

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 10-01-2007		2. REPORT TYPE Conference Proceedings		3. DATES COVERED (From – To) 10 July 2006 - 14 July 2006	
4. TITLE AND SUBTITLE International Heliophysical Year SCINDA Workshop			5a. CONTRACT NUMBER FA8655-06-1-5084		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Abebe Kebede and Jyoti Nair			5d. PROJECT NUMBER		
			5d. TASK NUMBER		
			5e. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) NC A&T STATE UNIVERSITY 1601 East Market Greensboro 27411 USA			8. PERFORMING ORGANIZATION REPORT NUMBER N/A		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) EOARD PSC 821 BOX 14 FPO AE 09421-0014			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S) CSP 06-5084		
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. (approval given by local Public Affairs Office)					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The Final Proceedings for International Heliophysical Year SCINDA Workshop, 10 July 2006 - 14 July 2006 Overall goal is to establish space science expertise and develop a network of space weather observations across Africa. First portion of the workshop will cover equatorial aeronomy and the physics of low latitude ionospheric disturbances that affect space-based communication and navigation systems. Latter part of the workshop will provide instruction on the deployment, operation and interpretation of SCINDA sensors and their associated data. Participants will be asked to set-up a GPS TEC/scintillation system on-line at their home institution at the conclusion of the workshop.					
15. SUBJECT TERMS EOARD, Space Weather, Radio Propagation, Solar Physics					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UL	18, NUMBER OF PAGES 35	19a. NAME OF RESPONSIBLE PERSON GEORGE W YORK, Lt Col, USAF
a. REPORT UNCLAS	b. ABSTRACT UNCLAS	c. THIS PAGE UNCLAS			19b. TELEPHONE NUMBER (Include area code) +44 (0)20 7514 4354

Final Report

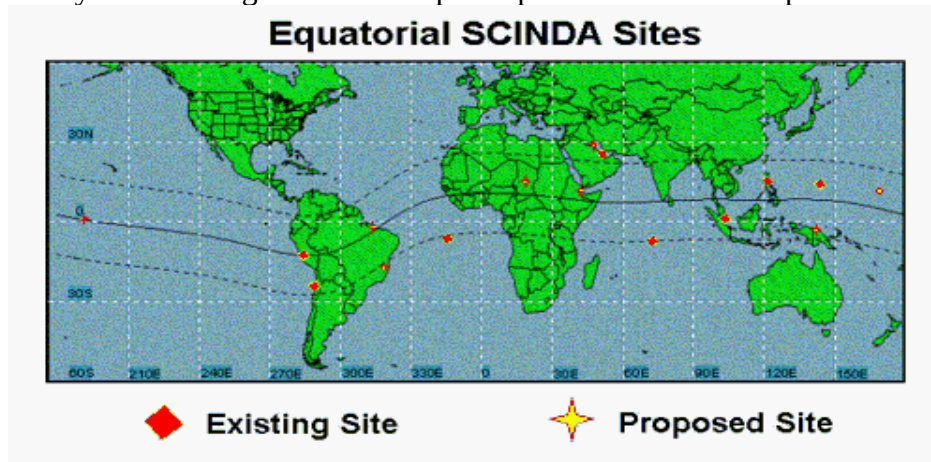


Prepared by: Abebe Kebede and Jyoti Nair
Department of Physics
North Carolina Agricultural and Technical State University
Greensboro, NC 27411

October 1, 2006

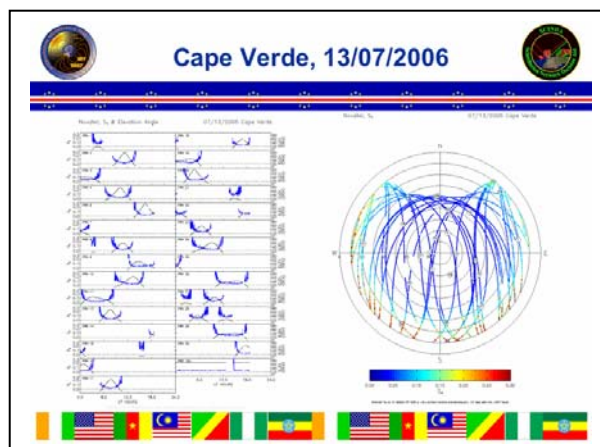
EXECUTIVE SUMMARY

The first Heliophysical Year International SCINDA Workshop was held at Sal, Cape Verde, during the period of July 10-14, 2006. Support for the workshop was obtained from the European Office for Aerospace Research and Development (EOARD), the Capacity Building for Research and Education in Space Science (CBPRESS) program based at NC A&T State University and US Air Force Research Laboratory (AFRL). This 5-day workshop was organized by the Air Force Research Laboratory, NC A&T State University, the Instituto Nacional De Meteorologia E Geofisica Republico De Cabo Verde (INMG). Representatives from Nigeria, Ethiopia, Cape-Verde, Cote D'Ivoire, Malaysia and Congo Brazzaville participated in the workshop.



The overall goals of the workshop were to establish space science expertise and to install Scintillation Network Decision Aid (SCINDA) across Africa following the geomagnetic equator. SCINDA is a real-time, data driven communication outage forecast and alert system developed for the United States Air Force Space Command by the Air Force Research Laboratory (AFRL), Ionospheric Hazards Specification and Forecast Team, Hanscom AFB. Its purpose is to aid in the specification and prediction of satellite communication degradation due to ionospheric scintillation in the equatorial region. Ionospheric disturbances can cause rapid phase and amplitude fluctuations of satellite signals observed at or near the earth's surface; these fluctuations are known as scintillation. The present equatorial SCINDA sites are shown in figure below.

The workshop has provided instructions on the deployment, operation and interpretation of data from SCINDA sensors. These instructions were accompanied by talks by the participating scientists, and meal time discussions on how to advance space science research and education in Africa in the future. At



the end of the workshop, the participants learned to setup a GPS TEC/scintillation system on-line at their home institution. Low latitude ionospheric disturbances routinely degrade UHF SATCOM and other space-based RF systems. The workshop squarely addressed those impacts by providing the requisite training to install and operate sensors that provide real-time warnings of scintillation impacts on DoD systems. As many as 7 new observing sites will be established as a direct result of the workshop.

Signatures

Dr. Abebe Kebde, USA, _____

Dr. Benvenu Dinga, Congo-Brazzaville _____

Dr. Gizaw Mengistu, Ethiopia _____

Dr. Baylie Damtie, Ethiopia _____

Dr. Rabi Babatunde, Nigeria _____

Dr. Jyoti Nair, USA, _____

Dr. Keith Groves, USA, _____

Dr. Olivier Obrou, Cote d'Ivoire _____

Ing. Jose Pimenta, Cape Verde, _____

Dr. Zainol, Malaysia _____,

Mr. Ita Eyo, United Kingdom, _____

Dr. Oyedmi Oyekola, Nigeria _____,

Mr. Sabino Batista, Cape Verde _____

Contributed talks

Variability parameters for *fof2* at equatorial latitudes

O. K. Obrou^(1,2), D. Bilitza⁽²⁾, J. O. Adeniyi⁽³⁾, A. T. Koba⁽¹⁾

Laboratoire de Physique de l'Atmosphère, Université de Cocody, COTE-D'IVOIRE

Raytheon ITSS, GSFC/NASA Code 632, Greenbelt, MD, 20771, USA

Physic department, University of Illorin, NIGERIA

This paper presents a study of the parameters implemented to characterize the variability of the equatorial ionosphere. It covers six years of high, moderate and low solar activity epoch at two equatorial stations that are next to the magnetic equator, Ouagadougou (dip +5.9) and Korhogo (dip -0.67). The result shows that the density function of foF2, the critical frequency of the F2 layer, is closed to a normal distribution that is some time flattened out with increased solar activity. The relative difference (mean-median/mean) of foF2 is lower and does not show a prominent seasonal effect. Regardless of the solar epoch, only few values are out of the range -4 to +4 percent mainly observed at nighttime. The lower deciles and lower quartiles to median ratios showed higher value during daytime and lower value at nighttime hours. The contrary is observed with the upper deciles and upper quartiles ratios to median. The deciles to median ratios agree well with the International Telecommunication Union (ITU) variability index model during daytime hours.

Establishing Cosmic Ray Station and other space research facilities in Ethiopia

Baylie Damtie¹, Tilmann Bosinger², Ilya Usoskin³

Department of Physics Bahir Dar University, Bahir Dar, P.O.Box 79, Ethiopia

Department of Physical Sciences, Oulu, 90014 Oulu University, P.O.Box 3000, Finland

Sodankylä Geophysical Observatory, Oulu unit, P.O.Box 3000, 90014 University of Oulu, Finland

Ethiopia (former Abyssinia) has been a first-class research field for geologists and especially seismologists from the early last century onwards. This is largely due to the Great Rift Valley, a great tear across the surface of Earth, extending nearly 6000 km from Syria, through the Red Sea, Ethiopia, and down to Mozambique. Its geographical (from about 35°E-45°E and 3°N-15°N) and magnetic location (the magnetic equator crosses Ethiopia) is perfect for investigations related to many topics of space physics. Near Earth Space carries its specialty above Ethiopia in the sense of the Equatorial ElectroJet (EEJ), a narrowly north-south extended electric current flowing right across the country at an altitude of about 105 km. It comes, therefore, not as a surprise that pioneering work in the exploration of the EEJ was made at observation sites including Ethiopia (and other African countries located in the equatorial region). In the beginning of the seventies of last century, experiments in space physics were conducted in Ethiopia, thanks to the initiative and interest in coherent radar observations of a French team [1] and the Geophysical Observatory of the Addis Ababa University (AAU). The Geophysical Observatory in the campus of AAU is still operational and its present contribution to the scientific community is, among other activities, maintaining an INTERMAGNET station

of the world-wide, real time, satellite-linked, magnetometer network (<http://www.intermagnet.org/>). A review paper that describes space research activities in Ethiopia and in neighboring African countries during the seventies of last century can be found in [2]. Although the facilities installed by French scientists have provided valuable data, the expansion and continuous operation of these facilities did not materialize in Ethiopia. This may be due to the fact that the involvement of Ethiopian scientists in research and development of these facilities was very limited. Moreover, there was no any space physics formal training at Ethiopian universities in that time. Formal education in space physics has started in Ethiopia recently with the start of Space Physics Graduate Program jointly by Addis Ababa University and Bahir Dar University. In order to expand and strengthen this program, we are initiating a collaborative project in atmospheric research and educational programs with many national and international stake holders, including a commercial enterprises such as Eigenor heading towards development and operation of weather radars (<http://www.eigenor.com/BERCAB/index.php/Main Page>). This paper presents an overview of the research and training activities in space physics in Ethiopia and also the descriptions of one successful collaborative project between Oulu University (Finland), Bahir Dar University (Ethiopia) and Addis Abeba University (Ethiopia). Moreover, a brief description of other forthcoming collaboration is presented with the intention of attracting the attention of potential collaborators and funding agencies.

References

- [1] Hanuise, C., Crochet, M., Multifrequency HF radar studies of plasma instabilities in Africa , J. atmos. terr. Phys., 39, 1977.
- [2] Crochet, M., Radar studies of longitudinal differences in the equatorial electrojet: a review , J. atmos. terr. Phys., 39, 1977.

Ionospheric Vertical Plasma Drifts at F-Region near the Magnetic Equator

Oyedemi Oyekola

Department of Physics , University of Ibadan, Ibadan,, Nigeria

The ionospheric plasma drift is one of the most essential parameters for understanding the dynamics of ionospheric F-region. Consequently, it has been the subject of numerous studies with variety of observational techniques over the last few decades, mostly, at equatorial and low-latitude regions. F-region electromagnetic drifts are calculated from ionosonde observations acquired during the International Geophysical Year (1957/58) at Ibadan (7.4°N, 3.9°E, dip 6°S), Nigeria. We investigate ionosonde drift variations with solar and geomagnetic activity under three seasonal conditions, and compared these drifts with vertical drifts obtained by incoherent scatter radar and AE-E satellite measurements under similar solar and geomagnetic conditions. We show that except for solar minimum equinoctial period, there is an excellent consistence in the magnitude (nearly 20 m/s) and occurrence pattern of upward daytime ExB drift velocity at low and high solar activity periods. A clear seasonal and geomagnetic effect is apparent. In the nighttime sector, from sunset to sunrise, we find comparable trends among the three techniques during the period of high F-layer heights at equinox and December solstice, while opposite behavior occurs during June solstice season. In addition, the equinoctial average evening upward

drifts enhancements by the three methods are roughly comparable and occur at the same local time (19 LT) for all seasons. The evening reversal time from upward daytime to downward nighttime does not vary much except during the June solstice months and occurs earliest in December solstice and equinox, but least during June solstice. Furthermore, prereversal enhancement in ExB drift is found to be poorly correlated with solar activity as represented by F10.7 cm solar flux index and monthly average sunspot numbers during quiet period, but connected fairly well during disturbed time. The onset parameters required to trigger spread F irregularities at Ibadan longitude sector are estimated as 30 m/s and 400 km for prereversal peak ExB drift and virtual height of F-layer ($h'F$), respectively. Our observations are in good agreement with some results obtained for other equatorial and low latitude regions.

Diurnal Variation of Absorption of Trans-ionospheric Radio Waves in Equatorial Zone.

¹Rabiu, A.B. and ²Oyinloye, J. O.

¹Department of Physics, Federal University of Technology, P.M.B. 704, Akure, Nigeria.

²Department of Physics, University of Ilorin, Ilorin, Nigeria.

The investigation is primarily concerned with the hourly variation of the ionospheric absorption of high frequency radio waves propagated through the ionosphere in the equatorial zone. The monitoring system consisted of external dipole antennae, a radio receiver, a low-tension power supply, an amplifier, a rectifier, and a chart recorder. The ionospheric absorption obtained was strongest about noon and decreased toward the morning and evening hours. The O- and X- modes results were compared. The different results were discussed considering likely ionospheric region of reflection of the wave and spatial loss. Ionospheric absorption appears to have the major control on the hourly variation of the signal strength.

International Heliophysical Year (IHY): participation and opportunities

¹Rabiu, A. B., and ²Balogun, E. E.

¹Department of Physics, Federal University of Technology, Akure, NIGERIA

²Department of Physics, Obafemi Awolowo University, Ile-Ife, NIGERIA

¹tunderabiu@yahoo.com, ²eebalogun@yahoo.com, ² ebalogun@oauife.edu.ng

International Heliophysical Year is an international cooperation programme organized to commemorate fifty years of International Geophysical Year, IGY. With a focus on Sun-Earth connection and the prevailing Physics in the helio-geosphere, IHY promises to be the greatest international cooperation of the recent time. The paper highlights the opportunities and the probable gains of the Nigerian scientific community in the programme. A strong call is made for participation in the activity.

Characteristics of equatorial electrojet thickness

Rabiu, A. B.¹ and Nagarajan, N.²

¹Department of Physics, Federal University of Technology, Akure, NIGERIA
¹National Geophysical Research Institute, Uppal road, Hyderabad 500 007, INDIA.
²tunderabiu@yahoo.com, ³nandini@ngri.res.in,

The diurnal variation of the thickness of equatorial electrojet over Indian sector have been evaluated from Onwumechili's thick current shell format of continuous current distribution model of equatorial electrojet for the first time. The thick current shell model, which takes into account the vertical ionospheric currents, permits both the width and the thickness of the jet to be determined simultaneously. The thick current shell model is shown to give better hourly representation of jet behaviour than thin shell format hitherto being used. The thin current shell model best fits only the near local noon jet observation, as the electrojet is thinnest at period of maximum intensity. The transient variation of the jet thickness is explained in terms of the wind shears in consistency with the electrodynamics of the dynamo region.

Radiative transfer model in the atmosphere and experimental solar data of yaounde
location

E. Guemene Dountio^(1,2) ; D. Njomo⁽²⁾ ; Efa Fouda⁽¹⁾ ; A. Simo⁽¹⁾

Sun is the primary source of energy supplying the earth. This energy absorbed by the various components of the atmosphere, the oceans, the vegetation, earth surface, is at the origin of the forces which control the climatic changes, the general circulation of the atmosphere, the temperature of the atmosphere and that of the oceans, the ionization of atmospheric gases, etc. The solar energy received on earth surface is also directly used in technological applications such as solar heaters, solar dryers and other solar distillers, the photovoltaic generators, etc. The calculation of the thermal performances of these apparatuses can be well made only if the spectral and even angular distribution of the solar irradiation arriving on the ground surface is well known. Moreover, the well known of the characteristics of the solar radiation arriving on the ground could inform about the atmospheric phenomena which influenced its crossing, and consequently provide a better correction of the sensors response while receiving a signal from outer space in its direction, or the correction to be made on the response of a sensor while receiving data from an terrestrial sender. Just few measurements stations of solar radiation are running today and are not well managed, particularly in the developing countries where the maintenance of a park of pyranometers on the ground is difficult and expensive. Moreover where these measurements exist, they are rarely carried out for various wavelengths and/or angles. Such data are on the other hand accessible by numerical calculation, by solving the radiative transfer equation (ETR) in the atmosphere. One of the mayor factors attenuating the solar radiation received on the ground is scattering by clouds. The non homogeneous nature of the clouds justifies the difficulty shown by the researchers to insert realistic profiles of clouds in radiative transfer models in a parallel stratified atmosphere [1,2]. Several recent studies showed that these non homogeneity have significant impacts on the transmitted radiation, calculated either for the thick and continuous clouds [3] or for dispersed clouds [4,5]. Such structures must be studied with a multidimensional radiative transfer model, as for example the one of Stephens [6] judiciously exploited recently by Evans [7] which breaks up the angular part of

brightness into spherical harmonics while the space part is simply discretized by finite differences. We intend here to make a comparison between results of this model and the experimental data collected on the Cameronian site of Yaounde[8-13]. This in order to detect its forces, weaknesses and the possible improvements which could be done to guarantee a prediction free from any significant variation with reality. The first part is devoted to the description of the model. In the second, we have the results of the model as well as the values resulting from experimental measurements. The last part deal with the discussion of these results.

MINRESI/IRGM/LRE (Ministry of Scientific Research and Innovation/Institute of Geological and Mining Research/Energy Research Laboratory), University of Yaounde I / Faculty of Science/ Department of Physics/LATEE

References

- McKEE T., COX S. (1974) : Scattering of visible radiation by finite clouds. J.Atmos. Sci. vol.31, pp.1885-1892
- DAVIES R. (1978) : THE EFFECT OF FINITE GEOMETRY ON THE THREE-DIMENSIONAL TRANSFER SOLAR IRRADIANCE IN CLOUDS. J.ATMOS. SCI. VOL.35, PP.1712-1725
- CAHALAN R. et al. (1994) : The albedo of fractal stratocumulus clouds. J.Atmos. Sci. vol.51, pp.2434-2455
- WELCH R. , WIELICKI B. (1984) : Stratocumulus cloud field reflected fluxes : the effect of cloud shape. J.Atmos. Sci. vol.41, pp.3086-3103
- BARKER H. , DAVIES J. (1992) : Solar radiative fluxes for stochastic, scale-invariant broken cloud fields. J.Atmos. Sci. vol.49, pp.1115-1126
- STEPHENS G. (1988) : Radiative transfer through arbitrarily shaped optical media, part I : A general method of solution. J.Atmos. Sci. vol.45, pp.1818-1836
- EVANS K. (1993) ; Two-dimensional radiative transfer in cloudy atmospheres : the spherical harmonic spatial grid method. J.Atmos. Sci. vol.50, pp.3111-3124
- J. NGANHOU, EFA FOUA, S. SYAM SIEWE, E. MGBA MANI, C. RINGBE; Mesures du rayonnement solaire en république unie du Cameroun : stations de Yaoundé et de Garoua ; *DGRST/IRGM/LRE* ; Vol.1 ; Décembre 1982. BP.4110 Yaoundé:
- EFA FOUA, S. SIYAM SIEWE, J. NGANHOU, E. MGBA MANI; Mesures du rayonnement solaire en république unie du Cameroun ; *DGRST/IRGM/LRE* ; Vol.2; Août 1983. BP.4110 Yaoundé.
- A. SIMO, S. SIYAM SIEWE, BISSECK HANDS ; Solar radiation measures in Cameroon. *DGRST/IRGM/LRE* ; Vol.3; Jul-Dec 1983. BP.4110 Yaoundé.
- A. SIMO, S. SIYAM SIEWE, BISSECK HANDS ; Solar radiation measures in Cameroon. *DGRST/IRGM/LRE* ; Vol.4; Jan-Jun 1984. BP.4110 Yaoundé.
- A. SIMO, S. SIYAM SIEWE, BISSECK HANDS ; Solar radiation measures in Cameroon. *DGRST/IRGM/LRE* ; Vol.5; Jul-Dec 1984. BP.4110 Yaoundé.
- A. SIMO, C. TAKOUDJOU, BISSECK HANDS ; Solar radiation measures in Cameroon. *DGRST/IRGM/LRE* ; Vol.6; Jan-Jun 1985. BP.4110 Yaoundé.

IONOSPHERIC TEC MEASUREMENTS DURING THE 2003
OCTOBER/NOVEMBER MAGNETIC STORMS AT SCOTT BASE STATION
ANTARCTICA

Zainol Abidin Abdul Rashid¹, Sumazly Sulaiman¹, Mohd Alauddin Mohd Ali¹,
Baharudin Yatim²

¹Electric, Electronic & Systems Department, Faculty of Engineering
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, MALAYSIA

Email: zaar@vlsi.eng.ukm.my

²Institut Sains Angkasa (ANGKASA), G110 Physics Building,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, MALAYSIA

This present the investigation on the characteristics of the 2003 October/November magnetic storms based on GPS TEC measurement at Scott Base station Antarctica (GC: 77.9°S, 166.8°E GCM: 79.9°S, 327.2°E). To support the investigation, the daily GPS-TEC and percentage of TEC deviation ($\Delta\text{TEC}\%$) at Scott Base Station are compared with the solar wind IMF data from MFI/SWE instruments and with the planetary magnetic and solar indices from WDC. Results show that, the November 2003 storm was more intense than the October 2003 storm, however it has a shorter duration of about 32 hrs than the October 2003 storm, which has three injections with storm duration of about 60 hours. For the October storm, VTEC peak equal 114 TECU with $\Delta\text{TEC}\%$ equal 410% and the duration of the positive storm phase and negative storm phase are 23 hrs and 37 hrs respectively. For the November storm, VTEC peak equal 35 TECU with $\Delta\text{TEC}\%$ equal 50% and the duration of the positive storm phase and negative storm phase are 2 hrs and 30 hrs respectively. In the October storm, the positive storm phase lagging of about 3 hours with respect to the onset of the southward IMF Bz and for the November storm, the short positive storm phase lagging of about 9 hours with respect to the onset of the southward IMF Bz. During the first SSC and second SSC of the October 2003 storm, the TEC response was flat with $\Delta\text{TEC}\%$ of about 0%. The decreasing of Dst and the southward turning of the IMF Bz for October storm occurs at about the same time whereas for the November storm the decreasing of Dst was observed to lag by two hours. The TEC enhancement was observed to lag behind the southward IMF Bz by about 3 hours for the October storm and by about 9 hours for the November storm.

Keywords: Ionospheric TEC, Geomagnetic storm, IMF, GPS,

To establish a Space and Atmospheric Physics facility at North Carolina A&T State
University
Jyoti R Nair and Abebe Kebede

Department of Physics, North Carolina A & T State University
Greensboro, NC 27411
NASA Grant number: NNG04GD63G

The Study of Space and Atmospheric Physics is planned at Department of Physics, NC A&T State University, NC, to meet the needs of the minority community to build a general capability in atmospheric/space science as a necessary support for academic infrastructure development. The course will be intended for graduate and undergraduate students who wish to pursue research in space/atmospheric physics. In order to fortify this effort, we have initiated a collaborative work with US Air Force and GSFC, NASA. The main rationale of this proposed project work is to investigate the current scientific issues associated with MITS like the TEC variations, scintillations and disturbances, and the morphology/manifestations of Ionospheric Spread F phenomena that vary with locations (longitude and latitude), especially over low and mid-latitudes, which is also an important diagnostic for understanding space weather. In addition to this, we plan to install two ground based instruments, a magnetometer and a coherent beacon receiver, at North Carolina A&T State University (a mid- latitude station: Geog. Latitude $\sim 36^{\circ}\text{N}$), to provide local measurements for geomagnetic activity and TEC/scintillations effects respectively. Scientists, teachers/ professors and students who are interested in studying the space/atmospheric physics and located at different institutions can also make use of these facilities. This work will be the first of its kind in the sense that it will be first ground-based instruments to be installed in North Carolina in a minority community university (HBCU) as a part of Research and Education outreach in space/atmospheric physics. Some of these aspects are discussed here.

Post workshop communication

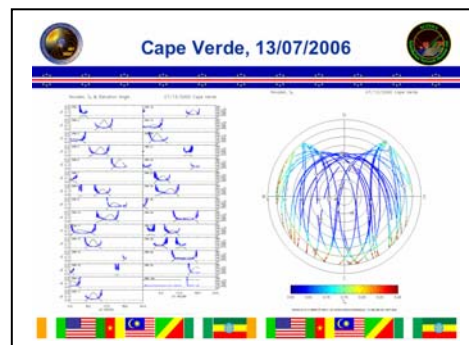
The deliberations of the recent International Heliophysical Year (IHY) workshops sponsored by national and international organizations made the way for the recognition to conduct a major IHY workshop in Africa (IHY-Africa) in the near future. As a prelude to the upcoming IHY-Africa workshop, Cape Verde hosted the first IHY SCINDA workshop on the continent of Africa on the island of Sal during July 10-14, 2006.



The IHY-SCINDA workshop was sponsored by the European Office of Aerospace Research and Development (EOARD), Air Force Research Laboratory (AFRL), North Carolina Agricultural and Technical State (NCATSU), NASA and the National Institute of Geophysics and Metrology (INMG). More importantly the program benefited from the support of ASA, the municipality of Sal, Hotel Morabeza, and the people of Santa Maria.

This workshop allowed scientists in Cape Verde to provide real-time data analysis and forecast of ionospheric disturbances in collaboration with their colleagues around the world. Shown in the figure is the first observation of ionospheric scintillation in the vicinity of the magnetic equator.

The participants of this workshop realized the value of the data to space scientists to understand the cause and implication of ionospheric disturbances on maritime and civil aviation enterprises. While providing the environment for cutting-age space science research, the scintillation monitoring systems have a profound contribution to the development of space science education programs in Africa..



As a direct result of the organization IHY-SCINDA workshop the participants are now leading members of the IHY-Africa forum. The IHY-Africa forum consists of leading scientists in space physics, instrument providers and the United Nations. While the major objectives of the forum is to facilitate the study of ionospheric disturbances on the African sector, it also provides the environment for exchange of ideas for a sustained infrastructure and human resources development to improve research in space physics.

The SCINDA curriculum

The general discussion involved topics of physical principles of ionospheric scintillation and detection systems .The curriculum covered equatorial aeronomy and the physics of low latitude ionospheric disturbances that affect space-based communication and navigation systems. The workshop provided training for over 15 African scientists and

INMG meteorologists on the deployment, operation and interpretation of SCINDA sensors and data. The trainees participated in setting up GPS TEC/scintillation system and on-line data management and processing. While the SCINDA workshop trains users of geomagnetic facilities, data acquisition and data reduction methodologies, several current and future research topics were discussed.

Countries and research interests

Cote d'Ivoire: Variability parameters for *f_of₂* at equatorial latitudes (Dr. Olivier K. Obrou)
Ethiopia : Establishing Cosmic Ray Station and other space research facilities in Ethiopia (Dr. Baylie Damtie and Dr. Gizaw Mengistu)

Remote Sensing of Composition, Chemistry and Dynamics of the Atmosphere (Dr. Gizaw Mengistu, Dr. Baylie Damtie)

Nigeria: Ionospheric Vertical Plasma Drifts at F-Region near the Magnetic Equator (Dr. Oyedemi Oyekola)

Nigeria Diurnal Variation of Absorption of Trans-ionospheric Radio Waves in Equatorial Zone and Characteristics of equatorial electrojet thickness (Dr. Rabi Babatunde)

Cameroon: Radiative Transfer Model In The Atmosphere And Experimental Solar Data of Yaounde Location (Dr. Guemene Emmanuel Dounito) (**)

Malaysia: Correlation Between Solar Event And Ionospheric Scintillation (Dr. Zainol Abidin Abdul Rashid)

Congo-Brazzaville: Sand Displacement in the Congo River (Dr. Dinga Bienvenue)

USA: Space and Atmospheric Physics facility at North Carolina A&T State University (Dr. Jyoti Nair and Abebe Kebede)

IHY-Africa Workshop in Addis Ababa, Ethiopia, November 2007

Following the deliberations of IHY workshop in United Arab Emirates, November 2005, and IHY-SCINDA workshop in Cape Verde, the participants of the first IHY-SCINDA workshop propose to organize the first IHY-Africa workshop in the city of Addis Ababa,

Scope of the workshop

The United Nations Basing Space Initiatives and the International Heliophysical Year 2007 (IHY-2007) will be dedicating their workshops and activities through 2009 to the IHY developing nations program. UNBSSI will assist scientists and engineers from all over the world in participating in the preparations for IHY 2007. The program will target activities that stimulate Space and Earth Science activities in developing nations, such as the establishment of ground-based instrument arrays and research programs. The program consists of a series of annual workshops hosted in varying international locations. A major thrust of the International Heliophysical Year (IHY) is to deploy arrays of small,



inexpensive instruments such as magnetometers, radio antennas, GPS receivers, all-sky cameras, etc. around the world to provide global measurements of ionospheric and heliospheric phenomena. The small instrument program is envisioned as a partnership between instrument providers, and instrument host countries. The lead scientist will provide the instruments (or fabrication plans for instruments) in the array; the host country will provide manpower, facilities, and operational support to obtain data with the instrument typically at a local university.

As a result of the UNBSSI and IHY initiatives several small instrument providers are lined up to deploy their equipment at numerous locations. The list includes the SCINDA: (Scintillation Network Decision Aid, US-Air Force), AWESOME: Space Weather Monitor Program (Stanford University), CARISMA and IHY-MAG Magnetometer Arrays (University of Alberta Canada), CALLISTO Frequency Agile Solar Spectrometers (The Institute of Astronomy, Zurich), CIDR (Coherent Ionospheric Doppler Radar, University of Texas at Austin, USA), Low-Frequency Radio Antenna Array (Massachusetts Institute of Technology), MAGDAS: Magnetic Data Acquisition System Project(Space Environment Research Center, Kyushu University, Japan), RENOIR: (Remote Equatorial Nighttime Observatory for Ionospheric Regions: University of Illinois), Rutherford Appleton Laboratory Low-Cost Ionosonde(Rutherford Appleton Laboratory, Brazil), SAVNET (South Atlantic Very Low Frequency NET-work), and VLF Array, Universidade Presbiteriana Mackenzie, Brazil). ¹

The Science

Much attention in space weather has been devoted to the large changes in total electron content (TEC) over the American sector during geomagnetic storms. The attention has been fueled by the ability to map the electron content using networks of ground-based, dual-frequency GPS receivers². There has been speculation that the large changes in plasma density and electrodynamics in the American sector are related to the unusual configuration of the geomagnetic field, including the South Atlantic Anomaly (SAA) and large values of declination. Steep gradients in TEC can disrupt operational systems such as the Wide Area Augmentation System (WAAS), leading to navigation errors sometimes exceeded 50 m, more than 10 times typical uncertainties of 2-3 m.

The speculation has spurred the need to target other geographic regions with significantly different geomagnetic field configurations. In particular over Africa where the magnetic equator is parallel to the geographic equator and more uniform in magnitude, one can expect significantly different ionospheric configurations. Unfortunately, this region doesn't have a dense network of ground-based GPS receivers available to perform a complementary study, nor does it have sufficient magnetometer chains to monitor the dayside plasma drift. This region is suitable to study phenomena associated with ionospheric irregularities. For example;

¹ International Heliophysical Year Workshop, Al Ain, United Arab Emirates

² Tim Fuller-Rowell, NOAA

a) Scintillations: Small scale irregularities associated with the ionospheric structure cause scintillation in radio signals propagating from the ground-to-satellite or satellite-to-ground. Phase and amplitude scintillation can cause the signals to be lost. Unlike the TEC changes, ionospheric irregularities can occur even on geomagnetically quiet days.

b) Electric fields and plasma content: One of the important drivers of the mid and low latitude ionosphere is electric fields. Zonal electric fields at the magnetic equator transport plasma vertically across the magnetic field, subsequently diffusing to high latitudes to form the equatorial ionization anomaly (EIA). During quiet geomagnetic conditions the day-to-day variability of the electric fields at low latitude can influence the height of the ionosphere and lead to the variability of scintillations. During storm times these same electric fields can be enhanced, either due to prompt penetration from high latitude or due to the disturbance dynamo, and can lead to dramatic restructuring of ionospheric plasma. Magnetometers spanning the equatorial electrojet are able to monitor the vertical plasma drift at the magnetic equator and so provide one of important drivers of the system. These same magnetometers can sense the natural Alfvén resonant eigenfrequencies of entire magnetic field lines, which can be inverted to give a measure of the equatorial plasma density in the magnetosphere and plasmasphere.

Organization of the workshop

The IHY-Africa workshop will be organized in three major sessions. IHY- SCINDA, funding agency forum, IHY-Africa general session.. Each session includes invited presentation, contributed papers and panel discussion. An international Advisory Board will be established to oversee the overall quality and effectiveness of the IHY-Workshop. The participants of IHY-SCINDA workshop agreed to serve as members of the International Scientific Committee. This committee will be chaired by South Africa, and co-Chaired by Cape-Verde. The local organizing committee will be co-chaired by Dr. Gizaw Mengistu, Addis Ababa University and Dr. Baylie Damtie, Dean of Graduate Studies of Bahir Dar University, and Dr. Kebede, USA, agreed to serve as the international liaison.

Potential Participants and source of support

Financial assistance will be sought from NASA, ESA, NSF, DOE, EOARD, UN and non-governmental organizations that have a vested interest in science education and research in Africa. Copies of this proposal will be submitted to such organization to solicit support for student and faculty travel in the host country and other parts of Africa.

Appendices

Appendix I: SCINDA WORKSHOP TRIP REPORT: Mr. Eyo Ita, EOARD representative

The Scintillation Network Design Aid (SCINDA) workshop was hosted from 10-14 July on Sal Island, Cape Verde. The SCINDA workshop was held in alignment with the events leading to the International Heliophysical Year (IHY) 2007. IHY 2007 will commemorate the 50th Anniversary of the International Geophysical Year (IGY), continuing its legacy of international research and advancement of the understanding of the heliophysical processes affecting the earth, the sun and outer space. IHY is a joint effort sponsored by the United Nations, the European Space Agency (ESA), the African Scientific Network (ASN), and NASA.

Represented at the SCINDA workshop were some of the leading scientists in space and ionospheric research in Africa and Southeast Asia including Nigeria, Malaysia, Cote D'Ivoire, Congo, India, Ethiopia, and Cape Verde. Representatives from the Air Force Research Laboratory (AFRL) and North Carolina A&T, the organizers, were present. The SCINDA workshop included presentations from the scientists on their research as it relates to space science, physics of the ionosphere and magnetosphere, country specific factors and spin-offs arising from the international collaborative effort to characterize scintillation and its global impacts, and ongoing research efforts within the EOARD area of responsibility. Presentations were made by AFRL on the physics, impacts and issues associated with scintillation as well as hands-on training on the installation, interpretation and operation of the SCINDA and associated systems, their monitoring and analysis of the data they collect. The workshop featured various events including a tour of the Airports Safety Administration (ASA) of Sal Island featuring airport traffic control facilities and operations, and the and the Institute of Meterorogical***** and a tour of Sal island. The closing ceremony featured a dinner hosted by the Minister of Agriculture and Infrastructure of Cape Verde, her excellency Dr. Madalena Neves.

The closing ceremony was filmed for television and various workshop attendees were interviewed by the TV news crew.

The SCINDA workshop was a huge success and culminated in the successful real-time turnover of ground based in-situ scintillation data gathered from the installed sensors, the first realistic test of the system. Cape Verde served as the prototype site for the installation and testing of the SCINDA system and the current plan by NASA and AFRL in alignment with IHY initiatives is to set up additional sites in various countries on the continent of Africa to form a network for collection, analysis and comparison of the data. Cape Verde has set the precedent for development of this project, its concept and associated spin-offs. There is a recommendation to hold the next SCINDA workshop one year from now in Ethiopia during which scientists will present, compare and analyze the data gathered and assess the understanding and exploitation of the phenomena to date. It

is hoped as well to expand the network to identify and to integrate more scientists from the pertinent regions and their activities of interest.

Scintillation, a phenomenon which has been researched extensively in universities in Africa, is characterized by the rapid spatio-temporal fluctuations in the phase and amplitude of electromagnetic signals reaching the earth. The physics and the dynamics of scintillation are influenced by numerous factors including ionospheric and magnetospheric activity, processes and events, geophysical effects, and patterns on the earth and are poorly understood. Scintillation is of particular interest to the Department of Defense due to its impact upon satellite communications and space/GPS-based navigation systems and the effects are most pronounced in geographical regions within a few degrees of the earth's magnetic equator, mainly in South America, Africa, and Southeast Asia. There is a large void in our understanding, modeling and adaptation of scintillation effects and these locations are particularly ideal for setting up ground-based recording stations due to their relative proximity to the dominant arenas of scintillation and to the affected systems for monitoring and collecting the data needed. They are the sites of the world where the best data is available and in addition to their operational value to DoD provide a means for calibration of satellite systems and validation of scintillation models. The main data of interest, scintillation parameters and ionospheric drift velocities, are recorded by the ground based receivers, are fed real-time into a LINUX based operating system and then are subsequently transformed into a color-coded scintillation map representing scintillation structures and communications impacts. The information derived includes the times, locations, probability, severity and impact of scintillation activity and recommendations regarding satellite reliability and use and the end product is tailored to the requirements of the warfighter.

The workshop was particularly of value to Africa due to the unique opportunity to contribute to a global scientific effort and to integrate into the mainstream scientific community. It has helped to establish a link and to identify talented scientists within our area of responsibility who can contribute to our common goals and mission, and provide a unique insight into the vast potential of Africa as an untapped scientific resource, the issues it faces, and ideas to bridge the void in our knowledge. The SCINDA concept, training, and installation were well received by these respective nations due not only to the aforementioned factors, but also due to their relevance to the research programs within the institutions themselves, the benefit, training and development of the current and future generations African scientists, infrastructure and human resources and the opportunities for collaboration. These have been assessed as factors which contribute to the unleashing of Africa's potential both in general and as it relates to our research mission within the EUCOM area of responsibility.

I have individually conducted interviews with the various representatives to delve into the country specific aspects first-hand from the standpoint of the researchers themselves, their insights, concerns, visions and thoughts for the future of science in Africa and how they can contribute. The information from these interviews supplement the compendium of presentations given, which can be found on the Edison House M drive at *****.

Dr. Oyedemi Oyekola, Oyo State Nigeria, University of Ibadan

- PhD. in Ionospheric Physics
- Researcher/lecturer at University of Ibadan since 1999
- Nigerian Association of Mathematical Physics treasurer

Nigerian University Commission (NUC) is the governmental body responsible for establishment of all universities in Nigeria. Potential and enthusiasm for scientific research is high albeit stifled due to various factors and education has not as yet been addressed as a priority within the government. Main emphasis for the last two terms have been economic development and reforms of the Nigerian political system which is currently recuperating from the last 20 years prior to 1999 of military coups and counter coups, mismanagement of the country's resources and corruption within military dictatorial regimes. The past and current generation of scientists have relied primarily upon their own means and upon support from outside of Africa to sustain emphasis on scientific research:

- (i) Money allocated to education (approximately 2% of GDP) and research at the governmental level is not channeled to the end users, the academic institutions, researchers and students and the youth.
- (ii) The university system has been on strike for the last 10-15 years with protest of conditions not conducive to productive scientific development.
- (iii) The university does not subscribe to journals and scientists have to rely either on the internet or on colleagues in order to stay abreast of science through conferences.
- (iv) Faculty do not have ready access and have had to purchase their own computers and equipment with minimal and in some cases no support from their respective institutions.
- (v) Support for international conferences has traditionally been discouraged at the university departmental level. The scientists with sufficient caliber, zeal and enthusiasm have had to fund and support themselves as well as to endure personal sacrifices in order to meet the demand for their research at an international level, which is high, and to interact with their international counterparts. In particular, Dr. Oyedemi has been invited to present publications on ionospheric studies at numerous symposia including Malaysia, China, UK, France, Netherlands, India but has missed opportunities due to lack of support and constraints. Endeavors to present works in international conferences have been self-funded with the exception of the SCINDA workshop. There are numerous other similar examples.
- (vi) There is very high potential but the environment, working conditions and facilities need to be vastly improved in order to advance and to not discourage the youth.
- (vii) As council treasurer on the Nigerian Association of Mathematical Physics organizes conference every November in Nigeria. Current goal is to incorporate Republic of Benin and representation from America and Europe.

Dr. Babatunde Rabi, Federal University of Technology, Akure, Nigeria

- Phd from University of Nigeria, Nsuka (UNN). Lecturer at 1993-2001
- National coordinator for IHY for Nigeria
- Attended the ICTP in May and were assisted by various space agencies in Europe as well as NASA

Nigeria is rich in natural and human resources and the Obasanjo administration has implemented massive reforms since 1999. The root of problem facing Nigeria is that government is interested in technology acquisition and not in basic scientific research. The root of problem hindering academic development is that the national policy does not create a conducive environment for scientific learning and research. The National University Commission is responsible for accreditation and regulation of all university systems in the country, and yet the procedures are counter-productive to the end users. The federal government claims that they spend billions of Naira on education but it inevitably is tied up in the hands of administrators and does not reach the academic institutions. Grants from external agencies and nations have been of great help to Nigerian scientists.

Dr. Gizaw Mengistu, Addis Ababa University, Ethiopia

Department of Physics, Assistant professor since 1994

- Undergraduate training from Addis Ababa University and PhD. from Germany
- Addis Ababa University was formed by America in the 1940's and 50's and many of its students go to the US for further study.
- Collaborations with Germany and South Africa

Conducted measurements of atmospheric trace gases within 10 degrees latitude/longitude of Ethiopia utilizing Fourier Transfer Infrared Spectroscopy equipment and technology loaned to the university from Germany. Significance is that this is the first in-situ measurement conducted in the tropics in Africa. Currently is in collaboration with Germany to extend this science to the whole of Africa and Germany is willing to donate the instruments and equipment necessary. The next immediate goal is to focus on Ghana. Germany is interested in the tropics due to the mechanism of ozone depletion in the polar regions. Most of the water vapor originates from the tropics and reaches the polar region which freezes entrained chlorine gases. In the spring it dissociates releasing chlorine ions into the atmosphere, thus constituting an alternate source for ozone layer depletion. The Institute of Geophysics and Seismology, and the Center for Space Science and Atmospheric Research support this initiative but currently are limited by financial support. The majority of support comes from Germany as well as donations from local businessmen and individuals and the scientists themselves. The Ethiopian government supports and endorses this initiative but lacks the financial resources. SCINDA GPS system broadens the focus of this research group to generalize atmospheric studies to density fluctuations within the ionosphere. The algorithm developed can be adapted to provide calibration for the GPS system and physical input into scintillation models. Assessment is that Africa, although it has significant unrealized potential is not yet at a stage of self-sustainment with regard to scientific research. This study is an example via

which through collaboration with the EU, South Africa and others a positive research environment can be sustained and infrastructure and skilled manpower can be developed in Ethiopia

Dr. Baylie Damtie, Bahir Dar University, Ethiopia

- Associate professor of physics and Dean of graduate programs. Also adjunct professor at Addis Ababa University
- Obtained Phd from University of Tronso, Finland
- In partial collaboration with UCLA, Norway, Air Force Research Laboratories and with N.C. A&T

For doctoral work developed atmospheric radar systems for investigation of ionosphere and study of space debris. Developed innovative coding and decoding algorithms for RF signals. Currently is in collaboration with Finland which has provided some funding and instrumentation for this research.

Currently has funding (\$300,000) from the World Bank through the ministry of education for Bahir Dar University for three years to establish a virtual laboratory to enhance teaching methods of science to students. The university generally supports sometimes supplements the funding for research if external funding is available. It also provides encouragement in the way of recognition to scientists. The university's location at the source of the Nile River (the blue Nile) has been assessed as being of vital importance as a natural resource to life on the continent as it supplies 86% of the water in Egypt. Stability in Africa is linked to stability in Ethiopia. Atmospheric monitoring and monitoring the water source are prime areas of importance to the university.

Developed a method to apply the radar encoding/decoding algorithm from to sonar. High resolution 3D images of the environment beneath the water surface is an area of interest to Finland and measurements of the lake in Bahir Dar are in progress. The inversion technique utilizes pulses with irregular spacing, the Doppler effect and autocorrelation to overcome the limitations of traditional systems (the Doppler/Range dilemma for which it is impossible to determine the velocity and range to a target is alleviated by analysis of the spectrum/signature of the target- an Ethiopian student is currently developing an algorithm to study the signal correlation). The Finnish ambassador to Addis Ababa has endorsed the project for a 2 million Euro grant from the Finnish government. Due to irregularities in the May 7, 2006 elections in Ethiopia the Finnish government has indefinitely postponed approval of the grant. The elections were held to determine the governing party which chooses the prime minister. The opposition party, which is led by a group of academics and intellectuals, contested the results of the election and were consequently jailed by the president. The EU was in support of the opposition party and had requested that the president release them, a request which was denied. Consequently, Finland suspended all bilateral agreements with Ethiopia, although they still provide humanitarian and some limited financial assistance. These political events have impeded a unique collaborative research opportunity which previously was viewed with optimism by the Finnish government. It is hoped that in October 2007 the EU will change its position.

Dr. Abebe Kebede, NC A&T State University, USA

- Originally from Ethiopia and has lived in the US for over 20 years
- Undergraduate training from Addis Ababa University, Ethiopia and Masters/Phd from Temple University
- Currently director of space programs at NC A&T. Single-handedly created and developed the program from the ground up and has obtained numerous grants from NASA
- Organizer of the SCINDA workshop and various events which collectively led to its concept

Over years of experience Dr. Kebede has learned numerous attributes of the American educational system which can be used as a model for African systems and is intimately linked into a network of international scientists, and in particular African scientists. The root cause with regard to lower scientific research and development in Africa is lack of organization and access to vital infrastructures. The basic facilities normally taken for granted such as internet, books, equipment, training opportunities, etc. have not in general been part of the plan or educational emphasis of the indigenous governmental systems. Given the continental context as a war context investment should be directed toward programs that lead to more organization and to international collaboration. Utilizing SCINDA as model for instance, students can launch satellites aboard the space shuttle to conduct research projects and experiments of benefit to the Air Force. A scientific journal and proceedings on SCINDA can be published. Projects such as these are a source of inspiration for the current generation of young people. The main idea is to put in place the elements for sustainable development of scientific research in Africa in alignment with the common goals of the Air Force, Department of Defense, the US government and the rest of the world. What is missing in Africa is a role model for scientific research and a reward system for scientific achievements. The current system is not creating scientific leaders, but rather opportunists. The proposal is for the next SCINDA workshop to be held in Ethiopia to compare and present the data acquired from the monitoring stations and lessons learned. It is acknowledged that by sheer virtue of obtaining the scintillation monitoring equipment that Cape Verde is working for the US government who should maintain a stake in the progress for Africa as well as its future implications. The amount of educational material being produced simply on the NASA website far exceeds that existent in the whole of Africa combined. This information should be made available to Africa. International graduate programs should be open to African students to orient them more to the scientific program around the world, and also accessibility should be broadened. For example, the representative from Cameroon was unable to attend in Cape Verde due to difficulty obtaining a transit visa through Europe, the least tortuous route. Africa needs to find a way to develop a larger community so that it becomes part of the mainstream community. We must find the African scientists and solicit their input into this process. Access is not uniform, but conferences such as SCINDA have been vital in incorporating the contributions and in scraping the surface of the potential realizable from the African continent. The African Scientific Network has been of some help as a model to bring the African scientists together. The network is

currently based in the US and currently has 2000 members. Most of the organization and the coordination has been done at NC A&T which hosts the server. It is run on a full volunteer basis with no external funding as has been listed by Harvard University as a sustainable development program.

The potential for sustained material research, informational technology and computational sciences and physics is particularly high in Africa for the following reasons: Materials research would satisfy the energy needs and enhance the quality of life of Africa. For computational sciences and nanotechnology/molecular physics it can be realized very easily because it does not require a significant infrastructure and has the potential to skyrocket with relatively minimal investment. SCINDA falls under the realm of computational sciences, is relatively easy to develop and implement, and has served as a model and precedent to bring many African countries together.

Dr. Oliver Obrou, University of Cocody, Abidjan,, Cote d'Ivoire

Lecturer since 1998, Ionospheric Physics and Equatorial Ionospheric Modeling
Fulbright Exchange Program alumnus, Adviser to network manager at university: current goal to acquire satellite connectivity to improve speed.

The majority of research programs in Cote D'Ivoire have existed through strong ties and collaboration with France. Some collaboration is ongoing with Senegal. The University of London has donated a Fabry Perot interferometer and geomagnetic recorder to measure neutral winds in the ionosphere. Due to the political situation in Cote D'Ivoire the national research program has been severely disrupted. There was a coup d'etat in 2002 and rebels have established their headquarters in the building in the northern part of the country which housed the equipment and monitoring station. The building has been vandalized. Efforts are in progress to re-establish the experimental site nearer to the magnetic equator or to the southern part of the country. The university budget for the laboratory is approximately \$6000 per year. The most major impediment to scientific research in the country besides funding could be removed by improving the internet connection. The current Head of State was educated in La Sorbonne University, France and was a history professor at University of Cocody, Cote d'Ivoire. Education and research are relatively important on his agenda for the direction for country but were overcome by events due to an attempted military coup in 2002 which led to a rebellion. The rebels have subsequently refused to disarm as agreed upon, although the government has lived up to its end of the bargain. France, who facilitated the peace agreement and round table negotiations, has suspended their research collaboration to Cote D'Ivoire due to the unstable political situation and protests against them. The main element inciting the protests and demonstrations of the general populace against France has been the fact that a rebel without a primary education (although not picked by France) was appointed as minister of defense and interior affairs as a result of the negotiations. The political crisis has severely disrupted the research program in existence. The laboratory has made its needs known to the prime minister as of 2002 and promises were made with focus on research, however the political situation abruptly degraded between late 2002 to 2003.

Currently, the university faculties in Cote D'Ivoire are on national strike due to inadequate resources allocated to scientific research.

Dr. Dinga Bienvenu, University Marien Ngouabi, Congo Laboratoire Physique Atmosphere, Congo (Brazaville)

Performed his PhD. research on the Congo river

Studied the dynamics of sound in the Congo River. The currents in the river are second in strength in comparison with the Amazon River and in conjunction with submerged obstructions (sand banks) had been the cause of numerous boating accidents. Advised the Congo government based on study of which obstructions to remove from the channel to permit safe navigation. Dr. Dinga is also making measurements for the University of Brazaville on solar radiation. Congo's location with respect to the equator has enabled the measurements which facilitate correlation of the surface radiation to those obtained from satellites. Currently measurements are obtained by pyronometer, which is difficult and cumbersome to use. Currently there is an initiative to determine for a private company the optimal locations for the installation of solar panels. Data obtained from SCINDA is of great benefit for satellite correlation and for physical input of atmospheric conditions.

Overall assessments:

- Government does not usually place emphasis on funding research but supported the Congo River experiment in collaboration with South Africa and the countries bordering the river.
- Congo has not yet collaborated with America or with Europe except for some radiosondes provided to Congo by NASA
- Due to the war in Congo a majority of the experimental equipment has been destroyed, although the university is attempting to procure new equipment. There are also difficulties with the internet capability in Congo.
- Research and collaboration is supported at the university level but not financially.

Dr. Jyoti R. Nair, NC A&T State University, USA

-Originally from Indian Space Research Organization (ISRO), India, now working at NC A&T State University, USA.

-Co-organizer of SCINDA workshop.

-Speciality: Dynamics and Electrodynamics of Magnetosphere/Ionosphere Physics.

- Research Associate at university and helped to develop and promote the space science program, as well developing interest and enthusiasm among the students in the space science/atmospheric science field and outreach programs.

- has obtained grants from Goddard Space Flight Center, NASA, and currently submitted proposals to National Science Foundation (NSF) and Air Force Office of Scientific Research (AFOSR) to get funding in order to sustain the space science program at the University.

-Presently, planning to investigate the dynamics and electrodynamics associated with the earth's Magnetosphere-Ionosphere Physics in collaboration with Dr. Dieter Bilitza,

GSFC, NASA and with Dr. Keith Groves, US Air Force, Boston, USA. Currently, there is no collaborations with European scientists but trying to extend the collaboration with European scientists in future work, especially, related to SCINDA network.

-Completed Ph.D from Space Physics Laboratory, Vikram Sarabhai Space Center, ISRO, India, and during this research (Ph.D) tenure, she utilized ground-based radar systems like VHF, HF, Ionosonde, Magnetometer, MST radar and DE-2 satellite data to investigate the dynamics/electrodynamics associated with the E and F regions of the equatorial Ionosphere in India. She published almost a dozen research papers in peer-reviewed journals (like JGR, GRL, Ann. Geophys., and JASTP) during her Ph.D period. Plan to install ground based instruments like magnetometer and coherent beacon receiver at the present university campus to study the dynamics and electrodynamics of the mid-latitude ionosphere, which plays an important role in the space weather community. Was instrumental in the planning for the SCINDA measurement locations and is interested in extending study of scintillation to the mid-latitudes, including the greater latitudes in Africa, and in the spread of scintillation network.

Dr. Zainol Abidin Abdul Rashid, Malaysia

- Satellite & Mobile Research Laboratory (responsible for developing as a tool for education)
- First degree in electronics from the National University of Malaysia
- Second and doctoral degree from University of Bradford, UK

Studied the influence of ice on satellite signals and developed the first Malaysian microsatellite. One of former students is project manager for a minisatellite to be launched in 2007 by Space-X, owned by a private American company.

Obtained a grant from Malaysian government to develop the laboratory and also developed a beacon receiving system at very low cost. This is the only laboratory in Malaysia devoted to satellite research and currently trains students interested in the space program. Currently has collaboration through Antarctica and New Zealand. No current collaboration with Europe but has established links in Colorado via UNAVCO. Guidance directly from the Prime Minister is to emulate the western scientists, to go where they go and to do what they do.

Jose Pimenta Lima, Cape Verde

- Education/training from the Hydrological/Meteorological Institute of Leningrad (now St. Petersburg) from 1982-1988
- Director of National Institute for Meteorology and Geophysics (INMG)
- Mayor of Sal Island from 2002-2004 and with vast political experience in the municipality and the government, as well as in academia
- Hosted and coordinated the SCINDA workshop from the Cape Verde side
- has made some partnerships with different institutions
- Current proposal to install fiber-optic cables from INMG to Amilcar Cabral Airport: attempting to get funding from NASA

Cape Verde obtained independence from Portugal in 1975 and due to its geographic location along air and shipping routes connecting Africa, Europe, and the Americas is recognized for its global strategic importance. First goal is to improve the facilities which make Cape Verde able to provide the international services that it does and to devote more emphasis toward research and technology. Currently the focus is more operational in nature and the vast part of its GDP is based on tourism and services. INMG provides support for various sectors including marine, tourism, fisheries, agriculture, seismology, aeronautics and radar monitoring, and geophysics. In 1997 and 1998 Cape Verde bought seven weather stations to upgrade the primary network, which prior to that relied on classical systems remaining from the days of independence. The Portuguese took with them all of the operational manuals when they left in 1975 and the technicians today have operated based largely on experience and tribal knowledge. The main domain of international service lies in aviation, atmospheric measurements and in maritime navigation, due in part to the high international demand for geographic crossings of the islands. NEXWOS, the Network of Weather Servicing Systems, was bought in the US and the system can be implemented in Sal and in Sao Vicente islands but not on the remaining 8 islands. The systems in place are too old and some of the facilities are no longer available commercially. Currently they are not able financially to make the upgrade. Another area requiring improvement is in upper air observation. Cape Verde utilizes a software system called ATIR to process data obtained from the radiosondes, launched once per day. The results are sent to WMO global network through Dakar, Senegal, the regional telecommunications center for global observation. Cape Verde is in need of radiosondes and sometimes has had to stop observations due to lack of spare parts. The hydrogen generator is over 20 years old and there is a shortage of sodium hydroxide, a product needed to produce the hydrogen gas. The existing hydrogen generator was obtained from Canada. The difficulties with technology, instrumentation and systems detract from the ability to obtain the best data for observations and research. If they could upgrade these systems and improve the working conditions for the operators it would massively enhance their contribution to the research and development potential in Africa. Cape Verde has an oceanography station in Palmeira port and some collaboration with the University of Hawaii and has also started some dialogue with the US on geological survey to study the haze which originates from the Sahara through Cape Verde and to the Caribbean and its impact on human health, weather and observations, and microbiology on the islands and their ecosystems.

If Cape Verde can expand its collaborations and upgrade its technical support it would be the first very important step to improving its work in the ocean. One problem Cape Verde has experienced over the course of the 19th and 20th century is severe drought which has prompted over half of the native population to emigrate abroad, primarily to the US and to Portugal. An idea being considered is to artificially inseminate clouds to produce rain and experiments will be conducted along these lines in August in collaboration with NASA. There is currently not a system in place for tracking hurricanes and the closest fixed point is in Senegal, 500km away. The radar cannot cover the islands. Cape Verde was represented at a recent hurricane committee meeting for the Caribbean, Central and North America and would like to send some personnel to the hurricane center in Florida for a 1 month training course.

Cape Verde currently has good collaboration with WMO, the Portuguese speaking West African countries and with ECOWAS which has aided to a certain extent in maintaining their technological capabilities. There is a high demand by government, local and overseas organizations for the weather data collected by Cape Verde islands.

Cape Verde, due to its relative lack of natural and indigenous resources, acquires most of the raw materials needed for its industrial development from abroad. The major trading partner is Portugal and second the US.

Cape Verde is currently establishing its university system, which will include an amalgamation of the existing institutes of higher learning on the islands. The previous generation of scientists have been trained mainly in Portugal, the Soviet Union, Cuba, Algeria, France, and Yugoslavia and the current more so in Portugal and in Brazil. Over the few decades since the days of independence, they have returned to develop, expand and broaden the educational and research capabilities of Cape Verde and an increasing number of students are receiving education from the different institutes that provide higher education on the islands. The launching of the university is presently in progress within the government and will centralize the coordination and administration of the different institutes.

Appendix II SCINDA Workshop Application Form

**International Heliophysical Year SCINDA Workshop
hosted at Cape Verde
(10-14 July 2006, Sal, Cape Verde)**

PRELIMINARY APPLICATION FORM

I hereby apply to participate in the SCINDA Workshop on International Heliophysical Year (Nominees should be familiar with the objectives and program topics of the workshop).

A. PERSONAL DATA

1. Family name: _____ First Name: _____
2. Sex (Male/Female): _____ Date of Birth: ____/____/____
Day Month Year
3. Nationality: _____
4. Current title/position: _____
5. Agency/organization: _____
6. Principal functions/duties: _____
7. Official mailing address: _____
City: _____ State: _____ Country: _____
8. Phone: _____ Fax: _____
— Phone: _____ Fax: _____
Email: _____
(Please make sure to double check your phone/fax numbers and E-mail addresses, since these will be principal means to contact you)
9. Contact in case of emergency: Name: _____
Address: _____
Phone: _____ Fax: _____

B. ACADEMIC AND PROFESSIONAL BACKGROUND

10. Your academic background (degrees, where and when obtained, and a description of your fields of study):

11. Your professional experience relevant to this workshop: (please use an additional page if necessary):

12. Provide information on the programmes in your country that could benefit from your participation in this workshop and be explicit in how you will personally contribute to these programmes.

C. HEALTH REQUIREMENTS

13. Life/major health insurance for each selected participant is the responsibility of his/her institution

D. PARTICIPANT PRESENTATIONS

Participants at the workshop have an opportunity to give 15 minutes presentations (to be agreed to with the Workshop Program Committee) on Space Physics or related areas of interest.. If you would like to present a talk, please indicate its title and give a short description of the presentation (you need also to attach your paper (and the abstract of the paper) to this Application Form)

:

E. SITE SPECIFIC INFORMATION

Please provide a specific location where you propose to install the SCINDA GPS sensor system (City, Institute, Building, etc.):

16. Please assess the suitability of this location after reviewing the scintillation system requirements document attached and provide information on the following site characteristics:

17. Does the site offer a climate-controlled environment? Is it secure? Is the site occupied? If so, at what times are personnel present? Who will primarily be responsible for the site and the equipment?

18. Is there access to the roof or other elevated area with a clear view of the sky (no major obstructions)? What length of cable would be required to get from the receiver to the antenna? Will the cables be exposed, on the ground, etc?

19. What type of electrical power is available at the site (e.g, 220V, 50 Hz)? What type of receptacles are used for electrical plugs? Are adapters to US-type plugs readily available?

Is the main electrical source reliable? Are outages frequent, extended, etc?

20. What type of internet connection is available? Is the network reliable? Can you estimate approximate throughput? If no network is available is it possible to obtain a phone line and dial out to an internet service provider? Is it possible to obtain privileges for secure shell (SSH) access into a computer on the network (makes remote system maintenance much easier to perform)?

21. Would the site also accommodate the VHF receiver system and the spaced antenna baseline (50-120 meters in an E-W direction) needed for drift measurements?

22. Please provide any additional comments or questions you might have regarding the siting and set-up of the GPS sensor. The objective is to exchange as much information as possible to insure that relevant siting criteria are satisfied.

23. It would be beneficial if you could provide any schematic drawings or photos of the site where the system will be set up. This will enable us to better assist you with any problems that may arise.

Note: The FULLY COMPLETED Application Form should be forwarded to Dr. Abebe Kebede, North Carolina A&T State University, Physics Department, Greensboro, NC 27411, **no later than 15 May.** To accelerate processing of your application, you may **directly fax** an advance copy to (336) 256-0815, or by Email to gutaye@ncat.edu

Appendix III: Samples of Letters of Invitation

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Appendix IV: Financial Report

Appendix V: SCINDA Workshop in Pictures

