

Centre for Basic Space Science (CBSS), Nsukka,  
National Space Research and Development Agency (NASRDA), Abuja,  
Nigeria.



# Brief Profile

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# NASRDA CENTRE FOR BASIC SPACE SCIENCE (CBSS) , NSUKKA-NIGERIA

## PROFILE

### CBSS Mandate

The Centre for Basic Space Science (CBSS) which is one of the activity centres of the National Space Research and Development Agency (NASRDA) of Nigeria is engaged in the Studies, Research and Development in:

a. Basic Space Science, which comprises:

- i. Astronomy and Astrophysics
- ii. Space weather
- iii. Solar Terrestrial Physics
- iv. Cosmology and Origin of Life
- v. Atmospheric Physics and Geomagnetism
- vi. Rocketry & Satellite Science & Technology

b. Design and fabrication of Basic Space Research Instruments such as Telescopes, Mirror Systems, Antennas, Sensors, Payload Systems, appropriate Software, etc.

### 1. Vision

CBSS is envisioned to play strategic role in the development of Space Science and Technology as a driving force and engine of economic growth and as a major ingredient for human resources and infrastructural development.

### 2. Mission Statement

CBSS mission is to carryout studies, research and development in Basic Space Science, nationally (Nigerian Universities and Research Institutes) and Internationally (other world Space Agencies) for the benefit of Nigeria, Africa and the entire World.

### Brief history of CBSS

The idea of establishing a Centre for Basic Space Science Research and development in Nigeria was catalyzed by the UN Workshops in Basic Space Science which was initiated in 1991. This was followed by a presentation of a paper titled "Basic Space Science and Technology in Nigeria in the 21<sup>st</sup> century, (preparations for a take-off)" by Professor Pius N. Okeke, (FAS) in a public lecture organized by the Nigerian Academy of Science, Lagos, in 1999.



Prof. P.N. Okeke (FAS) delivering speech at the 1<sup>st</sup> UN Workshop in Basic Space Science in India in 1991.



Prof. Hans Haubold who has been in charge of UN outer space affairs, (between 1991-2011) introduced the concept of Basic Space Science and played a great role in the Centre's development.



1<sup>st</sup> UN workshop in 1991 attended by Prof. P.N. Okeke (FAS) which introduced the term "Basic space Science".



1<sup>st</sup> United Nations workshop in Basic Space Science, in Nigeria, 1993.

The term Basic Space Science refers mainly to the following areas of Space Science: Astronomy, Cosmology, Solar-Terrestrial Physics, Ionospheric Physics and the Science of the Earth's Environment. In 1996, Prof. P.N. Okeke was asked by the UN to present a paper on Space Science Research in Africa. In his findings he reported, that after 20 years of individual efforts, Basic Space Science is yet to grow in Africa. He recommended that African Governments should quickly intervene. You may recall that efforts to set up Astronomy Observatory in Nigeria dated back to 1962 when Prof. Gaustard introduced the teaching of Astronomy and Astrophysics, in the University of Nigeria, an effort that was thwarted in 1967 by the Nigerian civil war. At the end of the war, Prof. S.E. Okoye, the first Nigerian Astronomer took over the batten and established a prime Centre for Radio Astronomy in Nsukka, Nigeria, in 1978 to carry out Postgraduate Research in Astronomy and Cosmology. Professor S.E. Okoye then handed the batten to Professor P.N. Okeke who then widened the scope of the Centre to include apart from Radio Astronomy, other areas of Basic Space Science.



Fr. Top left: Tech. Eweni, Prof. P.N. Okeke, late Prof. S.E. Okoye, Prof. Hagis, Engr. N.C. Adibe, (Standing 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> left), Prof. A.A. Ubachukwu (standing 9<sup>th</sup> left) and others with the pioneering 10m Radio Telescope at UNN (1985).

These efforts prompted the Federal Government of Nigeria while establishing the National Space Research and Development Agency (NASRDA) in 2001 to recognize a Centre for Basic Space Science as one of the developmental Centres of NASRDA.

### COMMISSIONING OF THE CENTRE FOR BASIC SPACE SCIENCE, NSUKKA.

(i) CBSS was commissioned on behalf by Prof. Borofice on behalf of the honourable minister with a National Workshop on July, 12<sup>th</sup> 2004.



CBSS opening ceremony invitation card.



The then V.C. UNN, Prof. C.O. Nebo, the then DG NASRDA, Prof. R.A. Borofice (OON) and other dignitaries during the opening ceremony of the National workshop and commissioning of CBSS.



The then DG of NASRDA Prof. R.A. Borofice (OON), cutting the opening tape while the then VC UNN, Prof. C.O. Nebo looks on, during the commissioning of CBSS in July, 2004.



The Director CBSS Prof. P.N. Okeke (FAS), posing with the picture of the proposed 25m Nigerian Radio Telescope.

## CBSS RESEARCH FACILITIES AND PROJECTS

### (1) Atmospheric Science Research

#### Research team

Prof. P.N. Okeke (FAS), Prof. F.E. Opara (FAS), Prof. Mrs. F.N. okeke (FAS), Dr. B.G. Ayantunji, Engr. Inwelegbu J.O., Esther Hanson, Engr. Lanre Daniyan, Najib Yusuf

#### (i) The NECOP (Nigerian Environmental & Climatic Observing Programme)

The NECOP (Nigerian Environmental & Climatic Observing Programme) instrument is a solar powered real-time Wireless Network of Meteorological and Climate observing stations located across Nigeria (based on a Campbell wireless telemetry instrument; with 5mins update cycle), measuring: Air temperature, Relative Humidity, Solar Radiation, Wind Speed, Wind Direction, Atmospheric Pressure, Precipitation, Soil Temperature And Soil Water Content. Currently there are 16 NECOP stations spread across the country.

#### Contents of Research:

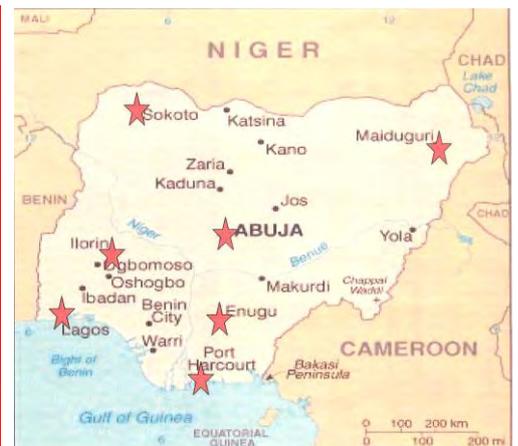
- 1) Real time meteorological and climatological forecasting
- 2) Warning tool by decision makers involved in management of Meteorological and Climatological hazards.
- 3) Educational training tool for students in all levels of study.



The NECOP instrument.



A NECOP station.



Nigeria NECOP Network distribution

#### (ii) Microwave Propagation project

The Davis vantage II instrument is used for microwave propagation study. It combines rain sensor, UV sensor, solar radiation sensor, temperature and humidity sensors and anemometer (integrated sensor suite – ISS) to study:

#### Contents of research:

- 1) The Radio Refractivity and it's effects on Radio Communication Systems.
- 2) Rain attenuation and its effect on Satellite Communication.
- 3) Development of Radio Refractivity Distribution Map, Rain Attenuation Map and other information necessary for effective Radio Communication planning in Nigeria.



Davis instrument for Atmospheric data collection. Provision of mast for installation of instruments at varying heights.

### (iii) The Micro rain radar (MRR) project

#### Contents of research:

- Vertical Profiles of Rain Fall Rate.
- Drop Size Distribution with a high spatial (~30 m) and temporal (~10 s) resolution.
- Rain Attenuation study.



MRR Antenna.

The MRR installation team and MRR instrument room at CBSS.

### (iv) Fluxgate Magnetometer project

The Fluxgate magnetometer instrument is one of the major instruments used at CBSS and it collects data for:

- Geomagnetic study
- Magnetic Field Variation along the surface of the earth.
- Mineral investigation, Petroleum and Gas exploring.
- Archaeological investigation.
- Hydrological survey.
- Pipeline Survey.
- Environment Disaster Monitoring.
- Ferromagnetic body detecting.



The Fluxgate Magnetometer.

**(v) SID Monitor project**

The CBSS SID project is a part of an international network station for data collection to monitor solar flares.

**Contents of research:**

- Monitoring Sudden Ionospheric Disturbances (SID) (solar flares, Lightning, Corona Mass Ejection (CME) ) and other dangerous solar events.
- Study of the effects of SIDs on our communication equipment and day to day solar activities.



SID monitor Receiver and CPU



SID monitor VHF loop Antenna.



Solar power backup for SID.

While carrying out Ionospheric research, CBSS designed and fabricated a cheap and effective SID monitor.



Cheap and effective SID monitor fabricated by CBSS Engineers

## (vi) SCINDA/GPS Receiver project

The CBSS SCINDA/GPS system is an internet protocol online-based data collection project contributing to the worldwide GPS scintillation intensity and total electron content (TEC) data for ionospheric research. This project is installed in collaboration with the USA air force research laboratory.

### Contents of research:

- Satellite Navigation and Positioning.
- Earth's Plate Tectonic movement.
- Geodetic Mapping.
- Ionospheric Scintillation.
- Structure and Dynamics of the Ionosphere.
- Total Electron Content of the Ionosphere.
- Electron Density Profiles.
- Space Weather Modelling and Prediction.



GPS Antenna and Solar power backup.

GPS Receiver and CPU.

## (2) Astronomy Research

### (i.) Optical Astronomy

#### Research team:

Prof. P.N. Okeke (FAS), Prof. F.E. Opara, Dr. F.B. Sigalo, Ofordum N., Sudum Esaewi

#### Contents of Research:

- Night Sky observations and Astrophotography.
- NASRDA/CBSS Moon Sighting Programme.
- Space Science Popularization.



Optical Telescope Dome by CBSS.

25cm Meade LX200GPS inside the Dome.

CCD Camera incorporated in the Telescope

## Observation of 2006 Total Solar Eclipse in Nigeria and creation of National awareness.



Total Solar Eclipse image from our Telescope.



CBSS Total Solar Eclipse observation group.

### (ii) Radio Astronomy: The proposed 25m Nigerian Radio Telescope (NRT) project

One of the major recommendations

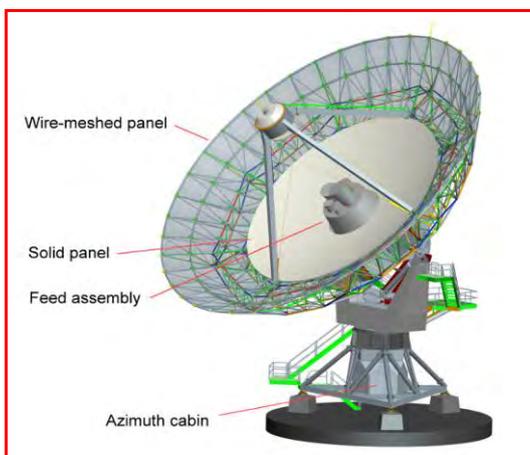
#### Radio Astronomy research team

Prof. P.N. Okeke (FAS), Prof. F.E. Opara, Dr. F.B. Sigalo, Engr. Inwelegbu J.O., B.I. Okere, Ofordum C.N. Engr. Omowa Edward, Engr. Seye Adedoja, Ike obi, Daniel okoh

#### Contents of Research:

The 25m NRT is under construction by China in collaboration with our Engineers. When completed and installed in Nigeria, the 25m NRT will be used for frontline research in:

- Radio Pulsars.
- Radio Spectroscopy.
- Planetary Science.
- Very Long Baseline Interferometry (VLBI) experiments.
- Space Geodesy Programmes.
- Ground station for VLBI Networks- eg: the Japanese VSOP2.
- Monitoring Nigerian Space.



The proposed 25m NRT.



The 25m NRT control room.

The feasibility study of the radio quietness of the site where the 25m Radio Telescope will be installed was carried out using Aronia Spectrum Analyser. This instrument is also being used in the measurement of base antenna radiation.

### **The 3m Small Radio Telescope (SRT) project**

In preparation for the installation of the 25m radio telescope, CBSS has successfully assembled and installed a 3m Radio Telescope for capacity building, astronomy education and astronomy popularization.



inspecting assembly of the 3m SRT, while some staff looks on. Frontend: 3m parabolic dish antenna and feed.



3m SRT CPU, rotator controller and receiver.

The 3m SRT instrument is used for:

- Capacity building for 25m NRT.
- Learning Radio Telescope operations, control and observations.
- Space Science Popularization.

### **The Radio Jove Project**

Also in her effort to enhance astronomy education, CBSS has installed a Radio Jove for Jupiter monitoring.



Radio Jove Antenna Array at CBSS



The 20.1 MHz Radio Jove Receiver room

The Radio Jove instrument is used for:

- Observing Jupiter and the Sun.
- Educational Tool and Space Science Popularization.

### (3) Near Earth Object (NEO) research

#### Research team:

Prof. P.N. okeke (FAS), Engr. Inwelegbu J.O., Okere B.I., Dr. B.G. Ayantunji, Engr. Daniyan Lanre, Ofordum N. Najib Yusuf, Ike obi, Engr. Nasiru Aliyu, Sudum Esaewi

**Collection and analysis of Meteorites which landed in different parts of Nigeria.**



Pictures of Meteorites that fell in the Northern parts of Nigeria collected and analysed by CBSS staff.

### (4) Basic Space Science Instrumentation and ICT/Software research

#### Research team

Engr. Inwelegbu J.O., Nkiru Iloanusi, Engr. Daniyan Lanre, Engr. Omowa Edward, Engr. Nasiru Aliyu, Musa Ibrahim Engr. Seye Adedoja, Engr. Dare Odeyemi, Engr. Gayus Ishaku

#### Instrumentation/ICT research contents:

- Fundamental study of electromagnetic interactions in atmosphere and ionosphere;
- Radio propagation theory and experimental study of electromagnetic fields in conducting media (space plasma and ground);

- Development of advanced sensors and systems for measuring the parameters of physical fields and data collection and processing for space industry, atmospheric and geophysical applications.

The instrumentation/ICT research department of CBSS carries out the design and fabrication of Basic Space research Instruments such as Telescopes, Mirror Systems, Antennas, Sensors, Payload Systems and appropriate Software according to our mandates. Some of the mechanical fabrication machinery includes power saw, arc welding machine, drill press, electric filing machine, etc.



Mechanical machines, tools and equipment.

### Instrumentation Research Spinoffs

#### (i) NECOP Spinoff Services.

(a) CBSS has been able to develop an efficient Car Tracking/Human Tracking System while working with Wireless Telemetry Environmental and Climatic Real Time Monitoring Station Networks.



CBSS Car Tracker System.

(b) The wireless telemetry data collection technology can be adapted to other scientific equipment with standard RS232 interface.

#### (ii) Solar terrestrial physics research Spinoff

While studying solar variability CBSS has perfected the technology of providing cheap but effective Photovoltaic (PV) Solar power for scientific instruments, offices and homes.

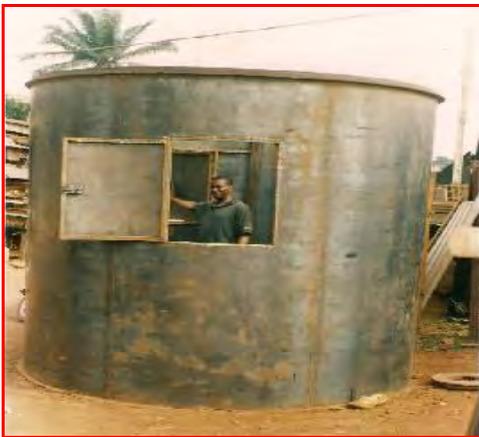


Home 1.5 KVA Solar PV Inverter.



Solar PV Inverter for Scientific Instrumentation.

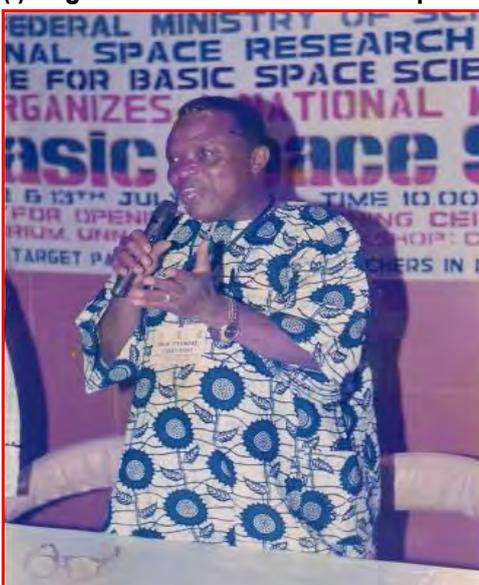
### (iii) Optical Telescope research spinoff



Optical Telescope Dome designed and constructed by CBSS Engineers with 25cm Meade LX200GPS OT inside the Dome.

### Workshops and Seminars.

#### (i) Organized a National Workshop to mark the Commissioning Ceremony of CBSS in 2004.



The Director CBSS Prof. P.N. Okeke(FAS) delivering welcome address at the workshop, while participants look on.

**(ii.) Organized CBSS/UNESCO Space Education Seminar in May, 2005.**



Launch of Air Rocket during the CBSS/UNESCO 2005 Space Education Seminar.



The Director CBSS Prof. P.N. Okeke (FAS) receiving optical telescope donation from UNESCO officials in 2005.

**(iii) Space Science Popularisation Programme in Minna, Niger State.**



The Director CBSS Prof. P.N. Okeke (FAS) in a group photograph with undergraduate students of FUT Minna, after a Science popularization programme.



The director Prof. P.N. Okeke (FAS) in a group photograph with secondary school students of Minna-Niger State.

**(iv.) Hosted IHY African Regional International School at Enugu in 2008.**



Participants at IHY African Regional International School Enugu in 2008.



Participants at IHY African Regional International School Enugu in 2008.

**(v.) Space Science Popularisation Programme in Enugu 2010.**



Participants at Space Science Popularization program in Enugu 2010.

**(vi.) Workshop on African participation in IHY at Abuja in 2010.**



Participants at Workshop on African Participation in IHY at Abuja in 2010.

**(vii.) Workshop on Space Science Popularization at Abuja in 2010.**



The Director CBSS Prof. P.N. Okeke (FAS) delivering opening speech, and participants at Workshop on Space Science popularization July, 2010.

**(Viii) Oct. 2011 UN/Nigeria/NASA/ESA/JAXA Workshop on International Space Weather Initiative (ISWI).**



From left: Prof. Hans Haubold, DG. NASRDA, Chairman Senate Committee on ST, Prof. Borofice; Conference delegates in a group photograph.



Prof. Hans Houbold conferred with the title “The Moon of Africa”; CBSS receives ISWI regional office status.

**CBSS designed and deployed a dynamic and database-driven Website for ISWI 2011.**



ISWI 2011 website @ <http://www.iswinigeria.org.ng/>

CBSS website @ <http://www.cbssonline.com>

**(ix.) Organized Astronomy Workshop in conjunction with Space Generation Advisory Council (SGAC).**



The Director CBSS Prof. P.N. Okeke (FAS) and other participants listening at the SGAC workshop.



CBSS staff during the CBSS/SGAC Astronomy workshop.

**(x.) Publication of Nigeria Journal of Space Research (NJSR) and CBSS Newsletter.**

CBSS has published over ten volumes of the NJSR.



CBSS NJSR.

CBSS Newsletter.

**(xi) Development of CBSS permanent site**



Permanent Site inspection by Chinese Collaborators.

A section of the permanent site.

**(xii) Astronomy for the Public/Schools**

**The 4D2U Planetarium science popularization instrument.**

CBSS is involved in astronomy for the public using the 4D2U planetarium donated by National Astronomical Observatory of Japan (NAOJ). Also, Galileoscopes and David Levy-Comet Hunter optical telescopes are being used for primary and secondary school popularization.



4D2U Planetarium in a Space Science Popularization session at CBSS Observatory.



Primary school pupils queued up to observe through the Comet-Hunter optical telescope.

Section of Primary School Pupils in group photograph at the event.

### (xiii.) Manpower Development Training



CBSS Staff on Radio Telescope Training at NAOJ in 2006, SAAO Cape-Town in 2006, and Urumqi Astronomical Observatory (UAO) in 2010.

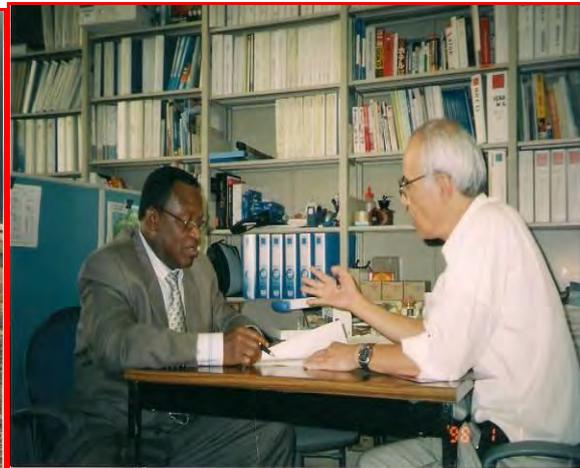
### International research Collaborations

CBSS has signed MOU with several international institutions in various research areas. These Collaborators include:

- (i) University of Delaware, USA.
- (ii) Harvard-Smithsonian Centre for Astrophysics.
- (iii) National Astronomical Observatory of Japan (NAOJ).
- (iv) HartRao Radio Observatory South-Africa.
- (v) Stanford University, Ireland.
- (vi) Boston College Dublin.
- (vii) South African Astronomical Observatory (SAAO), Cape Town.
- (viii) Urumqi Astronomical Observatory, China (UAO).
- (ix) Ethiopian Space Science Society (ESSS).
- (x) Nanjing Institute of Astronomical Optics and Technology (NIAOT), China.
- (xi) USA Airforce Research Laboratory.



NAOJ experts on a collaborative visit to Nigeria in 2005.



NAOJ Radio Telescope expert Prof. N. Kawaguchi, discusses with Prof. P.N. Okeke (FAS) on the 25m NRT in 2005.

## **Future Direction.**

CBSS is working towards achieving the following in nearby future to be able to offer service to the following sectors of the economy:

- (i) Transportation: Our weather data is very important for efficient management of the transport industry which comprises air, land and maritime.
- (ii) Agriculture: Data and results from our research is employed to enhance agricultural productivity and food security.
- (iii) Tourism: Apart from our weather results boosting tourist industry, various meteorites and space debris at CBSS can also serve as tourist attraction.
- (iv) Telecommunication and Broadcast: our radio propagation study will enhance the quality of our telecommunication and broadcasting industry.
- (v) Construction: Data on weather vagaries and tectonic stability will enhance the construction industry.
- (vi) Oil and gas: research results from CBSS will enhance the oil and gas industry more especially in the area of environmental protection.
- (vii) Power and Energy: The solar and wind energy budget is very essential for the development of alternative energy source across Nigeria.
- (viii) Defence: The precision of military target is very important and our research result will help in this area.
- (ix) Internal security: GPS tracking system develop by CBSS engineers will greatly help in enhancing internal security.
- (x) Disaster management and prevention: Our NECOP project was specifically conceived for this purpose.
- (xi) Our 25m Telescope will be installed and made functional by the end of 2012 and this will attract a large number of international collaborative projects, and in addition will generate incredible spin offs and manpower and physical developments.
- (xii) The centre is also assisting and playing advisory roles in other NASRDA centres such as Satellite Science, high altitude Sounding Rocket research, as well as in the Centre for Geodesy and Geodynamics.
- (xiii) With the present position of the Director as the President of African Astronomical Society (AFAS), it is expected that CBSS will play a leading role in the development of Astronomy not only in Nigeria but Africa in general.
- (xiv) Equatorial Electrojet studies using an array of magnetometers.
- (xv) Saharan Aerosols and pollution studies in Nigeria.
- (xvi) Participation in the study of Near Earth objects.
- (xvii) Low atmosphere investigation using unmanned aerial vehicles (UAV) and balloons.
- (xviii) Cosmic ray measurements and Neutron monitors.