbola as IHY ambassador by IHY Nigeria. (The golden pendant of IHY made available to IHY Nigeria by the International Office of IHY was used to decorate the DVC by Prof. Yumoto).
✓ MAGDAS Observatory site; selection of spot for location of sensor.
✓ Visit to the site by the Deputy Vice chancellor, Academic, Prof. L. E. Edungbola, the Dean, Faculty of Science Prof O. B. Oloyede and the immediate past Dean, Prof. T. O. Opoola.
✓ Construction of sensor hut began.

Tuesday 22nd August, 2006
University of Ilorin
✓ Completion of the sensor’s hut.
✓ Installation of Solar Power Systems for MAGDAS.
✓ Survey of the radio link for internet connectivity started.
✓ Visit too the site by the Deputy Vice Chancellor Administration, Prof. I. O. Oloyede,

Wednesday 23rd August, 2006
University of Ilorin
✓ Prof Yumoto traveled to and fro Abuja by air to procure his visa for Cote d’Ivoire.
✓ Linking the sensor to the data acquisition system
✓ Installation of the Radio link for internet connectivity at the Observatory.
✓ IP address was produced
✓ The MAGDAS unit was accessible from SERC Kyushu University Japan.
First MAGDAS data from Nigeria was received at Kyushu University.

University of Ilorin
- Perfection of the Installation
- Public lecture was delivered on MAGDAS by Prof K. Yumoto at the New Science Lecture Theatre by 4.00 pm. Press were in attendance.

Friday 25th August 2006
Nigerian Television Authority Complex
- Prof. K. Yumoto featured as the special guest on a documentary telecast by the Nigerian Television Authority, Ilorin. A 30 minutes show.

University of Ilorin
- Visit to the MAGDAS site by the Vice Chancellor, Prof. S. O. O. Amali; the Deputy Vice Chancellor, Academic, Prof. L. E. Edungbola and the Deputy Vice Chancellor, Administration, Prof. I. O. Oloyede and some other principal officers of the University
- MAGDAS installation was declared satisfactory by Prof. K. Yumoto.
- Luncheon hosted by the Vice Chancellor on behalf of the University management to commemorate MAGDAS installation.
- Memorandum of understanding was established and signed between Kyushu University, Japan and the University of Ilorin, Nigeria.
- Nigerian Newspapers reported news on MAGDAS installation!

Saturday 26th August 2006
- Departure from Ilorin to Lagos by road.
- Procurement of tickets to Cote d’Ivoire via Bellview Airline.
- A night at a Lagos Guest house.
- Special parting Dinner hosted by Prof. K. Yumoto.

Sunday 27th August 2006
Murtala Mohammed International Airport, Lagos.
- 7:00 am. Departure to Cote d’Ivoire.
MAGDAS
Installation Proposal For Africa

From

SERC
2008. 3. 31
The Basic MAGDAS Installation
(explanatory text not on this page —— see another page.)

Prepared by G. Maeda 28 July 2007
Jul23/first sheets/rough layout
MAGDAS Requirements:

1. good security
2. electric power (100W)
3. Internet connection
4. sufficiently noise free

Requirements for

the Main Unit (Instrumentation)

- Environment appropriate for computer equipment
  (moderate humidity and moderate temperature).
  Air conditioning is best.
- Connection to the Internet
  (need fixed IP address)
- Electric power
- small table to rest on
- loving tender care

Requirements for the sensor cable

- total length is 70m; therefore,
  distance between Instrumentation Building
  and Sensor House should be between
  50m and 60m. depending upon actual
circumstances of the station.
- should be protected by a tough tube.
  This tube is available from SERC.
  upon request. Tube is about 5 cm in diameter.
- Cable is lightweight and fragile.
- Tube should go underground by about 10 cm. Some care is needed so that water does not seep into it.

Requirements for the sensor house

(attached photos from Taiwan offer some idea)

Photo 1
The base must be very sturdy. As you can see, it is a big chunk of poured concrete. Must not contain any metallic rods. The walls are formed with block and mortar. Need hole for tube entry.

Photo 2
Taken from the Instrumentation Building.
Note that the tube is running in a trench.
Later. the trench was filled in with dirt.
MAGDAS is intended to operate for ten years.
so a tough tube is needed.

Photo 3
This is the finished sensor house.
A good lid is needed to keep out rainwater.
Plexiglass is best (one cm in thickness).
But treated plywood is also okay.
The lid is held down with blocks.
At this site. the lid is also bolted down with four non-ferrie bolts. Bolts offer a degree of security.

Photo 4
The instrument is opened up. The external keyboard generally is not needed. The
instrument has its own small keypad, which is viewable in this photo. There is also a built-in LCD display to show instrument status.

Photo 5

In the closed state, the cable and sensor will fit into this case. When that is done, the total weight is just 15 kg. It even has wheels for easy transport inside airports.

Photo 6

View inside the sensor house. The blue vinyl tape keeps water out of the connectors. The sensor has a short cable and connector. The sensor cable is connectorized at both ends. The sensor cable is 70m in length. It cannot be extended.

Photo 7

Dr. Uozumi is adjusting the sensor. There are three adjustments: rotational (Y), and tilt (H and D).

The sensor must be perfectly parallel to the earth's surface. To achieve this, the sensor house itself must be fairly level; especially the platform (something smooth, flat, and heavy) that the sensor rests on.

The thickness of the sensor house depends upon many things. Please ask Prof. Yumoto for guidance on this matter. Temperature change control is one factor, for example.

End of text.

11:10 2007/07/28

gm

5/12
Sensor House under construction (Hualien, Taiwan)
Sensor House

Blue Tube protects the sensor cable, and goes underground.
Load for lid

Lid (keep out rainwater)

SENSOR HOUSE

Photo 3

8/12 2007. 7. 28
Sensor, cable, and protective tube are visible here.
Adjusting the sensor (direction and tilt)
Japanese university installs solar data system at UNILORIN

The Space Environment Research Centre of Kyushu University, Japan has installed a Magnetic Data Acquisition System (MAGDAS) at the University of Ilorin.

The News Agency of Nigeria reported on Friday that the N4 million equipment installed at the Physics Department made the university the first to have such a facility in Nigeria.

The leader of the Japanese team, Prof. Kiyokumi Umoto, who spoke at the installation session on Thursday in Ilorin said the system would be installed in two other African countries, Ethiopia and Cote d’Ivoire.

Umoto explained how the equipment worked and the benefits to be derived from it in terms of huge data to be gathered on space hazards and solar terrestrial physics.

In a chat with journalists, the Head of the university’s Physics Department, Dr. Isaac Adimula, said MAGDAS would be of great benefit to the Nigerian economy and the environment.

It has the ability to read and predict possible space hazards that could affect national and private infra-

structure, he said.

Adimula added, “The first beneficiaries are the students, who can learn to become future weather forecasters. The oil industry would benefit because we can now know when a magnetic storm will arrive and whether corrosion will occur in oil pipelines or not and preventive measures will be taken,” he said.

Adimula said MAGDAS would enable the energy sector to put up preventive measures once it knew that certain magnetic storms would knock down power lines.

He said providers of GSM services would also know how to prevent network failure from studying the predictions in space through MAGDAS.

In his brief remarks, the university’s Deputy Vice-Chancellor (Administration), Prof. Ishag Oloyede, called for the establishment of a Space Science Department.