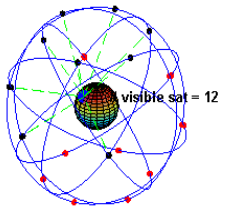
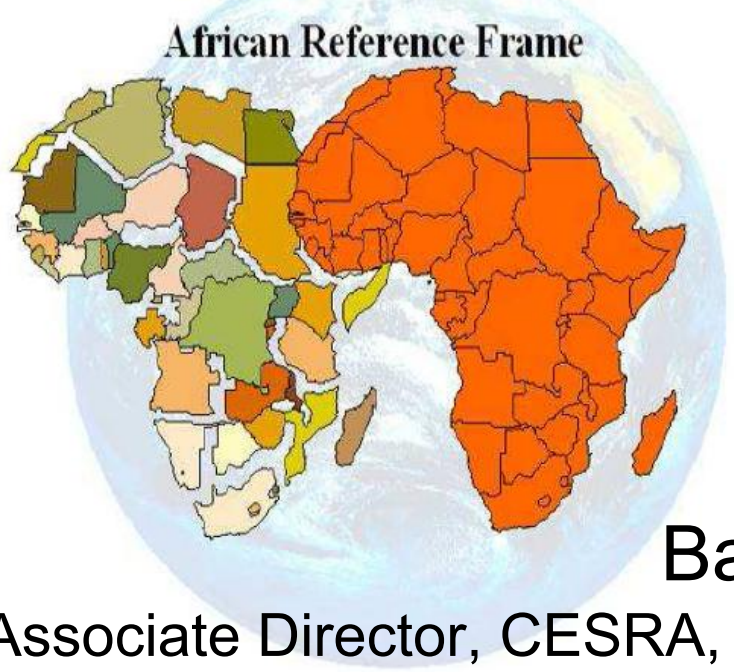
CESRA

Centre for Space Research and Applications



Briefs on AFREF



Babatunde RABIU

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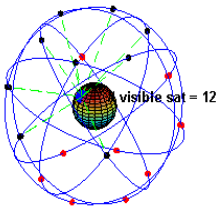
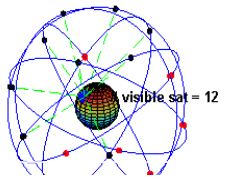
Email: tunderabiu@yahoo.com



Outline

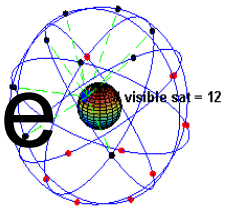
- About Africa
- AFREF
- Status quo
- Potentials of AFREF
- Ionospheric Studies Using SCINDA GPS



Africa !

- A continent
- 54 individual nations
- Multi-lingual structure
- English, French, Portuguese, Arabic, Spanish
- ~ 30 billion km^2
- ~ 850 million people
- ~14% of the World population

The African Geodetic Reference Frame AFREF



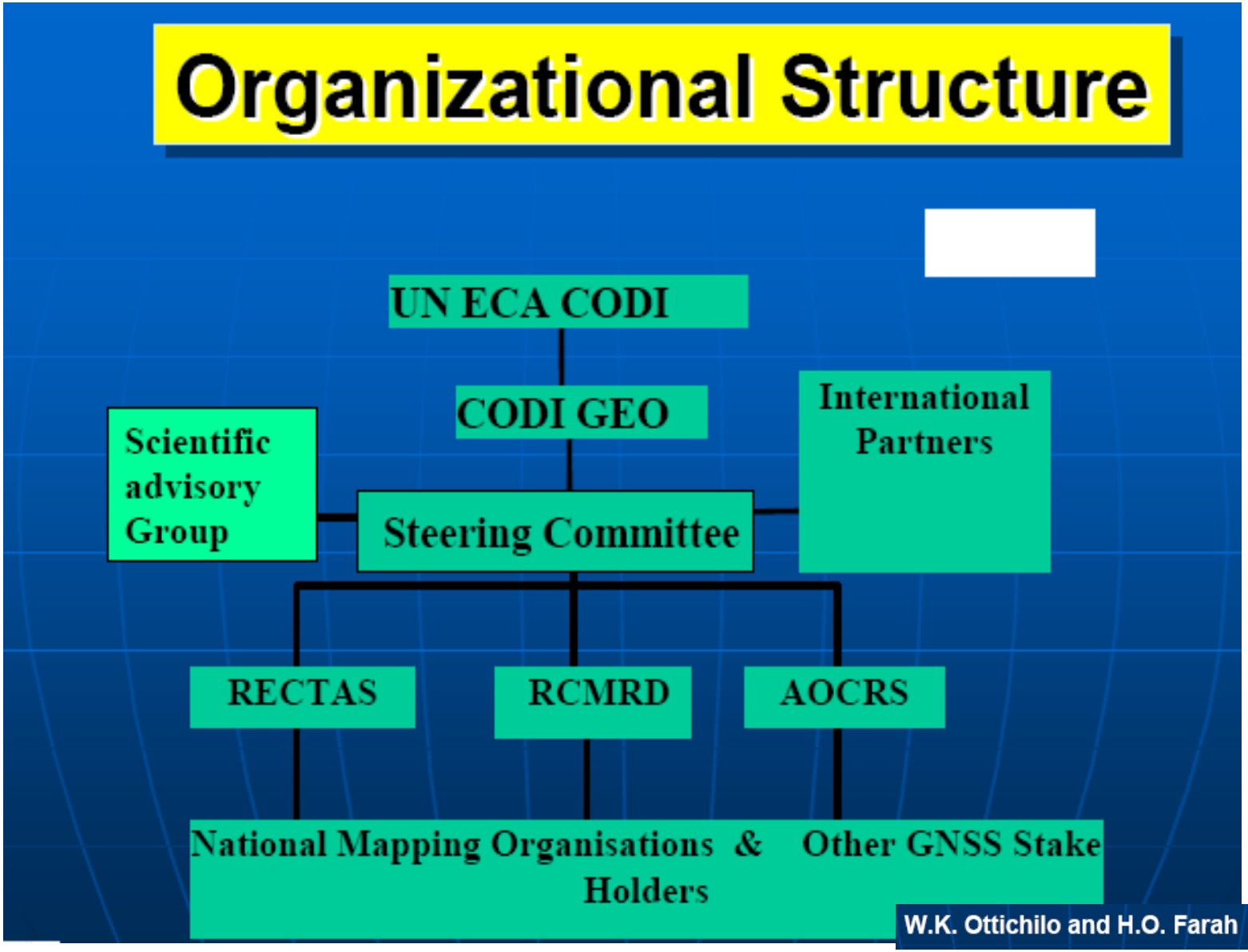
- a unified geodetic reference frame for Africa
- fundamental basis for the national & regional three-dimensional reference networks
- fully consistent and homogeneous with the International

  Terrestrial Reference Frame ITRF
- Densification of GNSS networks with its products in Africa
- Full implementation will include a unified vertical datum and support for efforts to establish a precise African geoid

http://geoinfo.uneca.org/afref/

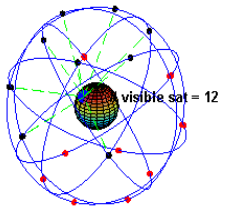
Organisational Structure of AFREF

Organizational Structure



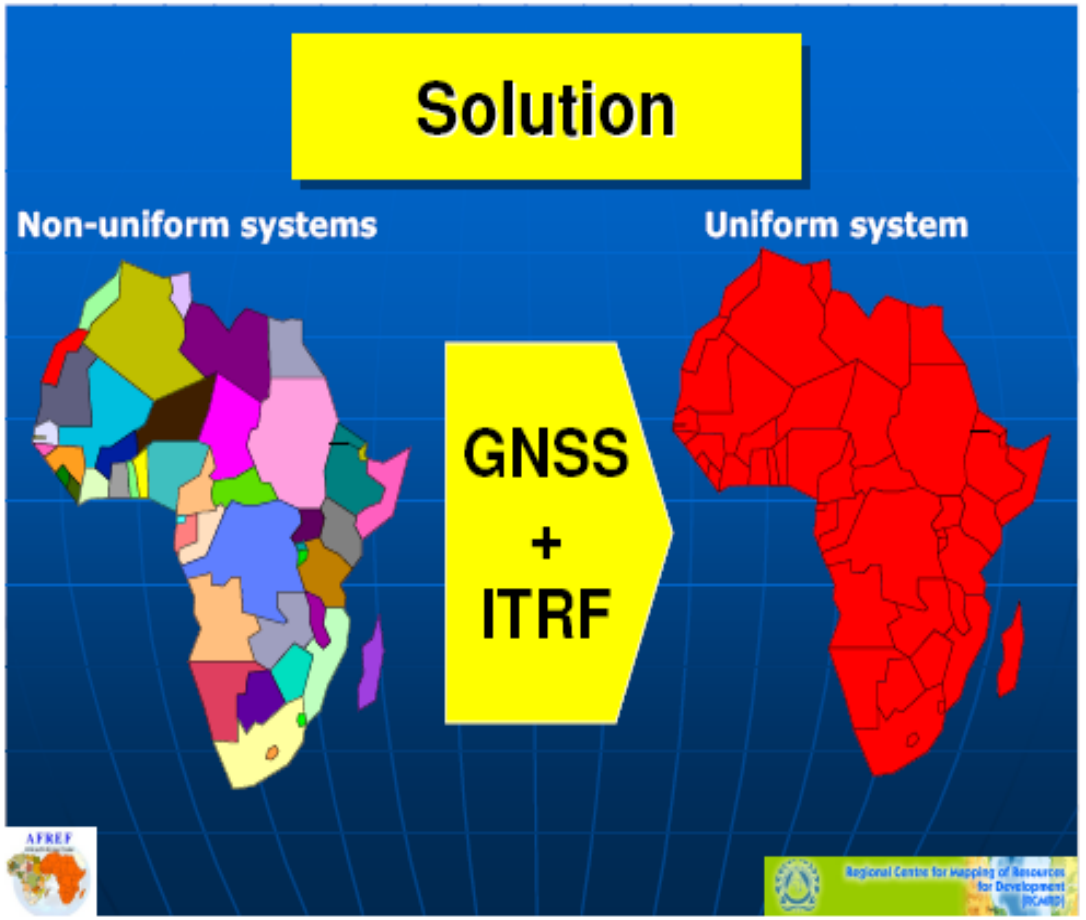
W.K. Ottichilo and H.O. Farah

AFREF: African solution

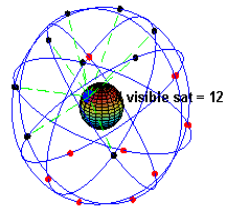


- ✓ each African country has its national geodetic reference system for producing maps and other geoinformation products - some countries even have more than one
- ✓ representation of cross-border features on maps cannot be done accurately
- ✓ For example, roads, watershed and ecosystem boundaries and wildlife reserves appear disconnected when national maps are joined together for regional planning and decision analysis
- ✓ Work on large infrastructure projects is normally undertaken in sections
- ✓ a uniform mapping surface is required to ensure that the sections join up.
- ✓ To unify the reference systems, parameters of the best fitting surface for map projections need to be determined and used by all countries.

Reducing 54 Reference frames to 1

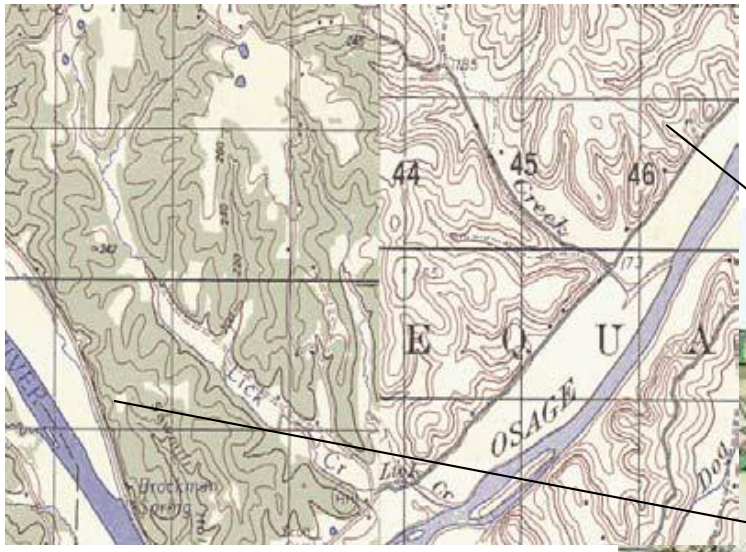


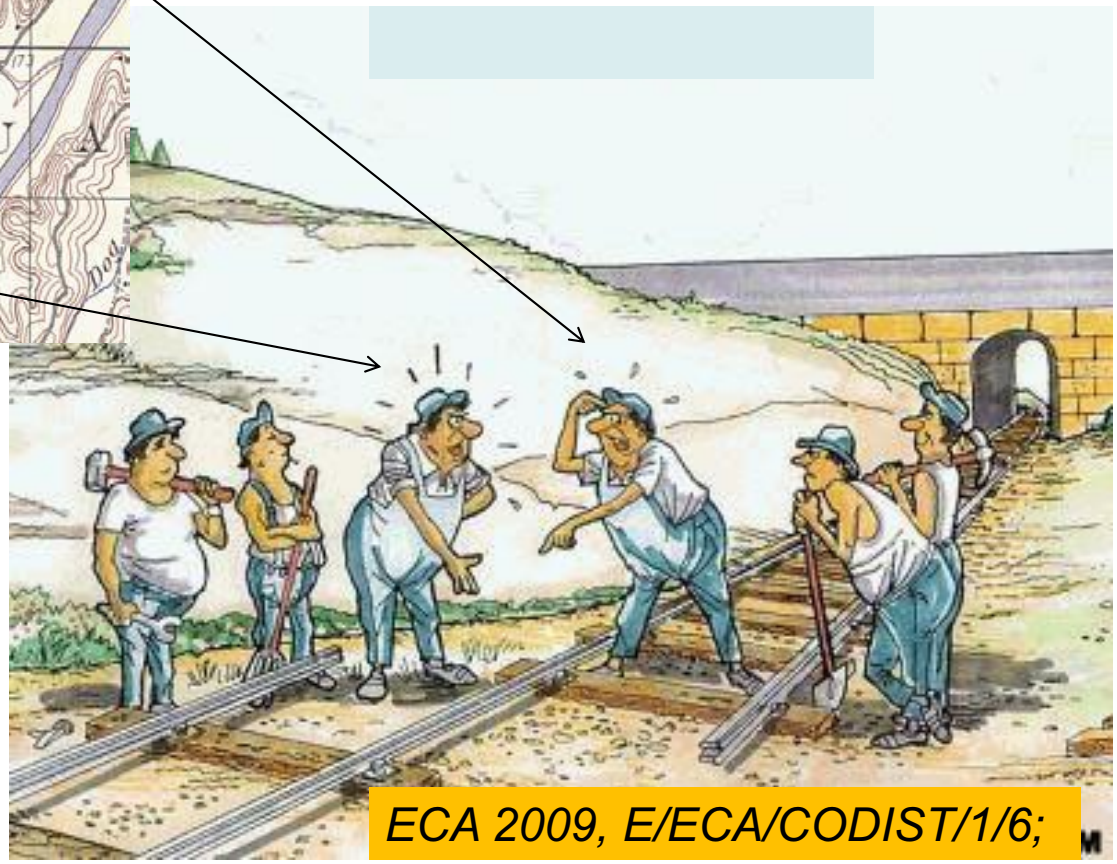
Combrinck (AFREF Presentation Berlin GNSS 2008)



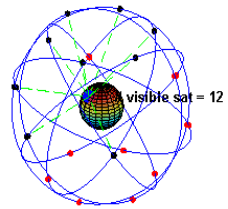
Consequences of using reference systems that are not consistent !

Products of incoherent maps - confusion



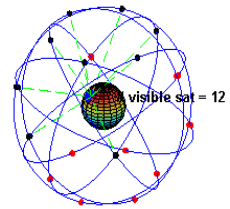


ECA 2009, E/ECA/CODIST/1/6;

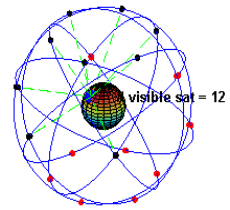


Strategy

- Densification of GNSS CORS
- Central processing of data



Status Quo

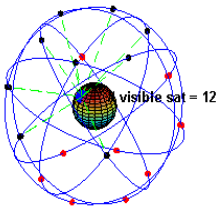


status

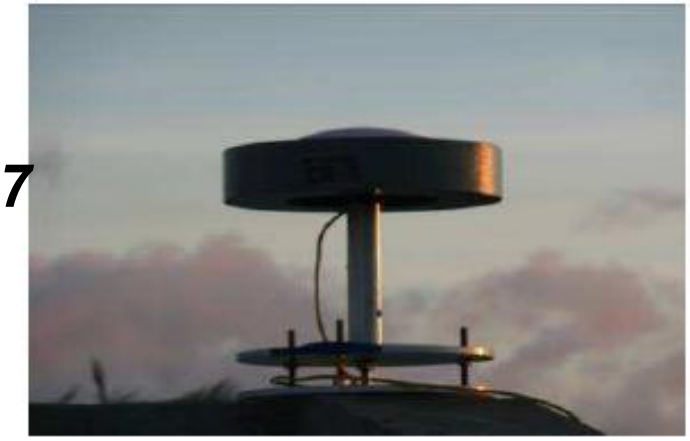
- More than 5 countries have established a network of CORS
  - Ghana
  - Tanzania
  - South Africa
  - Nigeria
  - Egypt
  - (???)

- About 20 countries now have at least one CORS

A typical AFREF CORS

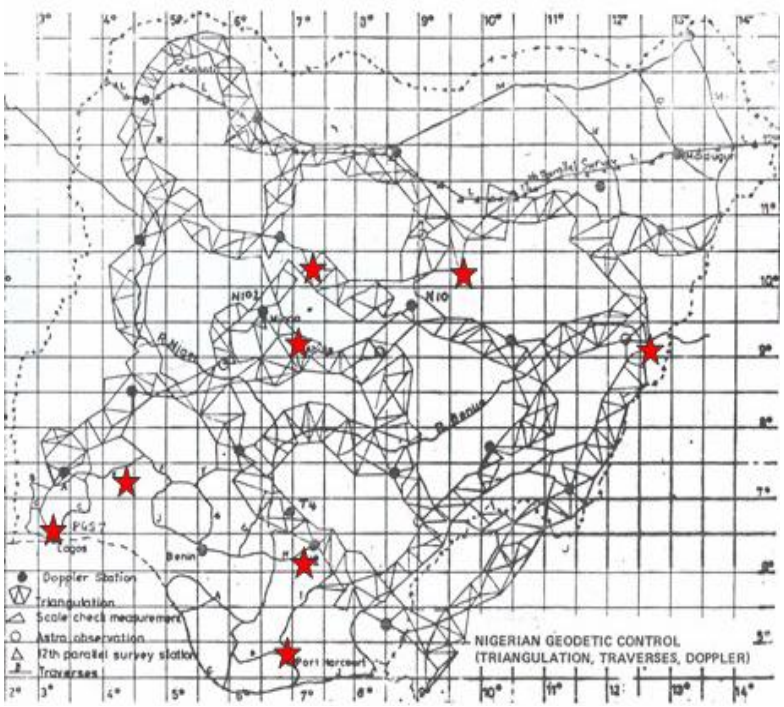


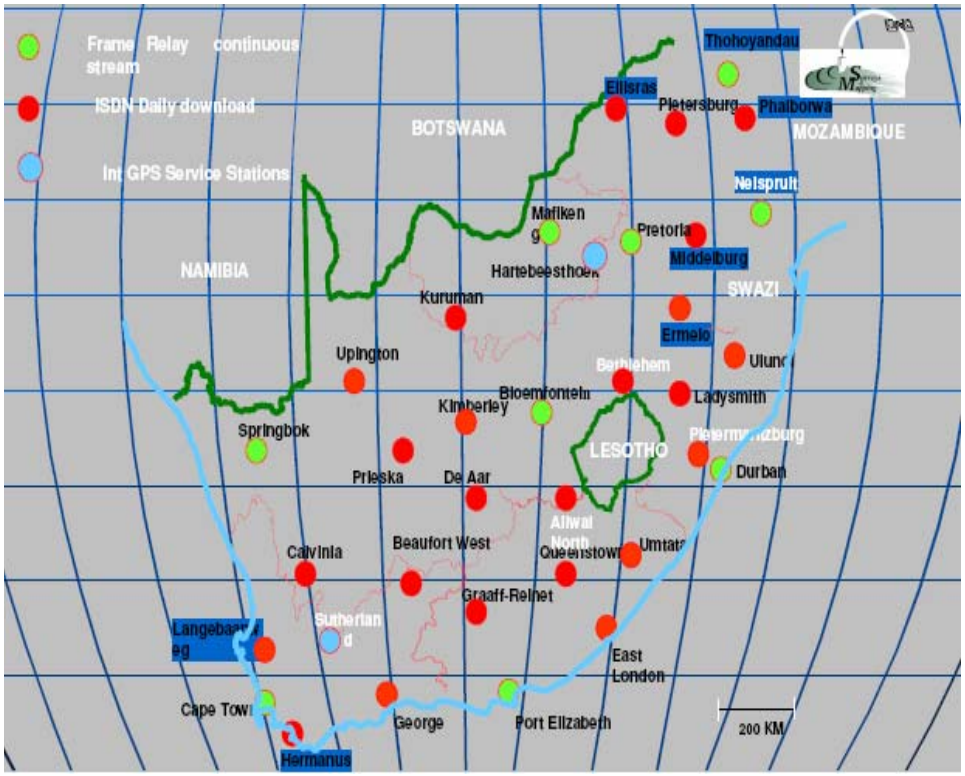
Pemba, Mozambique
Established: 08th November 2007



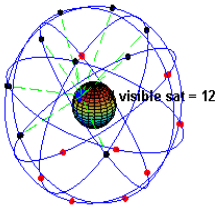
Courtesy: Fernandez 2007.

Densification of National networks





Ottichilo and Farah

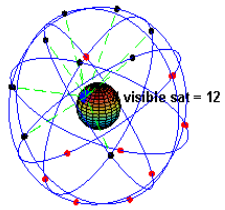


NIGNET: NIGerian GNSS Reference NETwork

- ✓ Promoted by OSGoF (Office of the Surveyor General of the Federation)
- ✓ to implement a new reference frame for Nigeria in line with the recommendation of the United Nation Economic commission of Africa (UNECA) through its Committee on Development, Information Science & Technology (CODIST).
- ✓ The installation is being done in collaboration with SEGAL, a collaborative project between University of Beira Interior and Institute Geophysical Infante D. Luíz in Portugal.
- ✓ The core of NIGNET is formed by a network of GNSS CORS
- ✓ NIGNET will contribute to ITRS through AFREF

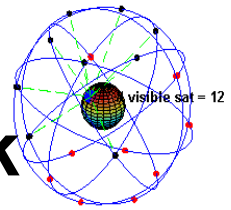
(Jatau et al, 2010, Sydney, Australia)

1st AFREF Stakeholders Forum



- ✓ on 26th September 2007 in Abuja, Nigeria
- ✓ Nigeria constitutes 25% of African Population.
- ✓ organized by the Office of the Surveyor General of the Federation (OSGOF)
- ✓ More than 100 stakeholders took part in the forum.
- ✓ Nigerian Institution of Surveyors (NIS)
- ✓ Surveyors Council of Nigeria (SURCON)
- ✓ States Surveyors-General, National Inland Waterways Authority (NIWA)
- ✓ Nigeria Association of Geodesy (NAG), the Armed Forces
- ✓ the Academia, Aviation industry, National Universities Commission,
- ✓ National Space Research and Development Agency
- ✓ (NASRDA), Regional Centre for Training in Aerospace Surveys (RECTAS)
- ✓ Chevron Nigeria Ltd, Shell Petroleum Development Company and other private sector organization.

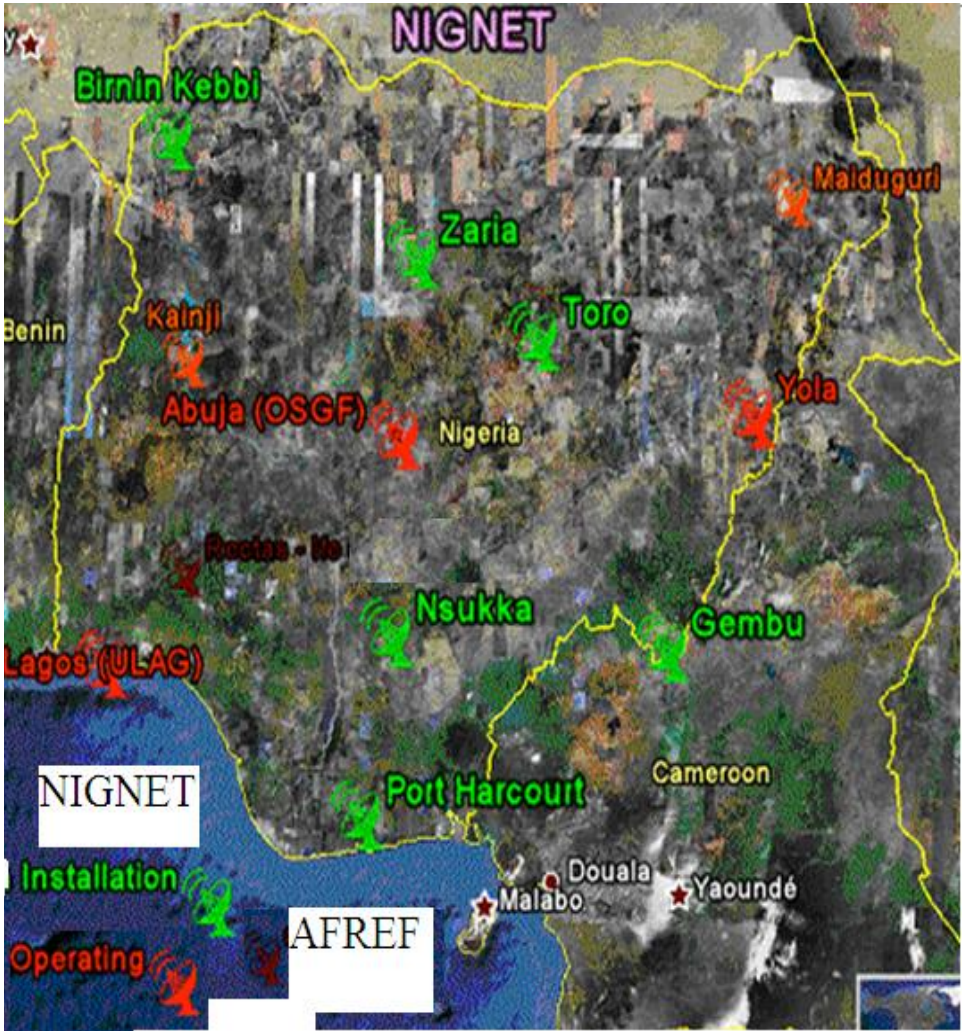
Benefits of Good national geodetic network



- ✓ Provides foundation for all geo-referencing activities.
- ✓ It is the base for coherent multipurpose Land Information System (cadastre) and its subsequent maintenance.
- ✓ positioning services,
- ✓ surveying & mapping,
- ✓ Community-Boundary mapping
- ✓ food security, disaster management,
- ✓ air, land & sea navigation,
- ✓ Effective land administration, registration & taxation
- ✓ emergency response, management of resources
- ✓ promotion of Good Governance
- ✓ revenue planning and collection.
- ✓ Checkmating corrupt practices

Chronology of Nigerian Reference Frame

- ✓ The first geodetic surveys of Nigeria were performed by the British Royal Engineers in 1910-1912
- ✓ Observation of existing geodetic networks (horizontal and vertical networks) started in the late 1920's
- ✓ Most of the network was materialized between the late 1940's and early 1960's
- ✓ OSGoF - the National Mapping Agency of Nigeria, initiated NIGNET in 2008

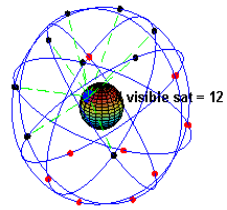


(Jatau et al, 2010, Sydney, Australia)

NIGNET

- **Top – OSGF station installed at OSGoF headquarters, Abuja**
- **Middle – UNILAG station installed at the campus of University of Lagos.**
- **Bottom Left –FUTY station installed at Federal University of Technology of Yola**
- **Bottom Right - location at Toro.**

(Jatau et al, 2010, Sydney, Australia)

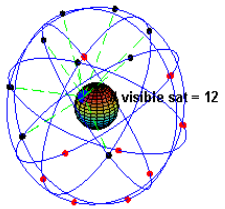


NIGNET Equipment & Operations

- NIGNET is served by state-of-art geodetic equipment, namely the latest version of Trimble CORS stations, NetR8 with Choke-ring antennas.
- The complete system is composed of the receiver/antenna plus a USB modem (the communications with the Centre of Control will be done using the GSM cellular network), a router (to manage the communications), and a solar panel system (the systems are completely independent of the national electricity grid).
- The optimization of the power consumption was a priority in the design of the system. The solar panels have 160W of power (charging a battery with 100AH) that permit to support consumptions up to 20W for an expected constant consumption of 11W.

(Jatau et al, 2010, Sydney, Australia)

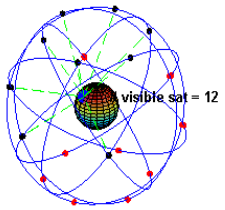
NIGNET equipment and operations



- located at Universities and Research Centers in order to also link NIGNET to the scientific community and foster the use of this network by more applications
- The NIGNET network is being installed with capabilities to support RTK positioning, both in single and network modes.
- The data from the permanent stations will be collected at a central station in Abuja where corrective data for the location of rover stations will be computed and will be provided to the users.

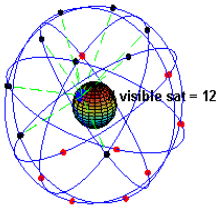
(Jatau et al, 2010)

NASRDA GNSS program



- ✓ The National Space Research and Development Agency (NASRDA) is a research & development institution established in May, 1999
- ✓ Mission - to vigorously pursue the development and application of space science and technology for the socio-economic development and enhancement of the quality of life of Nigerian people
- ✓ NARSDA is at moment collaborating with OSGoF to densify the GNSS CORS in Nigeria.
- ✓ More CORS will be installed by the end of 2010
- ✓ The target is 200 CORS (Personal Communination with SGoF, 2010)

Capabilities of AFREF (Combrinck, 2008)

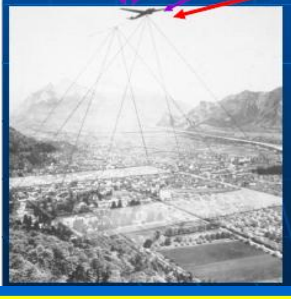


Applications in Land Surveys

AFREF Base Station

Applications in Mapping

Real time Differential corrections will improve GPS solutions for Mapping



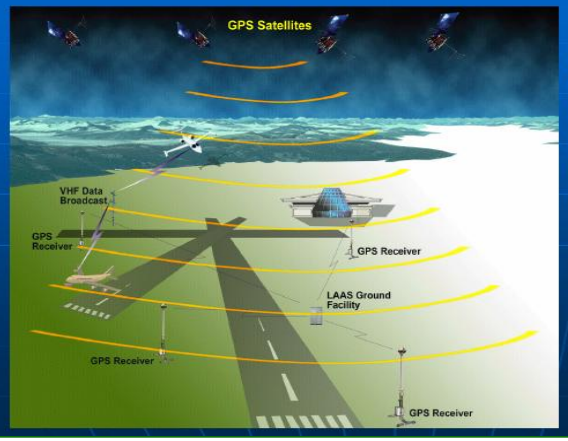
AFREF Base Station

Will provide Ground control for Mapping

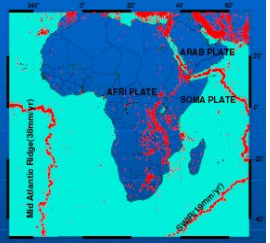
Applications in Water Navigation

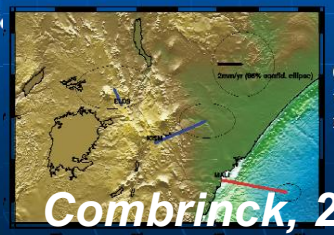
Real time Differential corrections will improv
GPS accuracy and precise docking

Applications in Air Navigati



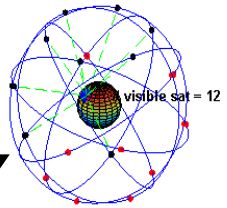
Applications in Crustal dynamics





GPS data from AFREF base stations will be used to continuously monitor earth crustal movements.

Combrinck, 2008, Berlin



International Heliophysical Year IHY

- A major program, which has facilitated increase of stations that can serve as CORS in Africa in recent time
- IHY activity has increased the CORS in Africa by more than 12

✓***Nairobi***

✓***Lagos***

✓***Addis Ababa***

✓***Sal, Cape Verde***

✓***Thika***

✓***Kampala***

www.ihy2007.org

✓***Abidjan***

✓***Akure***

✓***Ilorin***

✓***Lusaka***

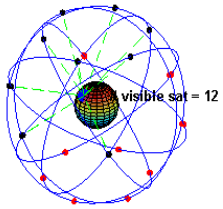
✓***Nsukka***

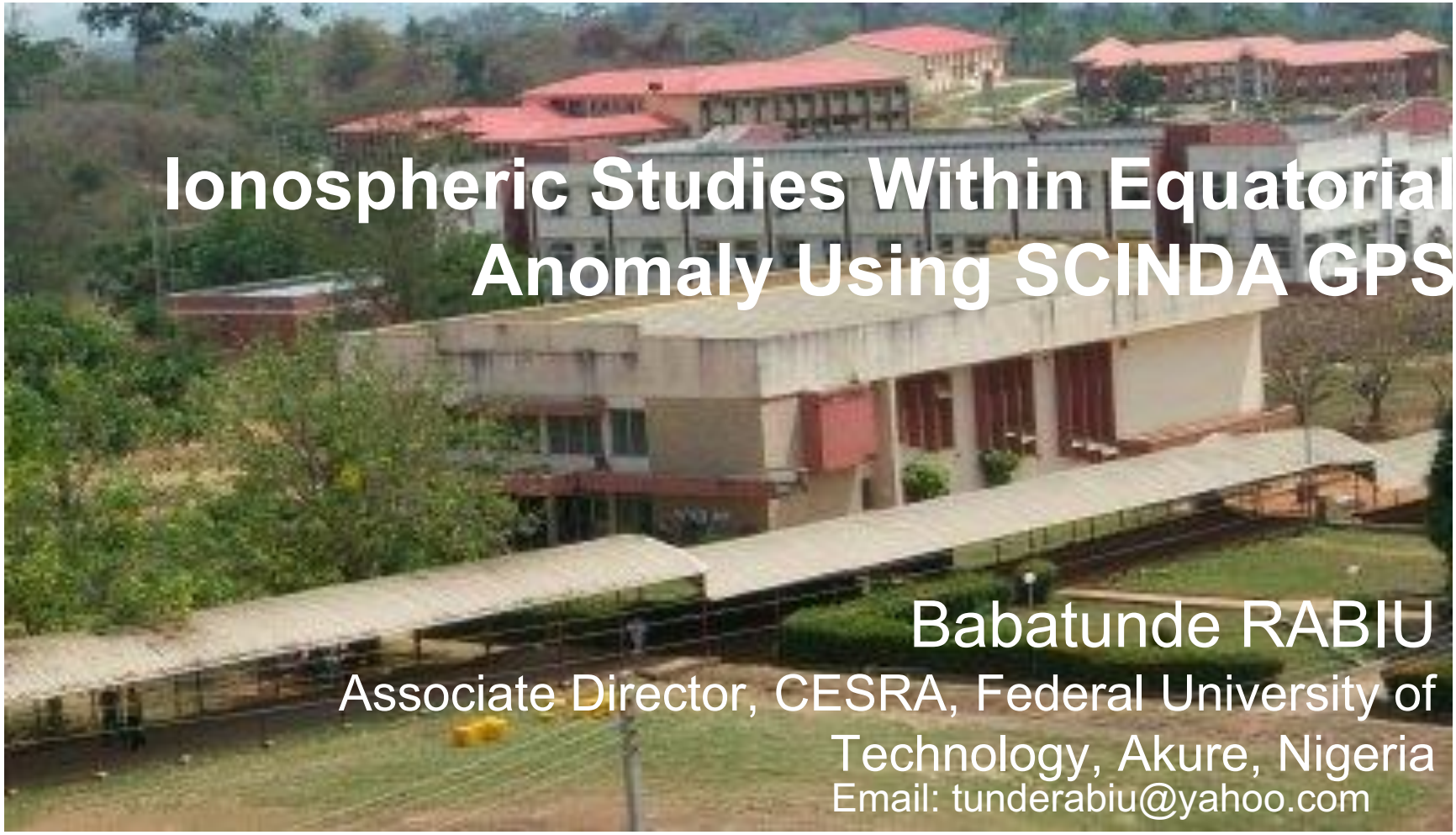
✓***Cairo***

✓***???***

CESRA

Centre for Space Research and Applications





Ionospheric Studies Within Equatorial Anomaly Using SCINDA GPS

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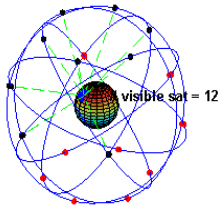
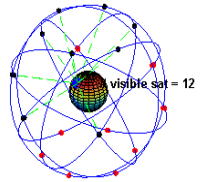
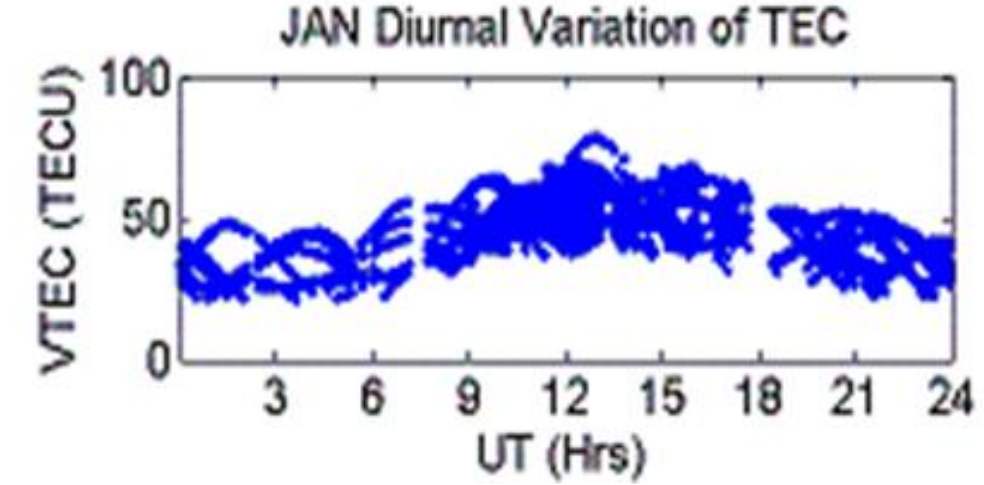
Email: tunderabiu@yahoo.com

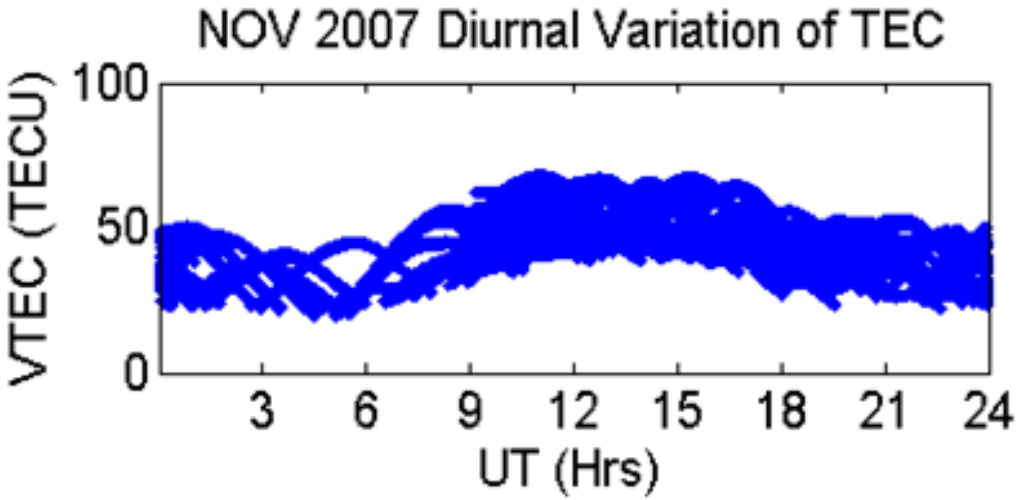


SCINDA facility at Akure, Nigeria

Mass plots of the Diurnal Variation of VTEC as observed from the data from all the visible PRN over Akure



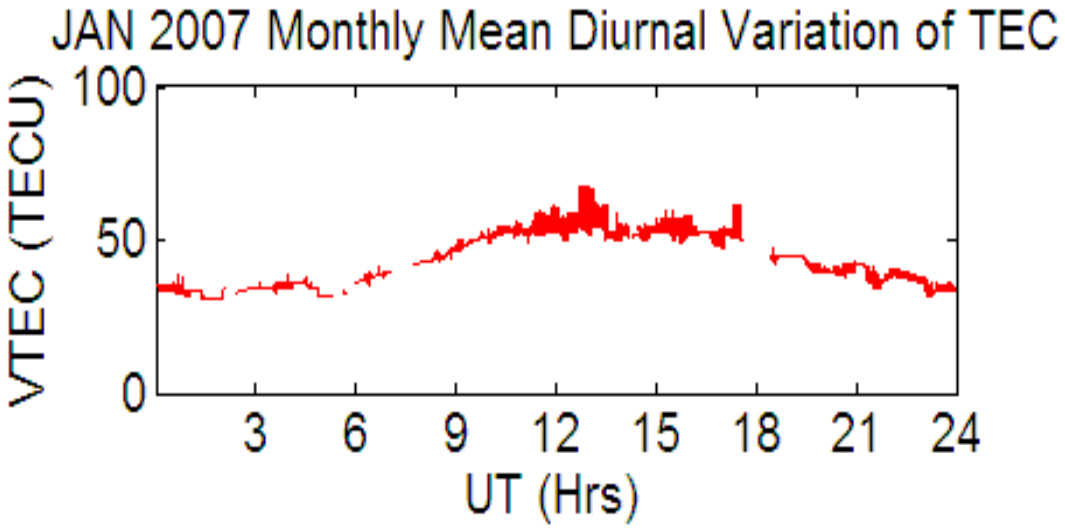


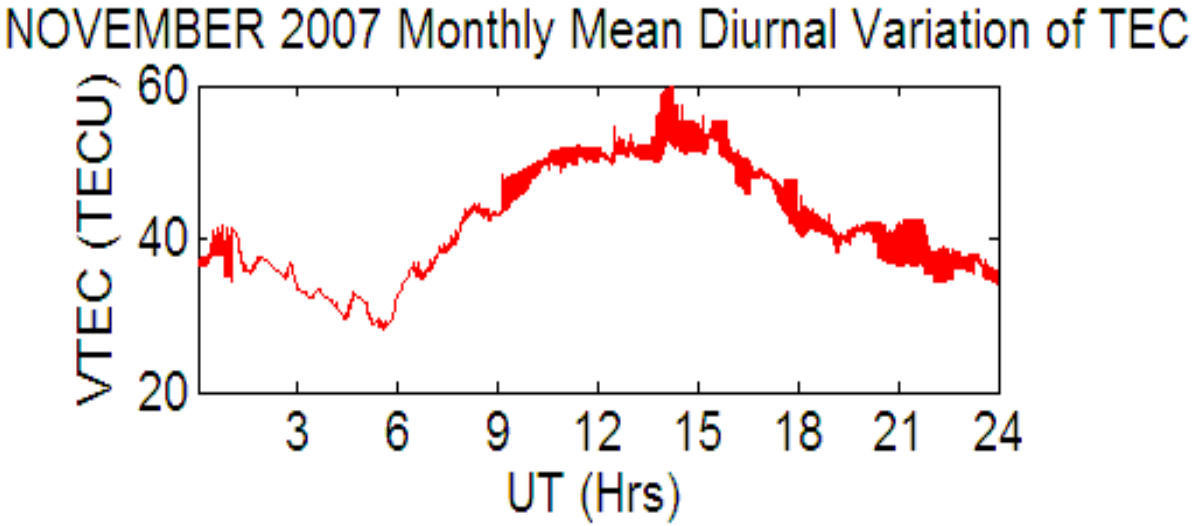


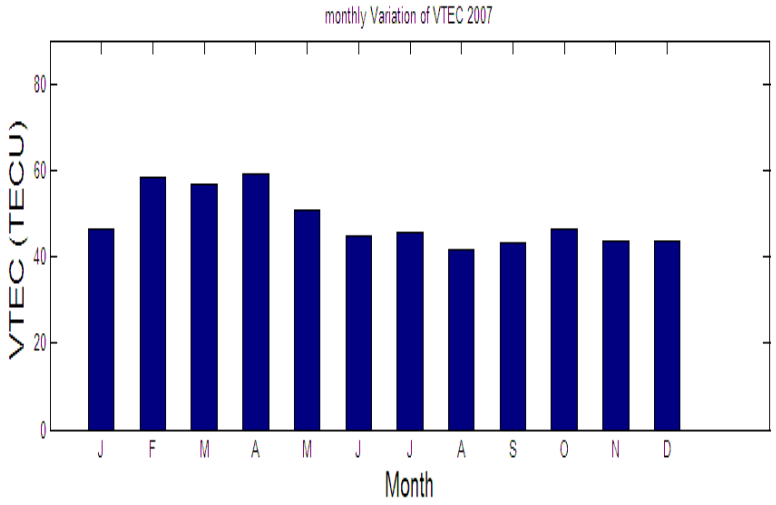
Diurnal Variation of VTEC over Akure

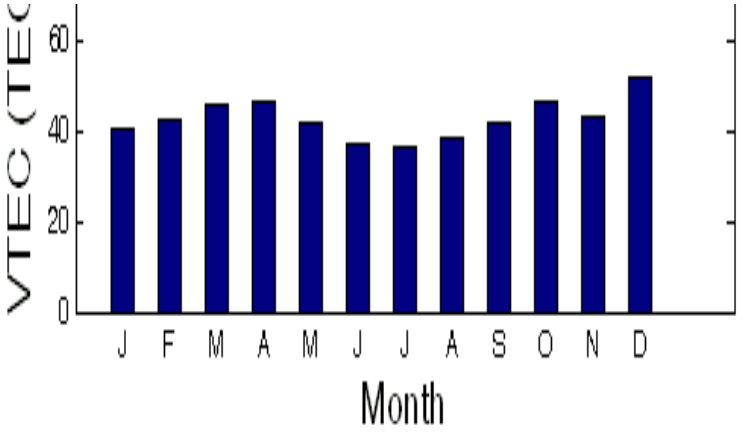
✓*pre-dawn minimum for a short period of time followed by steep early morning increase.*

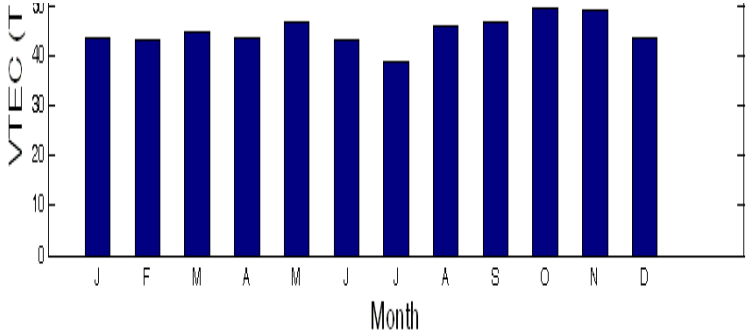
✓*TEC reaches maximum value between 1300UT (1400LT) & 1400UT (1500LT)*

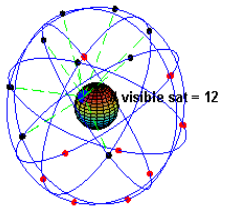






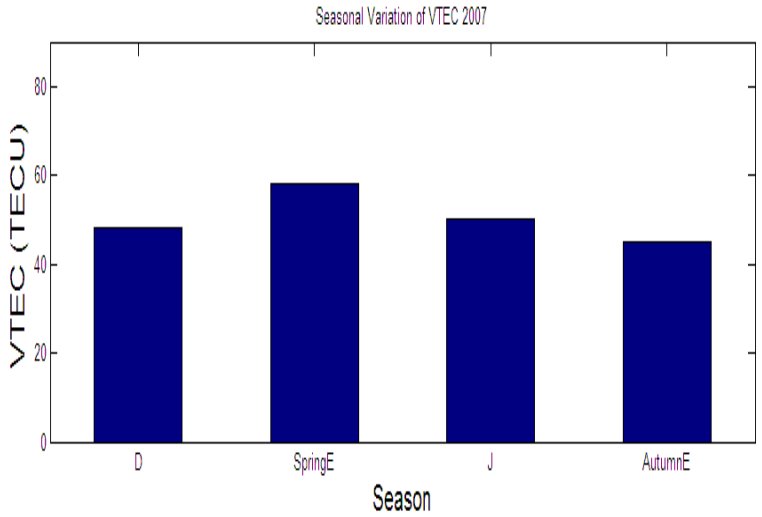


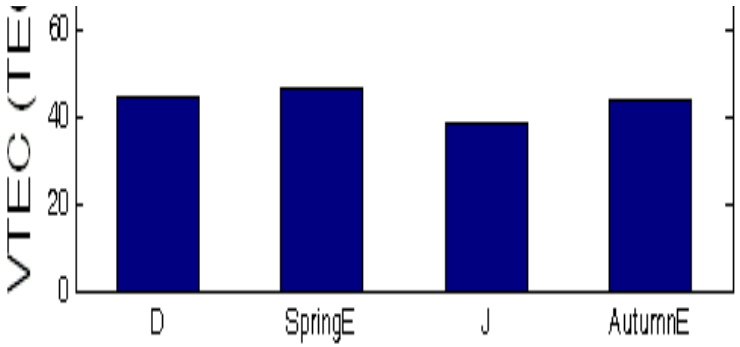


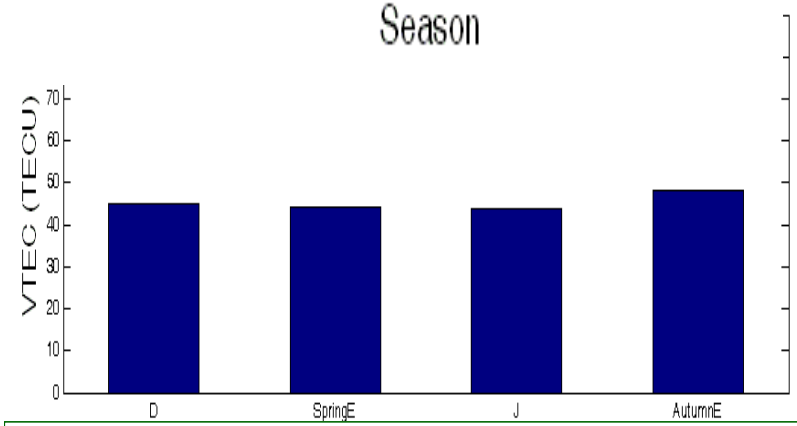


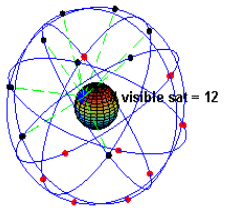
Monthly variation of TEC

- **TEC maximizes during Equinoctial months and minimizes during winter months**
- **intermediate values during summer months**
- **The average values for TEC in 2007, 2008 and 2009 are respectively 48.34, 42.89 and 45.64 TECU.**



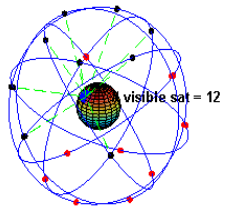






Seasonal variation of TEC

- **The semiannual variation of TEC is asymmetry with maximum in spring Equinox.**

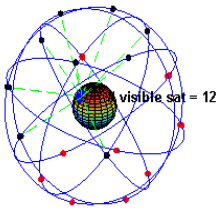


Concluding Note

If you want to go quickly go alone;

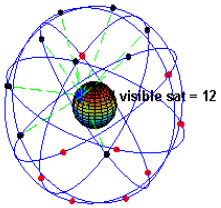
If you want to go far go with someone

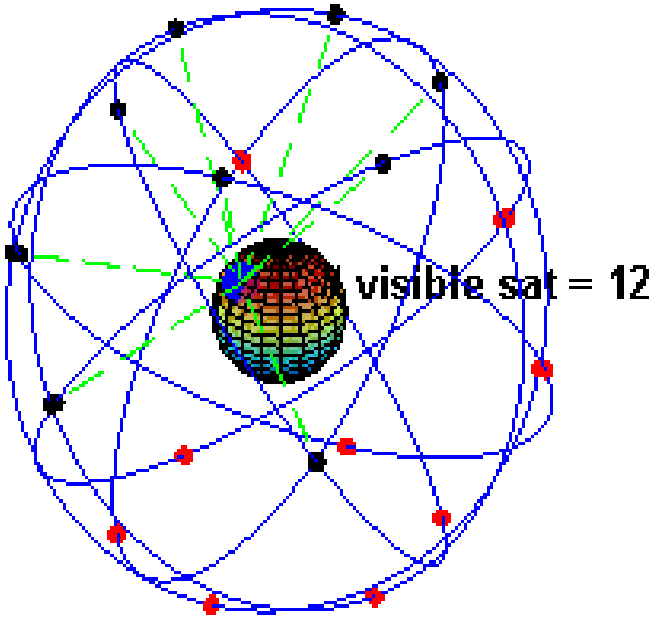
A Chinese Adage



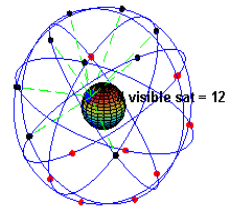
Acknowledgements

- Boston College
- Abdus Salam ICTP
- United Nations office for Outer Space Affairs UNOOSA, Vienna, Austria





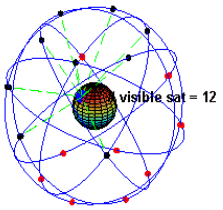
Thank You



A new approach …

R & D Approach

- **Intensify complimentary efforts at densifying the GNSS ground infrastructures**
- **University based National GNSS Network**
- **Continental GNSS Network**

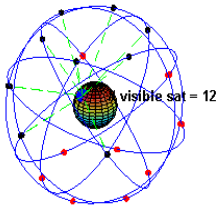


Mega-solution to Regional mega-problems

GNSS products are capable of

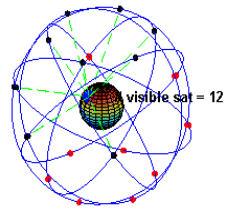
- producing good governance
- inhibits corruption
- create job opportunities
- advance wealth creation
- promote quality of living
- Secure society
- provide platform for sustainable manpower and economic development

U.S. Supports AFREF Development



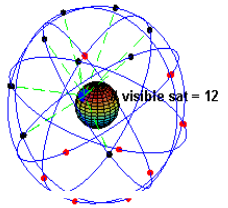
- AFREF is an African initiative
- ICG Working Group D addresses reference frame issues, including AFREF
- In 2008 through the UN Office for Outer Space Affairs (UNOOSA)/ICG, the U.S. facilitated the travel of twenty Africans to an AFREF workshop at the Africa Array Conference held at the University of Witwatersrand, Johannesburg, RSA
- U.S. plans to continue to support AFREF development through Africa Array, the UNOOSA and other existing international initiatives

Ray Clore, 3rd International Satellite Navigation Forum, Moscow, Russia, May 12-13, 2009.

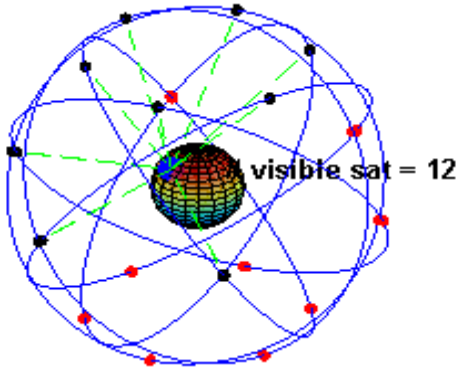


- ITRS (International Terrestrial Reference System) using the latest realization (currently

Benefits of IHY



Capacity Building in GNSS



- Knowledge & technological transfer
- International collaboration
- Availability of teaching & research facilities
- internationally competitive research
- Windows of postgraduate opportunities
- Control of brain drain
- Development of Research in BSS
- intra–continental partnerships